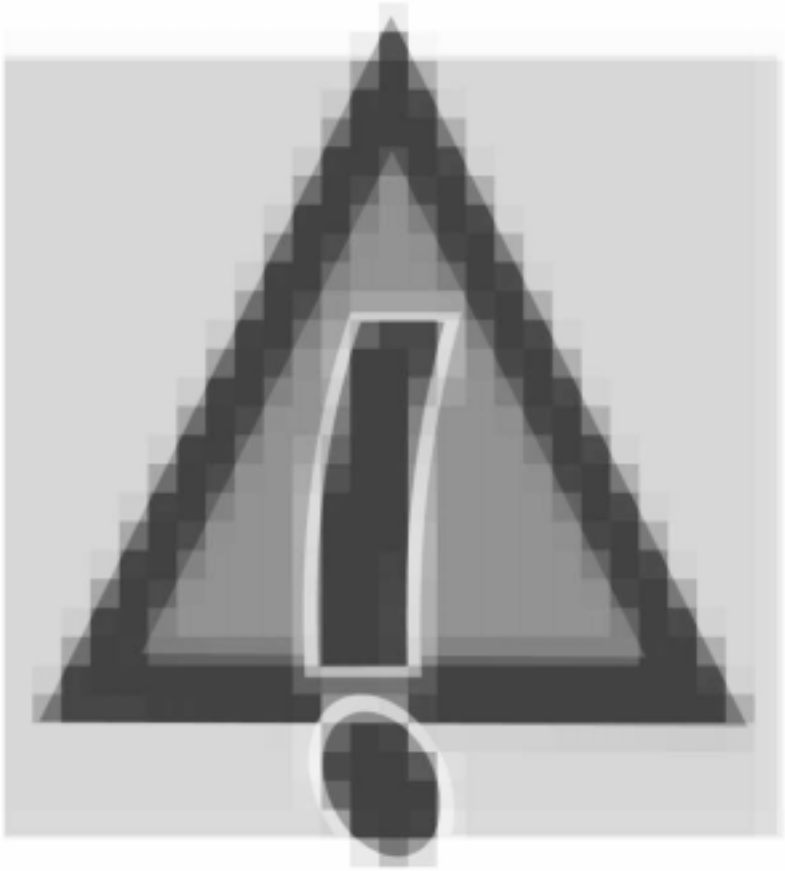
A Safety



Guidelines for Use

Proper use of MAGNETOM Harmony/Symphony presupposes that the operating personnel is thoroughly familiar with the operating instructions. Please read the entire System Manual prior to starting the system.

The user should be thoroughly familiar with the safety information contained in Part A.

Please note: Important safety instructions in this manual are shown against a grey background. Potential hazards are appropriately classified using the following set of signal words:

WARNING Warning is used to indicate the presence of a hazard which can cause personal injury or death.

CAUTION Caution is used to indicate the presence of a hazard which can cause damage to the equipment.

Notice Notice is used to notify users of operator information which is important but not hazard-related.

Adhere to the safety guidelines when using *RF-coils* (→ Page D.1–4) and during *Physiologically-Controlled Imaging* (→ Chapter E.1).

For reasons of linguistic simplification, we restrict ourselves to using the term “Siemens Customer Service”. Keep in mind, however, that this term also comprises all service personnel authorized by Siemens.

The guidelines for use provided on the next pages are a condensed version of the safety instructions described in the safety information contained in Part A.

Indications for use

The magnetic resonance imager is used for diagnostic imaging. It produces cross-sectional images in any orientation (tomograms) that display the internal structure of the head or body of the patient being examined. The images produced reflect the spatial distribution of protons (hydrogen nuclei) in tissue. When read by an MR-trained physician, MR provides images which are useful for diagnosis.

The contrast in the image is characterized by the influence of the following parameters:

- Proton density
- Spin–lattice relaxation time T_1
- Spin–spin relaxation time T_2
- Flow (e. g., blood perfusion)
- Chemical shift

The influence of each parameter depends upon the imaging conditions.

Contraindications

The use of the MR system is *contraindicated*

- ❏ for patients who have electrically, magnetically or mechanically activated implants (e. g., cardiac pacemakers, implantable insulin pumps), because the time varying magnetic fields produced by the system may interfere with the operation of these devices ;
- ❏ for patients with intracranial aneurysm clips, unless the physician is certain that the clip is *not* magnetically active ;
- ❏ for patients who have undergone tattooing or permanent eyelining as a cosmetic surgical procedure, unless the physician is certain that the product used is *not* magnetically active.

Warnings

Electronic implants

The functionality of electronic implants (e. g. pacemakers) may be susceptible to interference from magnetic and RF fields produced by the MR system. Persons with cardiac pacemakers or other implanted electronic devices are prohibited from entering the zone where the magnetic field exceeds 0.5 millitesla = 5 Gauss.

Control range 0.5 mT

Notice

Establish an exclusion zone outside which
the field strength does not exceed the value 0.5 mT.

Make sure that the exclusion zone (0.5 mT) is clearly defined, e.g. by markings on the floor or cupboards.

Make sure that endangered persons (e.g. those with cardiac pacemakers) do not enter this area.

Metallic implants

In larger metallic implants, sufficient eddy currents may be induced by time-varying magnetic fields to cause local heating of the body tissue.

The magnetic field exerts a force on ferromagnetic objects (e.g. traction devices) within the field which increases proportionally to the mass of the object. The introduction of ferromagnetic materials in proximity to the magnet may result in such objects becoming projectiles leading to serious injuries. Within tissue this force is able to relocate implants or larger prostheses and cause injury.

Patients exposed to magnetically active metal fragments during employment or at other times may have microscopic fragments in their eyes without knowing it. Patient screening must include questions specifically related to exposure to metal fragments.

Intracardial intervention

WARNING

Intracardial intervention

MAGNETOM Harmony/Symphony cannot be used in conjunction
with intracardial intervention

RF absorption in the body

During an MR examination part of the radiofrequency energy is absorbed by the body tissues of the patient and converted to energy. This can cause the body temperature to rise (→ Chapter D.2).

RF exposure during pregnancy

WARNING

RF exposure during pregnancy

The safety of the MR system when used to image fetuses and infants has not yet been established, nor has the safety of field exposure to pregnant personnel.

Decompensated patients, febrile patients, and those with serious cardiac problems, infants, early pregnancy, and those with impaired ability to perspire may be at risk because of a decreased ability to regulate temperature increases caused as a result of RF power deposition.

Hearing protection

During the measurement you must provide the patient with hearing protection to ensure that the noise level never exceeds 99 dB (A).

Noise

WARNING

Inform the patient that an MR examination creates noise. The patient´s hearing must be protected from damage with ear protectors (headphones or ear plugs).

Headphones are supplied with the system as hearing protection via which you can also play music to entertain the patient. If it is not possible to use the hearing protection because of limited space (e.g. head coil) you can give the patient earplugs.

Gaseous helium

The liquid cooling agent of the superconducting magnet evaporates slowly. It escapes into the ambient air via a duct. When the magnet *quenches* (→ page A.2–11) the gases evaporate rapidly. The dimensions of the escape gas duct have been calculated to be safe but the duct must be free of objects. In case of damage (the duct is either broken or blocked, e.g. by a bird's nest) the escaping coolant gases which are extremely cold can displace the oxygen in the air of the room to dangerous levels.

Precautions

Caution must be exercised when imaging patients

- ❏ who are likely to develop seizures or claustrophobic reactions
- ❏ who are at increased risk for cardiac arrest,
- ❏ who are unconscious or severely ill;
- ❏ Children and patients who are not able to recognize and / or signal heat sensations or peripheral nerve stimulation.

During operation

- ❏ Start and stop the system according to the procedures in → Chapter B.3.
- ❏ Never leave the system unattended while imaging.
- ❏ Constant contact must be maintained with the patient during the examination (visual contact or via monitor, intercom, etc.).

Adhere to the instructions for working with or at the magnet

(→ Chapter A.2 → Chapter A.3)

In case of emergency

If an emergency situation develops (hazardous conditions for the patient, system failure etc.):

Switch off the system immediately by pressing the EMERGENCY SHUTDOWN button (→ Page A.2–2).

In this case, do not restart the system. Contact Siemens Customer Service.

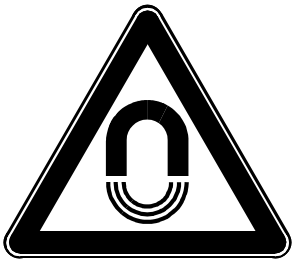
Contact Siemens Customer Service if the system does not function properly.

Warning signs

Warning symbols

Notice

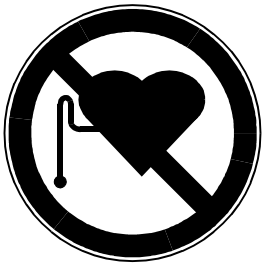
All warning and protection signs must be visible and at eye level in the vicinity of the MR system.



Magnetic field

Radio frequency field

Prohibitive signs



Implants which may be affected
by electromagnetic fields,
e.g. CARDIAC PACEMAKERS,
defibrillators, hearing aids,
insulin pumps, drug pumps

Open fire
Smoking prohibited

Implants made of metal
and other metal objects in the body,
e.g. splinters

Mechanical watches,
electronic data carriers such as
pocket calculators, digital watches etc.

Prohibitive signs

Fire extinguishers with magnetizable metal housing

Metal parts of any kind

Electronic data carriers such as credit cards, identification cards with magnetic strips, magnetic tapes

A.1 General Safety Instructions

The system is completely safe for the patient and operator when operated according to instructions.

The operating organization is responsible for access to the control area.

Ensure that unauthorized personnel (electrician, cleaning personnel) do not enter the examination room, unless they are accompanied by an authorized person.

Authorized personnel must ensure that persons with metal implants or carrying metal objects do not enter the examination room.

The door to the examination room must remain locked at all times when the room is not in use.

Examination room

WARNING

Unauthorized personnel may enter the examination room only when accompanied by an authorized person.

Legal regulations

Regulations that apply in the Federal Republic of Germany include the following.

- ❏ the electromagnetic compatibility law (EMCL) and
- ❏ the accident prevention regulations.

The accident prevention regulations also stipulate the permissible exposure to noise of the user.

If necessary the RF source must be registered with the authority responsible.

Regulations for containers under pressure

The magnet together with its cooling agent dewars are subject to the regulations for containers under pressure. If the dewars are taken out of operation an expert must repeat internal tests to the magnet and measure the pressure repeatedly.

Introduce a logbook

It is advised that MAGNETOM Harmony/Symphonyis only operated by fully trained, qualified personnel specifically named in the log-book.

Adhere to country-specific ordinances

In countries outside the Federal Republic of Germany, adhere to all country-specific regulations. However, we strongly recom-mend:

Adhere to all regulations contained in this operating manual if they exceed the ordinances of your country, in order to ensure the safety of patients, operating personnel, and third parties (VDE regulation 0107).

Post warning signs

As the operator it is your responsibility to ensure that a sufficient number of safety and warning signs are posted so that they are visible. You are also responsible for ensuring that individual areas are marked by warning signs in the correct manner.

Warning signs

Notice

Make sure the warning signs are clearly visible both inside and outside the examination room
(→ page xviii *Warning signs*).

Note the emergency shutdown buttons

The user should be fully aware of the functions and locations of all emergency shutdown buttons prior to working with the system (→ Page A.2–2).

Report accidents involving employees

As the operator of an MR system, the user is responsible for reporting all accidents resulting in injuries to personnel to the appropriate authorities or professional association.

Explosion protection

This equipment is not for use in explosion-prone environments (locations).

Safety tests

As the operator it is your responsibility to ensure that the safety tests described below are performed.

Inspect every 12 months

- ❏ Operation of MAGNET STOP function
- ❏ Operation of the TABLE STOP function
- ❏ EMERGENCY SHUTDOWN button
- ❏ EMERGENCY OPEN button (for pneumatic door)
- ❏ RF system
- ❏ Magnet system
- ❏ Protective conductor
- ❏ Safety-related accessories
- ❏ Other inspections (squeeze bulb, intercom, video monitoring system, warning signs)

Safety-related accessories

RF coils
- ❏ All coils of the transmit and receive system

ECG and pulse sensor
- ❏ ECG cables with clip-on electrodes
- ❏ ECG cables with clip-on electrodes (for infants)
- ❏ Disposable electrodes
- ❏ Pulse receptor

Other accessories
- ❏ *Non*-ferromagnetic patient gurney
- ❏ Patient trolley with exchangeable tabletop

The safety-relevant accessories are checked during preventive maintenance to ensure they are functioning properly.

Regular maintenance

In the interest of patients, operating personnel, and third parties, we strongly recommend that authorized personnel perform the maintenance prescribed by Siemens on a regular basis. This maintenance should be performed more frequently if the system is run under extreme operating conditions. Contact Siemens Customer Service if you have not obtained a maintenance contract.

Switch off the system immediately if a serious fault occurs and contact Siemens Customer Service.

Electronic cabinets

WARNING

The high voltages and currents present in the electronics cabinets can cause severe injury or death.

These cabinets may only be opened by Siemens Customer Service personnel.

Product safety

Modifications or upgrades to the MR system must adhere to all government regulations. As manufacturer, assembler, installer, or importer of the system, we will not be held responsible for the safety features, reliability, and performance of the product when :

- ❏ Installation, upgrades, resetting, or repairs to the system or upgrades to NUMARIS on the system disk are performed by personnel not authorized by Siemens
- ❏ Components affecting product safety are not replaced with original Siemens spare parts
- ❏ Electrical wiring in the MR suite does not meet the specifications of VDE ordinance 0107 or local regulations
- ❏ The system is used in a manner other than that specified in the guidelines for use.

Accessories

CAUTION

This product may only be used in conjunction with original Siemens accessories or accessories distributed by Siemens-authorized third parties.

For the use of accessories not approved by Siemens the user assumes all responsibility.

Siemens will not be held responsible for any repairs made without our express written consent.

Repairs or modifications

Prior to performing any work, upgrades, or modifications on the MAGNETOM or the installation location, we recommend that you contact Siemens to ensure that system operation will not be negatively affected. In addition, obtain a certificate indicating the nature and scope of the work to be performed. The certificate should specify the changes made to the nominal data or the type of work performed, including date, company name, and signature.

Please note: We can provide technical documentation for the product if requested. However, release of such documentation does not imply authorization to perform repairs.

Configuration with other equipment

If you want to connect the system with other devices or components:

Please note: You have to ensure that the configuration does not compromise the safety of the patient, operating personnel, and the environment.

Consult the manufacturers concerned or authorized experts.

System-related artifacts

The MR image may show artifacts despite careful preparation before and during the examination.

As the physician you should be able to recognize artifacts to rule out incorrect diagnostic interpretations. A detailed description of possible artifacts and how to avoid them is given in the *Applications Guide*.

