# *Signa® MR/i with Signa Select™ (ASP2) Learning and Reference Guide Volume 1: Beginning MR Imaging*

*2292261-100 Rev. 0 (03/01)*

# Medical Device Directive

These products conform with the requirements of council directive 93/42/EEC concerning medical devices, when they bear the following CE Mark of Conformity:

CE 0459

This equipment generates, uses, and can radiate radio frequency energy. The equipment may cause radio frequency interference with other medical and non-medical devices and radio communications. To provide reasonable protection against such interference, the:

GE Signa MR/*i* Systems

comply with emissions limits for (Group 2, Class A) Medical Devices as stated in EN 60601-1-2. However, there is no guarantee that interference will not occur in a particular installation.

If this equipment is found to cause interference (which may be determined by turning the equipment on and off), the user (or qualified service personnel) should attempt to correct the problem by one or more of the following measure(s):

- reorient or relocate the affected device(s);
- increase the separation between the equipment and the affected device;
- power the equipment from a source different from that of the affected device; and/or
- consult the point of purchase or service representative for further suggestions.

The manufacturer is not responsible for any interference caused by using interconnect cables that are not recommended or by unauthorized changes or modifications to this equipment. Unauthorized changes or modifications could void the user’s authority to operate the equipment.

Do not use devices that transmit RF Signals (**cellular phones**, transceivers, or radio controlled products) in the vicinity of this equipment as they may cause performance outside the published specifications. Keep the power to these types of devices turned off when near this equipment.

The medical staff in charge of this equipment is required to instruct technicians, patients, and other people who may be around this equipment to fully comply with the above requirement.

Immunity/Emissions Exceptions: Note the exceptions from the EMC test results. Check with the business EMC engineer for this information.

In accordance with the international safety standard IEC 601-1, this system is a Class I device, acceptable for Continous Operation, having ordinary protection against ingress of water with type B applied parts and is not for use in the presence of flammable anesthetics.

**CAUTION: User to call or contact the local authorities for disposal of the MR System at the end of its useful life.**

# Table of Contents

# About This Guide

## Introduction

This section explains the purpose and design of the Learning and Reference Guide. It provides the information necessary to understand the layout of the material in this guide.

### Purpose of This Guide

**Where Am I?**

This guide is written for health care professionals (namely, the MR technologist) to provide the necessary information relating to the proper operation of this scanner. The guide is intended to teach you the scanner components and features necessary to use it to its maximum potential. It is not intended to teach magnetic resonance imaging or to make any type of clinical diagnosis.

This guide should be kept with the equipment at all times. It is important for you to periodically review the procedures and safety precautions. **It is important for you to read and understand the contents of this guide before attempting to use this product.**

### Prerequisite Skills

Since this guide is not intended to teach magnetic resonance imaging, it is necessary for you to have sufficient knowledge to pass the ARRT Magnetic Resonance Imaging Examination. This knowledge is gained through a variety of educational methods including clinical working experience, hospital based programs, and as part of many college and university Radiologic Technology programs.

## How The Guide is Organized

This guide contains four volumes with chapters within each part covering a multitude of topics. The current section, About This Users Guide, is an introduction to the manual providing information on the purpose, prerequisite skills, manual organization, chapter format, and graphic conventions, which identifies the visual symbols used throughout the manual.

- **Volume 1: Beginning MR Imaging**
  - Chapter 1, Working Safely, provides information about safety features of the scanner. This chapter should be reviewed prior to all other chapters.
  - Chapter 2, Getting Started and Basic Problem Resolutions, provides information regarding the system components, interface, startup and shutdown procedures, and mouse basics. It is essential to review this chapter along with chapter one before moving on to the other sections, as it provides the necessary information on the system components and interface that the other sections will refer to.
  - Chapters 3-11, provides an introduction to scanning, as well as coil selection/positioning, building and saving protocols, and scheduling/entering patient information. These chapters also provide information regarding scanning with a protocol, optimization of image quality with pre-scanning, displaying, filming and managing images.
- **Volume 2: Concepts of Specific Pulse Sequences**
  - This volume provides information of pulse sequences that may be available on your LX Scanner. It is essential to review this chapter prior to developing any site original protocols, as it provides the necessary information on pulse sequence compatibility with imaging options and contrast producing information.
- **Volume 3: Optimizing Images with Imaging Options**
  - Chapter 1, Improving Image Quality, provides the necessary information to use various imaging options to control artifacts, enhance resolution, contrast as well as minimize motion.
  - Chapter 2, Gating and Triggering, provides the necessary information to safely use gating and triggering methods when scanning. It is essential to read this

chapter before attempting any gating/triggering procedures.

  - Chapter 3, Triggering CEMRA with SmartPrep, provides the necessary information to set up and scan using the SmartPrep option.
  - Chapter 4, Bolus Chasing with SmartStep, provides the necessary information to set up and scan using the SmartStep option.
  - Chapter 5, Imaging Real-time with iDrive, provides the necessary information to set up and scan using the iDrive option.

- **Volume 4: Post-Processing and Analysis**
  - Chapter 1, Sharpening and Smoothing Images with ClariView, provides information on how to use the ClariView filtration option.
  - Chapter 2, Editing Patient Information, provides the steps necessary to successfully edit patient information after the patient has already been scanned.
  - Chapter 3, Adding and Subtraction Images, provides the steps necessary to add or subtract images that have already been scanned.
  - Chapter 4, Defining a Region of Interest with MIROI, provides information on how to use the MIROI option.
  - Chapter 5, Creating Vascular Projections-IVI, provides the necessary information on how to create and manipulate MRA vascular images.
  - Chapter 6, Reformatting Images, provides the necessary information on how to create and manipulate reformat images.
  - Chapter 7, Analyzing Images with FuncTool, provides the necessary information on the use of the FuncTool post-processing option.

# Chapter Format

Each chapter contains a consistent format. This consistency provides uniformity for content delivery and a better learning environment for you. Listed below are the components for each chapter.

## Introduction

The **Introduction** provides a short introduction to the chapter and a list of tasks to be presented. There are pre-questions related to the concepts and tasks of the chapter. These pre-questions will help you think about the concepts and tasks as you go through a particular chapter and to help reinforce the learning of the material covered.

## About...

The **About...** section lists and explains concepts necessary to perform the tasks within the chapter.

## How To...

The **How Do I...** section provides the detailed steps necessary to complete a given task. These detailed steps not only provide the steps to complete a task, but also provide additional information, as needed, related to a step.

On the first page of each task, there is an **In Brief** table in the outer margin. The **In Brief** table is intended to be used as a quick reference and provides only the steps necessary to complete a task.

## Graphic Conventions and Legend

The format of the page is such that you have room in the outer margin to make notes as needed, except in the area where the **In Brief** table is located in the **How Do I...** section. Table About-1 describes the terminology used for the various mouse functions. Table About-2 describes the conventions used when working with menus, buttons, text boxes and keyboard keys.

**Table About-1** Conventions for mouse actions

| Mouse Action | Description |
|---|---|
| Click | Clicking the left mouse button to select a button or icon. The button can be pressed in, not pressed in, or popped in/out. |
| Right-click | Clicking the right mouse button. |
| Middle-click | Clicking the middle mouse button. |
| Click and drag | Clicking and holding the left mouse button down while dragging the cursor to the desired location. |
| Right-click and drag | Clicking and holding the right mouse button down while dragging the cursor to the desired location. |
| Middle-click and drag | Clicking and holding the middle mouse button down while dragging the cursor to the desired location. |
| Double-click | Clicking the left mouse button twice in rapid succession. |
| Triple-click | Clicking the left mouse button three times in rapid succession. |

**Table About-2** Conventions for menus, buttons, text boxes, and keyboard keys

| Example | Describes |
|---|---|
| Select | Selecting an option in a check box or radial button and selecting a tab. |
| Press **Enter** | Pressing a hard key on the keyboard. |
| Press and hold **Shift** | Pressing and holding down a hard key on the keyboard. |
| Click **[Viewer]** | A button label or Interface button name. |
| Click  (Exam prior) | Selecting an icon-based button. |
| In the **Matrix** text box,... | The name of text box in which you can select or type text. |
| Type **`supine`** in the Patient Position text box (different font and bold) | Text you enter into a text box. |
| Select **Sort** > **Sort by date** | The pathway of selecting option(s) in a pull-down menu. |

## Safety Notices

The following safety notices are used to emphasize certain safety instructions. This guide uses the international symbol along with the danger, warning, or caution message.

**DANGER: Danger is used to identify conditions or actions for which a specific hazard is known to exist which will cause severe personal injury, death, or substantial property damage if the instructions are ignored.**

**WARNING: Warning is used to identify conditions or actions for which a specific hazard is known to exist which may cause severe personal injury, death, or substantial property damage if the instructions are ignored.**

**CAUTION: Caution is used to identify conditions or actions for which a potential hazard may exist which will or can cause minor personal injury or property damage if the instructions are ignored.**

**NOTE:** A Note provides additional information that is helpful to you. It may emphasize certain information regarding special tools or techniques, items to check before proceeding, or factors to consider about a concept or task.

This page intentionally left blank.

Volume 1

# Chapter 1

# Working Safely

### Where Am I?

## Introduction

This chapter focuses on the visible and invisible sources of hazard and concern in the MR environment and emphasizes the need to work safely. This chapter provides brief guidelines for working in a magnetic field, as well as, key concepts regarding magnet hazards, quench hazards, RF hazards, laser light hazards, metal sliver hazards, acoustic hazards, peripheral nerve stimulation hazards, patient alert system and equipment hazards. It contains the step-by-step instructions to help you learn how to:

- Eliminate Magnet Hazards
- Respond to Patient Emergencies
- Respond to Magnet Emergencies
- Respond to a Quench with Vent Failure
- Protect the Patient from RF Burns
- Protect the Patient's Eyes and Ears
- Check Cryogen Levels
- Handle Contact with Liquid Cryogens

**NOTE: This chapter is extremely important.** There is important safety information that you and the physician must understand thoroughly before using the system.

In addition, this chapter answers the following questions:

1. What is the security zone? What effects does magnetic flux have on ferromagnetic materials?
2. What is the exclusion zone? What effects does magnetic flux have on certain biomedical implants?
3. What hazards are associated with cryogens?
4. What hazards are associated with RF?
5. What risk does the laser alignment light pose?
6. What is the risk of metal slivers in the eye?
7. What risks do the gradients pose?
8. What causes peripheral nerve stimulation?
9. What is the patient alert system?
10. What are the sources of general equipment hazards?

# About... Working Safely

This section presents the concepts necessary to successfully complete the working safely process. Specifically you need to understand:

- Safety Information
  - Indications for Use
  - Restrictions on Use
  - Contraindications for Use
  - User Training
- Magnet Hazards
  - Security Zone
  - Exclusion Zone
- Quench with Vent Failure Hazards
- Liquid Cryogen Concerns
- Hazard Warnings
  - Laser Alignment Light Hazard
  - Peripheral Nerve Stimulation
  - Burn Hazards
  - Metal Heating Warnings
  - Thermal Stress
  - RF Power
  - Clinical Hazards
  - Acoustic Hazards
  - Equipment Hazards
- Patient Alert System
- Patient Emergencies
- MR Compatibility
- Safety Review

# Safety Information

The safety information described in this chapter is very important. You and your physician must understand it thoroughly before you begin to use the system. You will find additional safety information throughout your training guides. If you need additional training, seek assistance from qualified GE Medical Systems' personnel.

Make sure your training guides are readily available at all times. Be sure to review the procedures and safety precautions periodically.

## Indications for Use

The Signa® system is indicated for use as a diagnostic imaging device to produce transverse, sagittal, coronal, and oblique images of the internal structures of the internal structures and organs of the entire body. The images produced by your MR system reflect the spatial distribution of protons (hydrogen nuclei) exhibiting magnetic resonance. The Nuclear Magnetic Resonance (NMR) properties that determine image appearance are proton density, spin-lattice relaxation time (T1), spin-spin relaxation time (T2), and flow. When interpreted by a trained physician, these images provide information that can be useful in formulating a diagnosis.

## Restrictions on Use

CAUTION: Federal law restricts the sale, distribution and use of this device to or on the order of a physician.

CAUTION: This device is limited by federal law to investigational use for indications not in the "Indications for Use" statement. Under federal law, this device should only be used for the functions set forth in the "Indications for Use" statement.

WARNING: The Signa MR Imaging System is not designed to provide information for clinical stereotactic use. The spatial accuracy obtainable with Signa may not be adequate for stereotactic procedures and can vary depending on the patient, the pulse sequence used and the system itself. We therefore recommend that Signa images not be used for stereotactic applications.

NOTE: Clinical stereotactic use refers to being used in localization for surgical procedures.

## Contraindications for Use

The use of the your MR system is contraindicated (i.e., not advised) for:

- Patients with electrically, magnetically or mechanically activated implants (e.g., cardiac pacemakers and ferrous/electrically activated cardiac catheters), because the magnetic and electromagnetic fields produced by the your MR system may interfere with the operation of these devices.
- Patients with intracranial aneurysm clips.

### Implant and Prosthesis Hazards

WARNING: The magnetic field of the MR system can cause a ferrous implant (e.g., aneurysm clip, surgical clip, cochlear implant, etc.) or prosthesis to move or be displaced, resulting in serious injury. Patients should be screened for implants and those patients with implants are not to be scanned. Prostheses should be removed before scanning to help prevent injury.

WARNING: Induced electrical currents and heating can occur in the region of the metallic implants. Patients with implants are not to be scanned.

WARNING: Electrical discharges between conductive devices with points or sharp edges and the MR coils can panic a patient, causing the patient to injure him/herself. To help avoid such reactions, avoid placing any metal objects (e.g., limb braces, traction mechanisms, stereotactic devices, etc.) into the MR magnet.

## User Training

GE provides a training program in Milwaukee for one system operator from each new Signa site. You may arrange to participate through your local sales representative.

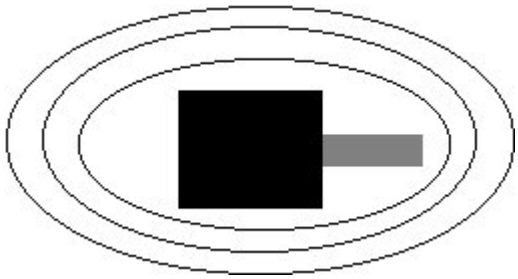
In addition, GE provides on site training by an MR Applications Specialist. Anyone who operates the system must attend this session after reading the Learning and Reference Guides and related training materials.

We strongly recommend that physicians who prescribe studies and reviews images on the your MR system attend at least two full days of professional meetings dealing with MR medical imaging each year. Such meetings include RSNA, the Society of Magnetic Resonance and the American Roentgen Ray Society. In addition, Signa user groups present symposia and workshops throughout the year that provide additional learning opportunities.

You are to train outside emergency personnel (e.g., fire department and other outside ambulance or emergency personnel) not to bring any ferrous fire fighting equipment, including axes, ferrous stretchers, or oxygen tanks into the MR scan room. Be sure to show such outside emergency personnel where the Emergency Magnet Run-Down switch is located.

# Magnet Hazards

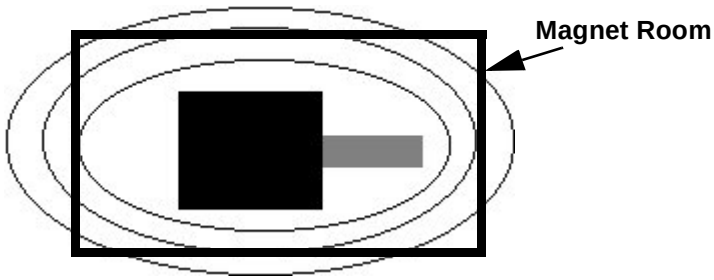
A magnet produces invisible lines of force that extend beyond the magnet that are called the fringe field. The size of the fringe field depends on the strength of the magnet and whether it is shielded. Active and inactive shielding are used to reduce or tighten the fringe field.



The magnetic field exerts force on susceptible materials and biomedical implants that create hazards. There are two critical zones, the Security Zone and the Exclusion Zone. Each zone has specific restrictions regarding people and materials.

## Security Zone

The security zone is the magnet room and the walls of the magnet room.




The attractive force of the magnetic field in the security zone can cause ferromagnetic items (e.g., items that contain substances such as iron, nickel, cobalt and various alloys) to become projectiles and contraindicated biomedical implants to fail. In short, ferromagnetic items and contraindicated biomedical implants CANNOT enter the security zone. The security zone warning sign must be posted at the entrance to the magnet room.

WARNING: The security zone warning sign must be posted on the entrance to the magnet room.


*Security Zone Warning*

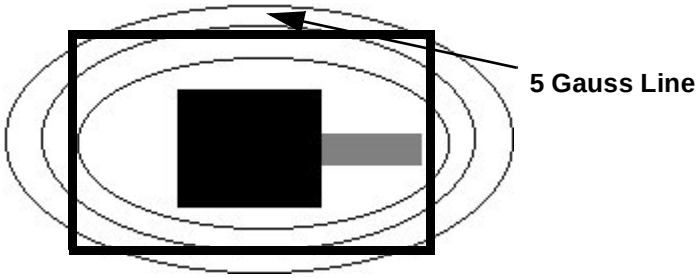
Non-ferrous **oxygen tanks**, wheelchairs, gurneys, IV poles, ventilators, etc. should be used in the scan room. Be sure anyone who has access to the MR suite is aware that only non-ferrous items are allowed in the scan room and that a policy and procedure for bringing medical devices and other equipment into the scan room is in place.

Something to Think About...

- Ferromagnetic is a substance such as iron, that has a large positive magnetic susceptibility.
- Ferrous means an item that can posses intrinsic magnetic fields and reacts strongly in an applied magnetic field. (Example: Iron, nickel and cobalt.)
- Common hospital equipment may be adversely affected when in proximity to the magnetic field or image quality may be affected by the presence of this equipment.

## Exclusion Zone

The exclusion zone begins at the 5 gauss line. Magnetic shielding may, however, restrict the 5 gauss line to the magnet room, making the security and the exclusion zone the same.



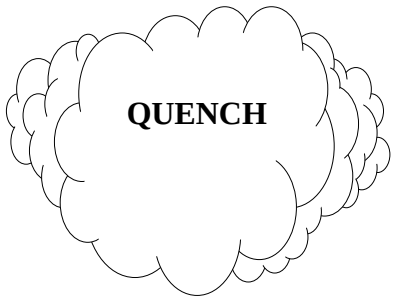

Gauss Line is a line that all personnel should be aware of and actively screening the changing conditions of the environment. There are gauss lines and equipment that must remain outside certain limits. Consult your GE Service Engineer to know where these gauss lines are located in your facility.

WARNING: The exclusion zone warning sign must be posted at the 5 gauss boundary; locate and read the exclusion zone sign(s) at your facility.


*Exclusion Zone Warning*

WARNING: The fringe field can cause injury by interfering with the normal operation of biomedical devices.

## Quench with Vent Failure Hazards




A superconductive magnet uses cryogens to super-cool the electrical conductor that creates the magnetic field. Liquid helium is used, although some systems also require liquid nitrogen. Temperatures as low as 269°C (-452°F) are achieved to create the proper environment within the magnet.

On rare occasions the magnets may lose their superconductivity so that the energy stored in the main coil rapidly dissipates as heat, and boils off the magnet's reservoirs of liquid helium and nitrogen. This is called a quench. Quenches are indicated by a loud noise, warning message, or the tilting of an image on the image screen.

A quench is a hazard only if the vent fails, resulting in the release of white clouds of cryogen vapor into the scan room.

The decay characteristics of the magnetic field in case of a quench or from activation of the Emergency Field Shut-Down Unit to the moment at which the field strength in the center of the magnet has fallen to 20 mT or 200 gauss is 2 minutes.

WARNING: In the unlikely event of a quench and the vent fails, a procedure needs to be in place to evacuate the patient and all personnel from the magnet room. Failure to follow these precautions can result in serious injury (e.g., asphyxiation, frostbite, or injuries due to panic).

## Liquid Cryogen Concerns

Cryogens come in large vacuum containers called dewars. Liquid helium is used although some service procedures also require liquid nitrogen. Nitrogen dewars weigh from 400 to 500 pounds when full, helium from 700 to 800 pounds. In addition to large dewars, there may be smaller helium gas cylinders present. This helium gas is used to fill the magnet to proper cryogen levels. Some special considerations should be observed when dealing with cryogens.

CAUTION: The following information defines the proper handling of cryogens.

- **Dewars and cylinders should not be tipped or heated nor should the valves be tampered with.**
- **The cryogens boil off as they cool the magnet wires and must be replenished periodically by qualified personnel. You or your service representative should monitor the rate of boil-off by the by checking the cryogen level with the meter found on the system cabinet.**
- **Contact with the cryogenic liquids or gas could result in severe frostbite; care should be taken when in proximity to these substances.**
- **Dewars should be stored in a well-ventilated area. Accidental release of cryogens from the containers could be in gaseous form, resulting in an asphyxiation hazard.**
- **Gas cylinders should be stored upright and secured to the wall with a chain with the metal protective top in place. (If the a cylinder falls over or the valve is knocked off, the container may act like a rocket; a full cylinder has enough power to penetrate walls.)**
- **Because the cylinder's metal cap may be magnetic, it should always be removed before bringing it into the scan room.**
- **If possible, all personnel should stay out of the scan room when a qualified service engineer is filling cryogens in the magnet. If personnel must be present, be sure to wear proper gloves, a face shield, and ear protectors.**
- **A qualified service engineer should be present any time cryogens are transported within the hospital or added to the magnet.**
- **It is crucial that ventilation and cryogenic systems be kept in good repair and checked regularly to be sure they are performing properly.**
- **Flammable materials must not be brought near the cryogen containers.**

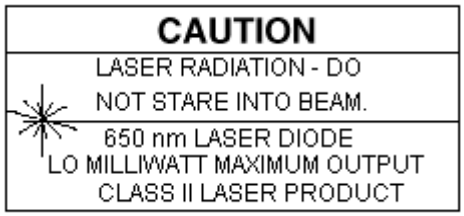
# Hazard Warnings

You need to be aware of the hazards that are associated with the MR magnet to ensure a safe environment.

## Laser Light Hazards

Your MR system uses a semiconductor laser alignment lights for patient landmarking. This type of alignment light casts a thin red light on the patient for the purpose of positioning and landmarking. The laser lights can cause eye injury.

The following label is the warning label for laser products and is located on the bottom of the magnet front cover.




Labels such as this provide warnings about laser radiation.

The eyes must be protected from laser radiation. The patient needs to be instructed to close their eyes when landmarking and the laser light is turned on. Exposing eyes to the laser alignment lights may result in eye injury.

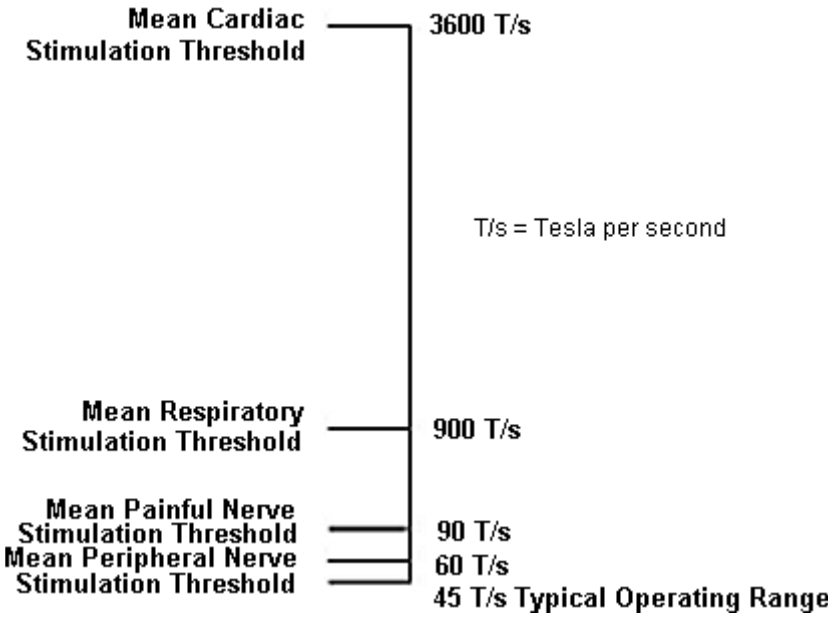
CAUTION: Do not leave the laser light on after you position the patient.

The label below is the laser aperture label and is located in the patient bore adjacent to the windows where the laser beams exit.


## Peripheral Nerve Stimulation

The gradients produce rapidly changing magnetic fields during scanning that can produce peripheral nerve stimulation (PNS) or a tingling sensation in some patients.

Signa typically operates in the 45 T/s range—PNS can occur in the 60 T/s range.




CAUTION: Due to the rapid rate of change of the magnetic fields (dB/dt) used during some EPI scans, a percentage of patients may experience a tingling or touch sensation. The above chart indicates the type of sensations caused at different dB/dt. This means a percentage of patients may experience PNS at 45 T/s. If this sensation is bothersome or uncomfortable to the patient, stop the scan. Change to a non-EPI pulse sequence to continue scanning the patient.

CAUTION: To reduce the possibility of PNS, make sure the patient's hands are not clasped or touching and feet are not crossed which could form a conductive loop.

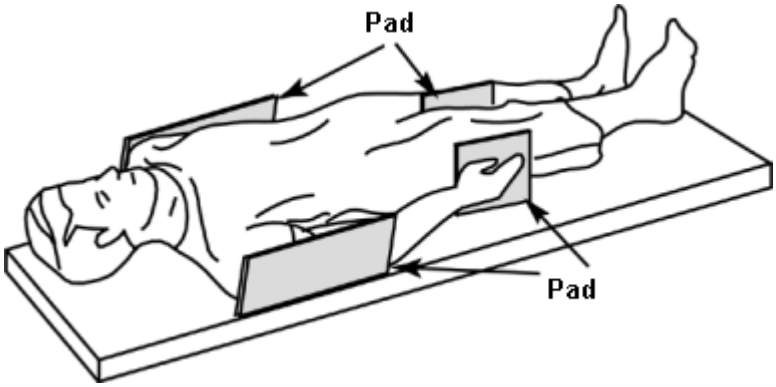
NOTE: Please report to GE Medical Systems all complaints of patient discomfort that may be associated with PNS during MR exams (e.g. muscle twitches, tingling sensations, or headaches). Use The Report of Patient Peripheral Nerve Stimulation form and forward when completed to: GE Medical Systems, Attn: QSR Programs, P.O. Box 414 (W709), Milwaukee, WI 53201-0414 USA (See form below.)

| ***Report of Patient Peripheral Nerve Stimulation*** | |
|---|---|
| **Report Date** | |
| **Date of MR Exam** | |
| **Hospital Name** | |
| **Telephone Number** | |
| **Name of Reporting Health Care Professional** | |
| **Patient Age** | |
| **Patient Weight** | |
| **Patient Height** | |
| **Patient Pathology** | |
| **Patient Medications** | |
| **Exam Number** | |
| **Series Number** | |
| **PSD (GRE, SE, FSE, EPI, IR)** | |
| **TR (ms)** | |
| **TE (ms)** | |
| **FOV (cm)** | |
| **Slice Thickness (mm)** | |
| **Interslice Spacing (mm)** | |
| **Slew Rate (T/m/s)** | |
| **Frequency Encoding Direction (RL, AP, SI)** | |
| **Were Patient's Hands Clasped?** | |
| **dB/dt (% peripheral nerve or T/s)** | |
| **Stimulation Severity (1=very mild, 2=mild, 3=uncomfortable, 4=very uncomfortable)** | |
| **Stimulation Description & Site** | |
| ***Please Duplicate Before Use*** | |

## Burn Hazards

### Patient Positioning Warnings

Positioning of the patient can affect the safety of the scan procedure. To help prevent a patient burn from closed loops formed by clasped hands or by hands touching the body, or from thighs contacting over a small area, insert non-conducting pads at least 0.25 inches thick between touching parts.




WARNING:Contact point heating warning information.

- **RF can cause localized heating at contact points between the patient/bore and patient/RF coil causing discomfort or burns.**
- **Place foam between the patient and the bore wherever a portion of the body comes in contact with the magnet opening.**
- **Always place a sheet or pillowcase between the surface coil and the patients skin to prevent burn injuries.**

### Patient Comfort Module

A sensor located in the bore of the magnet monitors bore temperature. The sensor posts appropriate messages for you in the System Status Display area of the monitor (upper left portion of the operator's monitor) that notify you when the magnet bore wall is becoming warm.

The temperature inside the room should be set at less than 70°F and the bore fan should be turned on at all times to keep air flowing inside the bore of the magnet.

WARNING:Bore heating warning information.

- **RF can also raise the magnet bore temperature and cause thermal stress; medical conditions can reduce a patient's ability to cope with external temperature increases.**
- **If the temperature continues to rise, the scan stops until temperature within the bore is lowered. When the sensor detects temperatures that may cause patient discomfort, the system posts this message on the screen:**
  - **"The patient comfort level is warmer than normal."**
  - **"The patient may be uncomfortable during the scan."**
  - **"The bore cooling system or magnet room temperature may not be normal."**
  - **"Further increases in temperature will inhibit scanning."**
- **When the temperature drops to a comfortable level, the message is cleared from the screen. If the temperature continues to rise, a second message appears on the screen:**
  - **"Scan inhibited. Patient comfort sensor trip."**
- **To facilitate a return to scanning, make sure:**
  - **Patient fan is ON.**
  - **Room temperature is normal, 21C° (70F°).**
  - **Air flow through the bore is unobstructed.**
- **When the magnet opening temperature decreases, the system posts this message:**
  - **"New scans can be initiated, but the patient comfort level is still warmer than normal."**

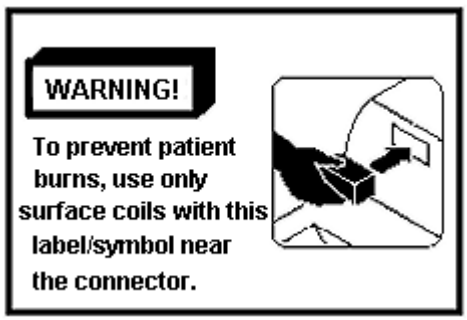
### Cable/Connector Warnings

WARNING: Cable/conductor heating warning information.

- **RF can heat non-compatible surface coils/gating cables, damaged surface coils/gating cables, surface coils that are not properly plugged in, and improperly routed cables can cause burns.**
- **The use of cable-connected surface coils, the original peripheral gating probe, (consult your GE Service Engineer for questions), or ECG gating accessories for patient scanning can result in local heating, leading to a burn or fire if proper scan preparation features are not followed. The cables often extend into the high intensity region of the RF field and it is possible that induced electrical currents in the cables may cause arcing and heating.**

### Surface Coil Warnings

WARNING: For Signa Horizon systems: use only Signa Horizon coils. Older Signa Advantage coils are not compatible with Signa Horizon systems and should not be used. Signa Horizon coils can be identified by this label. (This label is located on the coil itself and on the head carriage where the coil connector plugs in.)



WARNING: Observe the following warnings when using surface coils.

- **Remove unplugged surface coils or unused accessory devices from the magnet bore; a patient burn can result.**
- **When using the Breast Coil, make sure the patient's back and arms do not touch the magnet bore. Use thermal resistant material or padding between the patient and the magnet to prevent burns that could be caused by patient contact with the interior of the magnet bore.**
- **Use only GE or GE-authorized accessory coils and cables.**
- **Do not use surface coils with exposed coils or damaged insulation. Skin contact with metal conductors can cause burns.**
- **Use only accessories that are in good condition. If you suspect that an accessory is not in good condition, discontinue its use and contact your GE Service Engineer.**
- **Keep the length of cable in the bore to a minimum. Avoid bending the cable 180° and route cables out of the bore in the most direct way.**
- **Route cables through the center of the magnet bore. Place cables under the cushion whenever possible. Routing near the sides of the bore increases the likelihood of cable heating (from induced currents).**
- **Do not cross or loop cables; arcing and patient burns can result.**
- **Do not allow the surface coil cable to touch the patient; patient burns can result. Use a thermal resistant material or pad to keep the cable from touching the patient.**

### ECG Gating Warnings

WARNING: Observe the following warnings when using ECG gating.

- **Remove unplugged or unused accessory devices from the magnet bore; a patient burn can result.**
- **Do not use monitoring equipment when conductors are in the bore and touching the patient; burns can result.**
- **Use only GE or GE-authorized cables.**
- **Always bring the cable directly out of the magnet bore with no slack. Place cables under the cushion whenever possible.**
- **Keep the length of cable in the bore to a minimum. Avoid bending the cable 180° and route the cables out of the bore in the most direct way.**
- **Route cables through the center of the magnet bore. Place cables under the cushion whenever possible. Routing near the sides of the bore increases the likelihood of cable heating (from induced currents).**

### Peripheral Gating Warnings

WARNING: Observe the following warnings when using peripheral gating.

- **Remove unplugged or unused accessory devices from the magnet bore; a patient burn can result.**
- **Do not use monitoring equipment with conductors in the bore and touching the patient; burns can result.**
- **Use only GE or GE-authorized cables.**
- **Do not use leads with broken shields or exposed conductors. Use only accessories that are in good condition. If you suspect that an accessory is not in good condition, discontinue its use and contact your GE service engineer.**

- **Keep the length of cable in the bore to a minimum. Avoid bending the cable 180° and route the cables out of the bore in the most direct way.**
- **Check to see that the cable does not touch the sides of the magnet bore. Place cables under the cushion whenever possible. Routing near the sides of the bore increases the likelihood of cable heating (from induced currents).**
- **Check to see that the cable does not pass under or near the surface coil or surface coil cable.**
- **Check to see that only the sensor touches the patient. Keep cables from coming in contact with the patient.**

## Metal Heating Warnings

To maintain a safer scan environment, determine each patient's work history and thoroughly screen for any metal containing accessories.

WARNING: Eye makeups that contain metal flakes can cause eye and skin irritation during MR scanning. Instruct patients to wash off removable makeup before the exam to avoid the risk of eye injury. Before scanning, warn patients with permanent eyeliner or other metallic ink tattoos about the risk of skin irritation and instruct them to get prompt medical attention if they experience severe discomfort following an MR exam.

WARNING: Metal fragments/slivers can deflect and/or heat in a magnetic field, damaging surrounding tissues. Patients at risk for metal fragments in the eye should receive an eye exam to detect and remove any metal fragments that could deflect and damage the eye.

WARNING: Jewelry, even 14 karat gold, can heat and cause burns. RF can heat (even non-ferrous) metal and cause burns.

## Thermal Stress

The actual increase in tissue temperature caused by exposure to RF radiation depends on a variety of factors associated with the thermoregulatory system of the individual and the surrounding environment. Thermoregulatory is the ability of the body to maintain regulated heat capacity levels.

WARNING: Observe the following warnings concerning tissue heating.

- **RF can heat the patient's tissue, if you deliver RF faster than the patient's tissues can dissipate it. The amount of tissue heating depends on the patient's weight, type of pulse sequence, timing factors, number of slices and the use of imaging options such as saturation.**
- **A rise in body temperature can be a hazard to a patient with reduced thermoregulatory capacity. Reduced thermoregulatory capacity can be caused by pre-existing conditions, such as cardiac impairment, that result in reduced circulatory function, hypertension, diabetes, old age, obesity, fever, or an impaired ability to perspire. A patient with these complications must be carefully monitored at all times.**
- **The RF power monitor and SAR limitations help prevent excessive RF exposure to the patient; SAR values are calculated based on the patient's weight. To help avoid injury, enter the patient's correct weight to set operating limits and prevent excessive RF exposure.**

## RF Power

The RF pulses used in magnetic resonance causes tissues to absorb RF power. Under certain conditions, this may cause tissue heating. The amount of heating depends on several factors, such as patient size and pulse-sequence timing.

Before the patient is scanned, the computer estimates the level of heating and compares it to the predetermined exposure limits. If the scan exceeds these limits, the system then adjusts the scan parameters before starting the scan. The complete estimate is based in part on patient weight. Therefore, take care

to enter the patient's weight correctly to prevent excessive RF exposure or scan abort.

NOTE: The Signa RF power monitor helps prevent excessive RF exposure due to equipment failure. Since the monitor protects the patient, it must be operational at all times, even when a scan is not in progress. If it detects an equipment failure, it immediately disables the RF system. This system must be repaired or adjusted by qualified service personnel.

## Clinical Hazards

CAUTION: The confining conditions of the MR system can precipitate claustrophobia in some patients. To prevent injuries due to panic, provide instructions and comfort the patient as needed to alleviate anxiety.

### Pregnant or Infant Patients

CAUTION: The safety of MR scanning has not been established for imaging fetuses or infants. Carefully compare the benefits of MR versus alternative procedures before scanning to control risk to the patient. A physician needs to determine the decision to scan pregnant or infant patients.

### Biomagnetic Hazards

CAUTION: Subtle genetic or molecular changes could be caused by the magnetic fields used in MR. Carefully compare the benefits of MR versus alternative procedures before scanning to control risk to the patient.

CAUTION: It is prudent to minimize the time spent near the magnet to only that necessary to attend to the needs of the patient.

### High Risk Patients

WARNING: Patients having the following conditions are at greatest risk for complications during MR scanning:

- **Likely to develop seizure or claustrophobic reaction.**
- **Greater than normal potential for cardiac arrest.**
- **Unconscious, heavily sedated, or confused patients with whom no reliable communication can be maintained.**
- **Since direct observation from the operator's console is usually partially obscured by the magnet enclosure, be sure to closely monitor these patients at all times to quickly identify and respond to medical emergencies. In some cases, emergency personnel should remain with the patient or be on standby alert to help prevent serious complications or death.**

### SAR Limits

WARNING: The International Electrotechnical Commission (IEC) has the following requirements regarding SAR.

- **The examination room temperature is not more than 21°C and the relative humidity is not more than 60%. Temperatures above 21°C and the relative humidity above 60% could result in the limits in the definitions of the operating modes for whole-body SAR shall be reduced.**

- **Whole-body SAR is the value of the SAR averaged over the entire body of the patient.**

  **Three operating modes with regard to whole-body SAR are defined, namely normal operating mode, first level controlled operating mode, and second level controlled operating mode:**
  - **The normal operating mode comprises values of whole-body SAR not higher than 1.5 W/kg averaged over any 15 minute period. The Signa's maximum allowed is 2 W/kg.**
  - **The first level controlled operating mode comprises values of whole-body SAR not higher than 2 W/kg averaged over any period of 15 minutes. The Signa's maximum allowed is 2 W/kg.**
  - **The second level controlled operating mode comprises values of whole-body SAR that may exceed 2 W/kg averaged over any 15 minute period. When operating in this mode you need to click the [Accept] button to go from operating at 1.5 W/kg to 2.0 W/kg. The Signa's maximum allowed is 2 W/kg.**
- **Head SAR is the value of the SAR averaged over the head of the patient.**

  **Two operating modes with regard to head SAR are defined, normal operating mode and second level controlled operating mode:**
  - **The normal operating mode comprises values of head SAR not higher than 3 W/kg averaged over any period of 10 minutes.**
  - **The second level controlled operating mode comprises values of head SAR that may exceed 3 W/kg averaged over any period of 10 minutes. When operating in this mode you need to click the [Accept] button to accept these values if operating in second level controlled operating mode.**
- **The SAR algorithms for the Signa product calculate SAR values and set a limit on the number of slices/echoes per second in order to limit RF power deposition. The Signa power monitor and SAR algorithm limit SAR, regardless of the patient weight or pulse sequence used. The limits are conservatively estimated from worse case patient positioning as a function of weight.**

  **In addition, a power monitor module limits the RF amplifier output power to limit the patient SAR in case of a catastrophic failure. This module monitors peak power based on patient weight, and duty cycle based**

**on the pulse parameters. The peak power limits prevent you from using incorrect patient weights.**

## Acoustic Hazards

The gradients produce noise during scanning that can exceed 99 dBA in the bore. The sound level at the operator's console is in compliance with national regulations.

WARNING: Hearing protection is required to prevent hearing impairment.

GE Medical systems offers the following disposable ear protection of various noise reduction ratings that can be ordered through the GE accessories catalog.

The following table describes the available types.

| ***Description*** | ***dB*** |
|---|---|
| E8801BA EAR Disposable Foam Earplugs | 29 |
| E8801BB EAR Taperfit2 Foam Earplugs | 32 |
| E8801BC Max-Lite Foam Earplugs | 30 |

## Equipment Hazards

There are also general equipment concerns in the MR environment. You need to become very familiar with the location and proper use of certain emergency buttons and releases.

### Emergency Stop

The Emergency Stop button is located on the keyboard and on both the right and left sides of the magnet enclosure.

The Emergency Stop button disables the following systems:

- RF
- Gradient Power Supply

- Scan Room Unit
- Table and Patient Support Subsystem

WARNING: The Emergency Stop button does not remove the magnetic field, turn off the computer cabinets, operator's console, or camera. Refer to Safety Review to know when to use this button.

**Emergency Off**

The Emergency Off button is located on the wall next to all computer equipment, and next to the MRI magnet room doors. It disconnects all incoming power to the power distribution unit, with the exception of the magnetic field.


Use this button only in a major emergency in the computer or MRI magnet room. For example, use this button when you notice fire, sparks, or loud noises not associated with normal operation of the system. Use the following procedure if this button is activated:

1. Press the Emergency Off button.
2. Evacuate the patient.
3. Call the fire department, if appropriate. When the fire department arrives, evaluate the need for an emergency MRI magnet quench. If the fire-fighters need to take

ferromagnetic equipment into the MRI magnet room, quench the magnet.

4. Contact a service engineer before restoring power.

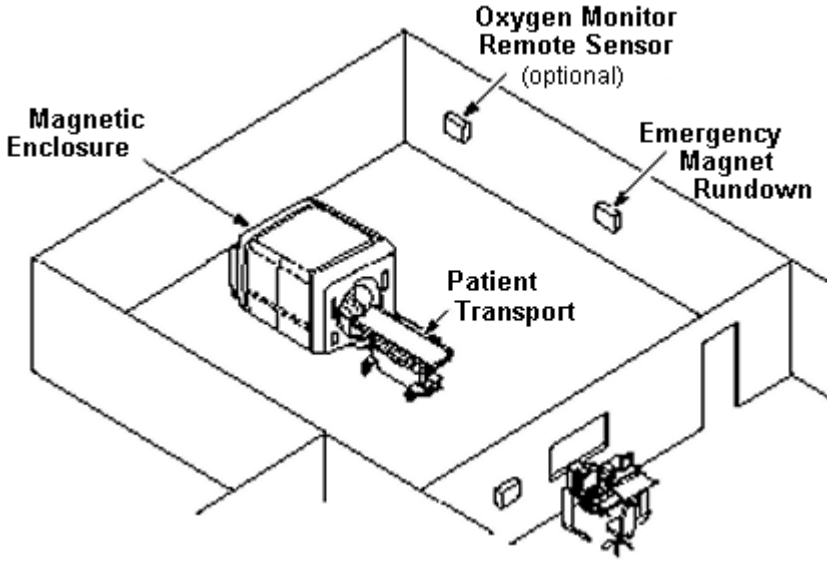
NOTE: To restore power after emergency off, the main circuit breaker must be reset before rebooting the system. Always contact a service engineer before restoring power.

WARNING: The Emergency Off button does not turn off the magnetic field. To avoid personal injury or equipment damage, do not bring any ferromagnetic equipment into the magnet room. Assume that equipment is magnetic unless it is clearly labeled otherwise. Refer to Safety Review to know when to use this button.

**Emergency Magnet Run-Down**

The Emergency Magnet Run-Down operates as follows and is located inside the Magnet Room:

- Rapid reduction of the magnetic field in about two minutes.
- Boil-off of cryogens, accompanied by loud hissing sound.
- Several days of down time to replace the cryogens.
- Several days of down time to replace the cryogens.




WARNING: The Emergency Magnet Run-Down should only be used to free someone pinned to the magnet or to remove a large ferromagnetic object captured by the magnetic field when injury to persons is imminent. A controlled magnet rundown should be performed in non-emergency situations by a GE Service Engineer. Refer to Safety Review to know when to use this button.

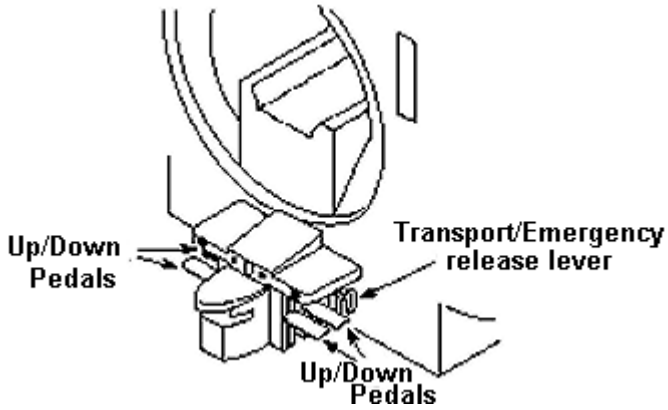
**Table Transport Emergency Release**

The Table Transport Emergency Release is used in the event the undock pedal on the patient transport does not function.

To release the transport with the Emergency Release:

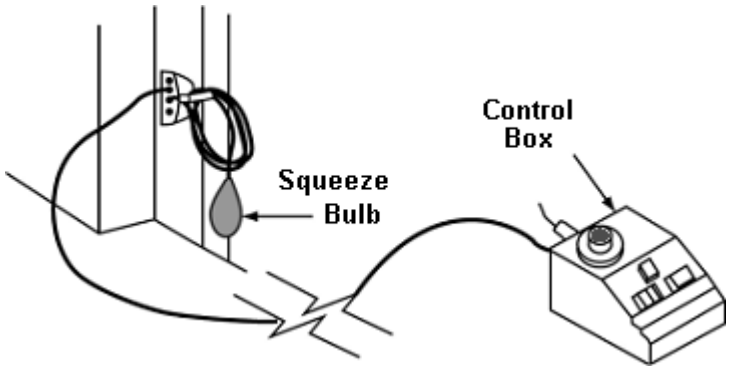
- Make sure the cradle is fully retracted from the magnet bore at the home position.

- Grasp the handle on the red lever and pull straight out to release the table.




## Patient Alert System

Your MR system has a patient alert system that enables the patient to alert the technologist at the console by squeezing a bulb. Squeezing the bulb causes the control box to light up and emit an audible signal. A switch on the control box allows you to set the signal for intermittent or constant light and sound.




Your MR system also has an intercom system that enables you to maintain verbal contact with the patient throughout the exam.

CAUTION: The patient alert squeeze bulb contains latex. If the patient is aware of a sensitivity/allergy to latex or if the patient is unsure and concerned about the possibility of an allergic reaction, cover the bulb with a towel, cloth, or plastic bag to shield the patient from the latex.

## Patient Emergencies

Before you begin any scanning procedure, explain the use of the patient alert system to your patient. Make sure he or she understands its purpose and use. Remember that implants, pacemakers, and ferromagnetic life support systems cannot be brought into the scan room.

Be sure to closely monitor patients with a greater than normal potential for cardiac arrest, seizure or claustrophobia, or patients who are unconscious or morbidly ill. Always maintain visual contact with the patient. In some cases, you might need to alert emergency personnel to remain on standby.

The patient table can be detached from the magnet system. It can also be lowered and raised. In the event that a patient needs emergency medical attention during the scanning session, use the undock pedal or the emergency table lever release for quick transportation of patients outside the scan room.

## MR Compatibility

The potential magnetic force on an object must be evaluated before the object is brought into the magnet room. A set of procedures and standards to be used to evaluate MR compatibility of hand-held, non-electronic equipment to be used in the magnet room is located in the Appendix: MR Compatibility Guidelines and Tests.

There are three criteria by which a device can be considered compatible. A device shall be considered MR compatible if and only if:

1. MR Safe - The presence in the magnet room does not pose an increased safety risk to the patient or personnel from three areas of concern:
    - Magnetic Forces - the device must not be attracted to the magnet with sufficient force as to be a projectile or sufficient torque as to cause personal injury.
    - Heating from RF or gradient field induction - the device must not be able to cause burns.
    - Induced voltage from RF fields - the device must not cause nerve stimulation.

WARNING: The attractive force of the magnetic field of the MR system can cause ferrous objects to become projectiles that can cause serious injury. Post the security zone warning sign on the entrance to the magnet room and keep all hazardous objects out of the magnet room.

2. Device Safety and Effectiveness - The device cannot have its functions altered by the magnetic field nor can it cause a safety risk when in the magnetic field. The large static magnetic field, the rapidly changing gradient magnetic fields, and the RF energy may affect a device.

WARNING: GE shall not be responsible for assessing the proper function of any device. The manufacturer of the device must make arrangements to test their device in the MRI environment. Written certification that the device functions as intended in the MRI environment shall be provided before the device shall be considered MR compatible.

3. Scanner Compatibility - The device cannot adversely affect the function of your MR system (SNR, artifacts, image distortion, etc.) in the following areas:

   - Static magnetic field homogeneity - the device must not cause significant changes in the shim.
   - RF interference - the device must not distort the RF transmitted by your MR system, nor can it generate RF in the sensitive, pick-up range of the MR coils.
   - Dynamic field homogeneity - the device must not create significant time dependent field distortions.

The degree of compatibility required depends on the devices usage and the materials used in fabrication. For example, a scalpel made of a non-ferrous metal might be zone 3, while one made of ceramic material could be zone 1. A device will be classified as compatible in one of four zones.

| ***Zone*** | ***Description*** | ***Typical Devices*** |
|---|---|---|
| **1** | Suitable for use in the imaging volume, potentially in contact with the patient. | Biopsy needle<br>Endoscopes |
| **2** | Suitable for use in the imaging volume, only if the device is at least 5 cm away from any anatomy for which spatial accuracy is required. | Positioners<br>Microscopes |
| **3** | Suitable for use in the imaging volume only when scanning is off. Spatial distortion and artifacts occur during scanning. | The majority of MR Safe hand-held surgical instruments. |
| **4** | Suitable for use in the scan room when kept more than 1.0 m from isocenter. | Furniture<br>Carts |

NOTE: Refer to Appendix: MR Compatibility Guidelines and Tests.

# Safety Review

| Situation | Procedure |
|---|---|
| Fire, sparks, a loud noise or other emergency condition in the scan room not associated with normal operation of the system. | Press an emergency off button at either the computer equipment room or scan room door. Remove the patient from the scan room. |
| Magnet quench, indicated by a loud noise, warning message, dense white vapor **with vent failure**, helium meter dropping considerably or the tilting of an image on the image screen. | Evacuate the patient and personnel from the scan room and close the scan room door. Follow the usual overnight procedure. All helium vapor should automatically be vented outside of the scan room. |
| Magnetic-field emergency, e.g., a person pinned between the magnet and a ferromagnetic object. | Press the emergency magnet run down button in the scan room. Remove the patient from the scan room. |
| Fire, sparks or a loud noise, indicating a severe system malfunction in the computer equipment room. | Press an emergency off button at either the computer equipment room or scan room door. Remove the patient from the scan room. |
| Fire or severe condition relating to the power distribution unit (PDU) or service outlets. | Press an emergency off button at either the computer equipment room or scan room door. Remove the patient from the scan room. |
| Overtemp indicator lights up at the remote power panel (RPP) or at the PDU, and an error message appears on the scan console's System Status Display area. | Remove the patient from the scan room. Check the PDU vent for obstructions. If the vent is obstructed, or if the overtemp light or message remains on, perform a system shutdown and then press an emergency off button at either the computer equipment room or the scan room door. |
| Patient needs medical attention. | Press the emergency stop button on the console or magnet and remove the patient from the scan room. |
| Table hydraulic failure. | Make certain that the cradle is fully retracted on the transport (the home position) before undocking the transport. Check for oil leaks. If the table latch is stuck and the table cannot be removed, pull the transport emergency release. |

In all cases, notify a GE Service Engineer as soon as possible.

# How to Work Safely

This section provides the step-by-step instructions for working safely in a Magnetic Field environment. Specifically, it describes how to:

- Eliminate Magnet Hazards
  - Eliminate Ferromagnetic Items from the Security Zone
  - Limit Access to the Exclusion Zone
  - Screening Form
- Respond to Emergencies
  - Patient Emergencies
  - Magnet Emergencies
  - Quench with Vent Failure
- Protect the Patient from RF Burns
- Protect the Patient's Eyes and Ears
- Check the Cryogen Levels
  - Systems with a Helium Level Meter
  - Systems with a Magnet Monitor Unit
- Handle Contact with Liquid Cryogens

NOTE: You should understand the following definitions before continuing.

- Ferromagnetic is a substance such as iron, that has a large positive magnetic susceptibility.
- Ferrous is a item that can posses intrinsic magnetic fields and reacts strongly in an applied magnetic field. (Examples are Iron, nickel and cobalt.)

## In Brief: Eliminate Ferromagnetic Items From The Security Zone

1. Keep magnet room door closed.
2. Limit and monitor access to magnet room.
3. Supervise all patients and personnel when in vicinity of magnet room.
4. Test all items for ferromagnetic properties before taking them into magnet room.
5. Remove all ferrous items from the immediate area of the magnet room.
6. Replace ferrous items that must remain in vicinity of magnet room with non-ferrous versions.
7. Tag ferrous items that remain at facility so that all personnel know the item cannot be taken into magnet room.
8. Do a pocket check before entering magnet room.
9. Keep magnet door in sight at all times.
10. Do not turn your back on patient or anyone else in the magnet room.

### Eliminate Magnet Hazards

# Eliminate Ferromagnetic Items From The Security Zone

1. Keep the door to the magnet room closed.
2. Limit and monitor access to the magnet room.
3. Supervise non-MR personnel when working in the magnet room or the vicinity of the magnet room.
4. Test all items for ferromagnetic properties before taking them into the magnet room.
   - Use a hand magnet to test items.
5. Remove ferrous items from the immediate vicinity of the magnet room.
   - Reduces the chance that someone might carry a ferrous item into the magnet room.
6. Replace ferrous items that must remain in the vicinity of the magnet room with non-ferrous versions whenever possible.
7. Tag ferrous items that remain at the facility so that all personnel know the item cannot be taken into the magnet room.
   - Tag all ferrous items with the same label to be consistent in identifying items that are not to be in the magnet room.
8. Do a pocket check before entering the magnet room.
   - Check for loose metal objects, such as keys, and remove.
9. Keep the door in sight at all times.
   - When working in the magnet room, do not stand between the door and the magnet or turn your back to the door.
10. When working in the magnet room, do not turn your back on the patient or anyone else in the magnet room.

## Eliminate Magnet Hazards

# Limit Access to the Exclusion Zone—Screen Patients and Personnel

There needs to be a screening procedure in place before patients and personnel enter the exclusion zone. The exclusion zone begins at the 5 gauss line. All personnel must be aware of and comply with the screening procedure.

1. Use a Patient Screening form routinely before bringing patient's or other personnel into the exclusion zone.
   - MR is contraindicated (not indicated for use) in certain patients; every patient and every employee must be screened prior to admission to the magnetic field.
   - See sample screening form.
2. Evaluate the patient/personnel prior to entry.
   - Identify circumstances that contraindicate admission to the exclusion zone or items that need to be removed before entering the security zone.
3. Discuss and review all items on the screening form.
   - Make sure that the patient understands each question he/she is answering.
4. Have patients who are at risk for metal eye slivers examined and/or x-rayed.
   - Follow your departmental policy.
5. Require patients to change clothes.
   - Provide clothes without pockets so items are not transferred.
   - Patients should not wear shoes into the magnet room as they may have collected metal on the soles.
6. Wash off non-permanent make-up.
   - Follow the precautions for patients with permanent make-up such as permanent eyeliner which can cause tissue heating.
7. Keep metal out of the bore.
   - A metal free bore prevent burns and image artifacts.

### In Brief: Limit Access to the Exclusion Zone

1. Use a Patient Screening form before bringing a patient or other personnel into the exclusion zone.
2. Evaluate the patient/personnel prior to entry.
3. Discuss and review all items on the screening form.
4. Have patients who are at risk for metal eye slivers examined and/or x-rayed.
5. Require patients to change clothes.
6. Wash off non-permanent make-up.
7. Keep metal out of the bore.

## Eliminate Magnet Hazards

# Patient Screening Form:

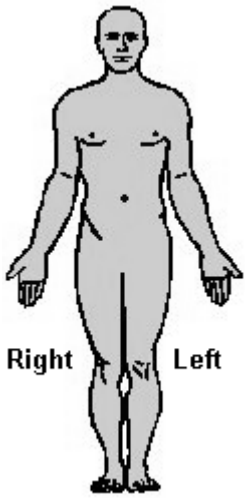
| ***Patient Screening Form:*** |
|---|
| **Date:** |
| **Patient Name:** |
| **Birthdate:** |
| **Weight (lbs):** |
| **Last menstrual period (if applicable):** |
| **Allergies:**_____ |
| **What have you eaten in the last four hours?**_____ |
| **Have you ever worked in a machine shop or similar environment where you may have been subjected to small metal slivers, particularly in the eyes? (Please Circle)**<br>**YES**<br>**NO** |
| **Previous MR study? (Please circle)**<br>**YES**<br>**NO** |
| **Date and type of MR study:**<br>**1.**_____<br>**2.**_____<br>**3.**_____ |
| **Recent X-Ray studies? (Please circle)**<br>**YES**<br>**NO** |
| **Date and type of X-Ray study:**<br>**1.**_____<br>**2.**_____<br>**3.**_____<br>**4.**_____ |
| **Have you ever had surgery other than dental surgery? (Please circle)**<br>**YES**<br>**NO** |
| **Date and Type of Surgery:**<br>**1. Head**_____<br>**2. Neck**_____<br>**3. Chest**_____<br>**4. Abdomen**_____<br>**5. Extremities**_____ |

The following items can interfere with MR imaging and some can actually be hazardous to your safety. Please check if you have any of these items:

**Yes No**

___ ___Cardiac Pacemaker or (Pacemaker lead wires)
___ ___Brain aneurysm clips
___ ___Aortic clips
___ ___Implanted neurostimulators or lead wires
___ ___Artificial heart valve
___ ___Insulin pump
___ ___Electrodes
___ ___Hearing aids
___ ___IUD
___ ___Shunts
___ ___Joint replacements
___ ___Fractured bones treated with metal rods, plates, pins, screws,nails _or clips
___ ___Harrington rod
___ ___Bone or joint pins
___ ___Prosthesis
___ ___Metal mesh
___ ___Wire sutures
___ ___Shrapnel
___ ___Dentures
___ ___Metal slivers in the eyes
___ ___Cochlear implants
___ ___Tattoo eyeliner
___ ___Others (please list)

_____




On the drawing above, please mark the location of any metal inside your body.

**Do not enter the scan room with any metal or magnetic-sensitive items. Check the items below if you have one of the following:**

___Glasses
___Removable dental work
___Hearing aid
___Jewelry
___Watch
___Wallet or money clip
___Pens or pencils
___Keys
___Coins
___Pocket knife
___Metal zippers or buttons
___Belt buckle
___Shoes
___Magnetic strip cards (credit cards, bank cards)
___Hairpins or barrettes
___Metal bra hooks
___Bra and girdle underwire support
___Sanitary belt
___Safety pins

## Respond to Emergencies

# Patient Emergencies

Dealing with patient emergencies requires special planning in the MR environment because of the magnetic field. Certain equipment used for resuscitation will not function in a magnetic field, and ferrous items can become projectiles. If a patient needs emergency medical attention during the scanning session, follow these steps:

1. Press **[Emergency Stop]**.
   - Located on the operator's console or magnet enclosure.

   - The scan aborts.
   - The power disables the patient handling and scan related equipment.
2. Notify emergency personnel, if necessary.
   - Since ferromagnetic life support and related equipment cannot be brought into the scan room, it must await the patient outside the scan room.
3. Squeeze the cradle release handle and pull the cradle all the way out to home.
   - The cradle releases.
     - ° If the cradle does not release, give it a strong tug.
4. Move the side rails of the transport into the vertical position.
5. Make sure that the cradle is fully retracted onto the transport.
   - The transport does not undock if not at home position.
6. Undock the transport.
   - Use the unlock pedal or emergency release handle.
7. Keeping the patient on the transport, remove from the scan room as quickly as possible.
8. Follow hospital emergency protocol.

### In Brief: Respond to Patient Emergencies

1. Press **[Emergency Stop]**.
2. Notify emergency personnel, if necessary.
3. Squeeze the cradle release handle and pull the cradle all the way out to home.
4. Move the side rails of the transport into the vertical position.
5. Make sure that the cradle is fully retracted onto the transport.
6. Undock the transport.
7. Keeping the patient on the transport, remove from the scan room as quickly as possible.
8. Follow hospital emergency protocol.

## Respond to Emergencies

# Magnet Emergencies

### In Brief: Respond to Magnet Emergencies

1. Press **[Emergency Magnet Run-Down]**.
2. Plan and rehearse for a magnet run-down that results in venting of cryogen vapor into the scan room.

In addition to patient emergencies, magnetic field emergencies can also occur. A magnetic field emergency is when the presence of the magnetic field is threatening harm or if someone is pinned between the magnet and ferromagnetic object, for example. All personnel should be familiar with how to respond to magnet emergencies.

A magnet run-down results in several days of downtime and may jeopardize your magnet. Your facility needs to define the specific circumstances that would require a magnet run-down so that no one makes an expensive mistake.

1. Press **[Emergency Magnet Run-Down]**.
   - Located in the scan room.
   - Results in rapid reduction of the magnetic field in about two minutes.
   - There is a boil-off of cryogens, accompanied by loud hissing sound.
   - Expect several days of down time to replace the cryogens.
   - Expect several days of down time to replace the cryogens.
2. Plan and rehearse for a magnet run-down that results in venting of cryogen vapor into the scan room.
   - **Do not activate the Emergency Magnet Run-Down switch during practice.**

## Respond to Emergencies

# Quench with Vent Failure

### In Brief: Respond to a Quench with Vent Failure

1. Do not panic.
2. Using the intercom, ask the patient to stay calm and remain on the table.
3. Turn on the scan room exhaust fan.
4. Prop open the door between the operator room and hallway.
5. Prop the door open to the scan room.
6. Enter the room and help the patient exit the scan room.
7. Evacuate all personnel from the area until the air is restored to normal.

A magnet quench can result in the release of cryogen vapor into the scan room if the vent fails; white clouds of vapor appear in the scan room. Cryogens during a quench can cause asphyxiation, frostbite, or injuries due to panic. Magnet quenches are indicated by a loud noise, warning message or the tilting of an image on the image screen. This procedure guides you through steps to follow in case of a sudden cryogen release into the scan room.

1. Do not panic.
2. Using the intercom, ask the patient to stay calm and remain on the table.
   - Tell them that someone will be in shortly to offer assistance.
3. Turn on the scan room exhaust fan.
   - Some systems vent automatically and there is no fan to turn on.
4. Prop open the door between the operator room and hallway.
5. Prop open the door to the scan room.
   - If helium is venting in the room, the scan room door may not open.
   - If the door cannot be opened break the window to the scan room to relieve pressure.
6. Enter the room and help the patient exit the scan room.
   - If a gurney or wheelchair is needed to remove patient, make sure it is a non-ferrous type.
7. Evacuate all personnel from the area until the air is restored to normal.

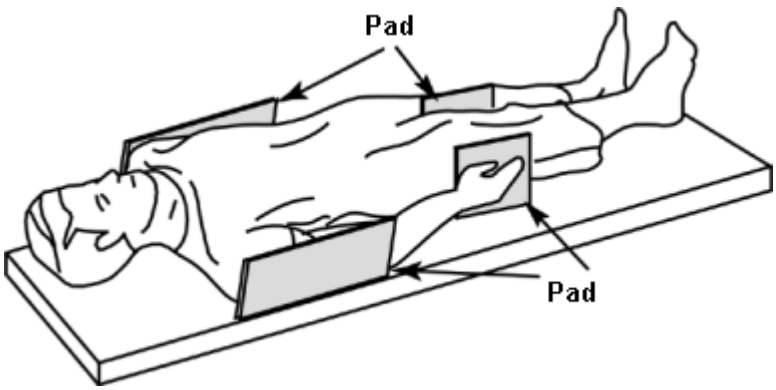
# Protect the Patient from RF Burns

## In Brief: Protect the Patient from RF Burns

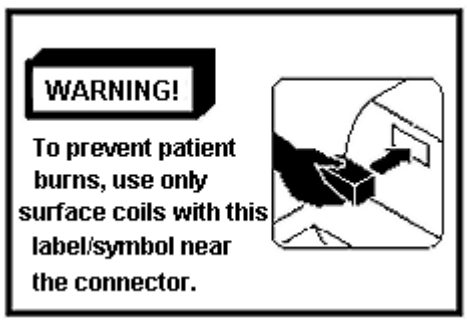
1. Position the patient properly.
2. Do not allow the patient's skin to directly contact the surface of the bore or the RF surface coil.
3. Use only approved RF coils that are not damaged.
4. Position RF cables down the center and directly out of the bore.
5. Do not loop or cross cables.
6. Use the appropriate gating cable for surface coil imaging.
7. Turn on the bore fan and light.
8. Show the patient how to use Patient Alert System.
9. Test patient intercom is in working order.
10. Enter the correct patient weight.
11. Respond to bore temperature messages.

There are important things that all personnel should be aware of to protect a patient from burns and peripheral nerve stimulation. The following steps should be followed by all personnel that position patients for scanning.

1. Position the patient properly.
   - Make the patient comfortable with cushions and/or blanket, if needed.
2. Do not allow the patient's skin to directly contact the surface of the bore, or the RF surface coil.
   - Use non-conductive padding that is at least 0.25 inches thick.




3. Use only approved RF coils that are not damaged.

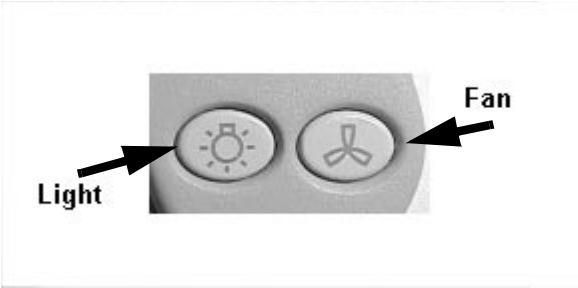



Labels such as this provide warnings about working with RF coils.

4. Position RF cables down the center and directly out of the bore.
5. Do not loop or cross cables.
   - Use the cable holders provided to route the cables so there are no loops in any cables in the magnet.

- Cable holders are located near the edges of the cradle, on either side.

6. Use the appropriate gating cable for surface coil imaging.
7. Turn on the bore fan and light.




8. Show the patient how to use the Patient Alert System.
   - Patients experiencing uneasiness or concern press the Patient Call Button. The patient holds a small wand-like device. When the button is pressed, an alarm emits a signal to you.
9. Test the patient intercom.
   - Make sure that the patient can hear you and you can hear the patient.
10. Enter the correct patient weight.
    - Correct weights help prevent excessive RF exposure.
11. Respond to bore temperature direction messages.
    - The temperature messages are located in message window on your console.

# Protect the Patient's Eyes and Ears

The gradients produce noise during scanning that can exceed 99 dBA in the bore. Hearing protection is required to prevent hearing impairment. The patient must close their eyes when the alignment light is on during positioning. Follow these guidelines to ensure proper eye and ear protection for your patient.

1. Provide the patient with hearing protection.
   - Earplugs or a headphone system with stereo music.
   - Earplugs reduce the intensity of the sound, while allowing your patient to hear normal conversations.
2. Make sure that the hearing protection device is properly applied.
   - Earplugs are comfortable and inserted fully. Pliable earplugs compress when they are rolled between the fingers and conform to the ear after they are inserted.
   - Headphone system is audible and comfortable.
3. Instruct the patient to close his/her eyes when the alignment light is on.
   - The laser alignment light for patient positioning can cause eye injury.

## In Brief: Protect the Patient's Eyes and Ears

1. Provide the patient with hearing protection.
2. Make sure that the hearing protection device is properly applied.
3. Instruct patient to close his/her eyes when the alignment light is on.

## Check the Cryogen Levels

# Systems with a Helium Level Meter

**In Brief: Check the Cryogen Levels for Systems with a Helium Level Meter**

1. Turn the helium meter power switch **[on]**.
2. Press **[Update]**.
3. Record the percent of helium reading.
4. Turn the power switch **[off]** when completed.

It is very important to check and record the helium level. Sufficient helium is necessary to avoid accidental quench. If the helium falls below 50% or the level your service engineer says is acceptable, contact a service engineer immediately. Follow the following procedure to check cryogen levels.

1. Turn the helium meter power switch **[on]**.
   - Located at the system cabinet.
2. Press **[Update]**.
   - Located at the system cabinet.
3. Record the percent of helium reading.
   - A logbook should be kept with daily recordings.
   - It is crucial that cryogenic systems be checked regularly to be sure they are performing properly.
4. Turn the power switch **[off]** when completed.

## In Brief: Check the Cryogen Levels for Systems with a Magnet Monitor Unit

1. Push the button on the Magnet Monitor Unit and hold for 10 seconds.
2. Record the value that is displayed in the LED when the LHe% light is illuminated.

### Check the Cryogen Levels

# Systems with a Magnet Monitor Unit

It is very important to check and record the helium level. Sufficient helium is necessary to avoid accidental quench. If the helium falls below 50 percent or the level your service engineer says is acceptable, contact a service engineer immediately. Follow the following procedure to check cryogen levels of a system with a Magnet Monitor Unit.

1. Push the button on the Magnet Monitor Unit and hold it for approximately 10 seconds.
2. Record the value that is displayed in the LED when the LHe% light is illuminated.
   - A logbook should be kept with daily recordings.
   - It is crucial that cryogenic systems be checked regularly to be sure they are performing properly.

# Handle Contact with Liquid Cryogens

## In Brief: Handle Contact with Liquid Cryogens

1. Immediately flush the area with large volumes of tepid water.
2. Cover the area with sterile dressing.
3. Notify a physician without delay.

In the unlikely event that someone comes in contact with a liquid cryogen, you should immediately follow these steps.

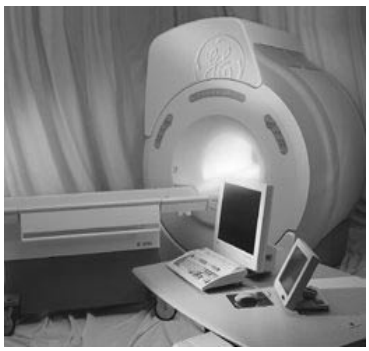
1. Immediately flush the area with large volumes of tepid water.
   - Tepid water is 105° to 111°F or 41° to 46°C.
2. Cover the area with a sterile dressing.
   - May also use a clean sheet if the exposed area is large.
3. Notify a physician without delay.

Volume 1

# Chapter 2

# Getting Started and Basic Problem Resolutions

**Where Am I?**



## Introduction

This chapter explains the Getting Started process. It also describes some basic problem resolutions. It contains both key concepts and the step-by-step instructions to help you learn how to:

- Start the system
- Navigate through screens and menus
- Perform a daily QA
- Shut down the system
- Reset the software
- Reset the TPS
- Power down under emergencies

In addition, this chapter answers the following questions:

1. When does it warrant for an emergency shut down?
2. Name the system and workstation components.
3. What are the names of the menus?
4. Where are the volume controls are located?
5. Where is the patient alert device located?
6. What is the autoview screen?

# About... Getting Started

This section presents the concepts necessary to successfully Get Started using your MR system. Specifically you need to understand:

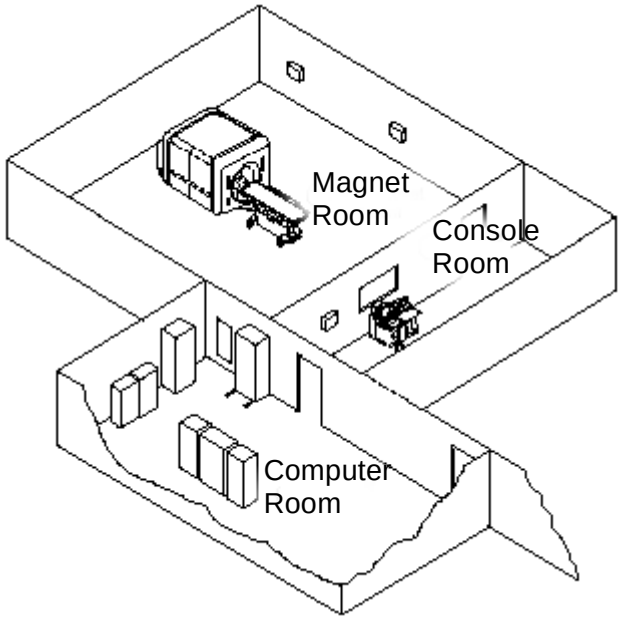
- Various MR system setup
- Mouse button configuration
- Understand what quality assurance and the benefits of performing it daily.
- Different types of MR interface menus.

## Workstation Components

There are several workstation components that need to be explained. Throughout this section you will become familiarized with a magnetic resonance suite, the magnet enclosure features, keyboarding components, mouse use and configuration of various parts of the MR workstation systems.

### Magnetic Resonance Suite

A magnetic resonance suite (MR suite), typically consist of a:




- Magnet room

- Console room
- System cabinet room (or computer room)

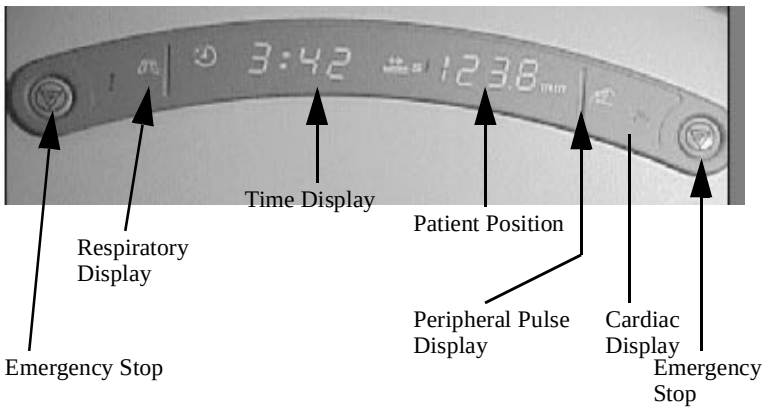
The **magnet room** houses the magnet, magnet enclosure and the table or patient transport. All of the equipment in the room should be equipment that is not harmed by the intense magnetic field. No other equipment or ferrous materials are allowed in the magnet room. Example: You should not take a metal mop bucket into the magnet room.

The magnet is the heart of the system. It is a superconducting magnet that generates the static magnetic field required for polarization if the body's nuclei. What does the magnet consist of? Well, it includes main coils usually made up of niobium-titanium (NbTi) wire embedded in a copper matrix that produce the static magnetic field. Cryogens are refrigerants which are used to cool the magnet coils. Shim coils are also used to compensate for in homogeneities in the main magnetic field. There are also gradient coils that produce the gradient magnetic fields during imaging, and RF coils that produce the RF field during imaging.

The **magnet enclosure** houses the controls used to position the patient, squeeze bulb or patient end of the patient call system, and the physiologic acquisition controller (PAC).

The controls used to position the patient are located across the top of the magnet as well as symmetrical buttons on each side.

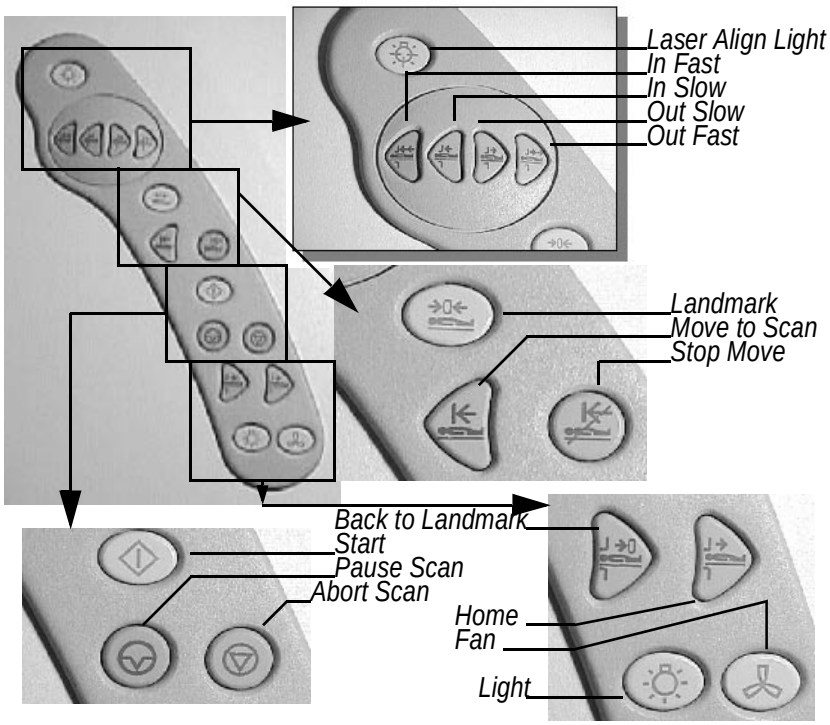
*LED Display - Located across the top of magnet.*




- **Emergency Stop** - Press to disable power to the patient handling and scan related equipment.
- **Respiratory Display** - Bar graph LED which views and indicates signal return and strength for the respiratory compensation bellows. Half or better of bar should be illuminated for indication of good signal.

- **Time Display/Patient Position** - Displays scan time and table position.
- **Cardiac/Peripheral Display** - Bar graph LED which views and indicates signal return and strength for the peripheral gating lead. Half or better of bar should be illuminated for indication of good signal. The ECG symbol blinks when the ECG leads are connected.

*Control Panel -Located on the sides of the magnet*



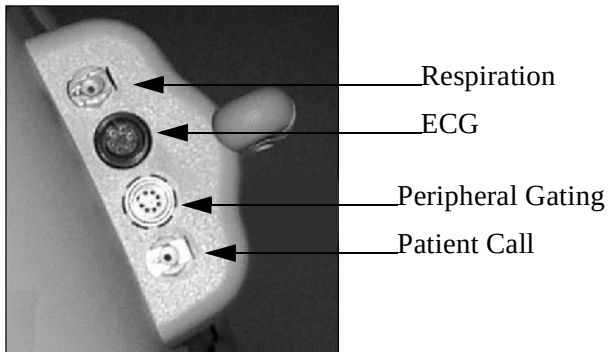

- **Laser Align Light** - Turns all alignment lights on or off. Alignment lights turn off automatically when Move to Scan is pressed. When the alignment lights are on, this button is lit and the landmark on message is posted on the status panel. Alignment light cannot be used during scans or emergency stops.
- **In Fast** - Provides quicker cradle movement by advancing the transport at 4 inches per second, as long as the table is docked and emergency stop is not active. This button can override any other cradle command, such as Move to Scan.
- **In Slow** - Provides slower cradle movement by advancing the transport at .5 inches per second, as long as the table is docked and emergency stop is not active.

- **Out Slow** - Provides slower cradle movement by retracting the transport at .5 inches per second, as the table is docked and emergency stop is not active.
- **Out Fast** - Provides quicker cradle movement by retracting the transport at 4 inches per second, as long as the table is docked and emergency stop is not active. This button can override any other cradle command, such as Move to Scan.
- **Landmark** - Enters the landmark being defined with the laser alignment lights. It does not function during active or paused scans or emergency stops.
- **Move to Scan** - Advances the defined landmark to magnet isocenter. It works either before or after a scan as long as the transport is docked and at maximum height.
- **Stop Move** - Halts in-and-out cradle movement. Also located on the operator's console, this button overrides any other cradle motion command, such as Move to Scan.
- **Back to landmark** - Returns the table back to last landmarked position. Back to Landmark cannot be used during scans or emergency stops.
- **Start** - Restarts a study if: Pause Scan has been pressed, the scan room door opens during a scan, cradle motion exceed 2mm.
- **Pause Scan** - Temporarily halts scanning. One consequence of Pause Scan is that image quality can be affected if the patient moves or breathes differently when the scan is resumed.
- **Abort Scan** - Aborts a scan during either prescan, an active scan, or after Pause Scan is pressed. Once selected, the scan cannot be restarted using the Start Scan hard key. **[Scan]** has to be selected on the display desktop, which starts the scan from the beginning.
- **Home** - Returns the table to the home position, fully retracted on the patient transport.
- **Fan** - An On/Off switch which controls the circulation of air within the magnet opening to help reduce the claustrophobia some patients experience. It should remain on at all times.
- **Light** - Controls the light within the magnet opening to help reduce the claustrophobia some patients experience. It may remain on at all times. A timer

automatically turns off the light after one hour if the scan table is undocked or lowered, or if the cradle is in the home position. The light automatically turns on again when the table is re-docked and the cradle leaves the home position or when the cradle is in use.

## PAC (Physiologic Acquisition Control) Unit

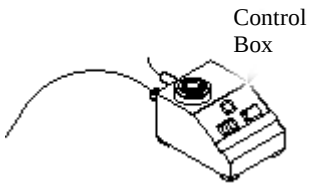
The Physiologic Acquisition Control is the system component from which the ECG leads, peripheral gating device, and the respiratory bellows are all connected. It can be located on either side of the magnet. There is a cable routing device attached to the PAC unit that is designed to keep the cables separated.




- **Respiration** - The port for the respiratory compensation bellows.
- **ECG** - A six pin connection for either the thin film or high impedance ECG leads.
- **Peripheral Gating** - A two port fiber optic connection for the peripheral gating lead.
- **Patient Call** - A patient activated system that allows a patient to signal for assistance during a scan.

The patient end of the patient alert system is also located on the magnet. It plugs into the PAC unit. The patient is given the rubber ball end of the alert system and when squeezed a loud audible sound is heard in the control room. This sound pattern can be changed to either pulsed or steady. A toggle switch on the control box selects the sound pattern. The control box is

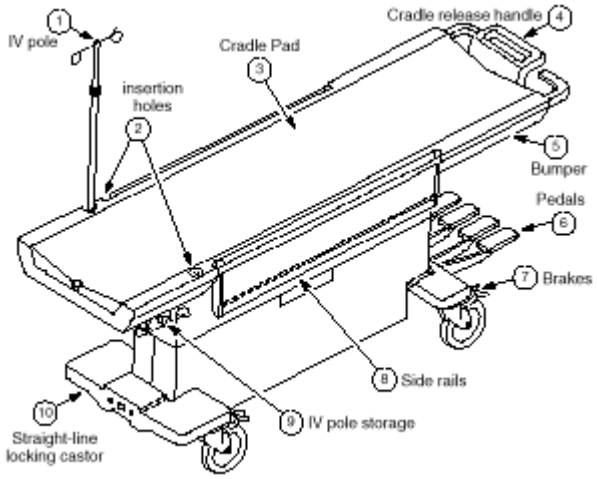
typically located on the operator's console, or mounted on the wall close to the desk.




NOTE: Be careful not to pinch the cable that connects the squeeze ball to the PAC unit, in the table. This could resound the patient alarm continuously and cause table cradle obstruction. Have an engineer check cable if you feel there might be a tear in the cable. If a tear has occurred, the patient alarm may not function properly.

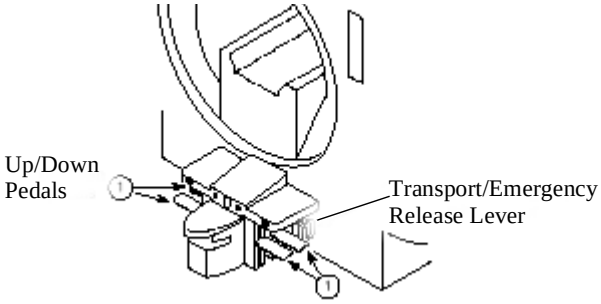
## MR Table/Patient Transport

The table or patient transport is used for patient positioning. It




can be removed from the scan room to simplify positioning patients and to speed scan room evacuation in emergency

situations. The transport supports 350 pounds. The rails in arm board position support 250 pounds.



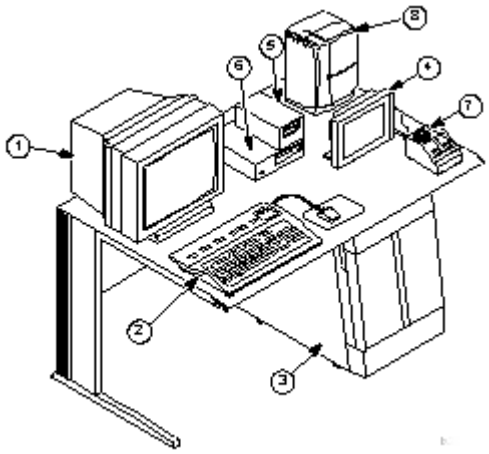

The patient transport connects to the base of the MR unit. It consists of Up/Down pedals, located on both sides of the magnet. And a transport/emergency release lever, located on the right side of the magnet.

NOTE: Arm boards need to be raised when using the table to move patient between rooms

- Someone must assist patient on and off the table.
- The table must be at the proper height.
- When loading the table when it is undocked in another room, the wheels must be locked.