Ambiguous artifacts

Notice

Ambiguous artifacts may be visible in the MR image. These are objects that actually lie outside the field of the image but which are assigned position coordinates that correspond to objects within the image field. This makes them visible on the MR image.

Image distortion

Notice

Images may be distorted along the edges. The gradient field may not be completely linear along the edge of the image field. This can cause distortion along the edge of the image (pixel coordinates are slightly offset as compared with the ideal image).

Slice distortion

Notice

Slices may be distorted along the edge of the image field because of the inhomogeneity of the static magnetic field. This can cause bulging along the edge of the image. (Pixel coordinates are slightly offset, out of the plane, as compared with the ideal image.)

Brightness

Notice

The brightness of the displayed image field may be at its greatest in the center of the image and may decrease towards the edge. The signal intensity is at its greatest in the center of the measuring field of a coil. The sensitivity of the coils and therefore the signal intensity decreases towards the edge.

Low bandwidth images

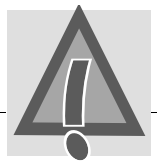
Notice

Low bandwidth images are more sensitive to artifacts and geometric distortions and should be used as localizers with caution.

Critical cases

Notice

In critical cases it is advisable to record a second orthogonal slice.



A.2 Patient/Personnel-Related Safety Instructions

Strictly adhere to the patient / personnel-related safety information described in this chapter. This information refers to:

- ❏ Use of the emergency buttons
- ❏ Hazards in the magnetic field
- ❏ Hazards in the RF field
- ❏ Hazards when working with liquid helium
- ❏ Potential mechanical points of injury
- ❏ Fire risk
- ❏ Safe patient monitoring and
- ❏ Use of the laser light localizer

For procedures when dealing with accidents involving the MR measurement phantoms (→ Page F.1–8).

Personnel

Notice

Authorized personnel should be instructed on a regular basis regarding the hazards and safety regulations associated with the MR system.

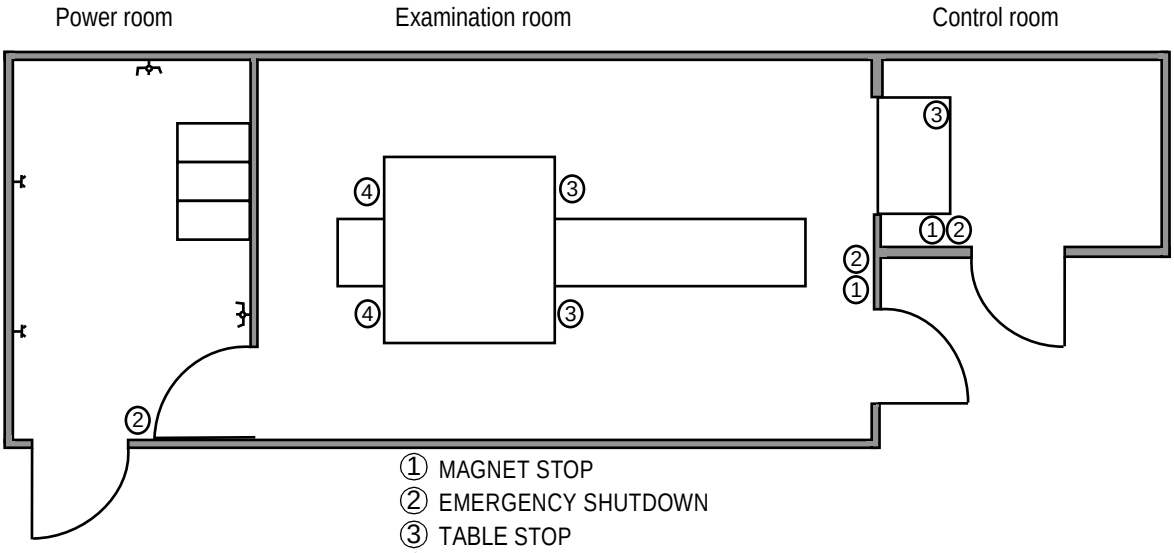
Fully inform the patient about hazards and patient conduct when preparing for the examination.

Emergency buttons

MAGNETOM Harmony/Symphony has three types of **emergency buttons**:

- ❑ **MAGNET STOP** buttons
- ❑ **EMERGENCY SHUTDOWN** buttons
- ❑ **TABLE STOP** buttons

The diagram below provides a summary of the emergency buttons and their location (example of an installation).



The system must be connected to the power supply via a circuit-breaker installed by the customer or via a multiple pole interrupting device with an EMERGENCY SHUTDOWN button. Electrical wiring in the rooms must meet the specifications of VDE 0107.

The EMERGENCY OFF and MAGNET STOP buttons can also be located on the other side of system if necessary.

EMERGENCY SHUTDOWN (electrical installation without magnet)

EMERGENCY SHUTDOWN button

CAUTION

Only use the EMERGENCY SHUTDOWN button
– to prevent injury to persons or damage to the system
– in case of fire
– in case of electrical accident.

The following rooms contain at least one EMERGENCY SHUTDOWN button:

- ❏ Control room
- ❏ Examination room
- ❏ Power room

The EMERGENCY SHUTDOWN switches are located next to the door at head height.

Before you start up the system make sure you know where the EMERGENCY SHUTDOWN switches are located and how to use them.

To trigger an EMERGENCY SHUTDOWN press the button!

TABLE STOP

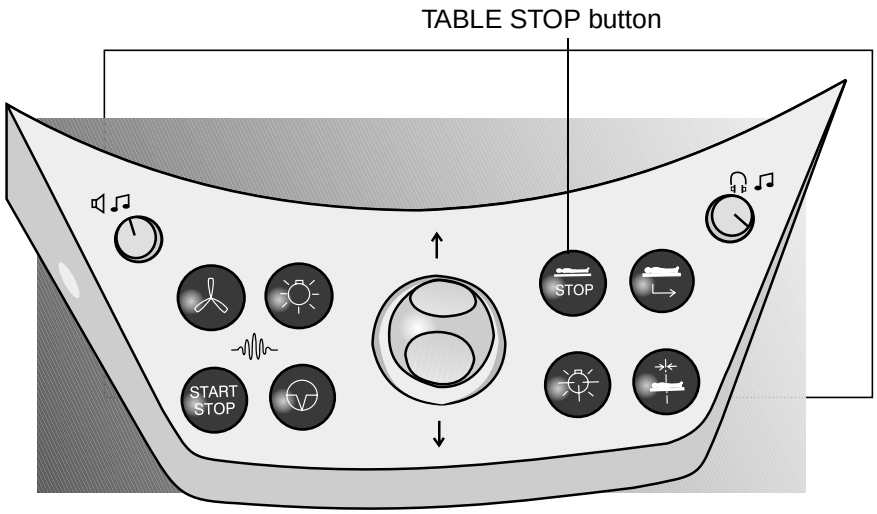
You can stop motorized movement of the patient tabletop in two different ways:

- ❏ Using the TABLE STOP buttons on the **operating units of the patient table**, left and right of the tabletop on the magnet.
- ❏ The TABLE STOP button on the **the intercom**.

Operating units

The TABLE STOP buttons are located on the operating units of the patient table.

An auxiliary operating unit is available as an option which can be mounted on the rear of the magnet. This also contains a TABLE STOP button.



Activate a STOP button immediately in the event of hazardous conditions or accidents caused by movements of the tabletop (danger of injury)!

Tabletop movement is stopped.

The following symbol appears on the display.

The brake is released and you can move the tabletop manually.

EMERGENCY SHUTDOWN button

CAUTION

If the TABLE STOP button fails to respond immediately, activate the EMERGENCY SHUTDOWN button!

Call Siemens Customer Service.

Intercom system

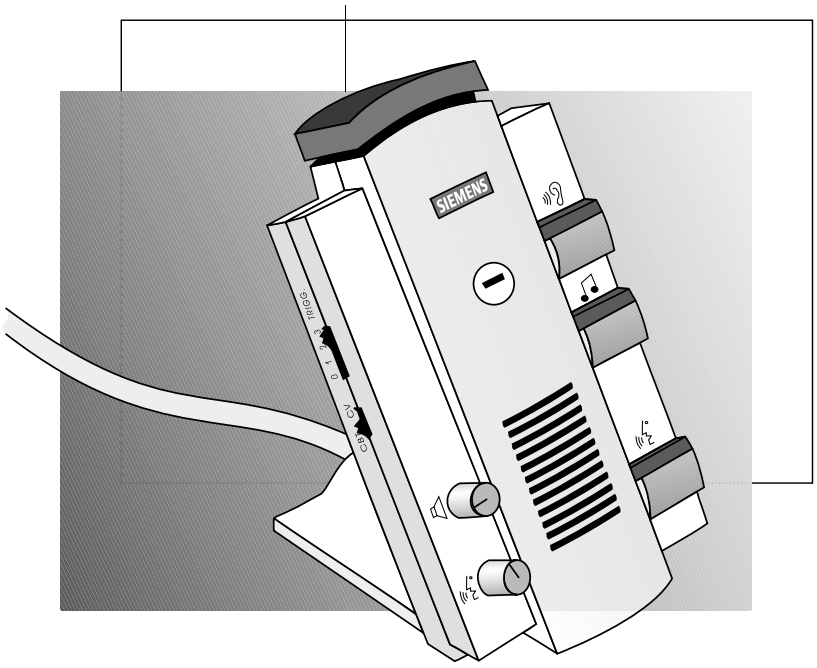
STOP

You can stop movement of the tabletop from the intercom in the operating room.

Press the red TABLE STOP button on the intercom.

You can now move the patient table manually in the horizontal direction. To do this, pull the tabletop by the handgrip located at the foot end of the patient table.

TABLE STOP button



Canceling TABLE STOP

As soon as you have clearly recognized the danger and eliminated it you can re-enable the patient table again:

To do this first press the joystick as far as it will go in the direction of the magnet (movement "in"). Then move the joystick in the same way in the opposite direction (movement "out") as far as it will go.

It does not matter in which order you perform the joystick movements.

Return the joystick to its original position.

You have now canceled TABLE STOP.

The TABLE STOP symbol on the display disappears.

TABLE STOP during a power failure

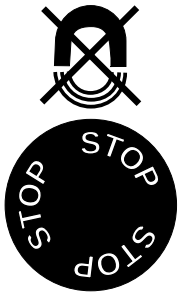
In case of a power failure or after a TABLE STOP the electric brake of the patient table is released.

The tabletop together with the patient can now be moved out of the magnet manually. To do this use the handgrip at the foot end of the patient table.

MAGNET STOP (magnetic field)

The MAGNET STOP function is used to reduce the field strength of the magnet to a low value as quickly as possible. During this process, magnetic field energy is converted to thermal energy. As a result, helium evaporates rapidly and is vented to the outside.

MAGNET STOP button



CAUTION

Only press the MAGNET STOP button in order to
— save persons from emergency situations in the magnetic field,
— deexcite the magnetic field if there is danger of fire.

Wait until the magnetic field has been deexcited to a value of 20 mT which is no longer dangerous in this situation.

Deexcitation of the magnetic field to 20 mT takes less than 20 seconds.

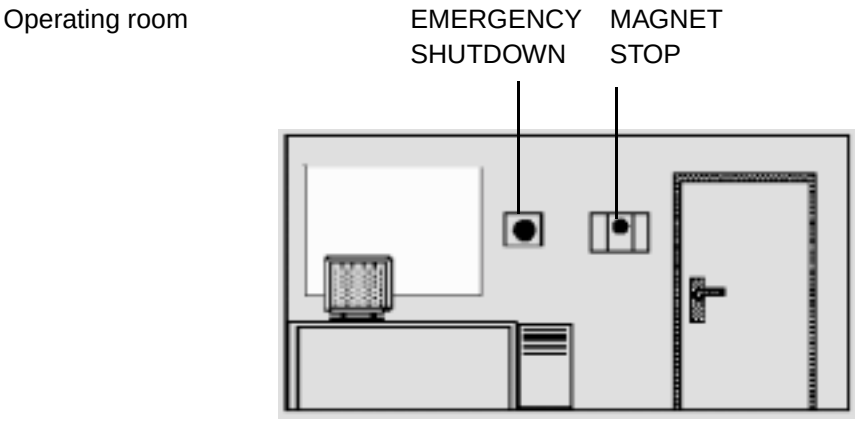
Only service personnel are authorized to put the magnet back into operation.

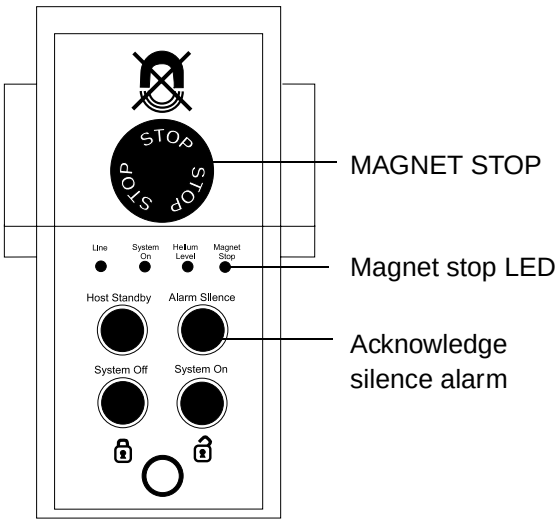
Location of the MAGNET STOP buttons

There are two MAGNET STOP buttons :

- ❏ In the operating room in the alarm box near by the operating console. The button is located under the plexiglass cover.
- ❏ In the examination room next to the door.

MAGNET STOP in the operating room

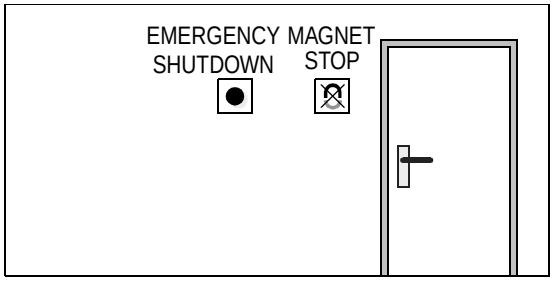




See → page C.3–1 for more information about display and functions of the alarm box.

MAGNET STOP in the examination room

Examination room



Quenching the magnet

MAGNETOM Harmony / Symphony has a superconducting magnet. Superconduction means that electrical current can flow without resistance. To achieve this the magnet is cooled in liquid helium. **Quenching** means stopping superconduction. The liquid helium (coolant) evaporates and is allowed to escape into the atmosphere through a vapor outlet tube. The energy of the magnetic field is converted to heat.

Quenching can be triggered by:

- ❏ a MAGNET STOP (→ page A.2–8)
- ❏ an accident (earthquake, fire etc.)

Noise

Quenching the magnet causes considerable noise (hissing, roaring) because large volumes of gaseous helium are allowed to escape into the atmosphere.

Therefore always check that the vapor outlet tube is not obstructed (→ page B.2–4).

Alarm

An alarm is triggered on the alarm box. The magnetstop LED lights up red and an alarm signal sounds (→ page C.3–3).

Removing the patient

Remove the patient immediately in case of danger.

Pay attention to potential dangers from helium (→ page A.2–24) and strong magnetic fields (→ page A.2–13).

Only Siemens Service can restart the magnet.

Emergency operation:

Open the cover above the button and press the MAGNET STOP button.

Location of the MAGNET STOP buttons → **page A.2–9**

Call Customer Service.

Quenching

WARNING

Caution! There is a risk of frost bite if you touch the vapor outlet tubes during quenching.

Risks in the magnetic field

The superconductive magnet with its high operating field strength gives rise to the following hazards:

- ❏ Force exerted on ferromagnetic materials
- ❏ Magnetic effect on metallic implants
- ❏ Adverse effects on electromagnetically activated implants (e.g. cardiac pacemakers) and
- ❏ Biomagnetic effects.

As the operator of such a system you must ensure that all the following rules are adhered to. You are responsible for all persons required to be in or in the vicinity of the magnet (such as patients, operating personnel, manual workers).

Magnetic materials

WARNING

Never wear magnetizable objects (watches, hair pins etc.). Never carry ballpoint pens, fountain pens, thumb tacks, scissors etc. in pockets.

Conductive objects

WARNING

Do not examine patients who are wearing conductive objects. Electrically conductive objects can be made of metal, conductive plastic or materials, for example.

Resuscitation equipment

WARNING

Never use resuscitation devices such as defibrillators, oxygen tanks etc. in the examination room.

Trolleys / hospital beds

WARNING

Never use transport gurneys or mobile hospital beds made of ferromagnetic material.

Non-ferromagnetic patient trolley

Notice

Always use a *non*-ferromagnetic patient gurney and patient trolley

Force exerted on ferromagnetic materials

The magnetic field exerts a force on magnetic objects (such as tools, keys, hospital equipment such as traction devices, gas tanks, paper clips, ballpoint pens) which is proportional to the mass of the object.

This force increases considerably at shorter distances!

Ferromagnetic objects attracted by the magnet become projectiles and can cause serious injury to the persons involved.

Magnetic materials

WARNING

Ferromagnetic objects inadvertently introduced into the proximity of the magnet become projectiles which could cause serious injuries.

Therefore only have (service) work under field carried out by authorized personnel. Only non-magnetic tools and equipment must be used.

No ferromagnetic objects

WARNING

Do not bring ferromagnetic objects (trolleys with rollers, traction apparatus with large weights etc) into the examination room! Objects are attached with great force.

Safety distances

We strongly recommend you to comply with the safety distances to reduce such a risk (→ Page A.3–1).

Magnetic effects on metallic implants

The force exerted by the magnetic field can cause implants (such as surgical clips) or larger prostheses to move in the tissue and cause injuries. As the user it is your responsibility to ensure that no persons with metal implants enter the examination room.

Examples:

- ❏ Artificial anus (anus praeter) with magnetic closure
- ❏ Artificial glands for insulin
- ❏ Artificial heart valves with steel parts
- ❏ Larger steel implants (aneurysm clips, hip joints, bone screws, tooth fillings)

Prior to examination the operating personnel must be quite aware of the possible injuries to which the patient could be subjected. If there is any doubt the examination must not be performed.

Eddy currents

In larger metallic implants conditions can occur to induce electric currents in the metal of the implant. These are eddy currents caused by high-frequency fields. They can cause local heating. Eddy currents can occur in all conductive metals - even those that are not ferromagnetic.

Ferromagnetic objects in body / implants

WARNING

Examine all patients for ferromagnetic objects in the body and for implants.
Ask the patient whether they have any such objects or implants in their body.
Do not perform any MR examinations on patients with ferromagnetic objects and implants in their body.

Tattoos / permanent eyelining

WARNING

The use of MAGNETOM Harmony/Symphony is *contra*indicated for patients who have undergone permanent eyelining as a cosmetic surgical procedure or tattooing unless the physician is certain that the materials which were used are not ferromagnetic.

Safety zone

WARNING

Metallic implants are subject to the force exerted by the magnetic field and local heating produced by eddy currents.
Persons with metallic implants must remain outside the exclusion zone indicated by the posted magnetic field warning signs.

Intracranial vessel clips

WARNING

The use of MAGNETOM Harmony/Symphony is *contra*indicated for patients with intracranial aneurysm clips, unless the physician is certain that the clip is not ferromagnetic.

Metal splinters

Notice

Inquire about metal fragments in patients with war injuries and other patients potentially exposed to metal fragments.

Adverse effects on electromagnetically active implants

A magnetic field can interfere with or prevent the operation of electronic or mechanical components in implanted devices such as cardiac pacemakers, drug pumps etc. As the user you are responsible for ensuring that persons with pacemakers or other electromagnetically active implants are not endangered by the magnetic field.

Prior to ramping up the magnet, you must ensure that all safety measures have been completed for the zone where the magnetic field strength exceeds 0.5 mT. You must indicate the exclusion zone (according to local ordinances) and ensure restricted access to the zone.

Implants

WARNING

Hazardous for persons with electromagnetically activated implants (cardiac pacemakers, drug pumps, etc.).

Observe the 0.5 mT exclusion zone.

Biomagnetic effects

Biomagnetic effects can be divided into two areas:

- ❏ Static magnetic fields (magnet) and
- ❏ Magnetic fields which vary over time (gradients).

In many counties legislation exists which sets limits on the time spent in static magnetic fields. The stutory exposure limits must be observed.

Extensive clinical studies have shown that the magnetic fields of the MAGNETOM Harmony/Symphony that vary over time do not cause nerve stimulation in any mode of operation.

Risks in the RF field

The RF system contains transmitter and receiver coils for the magnetic excitation of the atom nuclei in the human body and for receiving returned signals.

RF field

CAUTION

Please keep the door of the examination room closed while taking measurement
- an external RF field could impair the quality of the picture and/or
- the internal RF field could damage electronic devices outside if the door is left open.

High-frequency absorption in the body

Specific absorption rate

During transmission mode RF power is sent to the body in the form of electromagnetic energy. This power which is absorbed by the patient is dependent on the weight of the body and is expressed in W / kg as the specific absorption rate (SAR). As soon as the specific absorption rate exceeds the limit value determined by the cooling capacity of the body, the body temperature increases (→ Chapter D.2).

Patient weight

WARNING

The exact weight of the patient must be known prior to scanning.

Depending on the patient weight and type of examination, software and hardware monitoring in the MR system ensure that all applicable national guidelines regarding avoidance of health risks associated with high-frequency electromagnetic fields are maintained when MAGNETOM Harmony / Symphony is operated correctly.

You can display the specific absorption rate with NUMARIS (*NUMARIS Reference Guide*).

Squeeze bulb

Notice

The patient must be instructed to inform the operator via the squeeze bulb if he/she senses anything abnormal.

For measurements with the body coil and receive coils only:

Danger of burning

The following are receive coils only:

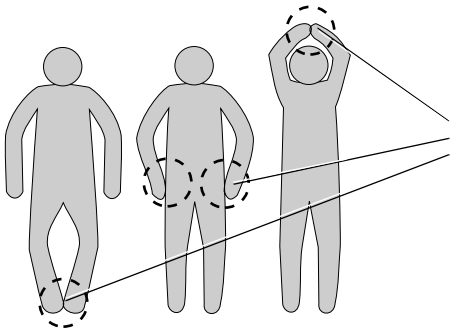
- ❏ CP head array
- ❏ CP breast array
- ❏ CP spine array
- ❏ CP body array
- ❏ CP neck array
- ❏ CP flex small
- ❏ CP flex large
- ❏ Flex loop large
- ❏ Flex loop small

WARNING

Hazard of burns because of wide loops

Local heating or skin burns are possible on the arms and legs of the patient especially at the points where the legs touch!

Therefore *always avoid* mutual skin contact when positioning the arms and legs. A distance of at least 5 cm must be observed. Use the positioning aids, e.g. blankets.



Examples of skin contact that can cause large surface loops. Avoid positioning the patient in this way.

Adverse effects on electromagnetically active implants

Electromagnetic waves in the high-frequency field can have an adverse effect on electrical circuits in active implants (e.g. cardiac pacemakers).

Implants

WARNING

Hazardous for persons with electromagnetically activated implants (cardiac pacemakers, drug pumps, etc.).

Observe the 0.5 mT exclusion zone.

Risks regarding cryogens

Cryogens are cooling agents used to maintain the superconductivity of the magnet. Liquid helium is used as a cooling agent. The characteristics of liquid helium are:

- ❏ it is odorless
- ❏ non-combustible
- ❏ non-toxic and
- ❏ so cold that it causes burns to the skin on contact (= frostbite).

Helium

WARNING

Helium cannot be detected through early warning signs, such as physiological reactions.

Oxygen deficiency

WARNING

The oxygen in the room air may be displaced at a *life-threatening* rate by the escaping helium gas.

Filling/refilling helium

Filling / refilling the magnet with cryogens must be performed with the utmost care and precision with strict adherence to all guidelines.

Siemens will therefore not accept any responsibility for the work performed or resulting damage if the magnet is filled with cryogens by persons not authorized to do this work.

Filling the magnet

WARNING

The magnet cryostats may only be filled/refilled with cryogens by Siemens Service technicians.

Helium gas can escape if a fault occurs or as the result of improper handling. The boiling point of the cooling agent helium is extremely low at –269 °C. It evaporates very quickly at room temperature expanding rapidly, displacing the oxygen in the ambient air. This results in danger of suffocation.

Coolant containers

WARNING

Cryogen dewars must be inspected regularly according to the manufacturer's instructions (regulations regarding pressurized dewars).
Cryogen dewars in the examination room must be made of anti-magnetic material.
Cryogen dewars must be removed from the examination room before beginning patient examinations.
Patient examinations may not be carried out during cryogen filling.

Handling of helium accidents

Danger of frost bite / suffocation

WARNING

Incorrect handling of liquid helium can lead to suffocation and/or frostbite.

Frostbite

Areas of the body covered by hair or permeable clothing are especially vulnerable to frostbite. These obstructions prevent the fluid gas from flowing away thus causing skin burns. The eyes are especially vulnerable!

Carefully remove clothing.

Rinse frozen parts of the skin with water to thaw it and cover with sterilized surgical dressing.

Call a doctor immediately.

Cold injury to skin

WARNING

Never rub frozen skin!

Recommendation:

Post a copy of these emergency measures in a visible place in the examination room.

Danger of suffocation

The air you breathe contains:

- ❏ 78% nitrogen
- ❏ 21% oxygen
- ❏ 1% inert gases

Rapidly escaping helium displaces the oxygen in the air (for example if a pipeline breaks). Oxygen concentrations less than 11 % are insufficient for human respiration.

All rooms must therefore be provided with ventilation; the air conditioning system must be switched on and be functional. Evacuation routes must be provided and clearly marked, they must not be changed.

Move unconscious persons from the room into the fresh air immediately (observe magnetic field).

Initiate resuscitation.

Call a doctor immediately.

Risk of fire

WARNING

Fire hazard

Helium is non-combustible.
However, oxygen in the room may condense into relief ports and vents which are in contact with liquid helium.
If these fittings are coated with flammable oils and grease, a potential fire hazard exists.

Potential points of injury

Ensure that the long hair of a patient does not become entangled in the moving tabletop. To avoid this use a hairnet, headscarf, paper cap etc.

Secure the arms of the patient using the restraining straps in such a way that the patient is not squashed between the tabletop and the opening wall in the magnet. Always secure restless and trauma-patients with the restraining straps!

When using RF-coils pay particular attention to potential points of injury!

Only move the tabletop using the table movement buttons if you can visually monitor all potential points of injury.

If you are using a patient table with exchangeable tabletop take special care that no parts of the body, hair or clothing of the patient becomes caught when transferring the exchangeable tabletop to and from the patient trolley.

If necessary, secure the patient with restraining straps.

Potential points of injury are identified by the warning label shown.

Danger of injury

WARNING

The potential for injury is greatest
when moving the patient into the magnet.

Fire protection

Danger of fire in the examination room

Helium gas as such is non-combustible. However, a potential fire hazard exists where gases escape (e.g. pipeline breakage) and oxygen condenses.

Therefore:

Danger of fire

CAUTION

No open flames, no smoking
in the examination room!

Flammable materials in the vicinity of the magnet and cryogen containers must be removed.

In case of fire, fire fighting procedures must comply with the existing environmental conditions. The fire department must be informed about the MR system and site so that it can take appropriate measures to fight the fire.

Synthetic materials

WARNING

Danger of fire

Never use blankets made of synthetic material to cover or bed the patient.

Use only blankets made of paper, cotton or linen.

Fire fighting

The following fire-fighting equipment should be used:

- ❏ CO_2 extinguisher (antimagnetic)
- ❏ Self-contained, antimagnetic pressurized air breathing apparatus (or tube connection)
- ❏ Close fitting, chemically treated overalls.

It is your responsibility as the user to provide the fire-fighting equipment.

Notifying the fire department

Notice

The fire department should be informed regarding the MR system and site characteristics before the system is started up for the first time.

Patient monitoring

Patient monitoring is necessary when the patient's condition is serious.

Physiological monitoring and / or measuring instruments are used under the responsibility of the user.

Monitoring vital signs

The vital signs of severely ill, unconscious or physically unstable patients for whom MR images are being measured should be monitored. Monitoring with *approved MR-compatible devices* is also mandatory for anesthesized or sedated patients. Vital signs include:

- ECG, pulse and temperature
- Saturation of arterial blood with oxygen
- Blood pressure
- Respiratory volume and possibly respiratory pressure
- Analysis of expiratory gases

Planning monitoring of sedated patients

Consult an anesthesiologist prior to planning patient monitoring.

Emergency situations

WARNING

Medical emergency situation

Immediately terminate the MR measurement should a medical emergency situation arise. The patient must be removed from the examination room for treatment, unless the medical equipment to be used is suitable for an MR suite.

Oxygen tanks, defibrillators and other resuscitation devices must *not* be used in an MR suite because of the magnetic force exerted on the objects and the electrical interference caused by the MR system.

Accessories for patient monitoring

The equipment used for patient monitoring must be approved for use in an MR examination room.

Heat / burns

WARNING

RF and gradient pulses could cause localized heating in cables, which could result in burns to the patient.

Monitoring devices

Notice

If not properly shielded, electronic monitoring devices can generate RF interference which degrades image quality.
High-speed changes in the magnetic field can cause malfunctions in the monitoring devices.