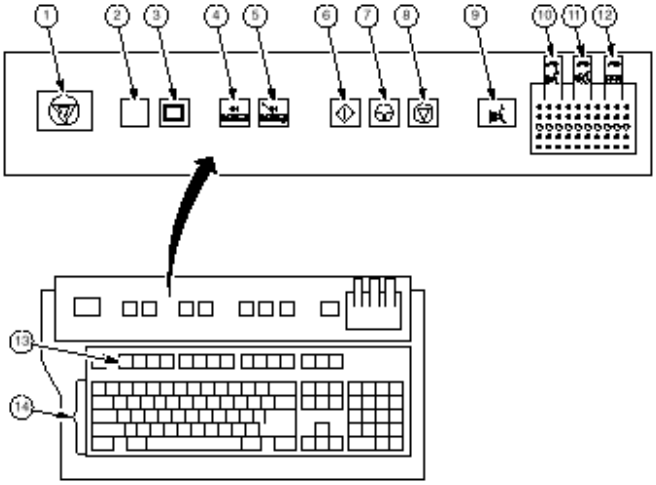
## Console Room

The console room, also called the control room is the room designed from which the technologist scans from and monitors the patient. It holds all of the necessary system components designed to accomplish scanning. Your MR system has several components in this room.



| ***No.*** | ***Description*** | ***Function*** |
|---|---|---|
| **1** | Workstation Monitor | Monitor that displays images and scan display, archive & network program information. All routine operations are carried out from this workstation monitor. |
| **2** | Keyboard & Mouse | Allows for communication to the workstation monitor and PC monitor. |
| **3** | Workspace Cabinet | The right side of your workspace cabinet houses archive devices and CD-ROM for the MR system.(This CD drive is primarily used by the GE engineers.) The left side houses the PC computer, a CD-ROM drive and a floppy disk port. |
| **4** | PC Monitor | Displays the CBT (computer based training) programs, on-line documentation, ECG, and Peripheral gated and/or respiratory wave forms. Note that the waveforms are not to be used for physiological monitoring. The patient's condition may not be accurately reflected, resulting in improper emergency treatment. Communicate with this monitor through the keyboard and/or mouse. Switch between monitors with the button on the keyboard. |
| **5** | DAT tape (optional) | Archive device to load images from a Signa Horizon onto the Signa system. The device can be placed into the right side of your workspace cabinet. |
| **6** | MOD (optional) | This option is an archive device to load images from a Signa Horizon onto the Signa system. The device can be placed into the right side of your workspace cabinet. |
| **7** | Patient Alert Reset Device | The reset device turns off the patient call alarm. |
| **8** | Computer | Desktop computer controls your MR system operations. |

There are also several buttons to point out on the keyboard:

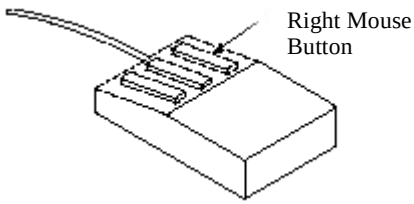


| ***No.*** | ***Description*** | ***Function*** |
|---|---|---|
| **1** | Emergency Stop | Press to disable all electrical power sources near the patient. It shuts down the RF, gradient amplifier, table movement, shim power supply and main MRI magnet power supply cabinets. It will not quench the magnet nor, turn off the computer. |
| **2** | Blank Key | This key has no function. |
| **3** | PC Icon | Press this key to transfer keyboard and mouse control between the PC monitor and your workstation monitor. |
| **4** | Move to Scan | Press to move the cradle to scan position. Release Move to Scan to stop the cradle. The system often posts a message in the system status display to prompt the user to press it. |
| **5** | Stop Move | Press to stop the cradle if it is moving. |
| **6** | Start Scan | Press to resume scanning after Pause scan or during scans for breathed techniques. |
| **7** | Pause | Press to stop the scan temporarily. |
| **8** | Stop Scan | Press to abort a scan during prescan, an active scan, or after pressing Pause scan. No data is reconstructed. |
| **9** | Talk | Press to activate the intercom system so you can speak to the patient inside the bore. Release Talk button to listen to the patient. |
| **10-12** | Volume Controls | These three controls regulate the volume for the patient communication system. Left control=MR operator at operator console. Middle control=patient in bore. Right control=not active. |
| **13** | Function keys | Press these keys for short cuts in certain archive procedures. |

| No. | Description | Function |
|---|---|---|
| **14** | Alphanumeric keyboard | Use the keyboard for entering information in text box, for annotating images, and for entering basic information such as filenames and network commands. Press **Delete** or **Backspace** to erase characters from the text box. Press **Enter** to confirm what is typed or selected. Press **Tab** to move across the areas on the current screen, on the scan and protocol desktops. Press the Up or Down arrow keys to move from one text box to the next on the scan and protocol desktops. Press the Up, Down, Left or Right arrow keys to adjust the window width and window level on the display desktop. |

## Mouse Basics

The mouse is the primary tool for interacting with the workstation. It allows selections to be made from the desktop, window/level adjustments, and image scrolling and magnification. Because the mouse performs most tasks easily, the keyboard is not used often. The mouse is a hand-held device that moves across the surface of a mouse pad. The mouse should always be operated on its mouse pad. Moving the mouse to the right causes the pointer on the screen to move to the right, and so on. If you've never used a mouse before, it does involve physical skill that requires practice - especially double-clicking.




The mouse has four main functions.

- Moving the pointer to position the cursor in a text box.
- Clicking on an area of the screen by pointing to it and pressing the mouse button (usually the left). This single-click function highlights an option, positions a cursor in a text box, and toggles a toggle button on or off.

- It is used to double-click on an option or function by pointing to it on the screen and then clicking the mouse button twice in rapid succession. In this example, a single click highlights, and the second (double) click finalizes, or selects, the highlighted option.
- It is used to press and drag; which means to press and hold a button while moving the mouse across the pad (and the cursor across the screen).
- It can also be configured for temporary left handed operation on your system. You need to change this every time you boot the system; the system default is for right handed operation. To change, boot the system all the way to the Signa ScanRx Desktop; open a command window and type: **`mouse`**. In the pop-up box change the mouse mapping to left handed. This setting lasts until changed back or the system is logged out of Signa scanning software.

Something to Think About...

- The mouse does not respond as expected. For example, you are using the middle mouse button to W/L but instead the magnifying glass is enabled, or you select a single item in the Display Browser and multiple items are selected.
- Toggle **Shift**. This problem can occur when **Shift** is depressed while the mouse is in the process of transitioning between the Signa system and the PC. Press **Shift** again to put the mouse into the proper mode.

## System Cabinet Room (Computer Room)

The System Cabinet Room houses the power distribution unit, RF, gradient and system control cabinets. The water chiller, shield cooler compressor and other equipment are also located here.

NOTE: The system cabinet room is often still called the computer room because it used to house the computer; however, the computer is now located in the console room.

This room is usually kept at very cool temperature, in order to keep the equipment in here from over heating. If you have any questions about the temperature settings, or the equipment kept in this room please consult your local GE Engineer.

## Quality Assurance

Quality control is an important part of the daily start-up procedure. Performing a daily QA test allows, you to make sure that your system is operating before you bring a patient in for scanning.

Document any changes in the operation of the system and list the changes in the service logbook. To help the service engineer pinpoint problems with the system, record any minor system repairs that are needed in the service logbook.

*Service Desktop Manager Menu*


# Desktop Organization

Your system interface is organized into desktops based on function. There are six main desktops: ScanRx Desktop, Protocol desktop, Display desktop, Image Management desktop, Service Desktop, and the InSite Interactive desktop.

The **ScanRx Desktop** 

is used for image acquisition and allows:

- Patient registration
- Protocol selection
- Selection of scan prescription
- Display of scan manager
- Prescanning
- Scanning
- Protocol creation

The **Protocol Desktop**  is used to pre-register patients, link existing protocols to registered patients and build new protocols.

The **Display Desktop**  is used for image display, post-processing applications and image management. The Display Desktop allows:

- Image display with basic functions
- Post-processing with specialized applications packages
- Archiving
- Networking
- Removing images

The **Image Management Desktop**  is used for networking of images to and from different system linked to system.

The **Service Desktop**  is used for Utilities functions and Shutdown functions. The Service Desktop allows:

- GE Service Engineer use
- Calibration and checks
- System Diagnostics
- Install
- Message
- TPS Reset
- System Shutdown
- C Shell
- Monitor Setting
- Restore/Save Protocols
- Configuration of coils

The **ilinq Desktop** 

is used to communicate with the GE OnLine Center about or question regarding your MR system. This information is sent to an OnLine Center Engineer or a GE Applications Specialist. This is a purchasable option.

## Types of Menus

Your MR system uses three main types of menus.

- The Display Browser screen - list the patient exams, series and images. The menu bar at the top of the Browser contains selections that activate sub-menus for:
  - Selection mode
  - Sort mode
  - Removing images
  - Networking images
  - Archiving images
  - Queue management
  - Service window
  - Message window
- The control menu - contains options for system setup, fault recovery, service functions and general utility functions.
- The root menu - contains options for system setup, fault recovery, service functions and general utility functions.

## Basic Problem Resolutions

This section of the chapter lists a few basic problems and their resolutions. This section is not designed to address all system problems. If you have any problems not addressed in this section please contact your local GE Service Engineer.

- If the monitor goes blank - Move the mouse, if screen does not return reboot the system. If system does not power up properly contact service.
- If the message screen displays a reset TPS message - Switch to Service Desktop. Click **[Reset TPS]** on the service desktop clipboard.
- If the screen locks or freezes & mouse elicits no response - Follow the procedure for a system reboot.
- If smoke or odor associated with electrical overheating, or a series of very loud two-tone blasts, like a foghorn occur- Press the emergency stop button, evacuate the patient, evacuate the MRI suite, then call service.
- If there is a fire in the computer room - Press the emergency off button, evacuate the MRI suite, call the fire department, then call service.
- If the system message displays "*The patient comfort level is warmer than normal*" - Stop scanning and check that bore fan is on. If the fan is on, contact service.
- If the mouse does not respond as expected. For example: Window W/L control is expected but depressing the middle mouse button enables the magnifying glass instead; or you are unable to select a single item in the Browser, instead, multiple items are highlighted. Try pressing the Shift key. This should place the mouse into the proper mode.

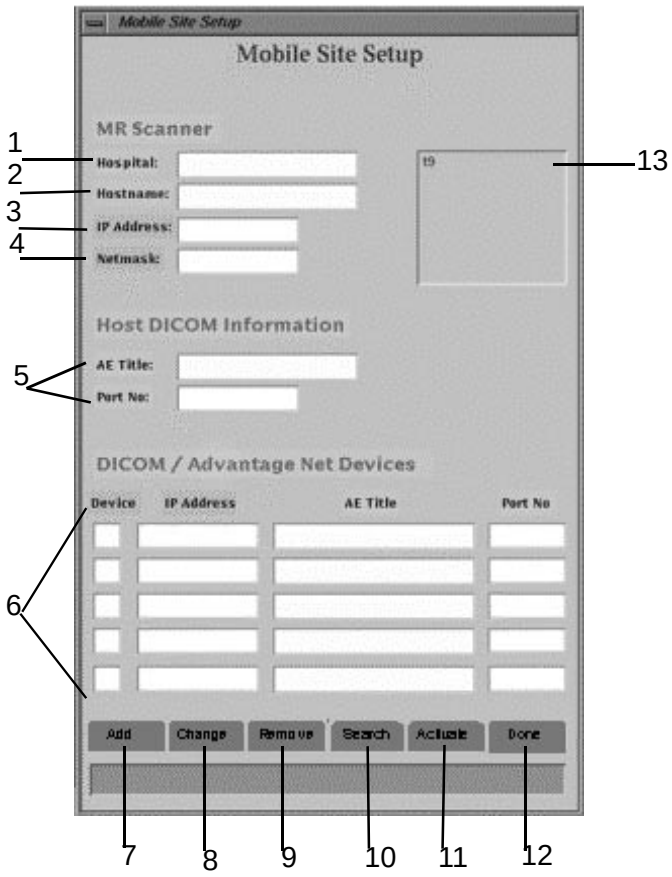
NOTE: For more basic problem resolution procedures see the detailed section of this chapter.

## Mobile Site Configuration

The first time you start your mobile system you need to perform a brief configuration, called the mobile site setup. This is where data concerning a specific site, such as Facility Name, IP address, and network DICOM information is input.

This window allows you to configure a mobile scanner for specific sites. Once the mobile site information has been

entered, it can be retrieved each time the scanner is at that location.The data for a facility can also be changed or updated from this window.




- **1- Hospital Name** - Enter the hospital name (up to 30 characters using A-Z, a-z, 0-9, &-only).
- **2 - Hostname** - The system's host name can consist of up to 30 characters, and is stored in the configuration file. A service engineer enters the system's host name initially.
- **3 - IP Address** - An IP Address is four integers with three dots between them that uniquely identifies the computer on the network. Consult a service engineer for this information.
- **4 - Netmask** - Netmask should be in hex digits. Consult a service engineer for this information.
- **5 - AE Title and Port No.** - Host DICOM information is optional for mobiles that interface with a Network DICOM device. Consult a service engineer for this information.

- **6 - Network DICOM Devices** - Used to add up to 5 Network DICOM Devices that interface with the mobile. Consult a GE Service Engineer for a list of IP Addresses, AE Title and Port No.
- **7 - Add** - Click **[Add]** to add a hospital to the list.
- **8 - Change** - Click **[Change]** to edit or modify previously stored hospital information.
- **9 - Remove** - Click **[Remove]** to delete a hospital from the list.
- **10 - Search** - Click **[Search]** to find a hospital on the list. Search options are executed by either hospital or hostname.
- **11 - Activate** - Click **[Activate]** to activate the selected hospital.
- **12 - Done** - Click **[Done]** to exit the Mobile Site Setup screen.
- **13 - List of Previously Entered Hospitals** - Select the desired hospital from this list to display the data or to change to a different hospital.

## Save Raw Data

The service engineer may request you to save raw data if an image reconstructs with an artifact or distortion. Raw data is the unreconstructed data that is used to create the image.The service engineer can use this information to help determine the cause of the artifact or problem.

The system will not automatically save the raw data, you must direct the system to save the raw data. Later in the chapter, the steps are provided to save the raw data to the system disk.

Something to Think About...

- Because the raw data resides in the temporary memory of the system, it is imperative to save the raw data **before** downloading the next series in the exam (save raw data before clicking **[Save Series]** or **[Prepare to Scan]**).
- It is only necessary to save raw data to the system disk, if there is intermittent trouble with artifacts, or if it is requested by a service engineer.

# How to Get Started Using Your System

This section provides the step-by-step instructions for getting started using your MR system. Specifically, it describes how to:

- Configure a mobile site
- Power on the MR system
  - Start your mobile system
  - Start your stationary system
- Navigate through screens and menus
- Perform a daily Quality Assurance test (QA)
- Shut down your MR system
- Reset the TPS
- Save Raw Data
- Power down under Emergencies
- Get help

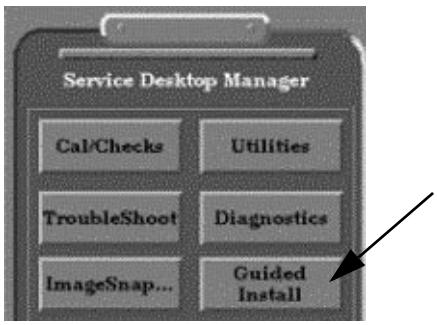
# Configure a Mobile Site

The first time you start your mobile system you need to perform a brief configuration, called the mobile site setup. This is where data concerning a specific site, such as Facility Name, IP address, and network DICOM information is input. Entering the data at this time saves you from re-entering the data each time you alternate sites.

The data is entered on the Mobile Site Setup window, accessed from the Service desktop. This window allows you to configure a mobile scanner for specific sites. Once the mobile site information has been entered, it can be retrieved each time the scanner is at that location.

1. Click Service desktop from the control panel.

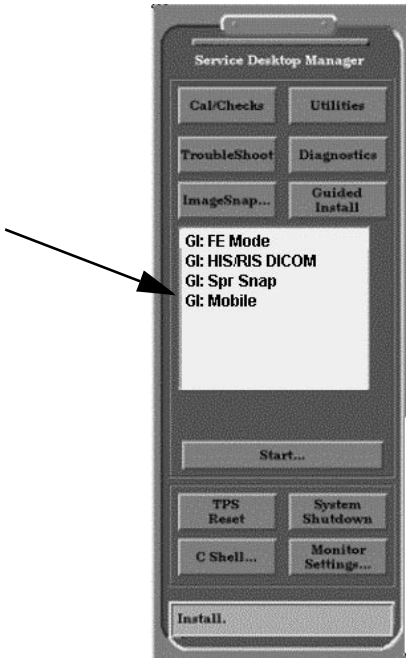
2. Click **[Guided Install]**.




## In Brief: Configure a Mobile Site

1. Click Service desktop.
2. Click **[Guided Install]**.
3. Select **GI: Mobile**.
4. Click **[Start]**.
5. Enter the password.
6. Click **[Add]**.
7. Enter the data.
8. Click **[Add]** to add another site.
9. Click **[Done]**.

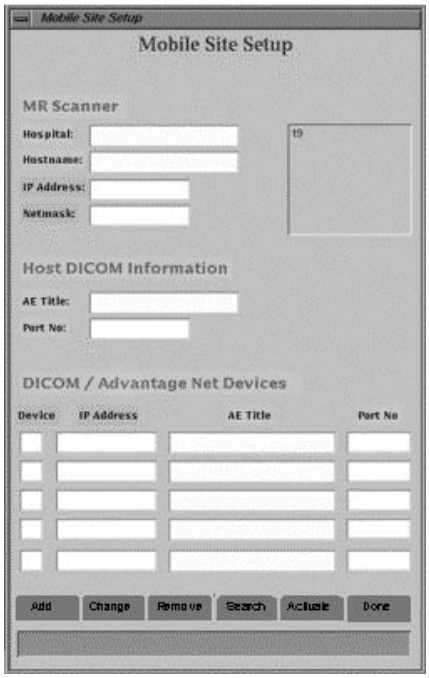
3. Select **GI: Mobile**.




4. Click **[Start]**.

5. Enter the password in the command window. Contact your service engineer to give you this password.

   - The Mobile Site Setup window appears.



6. Click **[Add]** to start and enter information into the Mobile Site Setup window.
7. Enter the data, in the text box, that applies to that specific site.
8. If you need to add another site, click **[Add]** and enter the data.
   - Before going on to the next step you should continue to add all other facility names and information to the system.
9. When all site information has been entered, click **[Done]** to close the Mobile Site Setup window.

## In Brief: Start Your Mobile System

1. Power **On** the Octane.
2. Type in **`mobile`** for the login name, and **`adw2.0`** for the password.
3. Click **[Guided Install]**.
4. Select **GI: Mobile**.
5. Click **[Start]**.
6. Enter the password in the command window.
7. Select a hospital/facility.
8. Click **[Activate]**
9. Click **[Activate Site].**
10. Click **[Done].**
11. Click **[Yes].**
12. Click **[Reboot]** and then click **[Enter].**
13. Click **[Signa]** and then click **[Enter].**
14. Type in **`adw2.0`** as the password.

### Power on the MR System

# Start Your Mobile System

Once your Mobile sites have been configured, you routinely start your system this way:

To recall and activate the site use the following steps.

1. Locate and press the **On/Off** Power Button on the Octane component.
2. Once Login screen appears type in **`mobile`** for the login name, and **`adw2.0`** for the password.
3. Click **[Guided Install]**.
4. Select **GI: Mobile**.
5. Click **[Start]**.
6. Enter the password in the command window. Contact your service engineer to give you this password
7. Select a hospital/facility from the list at the Mobile Site Setup window.
8. Click **[Activate]** on the Mobile Site Setup window.
9. Click **[Activate Site]** on the Mobile Site Activation window.


10. Click **[Done]** on the Mobile Site Setup window.

11. Click **[Yes]** on the Exit Mobile GUI menu.


12. Click **[Reboot]** and then click **[Enter]** on the Login screen.
13. Click **[Signa]** and then click **[Enter]** on the Login screen.
14. Type in **`adw2.0`** as the password.
    - The system displays the selected facility's information.

## Power on the MR System

# Start a Stationary System

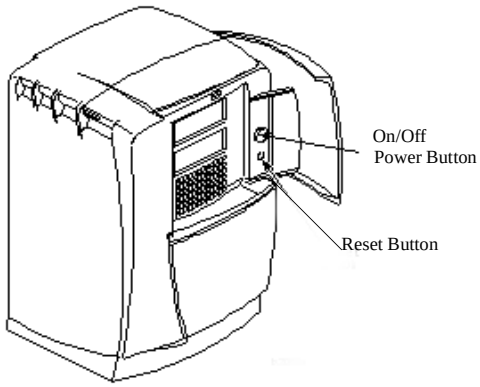
### In Brief: Start a Stationary System

1. Open the door on the aqua Octane machine. Press **[On/Off]**.
2. Wait for the log-in password screen appears. In login box type-in **`signa`**. In the password box type-in **`adw2.0`**.
3. Click **[Login]**.
4. Wait and do not interact with the system until it has fully powered up. (To know the system has fully powered up, look for the desktop, Rx Manager, Patient register, and Autoview windows.)

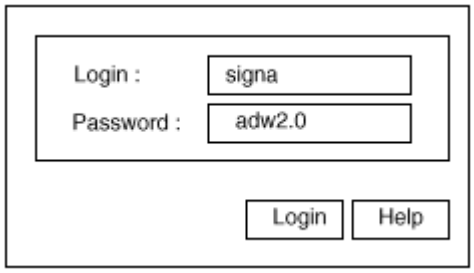
One of the first things you would want to know how to do is, start your new MR system. The steps listed below describe how this is done. There are two parts to this section, the first is starting a stationary system, the second is starting a mobile system.

NOTE: Mobile systems are defined as systems which are used to perform scans from more than one institution.

1. The **[On/Off]** is located within the octane computer. Open the door to the octane and then press this button.




2. System comes up to the login/password screen. From here type-in the login name, which is **`Signa`** and the password of **`adw2.0`**.




3. When finished entering the information, click on the **[Login]**. Your system then starts to come up.

NOTE: A message may appear across the screen stating *Do not interact with the system until this message disappears.* You should not at this time use the mouse or the keyboarding keys as to not delay the start up process.

4. The start up process usually takes about 5 minutes. Your system is ready when the message disappears and the desktop, Rx manager, Patient register and the Autoview windows appear.

# Navigate Through Screens and Menus

This section does not include any quick steps. All steps for screen navigation is discussed below.

1. To open a desktop, use the mouse to position the cursor on the icon you wish to open and then click with left mouse key.
2. To change desktops, click on the icon of the desktop that you want to change to. You do not need to close the desktop that you're on.
3. When entering data into a text box:
   - Use the mouse to position the cursor in the text box
   - Click once using the left mouse key
   - Enter your data
   - If text is already in the text box, use the mouse to position the cursor in the text box
   - Click and drag the left mouse over the text
   - Press the **Backspace** or **Delete** key on your keyboard
   - Enter your new data
4. When a message box appears, read message, click **[OK]** to close the box.

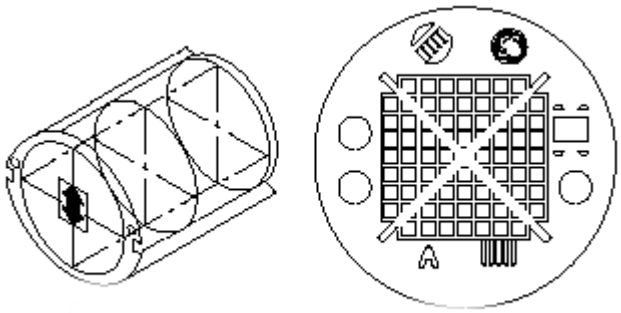
NOTE: Unless you click OK, you will not be able to proceed otherwise.

5. Right-click the title bar to access the control menu for a window.
6. Right-click and hold the background to access the root menu. Drag to the desired item.
7. Use the quit selection to exit the film composer and display applications. Do not use the iconify function.

# Perform a Daily QA Test

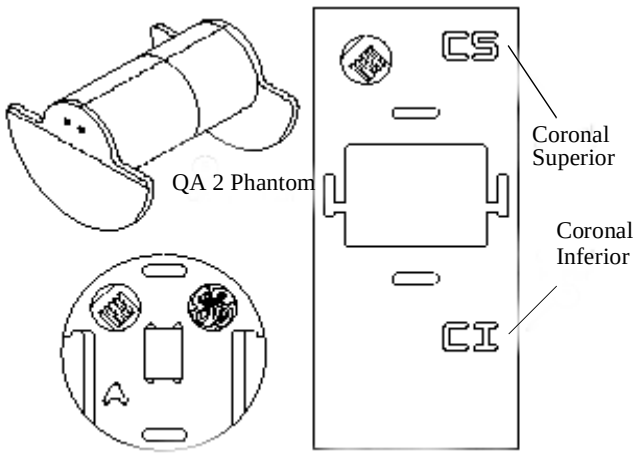
For this procedure you need to use a QA phantom. It acts to simulate the weight of a particular body part. After performing the procedure it provides useful information about the quality of your scan. There are two QA phantoms that are being used. One is simply called the QA phantom and the other is called the QA 2 phantom. Please be aware when discussing the QA phantom, either or could be used.

*QA Phantom*



QA Phantom  Axial Plane Image

*QA 2 Phantom*




QA 2 Phantom  Axial Plane Image  Coronal Plane Image

## In Brief: Perform a Daily QA Test

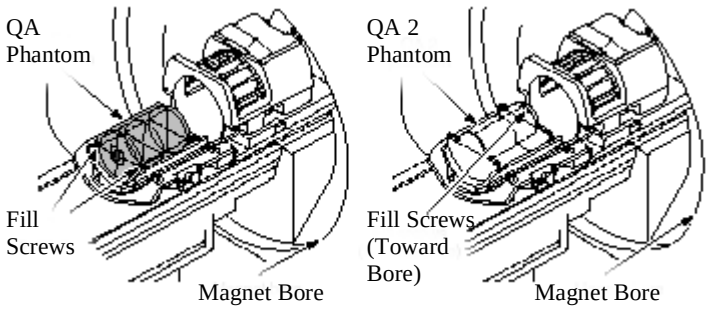
1. Select **[New Patient]**.
2. Enter the patient information.
3. Place head coil on trolley and attach base to trolley.
4. Position the phantom in the coil.
5. Slide the head coil cover over the phantom and align.
6. Slide the head coil cover away from the phantom.
7. Press **[Laser Alignment Light]**.
8. Press **[In Slow]**.
9. Rotate phantom until the sagittal line and alignment light are superimposed.
10. Press **[Landmark]**. Slide the head coil cover the phantom.
11. Press **[Move to Scan]**.
12. Now enter in the protocol.
13. Click **[Save Series]**.
14. Select **[Auto Prescan]**.
15. Click **[Scan]**.
16. Perform scan in coronal and sagittal planes.
17. Examine the images.

1. Click **[New Patient]**.

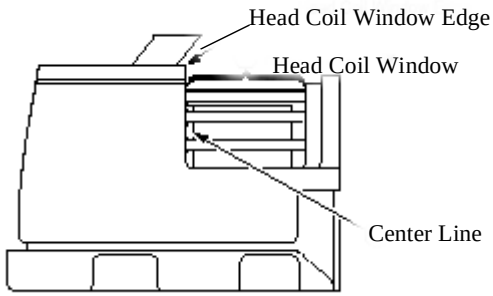
2. Enter the patient information by typing in **`Profile`** for the patient ID, a weight of 100 and other data deemed necessary.

3. Remove pads and straps from the head coil base. Place head coil cover on trolley and attach base of head coil cover to the patient transport.

4. Position the phantom in the coil base as shown below for the appropriate phantom.




5. Slide the head coil cover over the phantom and align the axial black line on the phantom with the top edge of the head coil cover window.




6. When aligned properly slide the head coil cover away from the phantom.

7. Press **[Laser Alignment Light]**.

8. Press **[In Slow]** until the cradle moves into to the bore far enough so the alignment light is centered over the axial line on the phantom.

9. Rotate the phantom until the sagittal line on the phantom and sagittal alignment light are superimposed.

10. Press **[Landmark]**. Slide the head coil cover into position.

11. Press **[Move to Scan]**. Cradle now moves to the landmarked position inside the bore.

12. Now enter in the protocol for the scan:

| SERIES | PATIENT ENTRY | POSITION | LANDMARK | COIL | SCAN PLANE |
|---|---|---|---|---|---|
| Axial Protocol | Head | Supine | Other | Head | Axial |

| MODE | PSD | OPTION | FLIP | TE | TR | FOV | THICKNESS |
|---|---|---|---|---|---|---|---|
| 2D | SE | None | --- | 20 | 300 | 24 | 10 |

| SPACING | START | END | FOV CENTER | ACQ. MATRIX | NEX | CONTRAST | AUTO CF |
|---|---|---|---|---|---|---|---|
| 10 | 50 | 10 | -- | 256x256 | 1 | No | Peak |

NOTE: Once protocol has been imputed you can now save this as your site's QA protocol by simply clicking on **[Save Rx as Protocol]**, located in the lower left corner of the screen. Make sure to name the protocol, something everyone in the department can remember. *Ex. QA Test.*

13. Click **[Save Series]**.

14. Click **[Auto Prescan]**. Once completed, record the R1, R2, TG and transient frequency values in the service log book for reference. These records can help service diagnose system problems in the future.

15. Click **[Scan]**.

16. Perform scan again in the coronal and then the sagittal planes and record values.

17. Now using the autoview, scroll through images using the left mouse key and sliding the autoview slide bar to the top. Verify that each image looks similar to the illustrations at the beginning of this section for the appropriate phantom image. If a discrepancy or change in image quality is noted, for example if the C on the coronal image is backwards, contact the service engineer.

# Shut Down your MR System

## In Brief: Shut Down your MR system

1. Wait for image reconstruction and archiving to complete.
2. Make sure you have ended the exam by clicking **[End Exam]**.
3. Go to the **Display Desktop**. Click **[Archive]**, then select **[Detach]**. Remove MOD from archive device.
4. Click **Service Desktop**. Click **[System Shutdown]**.
5. Confirm your selection.
6. When the startup screen appears, press **[On/Off]** on the Octane component.

NOTE: Step 6 can be bypassed if you choose to leave system at the startup screen. Consult your local service engineer on which option you should choose.

NOTE: All mobile system should complete step 6 before moving system.

A system shutdown terminates power to the systems electronics in an orderly fashion so image files are saved. This procedure does not turn off power to the MRI magnet, safety rules should still be followed to prevent injury or damage to the magnet.

1. Before you shut down your system, make sure all images have reconstructed and are available for display from the Display Browser.
2. Also make sure you have clicked **[End Exam]**.
3. Wait for all Archive and Network functions to be complete. Click **[Detach]**, located under Archive on the display menu bar. Then remove the MOD from the optical disk drive.

NOTE: By removing MOD prior to shutdown, helps to prevent MOD corruption.

4. Now click on the **Service Desktop**  icon, then click **[System Shutdown]**.
5. Confirm your selection with the left mouse button. The Desktop disappears from the monitor and eventually the startup screen appears.
6. When system reaches this point it is safe to terminate it's power by pressing **[On/Off]** located in the Octane component. System screen now goes blank.

NOTE: If you only want to shutdown for a few hours, bypass step 6. When step 6 is omitted the screen goes blank after a short while, as it enters the screen save mode. To view the screen again simply move the mouse. If having trouble deciding whether or not to leave system at the startup screen or terminate power, please consult your local service engineer.

# Reset the TPS

Resetting the TPS is one way to safely recover from many errors and conditions. You need to perform this procedure when the system prompts you to or when told to by an InSite Technician.

NOTE: Performing a TPS reset in the middle of a scan or reconstruction stops the process and image data is lost. It takes a few minutes for the system to go through the complex process of resetting itself, and the system cannot be used until it is finished. If there is a patient on the table, the patient landmark is lost, and the landmarking process must be repeated.

1. Select the **Service Desktop**  icon.
2. Click **[TPS Reset]**.
   - TPS stands for Transceiver Processing and Storage, it is a subsystem of your Signa system which oversees all processing of raw data after its acquisition. The TPS is housed in your system cabinet, located in your computer room.
3. Confirm your selection.
4. Check for a *"TPS successfully reset*" message in the system status display message box. Now you can re-landmark and resume scanning.

## In Brief: Reset the TPS

1. Select the **Service Desktop** icon.
2. Click **[TPS Reset]**.
3. Confirm your selection.
4. Wait for *"TPS successfully reset"* message to appear in the status display message box. Re-landmark and resume scanning.

# Save Raw Data

## In Brief: Save Raw Data

1. Click **Service Desktop**.
2. Click **[Utilities]**.
3. Select **Raw File Manager**.
4. Click **[Start]**.
5. Click **[Options]**:
   - **Save by pass.**
   - **Save by slice**.
6. Select the data.
7. Click **[TPS to Disk]**.
8. Select **File > Exit**.

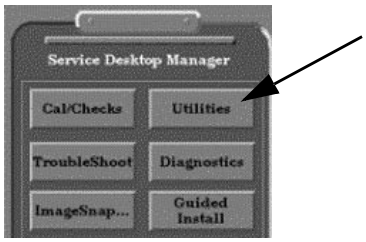
You may be asked by the service engineer to save raw data if you an image appears with an artifact or distortion. The service engineer can then use this information to help determine the cause of the artifact or problem. The following provide the steps to save the raw data to the system disk the raw data that was used to create the image.

Something to Think About...

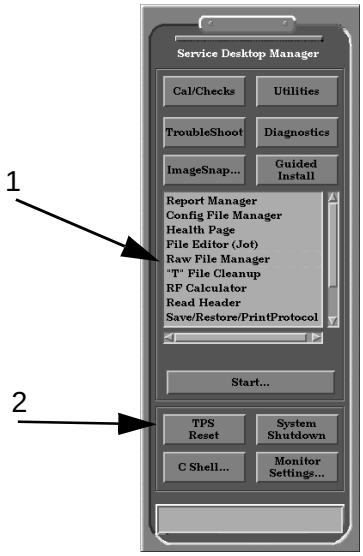
- Because raw data resides in the temporary memory of the system, it is imperative to save the raw data **before** downloading the next series in the exam (save raw data before selecting **[Save Series]** or **[Prepare to Scan]**).

1. Click **Service Desktop**.

2. Click **[Utilities]** from the Service Desktop Manager.

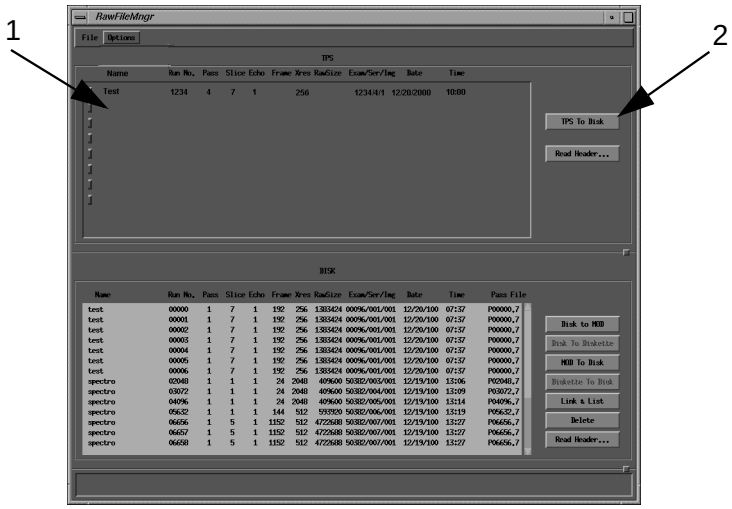



3. Select **Raw File Manager** (1) from the list.



4. Click **[Start]** (2).

   *The Raw File Manager (RawFileMngr) window appears.*




5. Click **[Options]** and then click one of the 2 options to save raw data:


   - **Save by pass**, to save the entire series.
   - **Save by slice**, to save only selected slices.

6. Select the data from the TPS (1) part of the window.

7. Click **[TPS to Disk]** (2).
   - The raw data is saved to the hard disk of the system, until it is removed.

NOTE: Raw data uses disk space, and as the disk becomes full system performance can be degraded.

8. Select **File > Exit** to close the RawFileMngr window.

# Power Down Under Emergencies

## In Brief: Power Down Under Emergencies

1. Press any **[Emergency Stop]**.
2. Evacuate the patient. Refer to chapter one for more detail on this.
3. Evacuate the MRI suite.
4. Contact your service engineer.

It is very simple to do an emergency shut down the on your MR system.

If you experience any system over heating, smoke, or odor associated with the system, this would be a few good reasons for emergency power down.

1. Press any **[Emergency Stop]**. Stops power to the magnet room.
2. Evacuate the patient. Refer to chapter one on responding to patient emergencies for more detailed instruction.
3. Evacuate the MRI suite.
4. Call service. After service has examined the system the correct cause of the emergency should be written down for future reference.

Volume 1

# Chapter 3

# Scan Rx Desktop

### Where Am I?


## Introduction

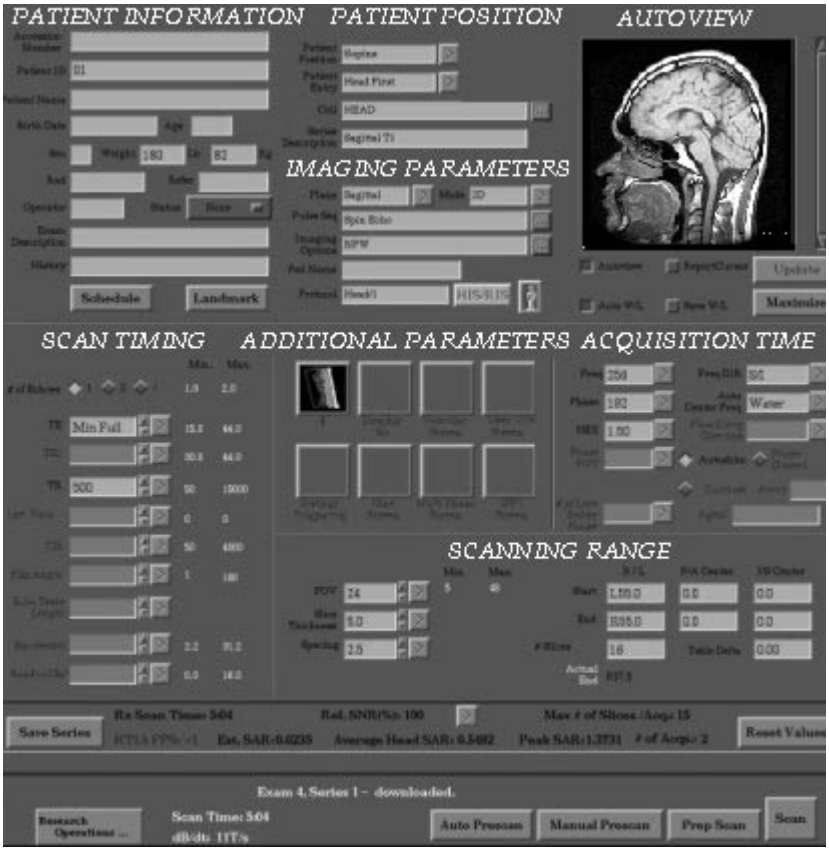
This chapter is an introduction to the scanning operations performed on the Scan Rx Desktop. It contains key concepts and guidelines on the user-friendly graphic areas contained in the desktop. This section describes the basic features of the Scan Rx Desktop and provides instructions to help you navigate through the required areas.

The Scan Rx Desktop is designed for one-screen scanning operation. The desktop provides the means for:

- Patient Registration
- Protocol Selection
- Scan Prescription
- Rx Manager
- Scan Initiation
- Prescan
- Protocol Creation

The Scan Rx Desktop environment provides all the clinical tools necessary for comfortable, efficient set-up of patient studies. These tools include patient scheduling and data entry, exam protocol selection, protocol viewing and editing with graphic prescription, scan data acquisition, image reconstruction, and dual AutoView image display layouts.

The Scan Rx Desktop opens when you click on the **Scan Rx** icon located in the control panel.




*Scan Rx Desktop*

# About... the Scan Rx Desktop

This section presents the concepts necessary to successfully understand and complete the primary functions of the Scan Rx Desktop areas and windows. The Scan Rx Desktop opens progressively. As you complete the information required for each area, another is available to access and complete. Specifically, you need to understand the following areas and the text boxes contained prior to scanning:

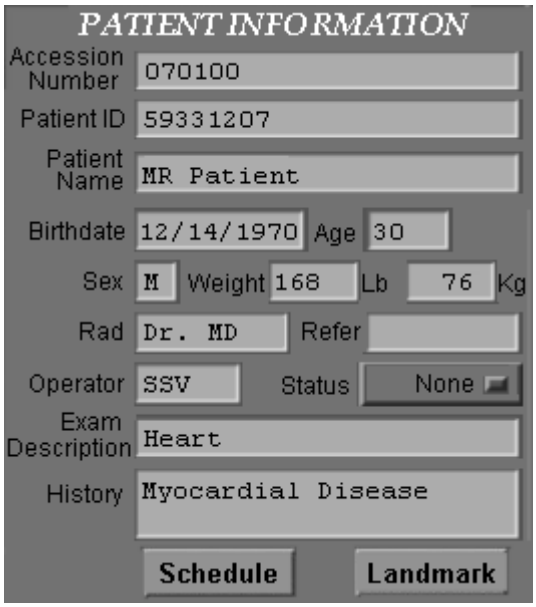
- Patient Information
  - Abbreviated Patient Information
- Patient Position
  - Patient Position
  - Patient Entry
  - Coil Type
  - Series Description
- Imaging Parameters
  - Imaging Plane
  - Imaging Mode
  - Pulse Sequence
  - Imaging Options
  - PSD Name
- Autoview Window
  - Autoview
  - Report Cursor
  - Update Images
  - Auto Window/Level
  - Save Window/Level
  - Maximize/Minimize
- Scan Timing
  - Number of Echoes
  - Number of Shots
  - Echo Time
  - Repetition Time
  - Inversion Time
  - Flip Angle
  - Echo Train Length
  - Bandwidth

- Additional Parameters
  - SAT Prescription Screen
  - Graphic Prescription Screen
  - Vascular Screen
  - User CV Screen
  - Gating Screen
  - Cine Screen
  - Multi Phase Screen
  - Diffusion Weighted Imaging Screen
- Scanning Range
  - FOV
  - Slice Thickness
  - Spacing
  - Start and End Locations
  - FOV Center
  - Number of Slices or Slabs
- Acquisition Timing
  - Acquisition Matrix
  - NEX
  - Phase FOV
  - Number of Acquisitions or Locations Before Pause
  - Frequency Direction
  - Auto Center Frequency
  - Flow Comp Direction
  - Autoshim
  - Phase Correct
  - Contrast
- Rx Manager
  - Scan Modes
  - Gating Control
  - New Series
  - End Exam
  - Rx Manager List
  - View Edit
  - Prepare to Scan
  - Save Rx as Protocol
  - AutoScan
  - AutoStep

- Series Control and Advisory Panel
  - Save Series
  - Reset Values
  - Relative SNR%
- Scan Operations
  - STL% or db/dt Level
  - Prescan
  - Prep Scan
  - Scan
  - Reference Scan

## Patient Information

The Patient Information area requires detailed information about the patient. This area opens after you select the **[New Pt]** button located in the patient registration area.




NOTE: You cannot leave the Patient Information area unless a Patient ID is entered.

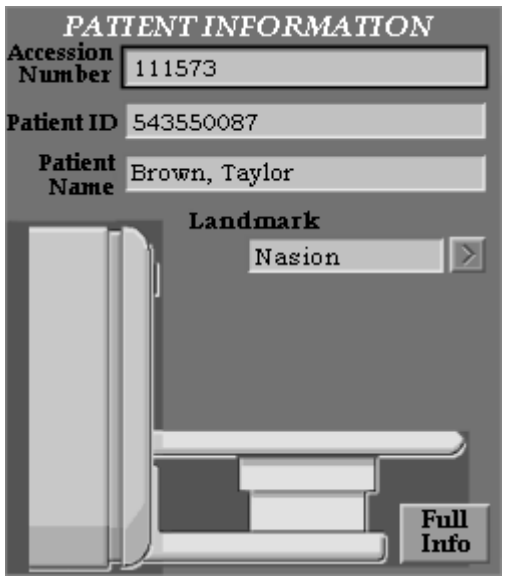
NOTE: You cannot leave the Imaging Parameters area unless the patient weight is entered.

The following table describes acceptable values.

| ***Selection*** | ***Description*** |
|---|---|
| **Accession Number** | This is generally related to a number assigned by the hospital, clinic, or site, and is tied to the patient's records. Enter the number manually or by using the optional bar-code reader if applicable. This text box is limited to 16 characters. |
| **Patient ID** | Enter any combination of numbers, letters, and dashes followed by **Enter**. This text box is limited to 64 characters. If the system finds the same ID in its memory, it displays all the pertinent data. The entry must be identical, including the use of upper-case and lower-case letters. Enter **MR** and the system re-displays the last (most recent) patient's data. |
| **Patient Name** | Enter the patient's name. This text box is limited to 64 characters. |
| **Birth Date** | Type in the patient's birthday: month # (1-12), day (1-31), and year (19xx or 20xx) and press **Enter**.<br>Valid type-in options are mm/dd/yyyy or mm-dd-yyyy. The year must be a four digit number. Note that the system can be configured for: mm/dd/yyyy or dd/mm/yyyy. |
| **Age** | If the birthday is entered, age is automatically calculated. Enter only whole numbers for age from 1-123 years. Days (1-90), weeks (1-52), or months (1-23) can also be entered; for instance, 28D, 4W, or 1M. |
| **Sex** | Enter **M** or **F**. |
| **Weight** | Enter the patient's weight in full pounds or kilograms, depending on how the system is configured. The system automatically calculates and displays the other figure. Weight limits are 2 to 350 lbs (1 to 158 kg). **Precision is important. If inaccurate, the system could abort the scan or deliver the wrong amount of RF power to the patient.** |
| **Radiologist** | Enter the radiologist's name. |
| **Referred By** | Enter the referring physician's name. |
| **Operator** | Enter the operator's initials. This text box is limited to 3 characters. |
| **Status** | The pre-defined list selections are: None, In, Out, Emergency, and Referral. |
| **Exam Description** | Enter the exam description. If this line is left blank, no information appears on the Exam page. |
| **Patient History** | Include relevant background information or additional information here. |
| **[Schedule]** | Provides access to the ConnectPro option. |
| **[Landmark]** | Provides access to the Abbreviated Patient Information area to select a landmark for anatomical reference. |

## Abbreviated Patient Information

An abbreviated version of the patient information area appears in the Patient Information area when the **[Landmark]** button is selected in the Patient Information area.



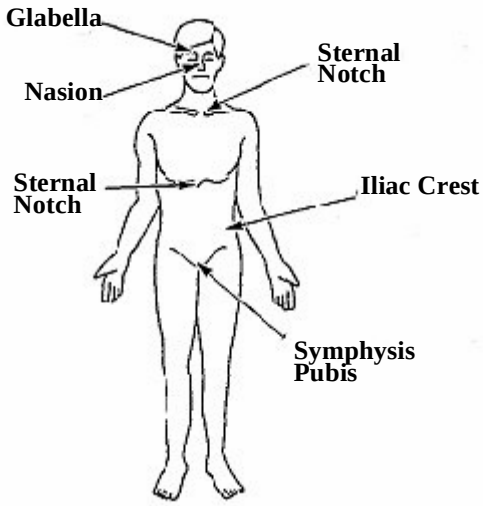

### Landmark

Landmark represents the position of the axial and sagittal alignment lights superimposed over an anatomical area.

- Select a landmark to establish an anatomical point from which all images in a series are referenced.
- Alignment and landmarking are steps taken to ensure the Region of Interest (ROI) center is as close as possible to isocenter. That is, the location within the bore of the magnet where the field strength is most homogenous.
- A landmark can be selected from the predefined list on the Abbreviated Patient Information area.


You can also type-in the first letter of the desired landmark, with the exception of Symphysis Pubis, which requires two letters. Upper and lower case entries are acceptable. For example, Nasion (**N**), Sternal Notch (**S**), Iliac Crest (**I**), or Symphysis Pubis (**SY** or **SP**).

The diagram below shows the landmarks most commonly used for MR imaging. These are not the only landmarks which can be used.




- The **[Full Info]** and **[Landmark]** buttons on the bottom-right of the window toggle between the full patient information and the abbreviated landmark areas.
- Landmarking helps bring the region of interest to isocenter from the third perspective, longitudinally.

NOTE: Selecting a landmark is not required, but if a landmark is not entered, the images have no anatomical reference.

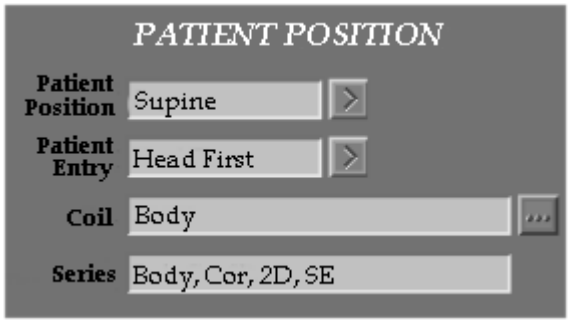
Something to Think About...

- An acquisition cannot be started without first establishing a landmark at the magnet enclosure. The landmark established should reflect the selection to ensure accurate image reference.
- Homogeneity decreases as distance from isocenter increases. Although it is not always possible to place the anatomy being scanned at isocenter, bring the anatomy as close to isocenter as possible, keeping the patient as comfortable as possible.

## Patient Position

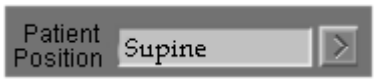
The Patient Position area opens after you select Patient Position from the Patient Protocols window. This area indicates

the patient's position, patient entry, the type of coil being used, and a description of the scan prescribed.



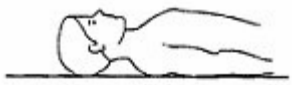

## Patient Position

The **Patient Position** text box contains four selections pertaining to the orientation of the patient.




If you have the Abbreviated Patient Information area displayed (by selecting the **[Landmark]** button in the Full Patient Information area,) the patient icon changes its orientation as you change the patient position information.

**Supine**



**Prone**

**Left Decubitus**

**Right Decubitus**

- You can select patient position from the pre-defined list or by typing one of the following shortcuts: (**S**) for supine, (**P**) for prone, (**L**) for left decub, (**R**) for right decub. These entries are not case sensitive.

WARNING: Ensure that the Patient Position selection matches the actual patient orientation. Making a selection that does not match the patient's actual position results in incorrectly annotated and/or rotated images, possibly resulting in improper medical treatment.

## Patient Entry

Patient Entry describes the orientation of the patient as head first or feet first into the magnet bore. If you have the abbreviated Patient Information area displayed, the patient icon changes its orientation as you change the patient entry information.

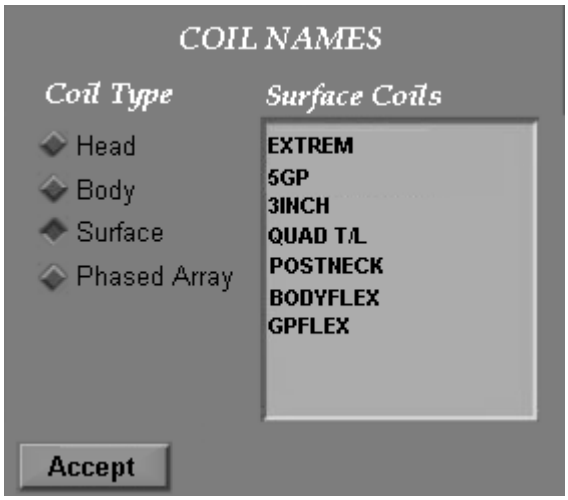

- This decision is determined by the anatomical area being scanned. For example, a cervical spine is typically placed head first and a knee is typically placed feet first.
- In the **Patient Entry** text box select an entry from the pre-defined list or type in one of the following shortcuts: (**H**) for head first or (**F**) for feet first. These entries are not case sensitive.

WARNING: Ensure that the Patient Entry selection matches the actual orientation of the patient. Making a selection that does not match the patient's actual position results in incorrectly annotated and/or rotated images, possibly resulting in improper medical treatment.

## Coil Type

The **Coil** text box allows you to select the coil from which the signal is transmitted and received, or in the case of a surface coil, only the receiving the signal. Selecting Surface or Phase Array displays a listing of all coils configured for the system.

When you select coil from the Patient Position area, the Coil Names window appears.




- The coil selection must match the coil connected.
- Select a coil that matches the anatomy to be scanned.
- Select a coil from the Coil Names window or by typing in one of the following shortcuts in the **Coil** text box: (**H**) for head coil, (**B**) for body coil or the full name of a surface or phased array coil. These entries are not case sensitive.

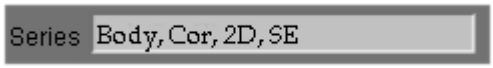
Something to Think About...

- The penetration depth of a coil is approximately half the coil's diameter.
- The smaller the coil, the better the SNR but less coverage and/or depth penetration.
- If a prescan failure occurs, make sure the coil key selection matches the coil in use.

WARNING: Improper use of arrays and coils may cause patient burns and other hazards. Read and understand all the surface coil warnings in the chapter Working Safely, Volume 1, before using an array or coil.

### Series Description

The **Series Description** text box allows you to enter a brief description of the series being prescribed.



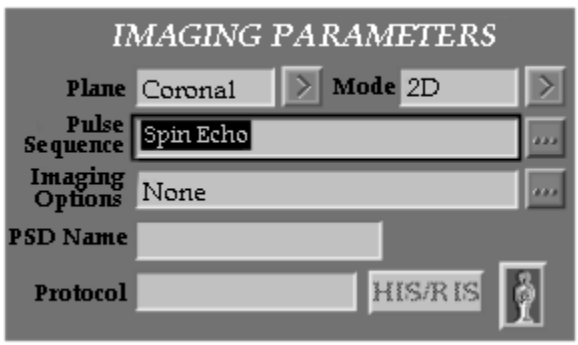

- This information appears on the series description line that is part of the series text page, which can be filmed and kept as part of the patient's MRI exam.
- The description may be helpful when you are trying to locate a particular series.

NOTE: If a predefined protocol has been selected, the series description appears automatically. However, this description does not change if the scan parameters are later adjusted.

NOTE: If a description is not entered, the system creates one based on the current patient entry, position, coil, mode, pulse sequence, and plane. For example, the default description could be Body, Cor, 2D, SE.

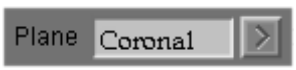
## Imaging Parameters

The Imaging Parameters area provides the selection of the imaging plane and mode, the pulse sequence, imaging options for the acquisition, PSD Name, and Protocol.




### Imaging Plane

Plane defines the scan plane for the acquisition.



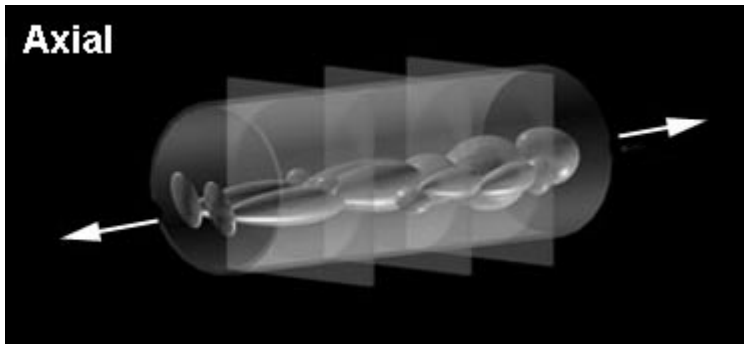
The planes used in MR imaging that can be selected are axial, sagittal, coronal, oblique, or 3-Plane.

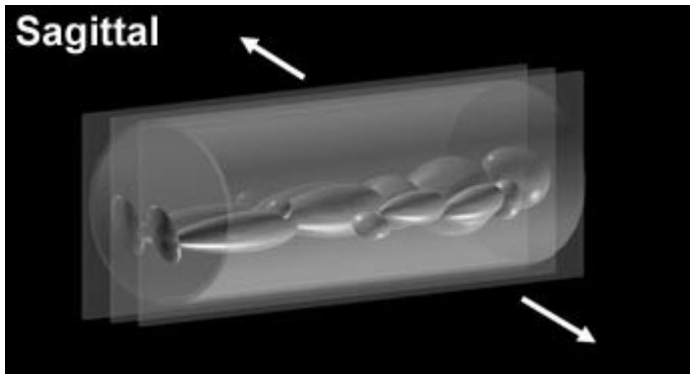
- Orthogonal planes are perpendicular to one another. Axial, sagittal, and coronal planes are all perpendicular to each other and are therefore orthogonal.
- Oblique planes are scan planes prescribed in any orientation other than the axial, sagittal, and coronal planes.
  - A simple oblique is a plane that has been tilted in just one direction from an orthogonal plane.
  - A complex oblique is a plane that has been tilted in two directions from an orthogonal plane.
- 3-Plane is a localizer that allows the sequential acquisition of three orthogonal scan planes acquired in a single series with one scan prescription.
  - This feature uses a Fast Gradient Echo (GRE) pulse sequence and can obtain the three planes in a single breath-hold.

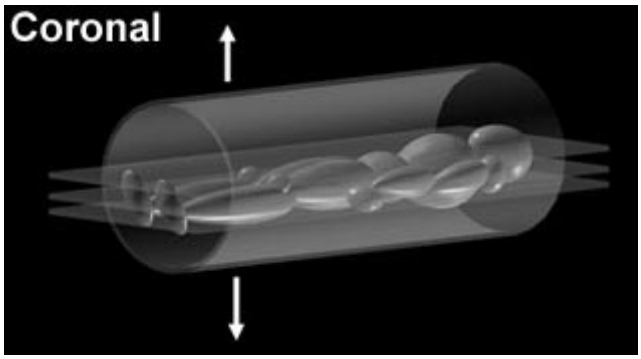
NOTE: Refer to Volume 2, for detailed information on 3-Plane Localizer.

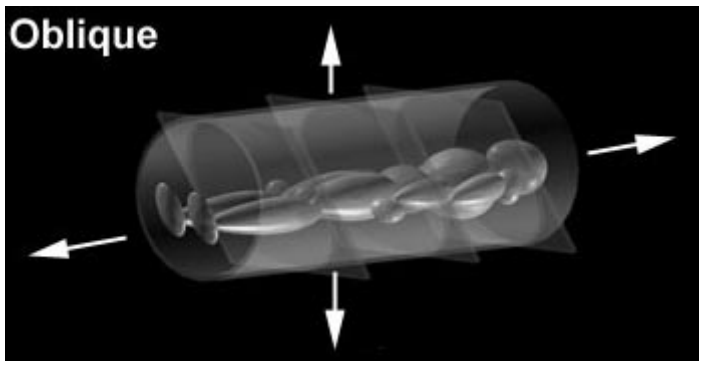
- The **Plane** text box contains a pre-defined list for plane selection. You can also type in the following shortcuts: (**A**) for axial, (**S**) for sagittal, (**C**) for coronal, (O) for Oblique, or (**3**) for 3-Plane. These entries are not case sensitive.

The following figures show the planes that may be acquired during MR imaging.






Something to Think About...

- Orthogonal images cannot be graphically prescribed from a localizer of the same plane.
- Oblique prescriptions can increase TR, TE, FOV, and slice thickness, and decrease the matrix selection and number of slices.
- The system annotates axial, sagittal, and coronal images as oblique if you select the oblique plane in the Imaging Parameters area.

## Imaging Mode

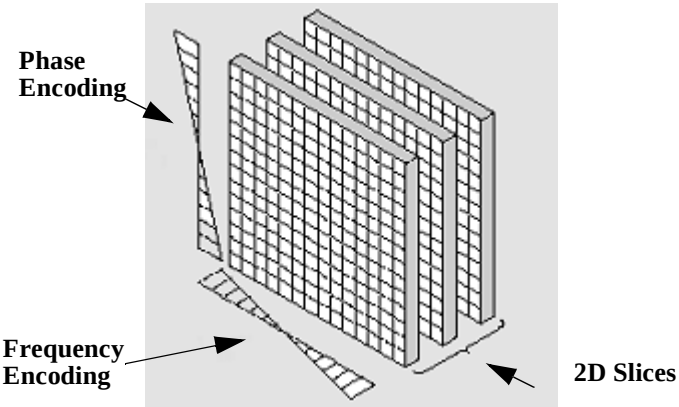
Mode defines the image format and type of image information to be gathered.


The **Mode** text box has predefined values to select 2D, 3D, Cine, or MR Spectroscopy. The desired imaging mode may be selected from the predefined values on the list or you can type in the following shortcuts: (**2**) for 2D, (**3**) for 3D, (**C**) for Cine, or MR Spectroscopy (**M**). These entries are not case sensitive.

### 2D Mode

2D Mode acquires and reconstructs raw image data into two-dimensional images whose brightness is proportional to the intensity of the MRI signal from the corresponding protons.

- The RF pulse and gradient pulse occur at the same time to excite an individual slice of a specific thickness of tissue.
- An individual slice is the area where the RF pulse frequency is the same as the resonant frequency created by the main magnetic field plus the slice-select gradient.
- Additional locations are excited by varying the excitation frequency of the RF pulse, thereby causing resonance in a slightly different location.
- Spatial encoding takes place in two dimensions, frequency and phase axes, to produce an image.



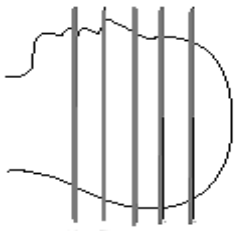

2D images can be acquired as multi-planar or sequential acquisitions.

- Multi-planar acquisitions acquire multiple images within a single TR. The order of slice excitation is odd-numbered images first, then even numbered images. Once all the

slices are excited, the number of phase steps multiplied by the NEX selected determines how many times this process is repeated.

The following diagram illustrates a multi-planar single acquisition with five slices.

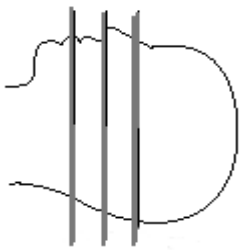
**1 2 3 4 5**



- Sequential acquisitions acquire all the data necessary for one slice location before moving on to the next location. An example of this is a 2D GRE sequence with the sequential option selected from the Imaging Options window.

  The following diagram illustrates a sequential acquisition with three separate slice locations for a total of three acquisitions.

**1 2 3**

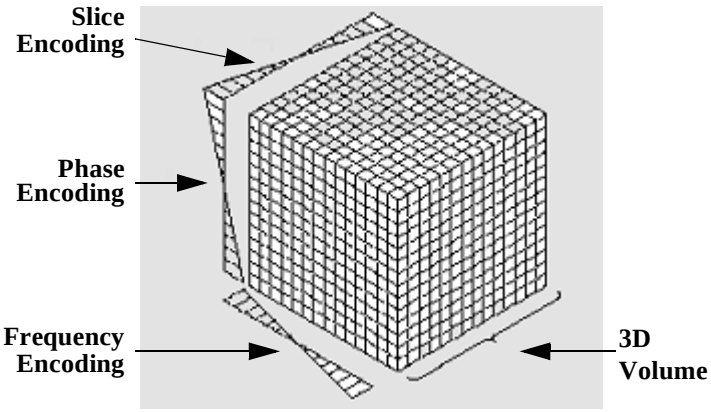


**3D Mode**

3D Mode excites an entire scan volume or slab with a wide RF pulse. Spatial encoding is done in the phase, frequency, and slice axes.

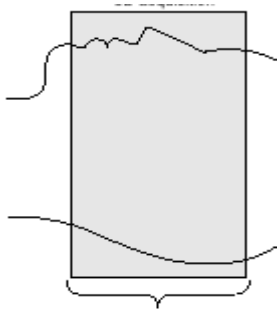
Explicit or graphic orthogonal and oblique 3D mode is available. The oblique 3D feature allows multiple groups of 3D volumes to be prescribed with different rotation angles and different offsets. The oblique 3D volumes can be prescribed explicitly and graphically for 3D Fast GRE/SPGR, 3D TOF, 3D Fast TOF GRE/SPGR and SmartPrep IA.

The diagram below shows the entire scan volume is excited with a wide RF pulse. Spatial encoding is done in the phase, frequency, and slice axes.




- The slice-select gradient is applied to create areas with slightly different phase relative to a point at gradient isocenter.
- The number of slice encodings affects scan time. TR x Phase Encodings x Slice Encodings x NEX = 3D scan time.
- The number of slice encodings performed determines the number of slices obtained from the volume.
- The amplitude of the slice encoding gradients determines the thickness of the slices to be reconstructed.
- Images are annotated 3D next to the PSD.

  The following diagram illustrates a 3D volume prescription in the head.



**3D Volume**

The 3D volume can be divided into a minimum of 12 slices for vascular imaging and 28 for non-vascular up to a maximum of 128 in increments of two. The system acquires four additional slices, two on each side of the volume, and throws out these

end slices which are aliased data. The number of locations available depend on the pulse sequence.

| ***Pulse Sequence*** | ***Min*** | ***Max*** |
|---|---|---|
| **3D Fast GRE/SPGR** | 8 | 128 |
| **3D GRE/SPGR** | 28 | 124 |
| **3D Vascular** | 16 | 128 |
| **3D Fast Vascular** | 8 | 128 |

NOTE: Whatever value of locations is prescribed, you obtain four less images, but the graphic volume deposited on the localizer image shows you exactly your end result. For example, if 32 locations are prescribed, 24 images reconstruct, although the images are acquired at the number of locations seen in Graphic Rx and the number of locations posted in the Scanning Range area.

### 3D MultiSlab

3D MultiSlab acquires multiple, overlapping image volumes, and combines overlapping locations from two adjacent slabs.

MultiSlab minimizes the saturation effects of slowly moving blood by allowing multiple volumes with decreased slab thickness. 16 to 32 slices per slab are common. Vessel to background contrast is improved as compared to 3D TOF by using larger flip angles and short TRs. MultiSlab provides coverage of larger volumes with decreased saturation of slow-moving or in-plane blood flow.

- MultiSlab acquisitions discard four slices from each slab, just as in 3D single slab imaging, to eliminate aliased image data.
- MultiSlab imaging also acquires an overlap region. A user defined area of each slab is acquired during both acquisitions of adjacent slabs. This overlap provides better transition between the slabs and decreases a venetian blind effect in the resulting images.
- MultiSlab images are annotated M3D next to the PSD.

### 3D Volume Prescription

3D volumes are acquired as prescribed by Explicit and Graphic Rx, but not all pulse sequences allow volume prescription in both R-S-A (right-superior-anterior) and L-I-P (left-inferior-posterior) directions. The following chart can be

used to determine the availability of R-S-A versus L-I-P volume prescriptions for 3D pulse sequences.

| Pulse Sequence | Multi-slab allowed | Volume Rx Capabilities |
|---|---|---|
| 3D GRE/SPGR | no | Explicit Rx can be done in either L-I-P or R-S-A directions. Graphic Rx (GRx) can only be done in L-I-P direction for orthogonal planes (note that oblique scan planes are not allowed with 3D GRE/SPGR). |
| 3D Fast GRE/SPGR | yes | Explicit Rx and Graphic Rx can be done in either L-I-P or R-S-A direction. |
| 3D TOF GRE/SPGR | yes | Explicit Rx and Graphic Rx can be done in either L-I-P or R-S-A direction. |
| 3D Fast TOF GRE/SPGR | yes | Explicit Rx and Graphic Rx can be done in either L-I-P or R-S-A direction. |
| 3D Phase Contrast (PC) | no | Explicit Rx can be done in either L-I-P or R-S-A direction. Graphic Rx (GRx) can only be done in L-I-P direction for orthogonal planes (note that oblique scan planes are not allowed with 3D PC. |
| 3D FSE | yes | Explicit Rx and Graphic Rx with no obliques, can be done in either L-I-P or R-S-A direction. |

Something to Think About...

- 3D images result in more RF pulses delivered to each slice in comparison to 2D images. The increased SNR due to the increased number of RF pulses can be used to increase the spatial resolution. This can be accomplished because the SNR is higher, so that you can afford to increase Matrix, decrease FOV, or prescribe thinner slices to improve spatial resolution.
- 3D Oblique volumes can be prescribed with different rotational angles and different offsets. These volumes can be prescribed explicitly or graphically for 3D Fast GRE/SPGR, 3D Fast TOF GRE/SPGR, and SmartPrep IA.
- 3D TOF GRE/SPGR allows prescription of multiple slabs, but they must be contiguous and at the same angle and FOV offset.

- Images acquired in 3D mode produce no cross-talk since there is no slice gap.
- As the slice thickness decreases, the slice aliasing increases. To reduce the aliasing artifact in the anatomy of interest, either increase the slice thickness or scan a larger slab.
- Slab overlap is crucial. If no overlap is prescribed between adjacent slabs, a substantial inter-slab boundary artifact (venetian blind) is created due to the decrease in blood-background signal to noise. An overlap of 25% on each end of the slab is recommended.

CAUTION: **Provide all patients with ear protection before any scan to help avoid possible hearing impairment.** Acoustic noise levels can exceed 99 dBA in the magnet bore.

### Cine Mode

Cine is an optional software package that lets you generate images for dynamic views of anatomy such as the heart. This option employs retrospective gating techniques.

NOTE: For additional information on Cine imaging, refer to Volume 2.

### MRS Mode

Magnetic Resonance Spectroscopy (MRS) is an optional software package that is an image-guided Proton Brain Exam. A clinical MRS package is available on 1.5T systems. It acquires a volume-localized, water-suppressed spectrum from a single or multiple voxel(s) or a volume of interest (VOI).

NOTE: For additional information on MRS imaging, refer to Volume 2.

## Pulse Sequence

The **Pulse Sequence** text box provides access to pre-defined RF pulse sequences for detecting specific types of proton emissions.

The **Pulse Sequences** text box contains a list of pre-defined available pulse sequences or you may type in the pulse sequence name in this text box.

NOTE: For specific information on PSDs and pulse sequence selection, refer to Volume 2.

## Imaging Options

Imaging Options provide appropriate image processing or filters for enhancing anatomical features or reducing noise.


The **Imaging Options** text box contains a list of predefined available options or you may type in the name of the imaging option in this text box. Multiple imaging options can be selected, but availability may be limited by the pulse sequence or other imaging options selected.

NOTE: For additional information on imaging options, refer to the chapter Optimizing Images with Imaging Options, Volume 3.

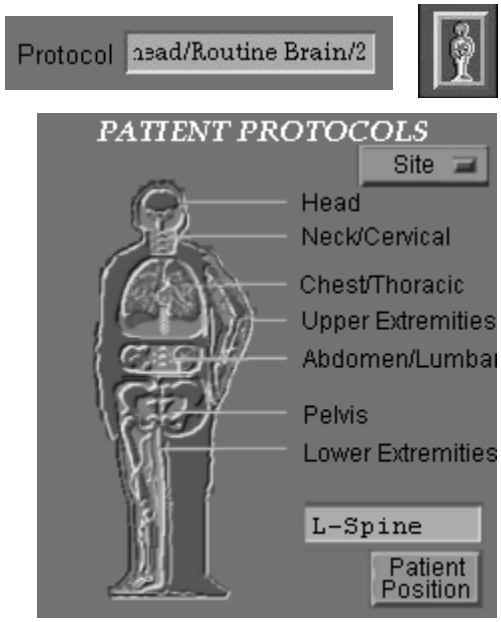
## Pulse Sequence Database Name

Use the **Pulse Sequence Database (PSD) Name** text box to select pulse sequences that are not listed in the Pulse Sequence list.


NOTE: For additional information on PSDs, refer to Volume 2.

## Protocol

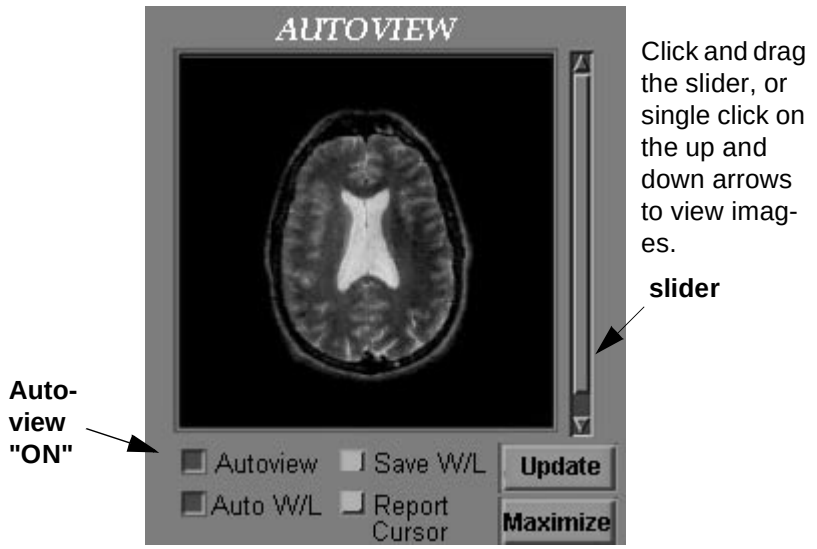
The **Protocol** text box allows you to type in the name of a protocol to download all the predefined values. Alternatively, select the humanoid to access the list of predefined protocols.




NOTE: For additional information on protocols, refer to the chapter Building and Saving Protocols, Volume 1.

# AutoView Window

AutoView Window is located in the upper right-hand corner of the screen and displays images as they are reconstructed.




- Use the AutoView Window to monitor the images reconstructing while performing other tasks, such as setting up for the next acquisition or archiving.
- Images displayed in the AutoView Window are annotated with the following information:
  - Exam number, series number, image number, patient name
  - PSD name, TR, TE, echo number, FOV
  - Scan location, report cursor with RAS values
  - Window and level values

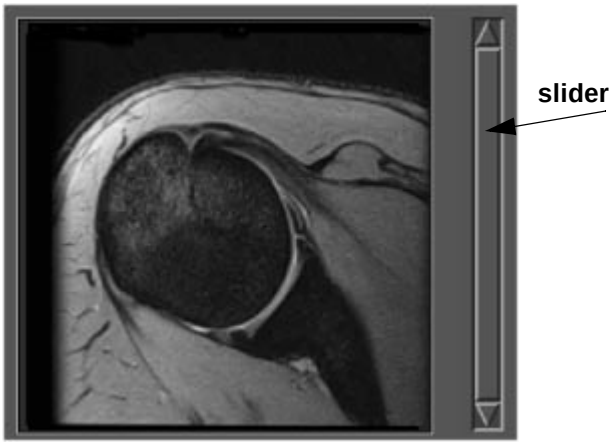
## AutoView

AutoView turns the AutoView feature on or off. When the button is selected, AutoView is on and the system automatically displays each image as it is reconstructed.


When AutoView is not selected, you are in the Review mode. The Review mode allows you to scroll through the images in AutoView display. When you turn AutoView back on, Review mode is turned off and the most recently reconstructed images are displayed.

- The AutoView Window buffer holds 256 images.
- AutoView Window holds only one exam at a time. As soon as the first image from the current exam is reconstructed, the previous exam's images are deleted from the AutoView display.

The image below shows the AutoView Viewport. It displays the most recently reconstructed image for the current exam. The viewport's standard image display is 256x256.



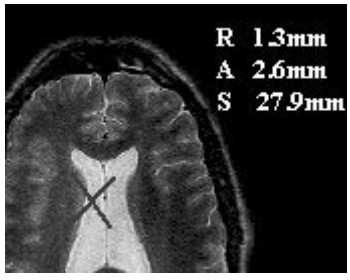

Use the slider to the right of the image for moving within the image set. Click on the arrows to move through the images one at a time. You may scroll through the images when AutoView is on.

## Report Cursor

Report Cursor shows the cursor-location RAS (Right Anterior Superior) coordinates with respect to the cursor's position on the image.

- Selecting Report Cursor turns AutoView off.


- Selecting AutoView turns Report Cursor off.



## Update Images

The **[Update]** button becomes active if images have reconstructed while Autoview was turned off.


- Click the **[Update]** button to add these images to the Autoview memory.
- Use the slider to review these images.

## Auto Window/Level

Auto W/L is the window and level feature that automatically calculates during reconstruction. It toggles on and off.


- The Auto W/L feature is on when the Auto W/L box is depressed. Manual window/level changes override the system settings.
- The Auto W/L feature is off when the Auto W/L box is not depressed. Manual window and level changes do not override the system settings.

## Save Window/Level

Use Save W/L when a particular image needs to be recalled. The button toggles on or off.


- The window and level settings of the image are saved when the Save W/L box is depressed. Then, each time you scroll through the images for later recall, the system holds that window and level setting.
- The Save W/L feature is turned off when the box is not depressed. No new window and level settings are saved.

### Maximize/Minimize

Maximize increases the size of the image display to a 512x512 resolution, while minimize displays the images at a 256x256 resolution.


A magnifying glass is available in the AutoView window when the right mouse button is pressed and held. The moveable square zone magnifies the image (in the zone) two times.

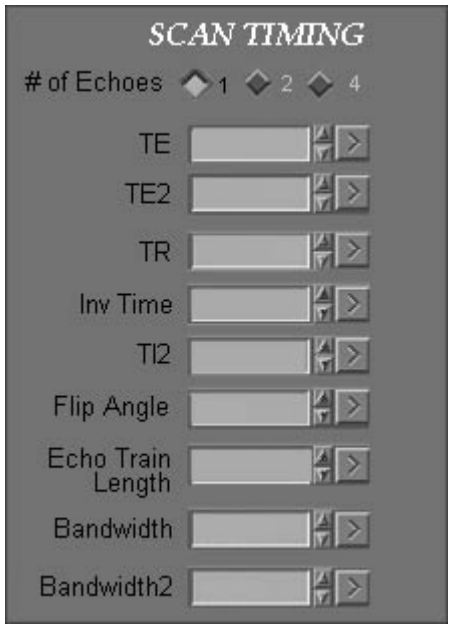
Something to Think About...

- During AutoView, the images are displayed in the order of the reconstruction. When using the slider, the images are viewed in order of series, image, and echo number. In addition, the image viewed has its image number noted to the left of the slider.
- Moving the slider temporarily pauses the display of any newly reconstructed images. Image display resumes once the slider activity is completed.
- When images from series one of the current exam reconstruct, images from the previous exam are deleted from the AutoView buffer.
- Changing the window level with the middle mouse button temporarily pauses the display of images. Image display resumes once the middle mouse button is released.
- Save W/L overrides Auto W/L.
- During a SAT or Graphic prescription, the AutoView Window is moved to the left and overlays the area reserved for Patient Register or Patient Information. The AutoView Window is returned to its original location once the prescription is complete for the SAT or Graphic prescription.

## Scan Timing

The Scan Timing area defines the time to echo (TE) and time to repeat (TR) scan timing parameters as well as the number of echoes, echo train length (ETL), number of shots, inversion time (TI), flip angle, and receive bandwidth (RBw). An advisory

area to the right of each text box displays the minimum and maximum values allowed.




You can enter values in this area in one of three ways:

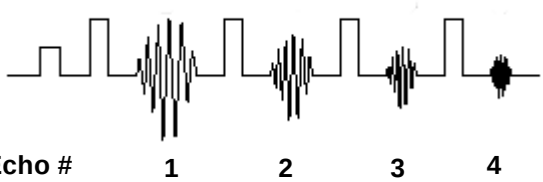
- Select text from the pre-defined list.
- Click on the up or down arrows to increase or decrease values already in the text boxes.
- Delete the text and type in a new text value.

## Number of Echoes

Number of Echoes determines the number of images produced from each slice location.


- Each echo yields an image.
- The number of echoes allowed is dependent on the pulse sequence.

° In late echo images, SNR decreases and T2 contrast increases.




- Acquisitions with different numbers of echoes can result in different contrast weighting.

| ***# of Echoes*** | ***Contrast*** | | | |
|---|---|---|---|---|
| | ***T1*** | ***PD*** | ***T2*** | ***T2**** |
| **1** | SE or SPGR | Usually FSE | Usually FSE | GRE |
| **2** | NA | SE or FSE | SE or FSE | Seldom acquired |
| **4** | NA | SE #1 PD/SE #2 early T2 | SE #3 middle T2/SE #4 late T2 | NA |

Something to Think About...

- Choosing two echoes requires choosing two echo times, TE and TE2. When **[1]** or **[4]** are selected, there is no TE2 selection because four echo studies use multiples of the first echo.
- The Flow Compensation option allows a maximum of two echoes.
- If Flow Compensation and POMP are applied to a two-echo study, Flow Compensation is applied to the second echo only.
- For 2 or 4 echo acquisitions, two bandwidths must be defined. Bandwidth is for echo 1, while Bandwidth2 is for echoes 2 to 4.

## Number of Shots

Number of Shots selection determines the number of TR periods to be repeated for an echo planar acquisition. The

number of shots selection replaces the Number of Echoes selection when an Echo Planar pulse sequence is chosen.


- To calculate the scan time for an EPI sequence, use the following formula:

  Scan Time = TR x Number of Shots x NEX

- A single shot EPI sequence is one in which all the required phase encoding steps are collected within one TR period. Single shot **[1]** is the only selection for DW EPI.
- The fewer the number of shots, the shorter the scan time, however, geometric distortion increases as the number of shots decrease.
- EPI protocols that use more than one shot to complete the image acquisition are referred to as multi-shot EPI. Multi-shot EPI fills K-space lines in an interleaved manner. The interleaved K-space yields a reduced effective echo spacing.
- The number of shots is annotated **SH**.

Something to Think About...

- The number of shots determine the speed and image quality of an EPI sequence.
- As the number of shots are increased, the effective echo spacing decreases and blurring in the image decreases.
- As the number of shots decrease, scan time decreases.

NOTE: The number of shots selection is valid only if the EPI option is purchased and installed on your system.

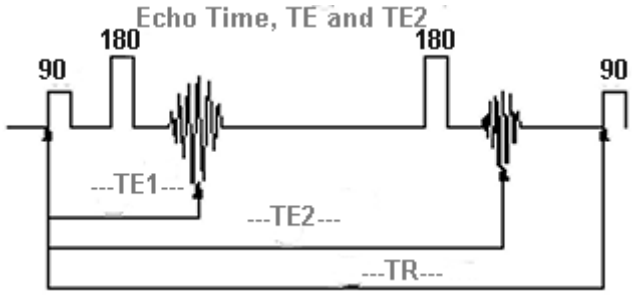
NOTE: For additional information on EPI imaging, refer to Volume 2.

## Echo Time

Echo Time determines the time between the center of the first excitation pulse and the peak of the echo, which usually occurs at the center of the readout gradient.

TE2, available for two echo sequences, is the time between the center of the first excitation pulse and the center of the second readout.

The following pulse sequence diagram displays a 90° excitation pulse and 180° refocusing pulses that generate the echo.

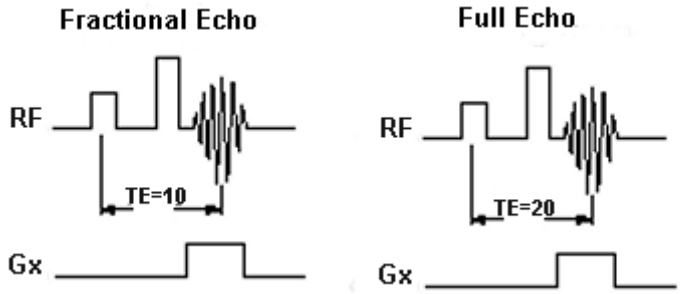



- Entries for the echo time (TE) are in milliseconds.
- The **TE** text box contains a list of predefined selections for the scan TE value, or you may enter a value in the text box. The arrows can also be used to change the TE.
  - Minimum obtains the minimum TE, whether it is a full or fractional echo. With fractional echoes, SNR may decrease because only a portion of the echo is read. The loss in SNR may be offset by the shortened TE which allows less T2 decay and therefore greater SNR. The smaller the FOV, the longer the minimum TE.
  - Min Full provides the shortest possible TE times without setting a fractional TE. This selection may increase SNR over a shorter TE acquired with a fractional echo technique.
- The **TE2** text box is available only for two-echo sequences.

**Fractional Echo**

Fractional Echo is a technique that shortens the time in which the readout gradient (Gx) is applied so that shorter echo times can be achieved. Because it is turned on for a shorter time, not all of the rephase portion of the echo is read which, in turn, affects the SNR.

The following diagram illustrates the pulsing differences between a fractional and full echo. Note the timing differences where the Gx is applied.




The following tables demonstrate the effects TE has on contrast, imaging parameter, and artifacts.

| | ***T1*** | ***PD*** | ***T2*** |
|---|---|---|---|
| **As TE** ⇓ | ⇑ | ⇑ | ⇓ |

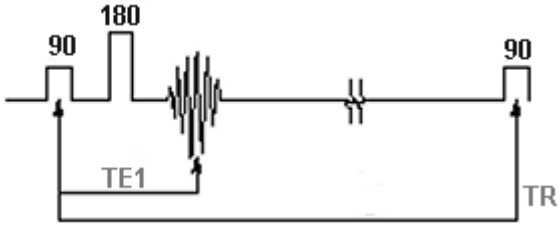
| | ***# of Slices*** | ***Scan Time*** | ***SNR*** | ***Res.*** | ***Flow Artifact*** | ***Mag Susc*** | ***RBw*** |
|---|---|---|---|---|---|---|---|
| **As TE** ⇓ | ⇑ | NA | ⇑ | NA | ⇓ | ⇓ | ⇑ |

Something to Think About...

- Fractional Echoes are annotated FR after the echo time.
- When GRE is selected with a fractional echo, the system only reads about 60 percent of the echo.
- When a Spin Echo (SE) is selected with a fractional echo, the system uses a sliding scale from 60% to 100% for the amount of signal it reads. As the TE gets closer to a full echo, the system has more time to read the signal and therefore it approaches reading 100% of the echo.
- The longer the TE, the greater the magnetic susceptibility artifacts. This is especially true in GRE and EPI imaging.
- Using Fractional Echo with lower bandwidths may compensate for SNR loss. As bandwidth decreases, SNR increases.
- Fractional Echo may affect the minimum values allowed for FOV, slice thickness, and matrix size.

## Repetition Time

Repetition Time represents the interval between successive excitation pulses of a slice.


TR controls the amount of transverse magnetization that recovers to the longitudinal plane. If full recovery for any given tissue does not take place, it eventually becomes saturated.

- In a T1-weighted image, a short TR is programmed to achieve saturation effects. The shorter the TR, the more saturation (T1) effects are seen in the contrast.
- In a PD or T2-weighted image, a long TR is programmed to minimize the saturation effects. Other effects such as dephasing (T2) or the number of protons in tissue (PD) can then predominate the image contrast.
- Entries in TR are expressed in milliseconds.

The following tables demonstrate the effects TR has on contrast, imaging parameter, and artifacts.

| | ***T1*** | ***PD*** | ***T2*** |
|---|---|---|---|
| **As TR** ⇓ | ⇑ | ⇓ | ⇓ |

| | ***# of Slices*** | ***Scan Time*** | ***SNR*** | ***Res.*** | ***Flow Artifact*** | ***Mag Susc*** |
|---|---|---|---|---|---|---|
| **As TR** ⇓ | ⇓ | ⇓ | ⇓ | NA | ⇓ | NA |

| | ***TE*** | ***TR*** |
|---|---|---|
| **T1-weighted** | Short ≤ 30 | Short ≤ 600 |
| **PD-weighted** | Short ≤ 30 | Long TR ≥ 2000 |
| **T2-weighted** | Long TE ≥ 80 | Long TR ≥ 2000 |

Different anatomy exhibit different characteristics, depending on the TR and TE selected, which in turn determines the weighting of the image (T1, PD, or T2). The following table illustrates some of these differences.