Monitoring equipment / iron components

WARNING

Some devices contain ferromagnetic components which are attracted by the magnetic field.

The following equipment is available for monitoring of and communication with the patient:

Video camera

As an option a video camera can be mounted on the rear of the magnet to monitor the patient. Usually the monitor used for monitoring is located on the operating console.

Intercom

An intercom is available to you for communicating with the patient.

ECG and pulse sensor

During measurement you can monitor the pulse and ECG of the patient with additional devices.

Patient monitoring

WARNING

Physiologically controlled imaging is *not* intended for monitoring the vital signs of patients in a critical condition. These values should be monitored with MR-compatible devices.

ECG cables / pulse sensor

WARNING

Use only ECG leads and pulse sensor provided by Siemens specifically for use with MAGNETOM.

Calling the nurse

The patient can give a signal to the operator using the squeeze bulb.

- ❏ Audible: Continuous tone on the intercom
- ❏ Visual: LED display on the intercom
- ❏ Audible: Short feedback signal through the earphones of the patient and the wall loudspeakers in the examination room.

You can confirm the signal by pressing the talk button on the intercom.

See → page C.1–24 for connection and operation of the **squeeze bulb**.

See → page C.4–2 for how to **call the nurse**.

See → page D.1–10 for instructions on **positioning** the patient with the squeeze bulb.

Inform the patient that he or she must press the squeeze bulb forcefully to call the nurse.

Intercom system

The operating personnel can monitor the patient by listening and give further instructions via the loudspeaker or headphones.

Patients who cannot be trusted to take up contact with the operating personnel in case of emergency (e.g. small children, sedated patients) must be monitored by a person who remains present in the examination room.

Music

You can entertain the patient by playing music in the headphones and via the loudspeaker → page C.4–3.

Monitoring equipment

Notice

Instruct the patient in the use of the monitoring equipment. Discuss the types of communication possible during the examination.

Patient monitoring

Notice

For better patient monitoring we recommend that monitoring of the examination room is always activated.

Damage to hearing

WARNING

Loud measuring sequences can damage hearing. The headphone is therefore not just for making announcements and playing music, it affords effective hearing protection. If you are measuring with coils for which the headphones are too large (e.g. CP Head Array), you must provide the patient with some other means of protecting his or her hearing, e.g. ear plugs.

Immobilizing the patients

Notice

Immobilize helpless patients with the straps provided.

Image position error

Notice

To avoid image position errors make sure that the patient is lying still.
If necessary check the patient position.

Laser light localizer

The laser light localizer on the magnet facilitates correct patient positioning (for operation → Page D.1–7).

The laser light localizer consists of two class II lasers.

Laser light localizer

WARNING

Possible radiation exposure due to laser light

Only use the laser light localizer as described here.

Protective glasses

Usually the eyelid's natural winking reflex to light provides sufficient protection for the eye. Anesthetized patients or patients who for any other reason have lost this reflex must be protected from the laser beam. A pair of protective glasses are provided for such cases.

Laser protective glasses

WARNING

Ensure that patients without a natural winking reflex wear protective glasses prior to positioning. The glasses can be removed before the measurement procedure.

You can order additional glasses under the following item number: 70 52 94 7 F 17 14.

Switching off the laser light localizer

Always switch off the laser light localizer after completing positioning of the patient.

The laser light localizer automatically switches off if the patient tabletop is not moved for one whole minute.

Maintenance and service

Laser light localizer

Notice

The light localizer has to be checked at regular intervals by Siemens Customer Service.

Beam exits as spot beam

WARNING

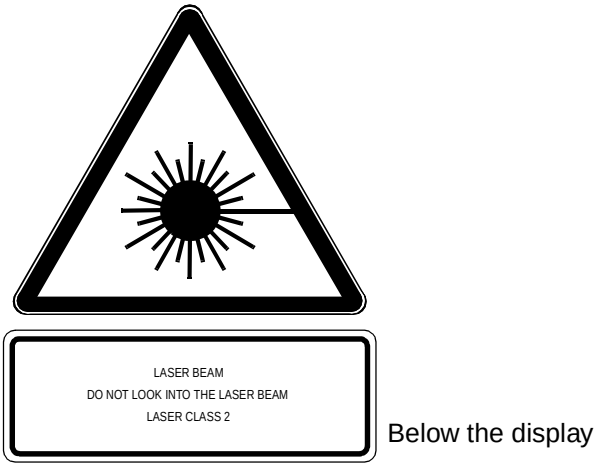
Do not perform any examinations if the laser beam exits as a spot beam rather than in form of cross-hairs.

Switch off the light localizer immediately and notify Siemens Customer Service!

Warning signs and labels

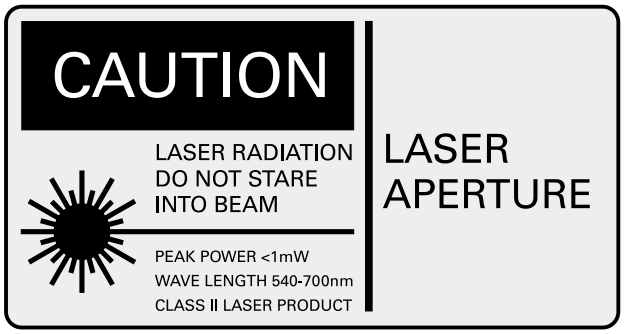
The labels shown below have been affixed to all laser-relevant locations on MAGNETOM Harmony/Symphony.

Warning label (except USA)



Below the display

Warning label (USA only)

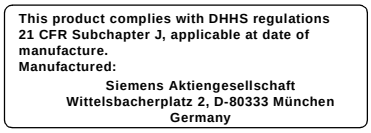


Below the display

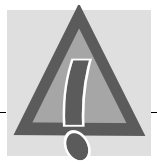
Identification label

On the magnet cover

Certification label (USA only)



On the magnet cover



A.3 System-Specific Safety Instructions

As the user it is your responsibility to ensure that only qualified personnel who have been trained in the use of MR systems are allowed to operate MAGNETOM Harmony / Symphony.

The system can only be activated via the keyswitch and the correct key to prevent unauthorized start-up of the system (→ Page B.3–2).

Effects of the magnetic field

The magnetic field can erase magnetic data media (e.g. disks, magnetic tapes, diskettes, credit cards) and destroy mechanically-sensitive components (e.g. watches, paging devices, hearing aids).

Safety distances

CAUTION

Do not enter the examination room with magnetic storage media or ferromagnetic objects in your possession. Observe the exclusion zone.

Exclusion zone

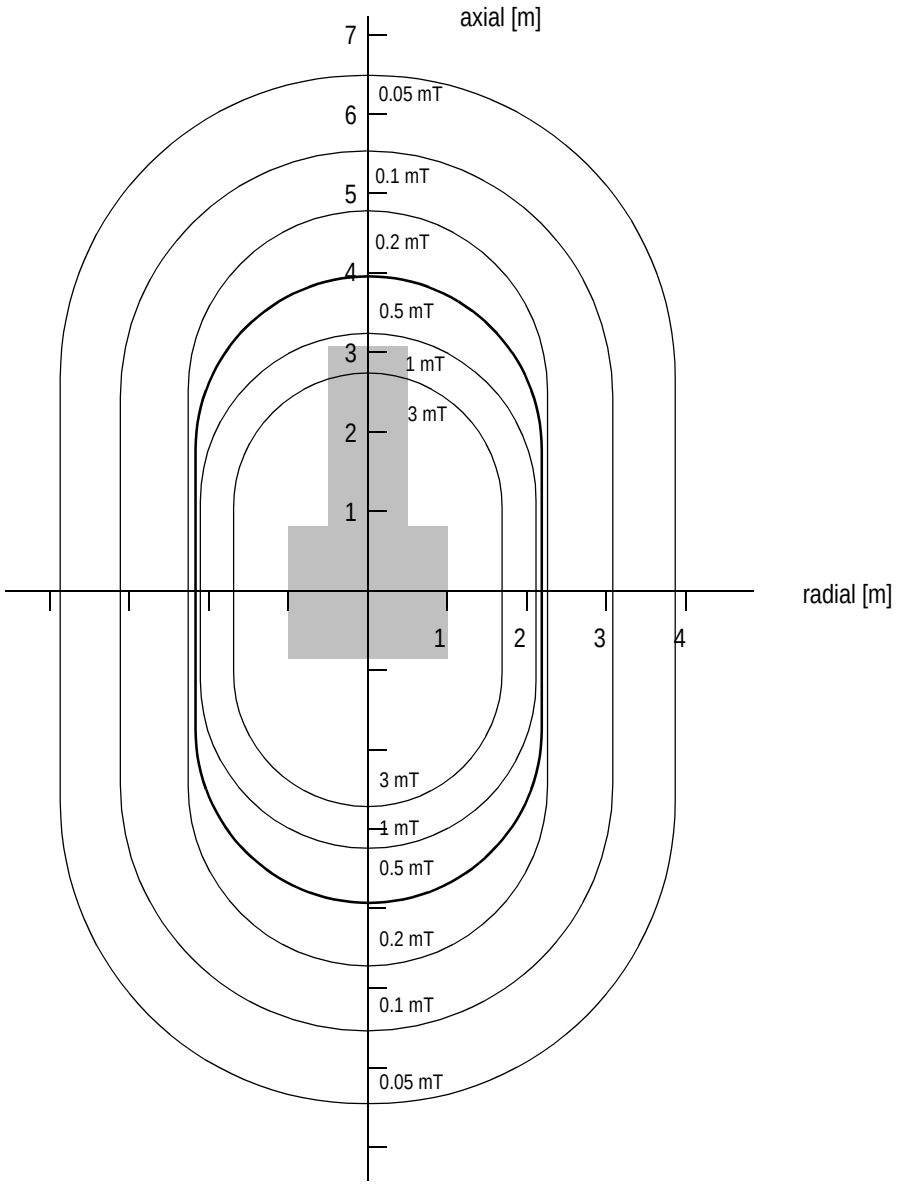
The following table shows the effects of the magnetic fringe field on devices located in the vicinity of the magnet and the exclusion zones. Observe the minimum distances to be maintained from the midpoint of the magnet's x-, y-, and z-axis.

Exclusion zone MAGNETOM Harmony

Magnetic flux density	Minimum distances (x=y=radial, z=axial)	Affected devices
3 mT	x = 1.80 m z = 2.70 m	Small motors, watches, cameras, credit cards, magnetic data carriers
1 mT	x = 2.10 m z = 3.30 m	Oscilloscopes, processors, disk drives, shielded color monitor
0.5 mT	**x = 2.30 m** **z = 3.90 m**	B/W monitors, magnetic data carriers, cardiac pacemakers, insulin pumps
0.2 mT	x = 2.40 m z = 4.70 m	CT installations by Siemens
0.1 mT	x = 3.10 m z = 5.50 m	Linear accelerators by Siemens
0.05 mT	x = 3.80 m z = 6.50 m	X-ray image intensifiers, gamma cameras, linear accelerators by outside vendors

Magnetic fringe field MAGNETOM Harmony

The figure below shows the magnetic fringe fields beginning at the center of the magnetic field.

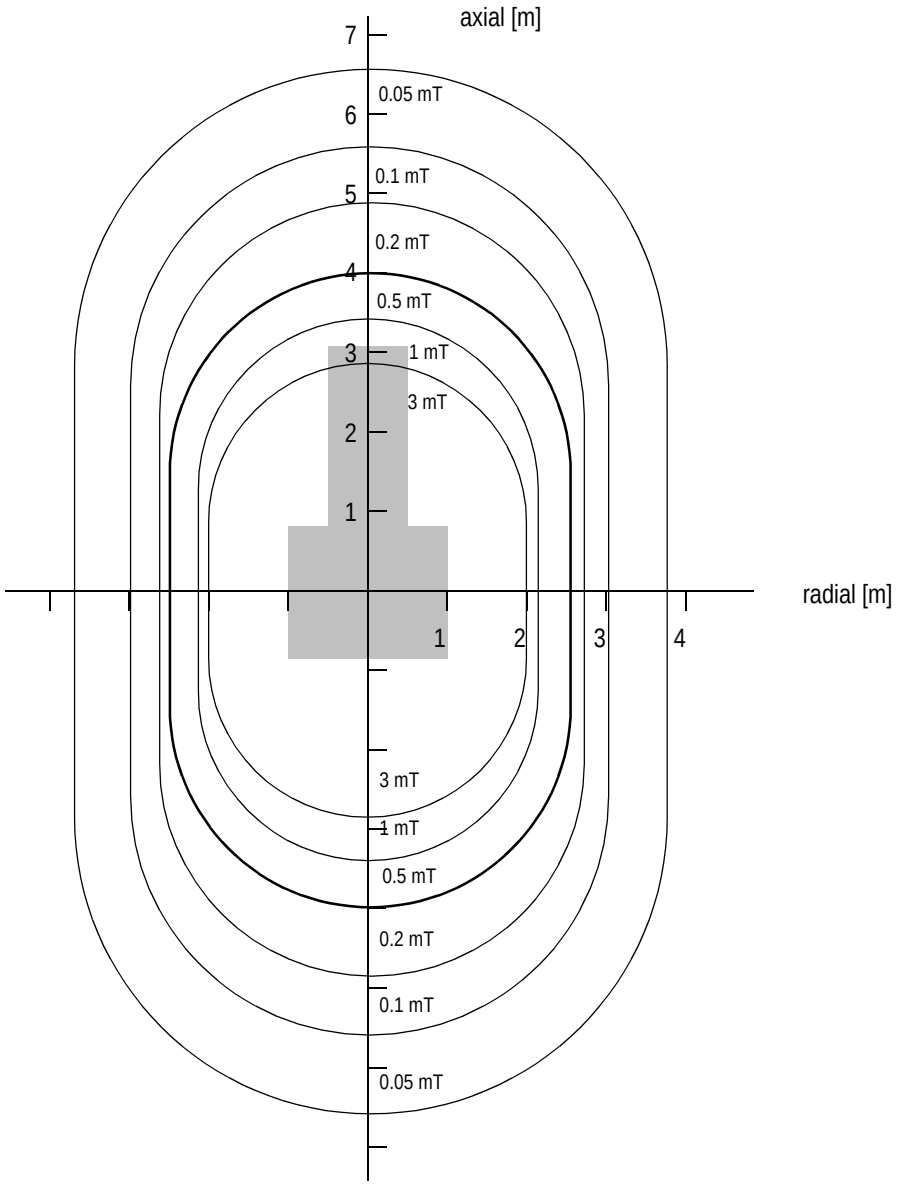


Exclusion zone MAGNETOM Symphony:

Magnetic flux density	Minimum distances (x=y=radial, z=axial)	Affected devices
3 mT	x = 2,80 m z = 2,00 m	Small motors, watches, cameras, credit cards, magnetic data carriers
1 mT	x = 2,20 m z = 3,40 m	Oscilloscopes, processors, disk drives, shielded color monitor
0,5 mT	**x = 2,50 m** **z = 4,00 m**	B/W monitors, magnetic data carriers, cardiac pacemakers, insulin pumps
0,2 mT	x = 2,70 m z = 4,80 m	CT installations by Siemens
0,1 mT	x = 3,00 m z = 5,60 m	Linear accelerators by Siemens
0,05 mT	x = 3,70 m z = 6,60 m	X-ray image intensifiers, gamma cameras, linear accelerators by outside vendors

Magnetic fringe field MAGNETOM Symphony

The figure below shows the magnetic fringe fields beginning at the center of the magnetic field.



Storage of helium dewars

As the user you are responsible for storing the dewars. You must ensure that they are stored according to local rules and regulations.

Helium containers

Notice

Dewars have to be stored in a secure, upright position and protected against damage.

Dewars may not be stored in locations which obstruct emergency exits and hallways.

Discuss all requirements for storing dewars with the respective gas suppliers.

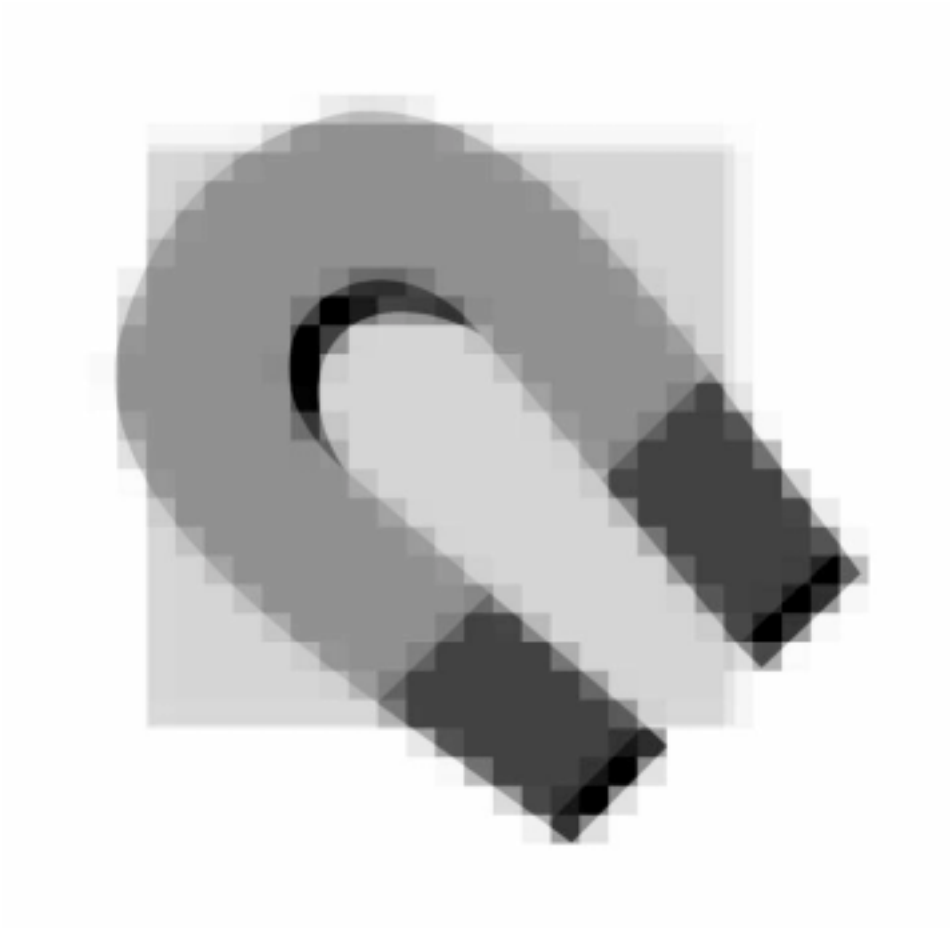
Helium containers

WARNING

Helium dewars must be inspected at regular intervals by trained personnel in accordance with the manufacturer's instructions.

Only anti-magnetic cryogen dewars may be used in the examination room.

B MR System



B.1 Components of the MR System

MAGNETOM Harmony/Symphony is a diagnostic imaging system which generates and displays tomographic images of the entire human body in any orientation. The technical imaging method is based on the physical principle of magnetic resonance (MR).

During measurement, the patient is placed in a strong homogeneous magnetic field. The hydrogen nuclei (protons) distributed throughout the entire body tissue generate signals when stimulated by an RF field. These signals are processed into MR images which can be displayed by the computer.

The MR system consists of the following components:

- ❏ Superconducting magnet
- ❏ Patient table
- ❏ MR coils
- ❏ Electronic cabinets
- ❏ Computer system
- ❏ Operating consoles
- ❏ Intercom system
- ❏ Video system (optional)

Superconducting magnet

Magnetic field

The superconducting magnet generates a strong homogeneous magnetic field with a field strength of 1.0 Tesla (Harmony) or 1.5 Tesla (Symphony).

Cryogens

After it has been installed, the magnet is filled with liquid helium and ramped to the desired nominal operating field strength. The energized magnet does not require electrical power to maintain the magnetic field. However, since the liquid helium evaporates slowly, it has to be refilled at regular intervals by service personnel.

However, the insulation of the magnet is so good that liquid helium only has to be topped up approximately every two years.

Shielding

Shielding (leakage field)

To minimize the effects of the magnetic leakage field on the environment (therefore also the effect of magnetizable parts on the magnet), the magnets of the MAGNETOM Harmony / Symphony are equipped with active, superconductive shielding.

Shielding against external interference

To provide effective shielding against external interference, the magnets of MAGNETOM Harmony/Symphony have a superconductive shielding system (E.I.S). These superconducting shield coils are discharged automatically once a day.

This guarantees consistent high quality of the display.

Gradients

The gradient system permits precise location of the desired slice position. The system consists of three coils X, Y and Z located at the magnet aperture as well as the gradient amplifier cabinet.

Opening

For measurement the patient table is moved into the magnet. You can control the lighting and ventilation inside the opening of the magnet from the operating units at the entrance to the opening.

Patient table

Basic patient table

On the basic patient table the tabletop is fixed.

The patient table is used to position the patient during measurement (→ Page D.1–7) and to position the required coil (→ Page D.1–5).

For triggered measurements, also connect the receptors of the physiological measuring unit to the table (→ Page C.1–3).

To position the patient in the magnetic field move the table into the magnet (→ Page D.1–9).

Table with exchangeable tabletop and trolley (optional)

You can remove the exchangeable tabletop from the patient table with the trolley. In this way you can transport patients easily.
With an additional second exchangeable tabletop and trolley productivity can be optimized (→ Page C.6–1).

MR coils

MR imaging places high demands on the RF antennas (coils) used.

Transmitting The transmit coils excite the hydrogen protons in the volume of interest as *homogeneous*ly as possible: All affected spins must be subjected to the same excitation.

Receiving The receive coils receive MR signals with as *little noise* as possible. The signal-to-noise ratio partly depends on the excited volume within the coil as well as the coil's distance from the object measured.

> The nearer to the measured object, the stronger the signal received.

This means: The signal to noise ratio improves as the distance between the coil and measured object is reduced.

Body coil

The body coil is integrated into the magnet. It functions both as a transmit and a receive coil. Although the coil has a large measurement field, it does not have the high signal-to-noise ratio of the RF-coils.

RF-coils

In order to ensure a high signal-to-noise ratio various optional RF-coils are available:

Receive coils

The following RF-coils are receive coils only

- ❏ CP head array
- ❏ CP spine array
- ❏ CP body array
- ❏ CP neck array
- ❏ CP flex small
- ❏ CP flex large
- ❏ Flex loop large
- ❏ Flex loop small

Transmit and receive coils

The CP Extremity is a transmitting and receiving coil.

Phantoms

The quality assurance of the coils requires several tests to be performed (→ Chapter F.1). During the test measurements the body of the patient is simulated by phantoms.

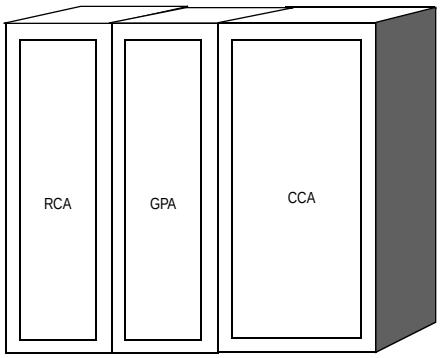
- ❏ *Loaded phantoms* simulate the weight of the patient
- ❏ *Coil phantoms* simulate the tissue

Electronic cabinets

The electronic cabinets are installed in the power room.

They comprise

- ❏ the control cabinet (CCA),
- ❏ the gradient cabinet (GPA) and
- ❏ the refrigerator cabinet (RCA).



The control cabinet contains the electronics for scan control, for generation of high frequency and the shim currents (optional) and the entire power supply and magnet monitoring.

The gradient cabinet contains the power electronics for generating the magnetic field gradient.

The refrigerator cabinet contains the cooling for the system components.

The electronic cabinets do not contain any operating elements.

Please leave maintenance to the service personnel.

No power room

Sometimes there is no power room for construction reasons. In such cases, the power cabinets can be located in the operating room, for example.

Computer system

The computer system comprises a host and an image computer (SMI-V). The computers are both fitted in one console next to the console table.

Host computer

The host computer works with the SOLARIS operating system and has a harddisk with an image and raw data memory.

You use the host computer when you are working with the NUMARIS user software.

The host computer is responsible for

- ❏ Patient administration
- ❏ Image retrieval and image storage
- ❏ Measurement sequence administration

The host computer also manages all interfaces between the user and the computer system.

These include:

- ❏ Monitors
- ❏ Mice
- ❏ Keyboards
- ❏ Console table (optional)
- ❏ Satellite consoles (optional)
- ❏ Exchangeable data media

Image computer

The image computer is responsible for image processing. This includes:

- ❏ Calculation
- ❏ Display
- ❏ Evaluation
- ❏ Editing and
- ❏ Filming and archiving

Documentation systems

The archiving and documentation equipment of the MR system consists of:

- ❏ An optical disk drive (→ Chapter G.1),
- ❏ A camera (→ manufacturer's instructions),
- ❏ A printer (→ manufacturer's instructions).

Network connection

The computer network allows you to process MR images on other systems or computers or to receive images from these systems or computers via data networking.

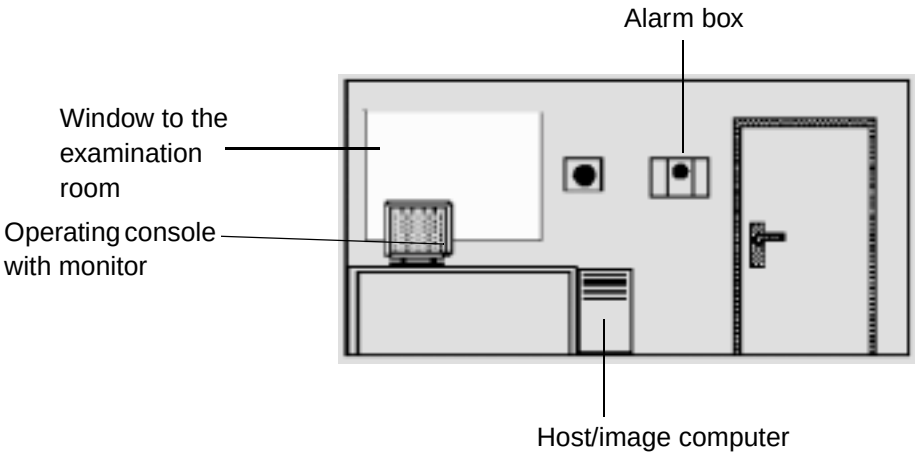
SIENET SIENET is a widely used network standard for the transfer of medical image data.

Use the **System Imprint** function to determine whether your system is network-supported (*NUMARIS Reference Guide*).

The systems or computers networked with your system are listed when you select the **System Info** function (*NUMARIS Reference Guide*).

Operating consoles

MRC The MR operating console (MRC) is primarily used for measurement.



MRSC The MR satellite console (MRSC) is optional and is mainly used for evaluating and archiving the measured images.

Alarm box The alarm box is installed close to the MRC. Its purpose is to

- ❏ display supervisory or warning messages (→ Page B.2–2)
- ❏ switch the system on or off (→ Page B.3–2).

Patient table To control the patient table two operating units are mounted one to the right and one to the left of the table. As an option you can install another auxiliary operating unit, on the rear wall of the magnet.

Video monitoring

A video camera can be obtained for patient monitoring, if required. A video camera is installed at the end of the magnet opening. The camera is used to monitor the patient during measurement. The LCD is located on the operating console → page C.5–1.

Intercom system

With the intercom system you can communicate with the patient during measurement → page C.4–1.

You can also play music for the patient's entertainment.

B.2 Daily Function Checks

Before starting up the system you must perform the following function checks.

- ❏ Helium level
- ❏ Alarm box
- ❏ Warning signs
- ❏ Squeeze bulb
- ❏ Fluids on floor
- ❏ Magnetizable material
- ❏ Contrast residues
- ❏ Filter grid
- ❏ Exhaust vent

Alarm box checks

Check the displays on the alarm box.

If the green **LINE** LED is lit the power supply from the line is normal.

If the LED **LINE** is not lit up the power supply to the system is interrupted.

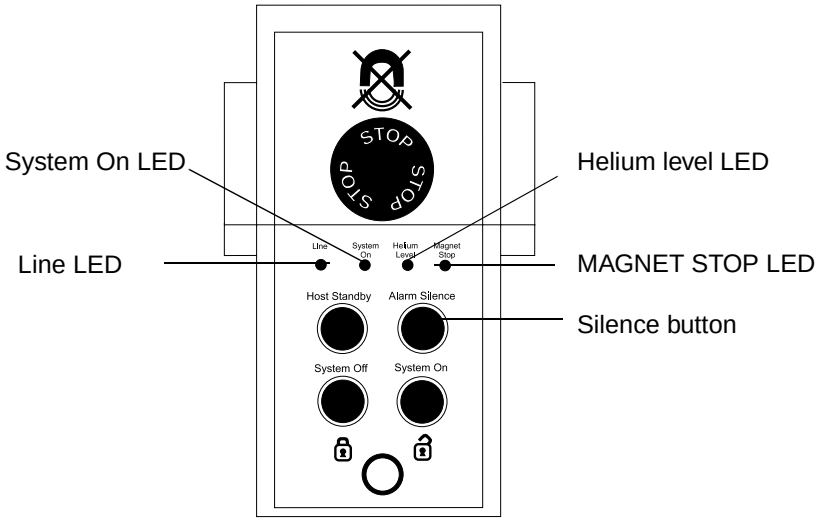
After a power failure, the battery supplies the magnet monitor with power for another 10 hours. During this time the magnet can still be quenched.