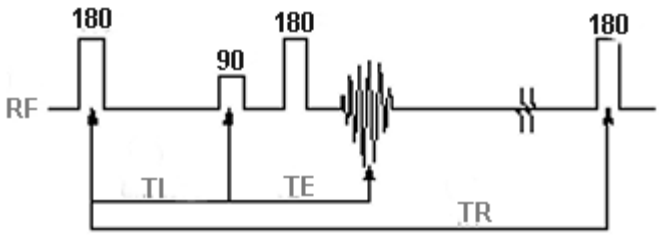
| | ***T1- Weighted*** | ***PD-Weighted*** | ***T2-Weighted*** |
|---|---|---|---|
| **CSF** | Dark | Intermediate | Bright |
| **Gray Matter** | Dark Gray | Light Gray | Intermediate |
| **White Matter** | Light Gray | Dark Gray | Dark |
| **Edema** | Dark | Intermediate | Bright |
| **Fat** | Bright | Bright | Dark |
| **Muscle** | Gray | Intermediate | Dark |
| **Bone Marrow** | Gray | Intermediate | Intermediate |
| **Cyst** | Dark | Dark | Bright |

## Inversion Time

Inversion Time (TI) primarily controls the contrast in an IR pulse sequence. It is the time between the first (180°) inverting pulse and the middle of the second (90°) refocusing pulse in an IR pulse sequence.


NOTE: This text box indicates the Prep Time when SPECIAL is selected on the User CVs page, or when IR Prepared or DE Prepared imaging options are chosen.

TI affects the number of slices.



The following table shows example TI times for 1.0T and 1.5T field strength systems.

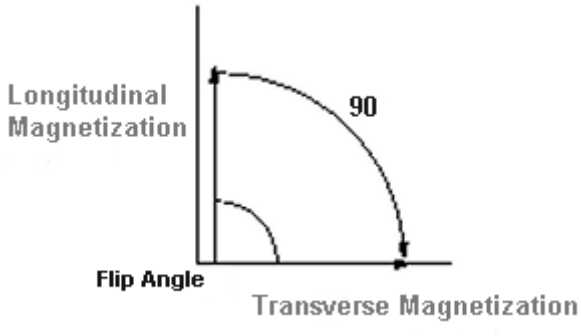
| ***Inversion Time*** | ***T1-Weighted*** | ***Fat Suppression*** | ***CFS Suppression*** |
|---|---|---|---|
| **1.0T** | ~750 ms | ~120 ms | ~2000 ms |
| **1.5T** | ~900 ms | ~150 ms | ~2200 ms |

NOTE: For additional information on an IR pulse sequence, refer to Volume 2.

## Flip Angle

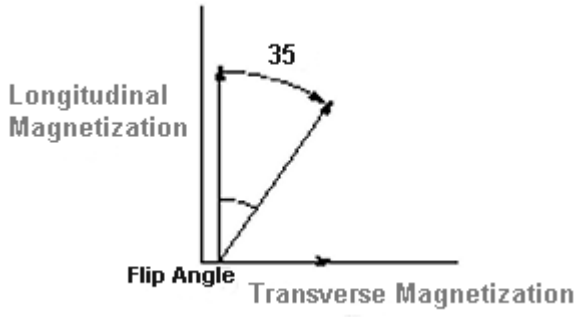
Flip Angle determines the rotational angle of the magnetization vector produced by an RF pulse relative to the longitudinal axis of the static magnetic field.


SE uses enough RF to move the longitudinal magnetization into the transverse plane. A standard 90° flip angle is used for the excitation pulse.




GRE sequences allow the flip angle to be varied. The amount of longitudinal magnetization moved to the transverse plane changes, based on the GRE flip angle. Select the flip angle

based on the contrast and SNR results desired. The flip angle affects the total amount of signal that recovers over time.




- As flip angles increase, T1 contrast increases.
- As flip angles decrease, T2* contrast increases.
- Flip angle selection range is 1° to 180° for most pulse sequences. If the system prompts you that there is a limitation, check the Advisory Panel.

Something to Think About...

- GRE Images may exhibit a lower SNR than conventional SE pulse sequences.
- The saturation effects of short TRs in fast SPGR/GRE scans limits the usable range of flip angles. Some sequences may prevent you from using large flip angles.
- SPGR does not automatically produce T1 weighting. Low flip angles and low TEs are likely to result in proton density weighted images. However, the optimal flip angle for achieving T1 contrast can also be exceeded by selecting a flip angle that is too high.
- When a GRE is acquiring data in the steady state, the TR is less than the T2 of the tissue and the Ernst angle effects SNR. In general, keep the flip angle and TR within ten points of one another to get maximum SNR.

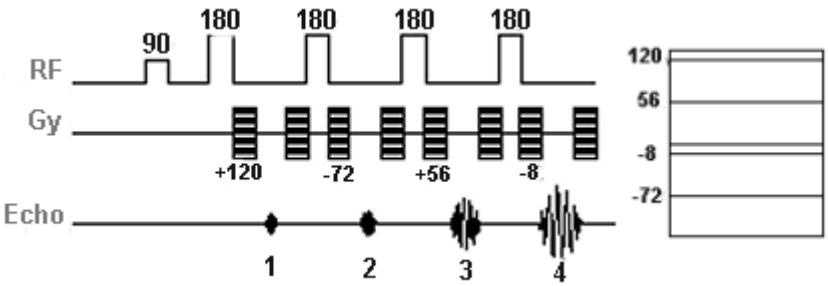
## Echo Train Length

ETL is the number of echoes per TR that you prescribe. ETLs can contribute from two to sixteen times more image data per TR, thereby decreasing acquisition time. ETL is available for

Fast Spin Echo (FSE) and Fast Inversion Recovery (Fast IR) pulse sequences.


- In FSE, the initial 90° pulse is followed by the acquisition of 2 to 128 echoes within a single TR (depending on the system configuration).
    - ° FSE acquisitions can be used to produce high resolution images with ultra long TRs in reasonable scan times. Ultra long TRs can be used to enhance myelographic effects, increase T2-weighting on brains, increase SNR, yield PD information for tissues with long T1 times, and increase the number of slices available.
- Long TR acquisitions can be performed in reasonable scan times because the scan time is divided by the ETL.
- The time between each echo in the echo train is called the echo space.

The following figure demonstrates that each echo is acquired with a different phase-encode gradient and each echo fills a unique line of K-space.



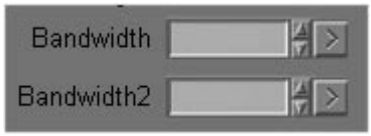

For Example, If you prescribe a 32 ETL, the scan time is already reduced by a factor of 32. For example, a 256x256 image with a 32 ETL requires 8 repetitions to obtain the required data. This is calculated by the following formula: TR x 256 ÷ 32 = 8.

The following table shows how various factors are affected as the ETL increases.

| | ***PD*** | ***T2*** | ***#of Slices*** | ***Scan Time*** | ***Edge Blurring*** |
|---|---|---|---|---|---|
| **ETL** ⇑ | ⇓ | ⇑ | ⇓ | ⇓ | ⇑ |

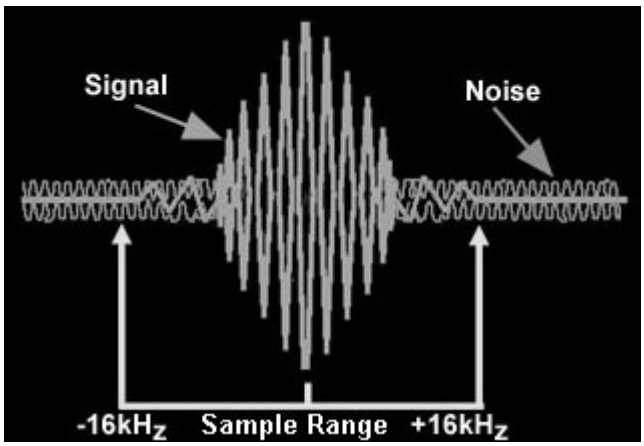
## Bandwidth

Bandwidth is a range within a band of frequencies that an MRI system is tuned to receive. The RBw of an image determines the number of frequencies sampled in an image.




As the RBw is narrowed, a smaller range of frequencies is sampled, thereby reducing the amount of aberrant frequencies detected. The result is an improved Signal-to-Noise Ratio (SNR).

The following figure shows that varying the bandwidth can narrows the system's receiver bandwidth to increase SNR.




- The system default is ±15.63 kHz for a 256 frequency matrix or ±32 kHz for a 512 frequency matrix. This means that the system detects signal from protons resonating at frequencies in the range of ±16 kHz, or ±32 kHz, from the Center Frequency.
- In the Scan Timing area, you have the following choices:
  - ° Bandwidth- which provides the bandwidth selection for one echo sequences.
  - ° Bandwidth2- which provides the bandwidth selection for echoes 2 and 4 in multi-echo sequences.
- The system annotates bandwidth in kHz in the lower left-hand corner of the image.
  - ° The minimum and maximum bandwidths depend on the TE, matrix, and FOV selected.

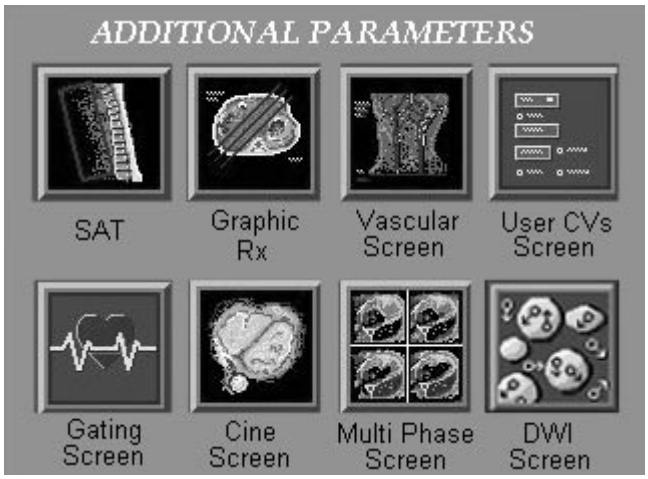
  - The area lists the minimum achievable bandwidths for the first (RBw) and subsequent (RBw2) echoes.
  - If a bandwidth is entered manually and the entry falls outside the minimum and maximum bandwidth values, the MRI system requests a different selection.
- Decrease the RBw to improve SNR.
- Increase the RBw to decrease the minimum TE.

There are many trade-offs associated with narrowing the receive bandwidth. The following table shows the effect decreasing RBw has on some parameters.

| | ***SNR*** | ***Sampling Time*** | ***TE*** | ***# of Slices*** | ***Motion*** | ***Chem Shift*** | ***Echo Spacing*** |
|---|---|---|---|---|---|---|---|
| **As RBw** ⇓ | ⇑ | ⇑ | ⇑ | ⇓ | ⇑ | ⇑ | ⇑ |

## Additional Parameters

The Additional Parameters area contains settings for Presaturation Pulses, Graphic Prescription, Vascular Imaging, User Control Variables, Gating, Cine, and Multi Phase, and DWI Imaging. These icons become available when a pulse sequence or imaging option that requires additional parameters to be defined.

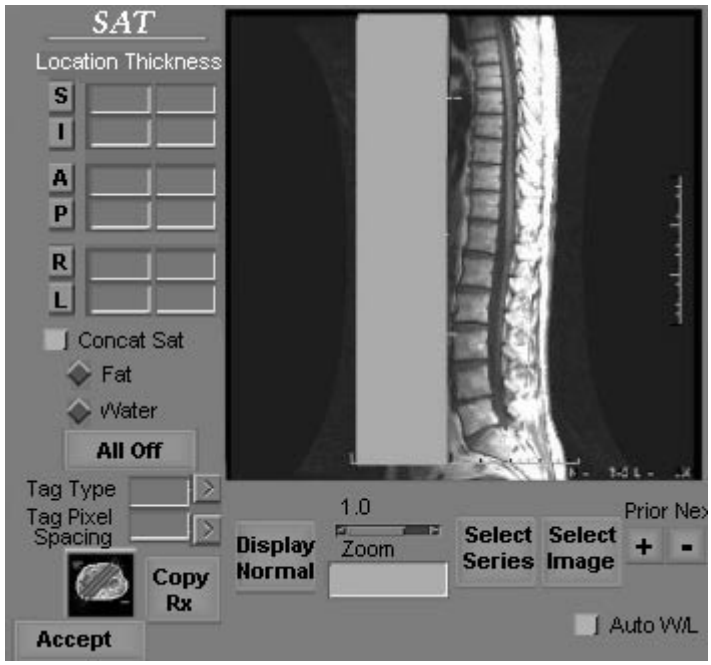


## SAT Prescription Screen

The SAT Additional Parameter screen provides functions for graphically and explicitly prescribing presaturation pulses and/or suppression techniques for an exam. Saturation pulses are used to saturate (and thereby eliminate signal from) tissues, a selected area, or across the FOV when suppression SAT pulses are used.


SAT pulses can be applied spatially to saturate an entire area of tissue or chemically to saturate specific chemical components (fat and water suppression).

Clicking the **SAT** icon in the Additional Parameters area opens the SAT screen.




*SAT Additional Parameters Screen*

The following table gives a description for each selection on the SAT screen.

| ***Selection*** | ***Description*** |
|---|---|
| **S, I, A, P, L, R** | Defines a SAT pulse in the selected plane. |
| **Location** | Defines the location of the leading edge of the SAT pulse. Leave the text boxes empty for default positioning of SAT outside FOV or enter a positive or negative numerical value to explicitly prescribe the SAT location. |
| **Thickness** | Defines the thickness/width of the SAT band. The default thickness is defined by the PSD and in most cases is 80 mm. Enter a value from 10 to 200 in steps of 1. |
| **Concat SAT** | Enables “walking SAT” for slice-select direction SAT pulses in concatenated acquisitions. |
| **Fat/Water** | To suppress either FAT or Water using spectral or chemical saturation pulses. Center Frequency must be set to FAT when Water is selected and vice-versa. |
| **[ALL OFF]** | Turns all selected SAT directions OFF. |
| **Graphic Rx icon** | Toggles to Graphic Rx screen and accepts current SAT entries. |
| **[Copy Rx]** | Copies SAT prescriptions for a previously prescribed series to current series. All SAT selections must be deselected to use copy Rx. Click on the desired series followed by **[Accept]**. The SAT bands appear on the currently displayed image. A double click on a series from the series list displays the image on which SAT bands were prescribed in the copied series, and the SAT bands for that series are posted. |
| **[Accept]** | Enters the prescribed values for the series and exits SAT. |
| **[Display Normal]** | Returns the localizer image to the original state. |
| **Zoom** | Adjusts magnification factor for displayed images using the slider bar. |
| **Text Box** | Enters series and image number for the image displayed in the SAT viewport. |
| **[Select Series]** | Lists all valid series from which a localizer image can be selected. |
| **[Select Image]** | Lists the images for the selected series. |
| **[-] [+] (prior/next)** | Displays the previous or next image in the series of the currently displayed image. |
| **Image View Port** | Displays the middle slice of the most recent series which could be used as a localizer for Graphic SAT prescription. |
| **Auto W/L** | Selects the Auto W/L option. |

The Additional Parameters **SAT** icon indicates the SAT pulses applied within the current prescription.


- Spatial SAT pulses applied at the default location and thickness are shown in upper case letters beneath the **SAT** icon, e.g., S, I.
- Spatial SAT pulses applied with a change to their thickness or location are shown in lower case letters, e.g., a. i.
- If Fat or Water suppression has been selected, the selection is indicated as FAT or WATER.
- If no SAT selections are made, the icon label reads “SAT”.
- The icon only indicates if SAT has been turned on at its default value or if the SAT pulse location/thickness has been altered. It does not indicate the actual thickness or location. To view the thickness and location of SAT pulses, enter the SAT screen.

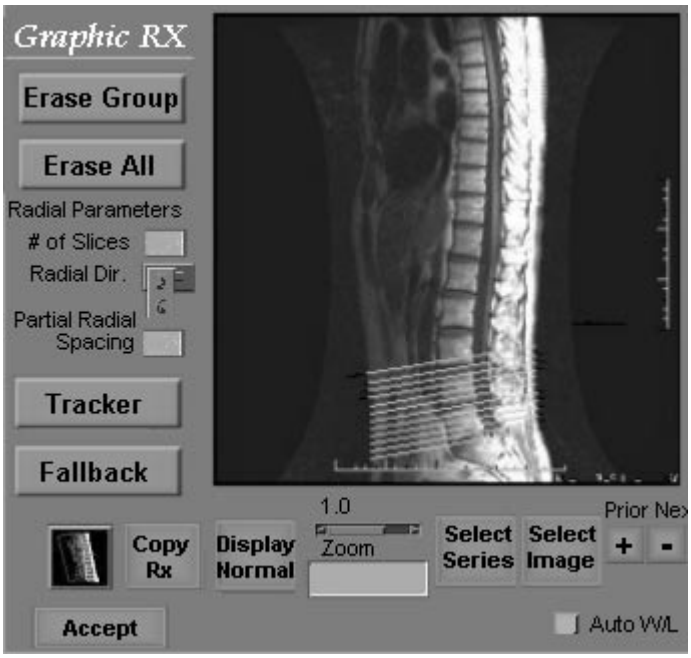
## Graphic Prescription Screen

Graphic Rx Additional Parameter screen is used to graphically define the scan locations on a localizer image using the same landmark.


Graphic Rx can be used to prescribe single or multiple groups of:

- 2D orthogonal slice locations from an orthogonal localizer
- 2D oblique slice locations
- 2D oblique slice locations with multiple angles
- 2D FSE-XL, FastCard, and SSFSE radial slice locations
- 3D orthogonal or oblique volumes

Clicking the **Graphic Rx** icon in the Additional Parameters area opens the Graphic Rx screen.




*Graphic Rx Additional Parameter Screen*

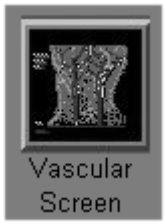
NOTE: For additional information on prescribing scan locations with Graphic Rx, refer to the chapter Scanning With a Protocol, Volume 1.

The following table gives a description and acceptable values for each selection on the Graphic Rx screen.[

| ***Selection*** | ***Description*** |
|---|---|
| **[Erase Group]** | Erases a deposited group of slices. |
| **[Erase All]** | Erases all deposited slices. |
| **[Reset Center]** | Allows you to change the center of the voxel prescription to the desired image location. |
| **# of Slices** | The number of slices prescribed for a radial graphic prescription. The maximum allowable is 16. |
| **Radial Dir.** | Clockwise and counter clockwise directions for radial prescription. System defaults to clockwise. |
| **Instructions for Add Group** | Adds a group of slices in a different location. |
| **[Tracker]** | Defines the tracker slice location and thickness in a SmartPrep acquisition. |
| **[Fallback]** | Moves the slice centers from off center prescribed position to isocenter in the slice select direction of localizer image. |
| **SAT icon** | Opens the SAT screen. The currently prescribed slices are automatically accepted. |
| **[Copy Rx]** | Copies a previous Rx with the same FOV, slice thickness, and spacing. A single click on the desired series to copy followed by **[Accept]** displays the same slice locations on the currently displayed image. A double-click displays image used to prescribe slices for the copied series and the slice locations. |
| **[Accept]** | Registers slice prescription and exits Graphic Rx. |
| **[Display Normal]** | Returns the displayed image to its default size. |
| **Zoom** | Adjusts magnification factor for displayed images using the slider bar. |
| **Text Box** | Enters series and image number for the images to be displayed. |
| **[Select Series]** | Lists valid series from which a localizer image can be selected. |
| **[Select Image]** | Lists the images for the selected series. |
| **[-] [+] (prior/next)** | Displays the previous or next image in the series from the currently displayed image. |
| **Image View Port** | Displays the middle slice of the most recent series which could be used as a localizer. |
| **Auto W/L** | Selects the window level mode to auto. |

## Vascular Screen

The Vascular Screen is available in the Additional Parameters area when prescribing a TOF, PC, Cine PC, or 3D FGRE pulse sequence.




The available options for reconstructions for vascular imaging are accessed in the Vascular Screen. There are four different types of image reconstructions: magnitude, weighted-phase, collapsed, and projection images.

- Magnitude images for Time of Flight sequences demonstrate the vessels clearly, while suppressing the static tissues.
- Magnitude images for Phase Contrast sequences demonstrate both vessels and static tissues. These images provide an anatomical frame of reference with an appearance similar to that of GRE.
- Weighted-phase images provide static tissue suppression to vividly reveal vascular anatomy.
- Collapsed images provide quick visualization of the vascular data set in the plane of acquisition, without interference from stationary tissue.
- Projection images create multiple views of a particular data set and permit visualization of the anatomy at various angles.

The following table shows the vascular pulse sequences that are compatible with various vascular reconstruction techniques.

| ***Pulse Sequences*** | ***Magnitude*** | ***Weighted Phase*** | ***Collapsed*** | ***0, 19, 0r 37 Projections*** |
|---|---|---|---|---|
| **2DTOF** | $X^2$ | | X | X |
| **3DTOF** | $X^2$ | | X | X |
| **FGRE 3D** | $X^2$ | | X | X |
| **2D PC** | X | $X^2$ | X | |
| **3D PC** | X | $X^2$ | X | X |
| **Cine PC** | X | X | | |

1. Optional.

2. Used as input for the creation of collapsed and /or projection images because they suppress static tissue.

NOTE: For additional information on the Vascular Screen Additional Parameter selections available for specific vascular pulse sequences, refer to Volume 2.

## User Control Variables (User CVs) Screen

User CVs Screen is used to define control variables which must be specified to initiate an acquisition for certain pulse sequences. Certain timing parameter combinations require access to User CVs for data entry. Depending on the pulse sequence chosen, the User Control Variables screen may vary.

If a pulse sequence requires a User CV, the User CVs Screen in the Additional Parameters area will be available.

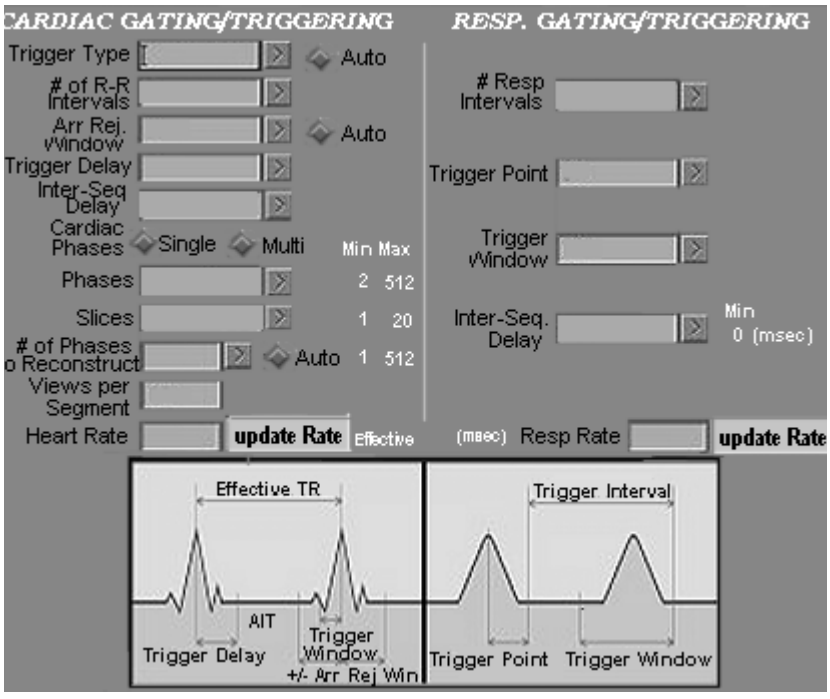

NOTE: For the User CV parameter selections specific to each pulse sequence, refer to Volume 2.

## Gating/Triggering Screen

The Gating/Triggering Screen is a combined Cardiac Gating/Triggering and Respiratory Gating/Triggering screen. It is used to enter gating/triggering parameters and allows for compatibility between features for selected pulse sequences.

The Gating/Triggering Screen is available in the Additional Parameters area when Cardiac Gating/Triggering or Respiratory Gating/Triggering is selected from the Imaging Options window.


The combined Cardiac and Respiratory Gating/Triggering Screen is displayed when the **Gating/Triggering** icon is selected.




*Combined Cardiac and Respiratory Gating/Triggering Screen*

NOTE: The selections available on this screen depend on the Pulse Sequence and Imaging Options selected. The selections in gray are unselectable if they do not require a value.

NOTE: For detailed information on the Gating/Triggering Screen Additional Parameter, refer to the chapter Gating and Triggering, Volume 3.

## Cine Screen

Cine is an optional GRE acquisition that acquires data continuously throughout the cardiac cycle. Cine scans employ retrospective sorting and reconstruction that allows the creation of images throughout all phases of the cardiac cycle. Cine GRE generates images that can be displayed in a movie loop temporal mode for dynamic views of the heart or vasculature.

NOTE: Cine is an optional software package to continuously sample data. It is compatible with GRE, SPGR, Fast SPGR, and Phase Contrast. Cine is not synchronized with the cardiac cycle.

The CIne Screen is available in the Additional Parameters area when a Cine pulse sequence is selected.


NOTE: For additional information on Cine, refer to Volume 2.

NOTE: For additional information on Cine Screen parameters, refer to the chapter, Gating and Triggering, Volume 3.

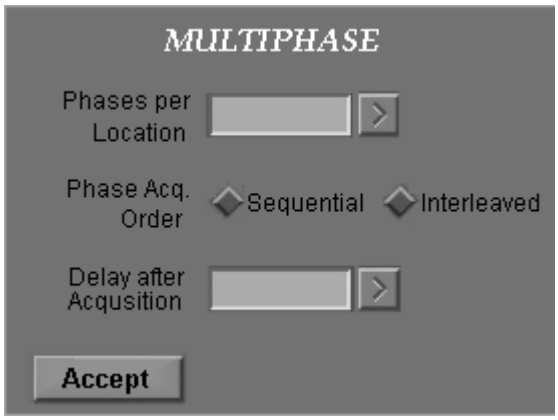
## Multi Phase Screen

The Multi Phase Screen allows the defining of parameters for imaging of the same slice at different times to provide temporal resolution. Images acquired with Multi Phase are annotated MP.

Multi Phase Screen is available in the Additional Parameters area when the Multi Phase Imaging Option is selected with a

Fast SPGR, Fast TOF GRE, Fast TOF SPGR, EPI, or Smart Prep sequence.


Clicking the **Multi Phase** icon gives access to the Multi Phase options.




### Phases Per Location

Phases Per Location indicates the number of phases to be acquired at one location.


### Phase Acquisition Order

Phase Acquisition Order indicates whether the image data is collected in either sequential or interleaved mode.


- In Sequential mode, the system acquires all images at the first slice location (pass 1) before moving to the second (pass 2) location.
- In Interleaved mode, the system acquires the first phase at each location (pass 1), then goes back and acquires the second phase at each location (pass 2), and so on.

**Delay After Acquisition**

Delay After Acquisition indicates the length of delay after every acquisition. The system resumes scanning automatically after the prescribed delay.


Applications for Multi Phase:

- Interleaved: dynamic contrast studies for liver, breast, and metastatic lesions.
- Sequential: kinematic range of motion studies of the joints or C-spine.

Something to Think About...

- The (phases÷location)x(number of slices) cannot exceed 512.
- Delay after acquisition times available are 20 ms to 20 seconds. Locations Before Pause may be selected from the Acquisition Timing area instead of programming the delay after acquisition from the Multi Phase screen. If so, select the minimum delay after acquisition from the Multi Phase screen.
- Images acquired at a single location with multiple phases (SSMP) may appear shifted upon display. This is most noticeable when these images load into a paging-loop mode.

## DWI Screen

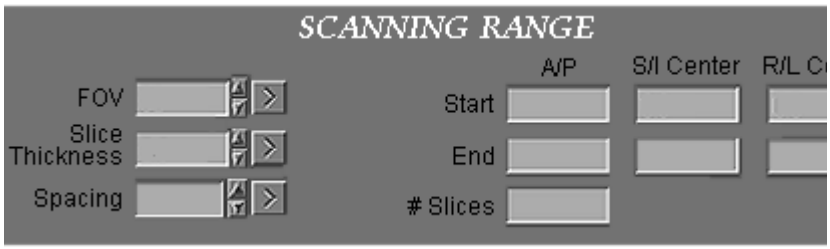
Diffusion Weighted Imaging (DWI) Screen in the Additional Parameters area is available with the optional DW-EPI package. Diffusion-Weighted Echo Planar Imaging (DW-EPI) is a single shot EPI pulse sequence designed to create images that differentiate tissues with restricted diffusion from tissues with normal diffusion.

The DWI Screen is available when a DW-EPI pulse sequence is selected from the pulse sequence window.


NOTE: For additional information on the DW-EPI optional software package, refer to Volume 2.

## Scanning Range

The Scanning Range area is used to select the Field of View (FOV) covering the anatomy of interest, the slice thickness and spacing, location of the slices and FOV center, and the number of slices in the acquisition. The entries can be made explicit or graphically for the scan locations, FOV center, and slice number.




### Field of View

FOV is the area of the anatomy selected for imaging.


Prescribe FOVs as large as the scanning range.

- For the body coil, choose FOVs from 1 cm to 48 cm, in 1 cm increments in all planes. The minimum and maximum alternatives vary, depending upon scan parameters and system configuration.
- For the head coil, choose FOVs from 1 cm to 28 cm, in 1 cm increments in all planes. The minimum and maximum alternatives vary, depending upon scan parameters and system configuration.

- ° EPI sequences in the head coil have a FOV range from 4 cm to 28 cm.

The FOV should be larger than the total number of slices times the slice thickness for the best spatial resolution. To calculate the pixel size (spatial resolution) for an acquisition, divide the FOV in millimeters by the phase or frequency of the acquisition matrix.

For example, for an 8 cm (or 80 mm) FOV and an acquisition matrix of 256x384:

80 ÷ 256 = 0.31 mm, 80 ÷ 384 = 0.21 mm

The pixel size is 0.31 x 0.21 mm.

As pixel size decreases, the SNR is reduced because fewer signal-producing protons are present per pixel. Other parameters assumed to be equal, SNR is proportional to the square of the FOV.

For example, halving the FOV from 24 to 12 results in a signal-to-noise (SNR) reduction of 75%. A 12 cm FOV image of the orbit is better resolved than a 24 cm FOV image. However, there is a substantial reduction in SNR under this scenario.

To compensate for loss of SNR, increase the number of excitations (NEX), adjust the TR, or slice thickness. Alternatively, decrease the matrix size or TE to generate more signal and improve image quality.

Something to Think About...

- When using a 3D acquisition as a localizer, make sure the FOV of the prescription intersects the localizer. To avoid FOV restrictions, use a center slice.
- To change FOV size for a graphic prescription, Graphic Rx must be open.
- The frequency gradient slope determines FOV. As the FOV decreases, gradient heating and minimum TE increases. This can lead to a reduction of slices.

## Slice Thickness

The **Slice Thickness** text box is for selecting the thickness of the slices being prescribed. In general, the thinner the slice, the better the resolution, and the lower the signal to noise.


- Slice thickness range in millimeters:

- 2D- 0.9 mm to 20 mm in 0.1 mm increments (1.5T range is 0.6 to 20 mm)
- 3D- 0.1 mm to 5.0 mm in 0.1 mm increments
- 2D PC slabs- 3 to 99 mm

- Use thin slices of 3 to 4 mm for small structures such as the pituitary, inner ear, spine, and vessels.
- Use thicker slices for studies of the abdomen, pelvis, and heart.

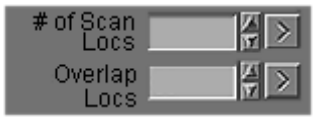
Something to Think About...

- The thicker the slice, the more partial voluming and certain structures may be hidden by overlying tissue.
- SNR is improved with a larger slice thickness.
- To avoid excess low-signal graininess when using thin slices, increase FOV, NEX, or TE.
- To change slice thickness for a graphically prescribed series, Graphic Rx must be open.

## Spacing

The **Spacing** text box allows selection of the space between the slices for everything except 2D and 3D vascular prescriptions.


The **# of Scan Locs** text box allows for the number of scan locations and overlap locations for 3D aquisitions.

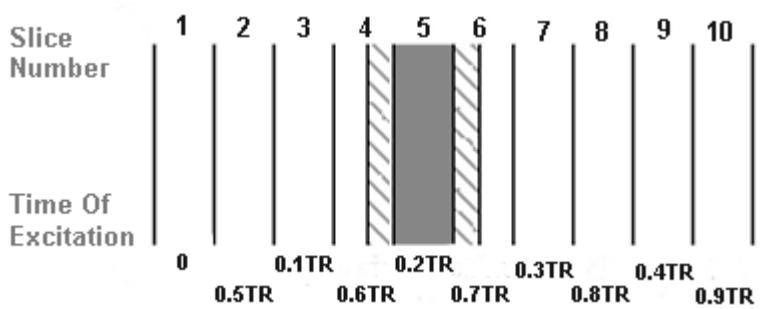



- Slice Spacing in millimeters:
  - 2D- variable interslice spacing in increments as small as 0.1 mm. The interleave option is available for multi-slice imaging.
  - 3D- 12 cm to 124 cm contiguous slice volume imaging in increments of 2.
- Overlap Location allows you to select up to 4 overlaps for 3D acquisitions (each overlap = 1 mm).
  - Prescribing an overlap allows you to acquire a continuous series of slices—with no gaps. Remember, any 3D acquisition has aliased image data on both ends

of the slab, which is discarded. If this aliased (and discarded) image data is in the overlap area, the scan prescription should result in a continuous, no gap, set of slices.

Choosing spacing allows you to increase the scan range or image coverage with larger interscan spacing to ensure complete coverage. Insert small gaps (spacing) between slices, to reduce cross-talk, typically 20% of the actual slice thickness. Cross-talk or overlap is caused by partial excitation of adjacent slices during RF excitation and refocusing by a 180° pulse. This causes a reduction in image contrast and SNR, as the expected TR and the effective TR may differ.

The following figure shows the effect slice spacing has on the excitation time. Note, for example, that excitation of slice #5 at time t = 0.2 TR also results in partial excitation of slices #4 and #6, which are excited at time t = 0.6 and t = 0.7 TR.




This difference in TR alters the contrast-to-noise ratio (CNR) and signal-to-noise ratio (SNR). The effects on short TR/TE sequences may be lower SNR and possibly, greater T1 contrast, similar to decreasing TR. The overall effect may be decreased CNR. Decreased SNR tends to offset the increase in contrast. This usually means that the scan's CNR has been decreased, although the cross-talk effect may not be the same for all slices.

If Interleave is selected or you have two or more acquisitions, the system acquires data from every other slice during the first pass, then goes back and acquires data from the rest. For example, slices 1, 3, 5, 7 first, then slices 2, 4, 6, and 8. Cross-talk is eliminated with Interleaved acquisitions.

Something to Think About...

- To reduce the effects of interslice cross-talk use:
  - Interleave (doubles the scan time)
  - Larger interscan spacing

- 3D technique
- Sequential

- To change spacing for a graphically prescribed series, Graphic Rx must be open.

## Start and End Location

The **Start** and **End** location text boxes specify the scanning range in relation to the landmark in the A-P, L-R, or S-I directions. Together, start and end determine the area covered in the scan and can be prescribed explicitly or graphically.


The system acquires the data in the order of the slices prescribed and automatically calculates the actual end location and the number of locations. This is based on scan thickness and the interscan spacing selected. The actual end location is displayed at the bottom of the Scanning Range area.

Something to Think About...

- Multiple slice thicknesses cannot be prescribed.
- To modify the end location or to add or subtract slices, enter a different value for the number of locations. The system automatically updates the actual end location.
- In 3-Plane Localizer acquisitions, start and end locations are not entered in the text box. Entries here reflect the FOV center for the axial images.
- Enter the scanning range from L to R, or I to S, or P to A: “LIP to SAR”- Left, Inferior, Posterior or Superior, Anterior, Right so that 2D and 3D acquisitions have images collected in the same direction within the exam.

## FOV Center

The FOV Center defines the center of an image. Ideally, this is located at the magnet’s isocenter. An off-center FOV is a FOV not centered at isocenter. This is accomplished by typing in appropriate numbers at the FOV center prompt in the Explicit Scanning Range area or using Graphic Rx.

The FOV Center defaults to zero unless otherwise specified. FOV center offsets can be done in the phase and frequency directions.

The following table demonstrates the slice select axis and offset for a defined orthogonal plane.

| ***Plane*** | ***Slice Select Axis*** | ***Offset*** |
|---|---|---|
| **Axial** | S/I | R/L and/or A/P |
| **Coronal** | A/P | R/L and/or S/I |
| **Sagittal** | R/L | A/P and/or S/I |

- S/I offsets bring the anatomy to isocenter by moving the table. You are prompted to move the table before prescanning.
- A/P and L/R offsets cannot be larger than 240 mm for body and surface coil imaging, or 120 mm for head coil imaging.
- In 3-Plane Localizer acquisitions, the FOV Center determines the center of the FOV for the middle slice of each plane. For example, if you prescribe three slices per plane are selected, the second slice of each plane is located at the FOV Center.

Something to Think About...

- In axials, sagittals, and coronals, two offsets are allowed. The system accommodates for any offset in the S/I direction by means of a table movement.
- Multiple groups and offsets in two directions can be prescribed in orthogonal acquisitions. In oblique acquisitions, only multiple groups can be prescribed.
- Axial images with a two direction offset prescribed explicitly results in a tilted image on the screen. Note that the annotation is correct.

## Number of Slices/Slabs

The **# of Slices** or **Slabs** text box specifies how many slices (slabs) are prescribed per acquisition. This text box only becomes available after the **Graphic Rx** icon is selected in the Additional Parameters area. The start and end locations determine the number of slices (slabs). A value is automatically entered in this text box if slice thickness, slice spacing, and start/end locations are specified.

The number of slices defines a 2D prescription.


The number of slabs defines a 3D prescription.


Up to 64 slabs are permitted and the **# of Slabs** text box is visible with the following sequences:

- 3D FSE
- 3D PC
- 3D GRE/SPGR
- 3D Fast GRE/SPGR
- 3D TOF GRE/SPGR
- 3D Fast TOF GRE/SPGR

Something to Think About...

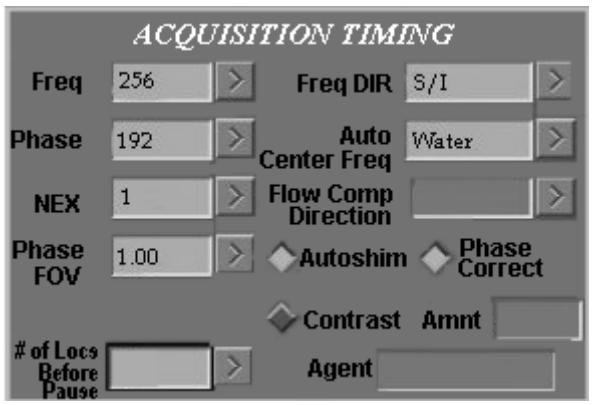
- A limited number of slices can be acquired in a given scan time. If too many slices are prescribed, the system automatically increases the number of acquisitions. Scan time increases accordingly.

  Your options are to:

  - Accept the longer scan time.
  - Increase the TR, shorten the TE, or reduce the SAT pulses. However, these choices may prevent the desired tissue contrast.
  - Switch from an oblique to an orthogonal plane.
  - Enter a smaller scanning range to reduce the number of slices.
  - Increase the FOV.
  - Increase the slice thickness or spacing to get the same coverage with fewer slices.
- In a 3-Plane Localizer acquisition, the number of slices entry determines how many slices are acquired for each plane.
  - This entry must be an odd number.

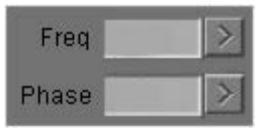
# Acquisition Timing

The Acquisition Timing area allows selection of timing parameters that define scan time, resolution, prescan settings, and indication for contrast material.




## Acquisition Matrix

An Acquisition Matrix is the number of data points collected in the frequency and phase encoding directions. More data points result in higher resolution. The matrix selections are frequency and phase.




- Frequency controls resolution.
  - ° Frequency encoding options are 256 or 512.
- Phase controls scan time and may control resolution.
  - ° Phase encoding options from 128 to 512 in steps of 32.

A matrix can be square or asymmetrical.

- A square matrix means that both phase and frequency values are equal.
- An asymmetrical matrix means that the phase axis is smaller than the frequency axis.

Matrix values, FOV, the Square Pixel imaging option, and the Phase FOV entry determine the size and shape of the pixel, which in turn determines image resolution.

This results in the following equation:

$$\frac{FOV}{MatrixValue} = PixelValue$$

For example, a 250 mm FOV and a 192 Phase x 256 Frequency Matrix results in a 1.28 pixel size.

$$\frac{250mm}{192Pmatrix} = 1.3 \qquad \frac{250mm}{256Fmatrix} = 0.98$$

therefore, 1.3 = 0.98 = 1.28 mm pixel.

- When the Square Pixel imaging option is selected, the pixel shape is always square and its size is determined by the frequency axis only. An asymmetrical matrix results in a rectangular FOV shape.


- When the Phase FOV is less than one and a symmetrical matrix is selected, the pixel shape is square and the FOV shape is rectangular.


- When Phase FOV is less than one and asymmetrical matrix values are selected, both the pixel shape and the FOV shape are rectangular.

- When Phase FOV is one and an asymmetrical matrix is selected, the pixel is rectangular and the FOV is square.


Match the size and shape of the matrix, FOV, and Square Pixel, or Phase FOV options to resolve the anatomy being imaged.

- Select a frequency encoding matrix from the pre-defined list or enter a value in the text box.
- Select a phase encoding matrix from the pre-defined list or enter a value between 128 and 512 in increments of 32, in the text box. The system automatically selects the closest valid value for each entry.

NOTE: The frequency encoding matrix value cannot be smaller than the phase encoding matrix, except for EPI sequences.

Something to Think About...

- A small matrix has a shorter acquisition time but less resolution. A 256 matrix produces standard resolution.
- A large matrix has more resolution but takes longer to acquire. A 512 matrix produces high resolution.
- Acquisition matrix selection does not affect the size of the displayed image. Normally, all images are displayed in an “auto expand” mode on a 512x512 matrix.

## NEX

The Number of Excitations (NEX) is the number of times the phase encoding steps are repeated in a given acquisition. You can prescribe up to 150 NEX.


The SNR increases by the square root of the ratio of NEX.

For example, increasing the NEX from 2 to 4 results in a 40% increase in SNR and a doubling of the scan time.

$$\sqrt{\frac{4}{2}} = 1.41$$

NEX is a factor in calculating scan time. Note the following equation: (TR) x (Phase Steps) x (NEX) = basic 2D scan time

Adjust NEX to change SNR and/or scan time.

Something to Think About...

- Typically, as resolution increases, the NEX value needs to be increased. An exception to this is 3D imaging.
- Select the NEX value that produces adequate SNR to make the diagnosis. Too much SNR wastes time, too little SNR produces undiagnostic images.

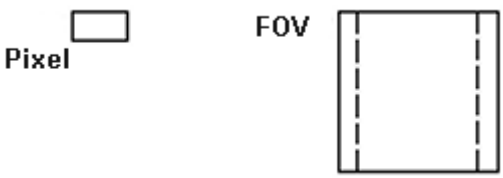
## Phase FOV

The Phase FOV shortens scan time by scaling down FOV size in the phase direction. The pulse sequences you prescribe determines the range and increments you can choose from. The pre-defined list displays the allowable values and the new FOV.


Phase FOV can be combined with a symmetrical or asymmetrical matrix.

- When Phase FOV is 0.5 or 0.75 and a symmetrical matrix is selected, the pixel shape is square and the FOV shape is rectangular.


- When Phase FOV is 0.5 or 0.75 and asymmetrical matrix values are selected, the pixel shape and the FOV shape are both rectangular.



The number of phase steps acquired is equal to: (Number of phase steps programmed) x (Phase FOV), which reduces the scan time in comparison to a full phase FOV.

For example, a 256 Frequency matrix, a 192 Phase matrix and a selection of 0.75 Phase FOV, results in the reduced scan time of: (TR) x (192P) (0.75) x (NEX) = new scan time.

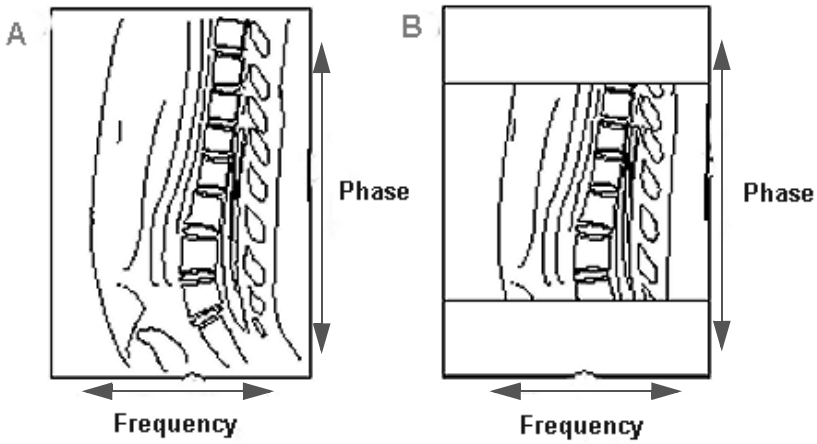
Useful applications for a small Phase FOV:

- Scans with anatomy smaller than the FOV in the phase direction, such as extremities, spines, axial, and coronal heads.
- High resolution images in a short scan time when combined with a symmetrical matrix.

Something to Think About...

- Phase FOV requires more precise placement of anatomy in the center of the FOV. This is easily accomplished with FOV center offsets and swing table positions.
- Phase wraparound occurs if anatomy exists outside the new, reduced FOV. SAT pulses placed in the phase direction can reduce the aliasing artifact.
- Phase FOV is not compatible with No Phase Wrap, POMP, Square Pixel, or NEX greater than one with Respiratory Compensation.
- SNR is reduced by approximately:
  - 14% for 0.75 Phase FOV.
  - 30% for 0.5 Phase FOV.
- Decrease the Phase FOV in EPI acquisitions to decrease geometric distortion and increase spatial resolution.
- Typically a Phase FOV less than one is not selected on a sagittal or coronal if phase and frequency are swapped.

The following diagram shows how your image is effected when phase and frequency are swapped.




**A**. Phase and Frequency swapped with a Phase FOV of 1.
**B**. Phase and Frequency swapped with a Phase FOV of 0.75.

## Number of Acquisitions/Locations Before Pause

Scan pause techniques can be used to pause a scan at predetermined points for scans with more than two prescribed slices. This text box name automatically changes depending on the pulse sequence selected to:

- # of Locs Before Pause
- # of Acqs Before Pause
- # of Reps Before Pause

The **# of Locs Before Pause** text box indicates the number of locations to be acquired before pausing the scan.


The **# of Acqs Before Pause** text box indicates the number of acquisitions to be acquired before pausing the scan.


The **# of Reps Before Pause** text box indicates the number of TRs to be acquired before pausing the scan in FSE sequences.

This feature is useful for pausing scanning at predetermined points for breath-hold, joint motion, or contrast perfusion studies. The “scan time remaining” clock counts down time before the pause. The **[Scan]** button must be selected to resume scanning after each pause.

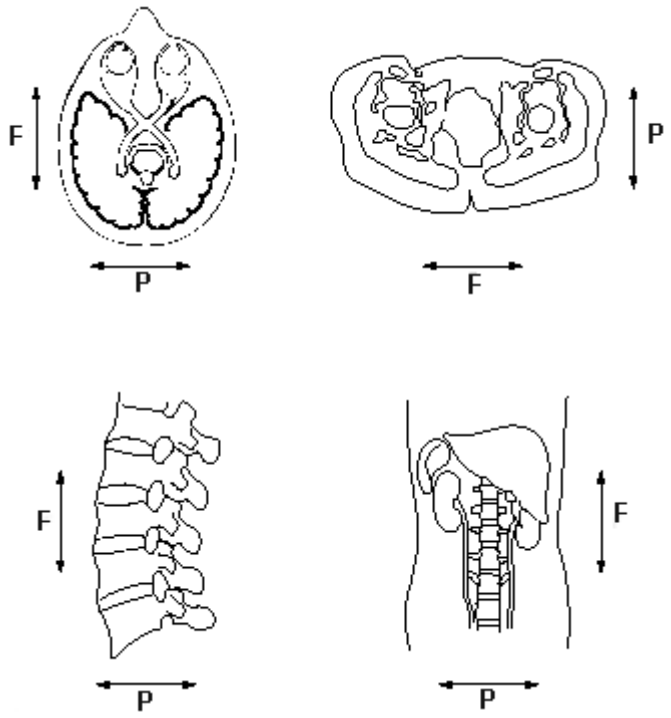
NOTE: The number of slices must be determined before the number of locations before pause is available.

## Frequency Direction

The Frequency Direction is the scanning direction associated with the frequency encoding gradient.


The phase and frequency axis determine the vertical and horizontal axis of the displayed image.

In general, frequency is the long axis of the imaging plane. Default frequency (F) and phase (P) directions are displayed in the following figures.




The default frequency direction is automatically entered in the **Freq DIR** text box. Swap frequency and phase directions by changing the entry from the predefined list.

The following table summarizes the default directions for phase, frequency, and slice-select based on the coil selection.

| ***Coil*** | ***Plane*** | ***Frequency*** | ***Phase*** | ***Slice Select*** |
|---|---|---|---|---|
| **Body, Extremity, Neurovascular, and Receive Only Surface Coils** | Axial | R/L | A/P | S/I |
| | Sagittal | S/I | A/P | R/L |
| | Coronal | S/I | R/L | A/P |
| **Head Coil** | Axial | A/P or EPI-R/L | R/L or EPI-A/P | S/I |
| | Sagittal | S/I | A/P | R/L |
| | Coronal | S/I or EPI-R/L | R/L or EPI-S/I | A/P |

For oblique prescriptions, the frequency direction selections in the **Freq DIR** text box are **Unswap** or **Swap**. Unswap is the frequency direction displayed prior to prescribing oblique slices.

NOTE: When acquiring a 3-Plane Localizer acquisition, the **Freq DIR** text box is not a selectable parameter and does not follow the default conventions for determining the frequency direction.

Something to Think About...

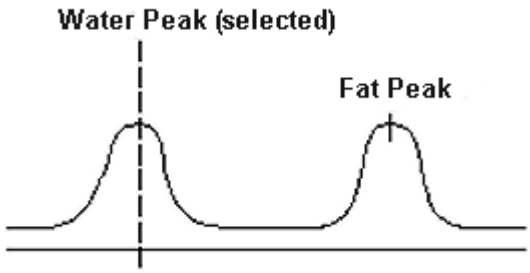
- Flow, motion, and other phase artifacts, such as aliasing or wraparound, are mapped onto the image in the phase direction. A wise choice of frequency direction can reroute these artifacts away from the region of interest. For example, sagittal spines have the frequency direction in the S/I direction and phase A/P, which routes motion artifacts through the vetebral bodies and spinal canal. One solution is to make phase run S/I so that the flow artifact from the aorta and vena cava runs parallel to the cord, rather than through it.

## Auto Center Frequency

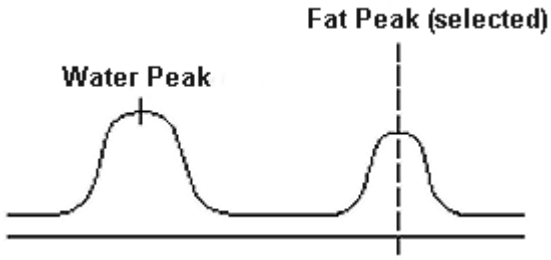
Auto Center Frequency (CF) fine-tunes the system's RF transmit/receive frequency to the precessional frequency of the protons under study.

Four CF options are available:

- Current
  - ° Skips center frequency tuning in prescan and uses the last center CF values.
  - ° Is used if a scan is stopped and the scan is re-initiated.
  - ° Is not used if scan parameters have changed since last series.
- Water
  - ° Is the default.
  - ° Centers on water peak as long as a valid fat/water pair is present.
  - ° Uses maximum peak if it cannot determine a valid fat/water pair.
  - ° Is the mandatory choice for fat suppression.

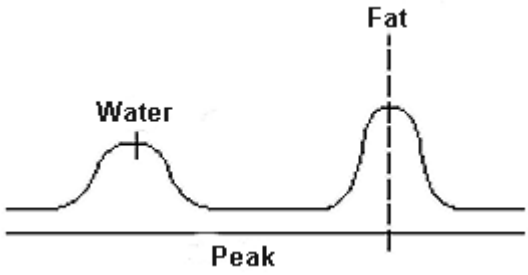



- Fat
  - ° Centers on fat protons, assuming a valid fat/water pair is present.
  - ° Uses maximum peak if it cannot determine a valid fat/water pair.
  - ° Is the mandatory choice for water suppression.




- Peak

° Centers on the maximum peak.




## Flow Comp Direction

The flow compensation direction allows you to prescribe a direction to reduce flow artifacts by putting the flowing protons into phase with the stationary protons. This feature is only available with FSE acquisitions.


- One direction must be chosen to apply the flow comp gradient: slice selection or frequency encoding.
  - ° The system suggests a direction based on the scan plane.
    - ° With sagittal or coronal scan planes, frequency is the default.
    - ° With an axial scan plane, slice is the default.
    - ° With oblique scan planes, no default is highlighted.
- The flow compensation direction should match the direction of the flowing protons.

  For example, a sagittal spine should have the same frequency axis as the flow compensation direction, which is head to foot, the direction of CSF and blood flow.
- Only one direction can be selected.

NOTE: A pre-defined flow compensation direction selection from a protocol, previous series, or scan takes precedence over these defaults.

Something to Think About...

- The flow compensation gradient is applied in the frequency or slice direction only. If phase and frequency have been swapped, the flow motion runs in the phase direction of the image and flow comp is then ineffective.

## Autoshim

Autoshim improves image quality by optimizing the X, Y, Z gradient shim settings, particularly with Chem SAT, Fast, and chemical-shift imaging.

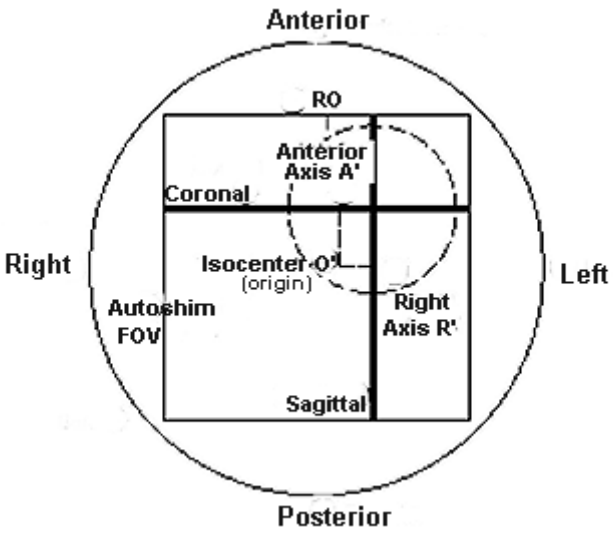

There are two Autoshim Modes:

- Automatic, which is selected in the Acquisition Timing area.
- Manual, which is selected from the Manual Prescan window as Grad Shimming.

Autoshim is the system's default and is included in Prescan. Autoshim uses the scan prescription parameters to calculate the optimal shim region. For the ROI, the system scans the intersection of three orthogonal planes in the following order: axial, sagittal, and coronal. ROI size depends on coil type and the FOV.

- The axial plane is always acquired at isocenter.
- The sagittal and coronal planes are acquired from the scan coordinates of the first and last slices scanned.
- Autoshim generates up to 12 images, two magnitude and two phase, from each scan plane.
- Nine images are displayed in Manual Mode, three magnitude, three phase, and three phase-difference images.
- Shim results can be saved in one of the ten Gradient Shim files.
- Autoshim sets up the PSD to acquire data from the sagittal and coronal plane. For display, the analysis program

calculates both the linear and quadratic coefficients for shim correction.




Select Autoshim for the following applications:

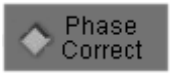
- First series for each new exam or area of anatomy.
- Chem SAT acquisition.
- Fat/Water suppression prescriptions.
- When using the imaging option Classic.

Something to Think About...

- No Current CF option appears, unless Autoshim is deselected.
- If Autoshim fails, prescan continues. You can still proceed with the scan. An error message is posted to the Advisory Panel.

## Phase Correct

Phase Correct is an option for FSE, FMPIR, and EPI pulse sequences. It obtains additional data prior to image acquisition and is used to correct for phase shifts.




Phase Correct compensates for undesired phase shifts due to eddy currents and RF misalignment. This is more noticeable on FSE scans because FSE combines data from many echoes acquired at different times to form a single image. Phase errors

between acquired echoes lead to ghosting and/or signal loss. Phase Correct compensates for these phase errors by means of RF phase shifts and gradient amplitude calibration.

- In EPI, Phase Correct performs a reference scan following a successful prescan.
- Phase Correct is not annotated on the images.
- Select Phase Correct for the following applications:
  - Off-Center FOV with FSEs that exhibit blurring.
  - Peripheral signal artifacts on sagittal FSE spines when using phased array coils.
  - Echo Planar Imaging.

Something to Think About...

- When using Phase Correct, scanning starts approximately four seconds after selecting the **[Scan]** button due to the additional data acquisition and calculations of correction values.
- Phase Correct cannot be used with the number of locations before pause in the Acquisition Timing area.

## Contrast

The Contrast selection provides a place to enter a contrast agent and amount for the current and all subsequent series.


If Autoscan is On and Contrast is selected, the first series in the Rx Manager containing contrast is not started until the contrast injection message box appears and you select the **[OK]** button. Autoscan must be reselected to restart auto scanning mode.

The contrast injection message does not appear again on this exam for subsequent +C series. An exception to this occurs when there is a series prescribed with contrast followed by a series prescribed without contrast, then another series with contrast. The contrast injection message appears again following the no contrast series.

## Rx Manager

The Rx Manager is used to create, view or edit, and prepare a series to be scanned. A series list is created in the Rx Manager upon selection of a protocol. Additionally, gating controls for the waveform display are accessed from Gating Control window and Auto Archive and Auto Transfer features from Scan Modes.

The Rx Manager is located on the left side of the screen on the Scan Rx Desktop.

The following table describes the functions of the Rx Manager control buttons.

| ***Selection*** | ***Description*** |
|---|---|
| **[Scan Modes]** | Sets Auto Archive, Auto Transfer, and system operation mode. |
| **[Gating Control]** | Controls the waveform display. |
| **[New Series]** | Adds a blank series to Rx manager. |
| **[End Exam]** | Ends the current exam and returns the desktop to the Patient Register. |
| **[View Edit]** | Allows modification of parameters. |
| **[Prepare to Scan]** | Activates Scan Operations area with parameters of highlighted series. |
| **[Save Rx as Protocol]** | Saves a Rx to the Site Protocol list with a user-defined name. |
| **[AutoScan]** | All series in RXD state in the Rx Manager are automatically scanned. |
| **[AutoStep]** | Automatically scans data acquisitions containing different stations with MultiStep option. |

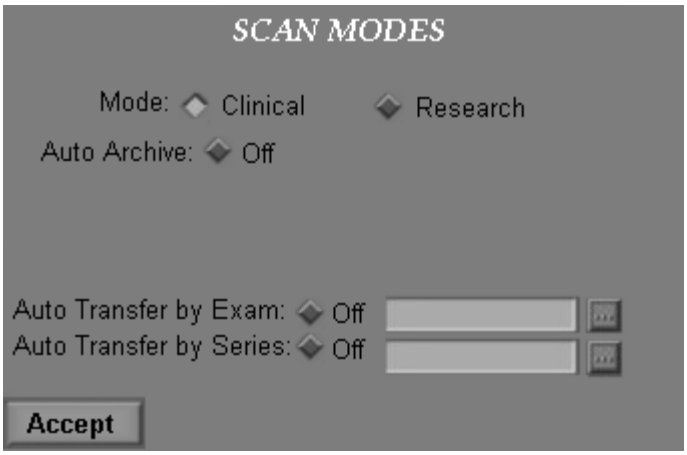
Applications of the Rx Manger:

- Reduce scan prescription time by using predefined patient protocols.
- Use the time-saving benefits of multiple prescribe ahead series concurrent with scanning.
- Adjust the gating controls for displayed waveforms on the PC monitor.

## Scan Modes

Scan Modes sets Auto Archive and Auto Transfer functions, as well as, the system operation mode (Clinical or Research).

The Scan Modes window appears when clicking the **[Scan Modes]** button in the Rx Manager.




### Mode

Mode selects the operation mode of the system; Clinical or Research.


- Clinical mode is the normal operation mode for most systems.
  - Clinical mode is the only selection available unless there is an agreement between the site and GE Medical Systems to enable the Research mode.
- To use Research mode, a special agreement with GE Medical Systems is required. Research mode allows the user to monitor SAR levels and to log CV (control variable) errors during pulse sequence operation.

### Auto Archive

Auto Archive automatically saves exams to the Magnetic Optical Disk (MOD) as they are completed; that is, when the **[End Exam]** button has been selected.

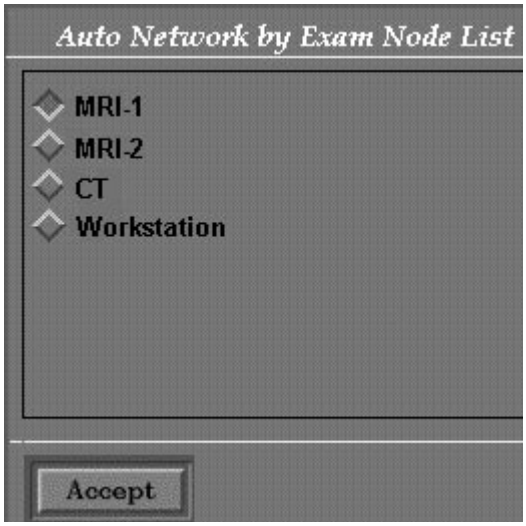

Auto Archive is functional only when the selected archive device is a local device. The Auto Archive feature state is maintained after a system reboot.

### Auto Transfer by Exam

Auto Transfer by Exam automatically sends the entire exam from the operator's console to a single remote host upon completion of an exam for review, image manipulation, or storage.

A remote host is any workstation (other than the one you are working on), that is in the network.

Auto Transfer by Exam can be used simultaneously with Auto Transfer by Series. You must turn Auto Transfer by Exam on and specify a remote host through the Auto Transfer Node List window.



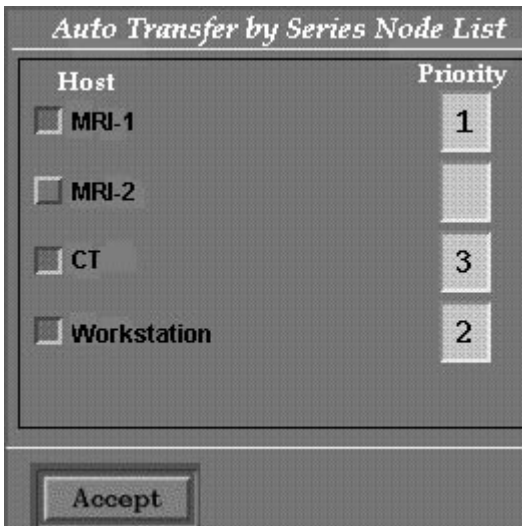

This feature must be activated and a host must be defined before you select the **[End Exam]** button. The exam is not sent unless you select the **[End Exam]** button first.

### Auto Transfer by Series

Auto Transfer by Series automatically sends images from the operator's console to as many as three remote hosts for review, image manipulation, or storage.

Auto Transfer by Series can be used simultaneously with Auto Transfer by Exam. The feature can be enabled or disabled as needed. A remote host, or hosts, must be specified through the Auto Transfer by Series Node List window. The entire series is transferred upon successful completion of the scan. If another scan is completed without selecting New Series, the additional images within the series transfer automatically when scanning is complete.

Up to three remote hosts can be specified for transfer by series. These hosts can be prioritized to specify in which order the hosts receive the images. Priority is specified by entering any number from 1 (highest) to 3 (lowest) in the **Priority** text box on the Auto Transfer Node List. A blank text box is considered the lowest priority. Equal priority can be given to remote hosts. The order in which the images are sent is at the discretion of the system. Once a priority number has been entered for a host, the text box holds that number until it has been deleted or changed.




Something to Think About...

- For image transfer to take place, Auto Transfer by Series must be fully enabled before the scan process has completed.
- Auto Transfer functions cannot be saved as part of a pre-defined protocol.
- Remote hosts are configured through Network and hosts cannot be added or deleted from the Auto Transfer Node List pop-up in Scan Modes.
- Auto Transfer by Series remains on until it is turned off or until a reboot is performed.

## Gating Control

The Gating Control window is used to set the cardiac and respiratory waveform display and functions.

There are two components to viewing a waveform:

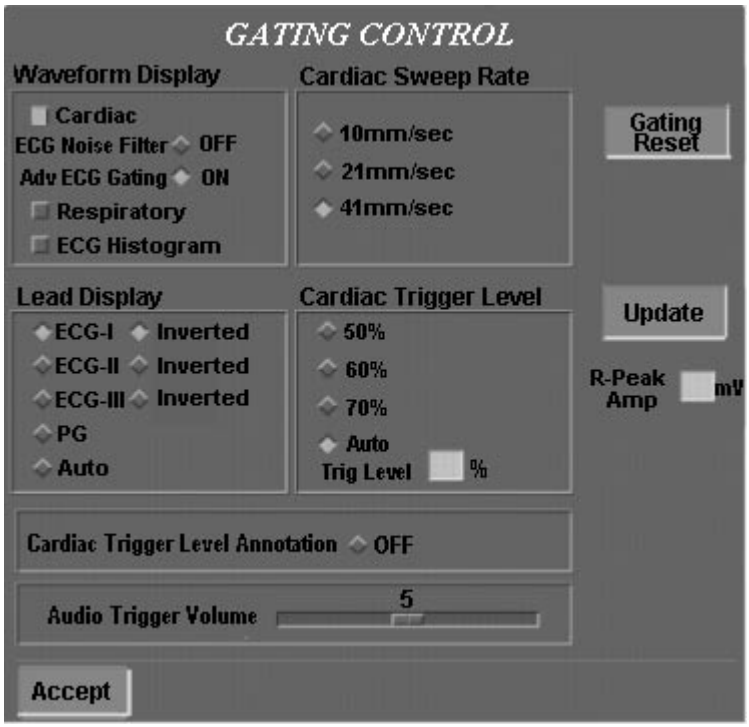
- The Gating Control window which is used to set the waveform options. The Waveform Display is for display

purposes only and does not affect a scan in progress if it is turned ON or OFF.

- The PC Monitor that is used to display the waveforms.

WARNING: Do not use Gating Waveforms for physiological monitoring. The patient's condition may not be reflected, resulting in improper emergency treatment.

The Gating Control window appears when the **[Gating Control]** button is selected in the Rx Manager.

The following table describes the functions of the Gating Control selections.

| ***Selection*** | ***Description*** |
|---|---|
| **Waveform Display** | Selects the display state for the cardiac waveform, respiratory waveform, or histogram on PC Monitor. |
| **ECG Noise Filter** | Moves the ECG gradient noise filter cut-off frequency down for improved cardiac filtering. |
| **Cardiac Sweep Rate** | Selects a sweep rate, at the speed at which the cardiac waveform displays. |
| **[Gating Reset]** | A reinitialize command is issued to the PAC to resets the gating control information. |
| **Lead Display** | Selects the ECG lead or PG for trigger. If Auto lead is selected, the PAC indicates the actual lead used. |
| **Cardiac Trigger Level** | Adjusts the level or threshold the system uses to “look” for triggers. |
| **Cardiac Trigger Level Annotation** | Controls the horizontal annotation marks on the waveform display. |
| **[Update] R-Peak Amp** | Updates the measured amplitude in millivolts (mV) of the displayed cardiac lead in peak signal. |
| **Audio Trigger Volume** | Adjusts the audio level of the trigger. Moving to the right increases volume. |

NOTE: For detailed information on the Gating Control window, refer to the chapter Gating and Triggering, Volume 3.

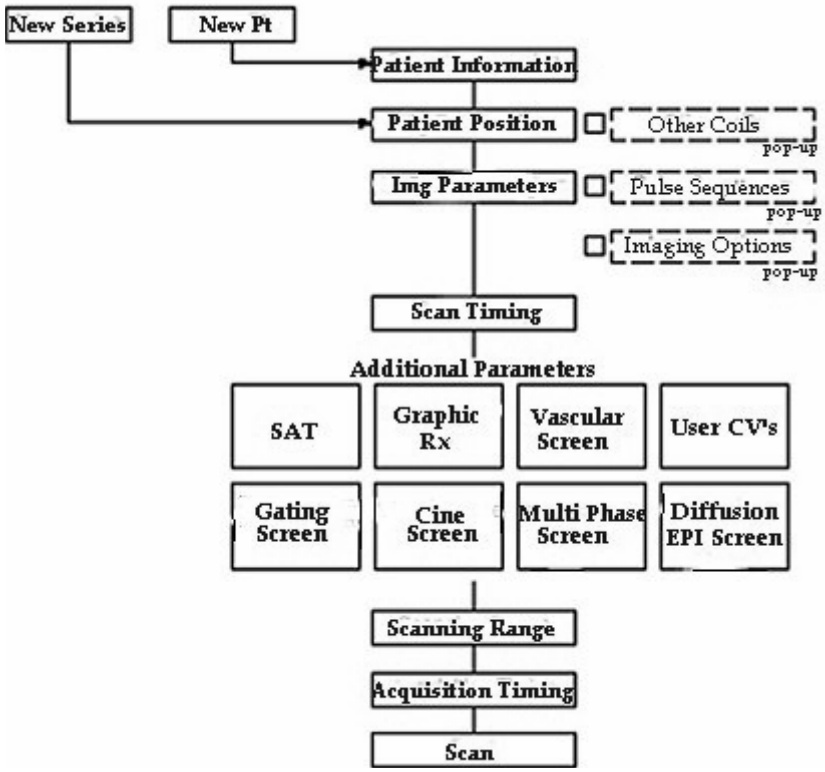
## New Series

New Series adds additional series to a patient’s exam. It is tracked in the Rx Manager list and begins at the Patient Position area. Select this button to add an additional series to the Rx Manager.


Selecting a New Series in the Rx Manager is only available with GE or Site protocols. New Series is not available after selecting Picture This protocols.

This following diagram is an overview of the scan process for New Patient or New Series. Several windows are found in the Patient Position and Imaging Parameters areas. The selections

made at the Pulse Sequence and Imaging Options windows subsequently affect which windows and choices are available for Scan Timing and Additional Parameter areas.




Something to Think About...

- A series cannot be scanned unless the **[Save Series]** button is used. Saving the series changes its status from INRX (in prescription) and places it in the prescribed or RXD state in the Rx Manager.
- The system automatically downloads the first series and, therefore, selecting the **[Prepare to Scan]** button is not required.

## End Exam

End Exam completes the current exam. It separates patient exams or anatomical regions for one patient.


Completing an exam with this key:

- Changes the status of the exam from current to completed.

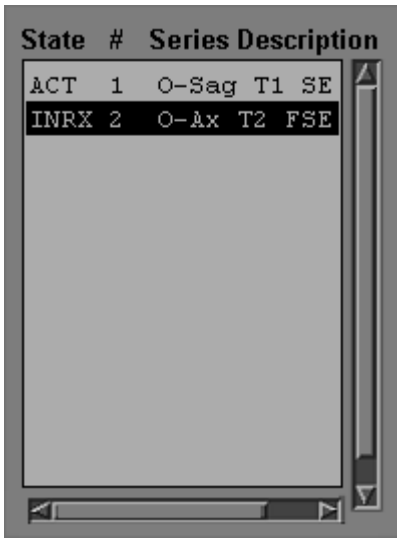
- Closes the scan screens and displays the Patient Register window.
- Makes New Patient selection available for the next patient or anatomy to be scanned.
- Makes the exam number available for archiving
- Removes the current images from the Autoview Window memory buffer.

Something to Think About...

- Once you select the **[End Exam]** button, no more images can be added to the exam number.
- You must select the **[End Exam]** button before Auto Store can save the exam's images to the MOD.

## Rx Manager List

The Rx Manager List shows the prescribed series state and series description. All scan information can be recalled by selecting and copying a series. This allows you to repeat a series exactly, without entering any information.




Each series in the Rx Manager list contains three pieces of information:

- The current state.
  - ° SCND indicates the series has been scanned and is complete.
  - ° ACT indicates the series is active and in the process of being scanned or ready to scan.

- RXD indicates the series is prescribed, once a successful download has occurred, and it is waiting to be scanned.
- INRX indicates the series is currently in prescription and is being processed, or it is being viewed in the prescription area.
- NEW indicates nothing has been done to the series or is only partially prescribed.

- The series number. A series number is not assigned until the scan is initiated.
- The series description.

For example, a typical series of entries in the Rx Manager List might include:

SCND 1. Sagittal T1 Loc

This indicates the series has been scanned, was the first series, can be used as a localizer, and remains in the list for easy access to the scan values.

ACT 2. Axial T2

This indicates that this scan was the second series and is currently being scanned or it is ready to scan.

RXD 3. Axial T1 Pre

This indicates that this scan is the third series and is ready for downloading.

INRX 4. Coronal T1 Pre

This indicates that the scan is the fourth series and has not been saved, it is being view/edited.

NEW 5. Sagittal T1 Pre

This indicates that the scan is the fifth series and has not been saved, nor is it being view/edited.

Something to Think About...

- Select the entries in the Rx Manager list in any order.
- The series highlighted in the Rx Manager is not necessarily the series being viewed on the desktop. The series in the INRX state is the series on the desktop.
- If a series on the desktop in the INRX state is not saved and the **[Scan]** button is selected, the system does not scan this series (the one on the desktop) but repeats the series previously scanned or the one in the ACT state.
- Series from different protocols can be added to the list. For example, if the current patient exam is a thoracic

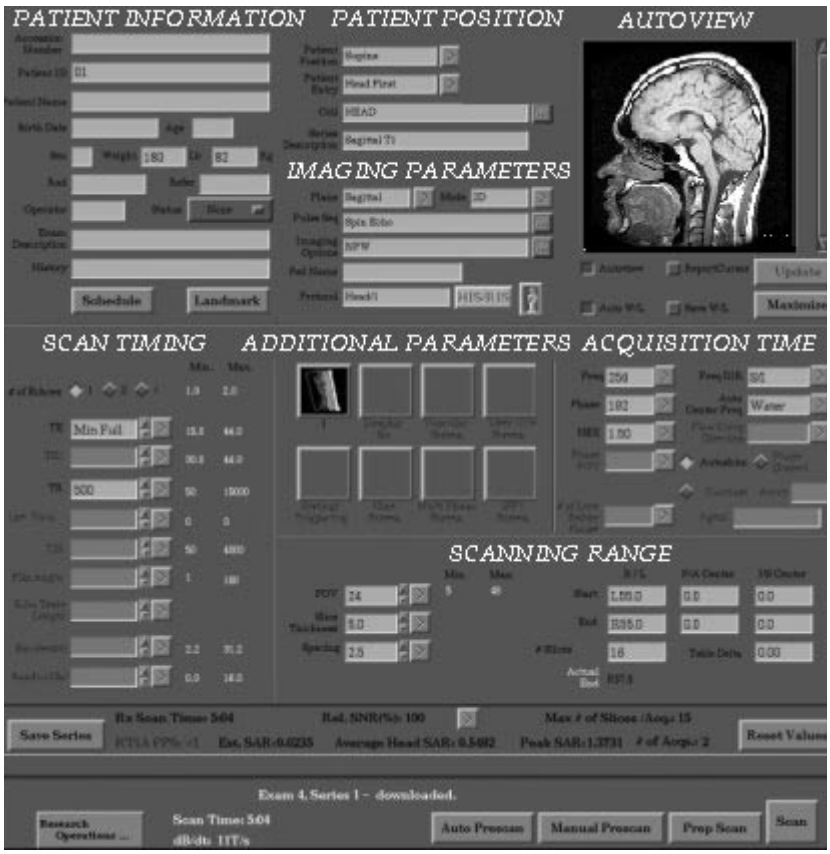
and lumbar spine study, the list can be arranged to have both exams ready to scan. Keep the landmark and orientation the same for each scan.

- The Rx Manager list is created when a protocol is selected. Select any series in the list and prescribe slice locations, change the stored protocol values, and save the protocol to the Rx Manager. The process can be repeated for as many series as needed.

## View Edit

View Edit allows you to review or edit a series in the Rx Manager. It can also be used to adjust a scan range after viewing the most recent acquisition.


The View Edit selection in the Rx Manager provides access to the scan parameters.




*Scan Rx Desktop*

The series can then be modified and saved again. A new series in the Rx Manager list changes to INRX if a view edit is performed.

Something to Think About...

- If you view or edit another series before a save series is initiated for the current series (INRX), changes for the current series (INRX) are saved and the INRX series is relisted in the Rx Manager as NEW.
- You can view but not edit a series that has a status of ACT (active) or SCND (scanned), even though the status of the series changes to INRX.

## Prepare to Scan

Prepare to Scan changes the status of a series from prescribed (RXD) to active (ACT) or ready to be scanned.


The system automatically moves the first series in the Rx Manager list to active status.

Something to Think About...

- Prepare to Scan is not needed if the **[AutoScan]** button is selected.
- Prepare to Scan is not needed for the first series of an exam.
- Prepare to Scan is required to download series on an individual basis.
- The series highlighted in the Rx Manager is the series prepared. Note that the series represented on the Scan Rx Desktop is not necessarily the series highlighted in the Rx Manager.

## Save Rx as Protocol

Save Rx as Protocol is used to save the current prescription as a site protocol. You must define the protocol name. This allows you to build predefined site protocols to reduce prescription set-up time and increase productivity.

When the **[Save Rx as Protocol]** button is selected, the entire series list in the Rx Manager is saved as a protocol in the site protocol list.

## Auto Scan

Auto Scan automatically downloads, prescans, and scans all RXD series in the Rx Manager. This feature extends the multi-tasking capabilities by allowing you to prescribe multiple scans in advance.


The next RXD series in the list begins automatically when the **[Auto Scan]** button is selected. All RXD series in the Rx Manager list are scanned sequentially.

Something to Think About...

- Auto Scan turns OFF if:
  - A table move is required (Move to Scan).
  - Move to scan is not activated after two audio alarms and scan times out.
  - A contrast series is in the queue following a non-contrast series.
  - A new landmark is selected.
  - New Patient or a patient from Patient Register list is selected.
- The following describes the behavior of contrast-enhanced series when Auto Scan is active:
  - AutoScan is on and there are no series in the Rx Manager in the RXD state.
  - When the first series containing contrast On is ready to scan, the contrast injection message appears. You must select the **[OK]** button to proceed.
  - The contrast message does not appear again in this exam for subsequent contrast-enhanced series. An exception to this occurs when there is a series prescribed with contrast followed by a series prescribed without contrast, then another series with contrast selected on. The contrast injection

message appears again following the no contrast series.

- If Auto Scan is turned on and there is no series in the Rx Manager in the RXD state but a series in a SCND or ACT state has been copied, the system AUTOMATICALLY changes its status to RXD. The system scans this series before there is a chance to edit the copied series.

### AutoStep

AutoStep provides automatic table movement and scan initialization for data acquisitions containing more than one station, until all stations are acquired. It is available with the MultiStep imaging option in the SmartStep software purchase option.


AutoStep is available with a SmartStep meta-series. All prescribed stations in the meta-series must be saved and prescanned before selecting AutoStep to initiate the acquisition.

NOTE: For additional information on the SmartStep meta-series using AutoStep, refer to the chapter Bolus Chasing with SmartStep, Volume 3.

NOTE: SmartStep is a purchase option on Signa MR systems running 8.3 or above software.

## Series Control and Advisory Panel

Series Control area allows prescribed acquisitions to be saved, parameters to be reset to their original values, and the relative SNR% to be monitored. This area also contains an Advisory Panel to provide information about scan time, the number of acquisitions, the maximum number of slices per acquisition, estimated and peak SAR, real time imaging frame rate notification, and posts messages during the prescription process.

## Save Series

The Save Series selection accepts the parameters and places the series in the RXD State in the Rx Manager.


A landmark must be established and all parameters must be completed for Save Series to be valid. The first series is automatically downloaded to scan when the **[Save Series]** button is selected.

Something to Think About...

- Once Save Series is initiated for the first series, patient information can no longer be updated.

## Reset Values

The Reset Values selection resets parameters to their original values before any modifications were made.


## Relative SNR%

The Relative SNR% meter reflects changes to parameters within a protocol that impact signal to noise.

The parameters used to calculate changes in SNR are:

- Fractional or full TE
- Receiver bandwidth
- FOV
- Slice thickness
- Frequency matrix
- Phase matrix
- NEX
- Phase FOV
- Square pixel
- 3D number of locations per slab

The relative SNR% is not an absolute value but a relative value based on the current set of parameters being equal to 100%. Changes made to parameters that affect SNR are calculated and relative SNR% is updated to indicate their impact on SNR. The relative SNR% for a protocol can be reset to 100% using the Reset SNR selection.

Something to Think About...

- Changes for SNR are not calculated for changes in TR or TE. Significant changes in TR and TE can change the SNR for an acquisition.
- The calculation does not include changes for TR, PSD, or coil selected.
- For a variable SE sequence, a relative SNR% is given for TE and TE2.

## SAR Level

Specific Absorbtion Rate (SAR) refers to the RF power absorbed per unit of mass of an object (Watts/kg).

- The SAR limits are not exceeded when the patient's correct weight is entered on the Patient Information area.
- If the head coil is in use, the estimated average head SAR shall be displayed along with the estimated average and peak SAR values.
- SAR levels for the patients are based on current scientific literature related to safety. The level of exposure shall be a medical judgment as to the patient's potential risk versus benefit.

## Frames per Second Notification

Frames per Second (FPS) notifications are displayed during Real Time Imaging acquisitions. FPS is dependent on the system hardware configuration. The FPS rate for the prescribed series appears prior to the beginning of the scan.

NOTE: For Real Time Interactive Imaging frame rates refer to the chapter Imaging Real-time with iDrive, Volume 3.

# Scan Operations

Scan Operations area displays the dB/dt level, provides prescan options to improve image quality, and allows you to start the scan prescription.

## STL% or dB/dt Level

The STL% or dB/dt level displays the value your site's governing board (Investigational Review Board) has approved for scanning limits.

- DB/dt refers to the rate of change in magnetic field to time which is expressed in Tesla/seconds.
- STL is an abbreviation for Stimulated Threshold Limit and the dB/dt is expressed in T/s. Your service representative sets the units in T/s or STL%.
- The Signa system is capable of operating under several modes: normal, first level controlled operating mode (research mode), and second level controlled operating mode (proprietary license agreement with GE).
- The screen appearance changes based on the operating mode (clinical vs research), the governing regulator (IEC vs FDA), and the pulse sequence (non-EPI or EPI).

NOTE: STL% values appear on systems outside the US.

The following table shows messages that appear during certain scanning situations with non-EPI and EPI pulse sequences.

| ***Mode/Governing Board*** | ***Scan Type*** | ***Imaging Parameter Area Message*** |
|---|---|---|
| **Non-Research IEC Hi Speed Echo Speed** | Non-EPI | **Accept>20 T/s [On]/[Off]** Selecting **[On]** means you might exceed 20 T/s and it produces the following message, **"Attention, possible patient peripheral nerve stimulation"**. You must select **[OK]** to proceed. **[Off]** allows you to use the default value set by site's governing board. |
| **Research IEC or FDA HiSpeed Echo Speed** | EPI | 1. The STL% or T/s can be changed by entering a value between the default and a maximum value allowed. If the value exceeds the default value the following message appears, **"Do you accept responsibility for operation up to [STL]% of peripheral nerve stimulation threshold limit?"** If your site does not have an STL% display but rather a T/s display, the message is, **"Do you accept responsibility for operation up to [ ] T/s?"** Select **[Accept]** to proceed with protocol prescription, or select the **[Reject]** key and enter a value less than or equal to the default value your governing board has approved. Note that the system never allows a protocol to exceed the maximum level set by your governing board.<br><br>2. If you enter a value that exceeds your governing board's maximum value, the following message appears, **"Valid range is 1 to xx STL%"** or **"Valid range is 1 to xx T/s [OK]"**. The xx STL% or xx T/s is the maximum value allowed by your governing board. You must select the **[OK]** button to proceed. |

## Prescan

The Prescan procedure optimizes performance and improves image quality.

Prescan accomplishes this by:

- Providing shim consistency through the Autoshim Program.
- Fine-tuning the system for optimal sampling of the individual patient's anatomy through the Center Frequency Program.

- Adjusting the RF transmit gain to ensure precise flip angles.
- Adjusting the RF receive gain to optimize the use of the receiver's dynamic range.

There are two Prescan Programs: Auto and Manual.


- Auto Prescan automatically adjusts and sets Center Frequency, Transmit and Receive Gain.
- Manual Prescan requires that you set the Center Frequency, Transmit, and Receive Gains.

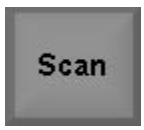
NOTE: For detailed information on prescanning, refer to the chapter Optimizing Image Quality with Prescanning, Volume 1.

## Prep Scan

Prep Scan can be used to eliminate the lapse in time between the moment you select the **[Scan]** button and the moment the system begins scanning. It is useful for breath-hold examinations. Prep Scan can be selected after Auto or Manual Prescan and before Scan.


## Scan

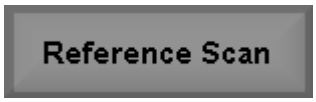
Scan initiates the acquisition and begins to scan the prescribed series.




When selected first, scan automatically adjusts and sets Center Frequency, Transmit and Receive gain then begins scan. Scan can also be selected after a successful Auto or Manual prescan.

## Reference Scan

Reference Scan initiates collection of “phase correction” data for EPI acquisitions. Needed when performing a Manual Prescan.




Reference Scan is included automatically when the **[Auto Prescan]** or the **[Scan]** button is selected.

NOTE: Reference Scan only appears with EPI acquisitions.

NOTE: Scan Operation keys (Scan, Manual Prescan, Auto Prescan, Prep Scan, Reset Values, and Save Series) can be activated by placing the cursor over the key and pressing the space bar.

Volume 1

Chapter 4

# Gradient, Shim, and Imaging Coils

Where Am I?

## Introduction

This chapter gives you a brief overview of the function of the gradient and shim coils. This chapter also explains the function and use of RF and imaging coils. The guidelines in this chapter help you to select the appropriate coil for common exams. This chapter contains the step-by-step instructions to help you learn how to:

- Position in the Head Coil
- Position in the Body Coil
- Position a Surface Phased Array Coil

In addition, this chapter answers the following questions:

1. What is the purpose of RF, surface and phased array coils?
2. How do surface and phased array coils affect FOV and depth penetration?
3. How do I select the appropriate coil?
4. What is the function of the gradient coils?
5. What is the function of the shim coils?
6. How do I position a patient in the head coil?
7. How do I position a patient in the body coil?
8. How do I position a patient using a surface or phased array coil?
9. What is a phased array coil?
10. How do I perform the head coil quality assurance test?