Check the power supply of the system and contact Siemens Customer Service.

Check the following displays for an alarm message:

- ❏ Helium level
- ❏ Magnet stop

If an alarm is displayed in the alarm box (LEDs lit red, audible alarm signal sounds), you can see which alarm has been triggered on the monitor.



Press the silence button to switch off the audible alarm.

Contact Siemens Customer Service.

Alarm box

WARNING

Patient examinations are prohibited if an LED glows red and/or an audible alarm tone is heard.

Contact Siemens Customer Service.

Additional checks

Helium level

If the helium level drops below a preset warning level, a message box is displayed on the console which you must acknowledge.

If this happens, inform Siemens Service or have the magnet refilled.

The system can be used without danger until the helium alarm signal is given on the alarm box.

Warning signs

Verify that all warning signs inside and outside the examination room have been posted as required (→ page xviii *Warning signs*).

Sqeeze bulb

Check the function of the sqeeze bulb. The patient must be able to call the nurse with the sqeeze bulb

Fluids on floor

Check the examination room, power and magnet room for leaking fluids or puddles on the floor (condensed water or cooling water).

Magnetizable material

Ensure that the examination room is free of magnetizable material or objects, e.g. vacuum cleaner, transport trolley, ladder, tools.

Filter grid

Check the metal mesh of the filter (if available) in the examination room. Ensure that no objects have been stored in the »cells«, e.g. pencils, pens, syringes, scissors.

Exhaust vent

Check that the exhaust vent is free of obstructions (→ Page A.2–24, → page –xvi).

Contrast residues

Ensure that the patient table has been wiped clean of contrast agent.

B.3 Starting and Stopping the System

The system recognizes three operating states:

- *System on*, all components are switched on, you can perform measurements with MAGNETOM Harmony / Symphony.
- *Host standby*, the measuring unit of MAGNETOM Harmony / Symphony is switched off, you can only use the host computer, e.g. to evaluate images or to diagnose patients.
- *System off*, MAGNETOM Harmony / Symphony is completely switched off.

You can define each operating state by pressing the relevant button in the alarm box.

Caution Perform the **daily function checks** before switching on the system! (→ Chapter B.2)

After you have switched on the power supply a program runs that checks the system for any malfunctions.

The magnet stop circuit is monitored continuously.

You will find additional information about NUMARIS software in the *NUMARIS Reference Guide*.

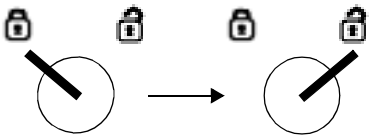
Starting the system

Switching on

Alarm box

Enable the system with the keyswitch (LOCK).

To do this turn the key by 90°.



unlocked

Press the SYSTEM ON button

System ON

The LEDs light up when the system is in operation.

The system is now switched on.

Operating console

The host computer loads the operating system.

Various tests and loading procedures are now performed. The relevant messages appear on the screen.

Once all tests have been completed the prompt
LOGIN:
appears on the screen.

Starting NUMARIS

Enter "MR" via the keyboard and press RETURN.

NUMARIS is now being started.

You can begin working at the operating console as soon as the NUMARIS workspace is displayed on the screen (*Working with NUMARIS*).

Function tests after system start-up

After the system has been started up, several tests are required prior to the patient examination.

TABLE STOP function Check the TABLE STOP function of the tabletop (→ Page A.2–4).

Squeeze bulb Ensure that the squeeze bulb works properly.

Video monitoring Check the video monitoring system for satisfactory image transfer.

Intercom system Ensure that you can communicate clearly with the patient in the examination room.

Locking mechanism Check the locking mechanism on the door of the examination room. Ensure that the special spring contact strips on the door-frame and on the door of the examination room are free of foreign material, e.g. such as cleaning fluid, floor wax, oil, grease, paint stains, blood stains.

Standby operation

You can only use the HOST computer in standby operation. All other components of the system such as the measuring unit or patient table are switched off. In standby operation you can save electricity.

This operating state is recommended, for example, if you wish to continue work on the computer after performing examinations.

If you try to perform a measurement in standby operation an error message appears on the monitor.

Switching on standby

You can activate standby mode by pressing the relevant button in the alarm box.

System On If the system is switched on all the components except for the host computer are switched off when you press HOST standby.

System Off If the system is switched off you must first enable the system with the keyswitch. You can then **only** start the HOST computer when you press HOST standby.

Quitting standby

System On If you press the button **System On** in the alarm box the other components of the system are started. Normal measuring operation is then possible.

System Off First close down all programs on the HOST computer as described in Chapter *Shutting down the software* (→ Page B.3–5).

Press the key **System Off**. This also closes down the HOST computer.

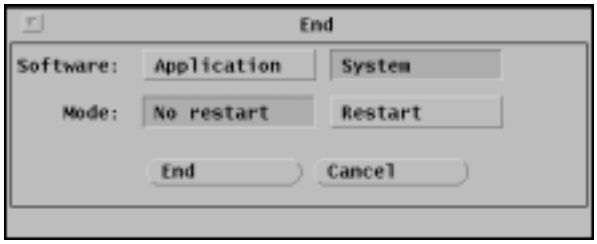
All the components of the system are now switched off.

Disable the system with the keyswitch.

Shutting down the software (MRC only)

Prior to switching off the system:

Call the »System End« function via NUMARIS.



If a satellite console is *not* connected to your system:

Software: System **Switch to System.**

Mode: No restart **Switch to No restart.**

End **Shut down the system software.**

The symbol > appears on the screen after a short time.

The system must be supplied with power for at least two minutes after the symbol appears, in order for some processes to end properly.

After this time you can switch off the system (→ Page B.3–7).

Ending the software for systems with the MRSC

If your system is equipped with a satellite console (MRSC), you must proceed as follows:

1. On the satellite console (MRSC)

Software: Application **Switch to Application.**

Mode: No restart **Switch to No restart.**

End **End NUMARIS.**

The »login:« appears on the screen after a short time.

2. On the operating console (MRC)

Software: System **Switch to System.**

Mode: No restart **Switch to No restart.**

End **End of system software.**

The symbol > appears on the screen after a short time.

The system must be supplied with power for at least two minutes after the symbol appears.

After this time you can switch off the system (→ Page B.3–7).

Switching off the system

End the software as described on the previous pages prior to switching off the system.

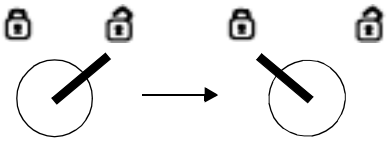
NUMARIS should have been shut down for at least two minutes prior to switching off the system.

Alarm box **Press the SYSTEM OFF button**.

System OFF

Disable the system with the keyswitch.

Turn the key back to the original position.

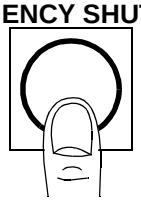


locked

In emergency cases

EMERGENCY SHUTDOWN button

EMERGENCY SHUTDOWN



Notice

In case of extreme emergency – and only then ! – you can press the EMERGENCY SHUTDOWN button. The entire system is immediately shut down.

NUMARIS does not respond

Sometimes NUMARIS does not respond to mouse commands. Then you cannot enter any more commands. You must exit NUMARIS or switch off the system.

You can exit NUMARIS without shutting down the system altogether by pressing the following key combination:

Ctrl+Alt+Del.

Use the key combination Ctrl+Alt+Del **only** then if the system does not respond. All images acquired during program standstill are lost.

NUMARIS is then exited without damaging the system.

You can then start up NUMARIS again.

C.3 Alarm Box

The alarm box is permanently installed in the operating room near the operating console of the host computer.

It fulfills the following functions:

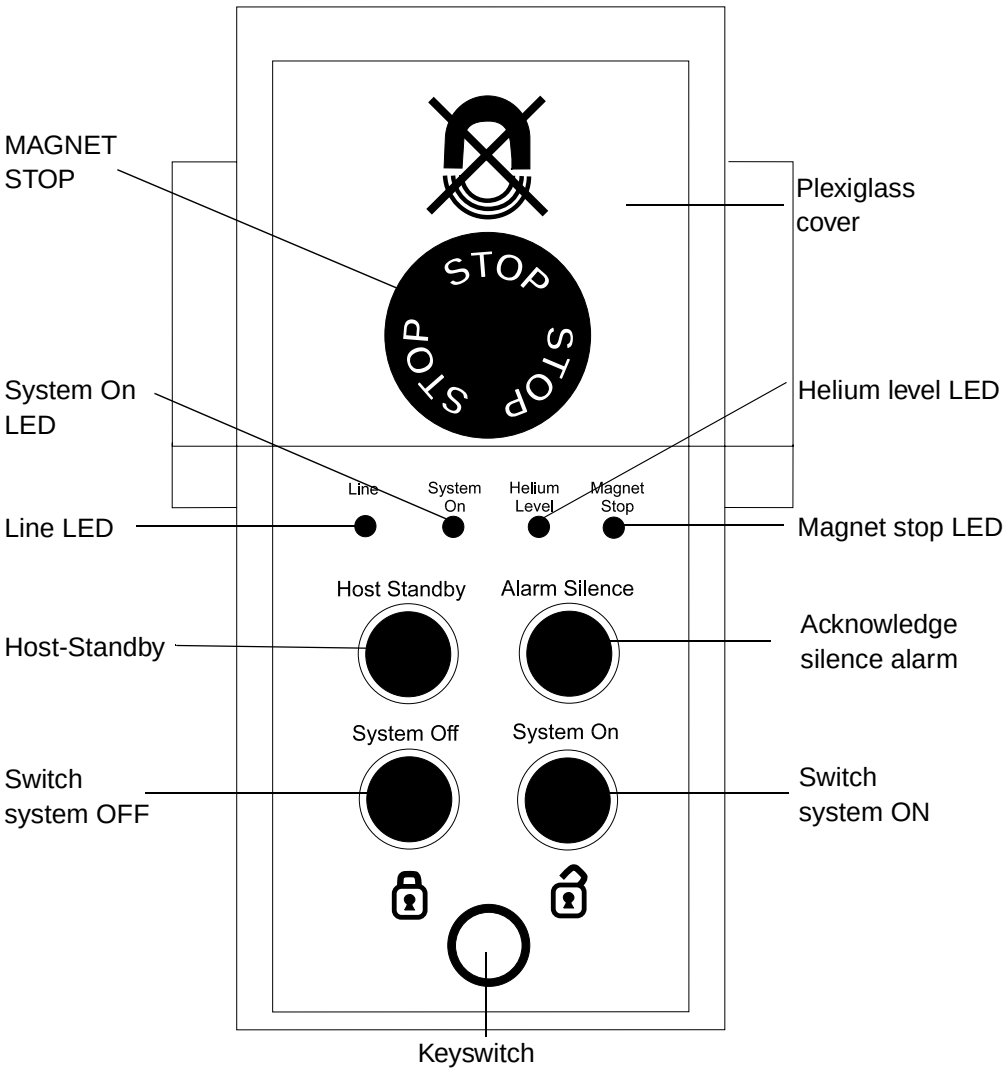
- ❏ Displaying alarms
- ❏ Acknowledging alarms
- ❏ Switching the system on and off (→ Page B.3–1)
- ❏ Switching standby operation on and off
- ❏ Executing MAGNET STOP (→ Page A.2–8)

Alarm box

WARNING

Patient examinations are prohibited if an alarm occurs – indicated by a red light and/or an audible alarm tone.

Contact Siemens Customer Service.



Alarm displays

LINE

Line indicates the power supply status.

A **green light** indicates normal power supply.

If the line LED does not light up, the normal power supply from the line has failed. The monitoring circuit of the magnet is supplied for another 10 hours by the battery. During this time the magnet can still be quenched. Check the power supply. Call Siemens Service.

HELIUM LEVEL

As soon as the helium level drops below the minimum level the *red* display lights up and an audible alarm signal is given (helium alarm).

The liquid helium level must be topped up. Contact Siemens Customer Service.

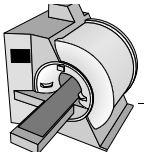
Timely before a helium alarm is displayed in the alarm box a warning appears on the monitor when the helium level reaches a level requiring a refill. Please contact Siemens Customer Service.

MAGNET STOP

The *red* LED lights up and an audible alarm signal is given if:

- ❏ The monitoring electric circuit of the magnet is interrupted. Contact Siemens Customer Service.
- ❏ The battery voltage no longer corresponds to the prescribed value. Contact Siemens Customer Service.
- ❏ Magnet stop is triggered. Contact Siemens Customer Service.

A more detailed description of the event causing the alarm appears on the screen.



Alarm box functions

Magnet Stop

If you operate Magnet Stop the field strength is reduced to a low value in a very short time. The magnetic field energy is converted to heat energy. Liquid helium evaporates immediately and is released into the environment (outside) via a rent.

The red Magnet Stop LED lights up and an audible alarm signal is given.

Alarm acknowledgment

Press the button **Silence** to acknowledge an alarm. The alarm signal then stops. The corresponding LEDs continue to be lit.

Lock

You can enable the system for operation with the keyswitch.

System on

You switch the system on here.

System off

You switch the system off here.

Host standby

The entire system with the exception of the host computer is switched off.

C.4 Intercom System

The intercom system consists of a operating console and a central unit.

The following functions are integrated in the intercom system:

- ❏ TABLE STOP
- ❏ Nurse call
- ❏ Intercommunication
- ❏ Playing music
- ❏ Monitoring physiological monitoring signals
- ❏ Hearing protection for the patient

The following diagram shows the operating unit of the intercom system.

The intercom is installed in the control room.