# About... Gradient, Shim, and Imaging Coils

This section presents the concepts necessary to successfully complete the coil selection and patient positioning process. Specifically, you need to understand:

- Gradient and Shim Coil Function
  - ° Gradient Coils
  - ° Shim Coils
- Imaging Coil Function and Classification
  - ° Head Coil
  - ° Body Coil
  - ° Surface and Phased Array Coils
- Coil Sensitivity Range
  - ° Adaptive Phased Array
- Performing Coil QA
  - ° Performing Head Coil QA
  - ° Performing QA for Other Coils

## Gradient and Shim Coil Function

### Gradient Coils

The gradient coils are three sets of wire coils wrapped around a fiberglass cylinder located within the magnet housing. Electric current flows through these gradient coils and is turned on and off very rapidly, thereby producing expansion and contraction of the gradient coils. This expansion and contraction creates the tapping sound when scanning.

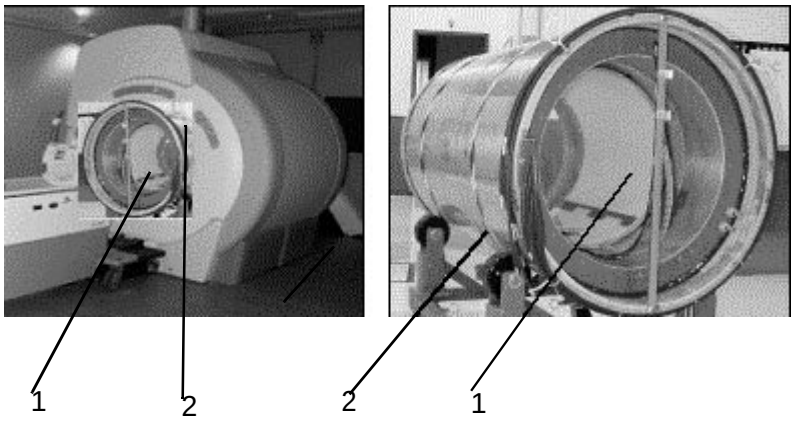
The electric current flowing through these coils produces another magnetic field. Because the current is turned on and off in a specified manner, this magnetic field varies and is called a time-varying magnetic field. The MR image is the representation of a slice of anatomy that has been divided into cubes or voxels. These time-varying magnetic fields create controlled and graded variations in the static magnetic field; thus affecting nuclear precessional frequency in any given voxel of anatomy and allowing for spatial detection of signal within a slice. Knowing how much the magnetic field has been graded or altered at any given point in a slice, the system can determine

where each voxel is located by reading the precessional frequency of the signal within that voxel.

An MRI system uses three gradient coils. Each coil affects a different plane, the XY, YZ, or XZ plane, as it is turned on and off at different points in a pulse sequence. The scan plane and pulse sequence selected determines which gradient functions as the slice selective, phase encoding and frequency encoding gradient. The system calculates this automatically.

Consider the Z axis gradient, which is created by enclosing two coils, one on the top of the bore, the other on the bottom of the bore. If current is passed through the coil at the top of the bore, then magnetic field lines are created along the +Z axis. Then, by passing current in the opposite direction through the wire at the bottom of the bore, a similar but opposite field is created along the -Z axis. The net effect is offset at the middle of the two coils (isocenter), resulting in zero change to the static magnetic field at isocenter. The X and Y gradients are also located on the top and the bottom of the bore and use a similar method to localize signal in these planes.

The gradients are resistive magnets and are water cooled by the gradient chiller located in the computer room.




- 1 - Body Coil
- 2 - Gradient Coil

### Shim Coils

Shim coils are used to compensate for inhomogeneities and imperfections in the main magnetic field caused by environmental factors that cannot be controlled or eliminated. Your MR system shim coils are made of niobium-titanium (NbTi). These coils can be either superconducting or resistive coils. Current runs through the shim coils creating magnetic fields that alter the main magnetic field, and thereby compensates for inhomgeneities.

The presence of magnetic field inhomogeneities decreases system performance. This is particularly noticeable when imaging with Fat Saturation. When scanning with Fat Sat, be sure to select Autoshim on; this allows the system to automatically calculate the optimal shim values during Prescan. The initial shim values are adjusted during scanner installation and are checked and re-adjusted as necessary as part of preventive maintenance.

NOTE: For additional information regarding Autoshim, refer to the chapter Scan Rx Desktop.

## Imaging Coil Function and Classification

The head coil, body coil, surface, and phased array coils are RF coils that consist of loops of copper wire that transmit and/or receive the RF signal. The coils are used to transmit matching radio frequencies to resonate with nuclei in the anatomy of interest. The RF coil then acts as a receiver of the signal emitted by the nuclei upon cessation of the RF transmission. The received signal is the raw data used to create an image. Generally, the head and body coils give a uniform depth of signal. Surface coils are specialized coils used in imaging limited areas and with limited depth penetration. Phased array coils are two or more, closely coupled surface coils that receive signal over an area.

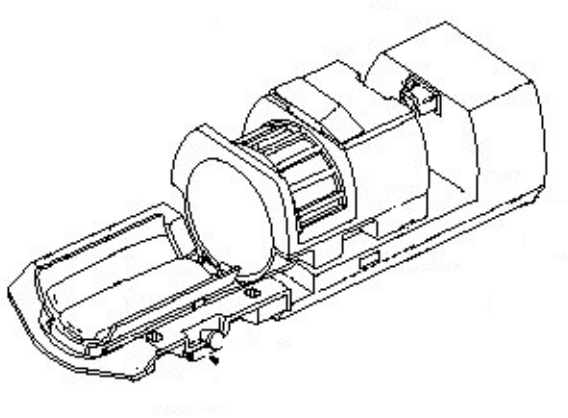
Imaging coils are tuned to match the precessional frequency of nuclei under evaluation.

| ***Magnet Field Strength*** | ***Hydrogen Proton Precessional Frequency*** |
|---|---|
| 1.0T | 42.6MHz |
| 1.5T | 63.9MHz |

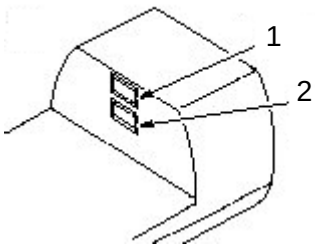
## Head Coil

The head coil is a one piece bird cage design device that transmits and receives RF signals. It provides higher Signal to Noise Ratio (SNR) than the body coil because it is smaller. The head coil is primarily used to image the head, although it can be used for imaging any body part that fits into the coil. The head coil is an example of a volume (uniform depth of signal) coil. A mirror gives the patient a greater sense of openness.

WARNING: Do not let the patient's skin touch the head coil. Place sponges or cloth between the head coil and the patient.

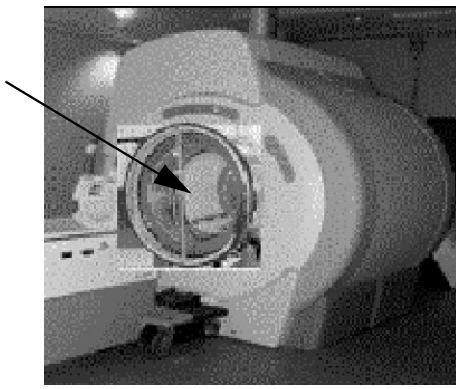


The head coil is plugged into the top outlet of the trolley (1).



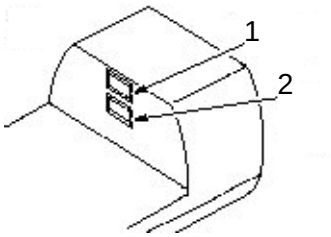
## Body Coil

The body coil (arrow in picture) is located within the magnet enclosure and is invisible to you and the patient. The body coil is a transmit and receive coil which excites nuclei and collects signals from them as they relax. It transmits the RF pulses that excite and rephase the protons, and receives the signals created by these protons. The body coil can also act as a transmit only coil when used with receive only coils. The body coil is a volume coil and is used for large FOV (Field of View) imaging and for uniform depth penetration.



## Surface and Phased Array Coils

Surface and phased array coils are used to increase SNR when imaging a limited area of the body. Flat surface and phased array coils do not have uniform depth penetration. Phased array coils are a number of coils combined together to increase SNR, and depending on the coil design, may increase available FOV (either length or depth) without decreasing SNR. An example of a surface coil would be a 3 inch coil; an example of a phased array coil would be the Torso array coil. The maximum number of coils of a phased array that can be turned on at one time is four. For those who have the phased array option, the phased array coils are plugged into the bottom outlet of the doghouse.



- 1 - The plug-in port for head or surface coils.
- 2 - The plug-in port for phased array coils.

WARNING: Some coils are transmit and receive coils. Be sure that the proper coil is selected (at the operator's console) before scanning the patient. **DO NOT SCAN TRANSMIT AND RECEIVE COILS WITH THE BODY COIL.** Making a coil selection that does not match the actual coil used may result in severe damage to the coil and possible patient warming. See the individual coil manuals for specific cautions and warnings.

## Coil Sensitivity Range

Generally, the length of a coil is equal to the FOV the coil covers; the depth of penetration is half the width of the coil. When selecting a coil, keep in mind the FOV you need, how deep you need to image, and the size of the patient. Phased array and surface coils give you better SNR, but this is only over a localized area. Also, phased array and surface coils need to be placed close to the area of the body you are imaging. It is best to choose the smallest coil possible to get the optimum SNR.

The following are some examples of different types of coils:

- Volume Coils
  - Head Coil
  - Body Coil
- Surface and Phased Array Coils
  - Wrist Coil
  - Shoulder coil
  - General Purpose (GP) Flex Coil
  - 3 Inch Round Coil

### Adaptive Phased Array

Sometimes one or more elements of a multicoil array extend physically beyond the selected FOV. These outlying coil elements are often better at receiving unwanted tissue signals

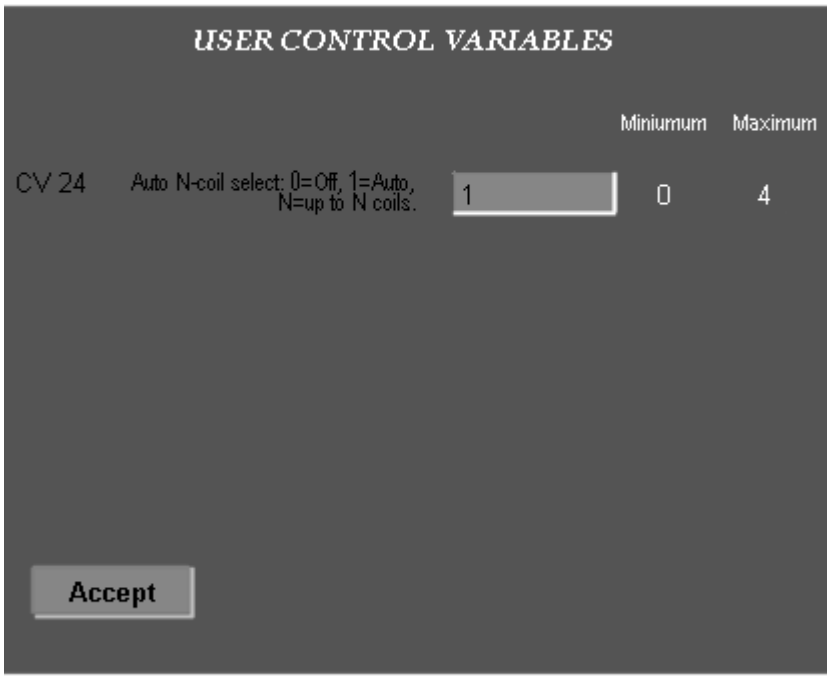
from outside than desired signals from inside the selected FOV. Signals from outside the FOV are often poorly controlled in the imaging process which can lead to ghosting in the phase encode direction. These ghosts, which can run across the entire phase encoding dimension of the offending receiver's image, often lie on the anatomy of interest.

The original version of Adaptive Phased Array (APA), known as N-coil, reconstruction solved this problem by identifying the ghosting receivers beforehand and hardcoding these receivers in the coil configuration file. Since the ghosting depends on FOV and receiver position, N-Coil reconstruction failed to identify the ghosting receivers in the run time.

By calculating the mean for each intermediate image, the new version of APA identifies the right receiver's images that contain ghosting and rejects them from the final combined image. APA achieves this by selecting the maximum mean of the signal from each coil and calculates the threshold of each image. Only the intermediate images that are above the threshold are combined to form the final image.

You can enable the APA feature by selecting the User Control Variable (CV) Auto N-Coil from the User CV screen in the Additional Parameters area of the Scan Rx Desktop.

This feature is only available with Fast Spin Echo (FSE) pulse sequences.



The following table summarizes the User CVs available for Auto-N coil.

| ***User Control Variables*** | | |
|---|---|---|
| Auto N-Coil | Off = 0 | Select 0 if you do not want to use the Adaptive Phased Array option. |
| | Auto = 1 | The system uses the selected FOV to identify which receivers to use during reconstruction. |
| | 2 Receivers = 2 | The system chooses two receivers with the highest signal intensity to use during reconstruction. |
| | 3 Receivers = 3 | The system chooses three receivers with the highest signal to use during reconstruction. |
| | 4 Receivers = 4 | The system reconstructs the images using all four receivers. |

# Performing Coil QA

## Performing Head Coil QA

You should perform a head coil Quality Assurance test (QA) every day. When the head coil is working normally, a QA scan produces a normal image showing no holes, distortions or other artifacts. If there are artifacts in the visual image, contact the service engineer and do not use the head coil for patient studies.

When performing the head coil QA test use the protocol in the table below:

| ***Patient Entry*** | ***Position*** | ***Landmark*** | ***Coil*** | ***Scan Plane*** | ***Mode*** |
|---|---|---|---|---|---|
| Head First | Supine | Other | Head | Axial | 2D |

| ***PSD*** | ***Imaging Options*** | ***TE*** | ***TR*** | ***FOV*** | ***Slice Thickness*** |
|---|---|---|---|---|---|
| SE | None | 25 | 300 | 24 | 3 |

| ***Spacing*** | ***Start*** | ***End*** | ***Acq. Matrix*** | ***NEX*** | ***Auto CF*** |
|---|---|---|---|---|---|
| **1.5** | **0** | **0** | **256x256** | **2** | **Peak** |

NOTE: For additional information on performing the daily QA, refer to the chapter Getting Started.

## Performing QA for Other Coils

Refer to the individual coil manuals for more detailed information and the QA for that coil.

# How to Select Coils and Position the Patient

This section provides the step-by-step instructions for selecting coils and positioning patients. Specifically, it describes how to:

- Position the Patient
  - Head Coil
  - Body Coil
  - Surface and Phased Array Coils

## Position the Patient

# Head Coil

The head coil is a bird cage design transmit and receive, volume coil. Use the head coil whenever imaging the head. The head coil can be used for any body part that fits into the head coil, but remember to place sponges so that the patient's skin does not touch the coil.

1. Unplug and remove all other coils from the magnet bore.

WARNING: Be sure that the proper coil is selected (on the operator's console) before scanning with the head coil. Do not scan using the head coil when the body coil selected on the operator's console. This could result in damage to the coil and possible patient warming.

2. Place the cage portion of the head coil on the trolley.
3. Place the base of the head coil assembly on the cradle and align with the table notches.
4. Lock the base.
   - Turn the knob clockwise until tightened.
5. Place a sponge in the coil base and cover with a sanitary liner.
6. Instruct the patient that during the scan it be quite noisy, and give the patient ear plugs.
   - If available, headphones may be substituted for ear plugs.
7. Give the patient the Patient Alert bulb and instruct the patient how to use it.
8. Have the patient lie supine with head in the cradle.
   - Shoulders should rest against the head cradle.
9. Use sponges to make the patient comfortable.
   - ° Usually, placing an angled sponge under the patient's knees helps to take pressure off his/her back.

## In Brief: Head Coil

1. Unplug and remove all coils from the magnet.
2. Place the cage of the head coil on the trolley.
3. Place base of coil on table and align notches.
4. Lock the base.
5. Place a sponge in the coil base and cover with a sanitary liner.
6. Give the patient ear plugs.
7. Give the patient the Patient Alert bulb.
8. Have patient lie supine with head in the cradle.
9. Use sponges to make the patient comfortable.
10. Use straps to immobilize the patient's head.
11. Instruct the patient close eyes.
12. Press **[Align Light]**.
13. Press **[In Slow]**.
14. Align cross of the align light with the glabella.
15. Press **[Landmark]**.
16. Slide cage part of coil over patient's head.
17. Plug in the head coil.
18. Press **[Move to Scan]**.

10. Use straps to immobilize the patient's head.
    - Security straps across the arms, abdomen, or legs provide patient safety and help control patient motion.
11. Instruct the patient close his/her eyes.

WARNING: Instruct the patient to close eyes before turning on the alignment light. The eyes must be protected from laser radiation. The patient needs to be instructed to close his/her eyes when landmarking and the laser light is turned on. Exposing eyes to the laser alignment lights may result in eye injury.

12. Press **[Align Light]**.
13. Press **[In Slow]**.
    - Moves table in slowly.
14. Align cross of the align light with the glabella.
15. Press **[Landmark]**.
    - Communicates the region of interest center to the system.
    - Automatically turns off the alignment light.

CAUTION: Do not leave the laser light on after you position the patient.

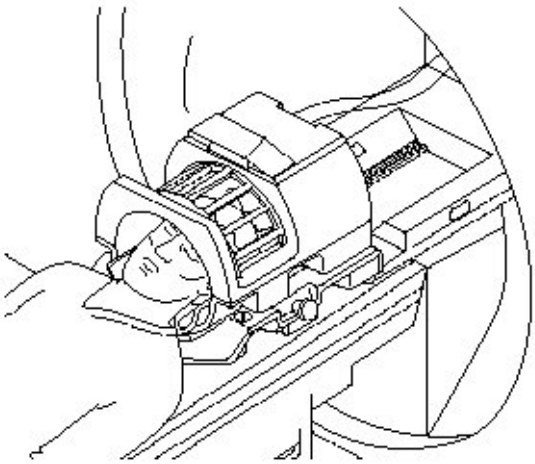
16. Slide the cage portion of the head coil over patient's head.
    - Slide it as far as possible, covering the entire head.
17. Plug in the head coil.
    - Make sure the cables are NOT twisted or looped.
    - The coil must be for this particular system.
        - ° Coils from other MR systems (including coils from other GE MR systems) must NOT be used.

WARNING: To prevent patient burns, use only coils with this label near the connector:

CAUTION: If there is any visible damage to the coil or cables DO NOT USE. Notify the service engineer.

18. Press **[Move to scan]**.
    - Moves the patient to isocenter (center of magnet).

The following figure shows a patient positioned in the head coil.



## Position the Patient

# Body Coil

### In Brief: Body Coil

1. Unplug and remove all other coils from the magnet bore.
2. Instruct the patient to lie supine on the table either head first or feet first.
3. Place sponges to make the patient comfortable.
4. Use straps to immobilize the patient.
5. Give the patient ear plugs.
6. Give the patient the Patient Alert bulb.
7. Instruct the patient close eyes.
8. Press **[Align Light]**.
9. Press **[In Slow]**.
10. Align cross of alignment light over the center of the area of interest.
11. Press **[Landmark]**.
12. Press **[Move to Scan]**.

The body coil is a volume coil. Use the body coil whenever you need to use a large FOV and/or need uniform depth penetration. Examples are abdomen imaging and cardiac or chest imaging. Unplug and remove all other coils from the magnet bore.

1. Unplug and remove all other coils from the magnet bore.
   - The body coil is built inside the magnet housing, so no coils need to be placed on the cradle.
2. Instruct the patient to lie supine on the table either head first or feet first.
   - Feet first is preferred, due to fewer problems with claustrophobia.
   - If possible, try to position the patient's arms away from the area of interest. When imaging the abdomen or chest you may want to bring the patient's arms above his/her head (if the patient can tolerate it).
3. Place sponges to make the patient comfortable.
   - Usually, placing an angled sponge under the patient's knees helps to take pressure off his/her back.
   - Place thermal pads where the patient touches the bore to help prevent warming.
4. Use straps to immobilize the patient.
   - Security straps across the arms, abdomen, or legs provide patient safety and help control patient motion.
5. Instruct the patient that during the scan it is quite noisy, and give the patient earplugs.
   - You may want to substitute ear plugs with headphones, if available.

6. Give the patient the Patient Alert bulb and instruct the patient how to use it.
7. Instruct the patient to close his/her eyes.

WARNING: Instruct the patient to close his/her eyes before pressing [Align Light]. The eyes must be protected from laser radiation. The patient needs to be instructed to close his/her eyes when landmarking and the laser light is turned on. Exposing eyes to the laser alignment lights may result in eye injury.

8. Press **[Align Light]**.
9. Press **[In Slow]**.
   - Moves table in slowly.
10. Align cross of the alignment light with the center of the area of interest.
11. Press **[Landmark]**.
    - Communicates the region of interest center to the system.
    - Automatically turns off the alignment light.

CAUTION: Do not leave the laser light on after you position the patient.

12. Press **[Move to Scan]**.
    - Moves the patient to isocenter (center of magnet).

## Position the Patient

# Surface and Phased Array Coils

### In Brief: Surface and Phased Array Coils

1. Unplug and remove all other coils from the magnet bore.
2. Position patient on table and position coil on patient.
3. Place sponges to make the patient comfortable.
4. Use straps to immobilize the patient.
5. Provide patient with ear plugs.
6. Give Patient Alert bulb and instruct patient on its use.
7. Instruct the patient close eyes.
8. Press **[Align Light]**.
9. Press **[In Slow]**.
10. Align cross of align light to the center of the coil.
11. Press **[Landmark]**.
12. Plug in the coil.
13. Press **[Move to Scan]**.

When imaging a small region of interest, remember that the smaller the coil the better the SNR. Use surface coils and phased array coils when imaging an area of the body where you are able to place the coil close to the region of interest. Surface Phased array coils have a limited depth of penetration, typically about half the width of the coil. They are NOT volume coils.

WARNING: Some surface coils are transmit and receive coils. Be sure that the proper coil is selected (at the operator's console) before scanning the patient. **DO NOT SCAN TRANSMIT AND RECEIVE COILS WITH THE BODY COIL SELCECTED.** Making a coil selection that does not match the actual coil used may result in severe damage to the coil and possible patient warming. See the individual coil manuals for specific cautions and warnings.

1. Unplug and remove all other coils from the magnet bore. Observe all warnings that are listed below:

WARNING: When using surface coils and phased array coils:

- **Remove all unplugged and unused accessory items from the bore, a patient burn could result.**
- **GATING: <u>DO NOT</u> USE BLUE WIRE TYPE ECG LEADS.There is a potential for patient heating with these leads. ONLY USE HIGH IMPEDENCE ECG LEADS when doing surface coil or phased array coil ECG gated scans.**
- **Only use coils and accessories that are in good condition. Inspect coils and accessories for damage. If damage is apparent DO NOT USE and notify the service engineer. DO NOT USE coils with damaged insulation. If the coils are exposed, patient burns can result, DO NOT USE these coils.**

- **Route cables out of the magnet through the center of the magnet bore. Position the patient to minimize the distance the cables extend into the bore.**

WARNING: DO NOT LOOP OR CROSS CABLES: Arcing and **patient burns can result**.

- **Do not allow the cable to touch the patient because burns could result. Use a thermal resistant material or pad to keep cable from touching the patient.**
- **The patient should not touch the magnet bore. Place pads between patient and bore to avoid touching. For large patients, use wide patient safety straps across the arms (or any other part of the body that is touching the bore).**
- **Use only compatible coils, make sure the plug has a compatibility tag as shown below. The coil must be for this particular system. Coils from other MR systems (including coils from other GE MR systems) must NOT be used.**

2. Position the patient on the table and position the coil on the patient.
3. Use sponges to make the patient comfortable.
   - Use appropriate sponges where necessary for coil positioning.
   - Usually, placing an angled sponge under the patient's knees helps take pressure off the back and makes the patient more comfortable.
   - Place thermal pads at points where patient touches bore.
4. Use straps to immobilize the patient.
   - Security straps across the arms, abdomen, or legs provide patient safety and help control patient motion.

5. Instruct the patient that during the scan it is quite noisy, and provide the patient with ear plugs.
   - If available, you may want to substitute headphones for ear plugs.
6. Give the patient the Patient Alert bulb and instruct the patient how to use it.
7. Instruct the patient to close his/her eyes.

WARNING: Instruct the patient to close his/her eyes before turning on the Align Light. The eyes must be protected from laser radiation. The patient needs to be instructed to close his/her eyes when landmarking and the laser light is turned on. Exposing eyes to the laser alignment lights may result in eye injury.

8. Press **[Align Light]**.
9. Press **[In Slow]**.
   - Moves table in slowly.
10. Align cross of the alignment light with the center of the coil.
11. Press **[Landmark]**.
    - Communicates the region of interest center to the system.
    - Automatically turns off the alignment light.

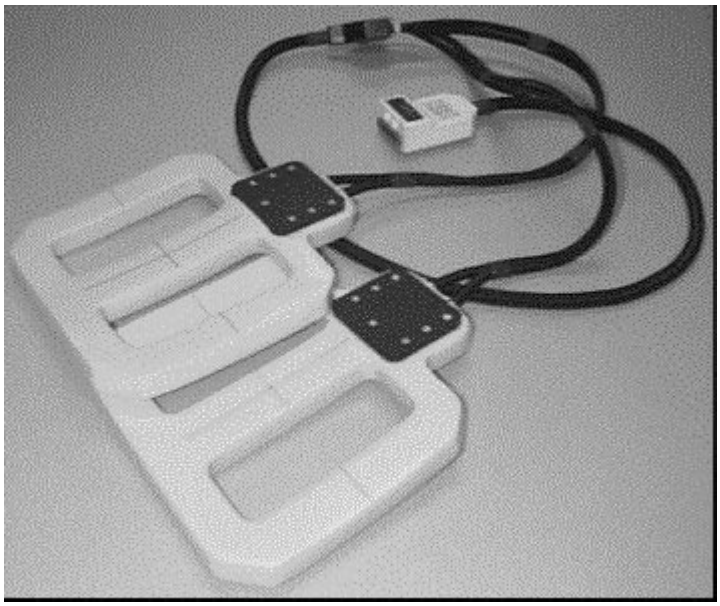
CAUTION: Do not leave the laser light on after you position the patient.

12. Plug in the coil.
    - The coil must be for this particular system.
      - ° Coils from other MR systems (including coils from other GE MR systems) must NOT be used.
    - The cables should not be twisted or looped.
13. Press **[Move to Scan]**.
    - Moves the patient to isocenter (center of magnet).

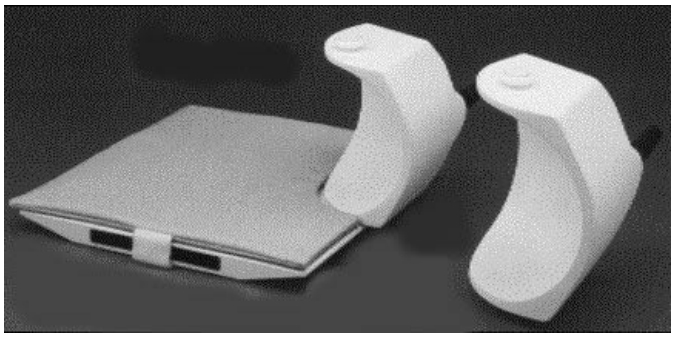
The figures below are some examples of surface and phased array coils. Please refer to the individual coil manuals for more detailed information on your site's coils:

- The CTL Array coil allows imaging of the C,T, and L spine without repositioning the patient. A volume neck coil is also built into this coil.

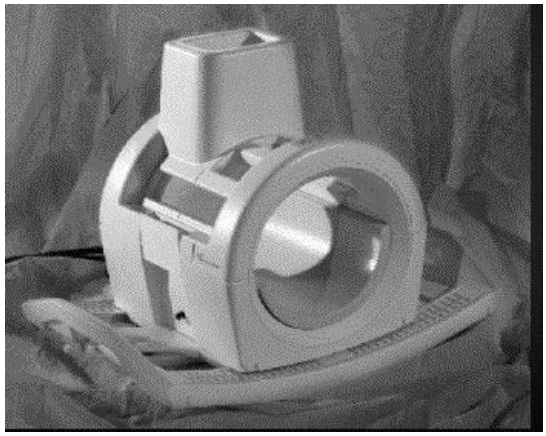
- The Torso Array coil for imaging and MR Angiography of the abdomen or pelvis. The pictured coil is a four element phased array coil.



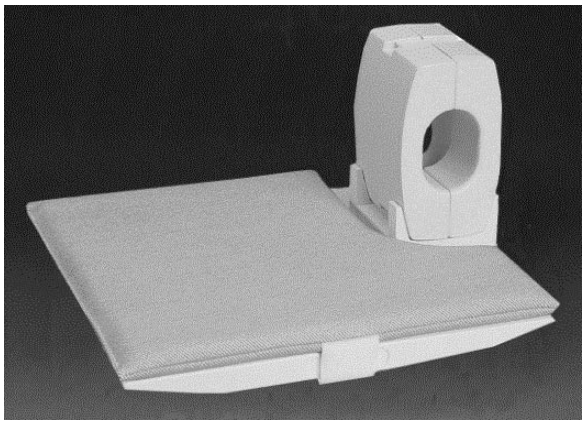
- The Shoulder coil allows for imaging of a patient's shoulder, two sizes allow for optimal imaging.



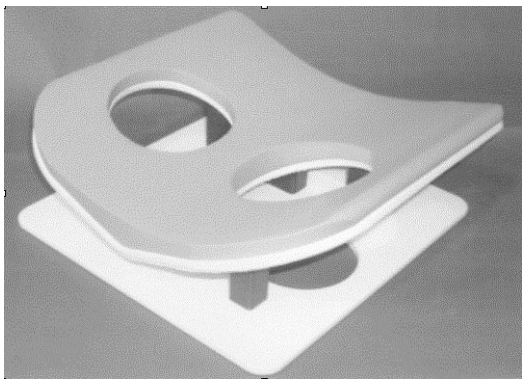
- The Extremity coil can be used to image the knee, ankle or foot.



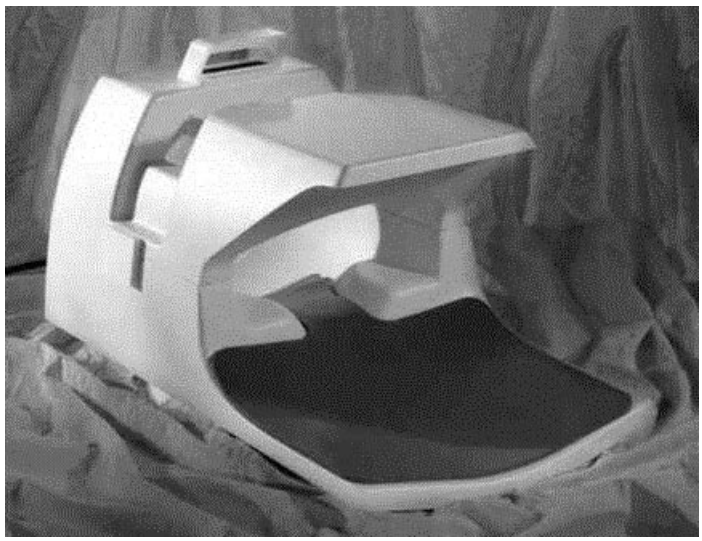
- The four element Phased Array Wrist coil is designed for wrist and hand imaging.



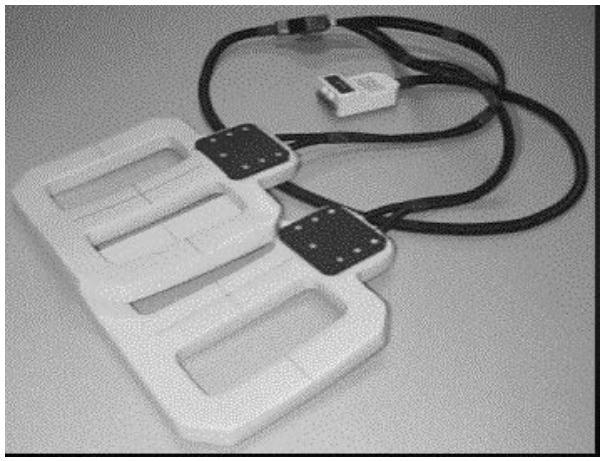
- The Phased Array Breast coil allows for bilateral or unilateral breast imaging and has an open design for biopsy capability.



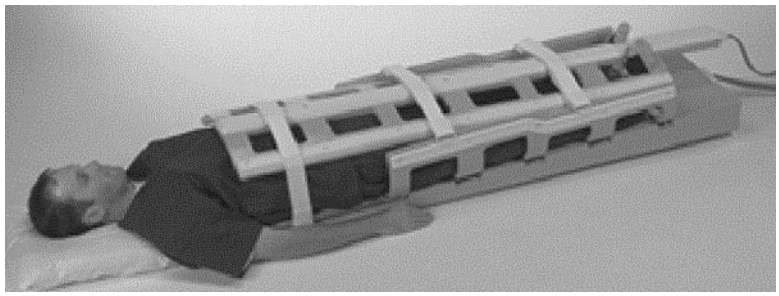
- The Neurovascular coil for imaging and MR Angiography of the head and neck without repositioning of the patient.



- The Cardiac Array coil, is a 4 element phased array coil for 1.5T systems; dedicated for cardiac imaging.

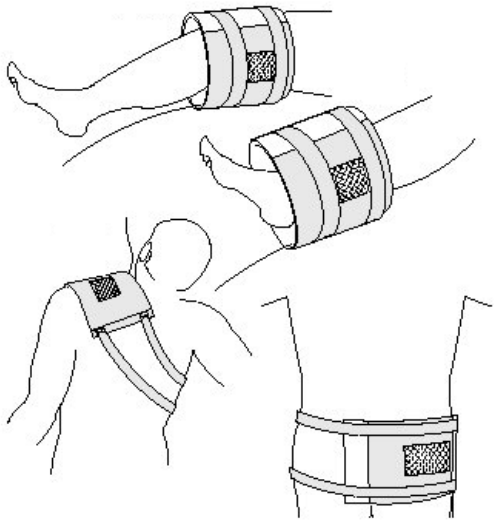


- The Peripheral Vascular coil allows for imaging and MR angiography of the lower extremities with moving the patient.



- The Torso Pelvis Array coil allows for imaging or MR angiography of the abdomen and/or pelvis without moving the patient. This is a four element coil with two sections, a torso section and a pelvis section.

- The General Purpose Flex (GPFlex) coil is a receive only coil, and can be used for imaging of the knee, ankle, brachial plexus, hip, or any body part the coil fits.



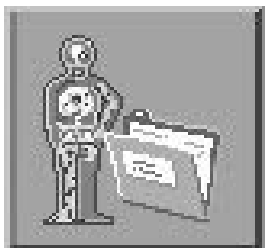
This page intentionally left blank.

Volume 1

# Chapter 5

# Building and Saving Protocols

**Where Am I?**



## Introduction

This chapter explains the protocol building and saving process. It provides highlights of key concepts and brief guidelines for building protocols and saving protocols for future use. This chapter also contains the step-by-step instructions to help you learn how to perform these processes:

- Building a Protocol
- Copying to a Site Protocol
- Editing a Protocol
- Saving a Protocol While Scanning
- Deleting a Site Protocol
- Copying a Series in a Protocol
- Printing Site Protocols
- Saving Site Protocols to MOD
- Restoring Site Protocols from MOD
- Deleting Site Protocols from MOD

In addition, this chapter answers the following questions:

1. What is a protocol?
2. How do I build a protocol?
3. How do I save a protocol?
4. Can I edit a saved protocol?
5. Can I save protocols for my site?
6. How can I remove a saved protocol?
7. Can I print the site protocols for my site?

# About... Building and Saving Protocols

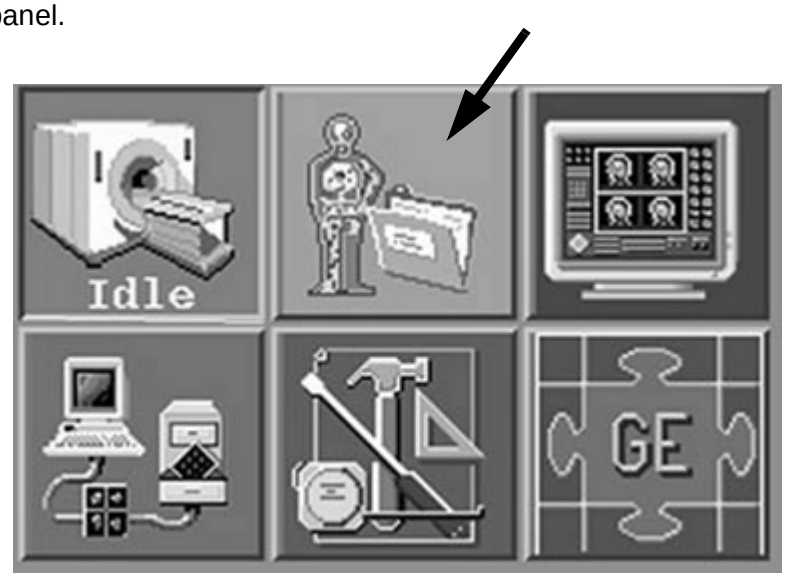
This section presents the concepts necessary to successfully complete the building and saving protocol process. Specifically, you need to understand:

- Building Protocols with the Protocol Manager
- Selecting and Saving from the Protocol Libraries
- Managing Site Protocols

## Building Protocols with the Protocol Manager

A protocol is a series of scan parameters that are used for imaging a particular part of the body. You can build and save protocols from the Protocol Manager Desktop.

The **Protocol Manager Desktop** icon is located on the control panel.




*Desktop Control Panel*

## Selecting and Saving from Protocol Libraries

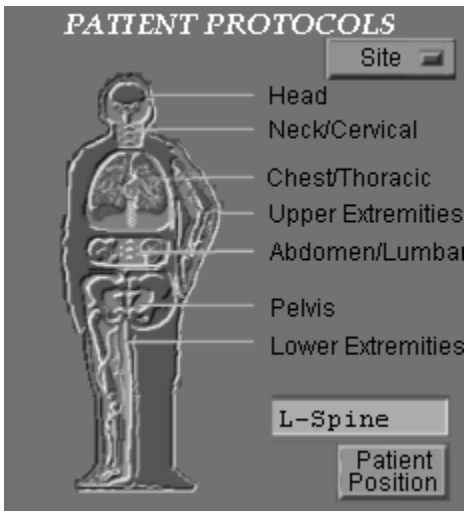
Protocol libraries are sets of scan parameters that are pre-programmed into your system. Your system comes with protocols in the GE and Picture This libraries. The Site library is empty until you create and save your own protocols. Using pre-programmed protocols optimize the scanning process and help maintain consistent imaging. Protocols from the GE and Site libraries can be edited, copied, pasted and saved to suit your particular needs. The Picture This protocols CANNOT be modified, this is insures that you obtain images similar to those “pictured”.

- Your MR system has 3 libraries of protocols:
  - Picture This
  - Site
  - GE

The protocol list is available in the Patient Protocols area.


- Each library contains eight protocol categories:
  - Head
  - Neck/Cervical
  - Chest/Thoracic
  - Upper Extremities
  - Abdomen/Lumbar
  - Pelvis
  - Lower Extremities
  - Other

  Protocol categories can contain up to 100 protocols, with up to 100 series each.




## GE Library

The GE library contains pre-programmed protocols that includes all of the protocols from the Picture This library, as well as additional protocols.

The GE library does not contain sample images but does allow scan parameter changes; you can edit the protocols from the GE library and save them to the Site library.

## Site Library

You create and save your own protocols into the Site library; the protocols from the GE library can be used (and edited) as a starting point.

The Site library is empty until you add your Site's protocols.

## Picture This Library

The Picture This library contains pre-programmed protocols with an image gallery. The image gallery shows examples of the image to expect when using these protocols.

Only start and end locations can be changed in this library.

Most series contain three sub-series choices, standard, faster, and higher resolution, and sample images to assist in selection.

The Picture This window reflects the scan time of the series as it is built into the Picture This library. Each Picture This series has a value entered for the number of slice locations (or number of slabs for 3D series). The scan time in the Picture This window reflects that value. If you change the number of locations (in either the Graphic Rx or on the Scanning Range area), and that change results in an increase or decrease in the number of acquisitions, the actual scan time is reflected in the Picture This window.

NOTE: The **[New Series]**, in the Rx Manager, is not available after selecting a Picture This protocol. The **[New Series]** is only available with GE or Site protocols.

- If you wish to exit a Picture This series that is currently in the process of prescription, click on the Humanoid icon and select a GE protocol or a Site protocol. At this point, the selected protocol can be edited, or the New Series button can be selected if you wish to build a protocol from scratch.

NOTE: Picture This protocol advisory panel may be incorrect. The maximum # of slices in the advisory panel may be less than the actual maximum number of allowed slices since the number is based on a single gradient configuration.

- Protocol for 1.5T HighSpeed, EchoSpeed, N1 Cervical spine, T1 FLAIR, series 9, maximum slices states 16, actual number is 19.

- Protocol for 1.5T HighSpeed, EchoSpeed, A4 Lumbar spine, T1 FLAIR series 12, maximum slices states 16, actual number is 19.
- Protocol for 1.5T HighSpeed, EchoSpeed, Routine Brain, T1 FLAIR oblique coronal, maximum slices states 22, actual number is 24.

## Managing Site Protocols

You can choose a protocol from any of the protocol libraries and save to the Site library. Protocols from the GE and Site library can be edited, although edited GE protocols can only be SAVED to the Site library. Remember, Picture This protocols CANNOT be edited. To streamline scanning you want to have commonly performed exam protocols stored in your Site library. You may want to have protocols saved with different parameters or coils to maintain efficiency (example: Liver protocol saved with patient positioned head first and patient positioned feet first). The Site library can be updated by editing or adding new series to the protocol. This library can also be stored on an MOD and printed to paper. This is especially important when software is upgraded and new features are added to your system.

NOTE: The Print Protocol feature requires a postscript printer. Many printers are “postscript ready” and an upgrade may not guarantee the printer’s compatibility with the Print Protocol feature. It is recommended, at this time, NOT to use this feature. DICOM print will be made available at a time that is yet to be determined.

NOTE: When a scan value within a protocol results in an incompatibility, the system sets the Protocol TR to the PSD’s default TR.

- For example, if a T2, sagittal, protocol of the spine is prescribed using a FOV of 36 cm or larger with Phase and Frequency swapped and Flow Comp turned on, when the protocol is downloaded, the TR is changed from the T2 value to the PSD’s default TR.
- The solution to this problem is to rebuild the protocol and not have Flow Compensation and Phase/Frequency swapped with a FOV larger than 36 cm.

# How to Build and Save Protocols

This section provides the step-by-step instructions for building and saving protocols. Specifically, it describes how to:

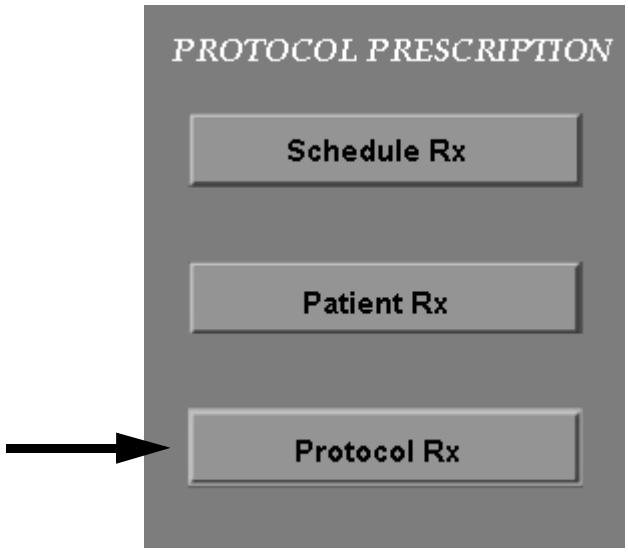
- Build a Protocol
- Copy a Protocol to Site the Library
- Edit and Save a Protocol
- Save a Protocol While Scanning
- Delete a Site Protocol
- Copy a Series in a Protocol
- Print Site Protocols
- Save Site Protocols to MOD
- Restore or Delete Site Protocols from MOD

# Build a Protocol

Protocol building is a valuable tool for you to use to maintain consistent imaging while optimizing your patient flow. Having pre-programmed protocols saves you from entering the scan parameters each time you scan a patient. You can build protocols a number of ways, which is covered later in the chapter. In this section we concentrate on building a protocol from the beginning (not editing a pre-programmed protocol).

1. Click the Protocol Manager desktop from the control panel.

2. Click **[Protocol Rx]** from the Protocol Prescription area.



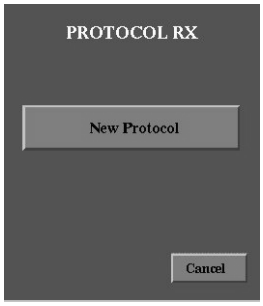

   - **[Schedule Rx]** ONLY appears if you have purchased the ConnectPro Plus option.

3. Click **[New Protocol]** from the Protocol Rx area.

## In Brief: Build a Protocol

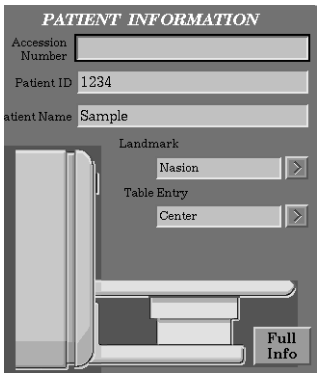
1. Click Protocol Manager desktop.
2. Click **[Protocol Rx]**.
3. Click **[New Protocol]**.
4. Enter information in the Patient Information area.
5. Enter information in the Patient Position area.
6. Enter information in the Imaging Parameters area.
7. Enter information in the Scan Timing area.
8. Select Additional Parameters and complete information.
9. Enter information in the Acquisition Timing area.
10. Enter information in the Scanning Range area.
11. Click **[Save Series]**. If done go to step 13.
12. Click **[New Series]**. Repeat steps 3-11 to add more series.
13. Click **[Save Rx as Protocol]**.
14. Select Protocol Category. Type name in **Protocol Name** text box.
15. Click **[Accept]**.

NOTE: Click **[Cancel]** to exit from Protocol Rx.



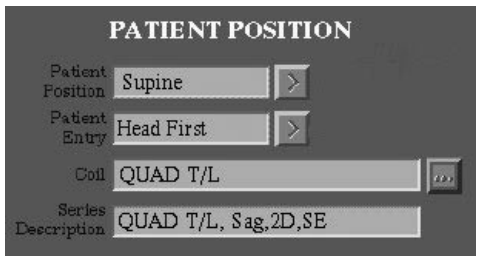

NOTE: For more detailed information regarding the areas and windows in steps 4-10 see the chapter titled Scan Rx Desktop.

4. Enter the information in the Patient Information area.



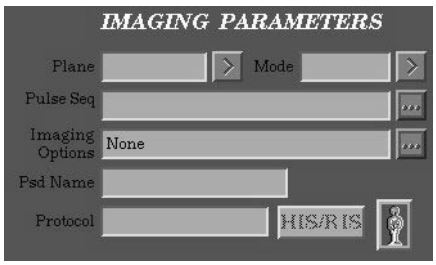

- When building protocols, not every text box needs to be filled in. This allows you to create protocols even is you do not know the exact parameters for every text box, window, or area. When you use the protocol, you can “fill in the blanks” to meet the requirements for the current patient. If an entry is required, you are prompted to enter data in that text box before continuing.
- Click the arrow below **Landmark** to view the menu, and then click the appropriate selection from the menu.

5. Enter the information in the Patient Position area.

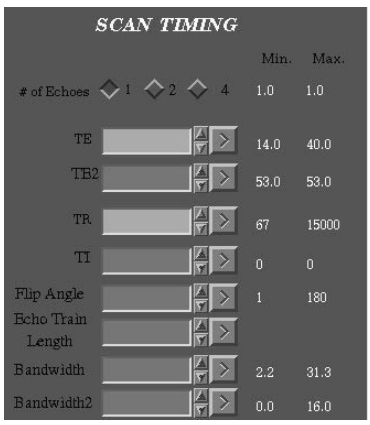



NOTE: See the Scan Rx Desktop chapter of this Volume for more detailed information regarding entering the information for steps five through 10.

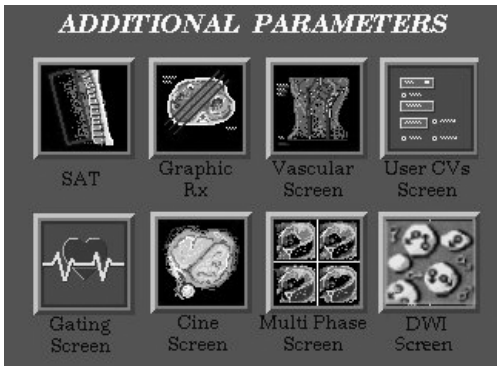
6. Enter the information required on the Imaging Parameters area. The arrows and the ellipse buttons, to the right of the text boxes, display menus and windows providing selections for these text boxes. The PSD name text box is used for type in PSDs only. Mode and pulse sequence text boxes must be filled to view the remaining areas and windows.



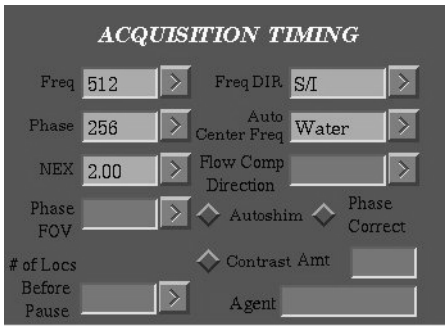

7. Enter the information required in the Scan Timing area.



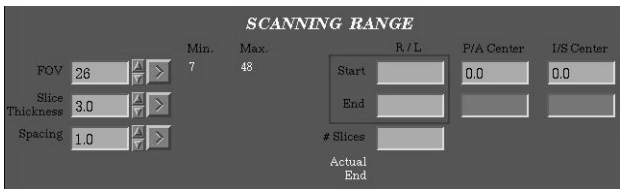
8. Select the buttons as needed for the Additional Parameters area. Complete the required information.




9. Enter the information required in the Acquisition Timing area.




10. Enter the information required in the Scanning Range area.




NOTE: If this is the first series of a protocol enter a scan range (example: scan plane sagittal, Type **`L40`** in the **Start** text box and type **`R40`** in the **End** text box). If this is not the first series of the protocol, and you plan to use Graphic Rx, no entries are needed for the **Start/End** locations.

11. Click **[Save Series]**. The series status in the Protocol Manager from INRX to RXD.

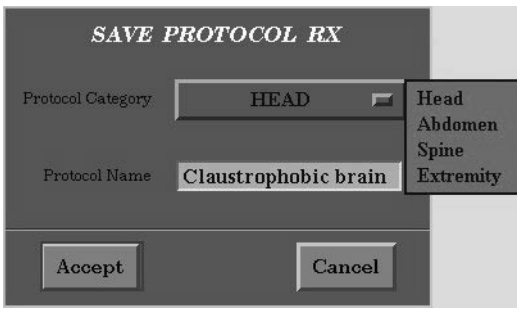
a) If no more series are needed go to step 13.

12. Click **[New Series]** from the Protocol Manager to add another series to the protocol and repeat steps 3-11.


13. Once all the series are created click **[Save Rx as Protocol]** on the Protocol Manager.


*The Save Protocol Rx window appears.*

14. Click the button to the right of Protocol Category, and then click a category from the menu. Type a unique name in the **Protocol Name** text box, example, **`Claustrophobic Brain`**.




15. Click **[Accept]** to save the protocol and return to the Protocol Prescription area.

- The protocol is saved in the Site library.
- To begin the protocol building process again, click **[Protocol Rx]**.
- Clicking **[Cancel]** exits without saving the protocol.

# Copy a Protocol to the Site Library

## In Brief: Copy a Protocol to the Site Library

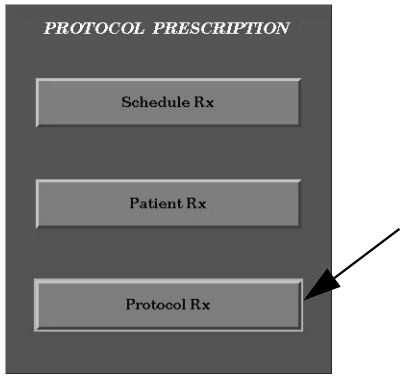
1. Click the Protocol Manager desktop.
2. Click **[Protocol Rx]**.
3. Select the library.
4. Click an area of the Humanoid to select protocol category.
5. Select desired protocol.
6. Select the desired series.
7. Click **[Accept]**.
8. Click **[Save Rx as Protocol]**.
9. Select the Protocol Category and type protocol name (must be a different name) in **Protocol Name** text box.
10. Click **[Accept]**.

You may find that you want to copy an entire protocol into another protocol. Instead of creating a new protocol, is much faster and easier to copy an existing protocol. Protocols can only be copied into the Site library.

This section gives you step-by-step instructions to copy a protocol.

1. Click the Protocol Manager desktop from the control panel.

2. Click **[Protocol Rx]** from the Protocol Prescription area.

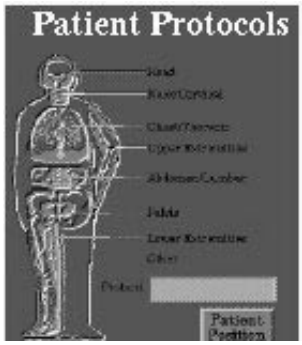



   - **[Schedule Rx]** ONLY appears if you have purchased the ConnectPro Plus option.

3. Click the button to the right of Patient Protocols, and then click to select the library from which to copy the protocol.


   *The protocol library menu appears.*

4. Click the region of the humanoid, from the Patient Protocols area, to select the protocol category.



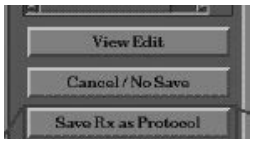

5. Select the desired protocol, from the menu.

6. Select the desired series.

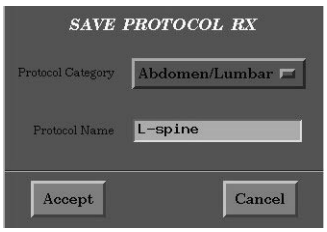
   - You can skip this step if you want to copy every series in the protocol.

7. Click **[Accept]** to continue.

8. Click **[Save Rx as Protocol]**, from the Protocol Manager.




9. Click the button to the right of Protocol Category. Select a category from the menu. Type a unique name in the **Protocol Name** text box.




10. Click **[Accept]** to save the protocol in the Site library under this name.

    - Click **[Cancel]** to exit without saving.

    - The protocol is now saved and can be found under the Site library.

# Edit and Save a Protocol

## In Brief: Edit and Save a Protocol

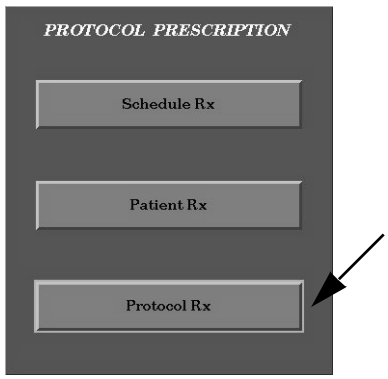
1. Click the **Protocol Manager Desktop** icon.
2. Click **[Protocol Rx]**
3. Select **Site** library from Patient Protocol area.
4. Click on area of the Humanoid to select protocol category.
5. Select desired protocol.
6. Click **[Accept]**.
7. Select series in Rx Manager to edit.
8. Click **[View Edit]**.
9. Make necessary changes and click **[Save Series]**. If done go to step 10.
   - Repeat steps 7-9 for any additional series to edit.
10. Click **[Save Rx as Protocol]**.
11. Click **[Accept]** or Protocol Category and type in new protocol name.

Once a protocol is saved you may wish to adjust the parameters. Editing a protocol allows you to do this without re-building the entire protocol. This section gives you step-by-step instructions to edit a protocol.

Protocols from the GE and Site libraries can be edited. Edited protocols can ONLY be saved to the Site library.

1. Click the **Protocol Manager Desktop** icon from the control panel.

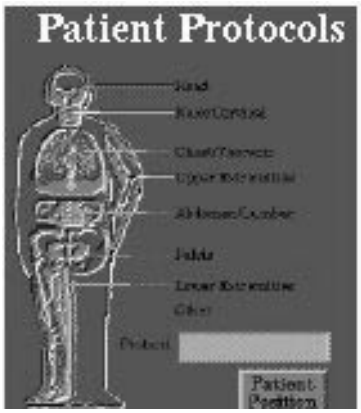
2. Click **[Protocol Rx]** from the Protocol Prescription area.




   - **[Schedule Rx]** ONLY appears if you have purchased the ConnectPro Plus option.

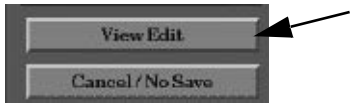
3. Click the button to the right of Patient Protocols, and then click to select the library from which you would like to edit the protocol.

4. Click a region of the Humanoid, in the Patient Protocols area, to select a protocol category.




5. Select the desired protocol from the menu.
6. Click **[Accept]** to continue.
   - Click **[Backup]** to return you to the Humanoid to select a different protocol category.
7. Select the series you want to edit from the Rx Manager.


8. Click **[View Edit]**.

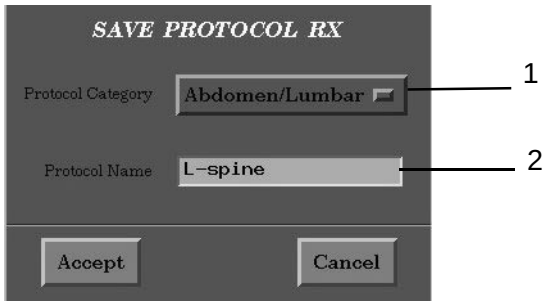



9. Make any changes to the series and click **[Save Series]** below the Scan Timing area.
   - If no other series need editing go to step 11.


   - To make changes to other series in the protocol repeat steps 7-9.
   - Once all changes have been completed go to step 10.

10. Click **[Save Rx as Protocol]** from the Rx Manager.


11. From the Save Protocol Rx window, do one of the following:
    - Click **[Accept]** to update the existing protocol.
    - Click Protocol Category (**1**), then click the desired category, and then type in a unique name (**2**) to create a new protocol.



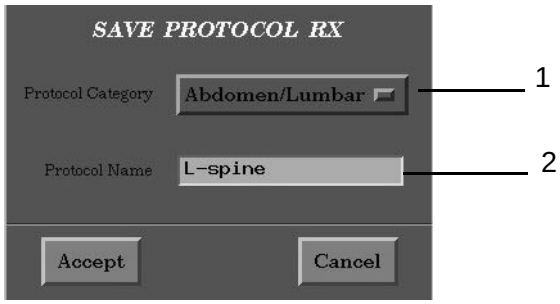

NOTE: The protocol is now listed in the Site library.

# Save Protocol While Scanning

After you have entered in the parameters for a scan you may want to save them as a protocol. Saving a protocol is similar to Building a Protocol. For more details on entering the scan parameters refer to the section on Building a Protocol steps three through 11.

1. Enter all the scan parameters from the **Scan Rx Desktop**.
2. Click **[Save Rx as Protocol]** from the Rx Manager.
   - This saves all series that are in the Rx Manager.


3. Click Protocol Category (**1**), and then click the desired category where to store the protocol.




4. Type in a protocol name such as **`L-spine`** at the **Protocol Name (2)** text box.
   - When in the **Scan Rx Desktop** you are creating a new protocol. You must type a new name in the **Protocol Name** text box.

NOTE: You can only update an existing protocol when in the **Protocol Manager Desktop**.

5. Click **[Accept]** in the Save Protocol Rx window to save the protocol.
   - The protocol is now saved in the Site library.
   - Clicking **[Cancel]**, exits without saving the protocol.

## In Brief: Save a Protocol While Scanning

1. Enter parameters from **Scan Rx Desktop**.
2. Click **[Save Rx as Protocol]**.
3. Click Protocol Category.
4. Type in name at **Protocol Name** text box.
5. Click **[Accept].**

# Delete a Site Protocol

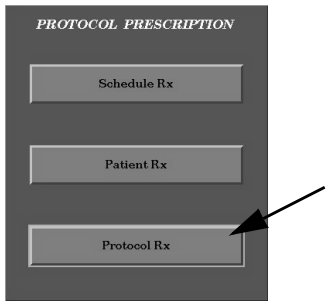
## In Brief: Delete a Site Protocol

1. Click the **Protocol Manager Desktop** icon.
2. Click **[Protocol Rx]**.
3. Select the Site library.
4. Click an area on the Humanoid to select protocol category.
5. Select protocol to delete.
6. Click and hold right mouse and select **Cut**.
7. Click **[Confirm]** to delete.
8. Click **[Backup]**.
9. Click **[Cancel]**.

If a protocol is no longer be needed, you may want to delete it from your Site library.

1. Click the **Protocol Manager Desktop** icon from the control panel.

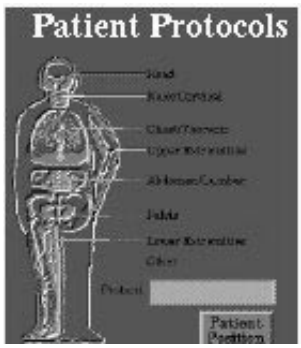
2. Click **[Protocol Rx]** from the Protocol Prescription area.




   - **[Schedule Rx]** ONLY appears if you have purchased the ConnectPro Plus option.

3. Click the button to the right of Patient Protocol and select Site library. Only protocols from the site library can be deleted.


4. Click the region of the humanoid, from the Patient Protocols area, to select the protocol category.




5. From the menu select the protocol you want to delete.

6. Right click on the selected protocol and select **Protocol Cut** from the menu.

   *A confirmation box appears.*

7. Click **[Confirm]** to remove the protocol from the Site library.
   - The protocol is now deleted from the Site library.

NOTE: Clicking **[No]** exits without deleting the protocol.

8. Click **[Backup]**.

9. Click **[Cancel]** to exit.

# Copy a Series in a Protocol

## In Brief: Copy a Series in a Protocol

1. Follow steps 1-6 from Copying a Protocol.
2. Highlight series to copy.
3. Right click and click **Copy Series**.
4. Select another or same series.
5. Right click and click **Paste Series**.
6. Click **[Save Rx as Protocol]**.
7. Select the Protocol Category and type protocol name (must be a different name) in **Protocol Name** text box.
8. Click **[Accept]**.

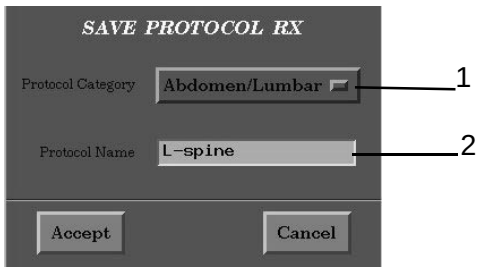
You may want to repeat a series either while scanning or when saving a protocol, For example, Pre- and Post-contrast injection. The same process is used for copying while scanning and while saving protocols.

1. Follow steps 1-6 from the prior section Copying a Protocol and continue with these steps.
2. Highlight the desired series from the **Rx Manager**.


3. Right click to display the menu, and then click **Copy Series**.

NOTE: You can delete a series, in the **Rx Manager**, by selecting (highlighting) that series and right click and then click **Cut**.

4. Select (highlight) another or the same series.
   - The copied series is placed immediately below the selected (highlighted) series.
5. Right click to display the menu, and then click **Paste Series**.
   - The copied series is placed just below the highlighted series. For example, if you copy series #2 and you want to paste after series #4, highlight series #4 after you click **copy** and before you click **paste**.
6. Click **[Save Rx as Protocol]** to save the updated protocol in the Site library.
7. Click the button to the right of Protocol Category (**1**). Select a category from the menu. Type a unique name in the **Protocol Name** text box (**2**).



8. Click **[Accept]** to save the protocol in the Site library under this name.
   - Click **[Cancel]** to exit without saving.
   - The protocol is now saved and can be found under the Site library.

# Print Site Protocols

## In Brief: Print Site Protocols

1. Make sure printer is connected.
2. Click the **Service Desktop** icon.
3. Click **[Utilities].**
4. Select **Save/Restore/Print Protocol**.
5. Click **[Start]**.
6. Select the anatomical category (select the protocol and/or series) you want to print.
7. Click **[Configure]**.
8. Select the correct printer and parameters.
9. Click **[Accept]**.
10. Click **[Print]**.
11. Click **[OK]**.
    - To print more protocols repeat steps 6-11. If finished go the step 12.
12. When done printing, click **[Exit]**.

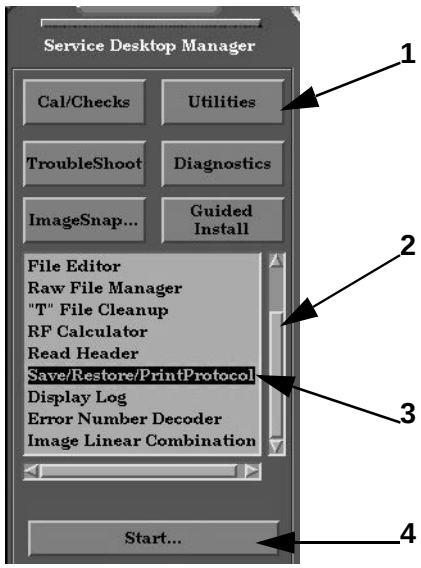
If you have a printer connected to your system you can print your site library. This section gives you step-by-step instructions to print your protocols.

NOTE: The Print Protocol feature requires a postscript printer. Many printers are “postscript ready” and an upgrade may not guarantee the printer’s compatibility with the Print Protocol feature. It is recommended, at this time, NOT to use this feature. DICOM print will be made available at a time that is yet to be determined.

1. Make sure printer is connected.
   - Contact the service engineer for initial printer connection, specific printers (must be a post script printer), and special cabling that may be necessary.
2. Click the **Service Desktop** icon from the control panel.

*The Service Desktop Manager appears.*

3. Click **[Utilities]** (**1**) from the Service Desktop Manager.




4. Click and drag the slider (**2**) to scroll down the utilities list and select the **Save/Restore/Print Protocol** (**3**).
5. Click **[Start]** (**4**) from the Service Desktop manager.

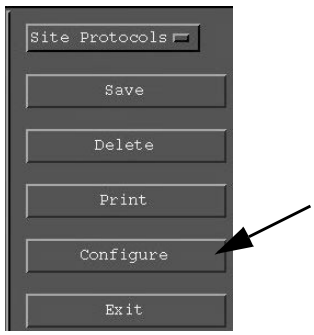
*The protUtilShell window appears.*

- The Protocol Selection menu defaults to the Site library.

6. From the left column, select the protocol category that you want to print.

NOTE: For more detailed steps on selecting anatomical category, protocols or series refer to the section Saving Protocols to an MOD step 6. Select the protocol and/or series to print.

7. Click **[Configure]** to ensure proper printer selection and parameters.




*A menu appears.*

8. Select the correct printer and choose parameters according to your printer set-up.

9. Click **[Accept]**.

10. Click **[Print]**.

*A confirmation message appears.*

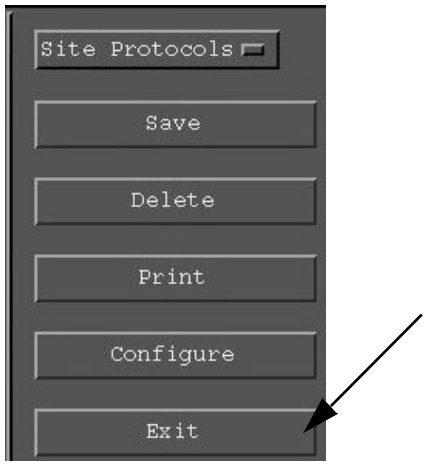
11. Click **[OK]** to print.

NOTE: Clicking **[Cancel]** exits without printing.

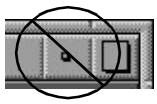

- The protocols print, if you are finished printing protocols go to step 12.

- To print more protocols repeat steps 6-11, when complete go step 12.

12. Click **[Exit]** to exit the protUtilShel window.




NOTE: Do Not click the second icon to the right, this action closes the protUtilShel window, placing the icon behind the Control Panel where it is inaccessible until the system is rebooted.



The print protocol process is completed. Select another desktop from the control panel to continue to another system function.

# Save Site Protocols to MOD

Saving your protocols onto an MOD (Modifiable Optical Disk) eliminates the need to re-create them if they are deleted from from your hard disk. For example, if your hard disk gets reformatted, your Site library is deleted. If you have the protocols saved on an MOD, you can easily and quickly restore your protocols to the system. You can save by anatomical area, by protocol, or by series.

It is the individual site's responsibility to save their own site protocols on an MOD as a backup. This section gives you step-by-step instructions on saving site protocols to an MOD.

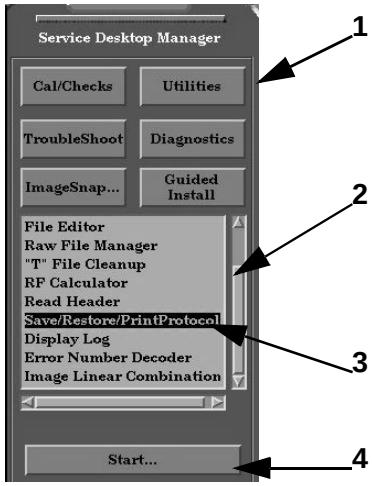
1. Insert a **new** MOD into the disk drive.

NOTE: It is very important to choose a new MOD to avoid accidental removal of already archived data. If the MOD has patient images on it, this patient information is lost when you save the protocols on the same MOD.

2. Click the **Service Desktop** icon from the control panel.

*The Service Desktop Manager appears.*

3. Click **[Utilities]** (**1**) from the Service Desktop Manager.




## In Brief: Save Site Protocols to MOD

1. Insert a **new** MOD.
2. Click the **Service Desktop** icon.
3. Click **[Utilities]**.
4. Select **Save/Restore/Print Protocols.**
5. Click **[Start]**.
6. Select the anatomical category (select the protocol and/or series) you want to save from the protUtilShell window.
7. Click **[Save]**.
8. Click **[Continue]**. If done saving go to step 9.
   - Repeat steps 6-8 to save additional protocols/series.
9. Select **Media** to check if protocols were saved.
10. Click **[Exit]**.
11. Click **[OK]** to exit and eject MOD.

4. Click and drag the slider (**2**) to scroll down the utilities list and then select **Save/Restore/Print Protocols** (**3**).

5. Click **[Start]** (**4**) from the Service Desktop Manager.

   *The protUtilShell window appears.*

   - The Protocol Selection menu defaults to the Site library on the protUtilShell window.
   - The Site library protocol categories appear in the 1st left column.

6. Select the protocol category desired.

   - Once the protocol category is highlighted, the Site's protocols for that category are shown in the middle column.
   - If more than one category is selected, the two remaining columns appear empty.

NOTE: To select more than one protocol category or series, click and drag.

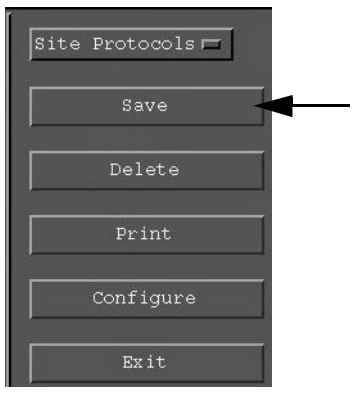
   a) Select the specific protocol from the middle column.

      ° Once the protocol is highlighted, the series' of the protocol are shown in the far right column.

   b) Select the series to be saved from the right column.

      ° Click and drag to select more than one series.

7. Click **[Save]**.




   *A new MOD warning message appears.*

   - This message states that the MOD will be reformatted, and all existing data on the MOD will be erased.

8. Click **[Continue]** to format MOD and save selected series to MOD. If done saving, go to step 9.

NOTE: Clicking **[Cancel]** does not format MOD and does not save protocols to the MOD.

- Repeat steps 6-8 if you would like to save more protocols or series to the MOD.

NOTE: To add an additional protocol to already saved protocols, it is best to re-save all protocols. This ensures that all protocols and changes are saved.

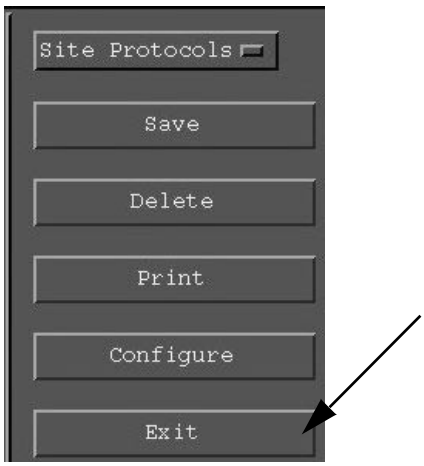
9. Click **Media** from the Protocol Selection menu, to check that protocols are saved to the MOD.


a) Select the protocol category.

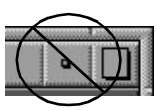
- The protocols appear in middle column

b) To check individual series, select the protocol to display the series in the right column.

10. Click **[Exit]** to exit the protUtilShel window.




NOTE: Do Not click the second icon to the right, this action closes the protUtilShel window, BUT places this icon behind the Control Panel icons where it cannot be accessed, until the system is rebooted.



*A confirmation message appears.*

11. Click **[OK]** to exit and eject the MOD.

NOTE: Clicking **[Cancel]** keeps you in the protUtilShell window and does NOT eject the MOD.

# Restore or Delete Site Protocols from MOD

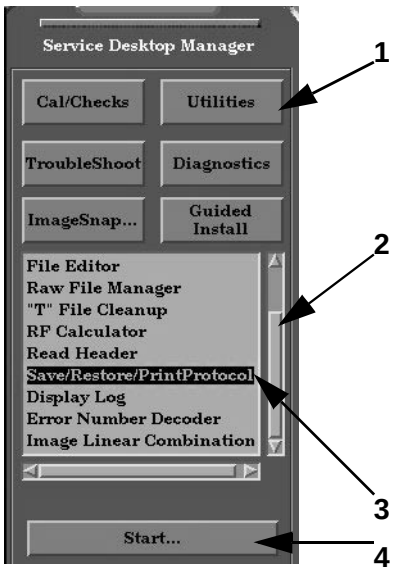
The restore option is designed to easily restore the site's protocols in the event of accidental deletion. The delete option gives you the opportunity to delete old or outdated protocols off the MOD. This section gives you detailed step-by-step instructions on restoring or deleting protocols from an MOD.

1. Insert the MOD that contains the Site protocols into the disk drive.

2. Click the **Service Desktop** icon from the control panel.

*The Service Desktop Manager appears.*

3. Click **[Utilities]** (**1**) from the Service Desktop Manager.




4. Click and drag the slider (**2**) to scroll down to the bottom of the Utilities list, and then select **Save/Restore/Print Protocol** (**3**).

## In Brief: Restore or Delete Site Protocols from MOD

1. Insert MOD into disk drive.
2. Click the **Service Desktop** icon.
3. Click **[Utilities]**.
4. Select **Save/Restore/Print Protocols**.
5. Click **[Start]**.
6. Click **Media**.
7. Select protocol category/protocol/series to be restored or deleted.
8. Select **[Restore]** or **[Delete]**.
9. Click **[OK]**.
10. Check the process by selecting **Site Protocols** if restoring, or **Media** if deleting, select protocol category.
11. Click **[Exit]**.
12. Click **[OK]** or **[Cancel]**.

5. Click **[Start]** (**4**) from the Service Desktop Manager.

   *The protUtilShell window appears.*

6. Click **Media** from the Protocol Selection menu.


7. Select the protocol category, from the left column, that you want restored or deleted.

   - If necessary, select the individual series to be restored or deleted.

NOTE: For more details on selecting protocol categories, protocols, or series see step 6 of the Saving Protocols to an MOD section.

8. From the protUtilShell window, do one of the following:

   - Click **[Restore]** to restore the protocols.
   - Click **[Delete]** to delete the protocols.

   *A confirmation message appears.*

9. Click **[OK]** to start the process.

   - Clicking **[Cancel]** exits without restoring or deleting the protocols.

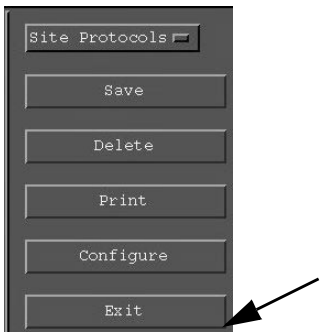
10. To check the process, do one of the following:

    - If you were restoring, set the Protocol Selection option menu to **Site Protocols** (**1**) and select the protocol category. The protocols are listed in the middle column and the series are be listed in the right column.


    - If you were deleting, set the Protocol Selection option menu to **Media** (**2**) and select the protocol category, the protocol should NOT appear.

      ° However, if you deleted individual series, the deleted series of the protocol should NOT appear in the right column.

11. Click **[Exit]** from the protUtilShell window.




*A confirmation message appears.*

12. Click **[OK]** to exit and eject the MOD.
    - Clicking **[Cancel]** keeps you in the proUtilShell window and does not eject the MOD.

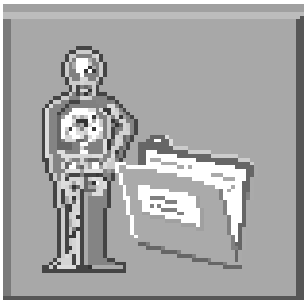
This page intentionally left blank.

Volume 1

# Chapter 6

# Pre-Registering Patients and ConnectPro

## Where Am I?



## Introduction

This chapter explains how to pre-register a patient, enter patient demographic information before their arrival in the MR department, and use the ConnectPro feature thereby increasing throughput by reducing patient set-up time. It contains the step-by-step instructions to help you learn how to:

- Enter Patient Information
- Link a Patient to a Protocol
- Sort the Patient Register
- Select a Registered Patient
- Delete a Registered Patient
- Enter Patient Information with ConnectPro Plus*
- Use Guided Install-Mapping Protocols to Action Items*
- Assign
- Image Storage*

NOTE: *Items with an asterisk are purchasable options.

In addition, this chapter answers the following questions:

1. Why do you pre-register a patient?
2. How do you enter the patient information?
3. How do you link a patient to a protocol at pre-registration?
4. How do you delete a patient from the register?
5. How do you sort once a patient is registered?
6. How do you use ConnectPro?*

NOTE: *Items with an asterisk are purchasable options.

# About... Pre-Registering Patients and ConnectPro

This section presents the concepts necessary to successfully complete the pre-registration process and using the ConnectPro and ConnectPro Plus features. Specifically you need to understand the concepts regarding:

- Pre-Registering Patients
- Deleting a Registered Patient
- Using ConnectPro
  - Navigating the Schedule Window
  - Ending Exams with ConnectPro
- Using Perform Procedure Step (ConnectPro Plus)
- Using the Guided Install for HIS/RIS DICOM
- Using the Guided Install for Mapping Protocols to Action Items

## Pre-Registering Patients

You can pre-register patients before their arrival in the MR Department, thereby helping to facilitate increased throughput. Once the patient arrives, you can bring up his/her information and move forward with scanning. To begin a scan, you must, at a minimum, enter the patient's ID and weight. The patient's weight determines the SAR (Specific Absorbtion Rate.)

NOTE: Refer to the Working Safely chapter for more detailed information regarding SAR.

WARNING: Entering a weight less than the actual patient weight could potentially harm the patient by exposing to high RF values and warming the patient.

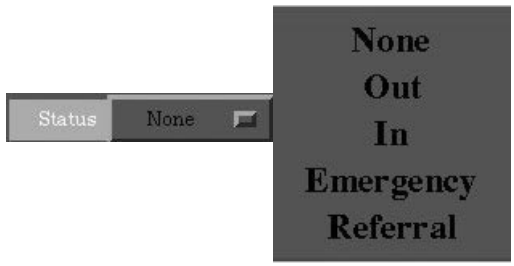
Something to Think About...

Patient Information requires detailed information about the patient. Refer to the Scan Rx Desktop chapter for more information.

- Accession Number:
  - This is generally related to a number assigned by the hospital, clinic, or site, and is tied to the patient's records. Enter the number manually or by using the optional bar-code reader, (if applicable).
- Entering Patient ID:
  - Enter any combination of numbers, letters, and dashes.
  - If the system finds the same ID in its memory, it displays all the pertinent data so long as the entry is identical, including the use of upper-case and lower-case letters.
  - Enter MR and the system re-displays the last (most recent) patient's data.
- Patient Name:
  - Type the name of patient here.

- Birthdate:
  - Enter month using numbers (1-12), day using numbers (1-31), and year (19xx or 20xx) as mm/dd/yyyy or mm-dd-yyyy. The year entry must contain four digits.
  - The birthdate entry is optional when pre-registering patients.
  - Note that the system can be configured for dd/mm/yyyy by the service engineer.
- Patient Age:
  - If the birthday is entered, the age is automatically calculated.
  - Enter only whole numbers, (i.e., no decimals) and age, in years, ranges from 1-123 years.
  - Days (1-90), weeks (1-52), or months (1-23) can also be entered. For example, 28D, 4W or 1M.
- Patient Sex:
  - Enter M for male.
  - Enter F for female.
- Patient Weight:
  - Enter either pounds or kilograms.
  - The system automatically calculates and displays the other weight measure.
  - Limits are 2 to 350 lb. ( 1 to 158 kg.)
  - Enter accurate weight information. Otherwise, the system could abort the scan or deliver the wrong amount of RF power to the patient.
- Radiologist:
  - Type the name of the radiologist.
- Referred By:
  - Type the name of the referring doctor.
- Operator:
  - Type the 3 initials of the operator.

- Select a **[Status]** from the menu.




- Exam Description:
  - Enter the exam description. If this area is not completed, no information appears on the Browser except the patient name.
- Patient History:
  - Include relevant background information regarding the patient's symptoms or other relevant information.
- Landmark:
  - Click this button. A new window appears that leads to the landmark text box for the Patient Information area.
- Schedule:
  - Access the ConnectPro Option by clicking **[Schedule]**.

## Deleting a Registered Patient

A patient's name is automatically removed from the Patient Register after clicking the **[End Exam]** button on the Rx Manager window.

If a patient cancels his/her exam or does not show up for an appointment, you can delete him/her from the patient register. It is also possible to copy, paste, and cut patient information within the register. Highlight the patient name with a left mouse click and use a right mouse click to perform the desired copy/paste/cut function.

## Using ConnectPro Plus

ConnectPro Plus is a purchasable option available for systems equipped with 8.2 software and above. This feature allows information from the Hospital Information System and/or the Radiology Information System (HIS/RIS) to cross over to the MR system. There are some new features and windows added to this option.

- The Worklist Search, also called the Schedule window, has been expanded to look for as few as two matching characters.
- The Schedule window has been expanded with multiple choices across the bottom of the window. From the choices on this window, you can change the procedure code associated with the patient. Also, you are able to view patient information, and the A.I. (Action Item) Mapping of protocols (attaching protocols to HIS/RIS codes).

Some background information may be needed to understand the purpose of the ConnectPro Plus feature. For example, Hospital and Radiology Information Systems (HIS/RIS) use procedure codes when ordering and charging for an exam or procedure. These codes vary by institution, but an example would be the use of CPT codes (codes for various procedures established by the AMA and used by federal Medicare/Medicaid programs). The codes used by the HIS/RIS may be unique to a hospital or clinic, but these codes can be configured on the system and linked to protocols in the system protocol library. When patient information from the HIS/RIS is called to the system through ConnectPro, the procedure code is part of the information. If the code is linked to a system protocol, that protocol is loaded to the Scan Rx Desktop along with the patient information. Series one of the protocol loads into the series prescription. The remaining series in the protocol is seen in the Rx Manager window.

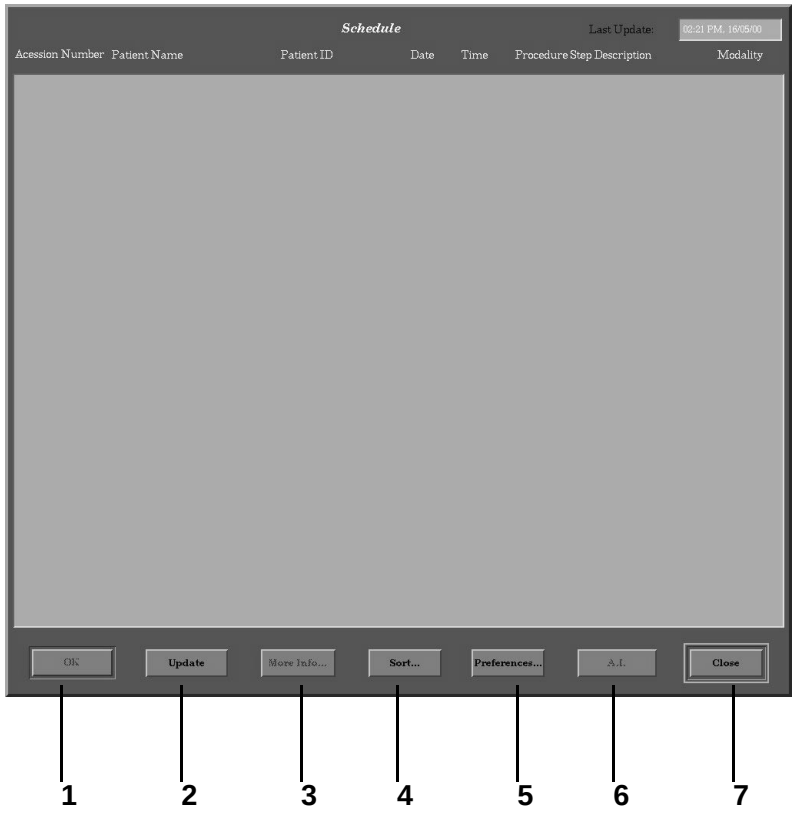
At the New Patient window in the Scan Rx Desktop, two or more numbers entered at the Accession Number or Patient ID text box prompts a search through the ConnectPro Worklist for a match. The search looks for the sequence of digits within the Accession Number or the Patient ID, depending which text box was used to enter the data. If the sequence was found, the patient information for that patient is entered into the Patient Information window. If two or more matches are found, the Worklist opens showing a list of all the matches. The Schedule Worklist can also be accessed by clicking either the **[Schedule]**

button from the Patient Information area in the Scan Rx Desktop, or by clicking the **[Schedule]** button from the Patient Information window in the Protocol Manager Desktop.

## Navigating the Schedule Window

The Schedule window appears showing a list of all patients that have been entered through the HIS/RIS system. Selecting (highlighting) the desired patient, and clicking the **[OK]** button at the bottom of the window, enters the information in the Patient Information area.

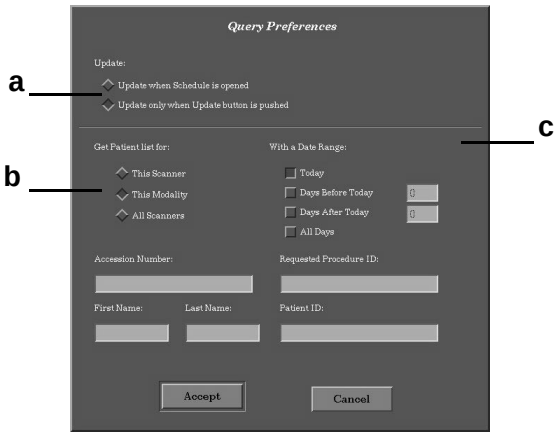
The buttons across the bottom of the Schedule window allow you to access more patient information. The following list gives brief information about each button.




- **[OK]** - (**1**) Accepts the selected patient and enters the patient information into the Patient Information area of the Scan Rx Desktop.
- **[Update]** - (**2**) Updates the list of scheduled patients.

- **[More Info]** - (**3**) Lists more information about the patient, such as Allergies, Alerts, Weight, etc. This information is for viewing purposes only and cannot be edited. The information on this window can be viewed by clicking and dragging on the slider on the right side of the window.
  - The most valuable information, to the technologist, is accessed by clicking the **[Scheduled Procedure A.I. (Action Item)]** button. This button is found at the bottom of the More Information window. The **meaning** column shows the procedure for which this patient is scheduled; this information comes across from HIS/RIS.
- **[Sort]** - (**4**) Sorts patients by either ID, Name, or Time (scheduled). Click the diamond to the left of the desired sort method.


- **[Preferences]** - (**5**) Provides customization of the Schedule Worklist. This window allows you to decide: when the Worklist is updated; the modalities to be included in the list; and the range of exam dates for the list. The list can also include a specific Accession Number, Patient Name, or Patient ID by entering the data on the Query Preferences window.



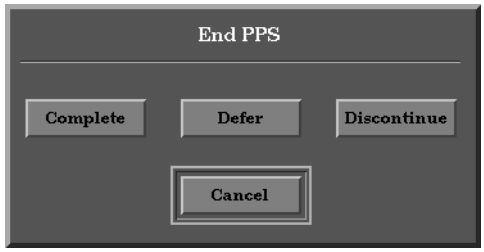

  - **Update** - (**a**) The diamond to the left of the option determines when the Schedule (Worklist) window updates. The first choice automatically updates when the Schedule window is opened. The second choice updates when the Update on the Schedule window is selected.
  - **Get Patient List For** - (**b**) Allows you to select lists for the scanner, the modality, or all scanners.

  - **With a Date Range** - (**c**) Allows you to select the patient list by a date or a range of dates. The entries with a text box to the right, require a number entered into this ftext box.
  - The remaining type-in fields allow you to perform a search on a specific patient. The search can be performed by typing the patient's name, ID number, Accession number, or by typing the Requested Procedure ID that lists all the patients scheduled for that procedure.

- **[A.I.]** - **Action Items** - (**6**) Shows the **A.I. Mappings Browser**, which lists all the protocol choices. If the protocol that came over from HIS/RIS is incorrect, selecting (highlighting) a protocol from this list and then clicking **[Accept]** maps (attaches) the correct protocol to the patient.
- **[Close]** - (**7**) Exits from the Worklist window and the exits the ConnectPro feature.

## Ending Exams with ConnectPro

If you have used the ConnectPro feature, when you click **[End Exam],** another window appears. It asks if you would like to Complete, Defer, Discontinue, or Cancel. The following list gives a description of each of these choices.




- **[Complete]** - Ends the exam and PPS (Performed Procedure Step). You can add a series, such as a screen save, but CANNOT edit the patient information, such as the patient name, ID number, etc. Also, you can still annotate on the images. On the Browser page, the PPS column of this patient shows the status of COMP (completed).
- **[Defer]** - Does not end PPS. You can still post-process and edit the patient information, such as the patient name, ID number, etc. On the Browser page, the PPS column of this patient shows the status of Inprog (in progress). Click **PPS** from the menu bar displays a window, and allows you to Complete or Discontinue the PPS on this patient.

- **[Discontinue]** - Notifies the HIS/RIS that you are aborting the PPS. This should be used only if the images you acquired were unacceptable. You would then need to re-scan the patient.
- **[Cancel]** - Exits from this window without ending or changing anything.

NOTE: When scanning with the Imaging Option SCIC (Surface Coil Intensity Correction) and PPS, you cannot complete the exam when finished scanning. The **[Complete]** button is not available on the Scan Rx Desktop if SCIC was selected. First click the **[End Exam]** button, then click the **[Defer]** button. Complete the exam from the Browser by clicking **PPS** from the Browser menu bar, and then click the **[Complete]** button.

NOTE: If you plan to apply ClariView filters to the images, and you have used PPS, do not complete the exam when finished scanning. Post-processing functions must be done before the exam is completed in PPS. First click the **[End Exam]** button, then click the **[Defer]** button. Apply the ClariView filters. Then complete the exam by clicking **PPS** from the Browser menu bar, and click the **[Complete]** button.

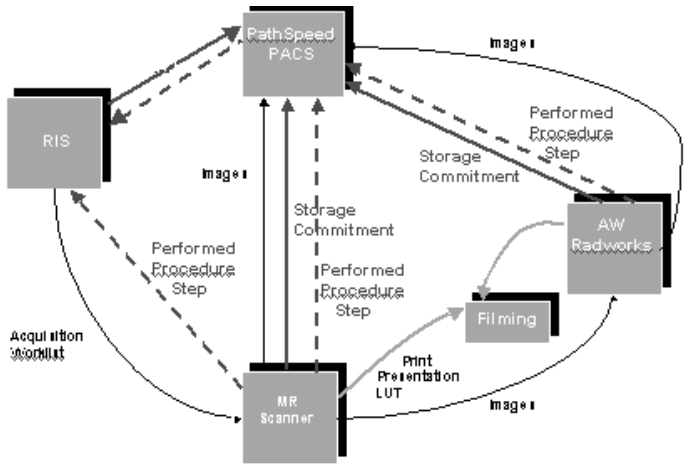
CAUTION: Although it is NOT recommended to edit patient information gathered from the HIS/RIS, the ConnectPro feature does NOT “lock” an exam from being edited. If patient information that has originated from the HIS/RIS Worklist Browser is edited, this information at the operator’s console DOES NOT match the patient information in HIS/RIS.

## Using Performed Procedure Step (ConnectPro Plus)

The following is an overview of ConnectPro Plus, which includes Performed Procedure Step (PPS).

The PPS is a closed loop of information transfer. The loop starts with the HIS/RIS, when the patient information is transferred to the system after you select the patient from the Schedule window. The PPS is completed when the images are archived and transferred to a PACS. The HIS/RIS is notified that the exam is complete and of the location of images (e.g., at the PACS).

The diagram below shows the complete circle of events that ensue when ConnectPro with PPS is used.




The dashed lines represent the PPS connectivity additions: from pushing images to end destinations to a fully integrated image and text workflow. PPS provides a feedback loop to the HIS/RIS system that the patient “session” is completed (or not) and therefore the MR worklist (schedule) is updated to reflect the patient’s session status.

ConnectPro Plus maintains connectivity between HIS/RIS, the MR system, and networked stations through following procedures:

- Detailed retrieval and display of patient information and procedures.
- Capability of prescribing protocols in advance on the Protocol Desktop with Worklist entries.

- Auto-load of protocols for Scan Rx and Protocol Rx from Worklist entry selection.
- Reports the worklist entries being performed.
- Reports real-time scan status to HIS/RIS, including actual protocols performed.
- Enables auto verify with PACs system with the list of completed images acquired and stored for the study.
- W/L transferred to PACs when **ss** is typed in the Accelerator Line at the operator's console. The **ss** entry must occur prior to network activity.
- Auto Archive on/off selection is retained after a reboot.

## Guided Install for HIS/RIS DICOM

The HIS/RIS DICOM mode requires no password to access. Configuration is restricted to HIS/RIS tab, which allows configuration of server and port setups, and to the SCP (charge codes used by the scanning facility when billing insurance) tab. The Verification tab is available to verify any changes made to HIS/RIS are legal. The Log File can also be viewed from this mode.

Mobile sites can also use the same steps as fixed sites for the HIS/RIS DICOM install. One reminder for mobile users, be sure to check that the IP address and the port number are correct on the HIS/RIS tab.

## Guided Install for Mapping Protocols to Action Items

The Guided Install allows you to save, change, or delete protocols that are mapped (connected) with an Action Item Code in HIS/RIS and mapped with the Action Item Code in the system.

Mobile Sites can follow the same steps as fixed sites to map protocols to charge codes; be sure to check that the IP address and the port number are correct on the HIS/RIS tab.

# How to Pre-Register Patients and Use ConnectPro

This section provides the step-by-step instructions for pre-registering and entering patient information into the system. Specifically, it describes how to:

- Enter Patient Information
- Link a Patient to Protocol at Pre-Registration
- Select a Registered Patient
- Sort the Patient Register
- Delete a Registered Patient
- Enter Patient Information Using ConnectPro Plus (PPS)*
- Use Guided Install-Mapping Protocols to Action Items*
- Assign Image Storage*

NOTE: *Items with an asterisk are purchasable options.

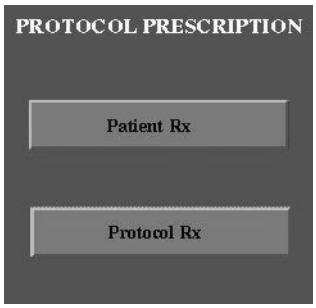
# Pre-Register a Patient

## In Brief: Pre-Register a Patient

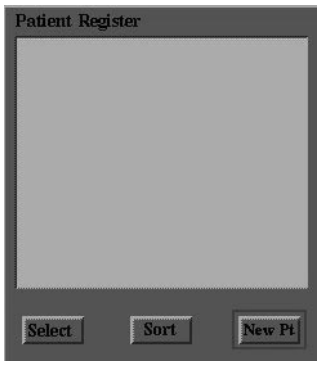
1. Click the **Protocol Manager** icon.
2. Click **[Patient Rx].**
3. Click **[New Pt]**.
4. At a minimum, enter the patient ID and name, then click **[Accept].**
5. Type information within each text box and press **Enter** on the keyboard.
6. Once all the information is entered on the patient, click **[Save RX as Protocol]**.

You can pre-register your patient or patients prior to their arrival in the MR Department, thereby helping to facilitate increased throughput.

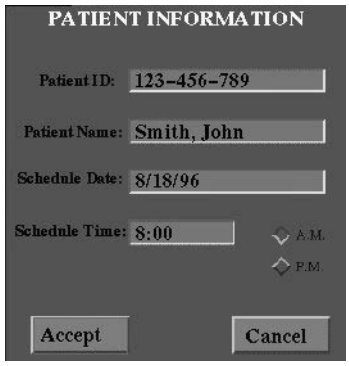
1. Click the **Protocol Manager** icon**.** 
2. Click **[Patient Rx]** from Protocol Prescription area.




3. Click **[New Pt]** from the Patient Register area.

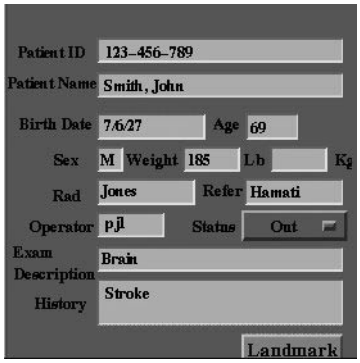



4. At a minimum, enter the patient ID and name and then click **[Accept]**. The time and date are not required fields.




5. From the Patient Information area, you can enter additional patient information. Type information within each text box

and press **Enter** on the keyboard. The Status text box and **[Landmark]** display additional, selectable information.




6. Once all the information is entered for the patient, click **[Save RX as Protocol]** from the Protocol Manager window. You can enter additional information at scan time. This completes the registration process.


*Protocol Manager*

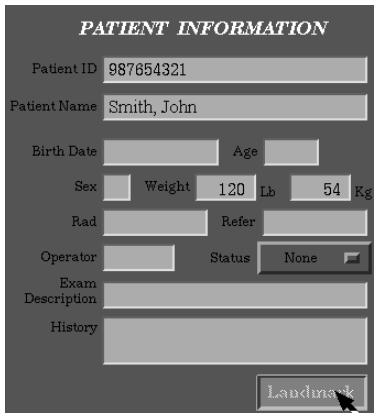
## In Brief: Link a Protocol to a Patient at Pre-Registration

1. Complete steps 1-5 from Entering Patient Information.
2. Click **[Landmark]**.
3. Click **[Site]**, **[GE]**, or **[Picture This]** from the Patient Protocol menu. Then click on the Humanoid, the area that corresponds to the body part of the patient you are scanning. Example: **Head**
4. Select the desired protocol and click **[Accept]** to download the entire protocol.
5. Click **[Save Rx as Protocol]** from Protocol Manager, and then click **[Accept]**.

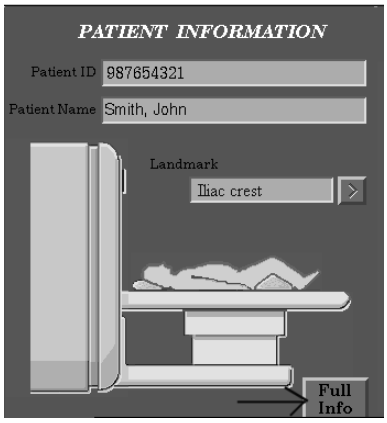
# Link a Protocol to a Patient at Pre-Registration

Pre-registering a patient can also include assigning a protocol. All patients for the day can be pre-registered with a protocol. This increases your site's productivity by having everything done ahead of the patient's arrival into your department.

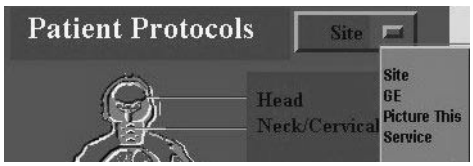
1. Complete steps 1-5 from pre-registering a patient.
2. Click **[Landmark]**.




- The following window appears after clicking on Landmark. Landmark provides options for the alignment light position.
- Select a Landmark, either from the menu, or click in the text box and enter any appropriate name.



3. Click the button next to the Patient Protocols title. Click **[Site]**, **[GE]**, or **[Picture This]** from the Patient Protocol menu. Click on the part of the Humanoid body that corresponds to the part of the patient body that you need to scan. (Example: **Head**)




4. Select the desired protocol and click **[Accept]** to download the entire protocol.


5. After the category and protocol are selected, click **[Save Rx as Protocol]** from Protocol Manager, and then click **[Accept]** on the Save Protocol Rx window.


*Protocol Manager*

# Select a Registered Patient

## In Brief: Select a Registered Patient

1. Click the **Scan Rx Desktop** icon.
2. Click **[Patient Rx]**.
3. Select an entry from the Patient Register area.
4. Click **[Select]**.
5. Click **[Accept].**

Once a patient is ready to be scanned, this function gives you the ability to select him/her from the patient register. The following steps help you to select a pre-registered patient.

1. Click the **Scan Rx Desktop** icon.


2. Click **[Patient Rx]**.
3. Select an entry from the Patient Register area.


4. Click **[Select]** to choose a patient.
5. Click **[Accept]** from the Patient Information window to view the information already entered for the patient.

NOTE: Click and drag the slider to view all data in the Patient Register area. The patient name and ID fields are 64 characters in length to accommodate long patient names and other useful data such as session numbers, left or right extremity, etc.

# Sort the Patient Register

You can sort patients within the register by three fields.

1. Click **[Sort]** on the Patient Register, from the Scan Rx Desktop, giving you the ability to sort the list by:
   - Patient ID number
   - Patient Name
   - Date / Time


*Patient Register*

NOTE: Only the patient ID or name is displayed if you sort by ID or Name. To see all three sort methods, click **Time** in the Sort text box.

## In Brief: Sort the Patient Register

1. Click **[Sort]** key to list by ID number, Name or Date.

# Delete a Registered Patient

When a patient cancels an exam or does not show up for an appointment, he/she can be deleted from the Patient Register located within the Scan Rx Desktop.

1. From the Scan Rx Desktop, select an entry in the Patient Register area.
2. Right click and click **[cut]** removing that patient from the register.
3. Click **[Confirm]**.

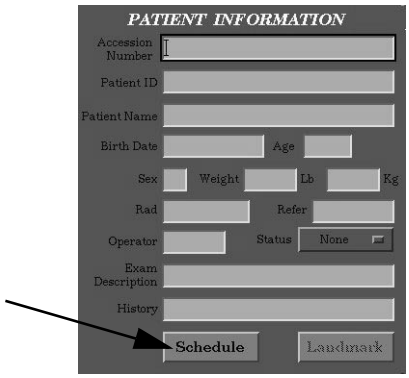
## In Brief: Delete a Registered Patient

1. From the Scan Rx Desktop, select an entry in the Patient Register area.
2. Right click and click **[cut]**, removing that patient from the register.
3. Click **[Confirm]**.

# Enter Patient Information Using ConnectPro Plus (PPS)

If your facility has purchased the ConnectPro Plus (and PPS-Performed Procedure Step) option, you can enter the patient HIS/RIS more quickly and with more accuracy than entering this information manually.

1. Click **[New Pt]**, from the Scan Rx Desktop.
   - Or, ConnectPro Plus can be accessed from the Protocol Manager Desktop by clicking **[Schedule Rx]** in the Protocol Prescription area. This pre-registers the patient and attach a protocol. (You CANNOT scan from the Protocol Manager Desktop; you can only pre-register the patient and attach a protocol.)
2. Click **[Schedule]** from the bottom of the Patient Information area.



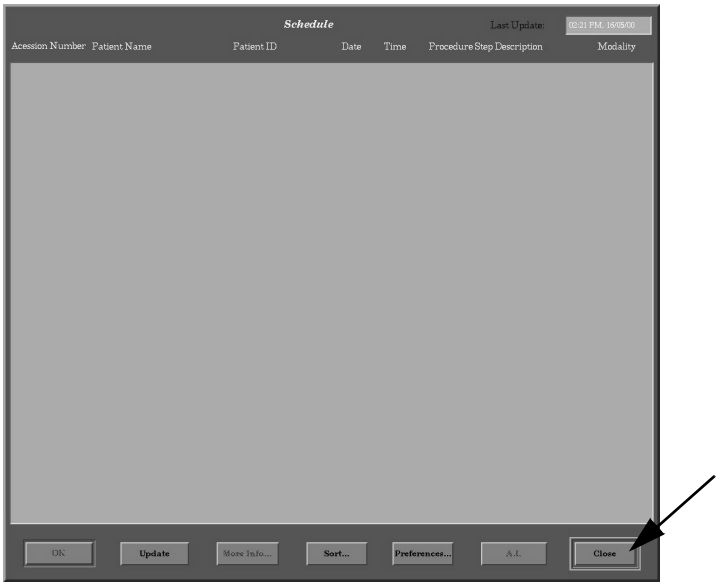

*Schedule/Patient Information*

   - You can type in the patient's name in the appropriate text box, or type in as few as two digits of the Accession number or Patient ID number to initiate the search.

## In Brief: Enter Patient Information Using ConnectPro Plus (PPS)

1. Click **[New Pt]**.
2. Click **[Schedule]**.
3. Highlight patient and click **[OK]**. Or if needed, click the buttons across the bottom of window to obtain patient information or other functions.
4. Scan patient.
5. When scanning is complete, click **[End Exam]**.
6. Click **[Complete]**, or other appropriate button.
7. After post-processing, click **PPS**, and then click **[Complete]**.

3. Highlight the desired patient from the Worklist window and click **[OK]** to enter the patient information and the attached protocol into the system.




*Schedule/Worklist window*

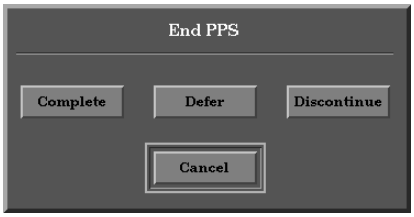
- The buttons across the bottom of the Worklist (Schedule window) allow for additional information on the patient. See the About... section in this chapter for more detailed information about these buttons.
- **[Close]** (arrow) - This button closes the Schedule (Worklist) window.

4. Scan the patient using your facility's normal procedures.

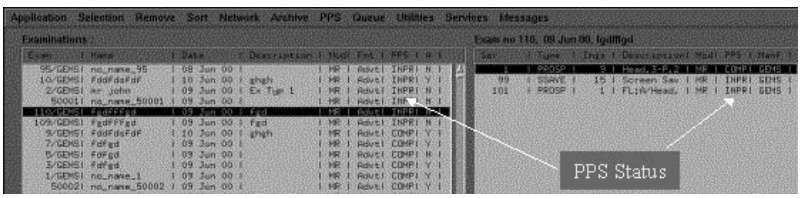
CAUTION: Patient data text boxes in the Patient Information area can be edited after the data is imported from the worklist. However, editing patient information from the Scan Rx Desktop results in the HIS/RIS data differing from the local patient data.

5. Click **[End Exam]**, after scanning is finished.


- The End PPS window appears.




6. Click the appropriate choice.
   - The selection made at this window annotates this exam in the Browser in the PPS column as follows:
     - **Complete** - Annotates as COMP.
     - **Defer** - Annotates as INPR (for In-Progress, exam is still active).
     - **Discontinue** - Annotates as DISC (for Discontinued, exam is aborted). The Discontinued message is sent to the HIS/RIS and therefore the exam is left on the Worklist.
     - **Cancel** - Annotates as INPR (for In-Progress, the exam is still active).




*Browser*

NOTE: When scanning with the Imaging Option SCIC (Surface Coil Intensity Correction) and PPS, you cannot complete the exam when finished scanning. **[Complete]** is not available on the Scan Rx Desktop if SCIC was selected. First click **[End Exam]**, then click **[Defer]**. Complete the exam from the Browser by clicking **PPS** from the Browser menu bar, and then click **[Complete]**.

NOTE: If you plan to apply ClariView filters to the images, and you have used PPS, do not complete the exam when finished scanning. Post-processing functions must be done before the exam is completed in PPS. First click **[End Exam]**, then click **[Defer]**. Apply the ClariView filters. Then complete the exam by clicking **PPS** from the Browser menu bar, and click **[Complete]**.

7. Once the post-processing is finished, exams with the status of INPR need to be changed to COMP. Click **PPS** from the Browser menu bar and click **Complete**.


*Browser Menu Bar*

- Once an exam is complete, a message is sent to the radiologists' console, the PACS, and the HIS/RIS stating that the exam is complete and that images may be retrieved and archived.

# Guided Install-HIS/RIS DICOM Mode

Selecting HIS/RIS DICOM mode requires no password to access. The following steps are used to check that the HIS/RIS system has been configured with the MR System. The actual configuration must be done by a service engineer with the assistance of the facility's Information Technology department.

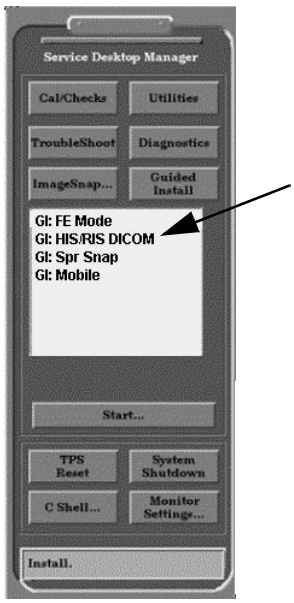
Configuration of the HIS/RIS tab allows configuration of server and port setups. and to the SCP (charge codes used by the scanning facility when billing insurance) tab.

Mobile sites can also use the same steps as fixed sites for the HIS/RIS DICOM install.

NOTE: Mobile users, be sure to check that the IP address and the port number are correct on the HIS/RIS tab.

1. Click the **Service Desktop** icon from the control panel.

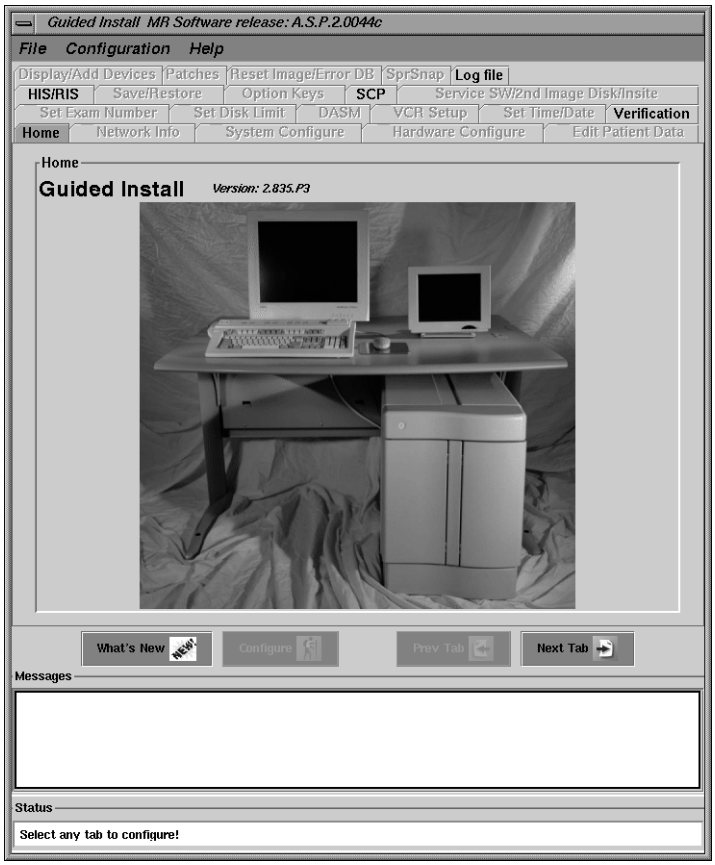
2. Click **[Guided Install]**.
3. Select **GI: HIS/RIS DICOM**.



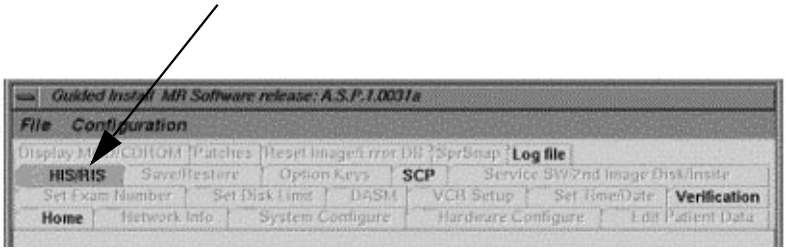

## In Brief: Guided Install-HIS/RIS DICOM Mode

1. Click the **Service Desktop** icon.
2. Click **[Guided Install]**.
3. Select **GI: HIS/RIS DICOM**.
4. Click **[Start]**.
5. Select the **HIS/HIS** tab.
6. Select **File > Exit**.

4. Click **[Start]**.
   - If the HIS/RIS configuration has NOT been done, you need the assistance of your facility's Information Technology department and service engineer to help set up the server and the port configurations. Continue with step 5 when the configurations have been completed.
   - The Guided Install window appears.



5. Select the **HIS/RIS** tab from the top of the Guided Install window.
   - The HIS/RIS tab allows you check that the MR system has been configured with the HIS/RIS.




   - If the systems have not been configured, notify the service engineer and facility's Information Technology department to complete this task.

6. Select **File** (arrow) in the upper left corner of the window, and then select **Exit** from the menu, to exit the Guided Install window.


NOTE: Clicking the icon, in the upper left corner of the Guided Install window, places the icon behind the desktop icons where it cannot be accessed.

# Guided Install-Mapping Protocols to Action Items

## In Brief: Guided Install-Mapping Protocols to Action Items

1. Click the **Service Desktop** icon.
2. Click **[Guided Install]**.
3. Select **GI: HIS/RIS DICOM**.
4. Click **[Start]**.
5. Select the **SCP** tab.
6. Click **A.I. Code** from HIS/RIS area. Type in desired code.
7. Select **A.I. Code** from the system area and type in same code as step 6.
8. Select the desired Protocol library.
9. Select the protocol to map with, from the system protocol libraries.
10. Select the desired Protocol Category.
11. Select the desired protocol.
12. Click **[Save]**.
13. Select **File > Exit**.

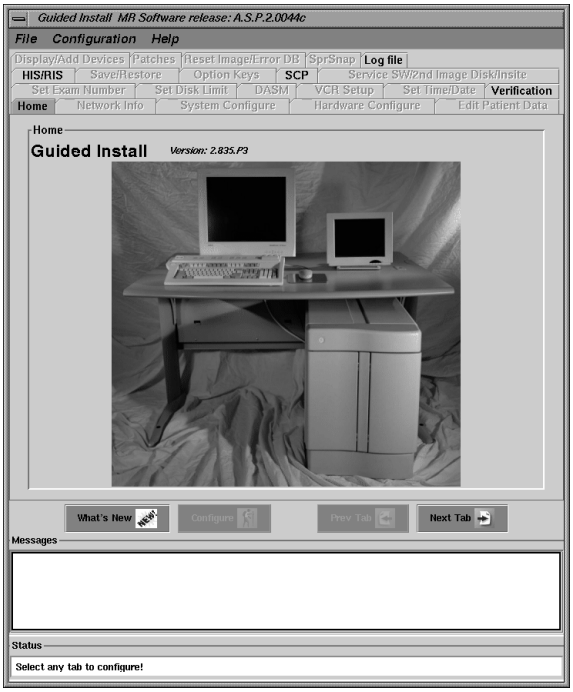
This function allows you to create the maps of protocols to Action Items. An Action Item is the procedure that gets attached to the patient once the patient is entered into the system from HIS/RIS. Also, from the SCP (charge codes used by the scanning facility when billing insurance) tab you can attach billing codes to procedures.

This section gives step-by-step instructions to map protocols with the Action Items.

1. Click the **Service Desktop** icon from the control panel.

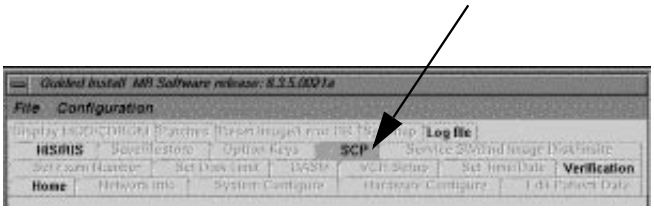
2. Click **[Guided Install]**.
3. Select **GI: HIS/RIS DICOM**.
4. Click **[Start]**.
   - If HIS/RIS configuration has been done, continue with step 5.
   - If the HIS/RIS configuration has NOT been done, you need the assistance of your facility's Information Technology department and service engineer to help set up the server and the port configurations. Continue with step 5 when the configurations have been completed.

- The Guided Install window appears.

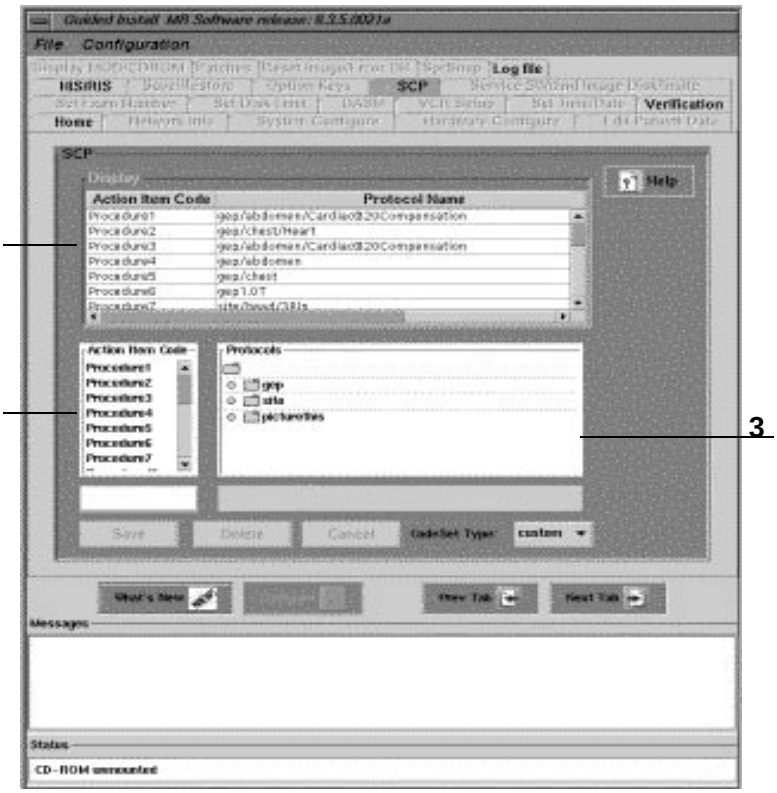



*Guided Install window*

5. Select the **SCP** tab from the top of the Guided Install window.



- The SCP Display window appears.




*Guided Install window*

- The top display box (**1**) shows the HIS/RIS Action Item Codes and the protocols linked to them. The lower two display boxes show the Action Item Codes for the system (**2**) and the system protocol (**3**) libraries.

6. To map protocols, select the procedure number from HIS/RIS Action Item Code (area **1**), and type in desired code, such as CPT code.
7. Select the procedure number from system Action Item Code (area **2**), and type in the same number (code) used in the HIS/RIS Action Item Code.
8. Select the desired Protocol Library.
9. Select the protocol to map with from the system Protocol libraries (area **3**).
10. Select the desired Protocol Category.
11. Select the desired protocol.

12. Click **[Save]** to save the mapping of the Action Item Code with the selected protocol.


- Click **[Delete]** to remove the mapping of this protocol to the Action Item Code.
- Click **[Cancel]** to cancel the mapping the process.

NOTE: Click **[Help]** to display step-by-step instructions for the mapping procedure. Refer to **[Help]** when you have questions about the Guided Install.


13. Select **File** (arrow) in the upper left corner of the window, and then select **Exit**, to exit the Guided Install window.


NOTE: Clicking the icon, in the upper left corner of the Guided Install window, places the icon behind the desktop icons where it cannot be accessed.

## Guided Install - HIS/RIS DICOM Mode

To connect the HIS/RIS and the MR system to activate Connect Pro, you need the assistance of your facility's Information Technology department and service engineer to help set up the server and the port configurations.

# Assign Image Storage

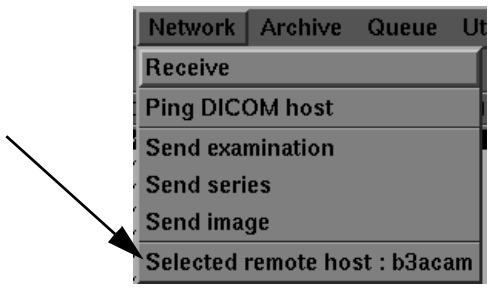
## In Brief: Assign Image Storage

1. Click **Network**.
2. Click **Remote Host**.
3. Select an entry.
4. Click **[Update]**.
5. Click **Yes**, **No**, or **Auto**.
6. Click **[Save]**.
7. Click **Archive**.
8. Click **Select Archive Device**.
9. Click **Remote** or **Local**.
10. Click **[Scan Modes]** and click Auto Archive **on**.

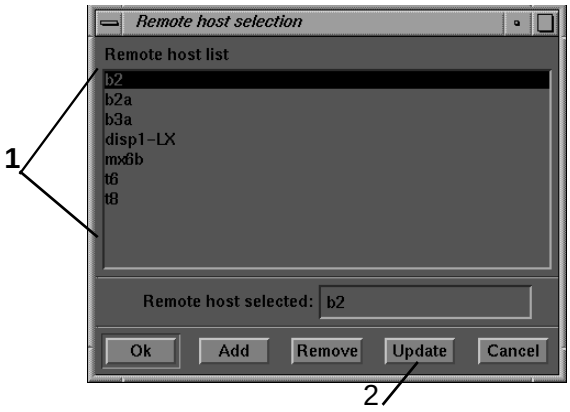
You can decide the meaning of the “Y” or “N” label in the archive column displayed on the Browser’s exam list. If you have a PACS (Picture Archival Computerized System), you can set the archive column of the Browser, such that “Y” means the images have been successfully transferred to the PACS. The archive column can also be set to mean that the images have successfully transferred to the MOD.

1. Click **Network** from the Display or Image Management Browser menu bar.


2. Select **Selected remote host** from the Network menu.

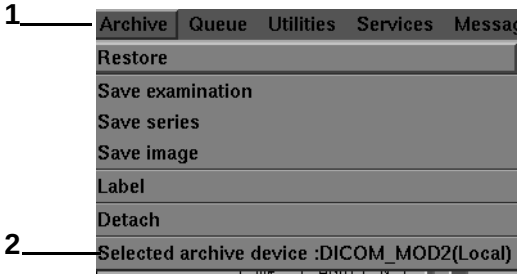



- The Remote host selection window appears.




3. Select one entry (1) from the Remote host list.
4. Click **[Update]** (2) from the Remote host selection window.

5. In the Archive Node area of the remote Host Parameters window, do one of the following:
   - Click **Yes** to have the archive “Y” label represent the successful transfer of images to the PACs system.
   - Click **No** to have the archive “Y” label represent the successful transfer of images to the MOD.
   - Only click **Auto** to test if the auto archive function is operational.
6. Click **[Save]** to close the window and save your changes.
7. Click **Archive** (1) from the Browser menu bar.




8. Select **Selected archive device** (2) to display the Archive Device Selection window.
9. Click **Remote** as the archive destination if you want the archive label “Y” to represent that an exam has successfully transferred to the PACs system.
   - Click **Local** as the archive destination if you want the archive label “Y” to represent that an exam has successfully transferred to a MOD.
10. Click **[Scan Modes]** from the Rx Manager window, and turn on Auto Archive.

Something to Think About...

- Currently, there is no mechanism for labeling both the successful transfer of images to MOD and PACs system.
- The archive destination selection (Local or Remote) must synchronize with the archive label (Yes or No) selected from the Remote Host Selection window.
- If Remote is selected as the archive destination device, verify that the PACs system is not on the Auto Transfer by Exam or Series list of nodes. The PACs system should not be an end destination for both Auto Archive and Auto Transfer.

This page intentionally left blank.

Volume 1

# Chapter 7

# Scanning with a Protocol

### Where Am I?


## Introduction

This chapter focuses on prescribing and performing scans using a protocol. It highlights key concepts and provides brief guidelines for registering a patient, selecting a protocol, editing a series, prescribing scan locations and saturation bands, and scanning a series. It also contains instructions to help you learn how to:

- Prepare the Patient for the Exam
- Start a Scan Prescription
- Transfer the Patient to the System Table
- Position the Patient
- Align and Landmark
- Select a Protocol
- Edit Protocol Parameters
- Define the Scanning Range
- Define Saturation Bands
- Scan

In addition, this chapter answers the following questions:

1. What types of protocols are available?
2. What functions are controlled in the Rx Manager?
3. How does graphic prescription define an area?
4. What is the general purpose of pulse sequences?
5. What is the general purpose of imaging options?
6. What factors affect contrast?
7. What factors affect spatial resolution?
8. What factors affect scan time?
9. What factors affect SNR?
10. What types of saturation techniques are available?

# About... Scanning

This section presents the concepts necessary to successfully complete a scan prescription process and begin scanning. Specifically, you need to understand:

- Protocol Libraries
  - Picture This Library
  - Site Library
  - GE Library
- Rx Manager
  - Series List
  - Scan Modes
  - Gating Control
- Pulse Sequences
- Imaging Options
- Parameter Trade-offs
  - Factors that Affect Contrast
  - Factors that Affect Spatial Resolution
  - Factors that Affect Scan Time
  - Factors that Affect SNR
- Defining a Scanning Range
  - Explicitly
  - Graphically
  - Radial Graphically
- Defining Saturation Bands
  - Spatial Saturation
  - Chemical Saturation
  - Graphic SAT Prescription

## Protocol Libraries

The Signa® system is designed to optimize productivity, and preprogrammed protocols are a significant factor in simplifying exam set-up.

Your MR system has 3 libraries of protocols:

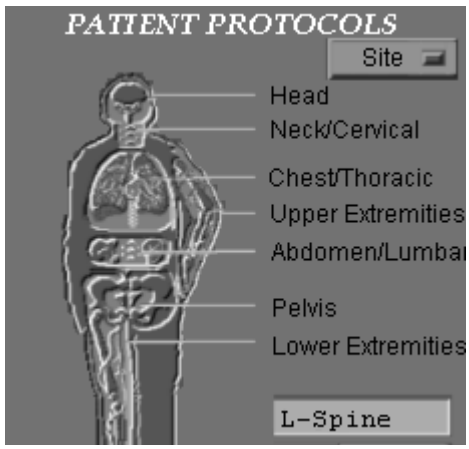
- Picture This
- Site
- GE

  The protocol list is available in the Patient Protocols area.


Each library contains eight protocol categories:

- Head
- Neck/Cervical
- Chest/Thoracic
- Upper Extremities
- Abdomen/Lumbar
- Pelvis
- Lower Extremities
- Other

  Protocol categories can contain up to 100 protocols, with up to 100 series each.



## Picture This Protocol Library

The Picture This library contains pre-programmed protocols and an image gallery.

- Each sub-series includes three category choices: standard, faster, and higher resolution. Each contains sample images to assist selection.
- The Picture This protocols do **not** allow scan parameter changes other than the entry of start and end locations and prescription of saturation bands.
- The Picture This window reflects the scan time of the series as it is built into the Picture This program. Each Picture This series has a value entered for the number of slice locations (or number of slabs for 3D) and the scan time in the Picture This window that reflects that value. If the number of scan locations is changed (at either the Graphic Rx or Scanning Range area), and that change results in an increase or decrease in the number of acquisitions, the actual scan time reflects the number of acquisitions.

## Site Protocol Library

The Site library does not contain any pre-programmed protocols initially. You create and save your own protocols into the Site library; the GE protocols can be used as a starting point.

## GE Protocol Library

The GE library contains pre-programmed protocols that include the protocols from the Picture This library, as well as, additional protocols. The GE library does not contain sample images but does allow scan parameter changes. You can edit protocols from the GE library and save them to the Site library.

## Rx Manager

The Rx Manager is used to create, view, edit, and prepare series for scanning. A series list is created in the Rx Manager upon selection of a protocol. The Rx Manager reduces scan prescription time by using predefined patient protocols and has time-saving benefits of multiple prescribe ahead series concurrent with scanning. It also provides access to the scan mode selection and gating control.

The Rx Manager is located on the left side of the Scan Rx Desktop appears after the selection of a protocol.


The Rx Manager has several controls for starting and ending an exam or pre-programmed protocol. The status of a series is listed in the window with the series description.

The following table describes the function of the controls in the Rx Manager.

| ***Selection*** | ***Description*** |
|---|---|
| **[Scan Modes]** | Sets Auto Archive, Auto Transfer, and system operation mode. |
| **[Gating Control]** | Controls the waveform display. |
| **[New Series]** | Adds a blank series to Rx manager. |
| **[End Exam]** | Ends the current exam and returns the desktop to the Patient Register. |
| **[View Edit]** | Allows modification of parameters. |
| **[Prepare to Scan]** | Activates Scan Operations area with parameters of highlighted series. |
| **[Save Rx as Protocol]** | Saves a Rx to the Site Protocol list with a user-defined name. |
| **[AutoScan]** | All series in RXD state in the Rx Manager are automatically scanned. |
| **[AutoStep]** | Automatically scans data acquisitions containing different stations with MultiStep option. |

NOTE: For additional information on the Rx Manager Scan Modes and Gating Control functions refer the chapter Scan Rx Desktop.

## Rx Manager List

The Rx Manager List shows the prescribed series state and series description. All scan information can be recalled by selecting and copying a series. This allows you to repeat a

series exactly, without entering any information. Series are loaded from the protocol library into the Rx Manager.


Each series in the Rx Manager list contains three pieces of information:

- The current state.
  - ° NEW- series is not yet prescribed or saved and cannot be scanned.
  - ° INRX- (in prescription) series is opened, not yet saved, and cannot be scanned.
  - ° RXD- (prescribed) series is saved and can be scanned.
  - ° ACT- (active) series is ready for scan and can no longer be edited.
  - ° SCND- (scanned) series has been scanned and can no longer be edited but can be re-scanned.
  - ° PSCD- (prescanned) series is pre-scanned and ready for scan (can no longer be edited).
- The series number. A series number is not assigned until the scan is initiated.
- The series description.

  For example, a typical series of entries in the Rx Manager List might include:

  SCND 1. Sagittal T1 Loc

  This indicates the series has been scanned, was the first series, can be used as a localizer, and remains in the list for easy access to the scan values.

  ACT 2. Axial T2

This indicates that this scan was the second series and is currently being scanned or it is ready to scan.

RXD 3. Axial T1 Pre

This indicates that this scan is the third series and is ready for downloading.

INRX 4. Coronal T1 Pre

This indicates that the scan is the fourth series and has not been saved, it is being view/edited.

NEW 5. Sagittal T1 Pre

This indicates that the scan is the fifth series and has not been saved, nor is it being view/edited.

Something to Think About...

- Select the entries in the Rx Manager list in any order.
- The series highlighted in the Rx Manager is not necessarily the series being viewed on the desktop. The series in the INRX state is the series on the desktop.
- If a series on the desktop in the INRX state is saved and the **[Scan]** button is selected, the system does not scan this series (the one on the desktop) but repeats the scan on the series previously scanned or in the ACT state.
- Series from different protocols can be added to the list. For example, if the current patient exam is a thoracic and lumbar spine study, the list can be arranged to have both exams ready to scan. Keep the landmark and orientation the same for each scan.
- The Rx Manager list is created as soon as a protocol is selected. Select any series in the list and prescribe slice and SAT locations, change the stored protocol values, and save the protocol to the Rx Manager. The process can be repeated for as many series as needed.

## New Series

New Series adds additional series to a patient's exam. It is tracked in the Rx Manager list and begins at the Patient Position. Select this button to add an additional series to the Rx Manager.


Selecting a New Series in the Rx Manager is only available with GE or Site protocols. New Series is not available after selecting Picture This protocols.

Something to Think About...

- A series cannot be scanned unless a series is saved. Saving the series changes its status from INRX (in prescription) and places it in the prescribed or RXD state in the Rx Manager.
- The system automatically downloads the first series and, therefore, selecting the **[Prepare to Scan]** button is not required.

## End Exam

End Exam completes the current exam. It separates patient exams or anatomical regions for one patient.


Completing an exam with this key:

- Changes the status of the exam from current to completed.
- Closes the scan s and displays the Patient Register.
- Makes New Patient selection available for the next patient or anatomy to be scanned.
- Makes the exam number available for archiving
- Removes the current images from the Autoview Window memory buffer.

Something to Think About...

- Once you select the **[End Exam]** button, no more images can be added to the exam number.
- You must select the **[End Exam]** button before Auto Store can save the exam's images to the MOD.

## View Edit

View Edit allows you to review or edit a series in the Rx Manager. It can also be used to adjust a scan range after viewing the most recent acquisition.

With View Edit, a series can be modified and saved again. A new series in the Rx Manager list changes to INRX if a View Edit is performed.

Something to Think About...

- If you view or edit another series before a Save Series is initiated for the current series (INRX), changes for the current series (INRX) are saved and the INRX series is relisted in the Rx Manager as NEW.
- You can view but not edit a series that has a status of ACT or SCND, even though the status of the series changes to INRX.

## Prepare to Scan

Prepare to Scan changes the status of a series from prescribed (RXD) to active (ACT) or ready to be scanned.


The system automatically moves the first series in the Rx Manager list to active status.

Something to Think About...

- Prepare to Scan is not needed if AutoScan is selected.
- Prepare to Scan is not needed for the first series of an exam.
- Prepare to Scan is required to download series on an individual basis.
- The series highlighted in the Rx Manager is the series prepared. Note that the series represented on the Scan Rx Desktop is not necessarily the series highlighted in the Rx Manager.

## Save Rx as Protocol

Save Rx as Protocol is used to save the current prescription as a site protocol. You must define the protocol name. This allows you to build predefined site protocols to reduce prescription set-up time and increase productivity.

The entire series list in the Rx Manager is saved as a protocol in the site protocol list.

## Auto Scan

Auto Scan automatically downloads, prescans, and scans all RXD series in the Rx Manager. This feature extends the multi-tasking capabilities by allowing you to prescribe multiple scans in advance.


The next RXD series in the list begins automatically when AutoScan is selected. All RXD series in the Rx Manager list are scanned sequentially.

Something to Think About...

- Auto Scan turns OFF if:
  - A table move is required (Move to Scan).
  - Move to scan is not activated after two audio alarms and scan times out.
  - A contrast series is in the queue following a non-contrast series.
  - A new landmark is selected.
  - New Patient or a patient from Patient Register list is selected.
- The following describes the behavior of contrast-enhanced series when Auto Scan is active:
  - AutoScan is on and there are no series in the Rx Manager in the RXD state.
  - When the first series containing contrast On is ready to scan, the contrast injection message box appears. You must select the **[OK]** button to proceed.
  - The contrast message does not appear again in this exam for subsequent contrast-enhanced series. An exception to this occurs when there is a series prescribed with contrast followed by a series prescribed without contrast, then another series with contrast selected on. The contrast injection

message appears again following the no contrast series.

- If Auto Scan is turned on and there is no series in the Rx Manager in the RXD state but a series in a SCND or ACT state has been copied, the system AUTOMATICALLY changes its status to RXD. The system scans this series before there is a chance to edit the copied series.

### AutoStep

AutoStep provides automatic table movement and scan initialization for data acquisitions containing more than one station, until all stations are acquired. It is available with the MultiStep imaging option in the SmartStep software purchase option.


AutoStep becomes available with a SmartStep meta-series. All prescribed stations in the meta-series must be saved and prescanned before selecting AutoStep to initiate the acquisition.

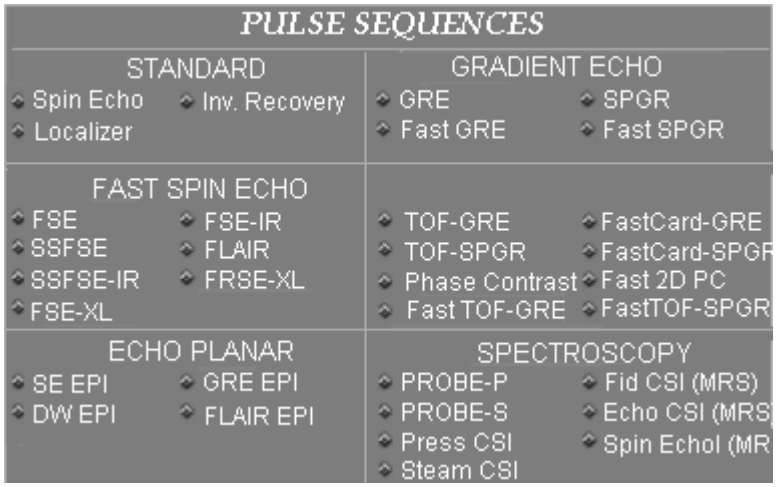
NOTE: For additional information on the AutoStep options refer to the chapter Bolus Chasing with SmartStep, Volume 4.

## Pulse Sequences

Pulse sequences determine the type of RF and gradient pulses used to excite and rephase the nuclei.

Pulse sequences are used to create and control contrast and can be divided into six categories based on how they regenerate the echo signal and fill k-space:

- Standard Spin Echo Sequences
- Fast Spin Echo Sequences
- Gradient Echo Sequences
- Vascular Sequences
- Echo Planar Sequences
- Spectroscopy Sequences




NOTE: For a better understanding of how pulse sequences collect data and create contrast, refer to Volume 2.

## Imaging Options

Imaging options are used to control artifacts, enhance resolution and contrast, minimize motion, and improve SNR.

NOTE: For a better understanding of how imaging options improve image quality refer to the chapter Optimizing Images with Imaging Options, Volume 3.

## Parameter Trade-offs

During protocol prescription, you use your knowledge of MR physics. Certain situations warrant trading scan time for contrast, resolution or coverage. Others require careful consideration of SNR. In the following section, these parameter trade-offs are discussed, as well as, their effect on image quality.

### Factors that Affect Contrast

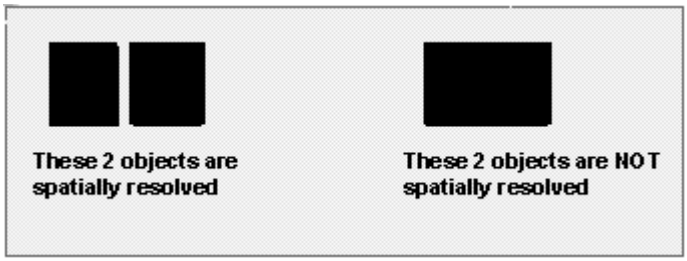
Contrast resolution is an image function providing the ability to differentiate the signal intensities of one anatomical region with respect to surrounding anatomical regions. This helps to distinguish pathology from normal tissue. Contrast is directly affected by scan timing parameters such as TR, TE, TI, and flip angle. The SNR can enhance or obscure contrast but cannot change the image weighting from one type of contrast to another.

- Proton Density, T1, and T2 components affect all images to some degree; however, the goal is to use pulse sequences and scan timing parameters so that one component affects contrast more than the others:
  - In a T1-weighted image, variation in T1 relaxation has the most significant impact on contrast.
  - In a T2-weighted image, variation in T2 relaxation has the most significant impact on contrast.
  - In a PD-weighted image, variation in proton density has the most significant impact on contrast.
- Scan timing parameters have minimum or maximum limits, depending on the type of pulse sequence. You can use parameters within these limits to produce the desired type of contrast in your images.
- Certain imaging options also affect image contrast:
  - Chemical Saturation
  - Magnetization Transfer
  - SPECIAL
  - Classic
  - IR and DE Prepped

- Surface Coil Intensity Correction
- Full Echo Train
- Tailored RF

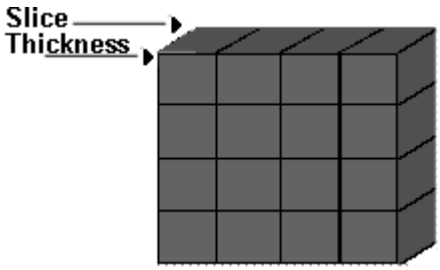
## Factors that Affect Spatial Resolution

Spatial resolution is the ability to distinguish two points as separate and distinct. Spatial resolution is measured in line pairs. The size of the line and space between determines the resolution.

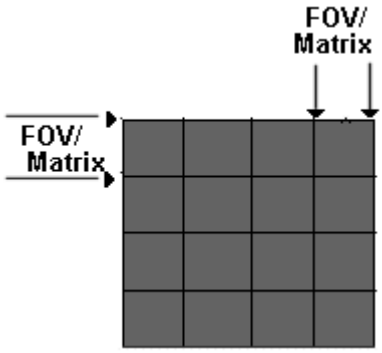



Spatial resolution is affected by voxel size. Voxels are three dimensional elements that make up the image. Voxel size is controlled by:

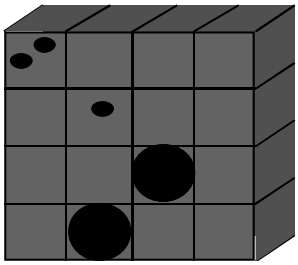
- Slice thickness
- Matrix
- FOV




Slice thickness controls the depth of the voxel.




Matrix and FOV control the in plane height and width of the voxel.



Structures smaller than the voxel create a partial volume.

A single intensity value is assigned to each voxel.

Spatial Resolution Formulas:

- Phase FOV ÷ Phase Matrix* = Phase Dimension (Pixel Width)
- Frequency FOV ÷ Frequency Matrix* = Frequency Dimension (Pixel Height)
- Phase Dimension x Frequency Dimension = Pixel Area
- Pixel Area x Slice Thickness = Voxel Volume

NOTE: *Matrix refers to the actual gradient encoding parameter and not the reconstruction parameter.

Imaging Options that enhance spatial resolution:

- Square Pixel
- Matrix ZIP
- Slice ZIP

## Factors that Affect Scan Time

The factors that affect scan time per acquisition depend on the pulse sequence and scan mode.

To calculate the scan time for certain pulse sequences and scan modes:

- 2D Spin Echo or a 2D Multi-planar Gradient Echo Sequence

  TR x Phase Matrix x NEX x Number of Acquisitions

- 2D Fast Spin Echo Sequence

  $$\frac{TR \times Phase\ Matrix (\times NEX)}{ETL} \times \text{Number of Acquisitions}$$

- 3D Fast Spin Echo Sequence

  $$\frac{TR \times Phase\ Matrix (\times NEX)}{ETL} \times \text{Number of Slices per Slab}$$

- 2D Sequential Gradient Echo Sequence

  TR x Phase Matrix x NEX x Number of Slices

- 3D Gradient Echo Sequence

  TR x Phase Matrix x NEX x Number of Slices x Number of Slabs

- Echo Planar Sequence

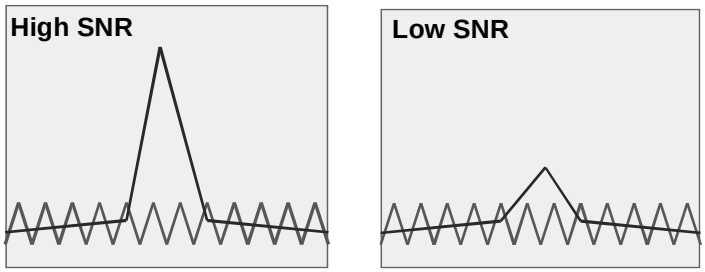
  TR x NEX x Number of Shots

## Factors that Affect SNR

SNR is the ratio of the amplitude of the signal received by the coil to the amplitude of noise or undesired signal.

$$SNR = \frac{\text{Amp. MR signal}}{\text{Amp. system noise}}$$

Noise is undesirable signal that is generated from the patient, the environment, and the system electronics. The bigger the parcel of information, the more signal contributes to it.



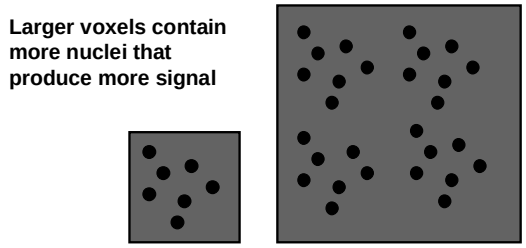

*Noise is random, but constant.*

Everything affects SNR in some way; some parameters have a minor impact and some have a major impact.

- Patient and System
- Pulse Sequences and Contrast Parameters
- Spatial Resolution Parameters
- Receive Bandwidth
- NEX
- Flip Angle

### Spatial Resolution Parameters and SNR

SNR decreases as spatial resolution increases due to the smaller voxel size.




As voxel size increases, SNR increases.
As voxel size decreases, SNR decreases.

Select the slice thickness and FOV to balance resolution and SNR needs.

- Increasing slice thickness decreases the resolution but increases the signal-to-noise ratio.

$$SNR = \frac{SliceThicknessNew}{SliceThicknessOld}$$

- Select the FOV to balance resolution and SNR needs.
  - Increasing the field of view decreases the resolution and increases the signal-to-noise ratio.

$$SNR = \left(\frac{FOVnew}{FOVold}\right)^2$$

Matrix size affects SNR.

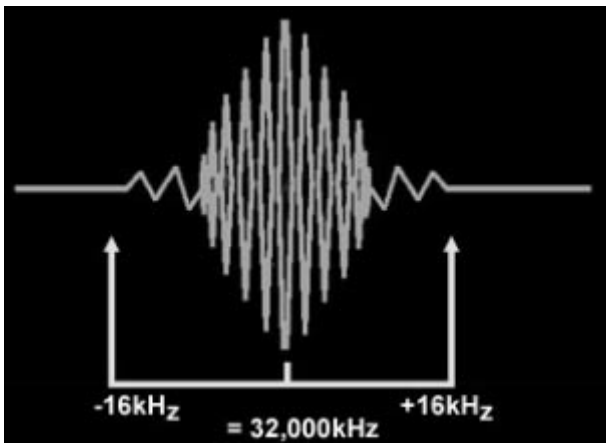
- More phase encoding samples increase SNR, but decrease the size of each individual pixel and therefore, decrease signal and signal-to-noise.

$$SNR = \sqrt{\frac{PhaseEncodesNew}{PhaseEncodesOld}}$$

$$SNR = \sqrt{\frac{FrequencyEncodesNew}{FrequencyEncodesOld}}$$

### Receiver Bandwidth and SNR

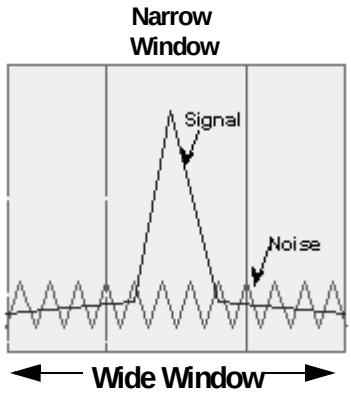
The receiver bandwidth (RBw) is measured as the range of frequencies in kHz. It is the rate at which the echo is sampled by the readout gradient.




A receiver band with a plus or minus 16 kHz means that we are sampling 16 kHz or 16,000 Hz each side of center frequency, for a total of 32,000 kHz.

By changing the value of the bandwidth, you can control how many frequencies are going to be read in each echo. This determines how much signal-to-noise is in each image.

SNR decreases by increasing the RBw. Refer to the following figure. As the window narrows, less noise is detected. As the window widens, more noise is detected.




Sampling rate controls the receive bandwidth. The narrower the bandwidth, the slower the sampling rate.

Sampling rate also affects readout time. This is shown in the following figures.

Slower sampling requires a longer readout time.

Faster sampling allows for a shorter readout time.

Decreasing the RBw has many trade-offs. The following are a few of the trade-offs that occur.

- Decreasing RBw increases chemical shift. Chemical shift is typically matched in the frequency direction of an image, and it occurs because fat and water precess at different frequencies.
- Decreasing RBw also increases the minimum TE available for a given TR. As you increase the minimum TE, you increase the amount of motion that you could potentially get in your resultant scan. Remember, motion appears in our echo because of the time that lapses between when our phase-encoding gradient is applied and our echo is read.
- Since the RBw controls the length of time that the receive window is open, it can have a major impact on the appearance of motion in our MR image.

**NEX and SNR**

The number of signal averages or NEX can also impact SNR. NEX is the number of times that you repeat the entire scan process.

Select the NEX to balance scan time and SNR needs.

- As the number of samples increase, the SNR increases.
- This relationship is not linear.

$$SNR = \sqrt{\frac{NEXnew}{NEXold}}$$

For example, if you double the NEX from 2 to 4, the signal increase equals the square root of 4 divided by 2, which equals the square root of 2, which equals 1.41. Doubling the NEX doubles the scan acquisition time but produces a 41% increase in signal-to-noise.

$$\sqrt{\frac{4}{2}} = \sqrt{2} = 1.41$$

Something to Think About...

- Resolution and SNR work in complete opposition to each other. Each time you make a field of view, matrix, or slice thickness choice, make sure that it is a careful blend of achieving a resolution good enough to make a diagnosis, without resulting in a signal-starved image.
- As a rule of thumb, SNR decreases as TR decreases or TE increases.
- Decrease bandwidth to balance minimum TE, minimum echo space, and SNR needs.

NOTE: Do not forget to refer to the Relative SNR meter and compensate for SNR changes.

## Defining a Scanning Range

The Scanning Range is where you define the Field of View (FOV), the slice thickness and spacing, location of the slices and FOV center, and the number of slices in the acquisition. The entries can be made explicitly or graphically for the scan locations, FOV center, and slice number.

### Explicit Prescription

Explicit prescription allows start and end locations and the number of locations to be entered explicitly in the Scanning Range without entering the Graphic Rx.

Explicit prescription can be used to prescribe a single group of:

- 3 Plane Localizer pulse sequence
- 2D orthogonal slice locations
- 2D oblique slice locations
- 3D orthogonal volumes
- 3D oblique volumes

Explicitly prescribe a series of scan locations by entering coordinates in the Scanning Range that represent the desired coverage of the anatomical locations. The actual end and total number of slices or slabs are calculated by the system and are displayed in the Scanning Range area.

## Graphic Prescription

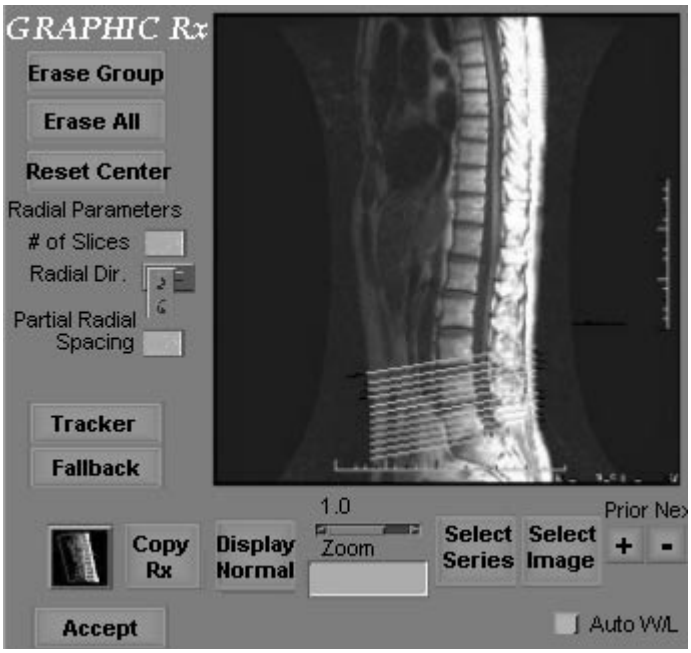
Graphic Prescription (Rx) is used to graphically define the scan locations using a cursor on a localizer image. To graphically prescribe orthogonal scan locations, the localizer image must have the same landmark and must not be in the same plane as the series being prescribed. Oblique slices can be prescribed from an orthogonal or an obliqued scan prescription.

Graphic Rx can prescribe single or multiple groups of:

- 2D orthogonal slice locations from an orthogonal localizer
- 2D oblique slice locations
- 2D oblique slice locations with multiple angles
- 2D radial slice locations
- 3D orthogonal volumes from an orthogonal localizer
- 3D oblique volumes

When a localizer image is acquired, the **Graphic Rx** icon is available in the Additional Parameters area.


The Graphic Rx screen appears when the icon is selected.



The following table gives a description and acceptable values for each selection on the Graphic Rx screen.

| ***Selection*** | ***Description*** |
|---|---|
| **[Erase Group]** | Erases a deposited group of slices. |
| **[Erase All]** | Erases all deposited slices. |
| **[Reset Center]** | Allows you to page through a data set and reselect a new center image for prescription. |
| **# of Slices** | The number of slices prescribed for a radial graphic prescription. The maximum allowable is 16. |
| **Radial Dir.** | Clockwise and counter clockwise directions for radial prescription. System defaults to clockwise. |
| **Instructions for Add Group** | Adds a group of slices in a different location. |
| **[Tracker]** | Defines the tracker slice location and thickness in a SmartPrep acquisition. |
| **[Fallback to R0]** | Moves the slice centers from off center prescribed position to isocenter in the slice select direction of localizer image. |
| **SAT icon** | Opens the SAT screen. The currently prescribed slices are automatically accepted. |
| **[Copy Rx]** | Copies a previous Rx with the same FOV, slice thickness, and spacing. A single click on the desired series to copy followed by **[Accept]** displays the same slice locations on the currently displayed image. A double-click displays image used to prescribe slices for the copied series and the slice locations. |
| **[Accept]** | Registers slice prescription and exits Graphic Rx. |
| **[Display Normal]** | Returns the displayed image to its default size. |
| **Zoom** | Adjusts magnification factor for displayed images using the slider. |
| **Text Box** | Enters series and image number for the images to be displayed. |
| **[Select Series]** | Lists valid series from which a localizer image can be selected. |
| **[Select Image]** | Lists the images for the selected series. |
| **[-] [+] (prior/next)** | Displays the previous or next image in the series from the currently displayed image. |
| **Image View Port** | Displays the middle slice of the most recent series which could be used as a localizer. |
| **Auto W/L** | Selects the window level mode to auto. |

Graphic Rx is available only if a valid localizer exists; the plane of the localizer cannot be the same as the plane of the prescription INRX. The exception is an oblique image which can be used to prescribe oblique locations.

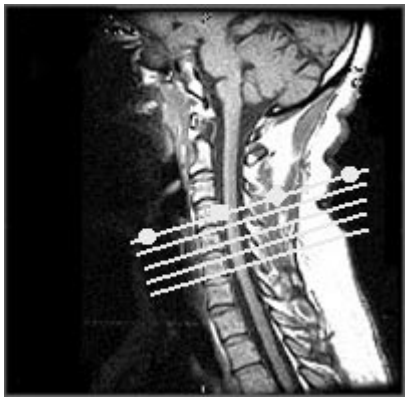
The system automatically displays the center image of the most recent valid series that can be used to select a localizer image. Use **[Select Series]** and **[Select Image]** to select a different image to be used as a localizer.


To edit FOV, slice thickness and spacing for a prescribed series, Graphic Rx must be open.

Once slices have been plotted, numeric values for the start/end locations, FOV center, and the number of slices prescribed appear in the Scan Location text boxes in the Scanning Range area.

The line cursor in graphic prescription has several meanings:

- The tic line on the line cursor represents the FOV center.
- The length of the cursor represents the FOV coverage.
- The cursor handles for oblique slices are used to define tilt.

Click anywhere on the line cursor other than the handles, and drag the mouse to adjust the position of the cursors.

Click and grab on one of the circular handles to tilt the line cursors. (Oblique plane only.)

Click, grab, and drag the diamond tic mark to add or remove slices from the prescription.

Click, grab, and drag the square to + or - slices from the prescription, and tilt the line cursor. (Oblique Plane only.)

In 3D prescription, the box displayed represents the size of the imaging volume based on FOV, slice thickness, and number of scan locations selected in the scanning range. Oblique 3D has the same operation on the graphic slabs as in the 2D oblique mode. The tilt angle handle, slice prescription handle, and tilt angle-slice prescription handle are available. Multi slab and single slab prescriptions are also available.

The localizer image can be magnified or minified.

If the number of slices is defined prior to opening Graphic Rx, that number of slices automatically appear when you click on the image.

**Copy Rx**

Use Copy Rx to copy the slice locations of a previous prescription in the same exam for use in a new series.


To use Copy Rx the following requirements must be met:

- The plane of the current prescription must be the same as the plane of the series to be copied. For example, to copy the slice locations of an axial series, the selected scan plane (at the Imaging Parameters) for the current prescription must be axial.
- FOV and slice thickness of the current prescription must be selected before entering Graphic Rx and must be set at the same values as the copied series.
- When copying an oblique series that was prescribed from an oblique localizer, one of the following must be true:
  - The localizer used for the current prescription must be from the same series used for the copied series, or
  - The localizer used for the current prescription must be an oblique image of the same plane and have the same tilt angle as the localizer used for the copied series.

The Graphic Rx series list, which opens when the **[Copy Rx]** button is selected, lists only those series in the exam which meet the necessary requirements. If there are no series meeting those requirements, the series list window does not appear and a message is posted in the Advisory Panel after selecting the **[Copy Rx]** button.

### Reset Center

The Reset Center option allows you to graphically prescribe your locations on one slice location and redefine a new center image at another slice location.


A message appears on the left side of the Graphic Rx screen displaying the number of the localized image.

Redefining the center image can be useful when prescribing axial orbits or shoulder images. For example, use a sagittal image where you see the optic nerves to prescribe the slice locations, then move to the center of the image and select the **[Reset Center]** button.

### Fallback

Fallback moves the slice centers from their graphically prescribed position to isocenter, along the localizer slice-select direction. This can be in either the phase or frequency direction for the prescribed slices.


Changes to the Graphic Rx are not readily noticed, but the resulting images fall back to isocenter in the slice select direction for sagittals and coronals. The fallback occurs only in the slice-select direction of the localizer and the imaging plane determines the phase and frequency direction.

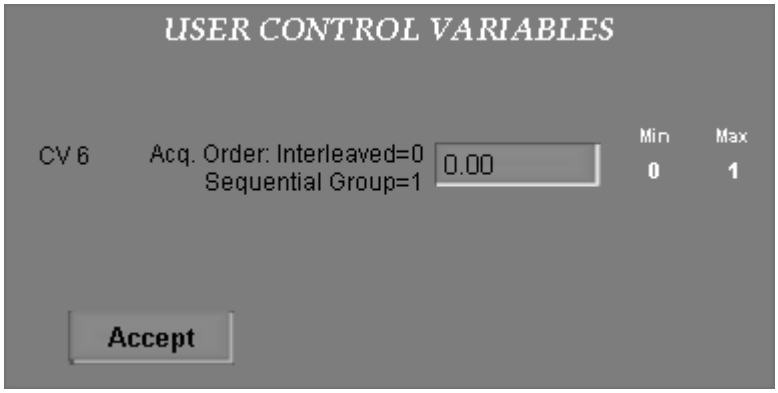
Something to Think About...

- The numbering of the slices within a graphic prescription group are numbered per group and not by the total number of slices. If you have prescribed three groups of three slices, each group has 1, 2, 3 slice numbers. For example:
  - Numbering prior to 8.3 software:1-3, 4-6, 7-9
  - Numbering now:1-3, 1-3, 1-3
- If Fallback is used, make sure the FOV is large enough to include the anatomy of interest when the FOV falls back. Of course, as FOV increases, resolution decreases. The system does not prevent you from scanning any FOV with an offset.

### Multi-Plane Graphic Rx

It is possible to prescribe multiple groups of slices within one acquisition. This is useful when an entire range of slice locations is not desired or needed for a given anatomical body part (e.g., axial spine and sagittal TMJ examinations).

If using a FSE-XL pulse sequence, a user CV becomes available with this prescription.




You must define the acquisition order by selecting an Interleaved Acquisition or a Sequential Group. Selecting Sequential Group (1) results in a Multi-Slice Multi-Angle (MSMA) acquisition and selecting Interleaved (0) results in a Multi-Slice Multi-Group (MSMG) acquisition.

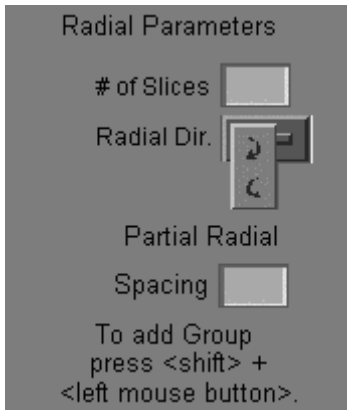
MSMA means that all prescribed slices are acquired within a single acquisition and MSMG means that only the slices within an angled group are acquired within a single acquisition. Three angled groups of slices therefore results in three separate acquisitions.

MSMA is compatible with FSE-XL, GRE, and SE pulse sequences. Note that, artifacts ranging from dark banding to low SNR to tissue contrast changes are likely to occur when MSMA angles intersect. To avoid these cross-talk artifacts, do not intersect the slices within the anatomy of interest. There is no cross-talk artifacts in MSMG.

### Radial Graphic Rx

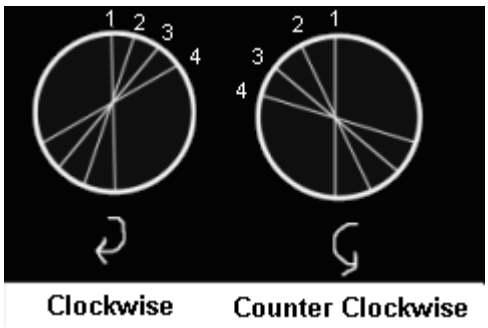
Radial Graphic Rx allows multiple slices to be acquired around a central axis in the same series. Radial and partial radial graphic prescription is available with FSE-XL, FastCard, and SSFSE pulse sequences. This type of prescription can be useful for imaging, but not limited to, knees, MRCPs, myelograms, and hearts.

The Graphic Rx screen contains the radial and partial prescription parameters.




You must define the number of slices and the radial direction while prescribing the acquisition.

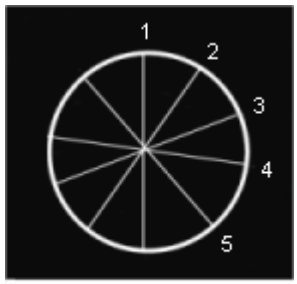
- The system defaults to one slice and clockwise rotation. These settings can be changed.
- The maximum number of acquisitions in one prescription is 16. If this limit is exceeded, an error message appears and you are not be able to accept the prescription.
- The radial direction can be clockwise or counterclockwise.




- The **# of Slices** and **Spacing** text boxes control the angle between the slices of the radial prescription.

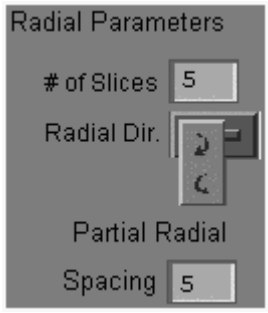
  For example, if you select 5 slices in the radial parameters and leave the **Partial Radial Spacing** text box empty, your

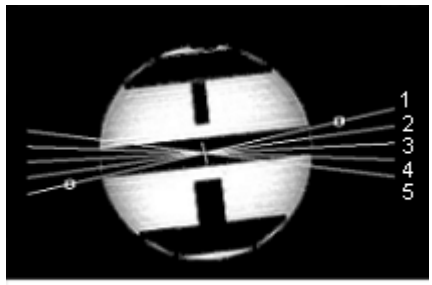
graphic prescription looks like a wagon wheel with a 36° angle between each slice.


**Wagon Wheel**

If you select 5 slices in the radial parameters and 5° in the partial radial spacing parameter, your graphic prescription looks more like cat whiskers and there are 5° between each slice location.




**Cat Whiskers**

Something to Think About...

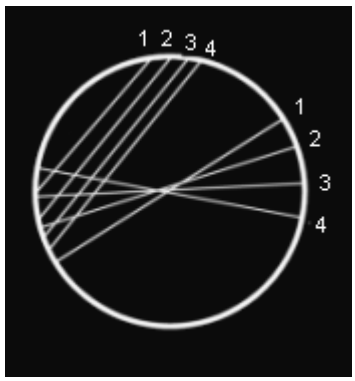
- When prescribing a second group, you must first enter the number of slices and the radial spacing before placing the cursor on the image and clicking. Once the Rx is prescribed on the image, you cannot change it. You must select the **[Erase Group]** or **[Erase All]** button, enter in the new values, and click the image to view the new prescription.
- Set the number of locations before pause to zero if all slices are the same angle. This allows you to scan all slices in one breath hold. For multiple shorter breath holds, type in any number to break up the group.
- Set the number of locations before pause to zero or one for a radial prescription. If you select one, the system pauses after each slice and you need to click the **[Scan]** button for each slice. Although zero is compatible, it causes cross-talk where the slices intersect.

- Set the locations before pause to the number of slices of the largest group when using MSMA. This enables you to scan one group or one angle at a time.

NOTE: After entering your graphic prescription, enter the number of locations before pause. The number of locations before pause can be of a confusing nature. If you select zero, you do not have to push the scan button for every slice (angle), but you may have cross talk problems. If you select one, you control the scan, so you could let the tissue relax by waiting a few seconds before pressing the scan button.

Since each slice is an angle and each angle is a group, the maximum number of locations before pause is always one unless you prescribe an oblique group on the same series.

For example, if you prescribe a radial scan with 4 slices and an oblique group with 8 slices, you could enter 8 in the **# of Locs Before Pause** text box. You would start the scan, the system would acquire those 8 slices, then you would hit scan four more times (one for each slice) to acquire the radial. The oblique slices in the group (single angle) would let you select 4 (or whatever number of locations before pause). See example below:




NOTE: Graphically prescribed locations override an explicit prescription.

NOTE: For additional information on the Additional Parameter Graphic Rx, refer to the chapter Scan Rx Desktop.

# Defining Saturation Bands

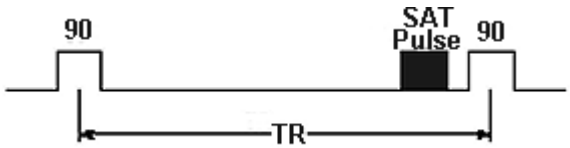
The additional parameter SAT option allows explicit or graphic prescription of presaturation (SAT) pulses on a localizer image from a valid series. A valid series is any prospective orthogonal series in the current exam with the same landmark. Oblique and collapsed vascular images cannot be used.

A combination of RF and gradient pulses decrease SNR in specific locations where spatial SAT has been supplied. SAT pulses can be applied spatially to saturate an entire area of tissue or chemically to saturate (suppress) specific chemical components.

## Spatial Saturation

Spatial saturation pulses are 90° RF pulses applied before the slice-selective excitation pulse. They deliver the RF pulses to anatomy outside or inside the imaging volume to saturate nuclei, so that the signal from this area does not contribute to the image.

The following basic pulse sequence diagram shows the location of the SAT pulse.




Shortly after the 90° SAT pulse, the 90° slice excitation pulse is applied. The tissues affected by the SAT pulses do not have time to adequately recover, thus, there is little or no longitudinal magnetization to excite from these tissues and little or no signal is produced. Immediately following the SAT pulse, a dephasing gradient is applied to dephase the spins in the region of the SAT pulse. A combination of RF and gradient pulses decrease SNR in the locations spatial SAT has been applied.

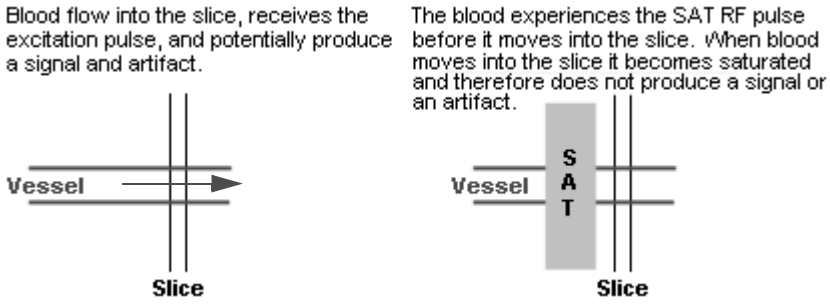
There are three types of Spatial SAT:

- Conventional SAT (SAT outside of the FOV)
- Concatenated SAT
- SAT in the FOV

### Conventional SAT (SAT outside the FOV)

A conventional SAT pulse applies extra RF pulses outside the FOV to minimize the signal from protons flowing into the FOV. If

blood is flowing along the slice-select axis, blood from outside the imaging volume flows into the entry and exit slices. This blood has not experienced RF excitation.




Spatial presaturation can reduce the signal from moving spins by saturating them before the spins move into the area being imaged. SAT pulses are generally applied in the slice-select direction to saturate blood that may flow into the slice and cause either flow-related enhancement (bright blood) or phase-blurred artifact.

Conventional Spatial SATs outside the FOV are useful to suppress the signal from protons that move within the imaging FOV, such as:

- Cardiac imaging
- Cervical, thoracic, and lumbar spines
- Body
- Joints
- Axial heads

Something to Think About...

- Without conventional SATs:
  - Bright signals can mask certain pathological states such as thrombus.
  - If the blood signal is bright, phase artifacts may appear bright across the image in the phase direction.
- SAT increases RF exposure to the patient and increases the SAR, especially for SAT pulses in more than one plane. This reduces the number of slices permitted.
- In general, if TR divided by the number of slices is greater than 150 ms, SAT may not be effective.

**Concatenated SAT**

Concatenated SAT makes spatial SAT “move along” with slice-select acquisitions for even more effective suppression of motion in the slice-select direction of concatenated acquisitions.

If the prescription is compatible with concatenated SAT, the **[Concat SAT]** button can be selected and the SAT pulses are automatically concatenated if:

- A SAT band is prescribed in the slice-select direction, without explicit instructions.
- More slices than a single TR can accommodate are prescribed resulting in a concatenated scan.
- The thicknesses of each slice of a pair, in the slice-select direction, are equal.

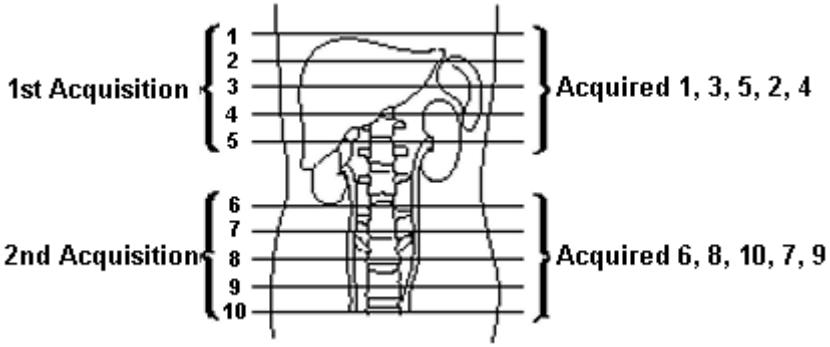
With a concatenated SAT activated, SAT overall performance is improved, especially when the scanning range is large enough to give presaturated protons time to recover before they reach the middle slices, when there is blood flow in the slice-select directions, and when the SAT pulses are outside the scanning range.

- When a Concatenated SAT is selected, the scanning range is divided into groups composed of contiguously ordered slices. For each acquisition, it moves the slice-select SAT pulses to presaturate regions outside of the acquisition range.

  For example, in a ten-slice, two-acquisition prescription, the SAT pulses would be applied first around slices 1 to 5, and then around slices 6 to 10. Slice spacing plays an important role with this subgrouping, since the acquisitions are grouped in contiguous order.
- After the system breaks the scanning range down into as many acquisitions as necessary, slices are distributed within each acquisition.

  For instance, in the ten-slice example, first-acquisition 1 to 5 would be acquired in this order: 1, 3, 5, 2, 4. Then, after a

three-second delay, slices 6 to 10 would be acquired in this order: 6, 8, 10, 7, 9.




For 2D Gradient Echo-Sequential and 2D SPGR studies, the system "walks" the slice-select SAT pulses along with each slice as they are imaged, applying a SAT pulse superior to the first slice and inferior to the second slice.

- Spatial Concatenated SATs improve SAT performance during scans, by:
  - ° Maintaining the effectiveness of slice-select SAT pulses over large scanning ranges.
  - ° Minimizing flow related artifacts, which can mimic pathology.
  - ° Moving SAT pulses in the slice-select direction along with the acquisitions, saturating tissue before acquiring each slice.