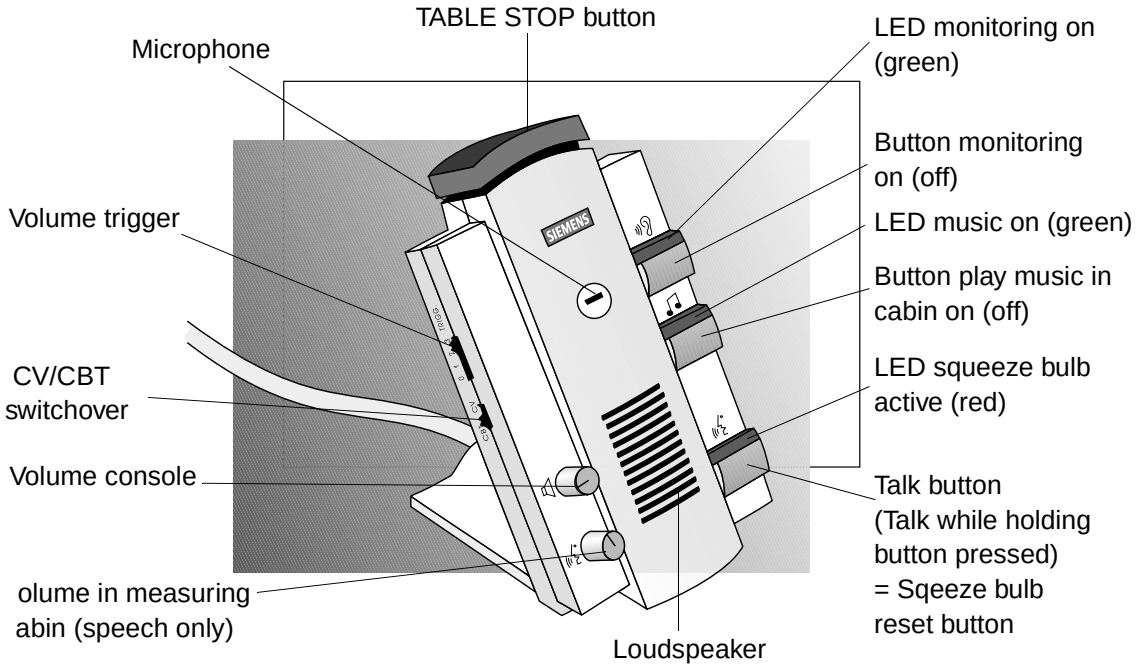


TABLE STOP

Press the **red TABLE STOP button** on the intercom.

The patient TABLE STOPs all movement immediately.

When you trigger TABLE STOP the table brake is released. The table can now be moved in the horizontal direction manually (cf. → Chapter C.1).

You can cancel TABLE STOP from the operating units in the examination room (→ Page C.1–15).

Nurse call

Ensure that the patient is holding the squeeze bulb in their hand during measurement. The patient can use the squeeze bulb to attract attention to themselves.

When the patient squeezes the bulb an audible signal sounds on the intercom.

As a response the patient hears a somewhat quieter audible signal in the headphones and via the wall loudspeaker as long as he keeps the squeeze bulb pressed.

Reset the audible signal with the talk button on the intercom. At the same time you can ask the patient why they called.

At the same time monitoring of the examination room is activated so that you can hear the patient.

See → page C.1–24 for connection and operation of the **squeeze bulb**.

Intercommunication

The intercommunication function is used to communicate with the patient during measurement.

You can talk while pressing the **talk button** on the intercom. Your announcement is heard by the patient through the headphones and wall loudspeaker.

Patient monitoring

Notice

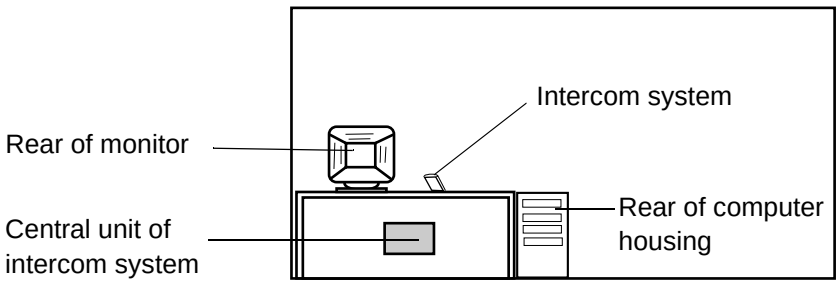
For better patient monitoring we recommend that monitoring of the examination room is always activated.

Playing music

To entertain the patient you can play music in the headphones of the patient and on the wall loudspeaker through the intercom system.

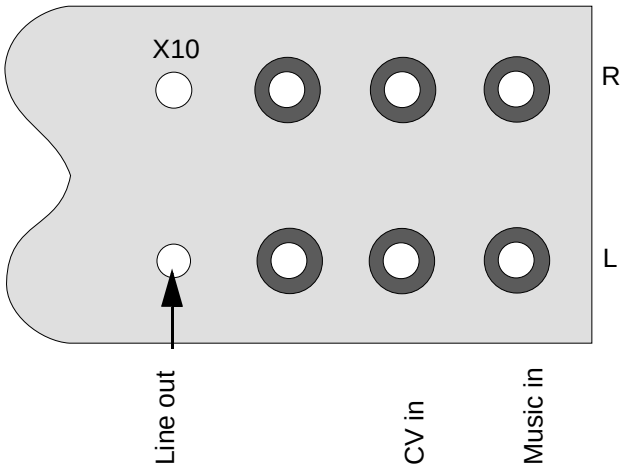
Connecting a unit

Connect an audio source, e.g. a CD player, walkman etc. You will find connectors (Music in) on the central unit of the intercom system (rear of the console) for that purpose.



Use a suitable cable. For a walkman that is, e.g. a CINCH cable ("Line Out" connector of the walkman to "Music In" on the central unit).

Connectors on the central unit



Switching on the unit

Switch on the audio unit and start playing the music.

Press the button "Music On/Off" (LED lights up green). The music is now played in the headphones of the patient (if connected) and on the wall loudspeakers in the examination room.

Headphones

Connect the headphones to the PMU box at the patient table.

The patient can now hear music through the headphones.

Adjusting the volume

You can set the volume of the headphones and wall loudspeakers in the examination room on the operating unit on the magnet.

Music in the operating room

If you want to hear music in the operating room, you must connect active speakers to the central unit of the intercom system (Line Out connector).

Announcements to the patient

The music is interrupted for patient announcements.

Monitoring signals

You can hear the trigger pulses of the physiological monitoring signals via the intercom.

You can set the volume on the intercom. You can select one of four levels: off, quiet, medium and loud.

Noise protection

The headphones provide effective protection for the patients hearing during loud measuring sequences. For the reason always use the headphones; announcements to the patient are audible even during loud measuring sequences.

CV/CBT switch

Reserved for future use.

D.1 General Information Regarding Patient Positioning

Patient cooperation is an important part of the MR examination. Position the patient carefully and properly so that he is as comfortable as possible.

Carefully follow the instructions under *Specific Absorption Rate* → Chapter D.2. Also follow the *Safety instructions for RF coils* → Page D.1–3.

Patient gurney

You can transport a patient unable to walk to the magnet with a *non*-ferromagnetic patient gurney. Siemens offers an optional MR compatible patient trolley.

Danger of accident

CAUTION

Danger of accident when using a patient gurney.

The gurney must not contain ferromagnetic material (iron, cobalt, nickel or alloys of these).

Hearing protection

Due to the acoustic noise associated with MR measurements you must offer the patient hearing protection which ensures attenuation of at least 20 dB.

Always use the headphones supplied as hearing protection. Ear plugs can provide some protection if headphones cannot be used due to space limitations.

Immobilizing the patients

Notice

Immobilize helpless patients with the straps provided.

Overview of RF coils

The following overview shows the RF coils available as an option together with their main area of application.

Name, German	Name, English	Area of application	Page
Kopfspule	CP Head Array	Head, head vessels	→ Page D.3–5
Hals-/Nackenspule	CP Neck Array	Head, neck, vessels	→ Page D.3–16
Brustspule	CP Breast Array	Female Breast	→ Page D.3–34
Wirbelsäulen-spule	CP Spine Array	Entire spine	→ Page D.3–12
Körperspule	CP Body Array	Body trunk	→ Page D.3–18
Extremitäten-spule	CP Extremity	Knees, feet, ankles	→ Page D.3–27
CP Flexspule groß	CP Flex Coil Large	Shoulders, hip	→ Chapter D.4
CP Flexspule klein	CP Flex Coil Small	Shoulders, elbows, hand, wrist	→ Chapter D.4
Ringspule klein	Loop Coil Small	Fingers/finger joints	→ Chapter D.4
Ringspule standard	Loop Coil Standard	Shoulders	→ Chapter D.4

Please note: A separate set of operating instructions is included with the *endorectal coil*.

Accessories

All accessories (cushions and pads) available for positioning are listed in the Appendix *Accessories for patient positioning*.

Safety instructions for RF coils

RF coils must only be used by personnel who are familiar with these operating instructions and whose qualifications mean that they are aware of the risks involved if RF coils are used incorrectly.

Safety measures

To prevent coupling between the coils and the integrated body antenna, each coil contains protective electronics. The active part of the protective electronics receives signals via the coil connector. *This is why connecting the RF coil is vital to proper operation*.

Coil / danger of destruction

CAUTION

The coil can be damaged.

Connect every coil to the corresponding socket in the patient table or the CP spine array.

As a prerequisite for safe and correct operation of the RF coil, the coil must be connected correctly:

If you do not follow these instructions, you may damage the coil. You will then *no longer* be able to perform examinations with this coil.

Correct handling of coils

Handle the RF coils with care. Store them in a safe place when they are not in use. Store them in such a way that avoids mechanical damage.

Damage to coils

Notice

Do not use coils which show mechanical damage.
Call Siemens Customer Service.

To avoid damage lift and carry RF coils by the lower section only. For optimal operation the coils must be used together with their positioning supports.

If the RF coils are used correctly, the applied RF output both during coil tuning and during patient measurements will *not exceed* the currently accepted limit values. This also applies if the active part of the electronics fail during a measurement.

Coil cables / contact with skin

Notice

Avoid direct contact of the coil cable
with the patient's skin.
If necessary, place a blanket made of
moisture-absorbing material (e.g. cotton)
between the patient and the coil cable.

Correct use of RF coils

The basic procedures for coil positioning, patient positioning and coil tuning are described below.

Refer to the descriptions in the following chapters for the specific application of the individual coils.

Coil positioning

Place the necessary positioning supports and cushions on the table.

Special positioning supports and cushions are provided with each RF coil. They are placed on the table and covered with paper disposable. Some supports are also used for positioning the coil.

Appendix II *Accessories for patient positioning* provides a detailed list of the available mats and cushions.

Please note: Ensure that the paper disposable does *not* get caught between the coil contacts.

Position the coil on the patient table.

The coils are designed in such a way that they fit on the patient table in certain positions. The precise position is given in the description of the individual coils.

Lower the patient table.

Press the relevant button on the operating console until the table has been lowered to a height which is comfortable for the patient.

Connecting the coil

Connect the coil
(does not apply to the integrated body coil)**.**

Open the protective flap and insert the coil connector into the socket. The coil cable must be neither pressed nor pulled.

Coil connection

CAUTION

Only start measurements when you are quite sure that the connected coil shows the correct display on the screen.

You must only operate a connected coil showing the correct display.

Coil tuning

The system recognizes the coils automatically and coil tuning is also performed automatically.

Patient positioning

Head first

Usually, the patient is positioned with the head towards the magnet.

Feet first

In some cases the patient is positioned with the feet towards the magnet.

The type of positioning used must be specified when you register the patient.

Marked coil center

As a rule, the region to be examined must lie within the marked coil center. The center of the coil is always indicated by a dash on the coil housing.

Use the cushions and positioning aids provided with the coil. Notes on correct positioning are given in the description of the individual coils.

Vacuum cushion

For stable and comfortable positioning of the patient, you can use vacuum cushions (optional) → Chapter D.5.

Danger of burning

he following are receive coils only:

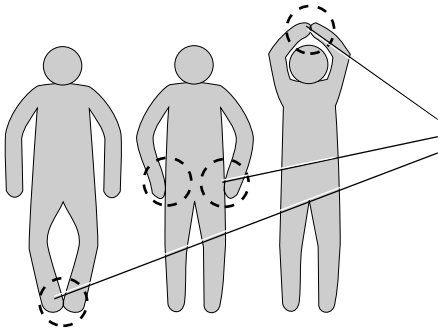
- ❏ CP head array
- ❏ CP breast array
- ❏ CP spine array
- ❏ CP body array
- ❏ CP neck array
- ❏ CP flex small
- ❏ CP flex large
- ❏ Flex loop large
- ❏ Flex loop small

WARNING

Hazard of burns because of wide loops

Local heating or skin burns are possible on the arms and legs of the patient especially at the points where the legs touch!

Therefore *always avoid* mutual skin contact when positioning the arms and legs. A distance of at least 5 cm must be observed. Use the positioning aids, e.g. blankets.



Examples of skin contact that can cause large surface loops. Avoid positioning the patient in this way.

TIP

Pull out the squeeze bulb connector before the patient gets on or off the patient table. The connector could be accidently damaged.

Positioning the patient

Notice

Position the patient in such a way that neither the positioning accessories nor the coil accessories catch on the edge of the magnet opening when moving the table in and out.

Synthetic materials

WARNING

Never use blankets made of synthetic material to cover or bed the patient.

Use only blankets made of paper, cotton or linen.

Positioning with the light localizer

Raise the patient table.

Press the button on the operating console until the table stops at the highest position. The function then automatically changes to TABLE FEED IN after a short intermediate stop.

Determining the center of the measurement field

Measurement field

The center of the measurement field is the center of the region to be measured. Use the light localizer to determine the center of the measurement field.

Move the region of the body to be examined into the magnet opening.

Switch on the laser light localizer (press button).

Please note: The light localizer switches off automatically after one minute.

For information about the light localizer → Page A.2–38 *Safety note*.

Correct the position of the tabletop until the laser crosshairs are fully aligned with the marked coil center (= center of measurement field).

If you are not using one of the surface coils you can mark the slice to be measured directly on the patient with the light localizer.

Mark the slice to be measured by switching off the light localizer.

Because the distance between the light localizer and magnet isocenter is precisely defined the actual distance between the center of the measurement field and the magnet isocenter can be calculated. This value is displayed on the screen in millimeters.

Please note: Precise positioning is a prerequisite for optimum image quality.

Move the patient tabletop into the magnet.

When moving the patient table in and out of the magnet, ensure that neither positioning accessories nor coil accessories get caught on the edge of the opening.

Press the button until the tabletop automatically stops in the center of the measurement field (0 mm).

Alternatively, you can move the slice to be measured into the measuring center by pressing the button "Center position".

Danger of collision

WARNING

Potential collision

The patient table can be moved beyond the rear end of the magnet out of the opening.
Remove any objects in front of the opening exit that might injure the patient or damage the tabletop.

Squeeze bulb

Instruct the patient how he or she can communicate.

The patient must hold the squeeze bulb in his or her hand during measurement in order to be able to give a signal if necessary (→ page A.2–35, → page C.1–24).

Therefore place the squeeze bulb in the patient's hand before moving the patient into the magnet.

To trigger a signal it is necessary to press the squeeze bulb forcefully.

See for how to **call the nurse** → page C.4–2.

D.2 Specific Absorption Rate

Absorption of energy results in a temperature rise in the body tissue.

Specific absorption rate

The specific absorption rate (SAR in W / kg) is used to measure the strain on the body at any point in time. It defines the absorbed RF energy per time unit and per kilogram of body tissue.

A distinction is made between local, partial and whole body SAR.

Specific energy dose

The cumulative energy absorbed in the course of the examination per kilogram of body tissue is measured by the specific energy dose (SED in Wmin / kg). It is used to measure temperature increase.