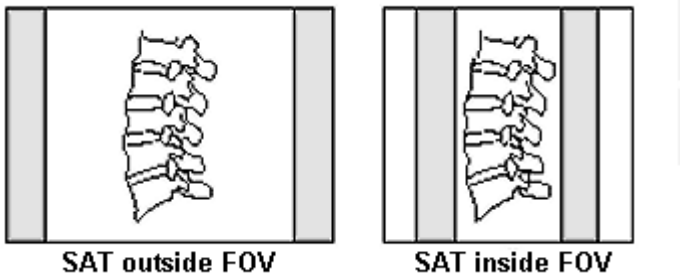
Something to Think About...

- The possibility of getting fewer slices per TR exists because of the time required to apply SAT pulses, increased SAR, and increased application of gradients.
- For a concatenated SAT pulse, at least one default band in the slice select direction must exist.
- A concatenated acquisition does not concatenate the SAT pulses unless the **[Concat SAT]** button is selected and there are SAT pulses selected in the slice direction. Concatenated acquisition and concatenated SAT are entirely independent functions.

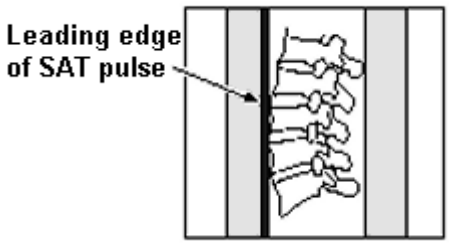
### SAT in the FOV

SAT pulses are applied in the FOV to effectively saturate specific tissues, which may otherwise give rise to flow or motion artifacts.

The inside edge of each SAT pulse is placed explicitly or graphically. The following figure shows the locations of spacial SATs in reference to a sagittal spine image.




You can select the thickness of the slice, so that only the appropriate amount of tissue is saturated. Note the leading edge of the SAT pulse is moved close to the anatomy imaged.




The thickness of the pulse may greatly affect the effectiveness of the saturation. Generally, the thinner the pulse, the better the saturation, because the RF power is focused over a small area. If there is only 40 mm of tissue to saturate, make the SAT pulse 40 mm wide. However, if the tissue area is larger, the area of suppression is smaller and all unwanted tissue may not be suppressed.

Spatial SATs moved inside the FOV are useful to suppress tissue motion that moves within the imaging FOV, such as:

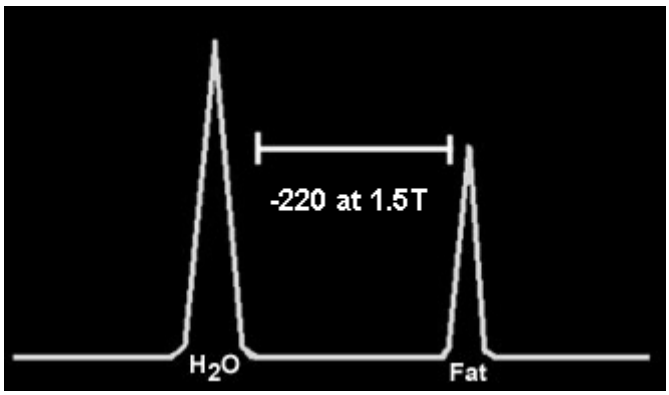
- Anterior abdominal wall
- Descending aorta when imaging the lumbar and thoracic spine
- Swallowing motion for the cervical spine
- Signal from tissue at the edge of the FOV, reducing wraparound

Something to Think About...

- When using SAT in the FOV over or near air-tissue interface, a loss of saturation due to susceptibility may be noticed.
- When using these SAT pulses in very large FOV (48 cm) scans, the SAT bands may appear to bend outward at the bottom and the top of the image. This is due to the magnetic field remapping process (GradWARP – Conformal Remapping) that occurs. This technique is used to correct for non-linearity inherent in any gradient magnetic field. This bend of the SAT pulse can be used as an advantage by moving the pulse closer to the anatomy in the middle.
- Directional pairs of SAT pulses (S, I or R, L or A, P) with the same thickness and tilt (Hadamard pairs) can be applied in 8 ms. If the pair have different thicknesses or tilts, they are applied individually causing a further reduction in the number of slices which can be acquired per TR.

## Chemical Saturation

Chemical saturation suppresses the signal from either fat or water. Chemical saturation delivers RF pulses within the FOV at a specific frequency to saturate and eliminate unwanted signal from selected nuclei. Chemical saturation takes advantage of the fact that fat and water precess at different frequencies.




Chemical saturation affects only the nuclei precessing at the same frequency as the RF pulse. During auto prescan, the system selects the appropriate center frequency based on your choice. If Fat SAT is chosen, for example, water is the required center frequency for auto prescan. The system then determines two peaks, fat and water, and centers on water. It then centers

the narrow SAT pulse at the appropriate frequency on the spectrum.

The success of these spectral saturation techniques depend on the uniformity of the anatomical area being imaged, in addition to the pulse sequence and coil being used. While the system is shimmed to a system specification to provide you with optimal homogeneity, once a patient is placed in the magnet bore, the homogeneity can be affected. For example, an abdomen may be more uniform than a shoulder.

Fat or water suppression reduces chemical shift artifacts because these artifacts are caused by relative shifts of fat from water. When one component is suppressed, there is nothing for the other component to shift away from.

Chemical Saturation techniques are useful to suppress fat or water in your images, such as:

- Suppressing fat in abdominal studies to reduce anterior abdominal wall breathing artifacts.
- Identifying fatty infiltrate in the liver.
- Demonstrating musculoskeletal or optic nerve tumors when used with contrast agents.
- Dramatically reducing chemical shift artifacts.
- Identifying fat by its dark appearance in fat-suppressed images.

Something to Think About...

- Chemical Suppression:
  - Decreases slice locations per TR because of extra time required to apply the pulse.
  - Contributes to SAR.
- Effectiveness of chemical suppression is reduced if the anatomy of interest is more than 20 cm from isocenter.
- Site or patient specific inhomogeneities may be unavoidable even at isocenter. The result can be uneven suppression.
- Fat and water cannot be selected at the same time.
- Fat/Water Suppression selections turn off when the pulse sequence (PSD) is changed.

### Classic and Improved Fat Saturation

In the classic version of Fat SAT, the saturation flip angle is set at a fixed value. This fixed flip angle is not always optimal when considering multiple fat components, number of slices acquired, and other parameters such as the pulse sequence, TE, and TR.

Improved Fat SAT is the default for Spin Echo and Fast Spin Echo pulse sequences. This includes the following selections as they are made from the Pulse Sequence: Spin Echo, FSE, FSE-XL, and SSFSE.

The multiple component nature of fat tissue and the use of multiple slice acquisition techniques have been determined to have a major impact on the effectiveness of Fat SAT. The Improved Fat SAT alters the flip angle based on all of the prescription parameters to improve and give a more uniform tissue saturation.

Overall uniformity of the fat suppression may or may not improve with the Improved Fat SAT algorithm. However, non-uniformity may appear greater on Improved Fat SAT images. This is because there is better fat suppression with this technique. The improved suppression contrasts greatly with areas of uneven suppression, giving the appearance that there is a problem with the Fat SAT itself. Factors affecting overall Fat SAT effectiveness remain the same:

- Anatomy offset from isocenter is likely to experience more non-uniformity than anatomy at isocenter.
- The shape and composition of the anatomy affects Fat SAT uniformity.
- Overall magnet homogeneity affects Fat SAT uniformity.

There are no changes to the user interface with the Improved Fat SAT for SE and FSE sequences. However, it may not be necessary to use Manual Prescan to adjust the CSA and CSF, although this procedure can be used if desired.

NOTE: Refer to Volume 1, Chapter 8, For information on chemical saturation prescan techniques, refer to the chapter Optimizing Image Quality with Prescanning.

NOTE: Fat suppression for SE and FSE sequences can also be obtained with the classic version of Fat SAT. The table below gives the type-in PSDs for accessing the classic method of Fat SAT.

| ***Sequence Desired*** | ***Selection at the Pulse Sequence*** | ***Type-in Required for the Classic Fat SAT*** |
|---|---|---|
| **Spin Echo** | SE | mempc |
| **Spin Echo with Flow Comp** | SE, Flow Comp is selected at Imaging Options. | fcmempc |
| **Fast Spin Echo** | FSE | fsec |
| **FSE-XL** | FSE-XL | fse-xlc |
| **3D FSE** | FSE, 3D is selected for Image Mode. | 3dfsec |
| **Single Shot Fast Spin Echo** | SSFSE | ssfsec |

Something to Think About...

- For FSE T2 fat suppressed accusations with Improved Fat SAT, non-fatty tissue (muscle in particular) may appear darker than desired.
  - ° Use FSE-XL whenever possible to take advantage of the shorter echo spaces. The variation of echoes used to create images is less than a standard FSE sequence.
  - ° Use the TE values of 70 to 80 ms to obtain better tissue contrast. The T2 of muscle is such that it loses signal at longer TEs.
  - ° Use ETLs of 8 to 12. Long ETLs average in signal from very late echoes, resulting in decreased signal from non-fatty tissue.
- The overall SNR of improved Fat SAT images may slightly decrease. Consider adjusting parameters which affect SNR, e.g., increase NEX, increase the FOV, decrease matrix size, decrease the RBw.
- The Fat SAT improvements decrease the possibility of poor or uneven saturation, however, tissue saturation may be reduced when the FOV is greater than 20 cm.
- Uneven saturation can still occur as a result of local inhomogeneities, e.g., at air/tissue interfaces or when the anatomy of interest is non-uniform.

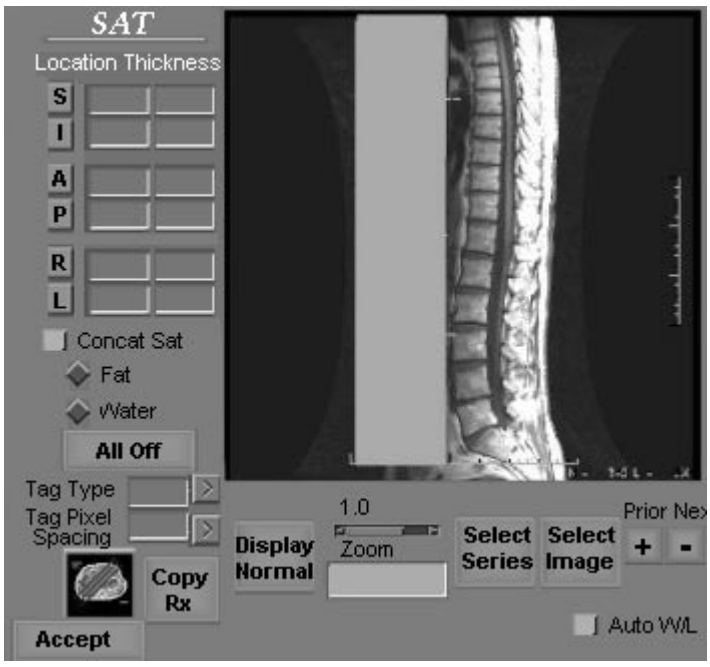
## Graphic SAT Prescription

You can graphically prescribe SAT pulses on a localizer image from a valid series within the current exam. A valid series is any prospective orthogonal series with the same landmark. Oblique images and collapsed vascular images cannot be used.

The SAT pulses are displayed as rectangular dotted areas representing thickness and location. The SAT localizer image can be changed to allow prescription of SAT pulses on various planes. Define, adjust, and erase graphic actions are supported as well as the placement and thickness explicit definition for the SAT slab.

The **SAT** icon is located in the Additional Parameters area.


The SAT screen appears when the icon is selected.



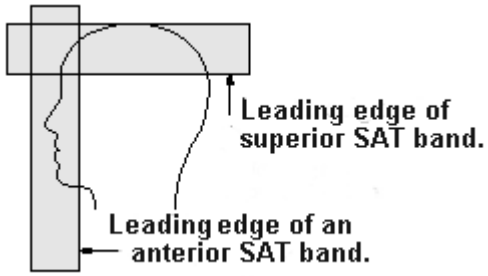

*SAT Additional Parameter Screen*

The following table gives a description for each selection on the SAT screen.

| ***Selection*** | ***Description*** |
|---|---|
| **S, I, A, P, L, R** | Defines a SAT pulse in the selected plane. |
| **Location** | Defines the location of the leading edge of the SAT pulse. Leave this text box blank for default positioning of SAT outside FOV. A positive or negative numerical value is entered here to explicitly prescribe the SAT location. |
| **Thickness** | Defines the thickness/width of the SAT band. The default thickness is defined by the PSD and in most cases is 80 mm. Enter a value from 10 to 200 in steps of 1. |
| **Concat SAT** | Enables "walking SAT" for slice-select direction SAT pulses in concatenated acquisitions. |
| **Fat/Water** | To suppress either FAT or Water using spectral or chemical saturation pulses. Center Frequency must be set to FAT when Water is selected and vice-versa. |
| **[ALL OFF]** | Turns all selected SAT directions OFF. |
| **Graphic Rx icon** | Toggles to Graphic Rx screen and accepts current SAT entries. |
| **[Copy Rx]** | Copies SAT prescriptions for a previously prescribed series to current series. All SAT selections must be deselected to use copy Rx. Click on the desired series followed by **[Accept]**. The SAT bands appear on the currently displayed image. A double click on a series from the series list displays the image on which SAT bands were prescribed in the copied series, and the SAT bands for that series are posted. |
| **[Accept]** | Enters the prescribed values for the series and exits SAT. |
| **[Display Normal]** | Returns the localizer image to the original state. |
| **Zoom** | Adjusts magnification factor for displayed images using the slider bar. |
| **Text Box** | Enters series and image number for the image displayed in the SAT viewport. |
| **[Select Series]** | Lists all valid series from which a localizer image can be selected. |
| **[Select Image]** | Lists the images for the selected series. |
| **[-] [+] (prior/next)** | Displays the previous or next image in the series of the currently displayed image. |
| **Image View Port** | Displays the middle slice of the most recent series which could be used as a localizer for Graphic SAT prescription. |
| **Auto W/L** | Selects the Auto W/L option. |

The SAT pulse default location and thickness change based on the PSD selected. Generally, the thickness for Spatial SAT pulses defaults to 80 mm in all directions. Default location for Spatial SAT pulses are 30 mm away from the FOV in slice direction, abutting the FOV in phase and frequency directions.

- Available SAT band thickness values are 10 mm to 200 mm in 1 mm increments.
- SAT bands may be prescribed inside or outside the scanning volume.
- SAT locations entered state the leading edge of the SAT pulse.




The **SAT** icon, located in the Additional Parameters area, indicates the SAT pulses applied within the current prescription.


- Spatial SAT pulses applied at the default location and thickness are shown in upper case letters beneath the **SAT** icon, e.g., S, I.
- Spatial SAT pulses applied with a change to their thickness or location are shown in lower case letters, e.g., a. i.
- If Fat or Water suppression has been selected, the selection is indicated as FAT or WATER.
- If no SAT selections are made, the icon label reads, "SAT".
- The icon only indicates if SAT has been turned on at its default value or if the SAT pulse location/thickness has been altered. It does not indicate the actual thickness or location. To view the thickness and location of SAT pulses, enter the SAT screen.

Something to Think About...

- SAT increases RF exposure to the patient and increases the SAR, especially for SAT pulses in more than one plane or if SAT pulses are obliqued. This reduces the total number of slices permitted per TR.
- In general, if TR divided by the number of slices is greater than 150 ms, SAT may not be effective.
- If you change the coil or image plane in the protocol, previously selected SAT directions are turned off.
- All SAT selections, including Fat and Water Suppression, are deleted if you change the Pulse Sequence.

NOTE: For additional information on the SAT Additional Parameter, refer to the chapter Scan Rx Desktop.

NOTE: For additional information on Spatial or Chemical Saturation, refer to the chapter Optimizing Images with Imaging Options, Volume 3.

# How to Scan with a Protocol

This section provides the step-by-step instructions for scanning with a protocol. Specifically, it describes how to:

- Prepare the Patient
- Start a Scan Prescription
- Transfer the Patient to the System Table
- Align and Landmark
- Select a Protocol
- Review the Protocol Parameters
- Define a Scanning Range
  - Explicitly
  - Graphically
  - Radial Graphically
- Define Saturation Bands
- Scan

# Prepare the Patient for the Exam

## In Brief: Prepare the Patient for the Exam

1. Thoroughly screen the patient to make sure they are MR safe.
2. Give the patient the information booklet to read.
3. Discuss the procedure with patient.
4. Explain the features of the bore.
5. Determine scan protocol.
6. Explain the exam/acquisition time length.
7. Enter the patient information at the console before positioning the patient.
8. Have patient use restroom prior to exam.
9. Describe the Patient Alert System.
10. Provide the patient with hearing protection.
11. Explain use of straps.
12. Ensure the patient comfortable.
13. Stay in constant oral and visual communication with patient.
14. Stress the need for the patient's cooperation.

Use this procedure to prepare your patient for an MRI exam. Some patients may experience feelings of fear and claustrophobia. The following techniques may help reduce or eliminate these feelings. Even if your patient does not exhibit signs of fear or claustrophobia, use these techniques for all patients.

Larger patients can feel anxious due to a confined feeling in the magnet. Degradation of image quality can also occur. Verify that the patient's weight does not exceed 350 pounds, which is the weight limit of the patient table.

1. Thoroughly screen the patient to make sure they are MR safe.
   - Screen for pertinent medical history and conditions that contraindicate scanning.
   - If proper screening cannot be performed, postpone MRI exams until screening can be done.

NOTE: Thoroughly read the Patient Screening section in Volume 1, Chapter 1.

2. Give the patient the information booklet to read.
3. Discuss the procedure with the patient:
   - The length of the exam.
   - What the patient sees.
   - What the patient hears.
   - What the patient feels during the exam.
4. Explain the features of the bore:
   - Soft lighting.
   - Good ventilation.
   - A microphone and speaker to enable the patient to hear and be heard at all times.
5. Determine scan protocol in advance.
6. Explain the exam/acquisition time length.
7. Enter the patient information at the console before positioning the patient.
   - Refer to steps on Start a Scan Prescription for detailed information.

8. Have the patient use the restroom prior to the exam.
9. Describe the use and function of the Patient Alert System.
    - A patient activated system that allows the patient to signal for assistance during a scan.
10. Provide the patient with hearing protection.
    - Use earplugs or music through an MRI-compatible stereo system.
11. Explain the use of straps.
    - Straps are to stabilize, not restrain the patient.
12. Ensure the patient is comfortable.
    - Use sponges and wedges to relieve pressure points and support the body in the correct position.
    - Ask if a blanket is needed.
13. Stay in constant oral and visual communication with the patient throughout the exam.
    - Some patients may require the physical presence of an operator or nurse in the scan room.
14. Stress the need for the patient's cooperation to attain a diagnostic study.

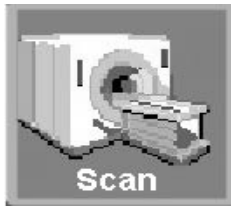
# Start a Scan Prescription

## In Brief: Start a Scan Prescription

1. Click **Scan Rx Desktop**.
2. Click **[New Pt]**.
3. Complete the patient information text boxes.
4. Confirm that all information is correct before proceeding.

Use this procedure to start a scan prescription. Scanning is the act of collecting data from a subject to produce MRI images. This procedure guides you through beginning a scan with a predefined protocol.

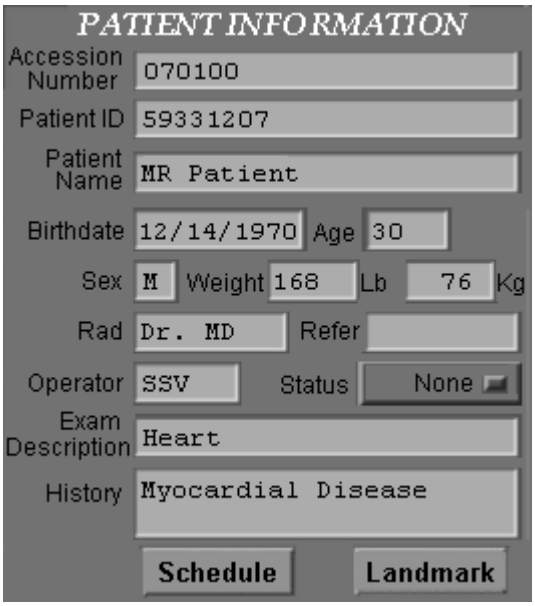
1. Click **Scan Rx Desktop**.




- Located in the desktop control panel.
- Allows you to start a new patient prescription.
- Once the system is ready, the Patient Register, Rx Manager, and AutoView areas appear on the desktop.

2. Click **[New Pt]**.
   - Located in the Patient Register area.

- The Patient Information area appears.




3. Complete the Patient Information text boxes.
   - Position the cursor in the text box, type the appropriate information in to the text box and press **Enter**.
   - At a minimum, you must enter the patient's identification number and correct weight.
4. Confirm that all information is correct before proceeding.

# Transfer the Patient to the System Table

## In Brief: Transfer the Patient to the System Table

1. Ensure that the patient is "magnet ready."
2. Bring the patient to the table.
3. If using a coil, place it on the table.
4. Adjust the table height.
5. Transfer the patient onto the table.
6. Help the patient with any medical accessories they may have.
7. Secure the patient with padding and straps.
8. Raise the table to scanning height.
9. Remove any wheelchairs or gurneys from the scan room.

The table itself is detachable and can support up to 350 pounds. The patient table is designed to accommodate the transfer of ambulatory, wheelchair and gurney patients. It is also very important to remember that conventional life-support equipment cannot be brought into the magnet room because it might contain metal parts and may malfunction. Although each procedure requires a few deviations, the general procedure is very similar. Follow these steps when transferring a patient and refer to the specific steps for each patient type (ambulatory, wheelchair, or gurney).

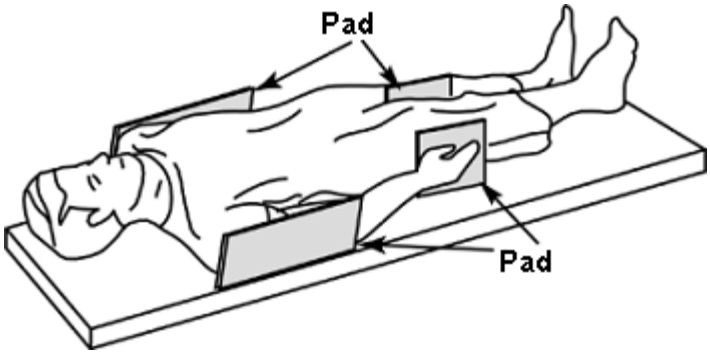
1. Ensure that the patient is "magnet ready."
   - The patient has completed the screening sheet and has removed all metal items.
2. Bring the patient to the table.
   - If using a wheelchair or a gurney, be sure it is non-ferrous.
3. If using a coil, place it on the table.
4. Adjust the table height.
   - Use the up and down foot pedals at the side or the magnet end of the table.
   - If the patient is in a wheelchair, lock the wheels.
   - If the patient is on a gurney, place it next to the table and lock the wheels. The table and gurney height should be the same.
5. Transfer the patient onto the table.
6. Help the patient with any medical accessories they may have.
7. Secure the patient with padding and straps.
8. Raise the table to scanning height.
9. Remove any wheelchairs or gurneys from the scan room.

# Position the Patient

Use this procedure as a guide to position the patient for an exam. Patient positioning depends on a range of factors including the type of study, the RF coil being used, and the patient's condition.

Regardless of patient position and orientation, patient comfort and safety are of primary importance.

- Whatever the study, two decisions must be made up front in terms of the patient's orientation within the magnet:
  - Patient entry
  - Patient position
- Localized heating may increase significantly near contact points where patients complete closed loops with their bodies (see figure below). A closed loop occurs when the patient's hands touch other parts of the body.
  - Radio frequency current flows through such loops through the cross sectional contact area. The heating mechanism depends on loop formation and depends inversely on contact area, i.e., the smaller the contact area, the greater the chance of heating.
  - To eliminate a closed loop, place a pad between contact points. Local heating decreases with the thickness of the pad used to break the loop. It is best to use 0.25 inch, nonconductive pads to minimize any contact heating.

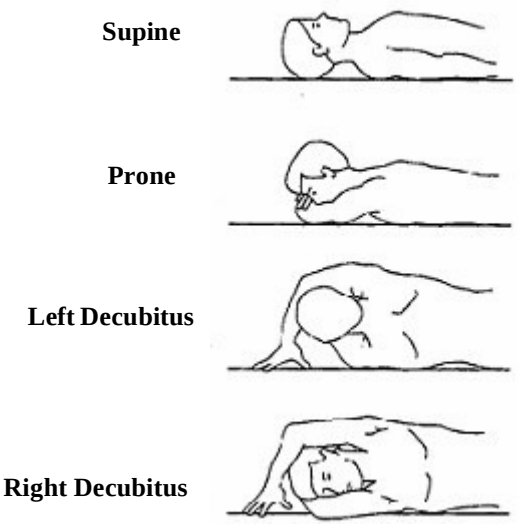



WARNING: To help prevent a patient burn from closed loops formed by clasped hands, by hands touching the body, or from thighs or knees contacting over a small area, insert non-conducting pads at least 0.25 inches thick between the touching parts.

## In Brief: Position the Patient

1. Position the patient in the coil.
2. Provide the patient with earplugs or music.
3. Provide the patient with comfort cushions.
4. Ensure the patient is comfortable and ready to begin the exam.

1. Position the patient in the coil.
   a) Decide whether to have the patient lie head-first or feet-first.
      - For head and neck exams, generally use the head-first position.
      - For body exams, the decision might be made to position the patient feet-first, although head-first remains more common.
      - When using the coils or prescribing a gated study, position the patient to minimize the distance that the cables extend into the aperture of the magnet.
   b) Decide whether to have the patient lie supine, prone, left decubitus, or right decubitus.
      - Coil requirements and patient comfort considerations can affect these choices.




NOTE: Always compare the patient entry and patient position with the information entered at the operator's console. Incorrect entries can result in incorrect left/right, anterior posterior, or inferior/superior image annotation.

2. Provide the patient earplugs or headphones for music.
3. Provide the patient cushions for comfort and to minimize any contact heating.
   - Use sponges and wedges to relieve pressure points and support the body in the correct position.
   - Use accessories, such as knee bolster.

- Insert non-conducting pads at least 0.25 inches thick between touching parts.

4. Ensure that the patient is comfortable and ready to begin the exam.
   - Ask if a blanket is needed.

# Align and Landmark

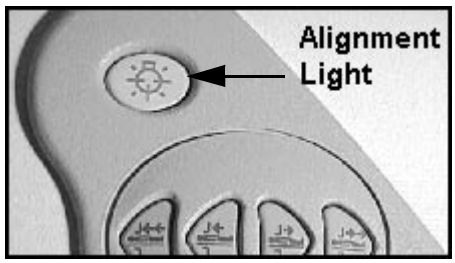
## In Brief: Align and Landmark

1. Position the patient at the magnet enclosure.
2. Press **[Alignment Light]**.
3. Press **[In Slow]** or **[In Fast]** to advance cradle to landmark position.
4. Press **[Landmark]**.
5. Press **[Move to Scan]**.
6. If cradle position display fails to count down to "0", press **[Move to Scan]** a second time.
7. Stay in the scan room until the cradle stops and check to make sure that the patient is comfortable.
8. Return to scan console.
9. Click **[Landmark]** on the Patient Information window.
10. Select an appropriate landmark or type in the desired landmark.

Use this procedure to align and landmark a patient during the scanning procedure. Alignment and landmarking are steps taken to ensure the Region of Interest (ROI) center is as close as possible to isocenter. That is, the location in the bore where the magnetic field is most homogenous. The purpose of selecting a landmark is to establish an anatomical point from which all images in a series are referenced. This procedure guides you through the alignment and landmarking processes.

- Alignment means properly centering the patient from the sagittal standpoint; that is, so the patient is not leaning from the right or left.
- Landmarking helps bring the region of interest to isocenter from the second perspective, longitudinally. For this step, the axial alignment light is used.

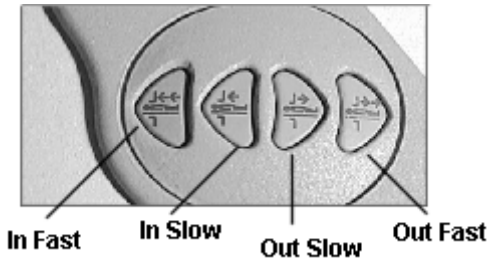
1. Position the patient at the magnet enclosure inside the scan room.
   - Refer to steps on Positioning the Patient for detailed information.
2. Press **[Alignment Light]**.
   - Located on the button control panel.




CAUTION: Exposing eyes to the laser alignment lights may result in eye injury.

- ° Do not stare directly into the laser beam.
- ° Instruct patients to close their eyes during landmarking to avoid eye exposure to the alignment light while the laser light is "on."
- ° Closely monitor all patients and prevent them from accidently staring into the beam.
- ° Do not leave the laser beam on after you position the patient.

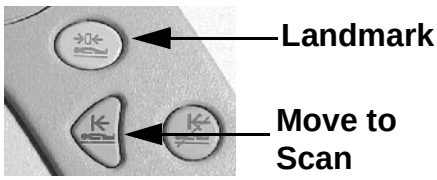
3. Press **[In Slow]** or **[In Fast]** to advance the cradle until the axial alignment light rests at the desired landmark.




   - Confirm centering with the sagittal and axial alignment lights.

NOTE: Homogeneity decreases as distance from isocenter increases. Although it is not always possible to place the anatomy being scanned at isocenter, bring the anatomy as close to isocenter as possible, keeping the patient as comfortable as possible.

4. Press **[Landmark]**.
   - Informs the system the position of the landmark.
   - The cradle location display reads "0" when the landmark has been established.




NOTE: A scan cannot be started until a landmark is defined in the magnet room.

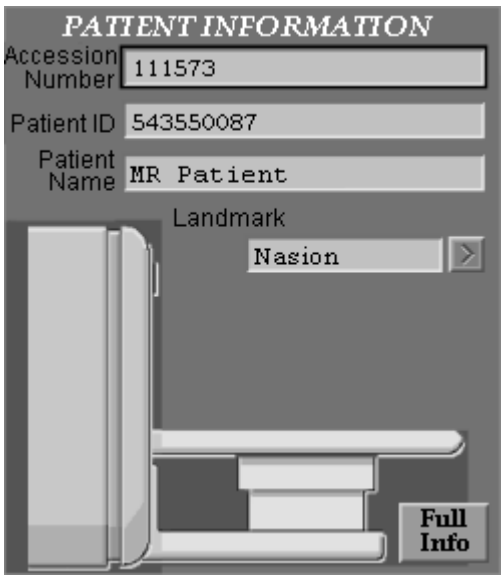
5. Press **[Move to Scan].**
   - The table moves the patient to isocenter.
   - The laser alignment lights turn off automatically.
   - Make sure all health lines are long enough to accommodate cradle travel.

- The cradle location display now counts down to "0" again as the cradle moves the landmark into isocenter.

- You can confirm the patient landmark by viewing a red dot when the alignment light is active. The red dot represents landmark.

6. If the cradle location display fails to count down to "0," press **[Move to Scan]** a second time.
   - If that does not work, move the table in or out with the in/out buttons and press **[Move to Scan]** one more time.
7. Stay in the scan room until the cradle stops and check to make sure that the patient is comfortable.
8. Return to the scan console.
9. Click **[Landmark]** on the Patient Information area.
   - An abbreviated Patient Information area appears.

The Landmark chosen should describe the alignment light position on the patient.



10. Select an appropriate landmark or type in the desired landmark.
    - Select from the predefined selections, or


    by positioning the cursor in the **Landmark** text box and typing in the appropriate landmark.


NOTE: Selecting a landmark is not required but if a landmark is not entered, the images have no anatomical reference annotation.

NOTE: Landmark annotation can be found on the exam text page.

# Select a Protocol

## In Brief: Select a Protocol

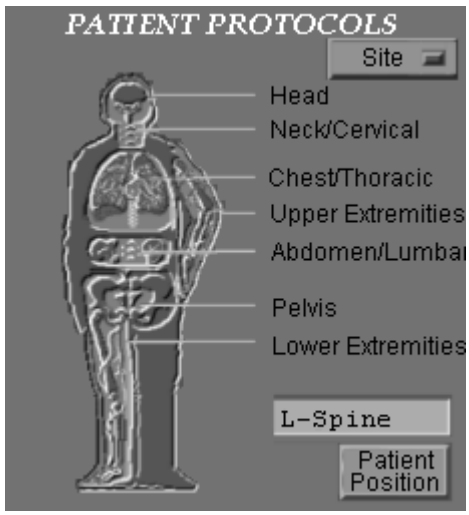
1. Click the Patient Protocol button and select **[Site]**, **[GE]**, or **[Picture This]**.
2. Select the desired protocol category.
3. Click desired protocol.
4. Select the desired series on the right window.
5. Click **[Accept]**.

Use this procedure to select a predefined protocol from the protocol library. This procedure guides you through beginning a scan with a protocol.

1. To select the protocol library, click the Patient Protocol button and select **[Site]**, **[GE]**, or **[Picture This]**.

2. Select the desired protocol category.

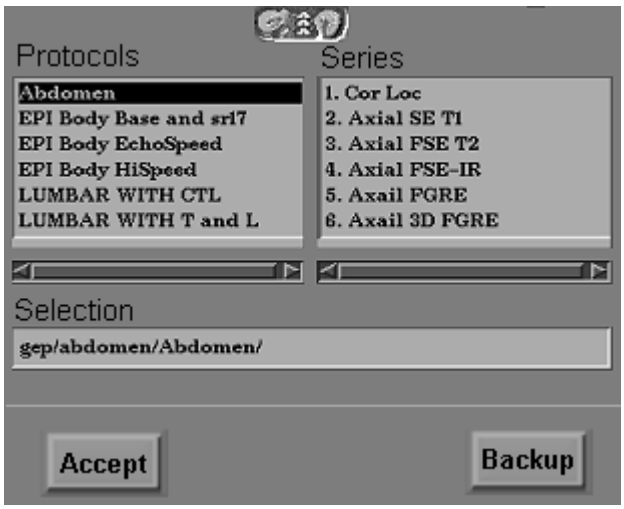
   - Select Head, Neck/Cervical, Chest/Thoracic, Upper Extremities, Abdomen/Lumbar, Pelvis, Lower Extremities, or Other.




When using the protocol option, select the category by clicking on the desired body part of the humanoid.

Also, you may enter the protocol name in the text box.

   - A Protocol and Series Description window appear.



3. Select the desired protocol category.
   - The protocol category is on the left side of the window; the associated series is listed on the right side.
4. Select the desired series on the right window.
5. Click **[Accept]**.
   - The selected series loads into the Rx Manager.
6. If using the Picture This library, click **[Accept]** to access the image gallery:
   - Select the weighting and plane, then the pulse sequence.
   - Highlight the series and click **Standard**, **Faster**, or **Higher Resolution** to view the associated image, scan times and number of available slices.
   - Click **[View Selection]** to list all of the series.
   - Select the desired series and click **[OK]**.

# Review the Protocol Parameters

## In Brief: Review the Protocol Parameters

1. Select the desired series in the **Rx Manager**.
2. Click **[View Edit]**.
3. Review the pre-defined scan parameters.
4. Check the Relative SNR meter.

Use this procedure to review the selected protocol parameters prior to beginning your scan. It is important re-examine the protocol parameters to ensure your desired choices are selected. This procedure guides you through the reviewing process.

1. Select the desired series in the **Rx Manager**.
2. Click **[View Edit]**.


   - The series opens on the Scan Rx Desktop and displays the pre-defined parameters.
   - Allows the revision or editing of a series in the Rx Manager. The series can then be modified and saved again.
   - A new series changes to INRX in the Rx Manager if a View Edit is performed.
   - Use View Edit to adjust the scan range after viewing the most recent acquisition.

3. Review the pre-defined scan parameters and confirm that:
   - Patient Position and Patient Entry parameters are correct for the current patient's orientation in the magnet.
     - ° Incorrect patient entry parameters result in incorrect image annotation.
   - Coil Selection is correct.
     - ° The coil selected in the protocol must match the coil connected to the system.
     - ° Incorrect coil selection can result in prescan failure, coil damage, or degraded image quality.

NOTE: If the coil connected does not match the coil selected in the current protocol, the system posts a message warning of the mismatch.

   - Scan Plane is correct.
   - Scan Mode is appropriate for the pulse sequence.

- Pulse Sequence is appropriate for the clinical circumstances.
- Imaging Options are appropriate for the clinical circumstances.
- Scan Timing parameters produce the desired contrast.
- Scanning Range parameters allow proper coverage of anatomy being imaged.
- Acquisition Timing parameters produce the desired spatial resolution, scan time, and signal-to-noise ratio.

4. If you make any parameter changes consult the Relative SNR meter as well as the scan time.


- Located in the Scan Operations area.

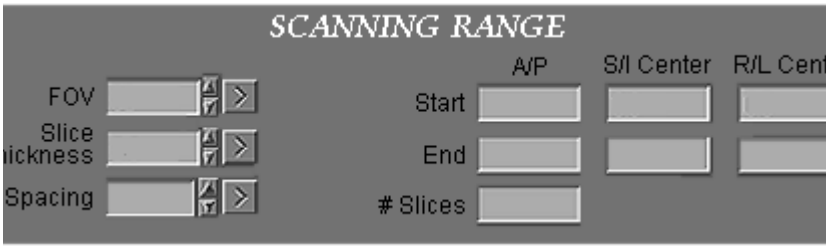
## Define a Scanning Range

# Explicitly

### In Brief: Explicit Rx

1. Enter the FOV in centimeters.
2. Enter the slice thickness in millimeters.
3. Enter the slice spacing or number of scan locations in millimeters.
4. Enter the start and end locations.
5. Enter the FOV center.

Use this procedure when prescribing a series of scan locations by typing in the coordinates representing the anatomical locations. Explicit prescription allows single groups of slices or volumes to be prescribed. This procedure guides you through the process of explicitly defining the scanning range.




1. Enter the FOV in centimeters to cover the area of anatomy selected for imaging.


   - Choose one of the system pre-defined values or enter your own value in the text box. Use the scroll arrows to increase or decrease the selected value in steps of 2 cms.
   - Anatomy outside the FOV in the phase direction results in aliasing.
   - Small FOVs produce:
     - increased resolution
     - decreased SNR
     - increased minimum TE value.

2. Enter the slice thickness in millimeters.


   - Choose one of the system pre-defined values or enter your own value in the text box. Use the scroll arrows to increase or decrease the selected value in steps of 1 mm.
   - Thin slices produce:

- increased resolution
- decreased SNR

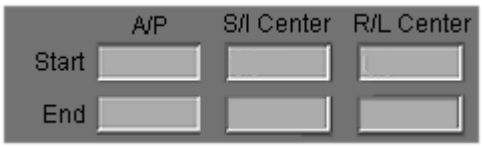
3. Enter the slice spacing or number of scan locations in millimeters.

   - Assigns a space between the prescribed slices.
   - Select a spacing that reduces cross-talk. This spacing is typically 20% of the slice thickness.
     - Cross-talk or overlap is caused by partial excitation of adjacent slices during RF excitation and refocusing by a 180-degree pulse. This causes a reduction in image contrast and SNR.
   - To reduce the effects of cross-talk, use one of the following:
     - Interleave (doubles scan time)
     - Use sequential imaging option
     - Larger interscan spacing
     - 3D technique
   - Choose one of the system pre-defined values or enter your own value in the text box. Use the scroll arrows to increase or decrease the selected value in steps of 1 mm.
   - Define the slice spacing for 2D acquisitions.


   - Define the overlap locations and number of scan locations per slab for 3D aquisitions.


     - Each 3D group is able to overlap on another group for a multi group prescription. Enter the number of slices that you want to overlap between slabs within the same group.

4. Enter the start and end locations.




- Start and End determine the area covered in the scan.

a) Axial Scan Plane-enter the S/I value for the most inferior location and the S/I value for the most superior location.

b) Coronal Scan Plane- enter the A/P value for the most posterior location and the A/P value for the most anterior location.

c) Sagittal Scan Plane- enter the R/L value for the most left location and the R/L value for the most right location.

d) Oblique Scan Plane- place the crosshair at the desired start location and enter its coordinates displayed on the image. Place the crosshair at the end location and enter its coordinates.

NOTE: The system automatically calculates the end location and the number of locations for 2D or the number of slabs for 3D based on scan thickness and the interscan spacing selected. The Actual End location is shown in brackets to the right of the End location explicitly entered.

5. Enter the FOV Center to define the center of the image.

a) Axial Scan Plane-enter the appropriate values for A/P and R/L Center. Enter 0 for no offset.

b) Coronal Scan Plane- enter appropriate values for S/I and R/L Center. Enter 0 for no offset.

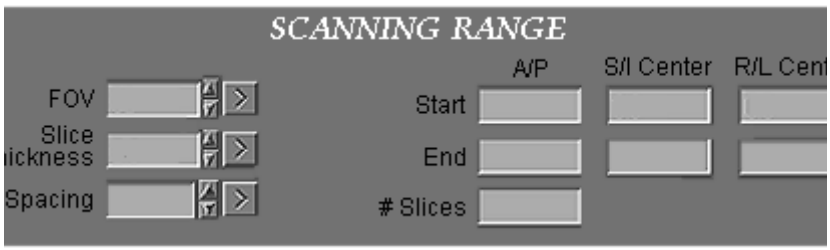
c) Sagittal Scan Plane- enter appropriate values for S/I and A/P Center. Enter 0 for no offset.

d) Oblique Scan Plane- place crosshair at desired FOV center on the image and enter the coordinates.

## Define the Scanning Range

# Graphically

Use Graphic Rx to graphically define the scan locations on a localizer image using the same landmark and coil. Either orthogonal or oblique imaging can be used. This procedure guides you through the process of graphically defining the scanning range.




1. Enter the FOV in centimeters to cover the area of anatomy selected for imaging.


   - Choose one of the system pre-defined values or enter your own value in the text box. Use the scroll arrows to increase or decrease the selected value in steps of 2 cms.
   - Anatomy outside the FOV in the phase direction results in aliasing.
   - Small FOVs produce:
     - increased resolution
     - decreased SNR
     - increased the minimum TE value
2. Enter the slice thickness in millimeters.
   - Choose one of the system pre-defined values or enter your own value in the text box. Use the scroll arrows to increase or decrease the selected value in steps of 1 mm.


   - Thin slices produce:
     - increased resolution

## In Brief: Graphic Rx

1. Enter the FOV in centimeters.
2. Enter the slice thickness in millimeters.
3. Enter the slice spacing or number of scan locations in millimeters.
4. Click **[Graphic Rx]**.
5. If necessary, click **[Select Series]** to choose a different series.
6. Use **[-][+]** to review the images and select the desired image.
7. Magnify the image if necessary.
8. Position the cursor on the image at the desired start location and click and hold left.
9. Drag the pointer to the desired end location and release.
10. Adjust the start and end locations, number of slices or slabs, and FOV center.
11. Note the start and end locations, number of slices or slabs, and FOV center.
12. Click **[Accept]**.

- ° decreased SNR

3. Enter the slice spacing or number of scan locations in millimeters.

   - Assigns the space between the prescribed slices.
   - Select a spacing that reduces cross-talk. This is typically 20% of the slice thickness.
     - ° Cross-talk or overlap is caused by partial excitation of adjacent slices during RF excitation and refocusing by a 180° pulse. This causes a reduction in image contrast and SNR.
   - To reduce the effects of cross-talk use one of the following:
     - ° Interleave (doubles scan time)
     - ° Sequential Imaging Option
     - ° Larger interscan spacing
     - ° 3D technique
   - Choose one of the system pre-defined values or enter your own value in the text box. Use the scroll arrows to increase or decrease the selected value in steps of 1 mm.
   - Define the slice spacing for 2D acquisitions.


   - Define the overlap locations and number of scan locations per slab for 3D aquisitions.


     - ° Each 3D group is able to overlap on another group for a multi group prescription. Enter the number of slices that you want to overlap between slabs within the same group.

4. Select **[Graphic Rx]**.


   - The Graphic Rx screen opens in the upper right corner.
   - The system automatically displays the center image of the most recent valid series that can be used to select a localizer image.

5. If necessary, click **[Select Series]** to choose a different series to be used as a localizer.


6. Use **[-][+]** to review the previous or next image in the series and select the desired image.


   - The series and/or image can also be selected by typing the desired series and/or image number in the text box. Example: series **2**, image **5**.


7. Magnify the image using the slider, if necessary.


8. Define the start location by positioning the cursor on the desired start location and click and hold left mouse button.

9. Drag the cursor to the desired end location and release.

10. Adjust the start and end locations, number of slices or slabs, and FOV.

    - To adjust the number of slices or locations, click the appropriate slice prescription handle and adjust the end location to add or remove slices.

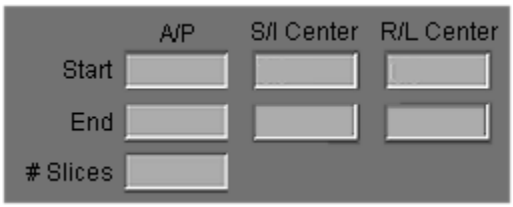

    - To adjust the angle for an oblique series, click the tilt handles and adjust the tilt angle. Oblique must be selected for the scan plane.
    - To prescribe a second group of slices, move the cursor to a new location, press **Shift** on the keyboard. Click and drag the left mouse button to deposit a new set of slices.
    - To copy a prescription from a previous series that was scanned in the same plane, same FOV, and with the same slice thickness:
        - Click **[Copy Series]** and select the series from the list.


        - Click **[Accept]** in the copy window.
    - To graphically prescribe your locations on one slice location and redefine a new center image at another slice location:
        - Select an image where you want to prescribe the slice locations, then move to the center of the image and click **[Reset Center]**.

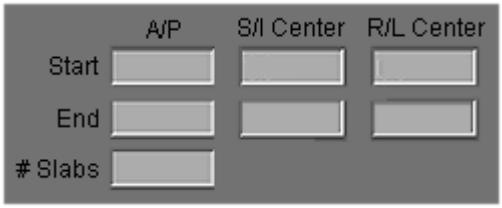
- To eliminate an undesired offset FOV (when using a non-zero localizer), click **[Fallback]**.


  - The fall back is in the slice direction.
  - The fallback button does not appear if prescribing an oblique prescription off of an oblique localizer.

11. Note the start and end locations, number of slices or slabs, and FOV.
    - Once slices have been plotted and accepted, numeric values for the start/end locations, FOV center, and the number of slices or slabs prescribed, appear in the Scan Location text boxes in the Scanning Range area.
    - For 2D techniques, the locations appear as follows.




    - For 3D techniques, the locations appear as follows.




12. Click **[Accept]**.

## Define the Scanning Range

# Radial Graphically

### In Brief: Radial Graphic Rx

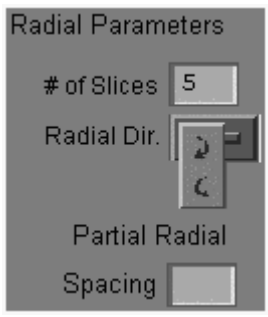
1. Follow steps 1-7 on how to defining the scanning range graphically.
2. Select the radial direction.
3. Enter the number of slices and degree of spacing desired in the text boxes.
4. Click on the image in the Graphic Rx.
5. Place the cursor in the center of the graphic prescription and move the entire prescription to desired location on image.
6. Click the rotating handle and rotate prescription the the desired starting slice number.
7. Hold the **Shift** key and click image to add another group to the prescription. Repeat as necessary.
8. Click **[Accept]**.

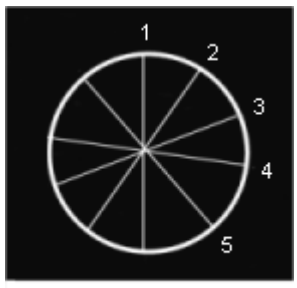
Use radial graphic prescription to acquire multiple slices around a central axis in the same series. A radial or partial radial prescription can be useful for imaging, but not limited to, knees, MRCPs, myelograms, and hearts. This procedure guides you through the process of graphically prescribing a radial sequence.

NOTE: The prescription must be an oblique 2D FSE-XL, FastCard, or SSFSE pulse sequence.

1. Follow steps 1-7 on how to define the scanning range graphically.
   - The Graphic Rx screen should be open.
2. Select the radial direction.


   - The radial direction can be clockwise or counterclockwise.
   - The system defaults to clockwise rotation.
3. Enter the number of slices and degree of spacing desired in the text boxes.
   - The **# of Slices** and **Spacing** text boxes control the angle between the slices of the radial prescription.
     - For a radial graphic prescription that looks like a wagon wheel, enter the number of slices and leave the spacing text box empty.

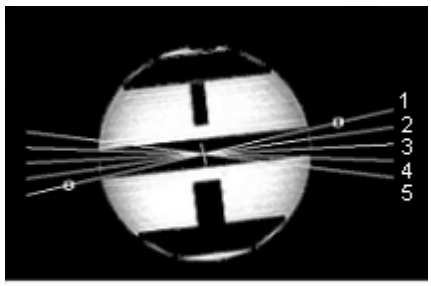



Wagon Wheel

     - For a partial radial prescription that looks like cat whiskers, enter the number of slices in the radial

parameters and a value for the degree of the angle between the slices in the partial radial spacing parameter.


**Cat Whiskers**

- The maximum number of slices in one prescription is 16. If this limit is exceeded, an error message appears and you are not able to accept the prescription.

4. Click on the image in the Graphic Rx.
   - Radial graphics appear on the image.
   - If you "draw" the slices using the cursor, you are not able to get the angles.
5. Place the cursor in the center of the graphic prescription and move entire prescription to the desired location on image.
6. Click the rotating handle and rotate prescription the desired starting slice number.
7. Hold the **Shift** key and click image to add another group to the prescription. Repeat as necessary.
   - If another group is desired with a different number of slices than the prior prescription, first change the number of slices to the desired amount, then hold the **Shift** key and click image.
   - Once the Rx is prescribed on the image, you cannot change it. You must select **[Erase Group]** or **[Erase All]**, enter in the new values, and click the image to view the new prescription.
8. Click **[Accept]**.
   - Saves the prescribed prescription.

NOTE: Refer to Radial Graphic Rx in the **About...** section of this guide for detailed information on setting the number of locations before pause during scanning.

# Define Saturation Bands

## In Brief: Define Saturation Bands

1. Click **SAT**.
2. Click **[Select Series]** and choose desired series.
3. Use **[-][+]** to review the images and select the desired image.
4. Magnify the image if necessary.
5. Prescribe the desired spatial, concatenated, or chemical saturation pulses.
6. Click **[Accept]**.

Use the following procedure to define saturation bands on your images. Use the SAT option to explicitly or graphically prescribe SAT pulses on an image from a series within the current exam. This option is also used for prescribing a concatenated SAT or prescribing a chemical saturation technique. This procedure guides you through the process of defining saturation bands during scanning.

1. Click **SAT**.


   - Located in the Additional Parameters area.
   - The SAT screen opens in the upper right corner.

2. Click **[Select Series]** and choose the desired series to prescribe the saturation pulses.


3. Use **[-][+]** to review the previous or next image in the series and select the desired image.


4. Magnify the image if necessary.


5. Prescribe the desired spatial, concatenated, or chemical saturation pulses.

   a) To explicitly prescribe spatial saturation:

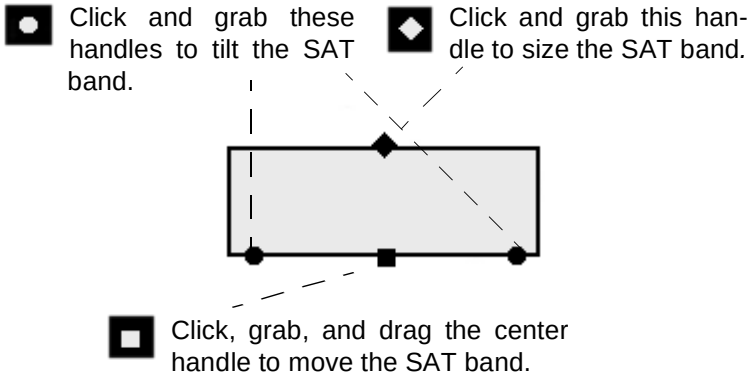
   - Click the desired spatial saturation band: **S**, **I**, **A**, **P**, **R**, and/or **L**.

- Accept the default thickness and location or enter a value for thickness and location.


If you do not enter any value in the location text box, the SAT band is placed outside the FOV.
To set a SAT band inside the FOV, enter the location corresponding to the leading edge.
The default SAT thickness is 80 mm for most sequences.

b) To graphically prescribe spatial saturation:

- Click the desired spatial saturation band: **S**, **I**, **A**, **P**, **R**, and/or **L**.
- Accept the default thickness and location or enter a value for thickness and location.
- Position the cursor on the image at the desired location for the inside edge of the saturation band and click left.
- Use the handles on the SAT band to change the size and location of the SAT band.




c) To prescribe concatenated spatial saturation:

- Click saturation bands in the slice direction.
- Select **Concat SAT**.


  - Two concatenated saturation pulses can be placed parallel to the acquisition slice when used with a

sequential series, or with an orthogonal series with two acquisitions.

° Concat SAT makes SAT pulses in the slice-select direction more effective in concatenated acquisitions and "moves along" with the slice-select acquisition for more effective suppression of motion in the slice-select direction.

d) To prescribe chemical saturation:

- Select **Fat** or **Water**.


- Click **[Accept]**.

e) To copy a saturation prescription from a previous series:

- Turn off all saturation bands.
- Click **[Copy Rx]** and select the series from the list.
- Click **[Accept]** on copy window.

NOTE: For information on optimizing chemical saturation with manual prescan, refer to the chapter Optimizing Image Quality with Prescanning.

# Scan

Use the scanning procedure to follow through with the scan after all scan prescription is complete. This procedure guides you through the scanning process.

1. When a series prescription is complete, click **[Save Series]**.


   - The series state changes from INRX to RXD.
   - The completed series is saved in the **Rx Manager**.

NOTE: The system automatically downloads the first series and, therefore, selecting **[Prepare to Scan]** is not required.

2. Select the desired saved (RXD) series in the **Rx Manager**.
3. Click **[Prepare to Scan]**.


   - The parameters are automatically downloaded for scanning.

4. Click **[Scan]**.


   - The system prescans and immediately proceeds to scan.
   - Or, click **[Auto Prescan]**, allow it to complete, then click **[Manual Prescan]** to manually prescan. When manual prescan adjustments are complete, click **[Scan]**.


NOTE: For additional information on Manual Prescan, refer to the chapter Optimizing Image Quality with Prescanning.

## In Brief: Scan

1. Click **[Save Series]**.
2. Select the desired series in the **Rx Manager**.
3. Click **[Prepare to Scan]**.
4. Click **[Scan]**.
5. Click **[New Series]** to add additional scans.
6. Click **[End Exam]**.

- To automatically prescan and scan all saved series, click **[Autoscan]** in the Rx Manager.

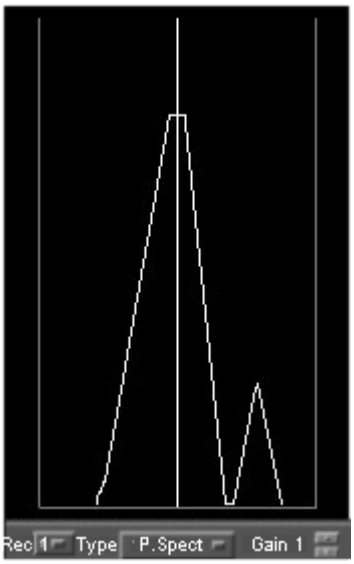

5. Click **[New Series]** to prescribe or add a new series to the Rx Manager.


6. Click **[End Exam]** when finished.

# Chapter 8

# Optimizing Image Quality with Prescanning

## Where Am I?




## Introduction

This chapter focuses on manual prescan and chemical saturation tuning. These are important tools to help you improve your image quality. The chapter highlights key concepts and provides guidelines for manual prescan and chemical saturation tuning. It also contains the step-by-step instructions to help you learn how to:

- Auto Prescan
- Match the Coarse Center Frequency to the Patient
- Adjust the Transmit Gain to Achieve Optimum Flip Angle
- Match Fine Center Frequency to the Patient
- Adjust the Receiver Gain
- Optimize Chemical Saturation

In addition, this chapter answers the following questions:

1. What are the purposes and benefits of MPS and CSTUN?
2. What are reasons for APS failures?
3. What values are set?
4. Why does transmit frequency need to match precessional frequency?
5. How does transmit gain affect the flip angle?
6. Why does the receiver need to be adjusted?

# About...Prescanning

This section presents the concepts necessary to successfully complete the prescanning process. Specifically, you need to understand:

- Purpose and Benefits
- The Two Prescan Programs
  - Auto Prescan
  - Manual Prescan
- Reasons for Auto Prescan Failures
- Precessional and Transmit Frequency
- Transmit Power and Flip Angle
- Receiver Sensitivity
- Prescan for Chemical Saturation

## Purpose and Benefits

Prescan optimizes the system transmit and receive values for each patient and area of interest. Every patient is a unique collection of protons that requires a unique combination of RF frequency and power to image. There are many reasons to prescan. The primary reasons are as follows:

- Prescan optimizes auto-shim values (when selected) to improve the homogeneity of the magnetic field with the patient in the bore.
- Prescan allows the manual optimization of chemical saturation.
- Prescan sets:
  - Center Frequency Coarse
  - Transmit Gain
  - Center Frequency Fine
  - Receive Gain

## The Two Prescan Programs

- Auto Prescan
- Manual Prescan


### Auto Prescan

Auto Prescan (APS) automatically adjusts the center frequency and the transmit and receive gains. These values appear in the message area upon completion of a successful APS.

Use APS for the most efficient, accurate, and consistent prescan.

### Manual Prescan

Manual Prescan (MPS) requires you to set center frequency, transmit gain, and scan TR.

Use MPS:

- If APS fails.

- When a particularly strong or weak signal exceeds the system's ability to self-adjust.
- When values have been manually set for chemical saturation techniques.

Four transceiver hardware settings are used in MPS.

- Center Frequency Coarse (CFL)
- Transmit Gain (TG)
- Center Frequency Fine (CFH)
- Scan TR (R1/R2)

NOTE: Remember that you are delivering RF to the patient during prescan.

Something to Think About...

- MPS takes longer than APS.
- MPS relies on your accuracy.

## Reasons for Auto Prescan Failures

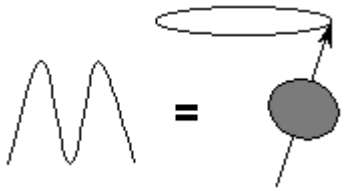
During an APS, the system may fail to automatically calibrate the RF power transmitted and received in a slice. The message *"Prescan Failed"* appears in the scan operations area, followed by a reason, if an error is detected.

- If APS fails and the system can determine the cause, the *"Prescan Failed"* message contains additional information. Two common messages and problems are:
  - *"Auto Prescan Failed. Table not at scan plane."* In this case, press the **[Move to Scan]** button to move the table to scan plane. Then click the **[Auto Prescan]** button.
  - *"Auto Prescan Failed. RF amplifier not ready."* To correct this problem, wait for the *"RF amplifier ready"* message to appear in the message area.
- In certain Center Frequency prescriptions, fat and water peaks may not be readily discernible. In such cases, the systems displays *"Auto Prescan Incomplete"* and "*Set AX manually."* At this point, the MRI system requires a MPS to find the desired peak.
- An improperly connected coil may result in a failed prescan with a message, "*TR Driver Fault.*" Check coil connections before proceeding with prescan.

## Precessional and Transmit Frequency

The center frequency matches the transmitting frequency of the system to the precessional frequency of the nuclei in the patient and region of interest. The closer these frequencies match, the more efficient the transfer of energy and the shift to resonance.

Each patient magnetizes differently and this results in a unique precessional frequency. The Larmor Equation calculates this frequency as shown in the graphic below.



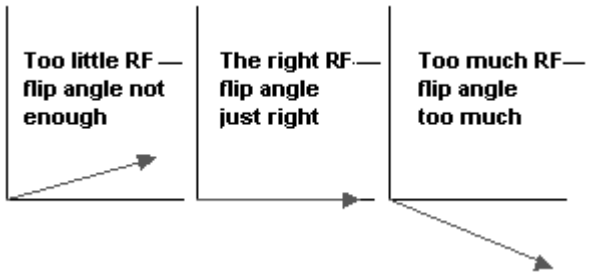

Various adjustments are made in order to move the location of the bandwidth and center frequency.

- Center Frequency Coarse adjustments are made on a scale of ±2000 Hz. The coarse adjustment allows you to view the spectrum (regardless of its location) compared to the current bandwidth location. Fat and water may appear as one peak.
- Center Frequency Fine adjustments use a scale of ±500 Hz. At this point the spectrum often has a fat and a water peak. You can center the spectrum's midpoint on the desired location.

## Transmit Power and Flip Angle

Transmit gain adjusts the transmitting power (amount of RF) the system uses in order to obtain the correct flip angles.

A correct transmit gain means that a 90° RF pulse flips the net magnetization vector exactly 90°.



## Receiver Sensitivity

Receive gain adjusts the analog and digital receivers for the level of signal returning from the patient. The receiver must be able to convert or translate the MR signal coming from the patient into a useful electronic signal. Signal exceeding the translation range of the receiver cannot be converted and becomes noise; like a radio playing too loudly.

To access receive gain, the scan TR (R1 and R2) are used.

- R1- Analog Gain
- R2- Digital Gain

NOTE: Improper adjustment to R1 and R2 settings results in distortion and can result in image quality degradation. If R1 and R2 are set too high, contrast reversal effects can occur. If R1 and R2 are set too low, a low SNR can occur.

## Prescan for Chemical Saturation

ChemSAT Tune (CSTUN) is a prescan function for the chemical saturation pulse. You must match the transmit frequency with the precessional frequency, and adjust the amplitude of the imaging pulse for the suppression pulse.

CSTUN:

- Allows the optimization of fat or water peak suppression.
- Adjusts the frequency of the SAT pulse using CSF.
- Adjusts the amplitude of the SAT pulse using CSA.

# How to Prescan

This section provides the step-by-step instructions for performing an APS or MPS. Specifically, it describes how to:

- Automatically Prescan
- Manually Prescan
  - Match the Coarse Center Frequency to the Patient
  - Adjust the Transmit Gain to Achieve Optimum Flip Angle
  - Match Fine Center Frequency to the Patient
  - Adjust the Receiver Gain
- Optimize Chemical Saturation

# Automatically Prescan

Use this procedure to automatically prescan with routine scan prescriptions. APS automatically adjusts and sets the center frequency, transmit and receive gains. This procedure guides you through the automatic prescan process.


Proceed with routine scanning prescription to begin this procedure.

1. Click **[Auto Prescan]**.


   - Located in the Scan Operation area.

2. Verify the completion of a successful APS.
   - The prescan values display in the Scan Operations area.

3. Click **[Scan]**.


   - Located in the Scan Operation area.
   - The acquisition begins scanning.

## In Brief: APS

1. Click **[Auto Prescan]**.
2. Verify the completion of a successful APS.
3. Click **[Scan]**.

## In Brief: Match Coarse Center Frequency

1. Click **[Manual Prescan]**.
2. Click **[Center Freq Coarse (CFL)]**.
3. Enter or adjust center frequency value then click **[Apply]**.
4. Repeat step 3 until the peak aligns with the center line.
5. Continue to the steps on adjusting the TG.

### Manually Prescan

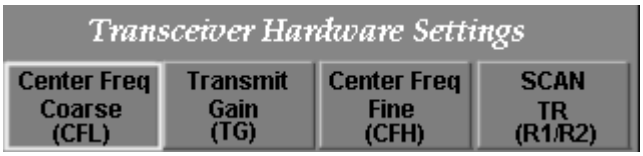
# Match Coarse Center Frequency to the Patient

Use this procedure during MPS to manually adjust and set the coarse center frequency to the patient. This allows you to tune the system for optimal sampling of the individual patient and anatomy. This procedure guides you through the process to match center frequency to your patient.

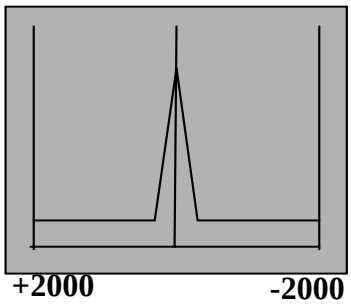
1. Click **[Manual Prescan]**.


- Located in the Scan Operation area.
- Allows you to begin the prescan program.
- The MPS window appears.

2. Click **[Center Freq Coarse (CFL)]**.

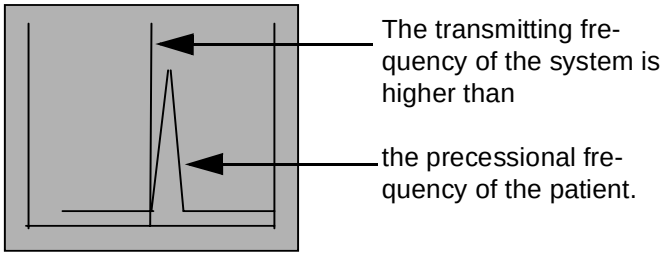



- Located in the Transceiver Hardware Settings area.
- The center frequency course setting displays a window of ±2000 Hz.
- Fat and water usually appear as one peak.

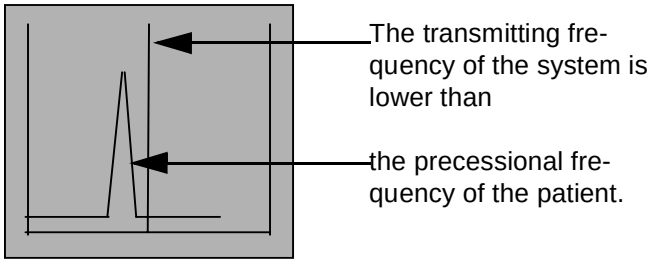


3. Enter the actual frequency value or adjust the midpoint by moving the **Delta Freq** slider and click **[Apply]**.


- Your goal is to get the water peak centered to the frequency line.
- Each time a frequency number is applied, the value is cumulative.
- A negative number moves the peak to the left. If the transmit frequency is too high, subtract frequency.




- A positive number moves the peak to the right. If transmit frequency is too low, add frequency.




NOTE: Make changes in small increments to avoid moving the peak out of the window.

NOTE: If you lose the peak, exit MPS and restart.

4. Repeat step 3 until the peak aligns with the center line.

NOTE: To return the Actual Frequency (Ax) to its original value, click **[Reset]** in the Gradient Shimming area of the window.

5. To continue the MPS process and achieve an optimum flip angle, continue steps on next page, Adjusting the Transmit Gain. Otherwise, click **[Done]** to close the Prescan window.

### Manually Prescan

# Adjust the Transmit Gain to Achieve Optimum Flip Angle

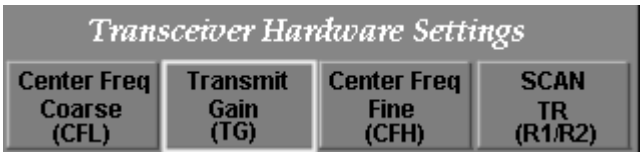
## In Brief: Adjust the Transmit Gain

1. Click **[Transmit Gain]**.
2. Select **Markers > Horizontal hairline**.
3. Click the horizontal marker and position at peak.
4. Adjust **Transmit Gain** slider.
5. Continue to move horizontal marker with profile peak until a optimum setting is reached.
6. Select **Markers > Horizontal Hairline** to turn off.
7. Continue to the steps on Matching the Fine Center Frequency.

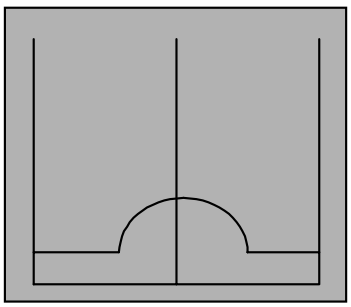
Use this procedure during MPS to manually adjust and set the RF Transmit Gain (TG) to ensure precise flip angles. This allows the appropriate RF energy to achieve maximum signal. This procedure guides you through the process to adjust the TG to achieve optimum flip angles.

Complete the steps on the course CF adjustment prior to setting the TG.

1. Click **[Transmit Gain]**.




- Located in the Transceiver Hardware Settings area.
- The correct TG produces the highest peak.
  - Too much or too little produces a smaller peak.

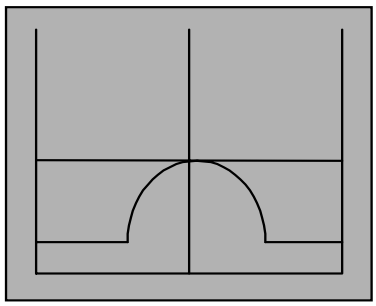


2. Select **Markers > Horizontal Hairline**.

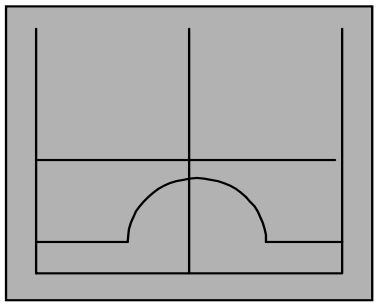

- Located on the MPS menu bar.
- A horizontal white line marker appears on the spectrum.

3. Click the horizontal marker and move marker to the peak of the image profile.
   - The goal of TG is to get the image profile at the highest peak. The highest peak indicates the protons have been flipped 90 degrees or into the transverse plane.
4. Adjust the **Transmit Gain** slider.


   - Increase the TG until the peak no longer increases.
     - Change the gain in increments of 10 to 20 initially and then 5 to 10 as you get closer to the peak value.



5. Continue to move the horizontal marker up as the image profile increases.
   - Increase the TG as long as the peak increases.
     - If the peak increases, the magnetization is moving closer to the transverse plane.
   - If the peak decreases, the magnetization is moving away from the transverse plane.
     - Once the peak of the profile falls below the marker, you have surpassed the optimum TG setting.
     - Decrease the gain until you find a setting that places the profile at the highest peak.



6. Select **Markers > Horizontal Hairline**.
   - The white line horizontal marker turns off.
7. To continue the MPS process, continue steps on next page, Matching the Fine Center Frequency. Otherwise, click **[Done]** to close the Prescan window.

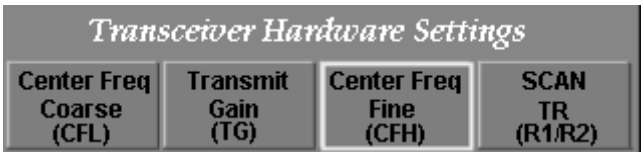
### Manually Prescan

# Match Fine Center Frequency to the Patient

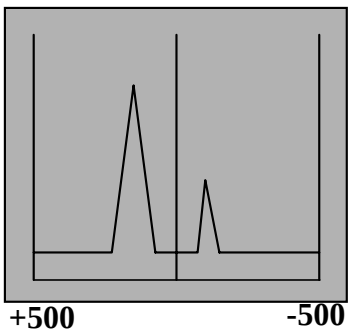
Use this procedure during MPS to manually adjust and set the fine center frequency to the patient. This allows you to fine tune the system for optimal sampling of the individual patient and anatomy. This procedure guides you through the process to match center frequency to your patient.

Complete the steps on the course CF and TG adjustments prior to matching the fine center frequency to your patient.

1. Click **[Center Freq Fine (CFH)]**.




- Located in the Transceiver Hardware Settings area.
- A fat peak is displays along side of the water peak.
- The center frequency fine setting displays a window of ±500 Hz.
- Fat and Water appear as two peaks at mid and high field.
    - The water peak is on the left.
    - The fat peak is on the right.

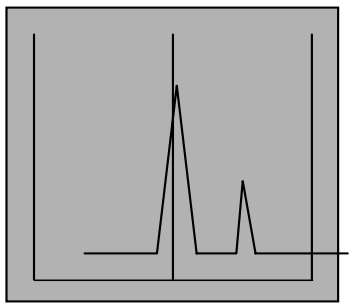



## In Brief: Match Fine Center Frequency

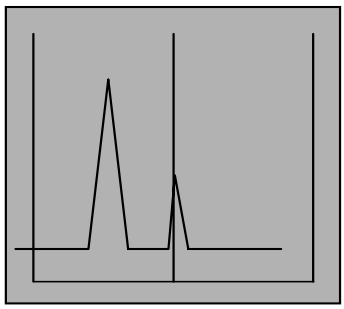
1. Click **[Center Freq Fine (CFH)]**.
2. Enter or adjust center frequency value and select **[Apply]**.
3. Repeat step 2 until the peak aligns with the center line.
4. Continue to the steps on Adjusting the Receiver Gain.

2. Enter the actual frequency value or adjust the midpoint by moving the Delta Frequency slider and click **[Apply]**.


   - The goal is to fine tune the desired peak on the center frequency line.
   - A negative number moves the peak to the left. If the transmit frequency is too high, subtract frequency.
   - A positive number moves the peak to the right. If transmit frequency is too low, add frequency.



Transmit frequency optimized for water.



Transmit frequency optimized for fat.

NOTE: Make changes in small increments to avoid moving the peak out of the window.

3. Repeat step 2 until the peak aligns with the center line.

NOTE: To return the Actual Frequency (AX) to its original value, click **[Reset]**.

4. To continue the MPS process, continue steps on next page, Adjusting the Receiver Gain. Otherwise, click **[Done]** to close the Prescan window.

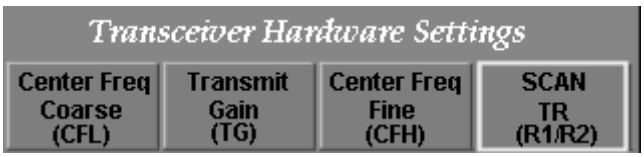
### Manually Prescan

# Adjust the Receiver Gain to Achieve Optimum Signal

Use this procedure during MPS to manually adjust and set the RF receive gain to optimize the use of the receiver's dynamic range. This procedure guides you through the process to adjust the receive gain to achieve the best signal-to-noise ratio (SNR).

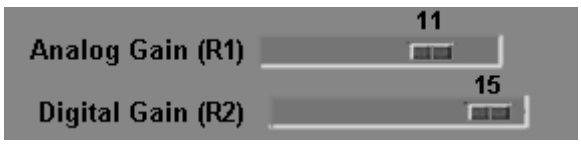
Complete the steps on the course center frequency, TG, and fine center frequency adjustments prior to adjusting the receiver gain.

1. Click **[Scan TR (R1/R2)]**.




   - Located in the Transceiver Hardware Settings area.
   - The goal of Scan TR is to assure both R1 and R2 values fall below 50%.

2. Set the **Analog Gain R1** value.



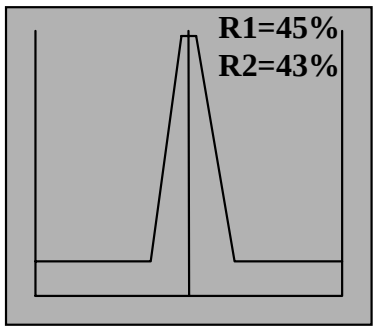

   - Check the analog gain (R1) value in the upper right corner of the spectrum display to verify the signal is less than 50%. If so, no change is necessary.
   - If R1 value exceeds 50%, use the Analog Gain (R1) slider to decrease the gain.
     - Decrease in increments of one, until the R1 value is as high as possible without exceeding 50%.
   - Analog receive gain range is 1 to 15. In most cases, the default setting is 11 and provides the best SNR.

3. Set the **Digital Gain R2** value.
   - Check the digital gain (R2) value in the upper right corner of the spectrum display to verify the signal is less than 50%. If so, no change is necessary.

## In Brief: Adjust the Receive Gain

1. Click **[Scan TR]**.
2. Set the **Analog Gain R1** value.
3. Set the **Digital Gain R2** value.
4. Click **[Done]**.
5. Click **[Scan]**.

- If R2 value exceeds 50%, use the Digital Gain slider to decrease the gain.
  - ° Decrease in increments of one, until the R2 value is less than 50%.
- Digital receive gain range is 1 to 15 (1 to 30 with EDR).




NOTE: R1 and R2 gains should not exceed 50%.

4. Click **[Done]**.
   - Located in the lower left corner of the window.
   - The MPS window closes.
5. Click **[Scan]**.


   - Located in the Scan Operations area.
   - The acquisition begins scanning.

# Optimize Chemical Saturation

Use this procedure for best manual prescanning results when using chemical saturation techniques. The overall success of ChemSAT depends somewhat on the uniformity of the anatomy to be imaged, in addition to the pulse sequence and coil being used. This procedure guides you through the process to optimize the chemical saturation techniques.

NOTE: It may not be necessary to use MPS to adjust the CSA and CSF for SE and FSE sequences using the default improved Fat SAT, however, this procedure can be used if desired.

1. Click **[Auto Prescan]**.


   - Located in the Scan Operation area.
   - At completion, note the results, especially any accompanying messages referring to CF peak selection.
     - When performing FAT SAT, make sure CF is set to water.
     - When performing WATER SAT, make sure CF is set to fat.

2. Click **[Manual Prescan]**.


   - Located in the Scan Operation area.
   - The MPS window appears.

3. Select **[Center Freq Fine (CFH)]**.
   - Located in the Transceiver Hardware Settings area.

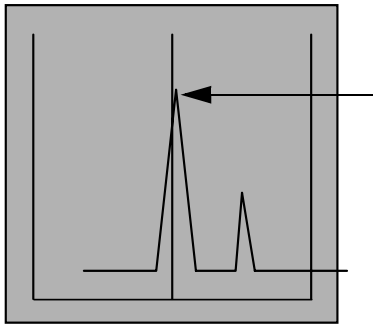
4. Check the offset between fat and water.
   - At 1.0T the shift is about 147 Hz.

## In Brief: Optimize Chemical Saturation

1. Click **[Auto Prescan]**.
2. Click **[Manual Prescan]**.
3. Click **[Center Frequency Fine (CFH)]**.
4. Check the offset between fat and water.
5. Evaluate for correct positioning of CF on the appropriate peak.
6. Select **Options > Modify RSP**.
7. Scroll through the list of names in the RSP Names window and double-click **csf**.
8. Enter the actual offset value for the chemical saturation pulse found in step 5 in the **Current Value** text box.
9. Scroll through the names in the RSP Name window and double-click **cstun**.
10. Enter `1` in the **Current Value** text box.
11. Check peak suppression.
12. Scroll through the list of names in the RSP Names window and double-click **csa**.
13. Enter new value in the **CSA** text box.
14. Recheck the peak suppression.

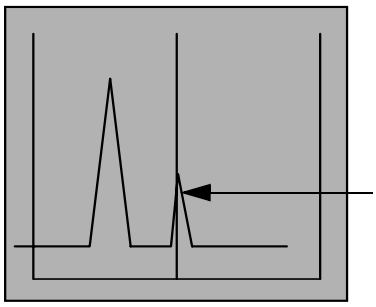
## In Brief: Optimize Chemical Saturation cont.

15. Click **[Accept]**.
16. Click **[Done]**.
17. Click **[Scan]**.




5. Evaluate for correct positioning of CF on the appropriate peak.

   a) Set CF to water when using fat saturation.



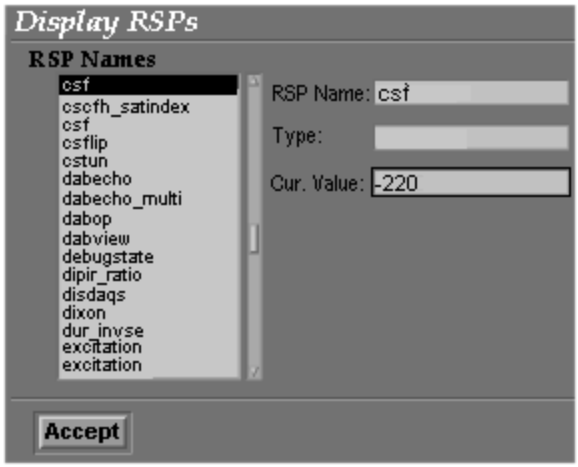

   - At 1.0T, subtract 147 Hertz.
   - At 1.5T, subtract 220 Hertz.
     - The CF shifts to the fat peak.
     - If not, adjust the frequency to determine the actual offset, and return center frequency to water

   b) Set CF to fat when using water saturation.

   - At 1.0T, add 147 Hertz.
   - At 1.5T, add 220 Hertz.
     - The CF shifts to the water peak.
     - If not, adjust the frequency to determine the actual offset and return center frequency to fat.

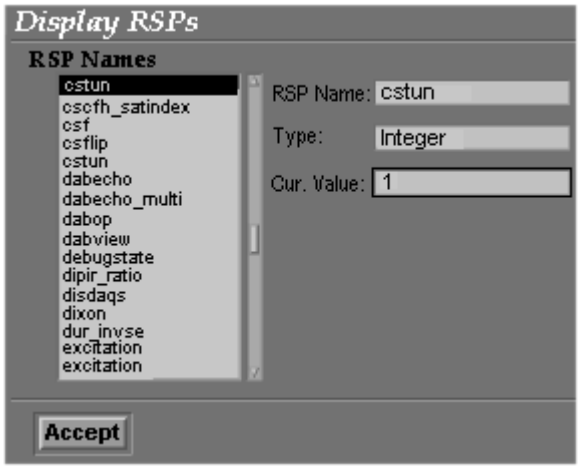
6. Select **Options > Modify RSP**.
   - Located on the MPS menu bar.
   - The Modify RSP (Real-time Sequence Parameters) window appears.

7. Scroll through the list of names in the RSP Names window and double-click csf. Alternatively, you can enter **`csf`** in **RSP Name** text box to adjust the offset value.
   - CSF allows changes in the frequency shift value expected between fat and water peaks.
8. Enter the actual offset value for the chemical saturation pulse found in step 5. This should be a negative number for Fat SAT and a positive number for Water SAT.

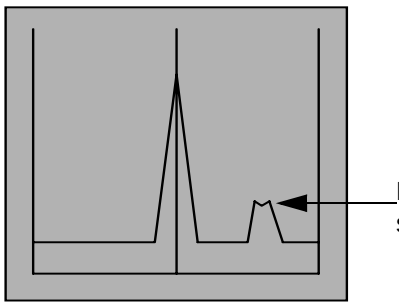



9. Scroll through the names in the RSP Name window and double-click cstun. Alternatively, you can enter **`cstun`** in the **RSP Name** text box to turn on the saturation pulse.
   - CSTUN allows entrance into the program to tune the ChemSAT pulse.
10. Enter **`1`** in the **Current Value** text box.
    - Valid values are 0 and 1.
      - One turns on the presaturation pulse to suppress either fat or water.

° The spectrum changes to show the result of the applied suppression pulse.



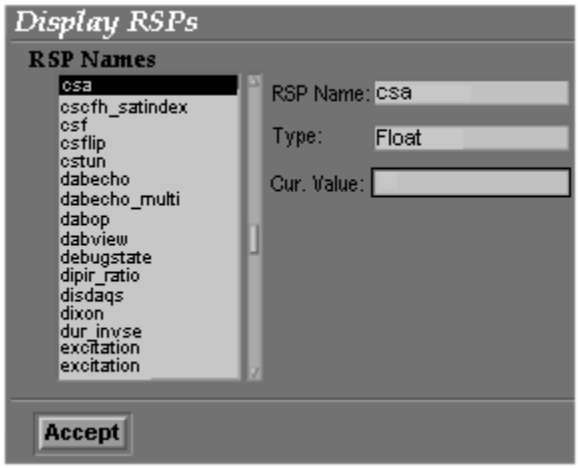

11. Check the peak suppression.



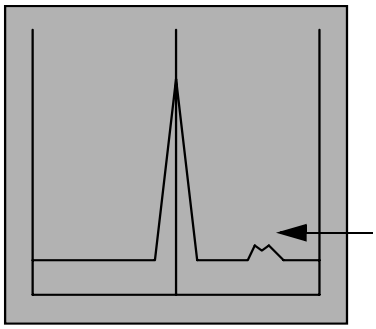

- If the peak is not sufficiently suppressed, continue to Step 12.

12. Scroll through the list of names in the RSP Names window and double-click on csa. Alternatively, you can enter **`csa`** in the **RSP Name** text box.
    - CSA allows changes in the amplitude of the ChemSAT pulse.
    - CSA defaults to a particular value unique to the MRI magnet strength and pulse sequence chosen.
    - Increasing CSA may provide a chemical SAT pulse which produces better saturation.
    - CSA represents a percentage of the original flip angle used to saturate the selected tissue.
13. Enter a new value in the **Current Value** text box.
    - Increase this value until the desired peak is optimally suppressed.

- ° Carefully evaluate both the fat and water peak.
- ° Your goal is to decrease the desired peak without affecting the peak centered over the line.




14. Recheck the peak suppression.




NOTE: You cannot always make the fat/water peak disappear.

15. Click **[Accept]**.
    - Accepts the changes and closes the Modify RSP window.
16. Click **[Done]**.
    - The MPS window closes.
17. Click **[Scan]**.


- Located in the Scan Operations area.
- The acquisition begins scanning.

This page intentionally left blank.

Volume 1

# Chapter 9

# Displaying Images

### Where Am I?

## Introduction

This chapter explains the image display process. It provides highlights of key concepts and brief guidelines for displaying and manipulating images. This chapter also contains the step-by-step instructions to help you learn how to:

- Sort Exams, Series, or Images
- View Patient List
- Refresh List
- Display Images in a Viewer
- Set a Primary Viewport
- Set a Secondary Viewport
- Cine Page
- Compare
- Analyze Images
- Manipulate Images
- Annotate Images
- Remove Annotation

- Apply Mattes to Images
- Measure
- Enhance Images
- Cross-Reference a Series
- Screen Save
- Set Up User Preferences
- Use Accelerator Commands
- Save State
- Reverse the Video (Inverse Video)

In addition, this chapter answers the following questions:

1. What is the Display Browser?
2. How do I display an image?
3. How do I display slice locations?
4. How can I magnify (enlarge) an image?
5. Can I annotate on an image?
6. How can I measure distance on an image?
7. Can I compare images from different series?
8. What are Accelerator Commands and how do I use them?

# About... Displaying Images

This section presents the concepts necessary to successfully complete the image display and manipulation process. Specifically you need to understand:

- Sorting Images
- Viewport Control
- Viewer Organization
- Window/Level Control
- Display Features
  - Cine Paging
  - Reference Image
  - Measuring
- Image Annotation
- User Preferences
- Accelerator Commands

## Sorting Images

Exams and images can be sorted in a variety of ways using the menu bar across the top of the Browser. Sorting allows you to change how exams, series, and images are listed in the Browser and the order in which they are displayed on the Viewer or the Mini Viewer.

## Viewport Control

The viewport is the section of the viewing screen that contains an image. For example, if there are four images on the viewing screen, there are also four viewports. Viewports can either be active or inactive and primary or secondary. The default is for the upper left viewport to be primary and active, while the remaining viewports are secondary and active. Active viewports are affected by display functions, while inactive viewports are not. The primary viewport is the one first affected by the display function. Secondary and active viewports are connected with the primary viewport and can be affected by display functions. For example, if you window and level on the primary viewport, the same window and level appear on the secondary and active viewports.

A single click on a viewport makes that viewport primary and active and the other viewports are now secondary and active. A double-click on the viewport to make that the primary and all others become secondary and inactive. Triple clicking in a viewport makes that the primary viewport and the others become secondary and active viewports.

The border around the image for primary and active viewports turns teal, or bright white if you have a black and white monitor. Secondary and active viewports borders are yellow, or bright if you have a black and white monitor. Inactive viewports have no borders or black borders.

## Viewer Organization

The Viewer is organized such that the Viewer window allows you to do a number of manipulations, such as cross-referencing a series (displaying slice locations on a localizer image), measuring a distance, magnification and multiple ways to view (display) images. The left hand column contains multiple buttons to perform the manipulations. Some of the buttons are simple on/off buttons, and others have menus or windows that allow for choices in the manipulation process. This chapter gives detailed instructions on how to perform these functions.

## Window/Level Control

The window and level values are adjusted to control which pixel values are visible in images, and the degree of contrast. The window level is an image adjustment, which is marginally similar to the brightness adjuster on a television. The window width is defined as twice the number of intensities above and below the currently set level.

Window/Level changes are controlled by the middle mouse button. If all viewports are connected, the W/L change to an image in one viewport is applied to all images within the series. There is one exception to this rule. If the series is a dual echo acquisition, changing the W/L of a first echo image only changes all first echo images and not all images within the series. Changing the W/L of a second echo image only changes the second echo images and not all the images within the series. This W/L method allows for independent image adjustment for first and second echo images when displayed side-by-side.

## Display Features

When you click the **Display Desktop** icon, the (Display) Browser appears. The Browser is the area that allows you to choose the patient, series and images to display. The Browser has the applications buttons located on the right side of the screen. These applications buttons take you to windows that allow you to view or manipulate the images. This chapter concentrates on Viewer or Mini Viewer application buttons. The other application buttons are discussed in other chapters/volumes of this document. After you have selected (highlighted) the patient, series, images you want to display,

clicking Viewer or MiniViewer takes you to the Viewer (display) window.

## Cine Paging

Access the Cine Paging function clicking the **[Paging]** button from either the Viewer or the Mini Viewer. This function allows you to page through images in a manner that gives the appearance of a moving picture. Paging can load up 256 images in the series with a speed up to 60 images (frames) per second. Paging has the control to set up the “movie” and control the speed (frames per second) of the “movie.” The default rate is 10 frames per second for each viewport. Image annotation is available but effects the frame rate’s performance.

The only valid formats for paging are 1-on-1, 2-on-1, and 4-on-1 with the Viewer and 1-on-1 with the Mini Viewer. Each viewport has the control of the frame rate, temporal versus spatial looping, as well as parameters specific to an individual viewport.

Whether the looping mode is temporal or spatial, the same mode is applied to all paging viewports simultaneously.

Temporal mode is the default mode and allows you to see how the images taken at the same location change over time. This gives you the effect of motion. In this mode, the system advances continually from first to last image, without pausing. or an example, an image set consisting of four images appears

in the following order: 1, 2, 3, 4, 1, 2, 3, 4, etc. Suggested application would be to review a cardiac motion study or a bolus contrast injection.

Spatial mode allows you to view images taken at different locations throughout the body. This method enables you to trace through the anatomy of interest. In this mode, the system advances sequentially through the images, then moves backwards through the sequence to the first image. Spatial demonstrates the motion of a joint or structure in two directions. For example, an image set consisting of four images appears in the following order: 1, 2, 3, 4, 3, 2, 1, etc. A suggested application would be kinematic studies of the TMJ or knee.

## Reference Image

The Reference Image function allows you to insert an image into a small viewport on the Viewer or Mini Viewer. This inserted (reference) image identifies the slice location of the main image. The reference image must be in another plane from the main image. The two images (the main image and the reference image) must be from the same exam, have the same horizontal landmark, same patient position, and same patient entry. When using Reference Image in the Viewer, the valid screen formats are 1-on-1, 2-on-1, 4-on-1, 6-on1, and 9-on-1. The Reference Image cannot be used on viewing formats larger than 9-on-1, but can be filmed with any film format. If using Reference Image in the Mini Viewer 1-on-1 is the only valid screen format.

Something to Think About...

- When no series or image is selected for the Reference Image, the system determines the reference image by scan and graphic prescription guidelines: the system uses the series and image used to prescribe the scan of the non-reference image, and starts with the lowest numbered series and image.
- The viewport image and the Reference Image cannot be a Screen Save, a 3D Rendered Image, or Combined Images.
- Inverse Video affects both the main image and the Reference Image.
- Series Binding is not be applied to the Reference Image.

A new series for the Reference Image is selected using the Accelerator Line. The Series **[+/-]** button on the Viewer Window are NOT available for new series selection of the Reference Image.

When filming, the main image and the Reference Image are filmed as displayed. The Reference Image does not appear on images filmed when using the **F4** key (print series). The Reference Image and its cutlines appear only if:

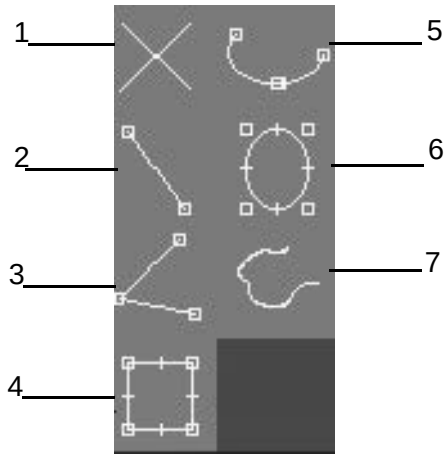
- The series displayed includes images scanned in an intersecting plane.
- The Image Scroll has not scrolled the intersection out of the Reference Image port.
- The Reference Image's cutline is not magged out of the Reference Image port.

## Measuring

You can use the Measure feature a number of ways to obtain information, distances, and areas of anatomy or pathology. The **[Measure]** button is found on either the Viewer or the Mini Viewer windows. The Measure feature:

- Reports the cursor to record a point on the image.
- Calculates the linear distance between two points on an image.
- Measures any anatomy or pathology on an image.
- Measures an angle and lists the angle of a line between two points.
- Measures a rectangular area, a curved area, an elliptical area, a curved area, and a free draw area.

Click the desired method of measuring from the menu.




- **1** - Measure with a cursor. Click and drag the cursor over the area of interest to display the cursor coordinates (A/P, I/S, and L/R locations).
- **2** - Measure with a straight line. Click and drag the endpoint to resize the line. (The opposite endpoint stays fixed). Click anywhere on the line except on the endpoints and drag to the desired area to measure angle and distance.
- **3** - Measure an angle. Click and drag on the endpoints to change the angle or click on the line to reposition. The angle measurement is reported.
- **4** - Measure a rectangle. Click and drag on the small boxes in the corner to change the size and shape of the rectangle, or on the tick marks to rotate the rectangle. Click and drag anywhere on the rectangle, except on the

small (corner) box or the tick marks, to move the rectangle over the area of interest. Standard deviation, m, and mmz measurements are reported.

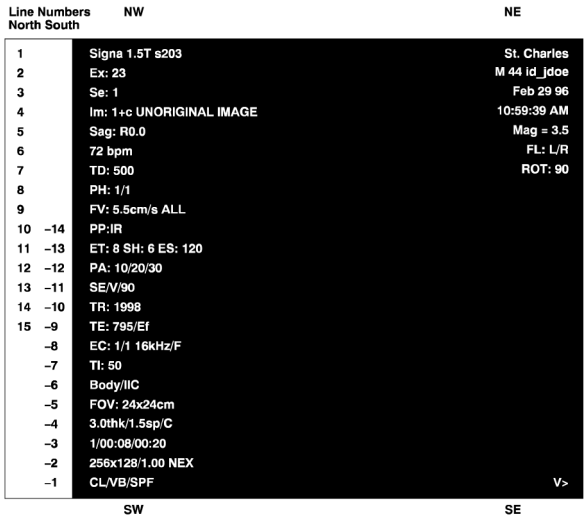
- **5** - Measure with a smooth curve. Click and drag the small box to the start point. To add the next point to the curve, move the cursor pointer to the desired location, hold down the **Shift** key, and click. Continue adding points by holding down the **Shift** key and clicking to outline the area of interest. Click and drag on a point to resize (all other points stay stationary). To close the endpoints of the curve, add the last point near (but not on top of) the first point. Now click the last point and drag it on top of the first point. To move the curve over the area of interest, click and drag anywhere on the curve (except on the points/boxes). To delete a point, while holding down the **Shift** key, click on the point to be deleted. Click anywhere on the image to hide the points. (Click on the curve to show points). Standard deviation, m, and mmz measurements are reported.
- **6** - Measure with ellipse. Click and drag on the small box to change the size and shape of the ellipse. Click and drag on the tick marks to rotate the ellipse. Click and drag anywhere on the ellipse, except on the small boxes or tick marks to move the ellipse over the area of interest. Standard deviation, m, and mmz measurements are reported.
- **7** - Measure with free hand trace. Click and drag on the small box to move it to the desired staring point. To start drawing, hold down **Shift**, and click and drag on the small box. (Or to define a series of segments, hold down **Shift**, and click on each desired endpoint location. To remove the most recently created segment, press **Backspace**.) To move the free drawn area click and drag anywhere on it. This trace cannot be resized. Standard deviation, m, and mmz measurements are reported.

## Image Annotation

Image annotation is the text that appears on the image. Annotation is either system supplied text or text/graphics that have been added by you. System supplied text is the data identifying the patient, hospital, physician, and image parameters. System supplied text is hidden from the screen

only, the film only or both. The next section about User Preferences discusses this in more depth.

This illustrates the location of system supplied annotation and is a composite of all possible parameters. Actual image annotation varies depending on the acquisition parameters and the customized screen annotations that were chosen.



The displayed annotation information uses abbreviations; the following tables list some annotation abbreviations.

## System Supplied

### Image Annotation

| ***Abbreviation*** | ***Description*** |
|---|---|
| Th | Thickness of slice |
| TB | Top/Bottom flip |
| LR | Left/Right Flip |
| RO | Rotated Image |
| W | Window (pixel value range) |
| L | Level (mid gray pixel value) |
| MF | Magnification Factor |
| FI | Flip |
| GSE | Gray scale enhancement |
| SP | Spacing between slices |
| DT | Trigger delay with MultiPhase imaging option (gated scan only) |
| TD | Trigger delay without MultiPhase imaging option (gated scans only) |
| Ph | Number of phases (gated scans only) |
| FV | Flow Velocity (phase contrast only) |
| v^ | Frequency direction |
| CS | Contiguous slice |
| C | A "C" following the slice thickness and spacing indicates contiguous slice (0 mm slice spacing) |
| I | A "I" following the slice thickness and spacing indicates Interleaved slices |

## Imaging Option Annotation

| ***Abbreviation*** | ***Description*** |
|---|---|
| UNORIGINAL IMAGE | Indicates the image is a combination of multiple images |
| 8/04:18/0: 01 | Number of scan/Total Scan Time/Pause Time |
| A–>P | Ramped Pulse Direction (annotation may vary due to direction) |
| /F | Fast Receiver was used for this scan |
| AS | Autoshim (series text page only) |
| CL | Classic |
| ED | Extended Dynamic Range |
| EG | ECG Gated |
| ES | Echo Spacing (EPI only) (Text page only) |
| ET | Echo Train |
| FC | Flow Compensation |
| FCf | Flow Compensation in the frequency direction (FSE scans only) |
| FCs | Flow Compensation in the slice direction (FSE scans only) |
| M3D | Multi-Slab 3D |
| MP | Multi Phase |
| MT | Magnetization Transfer |
| NP | No Phase Wrap |
| Ov | Number of slice locations on each end of slab that overlap with the neighboring slab |
| PC | Phase Correction (series text page only) |
| PG | Peripheral Gating |
| PM | POMP |
| PscOpts | Prescan Options (series text page only) |
| RC | Respiratory Compensation |

| ***Abbreviation*** | ***Description*** |
|---|---|
| RT | Rectangular FOV |
| RTr | Respiratory Triggered |
| SH | Number of Shots (EPI only) |
| Sl | Number of 3D slabs x slice locations per slab |
| SPF | Swap Phase and Frequency |
| SQ | Sequential |
| SqP | Square Pixels |
| St | Saturation Parameters |
| TRF | Tailored RF |
| trig | Respiratory trigger point as a percent of maximum (respiratory triggered scans only) |
| VB | Variable Bandwidth |
| VS | Views per Segment |

## Pulse Sequence Annotation

| ***Abbreviation*** | ***Description*** |
|---|---|
| IR | Inversion Recovery |
| SE | Spin Echo |
| SE/V | Variable Echo, Spin Echo |
| SE/EPI | Spin Echo, Echo Planar Imaging |
| GR[1] | Gradient Echo, both sequential and non-sequential |
| GRE/EPI | Gradient Echo, Echo Planar Imaging |
| 3D/GR[1] | 3D Gradient Echo |
| 3D/FGR[1] | 3D Fast Gradient Echo |
| 2D/FSE | 2D Fast Spin Echo |
| 2D/FSEIR | 2D Fast Spin Echo, Inversion Recovery |
| 3D/FSE | 3D Fast Spin Echo |
| 3D/FSEIR | 3D Fast Spin Echo, Inversion Recovery |
| SPGR[1] | 2D Spoiled Grass |
| SPRG/EPI | Spoiled Grass, Echo Planar Imaging |
| 3D/SPGR[1] | 3D Spoiled Grass |
| 3D/FSPGR[1] | 3D fast Spoiled Grass |
| TOF/GR[1] | 2D Time -of -Flight |
| 3D/TOF/GR[1] | 3D Time-of -Flight |
| 3D/TOF/FGR[1] | 3D Time-of-Flight Fast Grass |
| PC/GR[1] | 2D Phase Contrast |
| 3D/PC/GR[1] | 3D Phase Contrast |
| Cine/PC/GR[1] | Phase Contrast Cine |
| Cine/SPGR[1] | Spoiled Grass Cine |
| SPGR/EPI | Spoiled Grass, Echo Planar Imaging |
| Cine/GR[1] | Gradient Echo Cine |
| TOF/SPGR | 2D Time-of-Flight Spoiled Grass |
| TOFX | 2D Time-of-Flight with SAT Gap |
| 3D/TOF/SPGR | 3D Time-of-Flight Spoiled Grass |
| 3D/TOF/FSPGR[1] | 3D TIme-of-Flight Fast Spoiled Grass |

| ***Abbreviation*** | ***Description*** |
|---|---|
| 3D/TOF/MT | 3D Time-of-Flight with Magnetization Transfer |
| FSE | Fast Spin Echo |
| FSE/V | Fast Spin Echo Variable Echo |
| FMPIR | Fast Spin Echo, Inversion Recovery |
| FMPSPGR[1] | 2D Fast Multi Planar Spoiled Grass, both sequential and non-sequential |
| FMPGR[1] | 2D Fast Multi Planar Gradient Echo, both sequential and non-sequential |

[1] Includes Flip Angle Annotation.

## User Preferences

This button opens a window which is used to custom set the following functions:

**Annotation -** As it appears on the screen and/or the film.

- Full, partial, or custom annotation selects the amount of annotation that appears on the film or the screen. Custom opens a window that allows you to pick and choose multiple options for annotation on the screen or film.
- When Full annotation is selected, all annotation appears.
- When Partial Annotation is selected, only the following annotation appears:
  - Exam, series, and image number
  - Scan plane and location
  - Echo train
  - Flip angle
  - Pulse sequence
  - Timing parameters (TR, TE, TI)
  - Bandwidth
  - Number of echoes
  - Patient name
  - Date of exam
  - Magnification factor
  - Flip or rotation of image
  - Frequency direction
  - Window and level values

- When Custom Annotation is selected, only the selected annotation appears on the film or screen.
- Left, right, top, or bottom removes or shows the FOV location. For example, an axial image annotated with A200, P198, R200, and L198, selecting to remove left, removes the L198 annotation from the film or screen.

Something to Think About...

- When filming with the **F3** key be careful of the annotation on the film. If the film annotation is set to FULL and filmed with the **F3** key, the films have only PARTIAL annotation. This is to prevent annotation from overlaying annotation. If you want anything other than the default annotation to appear (when filming with **F3**) you need to click the **[Customize]** button in the film section of Annotation Level on the User Preferences window, then select the annotation that you want to appear on the film.

**Tick Marks** - Whether hidden or shown. Tick marks are a scale shown either on the right side of the image, at the bottom of the image, or in both places used for measuring.

**Grid Preferences** - Customize allows for a number a ways to display a grid on an image.

- Matrix lines - Are either on or off, the matrix lines form the grid pattern around the central vertical and horizontal line.
- Line style - Lines are selected as dotted or solid.
- Grid Spacing - This is the spacing between the grid lines in mm.
- Tick spacing - The space between the tick marks in mm.
- Tick Length - The length of the tick marks in mm.

**Right mouse button** - Controls the primary function of the right mouse to either scroll or magnify the image.

**Series binding** - Used when viewing images. With Series Binding On, when you reach the last image of a series, the next image displayed is the first image of the next series. With Series Binding Off when you reach the last image in a series the next image displayed is the first image of that same series.

**Square viewports** - Whether on or off, when the selected viewer format is larger than 4-on-1. For example, viewing with a 12-on-1 screen format, the viewports are rectangular when Square Viewports Off is selected. The images do not fill the

entire viewport. With Square Viewports On, the images are displayed as they appear on the film, each image fills the viewport and the entire format display is rectangular. Square Viewports On is recommended to help you select the correct magnification factor without overlapping annotation when filming magnified images.

**Presets** - Allows to create several predetermined values for window widths and window levels in the Viewer or the Mini Viewer.

## Accelerator Commands

The Accelerator Commands are a shortcut option for frequently used display and filming functions. A variety of functions can be performed by entering commands in the Accelerator Line. The Accelerator Commands are listed later in this chapter.

# How to Display Images

This section provides the step-by-step instructions for displaying and manipulating images. Specifically, it describes how to:

- Sort Exams, Series, or Images
- View Patient List
- Refresh List
- Display Images in a Viewer
- Set a Primary Viewport
- Set a Secondary Viewport
- Cine Page
- Compare Images
- Analyze Images
- Manipulate Images
  - Magnify Images (Zoom)
  - Apply the Magnifying Glass
  - Scroll
  - Grid
  - Erase All
  - Hide and Show
  - Display Normal
  - Reference Image
  - Flip/Rotate
- Annotate Images
- Remove Annotation
- Apply Mattes to Images
- Measure
- Enhance Images
- Cross-Reference a Series
- Screen Save
- Set Up User Preferences
  - Customize System Supplied Annotation
  - Tick Marks
  - Customize Grid Preferences

- Control the Right Mouse Button
- Control Series Binding
- Apply Square Viewports
- Customize the Window/Level Presets

- Use Accelerator Commands
- Save State
- Reverse the Video (Inverse Video)

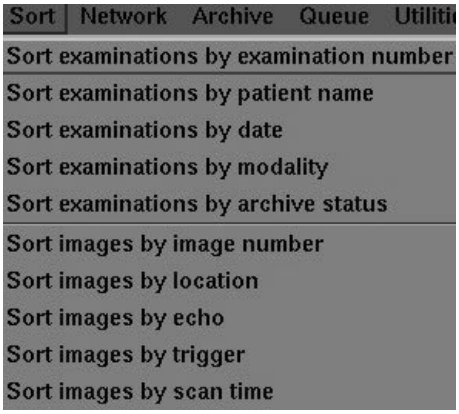
# Sort Exams, Series, or Images

Use this procedure when you want to change the way the exams are listed on the system. You can sort the exams by the examination number, patient name, date (of scan), modality, and archive status.

Once an image sorting mode is selected, and the Viewer or Mini Viewer is opened, the images are displayed in the order of the selected mode. When the Viewer or Mini Viewer is opened, it is locked into the currently selected sort mode. To change the image Sort mode you must return to the Sort menu and select another **Sort** mode.

1. Click **Sort**, from the Browser.
   - This is located on the menu bar at the top of the Browser.


2. Click on the sort method you prefer, from the Sort list.




Something to Think About...

- Only MR images that were acquired using cardiac gating can be sorted by trigger (trigger delay).
- If your facility has purchased the Connect/Pro PPS option, you can sort examinations by PPS status.
- The sort by name option responds alphabetically in the English language, but not other European languages or Asian languages.

## In Brief: Sort Exams, Series, or Images

1. Click **Sort**, from the Browser.
2. Click the sort method you prefer.

# View Patient List

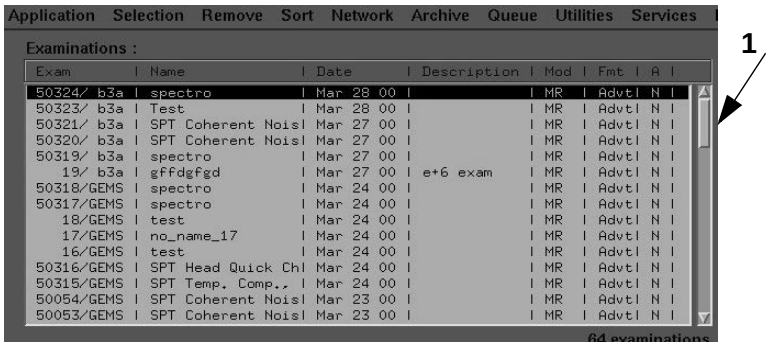
## In Brief: View Patient List

1. Click the **Display Desktop** icon.
2. Place cursor on the slider of the Examinations Section. Drag the slider to view the list.
3. With the cursor on slider of the Series or Images section, drag the slider to view contents.

When you click the **Display Desktop** icon the current patient list appears; this is called the (Display) Browser. The Browser allows you to view (browse) through the contents of the disk and to select images for display or manipulation functions. Using the Browser is the best way to view the list of exams and select them for utility functions, such as archiving or removing. The Browser also provides access to advanced post-processing features such as 3-D Model, Reformat, and IVI (Interactive Vascular Imaging).

1. Click the **Display Desktop** icon from the Control Panel.

   - The patient list appears on the Display Browser.




*Display Desktop/Browser*

2. You can view the contents of the first section titled Examinations by clicking and dragging up or down on the vertical slider (**1**), found on the right side of this section. Click (highlight) on the desired exam.
3. The series belonging to the exam are displayed in a window to the left of the exam window. The images belonging to the selected series are displayed under the exam window.To view the contents of these sections, click and drag the slider up or down. Click (highlight) on the desired series and/or images.
   - The series list shows the series number, the type of series, total number of images, a series description, modality and manufacturer.

- The image list shows the location, flip angle, echo, TE, TI, TR, trigger delay, thickness, spacing, FOV, matrix, NEX, and archive status.

# Refresh List

## In Brief: Refresh List

1. Click **Application**.
2. Click **[Refresh lists]**.

The patient list updates automatically once the images are reconstructed. If this does NOT happen automatically, you can refresh the list manually.

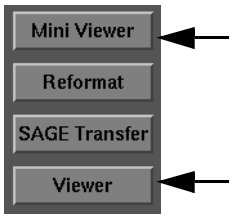
1. Click **Application** from the Browser menu bar.


2. Click **[Refresh lists]**.

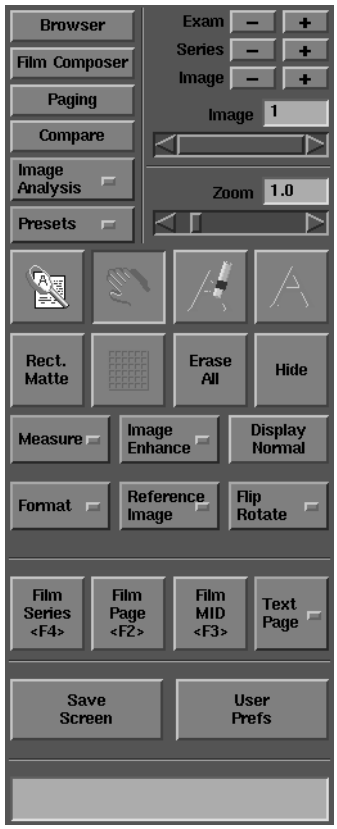
# Display Images in Viewer

There are a lot of different ways that you can move from one exam, series, or images to another. This section describes the way to change this information using the buttons on the Viewer or Mini Viewer window. You can also use the Accelerator Line which is discussed later in this chapter.

1. After selecting the exam, series or images to view (follow the instructions in View Patient List), click **[Viewer]** or **[Mini Viewer]** to display the selected images.




- Viewer window appears.




*Browser/Viewer*

## In Brief: Display Images in a Viewer

1. Follow instructions in View Patient List. Select the exam (series or image) and click **[Viewer]** or **[Mini Viewer]**.
2. Click **[Format]** and click the display format.
3. Move to a prior or next exam, series or image using **[+]** or **[-]**, typing in the number, or using the Image slider.
4. Change the window width and level settings, click and drag with the middle mouse.

NOTE: Mini Viewer has all the functions of the Viewer except:

- No Compare Mode
- No Save Screen
- No User Prefs

2. Click **[Format]**, from the lower left of the window, and then click on the desired display format. You can format to display 1 or more images on the screen.


3. You can move from one exam, series, or image by clicking **[-]** (minus) or **[+]** (plus) located next to the Exam, Series, or Image entry. The order in which the images are displayed is dependent on how the exams/images are sorted in the Browser.


- This moves you up or down the patient list, displaying each exam. Clicking **[+]** moves you to the prior patient series, or image on the list, and clicking **[-]** moves you to the next patient, series, or image on the list.

Something to Think About...

- A limited number of exams can be accessed in the Viewer when using the plus or minus exam key. Therefore, highlight an exam in the Browser as the start or reference point and use the exam plus and minus keys to navigate around that reference exam.

NOTE: Additional ways to change the image:

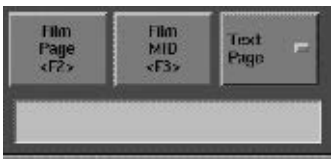
- Highlight the number in the **Image** text box (1) and type in the new image number in the text box, for example **32**.
- Or, clicking and dragging the Image slider (2), manually pages through the images.

4. Change window width and level settings to the desired contrast using one of the following methods:

   a) With the mouse cursor in the viewport, click and drag using the middle mouse button, in a diagonal direction and release once you achieve the desired window/level setting. Moving the mouse L/R changes the window width and moving the mouse Up/Down changes the window level.

   b) Using the **arrow keys** on the keyboard, pressing the **right** or **left arrow key** increases or decreases (respectively) the width by 2, pressing the **down** or **up arrow key** increases or decreases (respectively) the level by 2. Holding the **arrow key** down continuously provides accelerated increase/decrease until the key is released. The change is applied to the primary view first, then to the other views once you have stopped pressing the **arrow key** for a few moments.

   c) Using the **Accelerator Line**, located at the bottom of the Viewer window (shown in picture below), type **`ww`** and the value to change the width, and type **`wl`** and the value to change the level. For example, type **`wl 800`** and **`wl 250`** to set specific values for window width and level.




   d) Using the Predefined values from **[Presets]**. Click **[Presets]**, a window appears. Click the desired selection. These predetermined values are applied to the displayed images. See the steps for **[User Preferences]** later in this chapter for instructions on changing the preset values.


   e) Using the **F** (Function) keys located on the keyboard. See the chart below for keys and descriptions.

| ***Key*** | ***Description*** |
|---|---|
| **F5** | Resets the window level to the previous level. |
| **F6** | Uses the Predefined 1 window and level settings. |
| **F7** | Uses the Predefined 2 window and level settings. |

| ***Key*** | ***Description*** |
|---|---|
| **F8** | Uses the Predefined 3 window and level settings. |
| **F9** | Uses the Predefined 4 window and level settings. |
| **F10** | Uses the Predefined 5 window and level settings. |
| **F11** | Uses the Predefined 6 window and level settings. |
| **Shift + F6** | Changes the Predef 1 window/level settings to those of the active viewport. |
| **Shift + F7** | Changes the Predef 2 window/level settings to those of the active viewport. |
| **Shift + F8** | Changes the Predef 3 window/level settings to those of the active viewport. |
| **Shift + F9** | Changes the Predef 4 window/level settings to those of the active viewport. |
| **Shift + F10** | Changes the Predef 5 window/level settings to those of the active viewport. |
| **Shift + F11** | Changes the Predef 6 window/level settings to those of the active viewport. |

# Set a Primary Viewport

If you have more than one image displayed, you can set any viewport to be your primary viewport. A viewport becomes active or receives primary focus by clicking once on it. The other viewports are secondary and active (affected by display functions). Double clicking on a viewport makes it a primary viewport, and the other viewports are secondary and inactive. The frame around the primary viewport turns teal. If you have black and white monitor, the primary viewport has a white frame. Once a window has become the primary viewport and the others inactive, you can magnify and perform other image manipulation functions without effecting other images currently displayed on the screen.

1. Display two or more images in a multi-format setting.
   - For the steps, see the section on Displaying Images in a Viewer.
2. Place your cursor in the viewport you want to make primary, and double-click. Other viewports are secondary and inactive.

## In Brief: Set a Primary Viewport

1. Display two or more images.
2. With cursor in viewport that is to be primary, double click.

# Set a Secondary Viewport

## In Brief: Set a Secondary Viewport

1. Follow the steps in **Displaying Images in a Viewer.**
2. Double-click on the image to be isolated from the other viewports.
3. Single-click on the image to link.
4. Triple-click in a viewport makes that viewport primary and all others active.

Secondary viewports have a yellow or bright white (on black and white monitors) frame around it. Secondary and primary viewports are linked together. A change in one of the viewports is reflected in the other viewport. For example, changing the window width and window level in the primary image also changes the window width and window level secondary focused image.

1. Display two or more images in a multi-format setting.
   - For the steps, see the section on Displaying Images in a Viewer.
2. Double-click on the image that you want to isolate from the other viewports.
   - This is done by placing the cursor over the image that you want in primary focus and clicking twice quickly. The image has a frame around it and all the other images on the screen do not have any frames around them.
3. Single-click on the image that you want to link to.
   - This is done by placing the cursor over the image that you want in secondary focus and click once. This image now has a teal frame and the previous selected image has a yellow frame around it.

NOTE: You have to click on the image that you want to be in primary focus again. Remember that the teal (or white) frame is the primary focus and the yellow (or black) frame is the secondary focus.

4. Triple-click on a view activates all viewports and allows you to change the W/L, Scrolling, and Zoom (magnification) functions for all the viewports in unison.

# Use Cine Page

The Cine Paging function allows you to page through images in a manner that gives the appearance of a moving picture. Paging can load up 256 images in the series with a speed up to 60 images (frames) per second. **[Paging]** has the controls for the “movie” to get the “movie” set up and the speed (frames per second). Image Annotation is available but effects the frame rate’s performance. Cine Paging is accessible from either the Viewer or the Mini Viewer.

Suggested applications for Cine Paging include kinematic studies of the TMJ, or knee, heart motion studies and CSF flow studies.

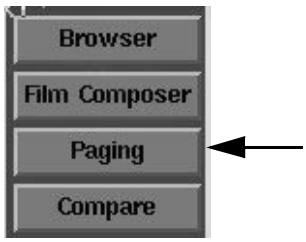
The default frame rate is 10 frames per second for each viewport. Maximum frames per second (fps) for 512 x 512 pixel images with no annotation are as follows:

| ***Number of Viewports*** | ***Maximum Frames Per Second (fps)*** |
|---|---|
| **1** | **60 fps** |
| **2** | **30 fps** |
| **4** | **15 fps** |

Image Annotation is available but effects the frame rate’s performance. Cine Paging is accessible from either the Viewer or the Mini Viewer.

The following are step by step instructions to use the Cine Paging function.

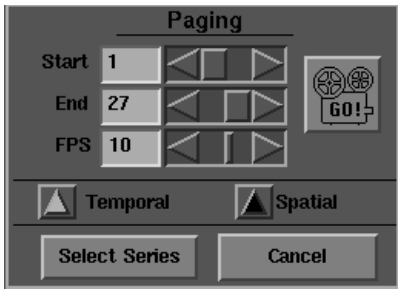
1. Select the desired series or images for cine paging.
2. Click **[Paging]**, from the Viewer or the Mini Viewer.




## In Brief: Cine Page

1. Select series/images.
2. Click **[Paging]**.
3. Select the first image in **Start** area.
4. Select the last image in the **End** area.
5. Set **FPS**.
6. Click **Temporal** or **Spatial** mode. If you do not wish to page images in another viewport go to step 11.
   a) Single click on desired viewport.
   b) Click on **[Select Series]**.
   c) Select exam and series.
   d) Click **[Viewer]**.
7. Click **[Go]** or **[Stop]**.
8. To change images/series have viewport in primary focus Repeat steps 3-7.
9. Click **[Cancel]** to exit from the Paging Mode.

3. In the **Paging** window, do one of the following to set the first image in the movie loop:




   - Click and drag on the **Start** slider to obtain the desired first image in the movie loop.
   - Use the scroll arrow to increment the start image of the movie loop.
   - Type in the image number in the **Start** text box, and press **Enter**.

4. In the **Paging** window set the last image using on the following:
   - Click and drag on the **End** slider the obtain the desired last image in the movie loop.
   - Use the scroll arrow to increment the end image of the movie loop.
   - Type in the image number in the **End** text box, and press **Enter**.

5. Set the FPS (Frames Per Second) using one of the following:
   - Click and drag the **FPS** slider to the desired rate.
   - Use the scroll arrow to set the FPS.
   - Type a value in the **FPS** text box, and press **Enter**.

6. Click on the **Temporal** or **Spatial** arrow to set the mode for looping. Go to step seven if you do not wish to page images in another viewport.
   a) To load images into another viewport for paging, single-click on the desired viewport.
   b) Click **[Select Series]** to return to the Browser.
   c) Select the exam and series desired for paging.
   d) Click **[Viewer]**.

7. Click **[GO]** (on the movie projector) to start the movie loop.
   - **[GO]** becomes **[Stop]** while the movie loop is running. Click **[Stop]** to stop the movie loop.

NOTE: There is a slight pause before the movie loop starts running for the images to load.

8. To change the images in a viewport or change the **FPS**, make that viewport the primary focus repeat steps 3-7.

9. Click **[Cancel]** to exit from the Paging Mode.

# Compare Images

## In Brief: Compare Images

1. Select exam/series/image.
2. Click **[Viewer]**.
3. Click **[Format]** and choose 2-on-1 or 4-on-1.
4. Click **[Compare]**.
5. From the Browser choose the second exam/series/image for comparing.
6. Click **[Viewer]**.
7. Click the **Left Series** or **Right Series** Up/Down arrows to move through the image set.
8. Click **[Cancel]**.

The Compare function allows you to compare images to one another. The images you compare can be from the same series, or a different series from the current exam, or you can even compare another exam or patient to the current one displayed. This feature is only available using the Viewer.

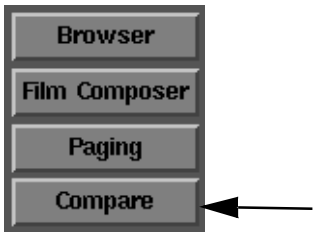
The following display functions are active in the Compare Mode: Magnify, Scroll, Annotate, Rect Matte, Grid, Display Normal, Cursors, and Measuring.

Cross Reference is not available while in Compare mode.

Something to Think About...

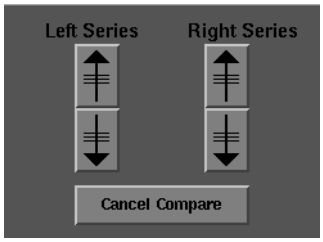
- You cannot film images using MID (**F3** key) in Compare mode, as they are two separate images.

1. Select the first exam, series and image that you want to compare.
2. Click **[Viewer]** to load the images.
3. Click **[Format]** and drag to the format you want to use.
   - Choose the format for viewing, only the 2-on-1 or 4-on-1 formats are valid for comparing.
4. Click **[Compare]** from the Viewer.




5. From the Browser, select the second exam/series/image that you want to compare with the first set of images.
6. Click **[Viewer]** and the Viewer returns with the Compare mode activated.
   - The monitor is divided into two separate Viewers. If you want to make changes to the first exam, click on that side to make that image the primary viewport. Make your changes, then click on the other side to make it the primary viewport and make the changes to that side.

7. Click the **Left Series** or **Right Series** Up and Down arrows to move through the image set that is displayed on either the left side of the Viewer or the right side of the Viewer.




   - If you want to move both Series at the same time, use the **Page Up** or **Page Down** keys on the keyboard.

8. When you are finished comparing the images, click **[Cancel Compare]**.

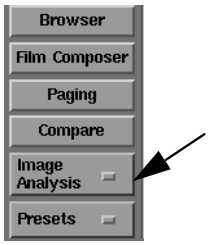
# Analyze Images

## In Brief: Analyze Images

1. Have desired images displayed.
2. Click **[Image Analysis]**.
3. Click desired function.

Image Analysis consists of some the more advanced function available on your system. Each of these functions are described in greater detail in Volume 4 of The Signa Learning and Reference Guide.

1. Display the desired images.
2. From the Viewer window, click **[Image Analysis]**.




   - A menu appears listing Image Analysis selections.
3. Click the desired selection to access the function.
   - Menu selections vary due to the functions your site has purchased.

## Manipulate Images

# Magnify Images (Zoom)

**In Brief: Magnify Images (Zoom)**

1. Display the desired images.
2. Select the method to zoom the images.
3. Click **[Display Normal]** to return to original size.

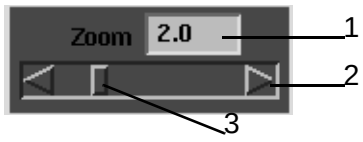
You can enlarge or reduce the size of the images using the Zoom control. You can use zoom to better visualize an area of interest. Zoom is found on both the Viewer and the Mini Viewer. The initial zoom factor of the image varies depending the display format (1-on-1, 4-on-1, etc.) and the image matrix size. The zoom factor can range from 0.5 (reduction) to 8.0 (enlargement) in increments of 0.1. The following table shows examples of the zoom factors.

| ***Display Format*** | ***Zoom Factor for a 256 x 256 Image*** |
|---|---|
| **1 x 1** | **4.0** |
| **2 x 1** | **2.0** |
| **4 x 1** | **2.0** |
| **3 x 4** | **1.0** |

The Zoom factor is displayed in the text box to the right of Zoom and in the upper right corner of the image.

Use the following steps to perform the Zoom function.

1. Display the desired images.
2. Do one of the following:
   - From the Viewer or the Mini Viewer, enter in the Zoom factor in the text box. Double click in the text box, type in the desired Zoom factor. Press the **Enter** key on the keyboard.
   - Click on the right or left arrows to increase or decrease the zoom factor by 0.1.
   - Click and drag the slider (found just below the word Zoom) left or right. This performs a continuous Zoom on the selected image.




     - 1 - the text box
     - 2 - the arrows
     - 3 - the slider

3. Click **[Display Normal]** to return to the original image size.

Something to Think About...

- If necessary, the operator's console automatically reduces the quantity of annotation when reducing the image size. This is to avoid overflowing the display area. If all annotation is not visible when viewing an image, magnifying the image displays more annotation.
- When an image is magnified you can activate the Scroll function to move the image around within its frame, centering over the area of interest.
- Zoom is applied to all images in the series **if** you have your view selection as primary, followed by secondary. It applies only to the primary if you de-select the other views.

## Manipulate Images

# Apply the Magnifying Glass

The Magnifying Glass allows you to magnify a square region of view with 2X magnification. The Magnifying Glass is moved about the image by moving the mouse. This function is applied with an image in the Viewer or Mini Viewer.

1. Click the **Magnifying Glass** icon.

2. Place the cursor in the image of interest.
3. Click on the right mouse and hold to activate the Magnifying Glass.
4. While holding the right mouse, move the mouse so the Magnifying Glass is over the area of interest.
5. Releasing the right mouse deactivates the Magnifying Glass.

Something to Think About...

- You can set the right mouse button to default as the Magnifying Glass, see the section on User Preferences in this chapter. This allows you to use the right mouse button as a magnifying glass without first clicking the Magnifying Glass icon.

### In Brief: Apply the Magnifying Glass

1. Click the **Magnifying Glass** icon.
2. Place cursor in image.
3. Right click and drag mouse to move the Magnifying Glass around the image.
4. Releasing the right mouse deactivates the Magnifying Glass.

## Manipulate Images

# Scroll

### In Brief: Scroll

1. Click the **Scroll** icon.
2. Place cursor in image.
3. Click and hold the right mouse button.
4. Move the cursor around the image.
5. Click **[Display Normal]** to return to original state.

Scrolling allows you to move the image within the viewport and to move the area of interest to the center of the viewport. Image Scrolling can be accessed from either the Viewer or the Mini Viewer and can be applied to any image.

1. Click the **Scroll** icon.

2. Move the cursor to the desired image.
3. Click the right mouse button and hold to activate the scroll feature.
4. While holding the right mouse button, move the cursor around the image. The image follows the cursor.
5. Click **[Display Normal]** to return the image to its original state.

Something to Think About...

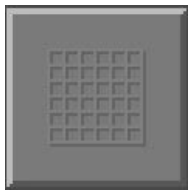
- If you have the right mouse button programmed to scroll (see section on User Preferences) you to use the right mouse button as a scrolling feature without first clicking the **Scroll** icon.
- If you have used a matte, the Scroll function scrolls your matted image within the viewport. It does not “pan” outside the matte.

## Manipulate Images

# Grid

Grid allows you to place a grid (matrix) over the primary image. See the section in this chapter on **User Preferences** to customize how the grid is displayed.

1. Put the image of interest into primary viewport.
2. Click the **Grid** icon.



3. Click the **Grid** icon again to turn off.

### In Brief: Grid

1. Put the image of interest in primary viewport.
2. Click the **Grid** icon.
3. Click the **Grid** icon again to turn off.

## Manipulate Images

# Erase All

### In Brief: Erase All

1. Put the image of interest in primary viewport.
2. Click **[Erase All]**.

The Erase All button is used to erase user added Annotation, Rect. Matte and graphics (such as a grid) operations. This feature works similar to the Display Normal feature described later in this chapter.

1. Put the image of interest in primary viewport.
2. Click **[Erase All]**.

## Manipulate Images

# Hide and Show

**In Brief: Hide and Show**

1. Put the image of interest in primary viewport.
2. Click **[Hide]**.
3. Click **[Show]**.

You can temporarily remove user added annotation using the Hide feature.

You can redisplay this annotation using the Show feature.

1. Have the image of interest in primary focus.
2. Click **[Hide]**.


3. Click **[Show]** to have the text reappear.

## Manipulate Images

# Display Normal

### In Brief: Display Normal

1. Put the image of interest in primary viewport.
2. Click **[Display Normal]**.

You can reset the image display to its original size and orientation using the Display Normal feature.This feature removes all filters, magnification factors (Zoom), flip/rotate, scroll, and image enhancements from the selected images.

1. Put the image of interest in primary viewport.
2. Click **[Display Normal]**


Something to Think About...

- Using **[Display Normal]** has NO effect on Rect. Matte, Annotation, or Graphics Operations. Use **[Erase All]** to remove these elements from the image.

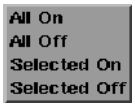
## Manipulate Images

# Reference Image

The Reference Image function allows you to insert an image into a small viewport on the Viewer or Mini Viewer. The inserted image identifies the slice location of the main image. This inserted (Reference) image must be in another plane from the main image. The two images (the main image and the Reference Image) must be from the same exam, have the same horizontal landmark, same patient position, and same patient entry.

1. Click **[Reference Image]**.


2. Click one of the Reference Image options from the menu by clicking the desired choice.




   - **All On** places the reference image on all the viewports.
   - **All Off** takes the reference image off all the viewports.
   - **Selected On** places the reference image on only the selected viewports.
   - **Selected Off** places the reference image off only the selected viewports.

3. The system automatically chooses a reference image for you. If you would like to use a different image for the reference do one of the following:
   - To change the reference image on a specific viewport, select (as you would to set primary viewport) the reference image viewport and type in **`ri 3 7`**, in the Accelerator Line. The example **`ri 3 7`** represents series 3 image 7 as the reference image (ri).
   - To change the reference image on all viewports, select all reference image viewports (as you would to set secondary viewport) and type **`ria 3 7`** in the Accelerator Line. The example **`ria 3 7`** represents series 3 image 7 reference image all (ria).

### In Brief: Reference Image

1. Click **[Reference Image]**.
2. Click the desired option from the menu.
3. Use the system reference image or change the reference image.

Something to Think About...

- The Reference Image only displays in the lower right corner of each viewport, the Reference Image CANNOT be moved.

## Manipulate Images

# Flip / Rotate

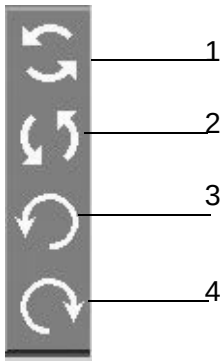
**In Brief: Flip / Rotate**

1. Put the image of interest in primary viewport.
2. Click **[Flip Rotate]**.
3. Click the Flip or Rotation desired.

You can flip or rotate the images you have displayed. Once you flip or rotate the images, they are annotated with the flip direction and the rotation. This annotation is on the top right of the image. If the images are not flipped or rotated there is no annotation flowing the FL: or ROT: annotation.

1. Put the image of interest in primary viewport.
2. Click **[Flip Rotate]**.


   - A menu appears.




*Flip Rotate*

3. Click on the desired manipulation.
   - 1 - Flips Left to Right, film annotation FL: L/R
   - 2 - Flips Top to Bottom, film annotation FL: T/B
   - 3 - Rotates Counterclockwise, film annotation ROT: 270
   - 4 - Rotates Clockwise, film annotation ROT: 90

# Annotate Images

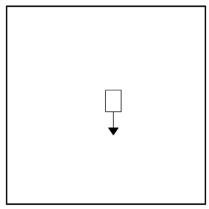
**In Brief: Annotate Images**

1. Have image of interest in primary viewport.
2. Click the **A** icon.
3. Move cursor to image and type text.
4. Drag box and arrow to desired location.
5. Click on arrowhead to change size/length of the line.
6. Type **`prop all`** for text to go on all images of series.
7. Click the **Erase Annotate** icon to erase a single area of annotation.

You can add annotation to the image, for example, to make comments or observations, to draw attention to a specific area of interest, or for labeling purposes. Multiple areas of annotation can be added to an image and then later deleted. Annotation includes an on-screen arrow for pointing out specific structures as well as text entry. The annotation function can be done using either the Viewer or the Mini Viewer. This procedure guides you through annotating images.

1. Place the image to receive the annotation in primary viewport.
2. Click the **A** (annotate) icon.
   - A text box and arrow are positioned in the middle of the image.

3. Move the cursor to the image and begin typing. The message is automatically placed inside of the displayed box. Press enter key to create a new line of text.



4. Drag the box and arrow to the desired location.
5. Click on the arrowhead and drag the cursor (now a pencil) to change the direction and length of the line.
   - Clicking and dragging the arrowhead into the text box hides the arrow, or type **`arrow off`** in the Accelerator Line. Typing **`arrow`** turns it back on.
   - Click the cursor outside the text box (or Ctrl X) to erase the text box lines.
   - Click the cursor on the text to make the text box lines reappear.
6. Type **`prop all`** in the Accelerator Line to propagate the text to all the images of the series.

7. Highlight the active text box and arrow, click the **Erase Annotate** icon to erase that single area of annotation.

NOTE: Clicking **[Erase All]** removes all areas of annotation.

# Remove Annotation

**In Brief: Remove Annotation**

1. Click **[Erase All]**, **[Erase Annotate]**, or **[Hide]**.

You can easily remove some or all of the user entered annotation.

1. Use one of the following methods:
   - To remove all the user entered annotation, click **[Erase All]**.


   - To remove specific user entered annotation, select (highlight) the text and click **Erase Annotate** icon.

   - To temporarily hide the annotation, click **[Hide]**. Click **[Show]** to redisplay the annotation.

# Apply Mattes to Images

The Matte function eliminates unwanted information or artifacts on or around an image before displaying or filming images. There are two types of matte: rectangular and elliptical. The size of the matte can easily be adjusted to fit the size of the area of interest.

1. While in the Viewer or Mini-Viewer, put the image of interest in primary viewport.
2. Click **[Rect. Matte]**.


- A rectangular matte appears on your image.

NOTE: Using the Accelerator Line, you may type the command **`ematte`** to use an elliptical matte instead of rectangular.

## Modifying a Displayed Matte

Once a matte is displayed you can modify its size and shape, add it to all images, copy it to a single image or remove it completely. The steps for doing these modifications are discussed below.

3. Click and drag on the plus sign (+) in the upper left corner of the matte to resize it.
4. Click and drag on any side of the matte to re-position it.
5. Type **`prop all`** in the Accelerator Line to propagate the matte to all the images in the series.
6. Click **[Erase All]** to remove the matte.


### In Brief: Apply Mattes to Images

1. Put image in primary viewport.
2. Click **[Rect. Matte]**.

#### Modifying a Displayed Matte

3. Click and drag the plus sign to size the matte.
4. Click and drag on side of matte to re-position.
5. If desired type **`prop all`** in the Accelerator Line.
6. If desired click **[Erase All]** the remove matte.

Something to Think About...

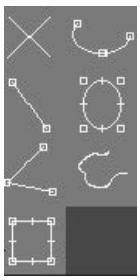
- Use the scroll function to scroll the matted image within the Viewport. It does not “pan” the image area outside the matte.
- To copy the matte, press **Ctrl C**, on the keyboard. Click on the new image and press **Ctrl V**, on the keyboard, to paste.

# Measure

You can use the Measure feature a number of ways to obtain information, distances, and areas of anatomy or pathology. **[Measure]** is found on either the Viewer or the Mini Viewer windows. It can report the cursor to record a point on an image, calculate the linear distance between two points, measure the area of anatomy or pathology, and list the angle of the line between the two points.

1. Put the image of interest in primary viewport.
2. Click **[Measure]**.


   - A menu appears.



*Measure*

3. From the window click on the desired method to measure.
   - The cursor starting point is placed in the center of the image.
4. Click and drag on the small box to draw or resize. Move them to the desired start and end location.
   - Once the start and end points are set, a real time readout of the distance and angle appears in the lower right corner of the image.
   - Up to three statistics are displayed on the screen at one time. If the measurement you want to see is not displayed, just click anywhere on the line and the measurement is displayed.

NOTE: Click **[Erase]** to erase the active (blue) Measure Distance line. If more than one measure is on the image, continue clicking **[Erase]**.

## In Brief: Measure

1. Put the image of interest in primary viewport.
2. Click **[Measure]**.
3. Select the desired option from the menu.
4. Click and drag where necessary.

# Enhance Images

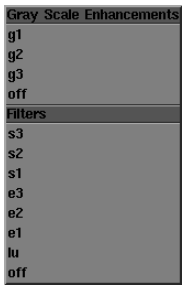
## In Brief: Enhance Images

1. Place image in Viewer.
2. Click **[Image Enhance]**.
3. Click on desired filter.
4. Click **[Display Normal]** to remove filter.

Image Enhance provides a menu of filters and gray scale changes. The filters are used for edge or lung enhancement or to smooth and image. The ClariView feature uses different filtering algorithms than the Image Enhance feature. The gray scale enhancement adjusts the gray scale to one of three different levels. The gray scale enhancement increases the image contrast so that the image has a more black/white appearance. Image Enhance is accessed through either the Viewer or the Mini Viewer.

1. Place desired image in the Viewer.
2. Click **[Image Enhance]**.


   - A menu appears, listing your choices for Image Enhancement.




3. Click on a gray scale or filter.
   - **Gray scale enhancement**: g1 results in the smallest contrast change while g3 has the most contrast change. Gray Scale Enhancement is generally used more for CT images than MR images.
   - **Filters**: those labeled **s** are smoothing filters (various levels), those labeled **e** are edge enhancing filters (various levels.) The filter labeled **lu** is for lung enhancement and is primarily used for CT lung images.

NOTE: Images are annotated on the middle right side of the image as, FLT: s2 or FLT: e1(examples.) Image Enhance filters can apply only one filter, at any time to an image.

4. Click **[Display Normal]** to display the image without the filter.


Something to Think About...

- Image Enhance filters are not additive. Only one filter may be applied to an image at any time. Applying a new filter negates the previously applied values.
- The Image Enhance gray scales and filters are applied to image data only. They are not applied to graphics, image annotation, or user added annotation.

# Cross Reference a Series

## In Brief: Cross Reference a Series

1. Put image of interest in primary viewport.
2. Type in the Accelerator Line one of the commands.

The Cross Reference feature displays lines on a view that represent where one series intersects another plane. Cross Reference is used for filming or viewing to provide an anatomical reference to the images acquired on an intersecting plane. You can cross reference an entire series, the first and last image of a series, a single image, or range of images within a series by typing in a single command in the Accelerator Line. Cross referencing can be done either in the Viewer or the Mini Viewer.

Something to Think About...

- The cross reference lines may overlap annotations. Take this into consideration when filming.
- You cannot cross reference more than one non-consecutive image with a single command.

1. Select the view on which to display the cross reference and put this image of interest in primary focus.
2. Type in the Accelerator Line one of the following commands:

NOTE: Be sure to follow the example, including the spaces.

- **`xr 3`** to display the slices for series 3.
- **`xr 3/5-%`** to display the slices for series 3 starting with image 5 through (/) the last slice number of the series (%).
- **`xr 3/10-60:5`** to display the slices for series 3 starting with image number 10 to image number 60, with an interval (:) of 5 slices.
- **`noxr`** to deactivate the cross reference mode (removes the Cross reference lines).
- **`xra`** to append an image to the cross reference display. For example: **`xra 2 11`** where 2 represents the series and 11 represents the image (displays the cross reference of a single slice).
- **`xr #`**(series number) **`extrema`** to display only the first and last slices of a series. For example: **`xr 3 extrema`** displays the first and last slice of series 3.

NOTE: A 3D data set with projection (PJN) images does not post the first and last slice with the cross reference type in command **`xr # extrema`**. You must use the cross reference type in command for images with a gap. For example: a 3D data set (series 3) with 1 collapsed image, 19 projection images, and 60 total slices, type in the following: **`xr 3/21-60:39`** to display the cross reference without the PJN images.

- Non-consecutive images require several commands. For example, to cross reference slices 2, 5, 6, 8 and 12 of series 3, the commands required are:

a) **`xr3 2`**

b) **`xr 3 5-6`**

c) **`xra 3 8`**

d) **`xra 3 12`**

- The resultant cutline would appear like this:

3/2----------
3/5----------
3/6----------
3/8----------
3/12----------

# Screen Save

**In Brief: Screen Save**

1. Put image in primary viewport.
2. Click **[Save Screen]**.

The Screen Save feature allows you to save any image, including manipulated images, to a new series in the same exam. Screen Save is available from the Viewer (but not from Mini Viewer).

1. Have image of interest in the primary viewport.
2. Click **[Save Screen]**.
   - The new series is available on the Browser. It is labeled as SSAVE with a series number of 99. If additional images are saved they are added to this series and the Imgs column increases by one for each image.
   - Window level is still adjustable and magnify is still available.


Something to Think About...

- Any annotation that is on the image cannot be removed once the screen has been saved; it is a “snapshot” of the screen and cannot be altered.

## Set Up User Preferences

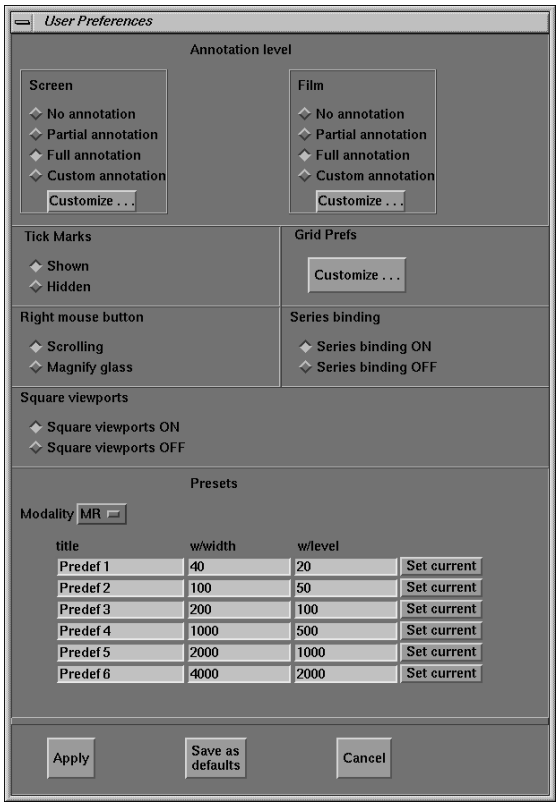
You can modify a number of system defined defaults to customize the display based on your site's preferences. These functions can only be set from the Viewer, not the Mini Viewer (although the effect can be seen on the Mini Viewer). This section gives you step-by-step instructions to set up and/or change any of these functions.

# Customize System Supplied Annotation

This gives you the ability to change and customize the system annotation as it appears on the screen (viewer) and on the film.

1. Display an image in the Viewer.
2. Click **[User Preferences]**.

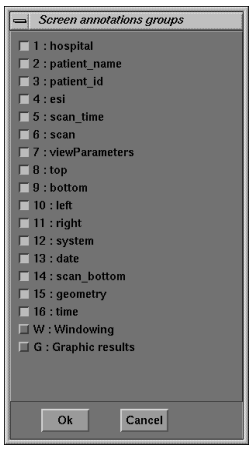

- The User Preferences window appears.




### In Brief: Customize System Supplied Annotation

1. Display images in the Viewer.
2. Click **[User Preferences]**.
3. Select **No, Full, Partial**, or **Custom Annotation** Select for screen or film.
4. To change custom annotation options go to step 5. Go to Step 7, if not changing custom annotation options.
5. To Customize annotation, click **[Customize]** and select the desired choices.
6. Click **[Ok]**.
7. Click one of the following: **[Apply]**, or **[Save as Defaults]**, or **[Cancel]**.

3. Choose whether you want to change the annotation on the screen (viewer) or the film; the process is the same for both.
   a) Click the button next to the annotation option **No annotation**, **Partial annotation**, **Full annotation,** or **Custom annotation** to turn on that option. Custom annotation displays whatever options are selected in the custom annotation window. Go to Step 9 if you do not want to select Custom annotation.
4. Click **[Customize]** and a window appears.




*User Prefs / Customize*

   - The buttons that are “in” show that annotation on the screen/film.

Something to Think About...

- When filming with the **F3** key be careful of the annotation on the film. If the film annotation is set to FULL and filmed with the **F3** key, the films have only PARTIAL annotation (Site name, patient name, system ID, and Lower Left corner - technique are missing). This is to prevent annotation from overlaying annotation. If you want anything other than the default annotation to appear (when filming with **F3**) click **[Customize]** in the film section of Annotation Level on the User Preferences window, then select the annotation (typically all) that you want to appear on the film.

5. Turn on or off any of the options, by clicking the button in front of the desired option to set the amount of annotation on the screen (or film).
6. Click **[Ok]** to accept the changes to the annotation and to close the window.

7. Do one of the following:
   - Click **[Apply]** from the User Preferences window to apply the selected options to the screen (or film). This is a temporary application and applies only to the currently displayed images.
   - Click **[Save as Defaults]** to permanently save the selections.
   - Click **[Cancel]** to exit without applying or saving the selections.

## Set Up User Preferences

# Tick Marks

### In Brief: Tick Marks

1. Click **[User Preferences]**.
2. Select **Shown** or **Hidden**.

This function allows you to turn the Ticks Marks on or off the Viewer, or Mini Viewer and the film. This function cannot be customized for film or screen, it is applied to both.

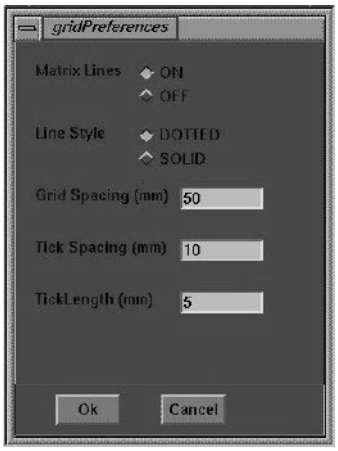
1. Click **[User Preferences]**.
2. Select **Shown** or **Hidden** in the **Tick Marks** area.

## Set Up User Preferences

# Customize Grid Preferences

The Grid Preferences allow you to control the Grid spacing and Grid appearance.

1. Click **[User Preferences]**.
2. Click **[Customize]** from the **Grid Prefs** area.
   - A grid Preferences window appears.




*User Preferences/Customize gridPrefs*

3. Click on the desired selections for:
   - **Matrix Lines** which turns on or off the lines that form a grid pattern about the central vertical and horizontal lines.
   - **Line Style** which changes to the grid lines to solid or dotted.

Double click in the text box to the right of the following and type in the desired number:

- **Grid Spacing** which changes the space between the grid lines in mm.
- **Tick Spacing** which changes the space between the tick marks in mm.
- **Tick Length**- which changes the length of the tick marks in mm.

4. Press the **Enter** key after typing in the text box.
5. Click **[Ok]** to save the changes.

### In Brief: Customize Grid Preferences

1. Click **[User Preferences]**.
2. Click **[Customize]** from Grid Prefs.
3. Click on the desired selections. Grid Spacing, Tick Spacing and Tick Length are text boxes.
4. Press **Enter**.
5. Click **[Ok]** or **[Cancel]**.
6. Click one of the following: **[Apply]**, or **[Save as Defaults]**, or **[Cancel]**.

- Click **[Cancel]** to exit without saving the Grid Preferences.

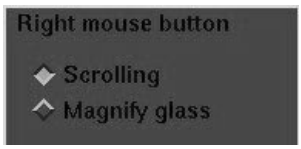
6. Do one of the following:
   - Click **[Apply]** from the User Preferences window to apply the selected options. This is a temporary application and applies only to the currently displayed images.
   - Click **[Save as Defaults]** to permanently save the selections.
   - Click **[Cancel]** to exit without applying or saving the selections.

## Set Up User Preferences

# Control the Right Mouse Button

This allows you control the default setting for the right mouse button on views.

1. Click **[User Preferences]**.
2. In the Right mouse button area select the desired function for the right mouse, when viewing.
   - **Scrolling** is the standard right mouse function.
   - **Magnify glass** is the alternate option.




3. Do one of the following:
   - Click **[Apply]** from the User Preferences window to apply the selected options. This is a temporary application and applies only to the currently displayed images.
   - Click **[Save as Defaults]** to permanently save the selections.
   - Click **[Cancel]** to exit without applying or saving the selections.


### In Brief: Control the Right Mouse Button

1. Click **[User Preferences]**.
2. In the **Right mouse button** area, click **Scrolling** or **Magnifying glass**.
3. Click one of the following: **[Apply]**, or **[Save as Defaults]**, or **[Cancel]**.

## Set Up User Preferences

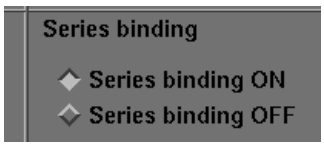
# Control Series Binding

### In Brief: Control Series Binding

1. Click **[User Preferences]**.
2. Click the button for Series Binding **ON** or **OFF**.
3. Click one of the following: **[Apply]**, or **[Save as Defaults]**, or **[Cancel]**.

Series Binding is a function used when viewing images. If Series Binding is on and you reach the last image in a series, the next image displayed is the first image of the next series. If Series Binding is off, and you are viewing the last image in a series, the next image to view is the first image of that same series. To turn Series Binding on or off complete the follow steps.

1. Click **[User Preferences]**.
2. In the Series binding area click the button to the left of the desired choice:
   - **Series binding ON** (To turn ON).
   - **Series binding OFF** (to turn OFF).




3. Do one of the following:
   - Click **[Apply]** from the User Preferences window to apply the selected options. This is a temporary application and applies only to the currently displayed images.
   - Click **[Save as Defaults]** to permanently save the selections.
   - Click **[Cancel]** to exit without applying or saving the selections.

## Set Up User Preferences

# Apply Square Viewports

Square Viewports affects the shape of the image viewports and the selected Format in the Viewer. If Square Viewports are on, the system displays the images in the Viewer exactly as they are seen on the film. The default is Square Viewports Off. The following instructions explain how to turn Square Viewports On or Off. To achieve the correct magnification factor be sure Square Viewports are on.

1. Click **[User Preferences]**.
2. In the Square viewports area select the desired choice:
   - Square viewports **On** (to turn on).
   - Square viewports **OFF** (to turn OFF).


3. Do one of the following:
   - Click **[Apply]** from the User Preferences window to apply the selected options. This is a temporary application and applies only to the currently displayed images.
   - Click **[Save as Defaults]** to permanently save the selections.
   - Click **[Cancel]** to exit without applying or saving the selections.


## In Brief: Apply Square Viewports

1. Click **[User Preferences]**.
2. Click the button for Square viewports **ON** or **OFF**.
3. Click one of the following: **[Apply]**, or **[Save as Defaults]**, or **[Cancel]**.

## Set Up User Preferences

# Customize the Window/Level Presets

### In Brief: Customize the Window / Level Presets

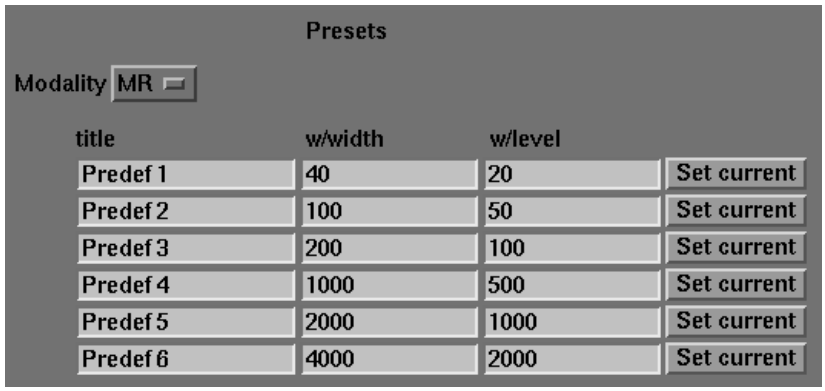
1. Click **[User Preferences]**.
2. Click **[Modality]** and select the modality.
3. Do one of the following: Type in new values/text, or click **[Set Current]**.
4. Click one of the following: **[Apply]**, or **[Save as Defaults]**, or **[Cancel]**.

The Preset selection allows you to preset six different filming Window Widths and Window Levels. Using these presets, you can quickly adjust the brightness and contrast of the image. If the operator's console is networked with a CT system, you have a separate set of six preset values for CT images. The following are step by step instructions to customize the preset values.

The Presets (1-6) values correspond to the Function (**F**) keys F6-F11. Pressing one of these **F** keys changes the window width and level to the Preset value.

NOTE: The **F5** key sets the window and level to the most recent settings.

1. Click **[User Preferences]**.
2. Click **[MR/CT]** and select the appropriate modality.




3. In the Presets area, do one of the following:
   - Select the text you want to change and type in the new title, w/width, or w/level. Press the **Delete** key (on the keyboard) to clear the text box.
   - Width and level need to be entered as numbers.
   - Click **[Set Current]**. To set the width/level on the image selected (and overwrites any type-in).

4. Do one of the following:
   - Click **[Apply]** from the User Preferences window to apply the selected options. This is a temporary application and applies only to the currently displayed images.
   - Click **[Save as Defaults]** to permanently save the selections.
   - Click **[Cancel]** to exit without applying or saving the selections.

# Use Accelerator Commands

## In Brief: Use Accelerator Commands

1. Place the cursor in the **Accelerator Line.**
2. Type in the Accelerator Command.
3. Press **Enter**.

The Accelerator Commands are type in commands that allow you to use as shortcuts to perform some functions. You can use these commands by entering text in a text box, called the Accelerator Line. The Accelerator Commands are listed after these instructions.

1. Place your cursor inside the **Accelerator Line** text box (the cursor must remain inside this text box).


   - **1** - the **Accelerator Line**.

2. Type text for desired command, using lowercase letters only.
   - To access the list of Accelerator Commands type **?** in the **Accelerator Line**. A window appears listing all the Accelerator Commands. Scroll the slider on the right to view entire list.

Something to Think About...

- Some Accelerator Commands can be accessed directly from the list by clicking on the command.
- Click **[Cancel]** to exit from the Accelerator Command list.

3. Press the **Enter** key (on the keyboard).
   - The following is a list of the available Accelerator Commands.

## Accelerator Command List

| ***Command*** | ***Type in Abbr.*** | ***Description*** |
|---|---|---|
| **?** | **?** | **Opens a list of these commands with abbreviations and descriptions.** |
| ***Paging*** | | |
| **paging interval** | **pi** | **Sets the interval between movie loop frames. For example: `pi 2`.** |
| **paging interval all** | **pia** | **Sets the interval between all movie loop frames. For example: `pia 2`.** |
| **paging mode** | **pm** | **Toggles between spatial and temporal mode. For example: `pm spatial`.** |
| **cine paging** | **pa** | **Runs a movie loop with given range and frame rate. For example: `pa 1 20 10`, where 1 and 20 define the slices in the movie loop and 10 represents the FMS.** |
| ***Series Selection*** | | |
| **exam<br>series<br>image** | **e<br>s<br>i** | **To select a particular Exam/Series/Image. When no e/s/i letters are specified, priority goes to image number, then series, and then exam. For example, `12/13` means series12/image13. For example: `e50 51`.** |
| **next exam** | **ne** | **Goes to the next exam in the Browser.** |
| **next series** | **ns** | **Goes to the next series in the Browser.** |

| | | |
|---|---|---|
| **previous exam** | **pe** | **Goes to the previous exam in the Browser.** |
| **previous series** | **ps** | **Goes to the previous series in the Browser.** |
| **series binding** | **sb** | **Sets the series binding to be on or off. For example: `sb on`.** |
| ***Annotation Level/Groups*** | | |
| **annotation none** | **an** | **Displays no annotations levels on the screen.** |
| **annotation partial** | **ap** | **Displays partial annotations levels on the screen.** |
| **annotation full** | **af** | **Displays all annotations levels on the screen.** |
| **annotation custom** | **ac** | **Turns on your predetermined advanced annotation on the viewer.** |
| **annotation groups** | **agp** | **Turns on/off annotation groups on the screen.** |
| **film annotation none** | **fan** | **Films no annotations.** |
| **film annotation partial** | **fap** | **Films partial annotations.** |
| **film annotation full** | **faf** | **Films all annotations.** |
| **film annotation custom** | **fac** | **Turns on your advanced annotation on the film composer.** |
| **film annotation groups** | **fagp** | **Turns on/off annotation groups in the film.** |
| ***Image Manipulation*** | | |
| **autofit** | | **Returns to autofit zoom factor. For example: `autofit`.** |
| **flip horizontal** | **fh** | **Flips image horizontally (top to bottom).** |
| **flip vertical** | **fv** | **Flips image vertically (left to right).** |

| | | |
|---|---|---|
| **rotate left** | **rl** | **Rotates image left by 90 degrees.** |
| **rotate right** | **rr** | **Rotates image right by 90 degrees.** |
| **normal** | **no** | **Returns to normal orientation and autofit zoom factor.** |
| **format** | | **Sets display format to a maximum of 5 rows and 5 columns. For example: `format 3 5`.** |
| **reset** | | **Resets the initial display parameters. For example: reset.** |
| **window level** | **wl** | **Sets the window level value. For example: `wl 250`.** |
| **window width** | **ww** | **Sets the window width value. For example: `ww 800`.** |
| **set initial windowing** | **siw** | **Sets windowing values to the initial values.** |
| **zoom** | **zoom** | **Sets the zoom factor. For example: `zoom 2`.** |
| **invert** | | **Inverts the video. For example: `invert`.** |
| **filter** | **fi** | **Turns on filters. For example: `fi edge1`.** |
| **gray scale enhance** | **gse** | **Changes the gray scale. For example: `gse g1`.** |
| ***Graphics*** | | |
| **reference image** | **ri** | **Turns on Reference Image for one image. For example: `ri 2 1`, where 2 represents the series, and 1 represents the image.** |
| **reference image all** | **ria** | **Turns on Reference Image for all images. For example: `ria`.** |

| | | |
|---|---|---|
| **reference image off** | **`nori`** | **Turns off Reference Image for the selected image. For example: `nori`.** |
| **reference image all off** | **`noria`** | **Turns off all Reference Images. For example: `noria`.** |
| **cross ref** | **`xr`** | **Displays the cross reference lines representing images im1 - im2 from the series s(`xr s#`), or from imx-% (the last image in the series: `xr s# # %`), or from the first and last images only within the series `xr s# extrema`.** |
| **cross ref off** | **`noxr`** | **Turns off cross reference on the selected image.** |
| **cross ref append** | **`xra`** | **Appends an image to the cross reference display. For example: `xra s2 11`, where 2 represents the series and 11 represents the image.** |
| **report cursor** | | **Creates a report cursor graphic. For example: click on report cursor from the help menu, and then press [Enter] when the cursor is positioned in the Accelerator Line.** |
| **report pixel** | | **Displays a 4 x 4 mm cursor that can be dragged to a new location. When the cursor is deposited, the mean, sd (standard deviation), and area are displayed. For example: click on report pixels from the help menu and then press [Enter] when the cursor is positioned in the Accelerator Line.** |
| **tick marks** | **`tm`** | **Turns tick marks on or off. For example: `tm on`.** |

| | | |
|---|---|---|
| **tick mark vertical** | `tmv` | **Turns vertical tick marks on or off. For example: `tmv on`.** |
| **tick mark horizontal** | `tmh` | **Turns horizontal tick marks on or off. For example: `tmh off`.** |
| **grid** | | **Turns Grid on or off. For example: `grid on`.** |
| **erase graphics** | `eg` | **Erases selected graphics.** |
| **erase all graphics** | `eag` | **Erases all graphics.** |
| **hide graphics** | `hg` | **Hides all graphics.** |
| **show graphics** | `sg` | **Shows all graphics.** |
| ***Filming*** | | |
| **print page** | `pp` | **Captures a page for filming.** |
| **print series** | `prs` | **Prints the current series.** |
| **text page exam** | `te` | **Opens the text page with exam information.** |
| **text page series** | `ts` | **Opens the text page with series information.** |
| **text page roi** | `tpr` | **Opens the text page with ROI information.** |
| ***Miscellaneous*** | | |
| **mouse mode** | `mm` | **Sets mouse right button mode to either image scroll or magnifying glass. For example: `mm scroll`.** |
| **user prefs** | `up` | **Displays the user preference panel.** |
| **user text page** | `utp` | **Automatically displays an annotation box so the selected viewport can be used as a user text page.** |
| **quit** | | **Quits Viewer or Mini Viewer.** |

| | | |
|---|---|---|
| **save state** | **`ss`** | **Stores save state parameters (W/L) for images between the first image and last image inclusive (entire series if first image and last image are not specified). For example: `ss 1-10`.** |

# Save State

Use the Save State feature to save parameters which are recalled every time the current series or images are viewed on the same operator's console. The following parameters are saved:

- Image Orientation
- W/L Values
- Graphics (including the user added annotation)

1. Enter the following command in the Accelerator Line **`save_state`** or **`ss`** followed by the image numbers to be saved, such as **`ss 1-10`**.

NOTE: The Save State parameters are stored LOCALLY on the operator's console only. The Save State parameters are not archived or transferred with networked images.

- Images with the Save State applied are archived in their original form.

## In Brief: Save State

1. Type **`save_state`** or **`ss_image numbers`** in the Accelerator Line.

# Reverse the Video (Inverse Video)

## In Brief: Reverse the Video (Inverse Video)

1. Put image in primary viewport.
2. Type **`invert`** in the Accelerator Line.
3. Type **`invert`** again to return to normal.

Reversing the video (inverse video) changes the blacks to white, creating a negative image.

This is applied to all images in Viewer.

1. Put the image of interest in primary viewport.
2. In the Accelerator Line type **`invert`**.


3. To return image to “normal,” type **`invert`** again.

Volume 1

# Chapter 10

# Filming Images

### Where Am I?

## Introduction

This chapter explains how to film images from the operator's console. You can send images that have been displayed, analyzed and manipulated to a laser camera for film output or to a printer for paper output. Clicking the Display Desktop icon takes you to the Browser, where you can film images using the Viewer or the Mini Viewer. This chapter contains the concepts and the step-by-step instructions to:

- Set Up the Film Composer
- Load with Drag and Drop
- Load with the Function (F) Keys
- Load Text Pages
- Erase an Image from the Film
- Print Images
- Select a Remote Printer
- Check the Print Queue
- Set Window and Level Presets

In addition, this chapter answers the following questions:

1. How do I set the  format?
2. How do I preset window widths and levels?
3. What are the different ways to film images?
4. How do I check the Print Queue?

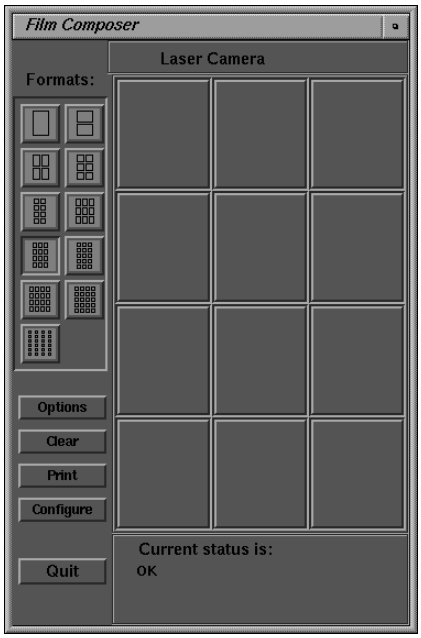
# About...Filming Images

This section presents the concepts necessary to successfully film images. Some of the concepts you need to understand are:

- The Film Composer
  - Setting Up the Filming Parameters
  - Print Options
  - Loading the Images
  - Printing
- The F (Function) Keys
- The Print Queue
- The Remote Printer

## The Film Composer

The Film Composer window allows you to choose a print format and send images to a laser camera for a film output or to a printer for paper output. The system must be linked to the appropriate output device. You can place images from multiple viewing applications, and therefore multiple studies, on the same film. The Film Composer can be accessed from the Viewer or the Mini Viewer.




Something to Think About...

- If the film composer disappears when Viewer functions are performed, click the **[Film Composer]** button from the Viewer window to redisplay the film composer.

There are three primary steps to the filming process:

- Setting up the filming parameters
- Loading the images
- Printing

## Setting Up the Filming Parameters

Setting the film parameters means to select the parameters you will use to film images at the operator's console:

- How many images to print on the film (typically up to 20). This is the Film Format.


*Film Composer/Formats*

  - ° The available film formats may vary depending on the laser camera or printer being used.
  - ° Use a 2 x 2 display format (4-on-1 screen) on the Viewer for filming, otherwise the magnification factor is different between the Viewer and filming.

Something to Think About...

- If configuring formats in the camera selected and film composer format list, does not automatically take the selected changes, then restart the film composer operation. Or, click immediately on Printer Label located at the top of the Film Composer application after configuring the printer.

### Print Options

A number of print options are available on the Film Composer and can be customized for your filming protocols. When you select these options they are set in your system, but may adjusted at any time.


*Film Composer/ Print Options*

- **Slide Format** - Images produced in slide format can be helpful for presentations or teaching files. If your camera is set up for slides, you can select On to print slides or Off to print regular films.

NOTE: If the selected output device does not support the slide format, this function is not available and the **[Slide Format]** button appears grey.

- **Greyscale** - Clicking this button turns the Greyscale on or off. If your system does NOT support Greyscale, this button is grey and you are not able to select it. The Greyscale is a vertical bar that displays varying shades of grey from white to black. If Greyscale is selected, it appears on the left side of the image.
- **Auto Printing** - Clicking this button turns auto filming on or off. If you select On, the system automatically sends the film to the printer when all the frames of the film are filled. If you select Off, the film does not go to the printer and you have to click the **[Print]** button on the Film Composer window to manually send the film to the printer and click the **[Clear]** button to clear the frames of the Film Composer.

- **Auto Clear Page** - Clicking this button turns the auto clear function on or off. If you select On, the frames of the film (in the Film Composer) are automatically cleared once the film goes to the printer. If you select Off, you have to clear the film manually by clicking the **[Clear]** button on the Film Composer window.
- **Icon labels** - Clicking this button changes the way images are displayed in the frames of the Film Composer (not on the actual printed film). This is a way to keep track of what has been placed on the film in the Film Composer. Clicking the **[E/S/I]** button shows the Exam number/Series number/Image number in the frame and clicking the **[Image]** button shows a small picture of the image being printed in that frame.
- **Expose Order** - Clicking this button allows you to change the order in which the images are loaded when using the Function keys. Click and hold the **[Expose Order]** button and drag to Left/Right/Top/Bottom for the films to be exposed from the Left to the Right and from the Top to the Bottom of the film. Drag to Right/Left/Bottom/Top to have films exposed from the Right to the Left and from the Bottom to the Top.
- **No. of Copies** - This feature allows you to customize the number of copies you create. Click on the up or down arrows just below No. of Copies to increase or decrease the number by one. Alternatively, highlight the text box and enter the number from the keyboard and press **Enter**.
- **The Status Area** - This message area keeps you informed of various conditions in the filming process (print queue empty, printing, film supply low, output device not connected, etc.). The Status area is found at the bottom of the Film Composer window. This area cannot be edited or changed. If an arrow appears in the lower-right corner of this area, click on it to see additional information regarding the filming status.


*Film Composer/Status Area*

### Loading the Images

Loading the images simply means displaying images within one or more viewing applications, and where each image is to be placed on the film. Loading with Drag and Drop allows you to place only one image into a frame on the film. Viewing and film formats do not need to be the same. The **F1** through **F4** keys along the top of the computer keyboard are accelerator keys for filming. Selecting the appropriate key places the images on the film with one keystroke.

### Printing

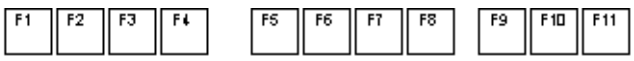
Printing is the act of transferring the images onto a sheet of film once you have set up the film parameters and loaded the images. The Print Series function, (available from the Viewer, the Mini Viewer and the Accelerator Line), allows you to set up and print the series currently being viewed.

## Using the F (Function) Keys

The top row of the computer keyboard is composed of keys labeled **F1** through **F12**. These keys are often called accelerator or function keys. These keys have preset filming and window/level functions associated with them.

The **F1** through **F4** keys are used exclusively for filming. The exact function of each key is detailed in the Loading with the F (Function) Keys section.

Keys **F5** through **F11** are used for adjusting the window/level of an image. The **F5** key corresponds to the most recently set window/level values. Keys **F6** through **F11** correspond to the 6 preset values that are customized from the User Preferences window.




*Keyboard*

- **F1** - Use **F1** to place a single image in the first available frame on the Film Composer. The cursor must be on the desired image to film.

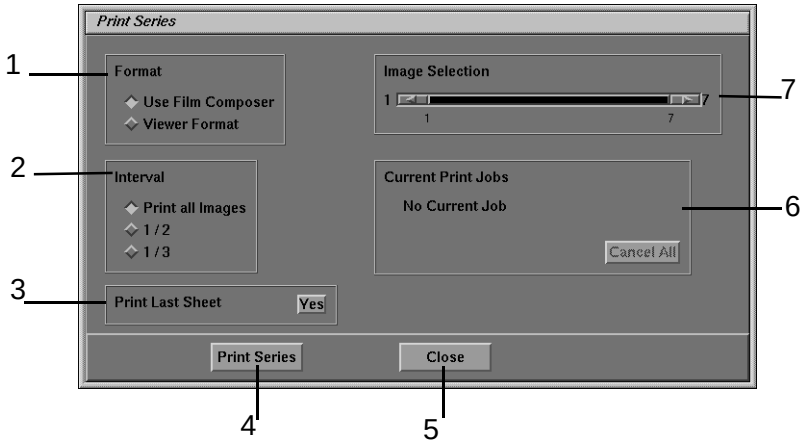
- **F2** - Use **F2** to load an entire page (all of the displayed images in the viewing application) of images into the Film Composer. If the viewing application and the Film Composer format are different, the Film Composer format automatically changes to match the viewing application's format. The cursor can be in any image on the Viewer or Mini Viewer. The Film Composer must be empty to use the **F2** key. If it is not empty, click the **[Clear]** button in the Film Composer window.
- **F3** - Use **F3** to film a multiple image display (**MID**) into one frame on the film. The images must be viewed in the manner you want them on the film (e.g., the screen divided vertically one image occupying each side). Since all the images are placed into a single frame, the resolution of a MID film is not as good as that of a film obtained when the same set of images is filmed using page filming. Also, the images must be magnified by a factor of 2 for them to fill the frame on the film. Scroll images if necessary. Place the cursor in any image on the screen, then press the **F3** key. You cannot skip frames using the **F3** key. Single image frames and **MID** (Multiple image) frames can be mixed on the same film.

Something to Think About...

- Filming using the **F3** key may result in Partial Annotation (Site name, patient ID, system ID, and Lower Left corner annotation - technique are missing) on the film. To prevent this, select Custom Film Annotation (see Displaying Images chapter, section User Preferences) and select the Annotation (typically select all choices) you want to appear. Click the **[OK]** button, and then click the **[Apply]** button for a temporary save, or click the **[Save as Defaults]** button or a permanent change to the film display state. Then film using the **F3** key.
- If a custom message annotated on the viewport spans the left-to-right borders of the viewport and the **F3** key is used for filming, the front portion (about 50%) of the message is cut off. To avoid this, use the **Enter** key and shorten the width of the message and lengthen in the vertical direction.
- **F4** - Use **F4** to film all the images in a single series with just one keystroke. The **F4** key can only be used with the Viewer. The cursor must be in any image on the screen. All of the images are filmed with the same window and level values when using the **F4** key. Typing

print series in the Accelerator Line also prints the entire series.

° The Print Series window appears after pressing the **F4** key, allowing you to customize the print series options.




1 - Format allows you to select to film the series using the film format or the Viewer format.

2 - Interval allows you select to print all the images in the series, or selecting 1/2 prints every other image in the series, or selecting 1/3 prints every third image in the series.

3 - Print last sheet, prints only the last sheet of images in the series.

4 - Clicking the **[Print Series]** button prints the series using the selected options.

5 - Clicking the **[Close]** button exits the Print Series window.

6 - Clicking the **[Cancel All]** button stops the printing of all the print series jobs.

7 - Clicking and dragging on either, or both, ends of the Image Selection slider allows you to select a specific group of images to print.

## The Print Queue

The Print Queue displays the jobs that are waiting to be printed. The queues for the laser camera (printer) and any remote (network) cameras can be accessed from the Print Queue. The Print Queue allows you to stop a job from printing. For example, to stop a duplicate film from printing.

## The Remote Printer

The Remote Printer is a printer, (usually in another area), that is networked to your system. This allows you to continue printing if your laser camera (or paper printer) is not functioning. For example, your camera or processor is shut down for maintenance or cleaning.

# How to Film Images

This section provide the step-by-step instructions for Filming Images. Specifically, it describes how to:

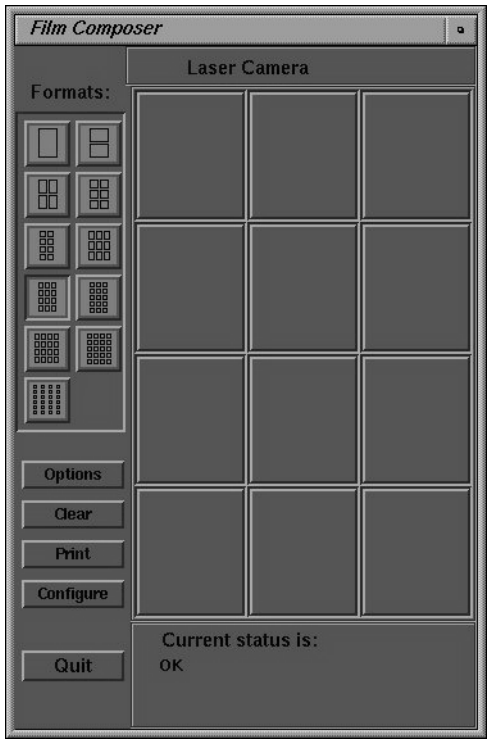
- Set Up the Film Composer
- Load with Drag and Drop
- Load with the Function (F) Keys
- Load Text Pages
- Erase an Image from the Film
- Print Images
- Select a Remote Printer
- Check the Print Queue
- Set Window and Level Presets

# Set Up the Film Composer

Use the Film Composer to print images on film (or paper). There are a number of options you can use when filming, such as film format, number of copies, auto print, and auto clear.

1. Click **[Film Composer]** from the Viewer, Mini Viewer, or Browser.


   - The Film Composer window appears.




*Film Composer*

2. In the **Formats** area, click on the type of film format you would like to use.

## In Brief: Set Up the Film Composer

1. Click **[Film Composer]**.
2. Select the film format.
3. Click **[Options]**.
4. Decide on Options. Click and hold the left mouse and move the cursor to the desired selection and release.
5. Click **[Done]** to close window and enable settings.

Something to Think About...

- If configuring formats in the camera selected and film composer format list, do not automatically take the selected changes, then restart the film composer operation.

3. Click **[Options]**.
   - The Print Options window appears.


*Film Composer/Print Options*

4. Decide the options you want. Click and hold the left mouse on the option, move to the desired choice to make the selection.
   - The number of copies option allows you to type in the desired number of copies. You can also click the up/down arrows to get the desired number.
5. Click **[Done]**.
   - Closes the Print Options window and enables all settings.

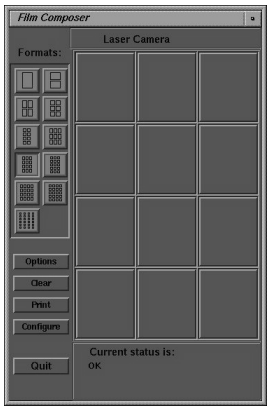
Something to Think About...

- If the film composer disappears when Viewer functions are performed, click **[Film Composer]** from the Viewer window to redisplay the film composer.

# Load with Drag and Drop

Loading the film with drag and drop allows you to choose the exact location on the film to place your image (allowing you to skip frames if desired). Loading with drag and drop allows you to place only one image into a frame on the film. Viewing and film formats do not need to be the same.

1. Have the images of interest in view.
2. Click **[Film Composer]** from the Viewer or the Mini Viewer.




*Film Composer*

3. Select the desired film format.
4. Place the cursor on the desired image.
5. Click and hold on the image, drag to the desired frame in the Film Composer.
6. Release to deposit (drop) the image.
   - If you clicked **[Image]** for your icon label, a reproduction of the image appears in the frame.
   - If you clicked **[E,S,I]** for your icon label, the exam, series, and image appear in the frame.
7. Mover cursor to the next image and repeat the click and use the drag and drop process as needed.

NOTE: It is not necessary to place images in consecutive frames, or fill all the frames on the film.

- If all the frames on the film are not filled, or if **[Auto Printing]** is Off, you must click **[Print]**. Also, you need to click **[Clear]** if **[Auto Clear]** is Off.

## In Brief: Load with Drag and Drop

1. Have images of interest in view.
2. Click **[Film Composer]**.
3. Select the film format.
4. Have the cursor in the desired image.
5. Click and hold on image, drag to frame in the Film Composer.
6. Release to deposit image.
7. Move cursor and repeat step 4-6 as needed.

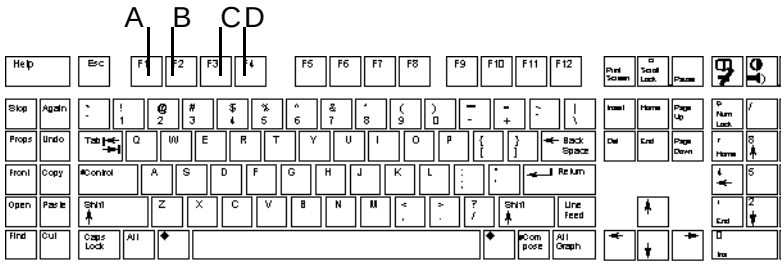
# Load with the Function (F) Keys

## In Brief: Load with the Function (F) Keys

1. Have images of interest in the Viewer or Mini Viewer.
2. Click **[Film Composer]**.
3. Select film format**.**
4. Press the appropriate Function key.

The Function **(F1** through **F4)** keys along the top of the computer keyboard are accelerator keys for filming. Pressing the appropriate key places the images on the film with one keystroke.

1. Display the images on the Viewer or Mini Viewer.
   - See the Displaying Images chapter for more information on how to display an image.
2. Click **[Film Composer]**.
3. Select a film format.
4. Move the cursor onto an image in the Viewer or Mini Viewer and hit the appropriate Function key. The images are loaded into the frames of the Film Composer in the order they were selected.




*Keyboard*

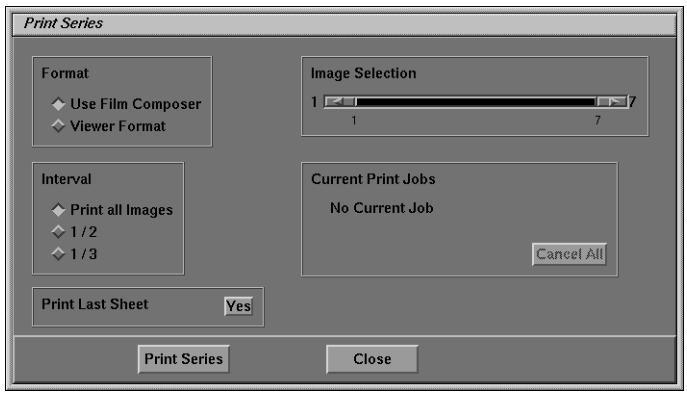
   - ° A, B, C, and D are pointing to Function keys **F1, F2, F3**, and **F4** respectively.
   - **F1** - Use **F1** to place a single image in the first available frame on the Film Composer. The cursor must be on the desired image to film.
   - **F2** - Use **F2** to load an entire page (all of the displayed images in the viewing application) of images into the Film Composer.
   - **F3** - Use **F3** to film multiple image display (**MID**) into one frame on the film. Place the cursor in any image on the screen, then press the **F3** key.

Something to Think About...

- Filming using the **F3** key may result in Partial Annotation (Site name, System ID and Lower Left corner annotation missing) on the film. To prevent this, select Custom Film Annotation (see Displaying Images chapter, section about User Preferences) and select the Annotation

(typically select all choices) you want to appear. Then film using the **F3** key.

- **F4** - Use **F4** to film all the images in a single series with just one keystroke. The **F4** key can only be used with the Viewer. Typing **`print series`** in the Accelerator Line also prints the entire series.
    - The Print Series window appears after pressing the **F4** key. Choose the options to customize the print series.



# Load Text Pages

## In Brief: Load Text Pages

1. Have images of interest in Viewer or Mini Viewer.
2. Click **[Film Composer]**.
3. Click **[Text Page]**, and then click either **[Exam]**, or **[Series]**.
4. Use the **F1** key or click **[Film]** on the text page to load text page on the film.

Text pages contain patient information. You may decide to have a frame on the film that lists this information. Text pages can list the exam or series information. The exam text page lists all the information entered on the Patient Information area and all the series (with scan parameter information) completed on this patient.

The series text page lists all the patient information entered on the Patient Information area and lists the images (image numbers, locations, plane and other parameters). The series text pages also list the prescan values for that series. Text pages can be accessed from the Viewer or the Mini Viewer.

1. Have images of interest in view.
2. Click **[Text Page]**.

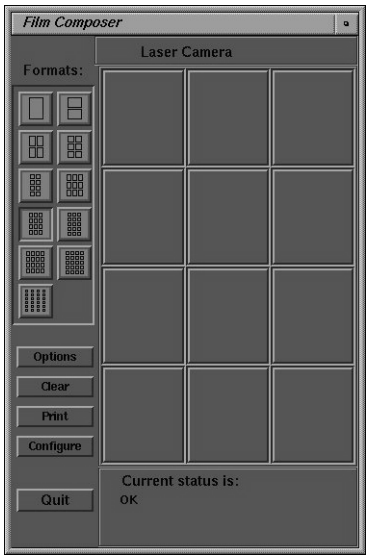

*The Text Page menu appears.*

3. Click on the desired choice.
   - **[Exam]** to show the Exam Text Page or **[Series]** to show the Series Text Page.
   - The Accelerator command for Exam Text Page is **`te`** and for Series Text Page is **`ts`**.
4. Load the text page on the Film Composer by pressing the **F1** key. The cursor must be inside the Exam or Series Text Page. You can also click **[Film]** from the bottom of the Text page.
   - Both methods of filming place the text page it in the next available frame on the Film Composer.

# Erase an Image from the Film

While filming, you may decide to remove an image from a frame on the Film Composer.

1. Have the Film Composer open with at least one image in a frame on the film.




*Film Composer*

2. In the Film Composer, click on the image you wish to erase.
3. A message appears asking if you really want to discard this image. Click **[Yes]** to discard the image, or **[No]** to exit without erasing the image from the film.

NOTE: If you want to erase all the images on the film, click **[Quit]**.

## In Brief: Erase an Image from the Film

1. Have images on a film in the Film Composer.
2. Click an image to erase.
3. Click **[Yes]** to discard or **[No]** to exit.

# Print Images

## In Brief: Printing

1. Have images in frames of film in Film Composer.
2. Click **[Print]**.
3. Click **[Quit]** or click on the iconify button to close the Film Composer.

Printing is the process of sending the images to the Print Queue and from there to the laser camera (or paper printer) to get printed on the film (or paper). As mentioned in the section on Film Composer, if you have Auto Printing on, the film prints automatically when the frames are full. Turn auto printing off if you want to check your film before it leaves the Film Composer. For example, to check that you have filmed images in the proper order. This procedure assumes auto print is off.

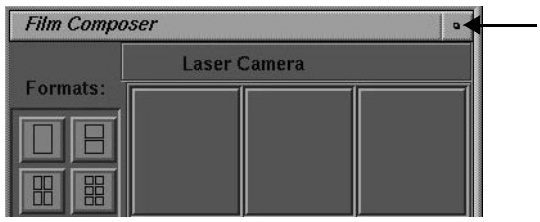
1. Have all the images needed in the frames of the film in the Film Composer.
2. Click **[Print]**.


   - Prints the contents of the Film Composer.
   - The Status area at the bottom of the Film Composer changes to display Printing..., and the image data are sent to the print queue. The output device prints the data when it reaches the top of the print queue.
   - If Auto Clear Page is On, the film in the Film Composer clears automatically.
     - If Auto Clear Page is Off, you need to click **[Clear]**. At the confirmation message click **[OK]** to clear the film from the Film Composer. Clicking **[Cancel]** exits without clearing the film.

3. When you are finished filming, close out of the Film Composer by clicking **[Quit]**.

NOTE: Clicking **[Quit]** clears any images left in the frames.

   - To close the Film Composer without losing any images in the frames, click on the Film Composer iconify button in the upper right hand corner of the Film Composer window.




*Film Composer*

# Select a Remote Printer

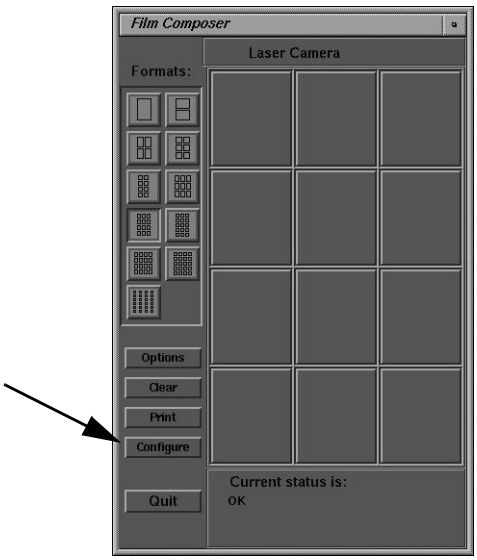
A remote printer is a printer (either a laser camera or paper printer) located outside of your immediate area. This printer can be networked to your system and used as an additional or backup printer. Only one printer can be used for a print job.

Something to Think About...

- The initial set up of a Remote Printer requires the assistance of a service engineer and your facility's Information Systems department.

1. Click **[Film Composer]**.


2. Click **[Configure]**.




*Browser/Film Composer*

*A window appears with buttons to* **[Add]**, **[Update]**, *or* **[Delete]** *printers.*

3. Click **[Add]**.
   - At this point you will need the assistance of your institution's Information Technology department for printer names, IP addresses, etc.

## In Brief: Select A Remote Printer

1. Click **[Film Composer]**.
2. Click **[Configure]**.
3. Click **[Add]**.
   - Enlist the help of IT dept. and service engineer to configure.
4. Click **[Done]**.
5. Click **[Configure]**.
6. Select the printer just configured.
7. Click **[Update]**.

4. Once the data for the remote printer has been entered, click **[Done]** on the Remote Configure window, to exit this window.

NOTE: DO NOT click **[Update]** at this point. You must first click **[Done]**.

5. Click **[Configure]**.

6. Select the printer just configured.

7. Click **[Update]**.

Something to Think About...

- If configuring formats in the camera selected and film composer format list, do not automatically take the selected changes, then click immediately on Printer Label located at the top of the Film Composer application after configuring the printer.

# Check the Print Queue

The Print Queue is the holding area for films that are waiting to go the laser camera or networked printers. In the Print Queue, you can view how many films are waiting to be printed or stop jobs from being printed.

1. Click **[Queue]**, from the menu bar on the Browser.


*Browser/Queue*

2. Click **Filming**.
   - The Filming Queue window appears. Two queues show, the top half of the window shows the Laser Camera Queue, and the bottom half of the window shows the Network Film Queue.
   - The job at the top of the list is the job currently being printed.

NOTE: If there are no jobs in the Print Queue, a message appears telling you the film composer queue is empty. Click **[OK]**.


*Queue/Confirm*

3. Do one of the following:
   - ° Click **[Pause All]** to temporarily pause all jobs in the Queue. The word **(Paused)** appears after each job.

## In Brief: Check the Print Queue

1. From the Browser, click **[Queue]**.
2. Click **Filming**.
3. Select the desired function.
4. Click **[Refresh]** to update or **[Quit]** to exit.

- Click **[Resume All]** to restart all jobs in the Queue. The word (Active) or (Pending) appears after each job. Active jobs are in the process of printing or networking (depending on the queue the job is in) and pending jobs are those waiting to print or network (again, depending on the queue).
- Click on a specific job to pause only that specific job. The word (Pause) appears after the job name.
- Click on a specific job to resume only that specific job. The word (Active) or (Pending) appears after the job name.
- Click on one or more jobs and click **[Clear]** to remove them from the Queue.

4. Do one of the following:
   - Click **[Refresh]** to update the window to show the current status of the jobs.
   - Click **[Quit]** to exit from the queue.
   - These buttons affect both queues.

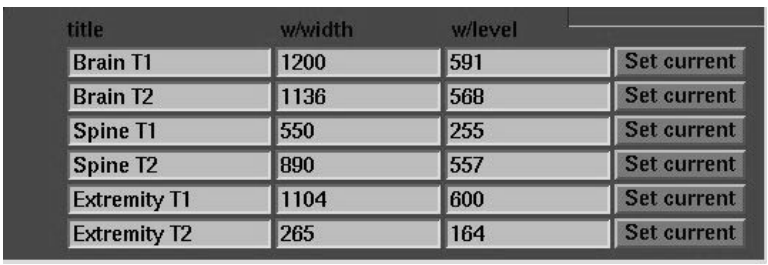
# Set Window and Level Presets

Using preset window widths and window levels allows you to quickly adjust the brightness and contrast of a displayed image. You can program up to six different settings for your system. If the operator's console is networked with a CT system, you can have a separate set of six preset values for CT images. The following are step-by-step instructions to customize the preset values. Pressing one of these "F" keys changes the window width and level to the preset value.

NOTE: The **F5** key sets the window and level to the most recent settings.

1. Display images in the Viewer. Window Width and Window Level presets cannot be set from the Mini Viewer.
2. Click **[User Preferences]**.


   - Located on the bottom left of the Viewer.
3. Click and hold **[Modality]** and select the appropriate modality.
4. In the Presets area, double-click on the text you want to change and press the **Delete** key (on the keyboard).
5. Do one of the following:
   - In the title, w/width, or w/level text boxes, type in the new text.
   - W/width and w/level need to be entered as numbers.




*User Preferences/Presets*

   - Click **[Set Current]** to set the Window Width and Level to that of the displayed image.

## In Brief: Set Window and Level Presets

1. Have images displayed in the Viewer.
2. Click **[User Preferences]**.
3. Click and hold, release on the appropriate Modality.
4. In Presets area highlight the text box and type text and/or values.
5. Type in the text desired for title, w/width or w/level. Or, click **[Set Current]**.
6. Click **[Apply]**, **[Save as Defaults]**, or **[Cancel]**.

6. Do one of the following:
   - Click **[Save As Defaults]**, to replace the current setting with the new setting and save for future use.
   - Click **[Apply]**, to apply the new settings on the displayed image. The settings are not saved.
   - Click **[Cancel]**, to exit without saving the changes.

Volume 1

# Chapter 11

# Managing Images

### Where Am I?

## Introduction

This chapter explains the process of managing images. It highlights key concepts and provides brief guidelines for creating an anonymous patient, as well as, saving, restoring, deleting, and networking images. This chapter also contains the step-by-step instructions to help you learn how to:

- Create an Anonymous Patient
- Select an Archive Device
- Label your Storage Media
- Save Images to a Storage Media or Remote Archive Device
- Restore Images to the System Disk
- View and Alter Queues
- Detach the Storage Media from your System
- Remove Images from the System Disk
- Network Images to and from Connected Stations

In addition, this chapter answers the following questions:

1. What is the feature status area?
2. What is an anonymous patient?
3. What is archive media?
4. What archive media are compatible with the system?
5. How do you label a MOD?
6. What messages warn about disk space limits?
7. What is a network?
8. What components can be networked?

# About... Managing Images

This section presents the concepts necessary to successfully complete the process of managing image data. Specifically you need to understand:

- Feature Status Area
- Anonymous Patient
- Archive Media
  - Selecting an Archive Device
  - Composition of the Archive Option
  - Labeling the Storage Media
  - Saving Images
  - Restoring Images from Local Archive Media
  - Archive Queues
- Managing Disk Space
  - System Disk Space
  - Removing Images from the System Disk
- Networks
  - Networking Terms
  - Network Queues

## Feature Status Area

The Feature Status area displays a status message to the right of the four image management icons. From left to right, the icons are for image reconstruction, filming, archive and network functions.

A continuously updated status message appears to the right of the image reconstruction, filming, archive and network icons.


- Scan Reconstruction Status
  - ° Text to the right of this icon indicates exam, series, and image numbers being reconstructed.
- Filming Status
  - ° Text to the right of this icon indicates filming status of the images being filmed.
- Archive Status
  - ° Text to the right of this icon indicates the archive status of the images being archived.
- Network Status
  - ° Text to the right of this icon indicates the status of the system's networking functions.

## Anonymous Patient

There may be times when you want the name of a patient to be kept confidential. You can do this using the anonymous patient feature.

Some situations for using this feature include:

- Your radiologist wants to take the films to a conference.
- You have scanned a test patient or volunteer and do not want the name displayed.
- You want to use the films in a display or at a show.

An anonymous patient can be created by exam, series, or even a single image.

# Archive Media

This section explains the set-up and use of an off-line filing system for images. The archive media feature allows you to save, remove, and restore images to and from a media storage device or remote host.

The archive system uses a Magnetic Optical Disk (MOD) for storage. Images stored on MOD are "off-line," meaning that in order to display the images, you must first restore them to the system disk. The MOD is considered a local archive device. Communication from your system to the MOD is in a DICOM format, so the MOD is listed in the archive window as a DICOM_MOD.

The archive function can read from and write to MaxOptix archive media. Archive can also be used to import data from Pioneer MODs or legacy digital audio tapes (DATs). Archive offers "read only" capabilities with these archive media.

In addition to the MaxOptics MOD, images can be archived to DICOM networked remote archive devices. The DICOM networked devices archived to your system are listed in the archive windows as remote devices.

## Selecting an Archive Device

Before saving or restoring image data the archive device must be selected. The archive function can be accessed from the Image Management or the Display Desktop.

- The archive devices on your system depend on your site’s unique configuration.
- To save images the archive device can be the local MaxOptics MOD, or a DICOM networked remote device (Remote Archive Host).
- To restore images the selected archive device must be a local device, the MaxOptics MOD, the Pioneer 5-1/4, MOD or Legacy DAT.
- The following compatibility issues exist for archiving to MOD:
  - 8.2.5 and 8.3 images cannot be saved to MaxOptics MODs labeled on a system with software that is Signa 8.2 or earlier.
  - Images stored on MaxOptics from Signa 8.2 or earlier, CAN be restored to a system with 8.2.5 or 8.3 software.

- 8.2.5 and 8.3 images cannot be saved to MaxOptics MODs labeled on Signa Advantage systems with 5.8 software and equipped with the MaxOptics MOD drive.
- Signa Advantage 5.8 MaxOptics saved images CAN be restored to Signa 8.1.5 and 8.3
- MaxOptics MODs labeled and saved to Signa 8.2.5 and 8.3 cannot be read and images cannot be restored to a Signa Advantage 5.8 system equipped with the MaxOptics MOD drive.
- The archive Browser of a DICOM MOD (note that the archive feature on Signa 8.2, 8.2.5, and 8.3 use the DICOM format) does not provide all image information in the same format as the Signa image Browser. Some of the discrepancies seen include slice spacing and number of echoes, as well as others. Note that Rectangular FOV and NEX (when No Phase Wrap is used) can be misleading. Therefore, it is recommended that the Archive not be used to obtain scan parameter information. Restore an image(s) to obtain the scan parameters.

NOTE: Remote archive devices must be configured through the Network. In addition, the network to that device must be active to save images to the desired remote archive host. See selecting a Remote Host in the Network section of this chapter to configure a remote archive device and select a remote archive host for saving images.

## Composition of Archiving Option

Your MR system equipped with the archiving option has a 5 ¼" MOD archive device. The archiving software is installed in the workspace cabinet. The archiving software is indicated by the presence of the Archive selection on the Browser menu bar. This can be accessed from the Image Management or the Display Desktop.

## Labeling the Storage Media

Brand new MODs must be labeled before they can be used on the system. MODs that contain data that is not needed anymore can also be relabeled. When an MOD is relabeled, all existing data on it are permanently erased.

Once the labeling process is complete, the Media ID, format type, number of images on the media and percent of media used are displayed at the bottom of the Browser.

Something to Think About...

- Archive media on remote archive devices cannot be labeled from your MR system.

## Saving Images

Archive images from the system disk on a regular basis. Archive as soon as an exam is complete to provide a back up in case of a disk crash. The time to store an image using MaxOptix MOD media is approximately 2 seconds per 512x512 image. Before attempting to save images on a MOD, be sure to be in compliance with the restrictions listed below.

### Restrictions for Saving Images

The ability to save images depends on the archive device type and the initial source of images.

- The following archive devices can be used to save image data:
  - The local MaxOptics MOD labeled on Signa.
  - DICOM Networked remote archive devices.
- Images from the following sources, once on your MR system, can be saved to local and remote devices:
  - Signa 4X.
  - Genesis (e.g. Signa 5X, CT Highlight Advantage or CT/MR Independent Console).
  - ODINA with Genesis shadow group.
  - ODINA with 9800 shadow group.
  - GE-YMS CT scanners with Advantage Net.
  - Advantage Windows 1.2 (except client data as indicated by *CL* in the *mod* column of the series list on the main Browser).
  - GE-YMS MR scanners.

NOTE: Only local archive devices can be selected for the Auto Archive function. Refer to "Networking from the Scan Rx Desktop" in the tasks section of this chapter and the ScanRx Desktop chapter for information regarding Auto Archive.

Something to Think About...

- The Archive window appears as Archive (active) if other items are already in the process of being saved or restored, but the window is still available. Requests are saved in a queue and executed as soon as the other requests ahead are completed.

- Items being saved cannot be deleted from the workstation system disk until the save process is complete. This is indicated by the gray Remove selection title on the Browser whenever items being saved are selected.
- Saving third party images is not allowed. Attempting to save these images results in an archive pause status for the selected images.

## Restoring Images from Local Archive Media

Image data residing on Pioneer MODs and Legacy DATs can be restored to your MR system. When restoring or reading from archive media, the system makes a copy of the image data and does not remove the image data from the archive media. Images must be restored to be viewed, you cannot view images directly from archive media. The time it takes to retrieve an image using MaxOptics MOD media are approximately 2 seconds per 512x512 image. Before attempting to restore images to the workstation, be sure to be in compliance with the restrictions listed below.

### Restrictions for Restoring Images from Archive Media

The ability to restore images to your MR system depends on the media type and image format.

- Media types available to restore image data to workstation:
  - MaxOptics or Pioneer MOD labeled on Signa.
  - MOD labeled on any Genesis OC/IC.
  - MOD labeled on a GE-YMS system equipped with a Pioneer brand MOD drive.
  - MOD labeled on Advantage Windows.
  - Legacy DAT labeled on any Genesis OC/IC.
- Image types that can be restored to your MR system:
  - All Genesis images.
  - GE-YMS.
  - Advantage Windows.

Something to Think About...

- Image data cannot be restored from remote archive devices.
- When viewing the Browser of the MaxOptics MOD, the displayed slice spacing may not be the same value as the spacing indicated on the workstation image Browser. This is because the DICOM definition of spacing is

generally the slice thickness plus the spacing. If these images are restored to your MR system, the correct spacing is reflected.

- The annotation for a DICOM image is incomplete for fields supported by Genesis or GE-YMS systems and not by DICOM. Be aware that DICOM images may not contain all the information that is provided by a Genesis or GE-YMS image.

## Archive Queue

An archive queue is a list of images transferring to or from an archive medium. The archive queue has both save and restore queues, therefore, it is not necessary to wait for one save or restore request to be carried out before setting up the next one. When a save request is set up, it is sent to the save queue. When a restore request is set up, it is sent to the restore queue.

If there are save and/or restore processes taking place, the Local Archive or Remote Archive windows open. The window depends on which device (local or remote), has a process taking place.

- The Local Archive window displays both the Archive Save Queue and the Archive Restore Queue.
- The Remote Archive window displays only the Remote Archive Save Queue. (Restore can not be done through remote devices.)

Each line in a queue represents a job to be executed as shown in the table below.

| ***Job*** | ***Representation*** |
|---|---|
| Entire Exam | Exam number |
| Entire Series | Exam number/series number |
| Single Image | Exam number/series number/image number |

All jobs are followed by the archive device name in parentheses. After the display of the archive device a status message follows.

- *(Active)* indicates the job is currently being executed.
- *(Pending)* indicates the job is waiting to be executed.
- *(Paused)* indicates the job is temporarily paused.

Something to Think About...

- Jobs in the restore queue have priority over jobs in the save queue. Save jobs are started once the restore queue is empty.
- If an entire exam or series is being saved or restored, only one job is executed for the entire exam or series, respectively. But, if only a certain series in an exam, or a certain image in a series is being saved or restored, a separate job is executed for each series or image, respectively.
- The restore queue is deleted on system shutdown or by selecting Detach from the Archive window, whereas the save queue is maintained under either of these conditions.

## Managing Disk Space

The system disk contains all of the operating software as well as the image data. The system disk is intended for temporary storage of image data for reviewing and filming. Once those tasks have been completed, archive the images should and remove them from the system disk.

### System Disk Space

Available disk space is always shown in the System Status Display area (located in the upper left corner of the screen). It reports how much space is available for 256x256 and 512x512 images, as well as, a percentage of how full the system disk actually is.


The system posts messages when disk space is low or at a critical level.

- The Low Image Space message warns that image space is becoming limited and recommends that you remove archived exams.

- The Critical Image Space message warns that image space is insufficient for the current acquisition and you must remove archived exams in order to continue.

Something to Think About...

- If image space is less than the predefined minimum, these messages continue to be displayed after each completed exam.
- To keep the system performing at normal speed, it is recommended that you delete images before the disk space reaches 65% capacity. As the disk space reaches maximum capacity, all system features slow down.

NOTE: Your system can hold up to 4 gigabyte of hard disk information. This allows a maximum number of 30,000 images on system hard disk. Through your GE Sales Representative you can also purchase more gigabytes for your hard disk. Up to 9 gigabyte are allowed at this time. This permits up to 90,000 images to be stored on the system. Ask your GE Sales Representative for more details about additional disk space.

## Removing Images from the System Disk

Eventually, you want to remove an image, series, or entire exam from the system image disk to make room for others. This function is performed by using the Remove selection located on the Browser menu bar.

Something to Think About...

- Once you have deleted an exam, series, or image from the system disk, it is permanently removed. Use care in making your decisions.
- Do not delete images which have been networked or filmed until you verify that these tasks have been successfully completed.
- The Remove menu title appears in gray and cannot be used if a selected item is in use by the Viewer or a Mini Viewer, if it is being used by a network “Push” operation, or if it is being used by an archiving “Save” operation.

# Networks

Networks link image acquisition systems and workstations together. By connecting these compatible devices to your scanner you now have the ability to quickly and easily transfer images between your scanner, remote workstations, and other image acquisition systems. With systems networked together, you may view images supported by your scanner from any station, or view images from other stations on your scanner.

Advantages to this capability include:

- Increased productivity of your medical imaging system. You can routinely off-load display, manipulation, and filming activities from your scanner to another workstation. The scanner is free to continue scanning patients. This also eliminates the problems associated with the hand-delivery of films.
- Increased accessibility to images and patient exams. You can have any images supported by your scanner available for additional review at any station on a network, when needed.
- A quicker access of images to the radiologist. Images can quickly be networked to another station (such as a GE workstation), to allow radiologist review prior to your patient even getting off the scan table.

## Networking Terms

The table below contains some terms that are associated with the process of networking.

| ***Term*** | ***Definition*** |
|---|---|
| **Remote Host** | Image acquisition or workstation connected to the network. Each host has its own network address. |
| **Transfer** | The moving of imaging data between stations. |
| **Transmit/Push** | The action of sending images from one station to another. |
| **Receive/Pull** | The action of retrieving images from another station. |
| **Auto Transfer by Exam** | Automatic image transfer of a newly completed exam. |
| **Auto Transfer by Series** | Automatic image transfer of a newly completed series. |

## Network Queues

A network queue contains a list of images transferring to or from an a network medium. The network queue has both send and receive queues, therefore, it is not necessary to wait for one send or get request to be carried out before setting up the next one. When a transmit request is set up, it is sent to the send queue, and when a receive request is set up, it is sent to the receive queue. To view the requests waiting in the queues, access the respective network queue.

If there are send or receive operations taking place, the Network Queue window opens, displaying network servers currently performing transfers to both Advantage Net and DICOM. Other servers not currently perfoming transfers are not displayed.

- The Send Images window displays the exams, series or images that are currently being transmitted from your MR system.
- The Receive Images window displays the exams, series, images that are currently being retrieved from another workstation.

Each line in a queue represents a job to be executed as shown in the table below.

| ***Job*** | ***Representation*** |
|---|---|
| Entire Exam | Exam number |
| Entire Series | Exam number/series number |
| Single Image | Exam number/series number/image number |

All jobs are followed by the remote server name in parentheses. After the display of the server name a status message follows.

- *(Active)* indicates the job is currently being executed.
- *(Pending)* indicates the job is waiting to be executed.
- *(Paused)* indicates the job is temporarily paused.

Something to Think About...

- Before sending or receiving images, check to see that there is enough room on the image disk to accommodate the images being transferred. Information about media disk space is displayed at the bottom of the Browser.

- Your MR system does not always inform you if the system has failed to completely transfer all the data requested. Therefore, check with the source or destination host to verify that the data has been transferred successfully. (The system tells if the network is active.)
- Remote hosts can be configured through the Remote Host Selection window. The hosts are generally configured by your GE Service Engineer or your site's network personnel. Consult your service engineer or network personnel for a list of hosts and their assigned host names.
- While your MR system allows you to remove host names from the Remote Host Selection list, you should do so with caution. When a host name is removed, it is permanently deleted. If a host name is inadvertently deleted from a configuration file, your service engineer or network personnel should restore it.
- Images cannot be retrieved from Advantage Windows to your MR system. The Advantage Windows consoles with version 1.2 and 2.0 lack the DICOM Query Provider to enable this functionality. If a connection is attempted, the Remote Browser for the Advantage Windows console appears blank. If other remote host cannot be reached, recheck cables. If problem persists contact your GE Service Engineer.
- When images are being sent from one Signa workstation to another Signa workstation, the receiving station shows the job on the Advantage Receive Queue. This is also shown in the Feature Status area.
- To network images created from an Advantage Windows 3.1 system to a Signa 8.3 system or higher, use the Network DICOM protocol.

# How to Manage Your Images

This section provides the step-by-step instructions for handling image data with archive media, managing available disk space and networking image data to alternate locations. Specifically, it describes how to:

- Create an Anonymous Patient
- Archive Image Data
  - Select an Archive Device
  - Label Storage Media
  - Save Images
  - Restore Images
  - Check the Archive Queue
  - Detach Storage Media
- Manage Disk Space
  - Remove Image Data
- Configure a Remote Host
  - Add a Host
  - Remove a Host
  - Update a Host
- Network Images to Alternate Locations
  - Network from the Scan Rx Desktop
  - Transmit Images to a Remote Host
  - Retrieve Images from a Remote Host
- Check the Network Queue

# Create an Anonymous Patient

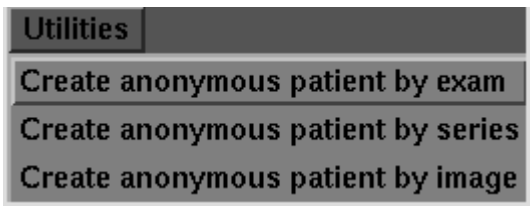
## In Brief: Create an Anonymous Patient

1. Click **Display Desktop**.
2. Select the patient you want to be anonymous.
3. Select **Utilities** > **Create anonymous patient by exam**, **series**, or **image**.
4. Click **[OK]**.

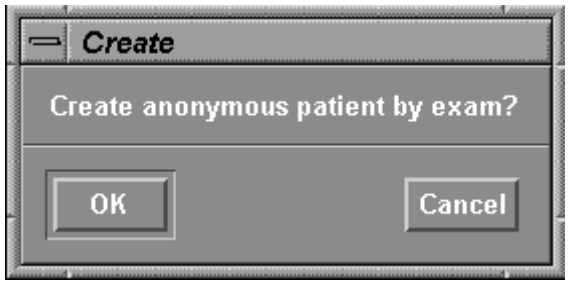
Use this procedure to change the patient name of a completed exam to Anonymous. The following steps guide you through changing your patient's name to Anonymous.

1. Click **Display Desktop**.
   - Located on the control panel.

   - If you have just booted up your system, the Scan Rx Desktop is the default menu.
   - The patient list appears on the Browser after entering the Display Desktop.
2. Select the patient you want to be anonymous from the patient list in the Browser.
   - If you want only specific series or images to be anonymous, carefully select only those series or images desired.
3. Select **Utilities > Create anonymous patient by exam, series,** or **image**.
   - Located on the Browser menu bar.



- The create box appears, prompting a selection to continue the creation process or to cancel the process.




4. Click **[OK]**.
   - The create process begins.
   - The listed name changes to anonymous followed by the exam number.

## Archive Image Data

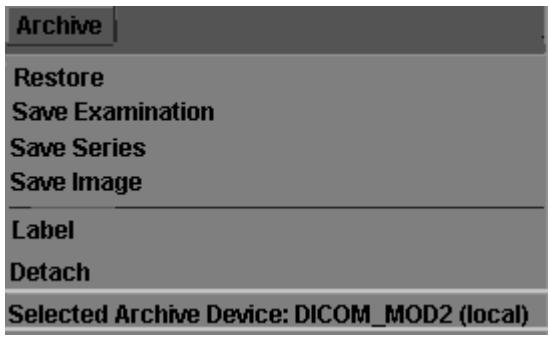
# Select an Archive Device

### In Brief: Select an Archive Device

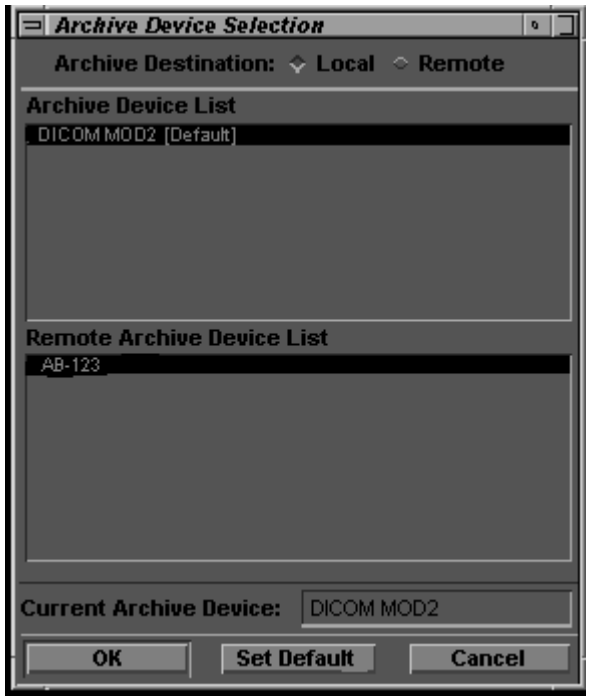
1. Click **Image Management Desktop**.
2. Select **Archive** > **Selected Archive Device**.
3. Select **Archive Destination > Local** or **Remote**.
4. Select desired Archive Device.
5. Click **[OK]**.

Use this procedure to select the archive device before saving or restoring image data. To save images the archive device can be the local MaxOptics MOD, or a DICOM networked remote device. To restore images the selected archive device must be a local device, such as the MaxOptics MOD, the Pioneer MOD, or Legacy DAT. The following steps guide you through selecting an archive device for your system.

1. Click **Image Management Desktop**.
   - Located on the control panel.
   - The Browser appears.
     - The Browser can also be accessed from the Display Desktop on the control panel.
2. Select **Archive > Selected Archive Device**.
   - Located on the Browser menu bar.



- The Archive Device Selection window appears.




3. Select the **Archive Destination** > **Local** or **Remote**.
   - Local accesses the MaxOptics MOD, Legacy DAT or Pioneer MOD.
   - Remote saves images to a remote device.
4. Select the desired archive device by doing one of the following:
   - Select the **Archive Device List** for local devices.
   - Select the **Remote Archive Host List** for remote devices.
5. Click **[OK]**.
   - The selection enables and the Archive Device Selection window closes.

## Archive Image Data

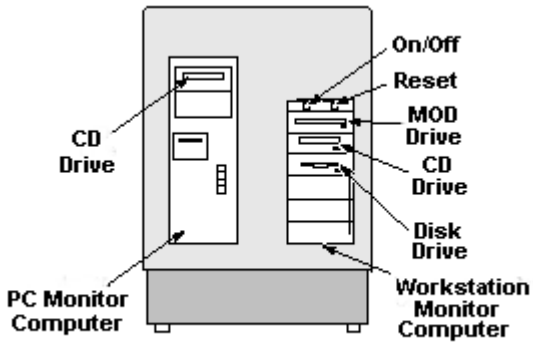
# Label Storage Media

### In Brief: Label Storage Media

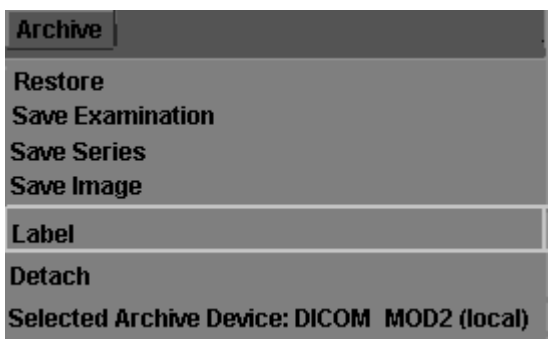
1. Insert MOD into MOD drive.
2. Click **Image Management Desktop**.
3. Click **Archive > Label**.
4. Enter an identification number in the **Media ID Number** text box.
5. Enter notes or remarks in the **Comments** text box.
6. Click **[Label]**.
7. Read warning about the destruction of existing data (on a used MOD) and click **[OK]**.

Use this procedure to label an MOD for use on your MR system or erase a used MOD in preparation for reuse. The MaxOptics MOD is the media that can be labeled from your MR system. Brand new MODs must be labeled before they are able to store image data. Also, use this procedure to relabel a MOD which contains data that is no longer needed.

1. Insert the MOD desired side up in the MOD drive.




2. Click **Image Management Desktop**.
   - Located on the control panel.
   - The Browser appears.
     - The Browser can also be accessed from the Display Desktop on the control panel.
3. Click **Archive > Label**.
   - Located on the Browser menu bar.



- The Format Window appears.


- The archive device name is shown in the upper left corner of the Format Window. The name reflects the MaxOptics MOD drive. This is set up during installation and requires no intervention.

4. Enter an identification number in the **Media ID Number** text box.
   - This value is the MOD label.
5. Enter notes or remarks in the **Comments** text box.
   - Typically, information about the type of images, MOD side, or pertinent information is entered.
     - The entered text appears at the bottom of the Archive Browser during selection of images to be restored from this MOD side.
     - The maximum number of characters allowed in this text box is 160.
6. Click **[Label]**.
   - The labeling process begins.
   - One of the following messages display:
     - If this is a new MOD, a confirmation message asks the you to *"Please refer to the Operator Manual for limitations regarding archive media exchange between GE Products."*
     - If there is no media in the drive, an attention message is displayed.


     - If the MOD has previously been labeled, an Erase message is posted, *"Selecting OK will erase the*

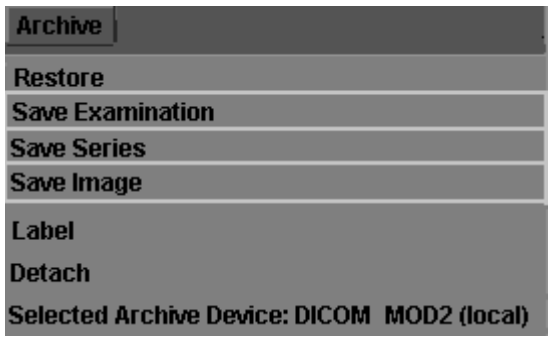
*contents of the disk. Are you sure you want to relabel the disk?"*

7. Click **[OK]**.
   - Acknowledges the message and continues the labeling process.

# Save Images

Use this procedure to save images on an MOD. The archiving feature allows you to save large amounts of image data onto the local MOD or remote archiving hosts. When saving/writing to archive media, the system makes a copy of the image data and does not remove the image data from the main system disk. The following steps guide you through saving images.

1. Insert the MOD desired side up in the MOD drive.
2. Click **Image Management Desktop**.
   - Located on the control panel.
   - The Browser appears.
     - The Browser can also be accessed from the Display Desktop on the control panel.
3. Select the desired patient exams, series or images to be saved from the Browser patient list.
   - You can select images for saving by:
     - Single or multiple examinations.
     - Single or multiple series within an examination.
     - Single or multiple images within a series.
4. Select **Archive > Save Examination**, **Save Series**, or **Save Image**.
   - Located on the Browser menu bar.




   - All items selected on the patient list for saving are written onto the media in the selected archive device.

## In Brief: Save Images

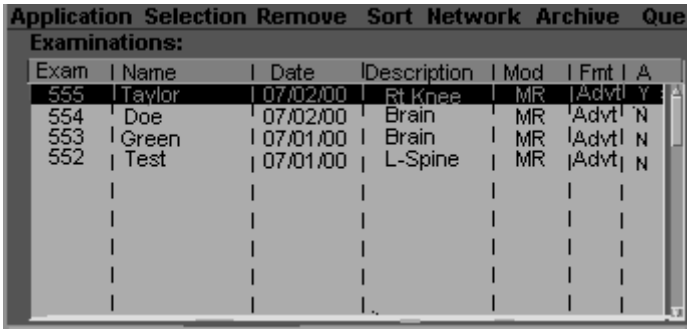
1. Insert MOD into MOD drive.
2. Click **Image Management Desktop**.
3. Select the exams, series or images to be saved.
4. Select **Archive > Save Examination**, **Save Series**, or **Save Images**.
5. Click **[OK]**.
6. Select **Archive > Detach**.

- The Save message appears requesting confirmation to save the requested examinations, series, or images.


5. Click **[OK]**.
   - Acknowledges the message and continues the save request.
   - The Feature Status area shows Archive (active) in the lower left corner beside the Archive icon.


   - The Archive window remains available for additional requests.
   - The archive status is displayed on the Browser.
     - The letter **Y** (for yes) appears in the Archive column, indicated by the letter **A**, of its respective entry in the images list. When archived images are networked directly to another Signa workstation, they also appear as archived on that station's Browser. This allows you to keep track of what images have and have not been saved.
     - If the images are received from a non-Signa system, the letter **N** (for no) appears in the Archive column,

regardless of whether or not they had been previously archived.




6. Click **Archive > Detach**.
   - The MaxOptics MOD ejects from the MOD drive.

## Archive Image Data

# Restore Images from Local Archive Media

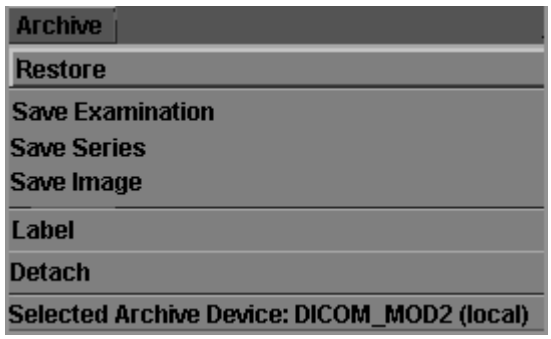
### In Brief: Restore Images

1. Insert MOD into MOD drive.
2. Click **Image Management Desktop**.
3. Select **Archive > Restore**.
4. Select the desired exams, series or images.
5. Click **Restore**.
6. Select **Restore Examination**, **Restore Series**, or **Restore Images**.
7. Click **[OK]**.
8. Select **Archive > Detach**.
9. Click on a different desktop to exit.

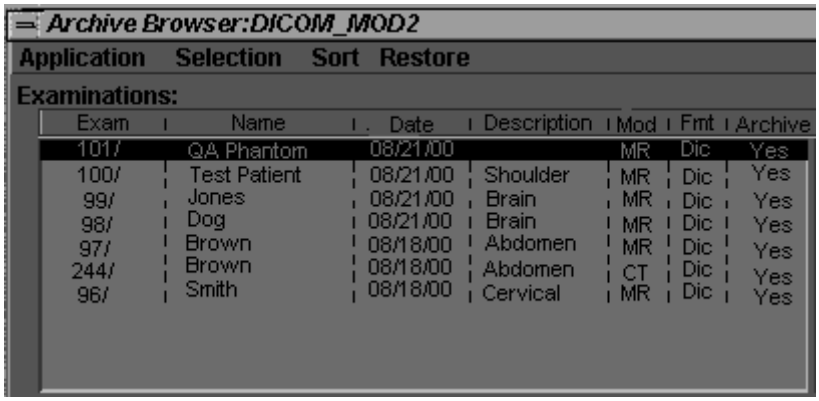
This procedure guides you through the restoration process of images from local archive media. When reading or restoring from archive media, the system makes a copy of the image data and does not remove the image data from the archive media. Images must be restored to be viewed; you cannot view images directly from archive media. Follow these steps to restore desired images:

1. Determine which side of the MOD contains the images to be restored (side A or side B) and insert in the MOD drive accordingly.
   - If you are restoring from a DAT, insert the tape into the drive.
     - See user documentation provided by the manufacturer of the DAT drive.
2. Click **Image Management Desktop**.
   - Located on the control panel.
   - The Browser appears.
     - The Browser can also be accessed from the Display Desktop on the control panel.
3. Select **Archive > Restore**.
   - Located on the Browser menu bar.

NOTE: See selecting the archive device earlier in this chapter.

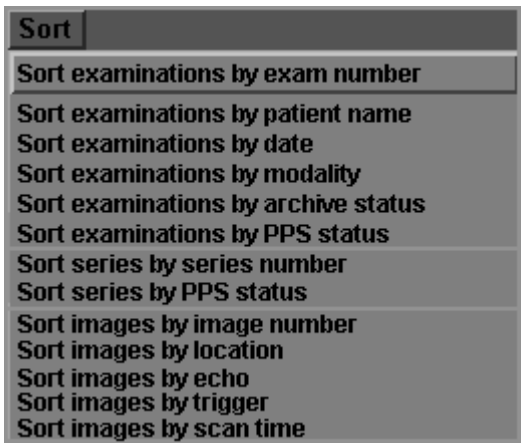


- The Archive Browser window appears, displaying the exams, series, and images on the media of the selected device.
- Verify that the selected archive device is the device needed for restoring.




4. Select the desired exams, series or images to be restored from the disk.
   - If necessary, use the Sort menu and Selection menu on the Archive Browser menu bar to quickly find the information you are looking for by doing one of the following:
     - Select **Selection > Select all of the examinations**, **Select all series**, or **Select all images**.


     - Select **Sort >** a sort method.

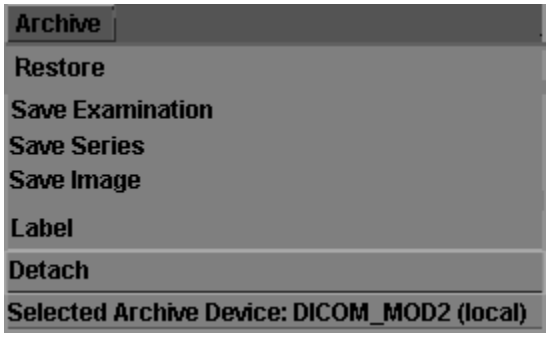


5. Select **Restore** > **Restore Examination**, **Restore Series** or **Restore Images**, depending on what is to be restored.
   - The Restore message appears requesting confirmation to restore selected examinations, series, images.


6. Click **[OK]**.
   - Acknowledges the message and the items selected begin to restore and read from the media to the workstation.
   - The Feature Status area shows Archive (active) in the lower left corner.


   - The Archive window remains available for additional requests. Requests are saved in a queue and executed as soon as the other requests ahead are completed.
   - Once requests are completed, the Feature Status area shows the last restored selection beside the Archive icon.
   - All restored images appear on the main Browser images list with **Y** (for yes) in the Archive column.

7. Select **Archive > Detach**.




   - The media is ejects from the drive.

8. Click on a different desktop icon to close the Archive Browser.
   - The Archive Browser closes automatically when the detach option in the Archive menu on the main Browser executes.

Something to Think About...

- You can select multiple entries by selecting one entry and holding down the **Shift** key or the **Ctrl** key on the keyboard.
  - Using the shift key selects all the entries between the first and second click.
  - Using the ctrl key selects only those items you click.
- If you select multiple exams, you cannot select specific series or images.
- If you select multiple series, you cannot select specific images.

## Archive Image Data

# Check the Archive Queues

### In Brief: Check the Archive Queues

1. Click **Image Management Desktop**.
2. Select **Queue > Archive**.
3. Select an option to **pause**, **resume** or **clear** the items in the Archive Queue.
4. Click **[Quit]**.

Use this procedure to check the status of images waiting to be archived. It is not necessary to wait for one save or restore request to be carried out before setting up the next one. When a save request is set up, it is sent to the Archive Save queue. When a restore request is set up, it is sent to the Archive Restore queue. The following steps guide you through viewing, pausing, resuming and deleting jobs in the archive queue.

1. Click **Image Management Desktop**.
   - Located on the control panel.
   - The Browser appears.
     - The Browser can also be accessed from the Display Desktop on the control panel.
2. Select **Queue** > **Archive**.
   - Located on the Browser menu bar.


   - The contents of the queues shown in the window is up to date at the moment it appears. To subsequently update the status of the queues, click **[Refresh]**.
3. From the Archive Queue select one of the following:
   - Click **[Pause All]** to temporarily suspend execution of all requests in a queue.
     - All jobs now have the (Paused) status.
   - Select an entry and click **[Pause]** to temporarily suspend the execution of a single request.
     - One job in the queue has the (Paused) status.
   - Click **[Resume All]** to continue the execution of a paused queue.
     - All jobs return to their original status and execution continues.

- Select an entry and click **[Resume]** to continue the execution of a single job in the queue.
  - The selected job in the queue returns to its original status and execution continues.
- Select an entry and click **[Clear]** to permanently remove a job from the queue.
  - The Cancel message appears requesting confirmation to clear the requested jobs in the queue.


  - Click **[OK]** to proceed and clear the requested queue.

4. Click **[Quit]**.
   - The Archive Queue window closes.

## Archive Image Data

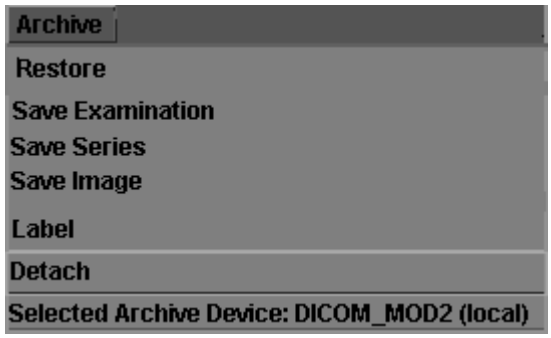
# Detach Storage Media

### In Brief: Detach Storage Media

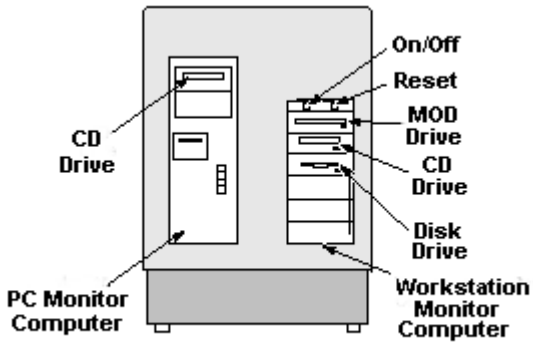
1. Confirm that examinations have been archived.
2. Click **Archive > Detach**.
3. Push the eject button on the MOD drive.

Use this procedure to detach an archive media from its drive. Once a local archive media has been used for save and restore operations, it cannot be ejected from the drive unless you first detach it. Before using this procedure to detach the MOD, allow all archive jobs to complete.

1. Confirm that examinations have been archived.
   - Check the Archive Queue.
   - Check the archive status on the Browser patient list.
2. Click **Archive > Detach**.
   - Located on the Browser menu bar.




3. Push the eject button on the MOD drive.
   - The archive media detaches from its drive.




NOTE: If the Detach option on the Archive window appears in gray lettering, this means that the archive media is already detached.

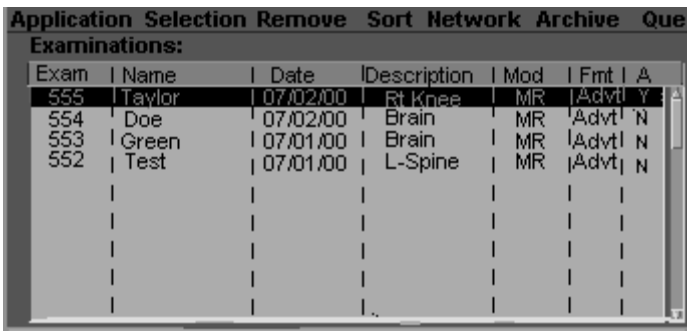
NOTE: You cannot detach a remote archive media.

## Manage Disk Space

# Remove Image Data

Use this procedure to remove an image, series, or entire exam from the system image disk to make room for others. Use care in making your decisions. Once you have deleted an exam, series, or image from the disk, it is removed permanently from the system. Before deleting images which have been networked, filmed, or saved via archive, verify that these tasks have been successfully completed. The following steps guide you through the image deletion process.

1. Click **Image Management Desktop**.
   - Located on the control panel.
   - Provides access to the Browser.
     - The Browser can also be accessed from the Display Desktop on the control panel.
2. Verify examinations to be removed have been archived.
   - This is very important. Once you have deleted an exam, it is permanently gone from the system.
   - Check the archive status in the patient list of the Browser.
     - The archived status column is represented by an **A**. Archive status is indicated by a **Y** (for yes) or a **N** (for no).




3. Select the exams, series or images on the patient list that you wish to remove.
   - To select non-consecutive images, hold down the **Ctrl** key on your keyboard as you individually select the exams (series or images).

## In Brief: Remove Image Data

1. Click **Image Management Desktop**.
2. Verify examinations to be removed have been archived.
3. Select the exams, series or images on the patient list that you wish to remove.
4. Select **Remove > Remove examination**, **Remove series** or **Remove image**.
5. Click **[OK]**.

- To select sequential images, select the first exam (series or image) from the patient list, then press **Shift** before selecting the last. All exams in between are selected.

4. Click **Remove > Remove examination**, **Remove series**, or **Remove image**.
   - The Remove message appears requesting a confirmation to remove the selected examinations, series, or images.

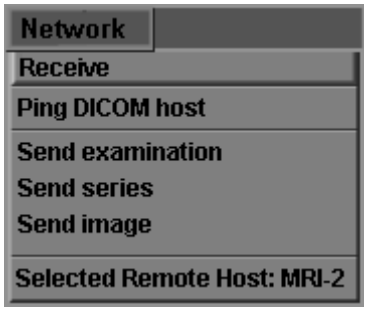

5. Click **[OK]**.
   - Acknowledges the messages and continues the removing process.
   - The system removes the selected item from the system disk and automatically updates the patient lists.

## Configure a Remote Host

# Add a Host

Use this procedure to add a remote host to your MR system to enable the networking features. This allows you to select where you are transferring your images to or where you want to pull images from. This procedure is usually carried out by the networking personnel at your facility or your local GE Service Engineer. This personnel usually has the necessary information needed for the network set-up procedure.

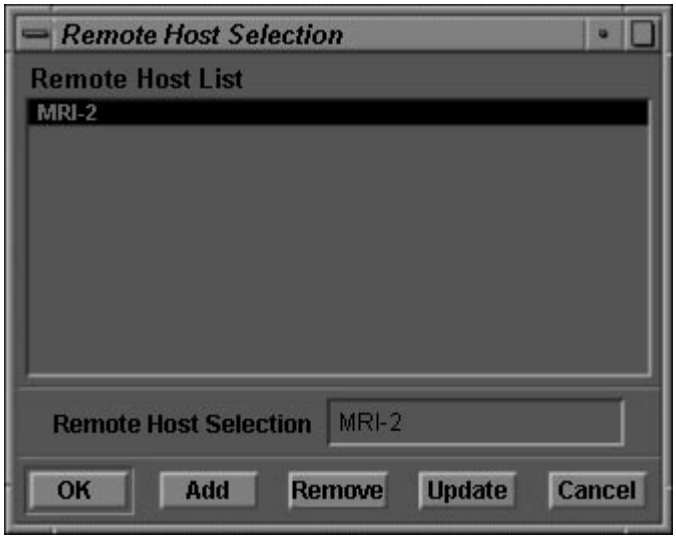
1. Click **Image Management Desktop**.
   - Located on the control panel.
   - The Browser appears.
     - The Browser can also be accessed from the Display Desktop on the control panel.
2. Select **Network > Select Remote Host**.
   - Located on the Browser menu bar.
   - Allows you to configure a new host on your system.



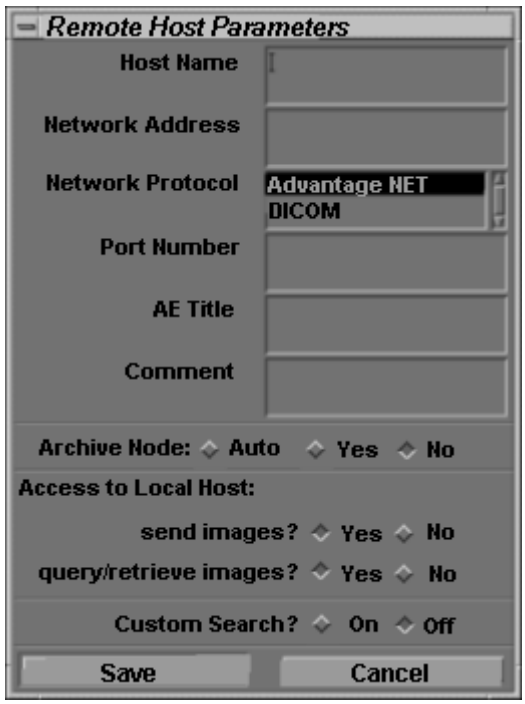

### In Brief: Add a Host

1. Click **Image Management Desktop**.
2. Select **Network > Select Remote Host**.
3. Click **[Add]**.
4. Fill-in information that corresponds to the host you are adding on the Remote Host Parameters window.
5. Click **[Save]**.

- The Remote Host Selection window appears.




3. Click **[Add]**.
   - Allows you to select additional parameters.
   - The Remote Host Parameters window appears.



4. Fill In the parameter information that corresponds with the host you are adding.
    - **Host Name** is the name that you choose to give your remote host.
        - Using this name is how you select a station from which to push or pull images.
    - **Network Address** is where the host is found within the network.
        - You must enter this correctly or the connection can not be made.
    - **Network Protocol** is what the system specifies as the communicating language between the your MR system and the host.
        - GE imaging systems networked to your MR system use Advantage NET.
        - The Max Optic MOD and other non-GE imaging systems usually network by using the DICOM language.
    - **Port number** is predetermined and is specific to the type of host as well as the protocol used.
    - **AE Title** is predetermined.
    - **Comment** area is where you put information that may be helpful in the distinction of two or more host closely related names.
        - For example: if your site has two MR systems, you may input MR#2 Outpatient Unit.
    - **Archive Node** allows you to select a remote host to be used to remotely archive.
        - **Yes** if the network station is an archive device.
        - **No** if the network station is not an archive device.
        - **Auto** if you want the machine to automatically look to see if the host is an archive device.
5. Click **[Save]**.
    - The Remote Host Parameters window closes and saves all the selections added.

## Configure a Remote Host

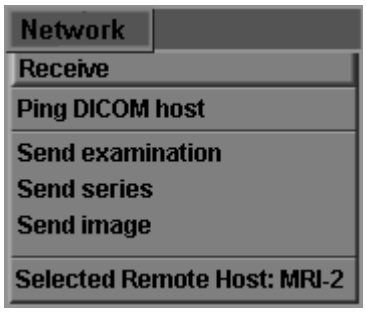
# Remove a Host

### In Brief: Remove a Host

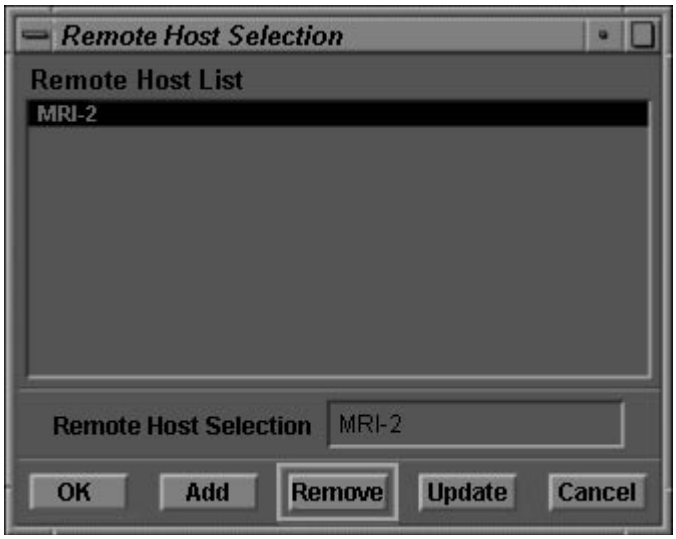
1. Click **Image Management Desktop**.
2. Select **Network > Select Remote Host**.
3. Select the host you want to remove.
4. Click **[Remove]**.
5. Click **[OK]**.
6. Click **[Cancel]**.

Use the following procedure to delete a remote host selection from your system. Before deleting a host, make sure this is what you would like to do because their is no "undo" button to correct a removal made by mistake. It is recommended to contact your GE Service Engineer or your facility's network personnel prior to any removal. These steps guide you through deleting an unwanted host from your system.

1. Click **Image Management Desktop**.
   - Located on the control panel.
   - The Browser appears.
     - The Browser can also be accessed from the Display Desktop on the control panel.
2. Select **Network > Select Remote Host**.
   - Located on the Browser menu bar.




   - The Remote Host Selection window appears.



3. Select the host you would like to remove.
4. Click **[Remove]**.
   - The Remove Host confirmation message appears.


5. Click **[OK]**.
   - Acknowledges the message and continues to remove the host.
6. Click **[OK]**.
   - The Remote Host selection window closes.

## Configure a Remote Host

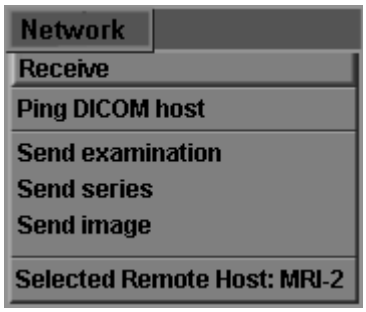
# Update a Host

### In Brief: Update a Host

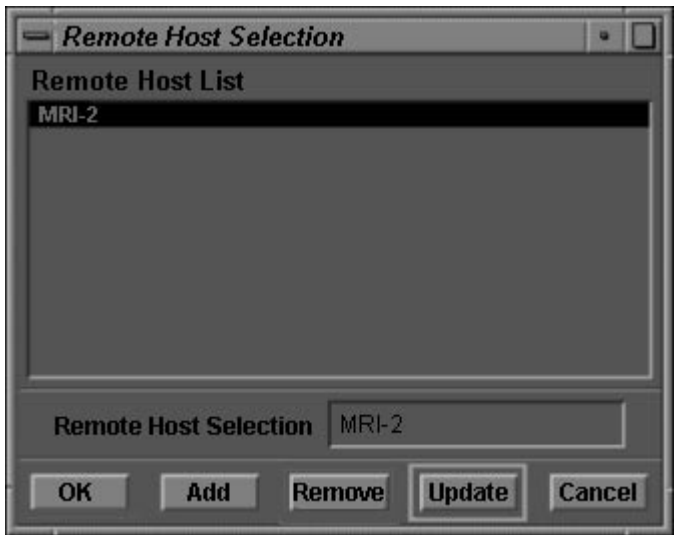
1. Click **Image Management Desktop**.
2. Select **Network > Select Remote Host**.
3. Select the desired host to update.
4. Click **[Update]**.
5. Make necessary changes or additions to the remote host parameters.
6. Click **[Save]**.

Use this procedure to update a remote host configured on your system. An update could include any modifications that were previously added or left off of the Remote Host Parameters window. It is recommended that you contact your GE Service Engineer or your facilities networking personnel prior to any updates. The following steps guide you through updating a remote host.

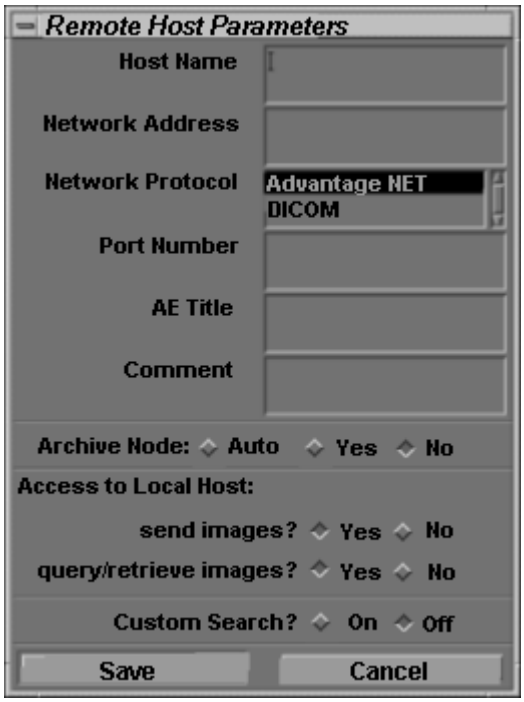
1. Click **Image Management Desktop**.
   - Located on the control panel.
   - The Browser appears.
     - The Browser can also be accessed from the Display Desktop on the desktop control panel.
2. Select **Network > Select Remote Host**.
   - Located on the Browser menu bar.




   - The Remote Host Selection window appears.



3. Select the host you would like to update.
4. Click **[Update]**.
   - Allows you to access to the Remote Host Parameters window to update your selected host.




5. Make necessary changes or additions to the remote host parameters.
6. Click **[Save]**.
   - Closes the window and updates remote host information.

## Network Images To & From Connected Stations

# Network from the Scan Rx Desktop

### In Brief: Network from Scan Rx Desktop

1. Click **Scan Rx Desktop**.
2. Click **[Scan Modes]**.
3. Select **Auto Transfer by Exam** or **Auto Transfer by Series**.
4. Specify a remote host destination on **Auto Transfer by Exam Node List** or **Auto Transfer by Series Node List** and priority level, if applicable.
5. Click **[Accept]**.

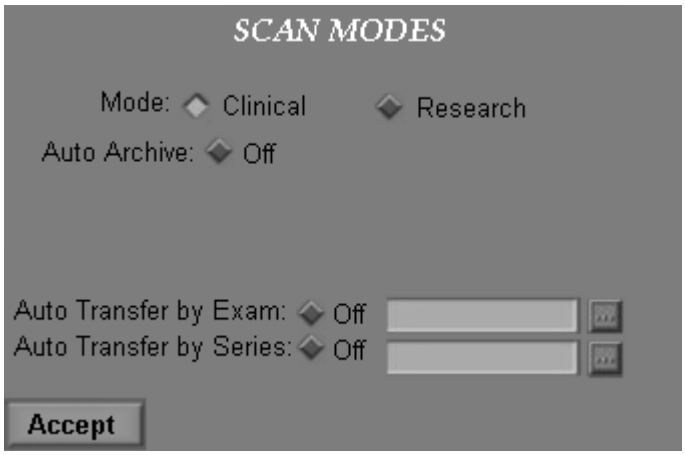
Use this procedure to network images from the Scan Rx Desktop to another host. It is very important to remember that you can only push images to another host from the Scan Rx Desktop. An advantage of this feature, is that you can program your MR system to push images automatically, after each exam or series is completed. The following steps guide you through networking images from the Scan Rx Desktop.

1. Click **Scan Rx Desktop**.
   - Located on the control panel.

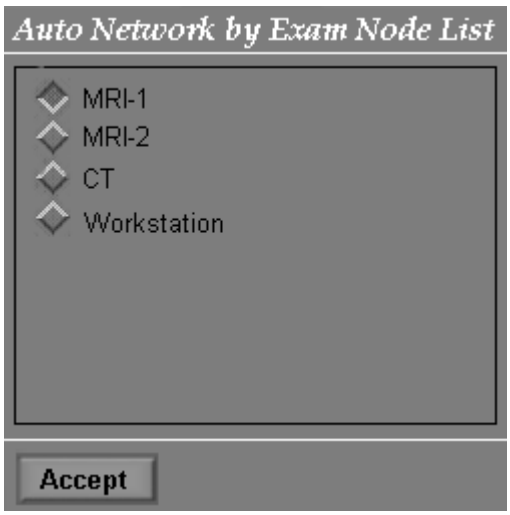

   - If you have just booted up your system, the Scan Rx Desktop is always the default menu the system begins.

2. Click **[Scan Modes]**.
   - Located on the Rx Manager.

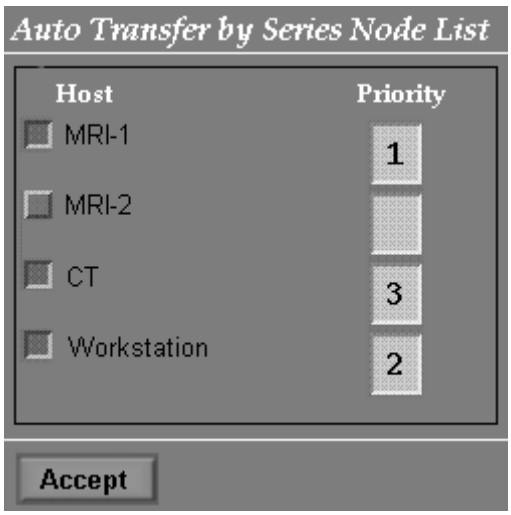

   - The Scan Modes window appears.



3. Select a transfer option by doing one of the following:
   - Select **Auto Transfer by Exam** to automatically send the entire exam from your MR system to a single remote host upon a completion of an exam.
   - Select **Auto Transfer by Series** to automatically send the series from your MR system to as many as three remote hosts.
4. Specify a remote host destination by doing one of the following.
   - Select remote host for **Auto Transfer by Exam** from the **Auto Transfer Node List** window.




   - Select up to three remote hosts for **Auto Transfer by Series** from the **Auto Transfer by Series Node List**.



- You can prioritize to specify in which order the hosts receive the images.

5. Click **[Accept]**.
   - Enables selections and closes the window.

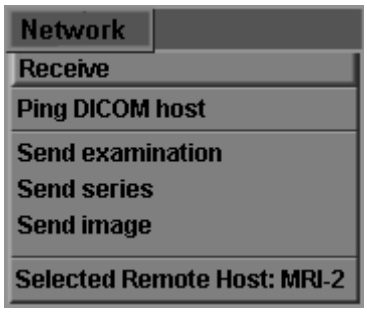
NOTE: For additional information on Auto Transfer by Exam or Auto Transfer by Series, refer to the Scan Rx Desktop chapter.

## Network Images To & From Connected Stations

# Transmit Data to a Remote Host (Network Send)

Use this procedure to send images from your system to another selected host. Transmit, or send, is the action taken when pushing images from one station to another. This is advantageous for additional review of images at any station on the network and to off-load display, manipulation, and filming activities from your system to another workstation. The following steps guide you through the process of sending images.

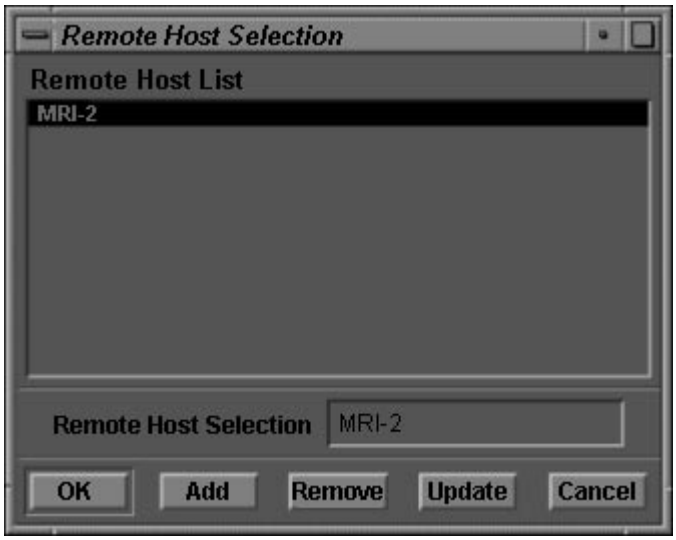
1. Click **Image Management Desktop**.
   - Located on the control panel.
   - The Browser appears.
     - The Browser can also be accessed from the Display Desktop on the control panel.
2. Select **Network > Select Remote Host**.
   - Located on the Browser menu bar.



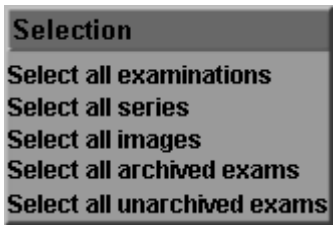

### In Brief: Transmit Data to a Remote Host

1. Click **Image Management Desktop**.
2. Select **Network > Select Remote Host**.
3. Select the desired host.
4. Click **[OK]**.
5. Select the desired exam(s), series or image(s) to transfer.
6. Select **Network > Send exam**, **Send series**, or **Send image**.
7. Click **[OK]**.
8. Select **Application > Quit**.
9. Click **[OK]**.

- The Remote Host Selection window appears.



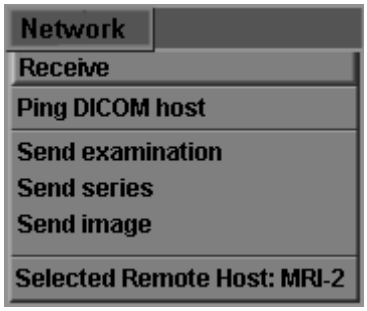

3. Select the desired host where from where you want to transfer the images.
4. Click **[OK]**.
   - Confirms selection of the requested host and closes the Remote Host Selection window.
5. Select the desired exam(s), series or image(s) to transfer by doing one of the following:
   - To select individual entries, select the exams, series or images you want to transfer.
   - To select a predetermined set, choose **Selection > Select all Examinations**, **Select all series**, **Select all images**, **Select all archived exams**, or **Select all unarchived exams**.




NOTE: Typing "ss" at the type-in command line saves the state of the W/L. The "saved" W/L is networked to a PACs or any other end destination.

- All of the items on the chosen list on the Browser are selected.

6. Click **Network > Send examination**, **Send series**, or **Send image**.




   - The Send message appears requesting a confirmation to send selected examinations, series, images to remote host.


7. Click **[OK]**.
   - Acknowledges the message and sends the selected exams, series or images from your system to the remote host.

NOTE: During the transmitting process, status of the process is displayed next to the Network status icon in the Feature Status area of the control panel. For example, the following figure shows the Network status displaying exam 50241 has been sent from the main workstation to the b12a workstation successfully.


8. Click **Application > Quit**.
   - Located on the Browser menu bar.
   - A message appears requesting confirmation to quit.
9. Click **[OK]**.
   - The Remote Browser closes.

## Network Images To & From Connected Stations

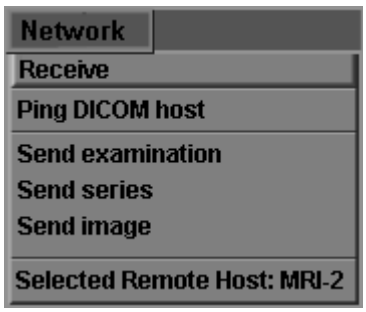
# Retrieve Images from a Remote Host (Network Receive)

### In Brief: Retrieve Images from a Remote Host

1. Click **Image Management Desktop**.
2. Select **Network > Select Remote Host**.
3. Select on the desired destination host.
4. Click **[OK]**.
5. Select **Network > Receive**.
6. Select the exams, series, images to retrieve.
7. Select **Get > Get Exam, Get Series,** or **Get Image**.
8. Click **[OK]**.
9. Select **Application > Quit**.
10. Click **[OK]**.

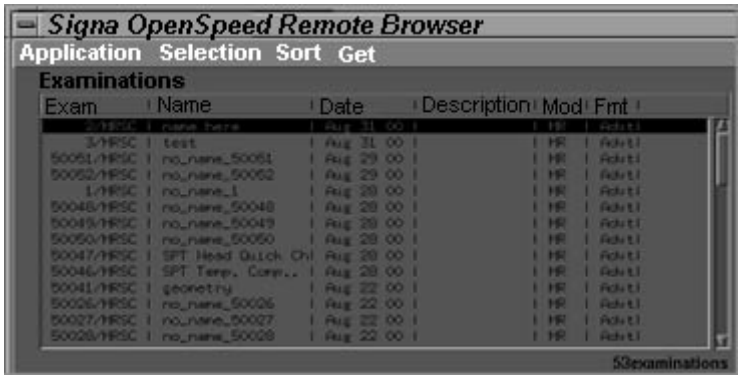
Use this procedure to retrieve images from another selected host to your system. Receive, or get, describes the act of receiving images from one station to another station. This is advantageous for additional review of images at any station on the network and to off-load display, manipulation, and filming activities from your system to another workstation. The following steps guide you through the process of getting images.

1. Click **Image Management Desktop**.
   - Located on the control panel.
   - The Browser appears.
     - The Browser can also be accessed from the Display Desktop on the control panel.
2. Select **Network > Select Remote Host**.
   - Located on the Browser menu bar.




3. Select the destination host you from where you want to pull the images.
4. Click **[OK]**.
   - Confirms the selection of the requested host.
5. Select **Network > Receive**.
   - Located on the Browser menu bar.
   - Allows you to view the Remote Browser you selected.

- The Remote Browser appears, listing the exams, series and images found on the host.




6. Select the exams, series, or images to retrieve by doing one of the following:
   - To select individual entries, select the exam, series or images you want to transfer.
   - To select a predetermined set, select **Selection > Select all Examinations**, **Select all Series**, or **Select all Images**.


   - All of the items selected on the patient list of the Remote Browser are highlighted.

7. Click **Get > Get Exam**, **Get Series**, or **Get Images**.
   - Located on the Remote Browser menu bar.


   - The Get message appears requesting confirmation of the pull transaction.

8. Click **[OK]**.
   - Acknowledges the message and the selected exams, series, or images on the Remote Browser begin transferring from the remote host to your system.
   - The Browser patient lists update automatically to reflect the arrival of newly transferred items.

NOTE: During the retrieval process, status of the process is displayed next to the Network status icon in the Feature Status Control area of the desktop control panel. For example, the following figure shows the Network status of exam 1207. Exam 1207 has been pulled from the remote MRI-2 workstation to main workstation successfully.


9. Select **Application > Quit**.
   - Located on the Browser menu bar.
   - A message appears requesting confirmation to quit.

10. Click **[OK]**.
    - The Remote Browser closes.

# Check the Network Queue

Use this procedure to check the status of images waiting to be transferred. It is not necessary to wait for one send or receive operation to be completed before setting up the next one. Each send or get operation is placed into the Network Queue. The queue is used to view the waiting network requests to be carried out. Also, images that have been paused in the queue can be resent to the desired initial destination from this area. The following steps guide you through viewing, pausing, resuming, and deleting jobs in the network queue.

1. Click **Image Management Desktop**.
   - Located the control panel.
   - The Browser appears.
     - The Browser can also be accessed from the Display Desktop on the control panel.
2. Select **Queue > Network**.
   - Located on the Browser menu bar.

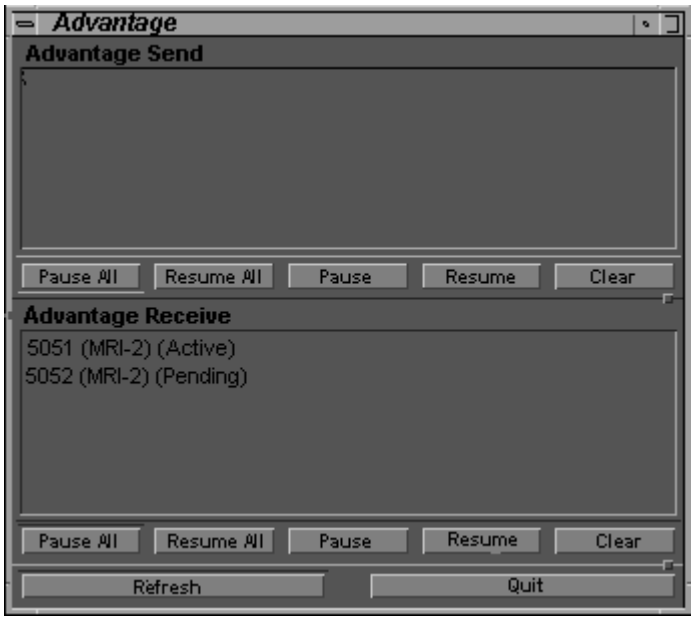

   - The content of the Advantage network queue displays up to date information. To subsequently update to the current status of the push and pull queue lists shown in each window, click **[Refresh]**.

NOTE: If there are no transfers in progress, the message *"All Network Queues are Empty"* appears. Click **[OK]** to acknowledge the message.

## In Brief: Check the Network Queue

1. Click **Image Management Desktop**.
2. Select **Queue > Network**.
3. Select an option to **pause**, **resume** or **clear** the items in the Archive Queue.
4. Click **[Quit]**.

- If transfers are in progress, the Advantage network queue appears.




3. From the **Advantage Send** or the **Advantage Receive** queue do one of the following:

   - Click **[Pause All]** to temporarily suspend execution of all requests in a queue.

     ° All jobs now have the (Paused) status.

   - Select an entry and click **[Pause]** to temporarily suspend the execution of a single request.

     ° One job in the queue has the (Paused) status.

   - Click **[Resume All]** to continue the execution of a paused queue.

     ° All jobs return to their original status and execution continues.

   - Select an entry and click **[Resume]** to continue the execution of a single job in the queue.

     ° The selected job in the queue returns to original status and the job is executed.

   - Select an entry and click **[Clear]** to permanently remove a job from the queue.

- The Cancel message appears requesting confirmation to clear the requested jobs in the queue.


- Click **[OK]** to proceed and clear the requested network queue.

4. Click **[Quit]**.
   - The Advantage network queue window closes.

This page intentionally left blank.

## Symbols



## Numerics



## A

## B



## C

## D



## E

## F



## G

## H



## I

## N



## O



## P

## Q



## R

## S

## T



## U

## V



## W



## X



## Y



## Z