Heating by RF

During the MR examination the patient's body absorbs energy from the RF field of the transmit coil. Depending on the type of coil used, energy absorption is either concentrated locally or comparatively equally across the part of the body exposed (e.g. CP extremity coil or body coil). If the local energy absorption rate (local SAR) is impermissibly high RF burns can occur. However, if the energy absorption rate is equally distributed across the (whole) body (whole / partial body SAR) the stress to the patient's thermoregulatory system / cardiovascular system must be taken into consideration.

RF burns

CAUTION

Tattoos, make-up, eye shadow etc.
as well as metallic rings and chains
may result in locally high absorption
and could cause RF burns.
Please follow the instructions regarding positioning of the patient.

Heat in excess of the body's own heat is dissipated by the patient's thermoregulatory system (e.g. by increased perspiration and blood flow).

If the patient absorbs more energy per unit of time then he / she can dissipate the body temperature increases. The longer this condition lasts the larger the increase in temperature. The increase in the body core temperature is usually far below 1 °C during one imaging session.

Effects

During the MR examination the patient might start to perspire; his heart rate might also increase.

Inform the patient about these possible reversible effects before the examination to ease patient anxiety.

Before the examination begins carefully check possible contraindications.

Observe strictly all instructions. Especially at increased SAR levels it is important to follow the instructions given on → Page D.2–8.

Non-observance of these instructions may lead to

- ❏ significant increase in body heat and therefore
- ❏ increased strain on the heart and circulation or in extreme cases
- ❏ pain or burns.

Always remain in contact with the patient during the examination!

SAR values

Notice

Only the examining physician or responsible medical personnel may decide whether the patient can be exposed to increased SAR levels. Always closely monitor the patient during examinations with increased SAR values (e.g. via ECG, pulse sensor, squeeze bulb).

After the examination is completed the body will cool down naturally (exactly as it does after exercise).

Recommended limits

International organizations and health authorities in several countries have published recommendations for avoiding health risks involved in MR examinations. These recommendations form the basis of the RF monitoring system integrated in MAGNETOM Harmony/Symphony. Recommendations regarding specified limits vary slightly. Follow the recommendations applicable to your installation.

Limit level

If we disregard the slight differences in the methods used to define the SAR and its limits, recommendations are all based on two different limit levels:

- ❏ the level of no concern and
- ❏ the upper limit level.

Level of no concern

For exposure to RF levels up to the level of no concern it can be assumed that exposure to these RF levels will not place undue stress on the patient's thermoregulatory mechanism, irrespective of the state of health of the patient.

Upper limit level

Patients with impaired thermoregulatory mechanisms and an impaired cardiovascular system should not be exposed to RF levels above the level of no concern. If the patient's thermoregulatory mechanisms and cardiovascular system are unimpaired, stress to the body which occurs with exposure to RF levels up to the upper limit level are safe for the patient (perspiration, increase in heart rate).

Monitoring SAR and SED

Monitoring SED

In order to limit the increase in the patient's core temperature during an MR examination the specific energy dose (SED) is monitored. The SED is calculated to ascertain the increase in temperature prior to each examination protocol.

If the SED could possibly result in a temperature increase of more than 1 °C by the end of the examination, a warning signal is displayed on the console.

The physician must then decide whether to interrupt or continue the examination.

Monitoring the SAR

The energy absorption rates (entire body, partial body, local SAR) are monitored at the same time. These values are monitored to limit local temperatures and avoid short-term high values. These values, too, are calculated prior to an examination and compared with official limit value recommendations.

If the system calculates that limit values will be exceeded during the examination the examination is not allowed to start and a warning signal is output on the console. The warning message also suggests suitable options to change (protocol parameters, limit values), which, if followed, will prevent the limit value being exceeded so that the examination can be continued (*NUMARIS Reference*).

SAR and SED display

The current SAR values and the cumulative energy doses (SED values) can be broken down according to body areas whenever required and displayed.

Exceeding the limit values

The SAR limits may be exceeded given certain combinations of RF coil / measuring program / patient (weight, positioning). If measuring programs with high SAR values are applied the recommended energy dose limit may be exceeded as the length of the examination increases.

The cumulative absorbed energy dose SED is logged throughout the course of the examination. A warning is displayed if the energy dose is to exceed recommended limits in the course of the next measurement. As a rule, you should either terminate the examination or interrupt it for approximately two hours.

With Measurement SAR you can switch between the level of no concern and the upper limit value by pressing the relevant button (*NUMARIS Reference*).

The monitoring equipment detects two different SAR limit values: The level of no concern and the upper limit level.

Level of no concern The lower level can be classified as the level of no concern.

Upper limit level Caution must be taken when exceeding the upper limit level because significant body warming can result. It should therefore only be applied to patients whose thermoregulatory mechanisms are unimpaired and who can be relied on to signal inadmissible heat sensations by pressing the squeeze bulb. If inadmissible heat sensations are experienced by the patient the examination must be stopped immediately.

SAR limit values / types of patients

WARNING

On activation of higher SAR limit values the patient can be heated up significantly due to the HF radiation. You must therefore observe the patient particularly attentively. For the same reason we advise you not apply higher SAR limits to the following groups of patients:
- Patients with restricted thermal regulation (e.g. small children, elderly people).
- Patients who cannot warn you of excessive heating (e.g. unconscious, sedated or disabled patients, small children.

Air conditioning in examination room

Notice

The automatic SAR limitation of the system is designed for a maximum temperature of 24° C and a maximum relative air humidity of 60% in the examination room.
Depending on the climate conditions, use of an air conditioner and/or measuring equipment might be necessary to maintain these ambient conditions. If the room temperature and/or humidity is higher than stated above, observance of the SAR limits in accordance with the IEC and FDA codes can no longer guaranteed.
It is in the responsibility of the operator to monitor the function of the air conditioner and the temperature and humidity of the examination room.

FDA: Federal Food and Drug Administration (USA)

IEC: International Electrotechnical Commission

Limitations when the upper limit is exceeded

Health of the patient

Ensure that the patient's thermoregulatory mechanisms are not impaired in any way. Thermoregulatory mechanisms can be impaired by the following:

- ❏ Fever
- ❏ Reduced ability to perspire
- ❏ Medication which increases metabolism or modifies the pulse rate, blood pressure and peripheral vascular resistance
- ❏ Pregnancy
- ❏ Impairment of the cardiovascular system.

Impairment of the cardiovascular system may impede the efficient transfer of heat from the body core to the periphery. Check whether the patient belongs to one of the following risk groups: Patients with impaired cardiac output, peripheral vascular disease or other heart conditions; patients with impaired ability to perspire or impaired sensory capability; children; patients not able to satisfactorily communicate heat sensations.

SAR limit values / types of patients

WARNING

Never activate the upper SAR limits for patients with diseases or taking medication that will impair their thermoregulatory mechanisms or patients who do not respond to extreme heat sensations (small children, unconscious, gravely ill or paralyzed patients).

Clothing and environmental conditions

Increased ambient temperature and humidity hinder the body's ability to rid itself of excess heat. Likewise, heavy clothing such as sweat suits insulates the body and hinders heat dissipation.

Ensure that

- ❏ Room temperature is approx. 24 °C, slightly higher room temperatures (<30 °C), however, are also tolerated.
- ❏ the patient is dressed in light clothing such as a night shirt. Any additional insulation (such as a blanket) should be removed.

SAR limit values / clothing

WARNING

Patients who are exposed to SAR limits up to the upper limit level must be dressed in light clothing, such as light pajamas or a night shirt.
Any added insulation must be removed.
Body heat may not be sufficiently dissipated if the patient is covered by a blanket.

E.1 Overview of Devices for Physiological Imaging

In physiological imaging, the physiological parameters of the patient are measured and used to trigger the measurement.

Patient monitoring

WARNING

Physiological imaging is *not* intended
for monitoring the vital signs of patients
in critical condition.
These values should be monitored
with MR-compatible devices.

In physiological imaging the measurement sequences are controlled by the physiological signals from the patient (triggered measurements that are synchronized with the progression against time of the signals) or the resulting MR images are subsequently sorted relative to the signal progression (retrospective gating).

The signals are acquired in the PMU (physiological measurement unit) via receptors attached to the patient.

Physiological measuring unit PMU (optional)

The PMU (physiological measurement unit) is located underneath the flap on the left at the foot end of the patient table.

It is used for connecting the receptors for the physiological signals and for processing and transmitting these signals to the MR measuring system.

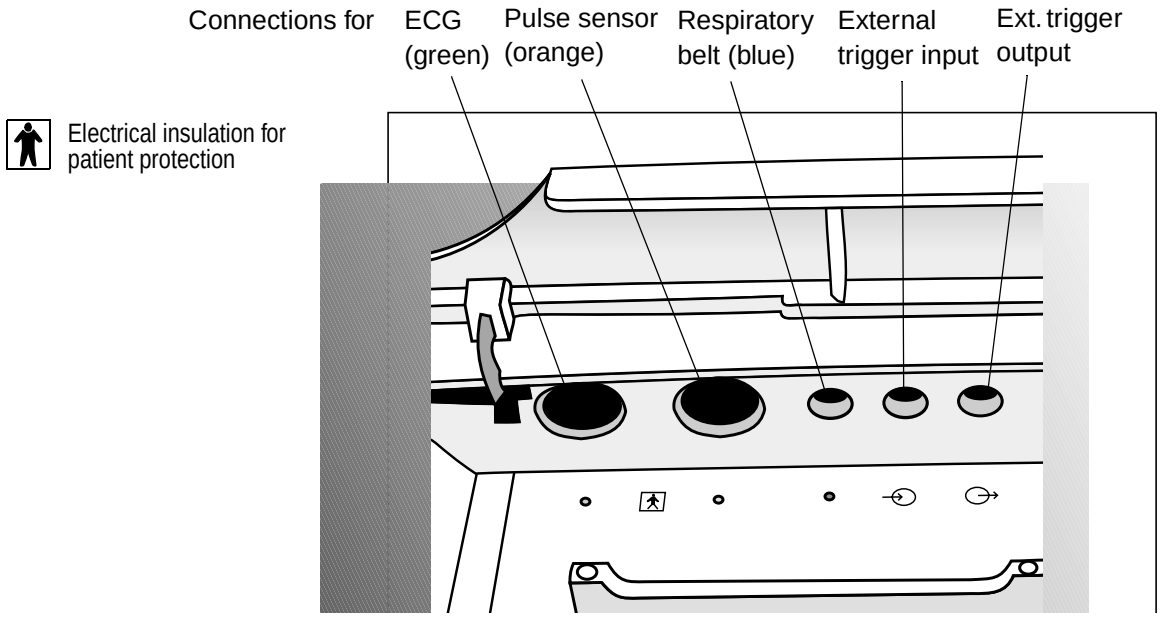
Values are displayed on the PMU display (optional) and in the measuring text field in the control area of the MR console.

Receptor connections on the PMU

You can connect the following sensors to the PMU

- ❏ the ECG sensor,
- ❏ the pulse sensor,
- ❏ the respiratory belt,
  as well as for
- ❏ input of an external triggering signal

The connections are color-coded.



Pulse sensor / danger of destruction

CAUTION

Do not bend the pulse sensor cable.

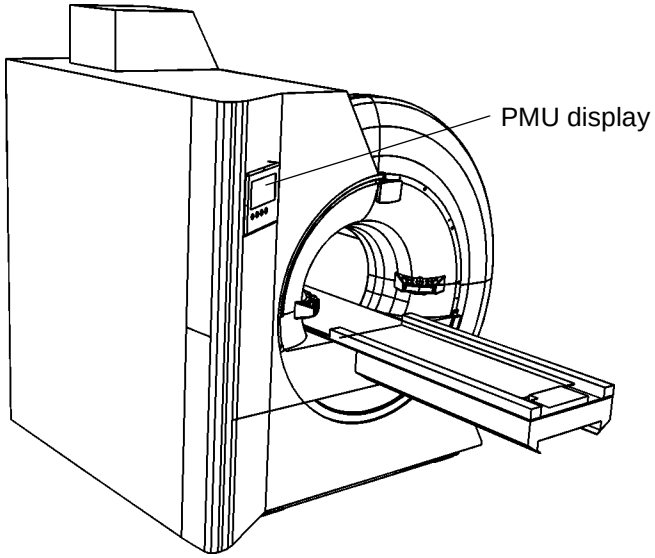
It is made of fiberglass and is easily damaged.

PMU display (optional)

The physiological signals are displayed on the PMU display which is incorporated in the housing of the magnet.

On the PMU display you can check whether the electrodes have been correctly connected and positioned and whether the best ECG cable has been selected.

You can also switch an acoustic heartbeat indicator on the display on and off.



Displays and keys on the PMU display

The following are output on the LCD display:

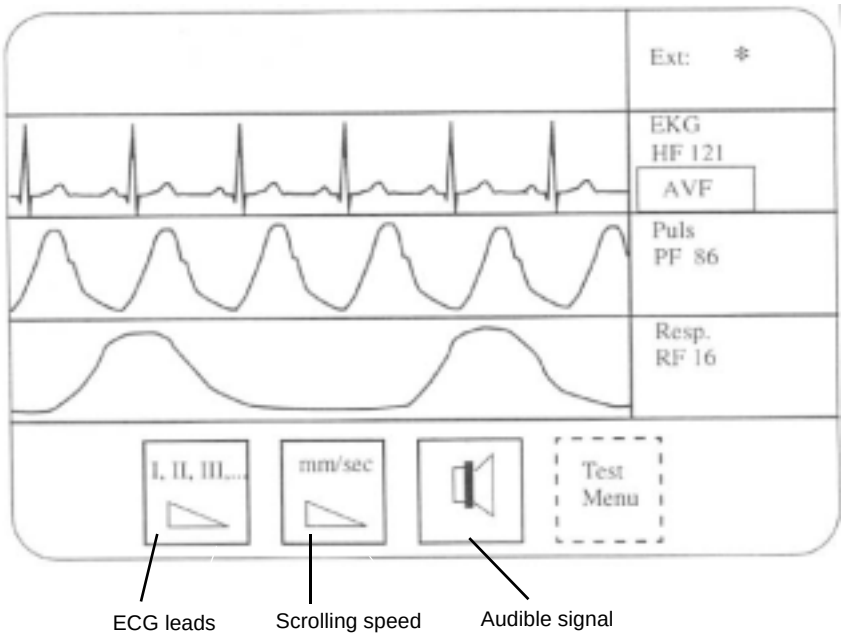
- ECG, pulse, respiratory and external signal and
- status messages.

You can control the following actions with three buttons on the touchscreen:

Scrolling speed If you press the button briefly, you can set the scrolling speed (3 levels) of the curves on the screen. If you press the button again at level 3 you switch back to level 1.

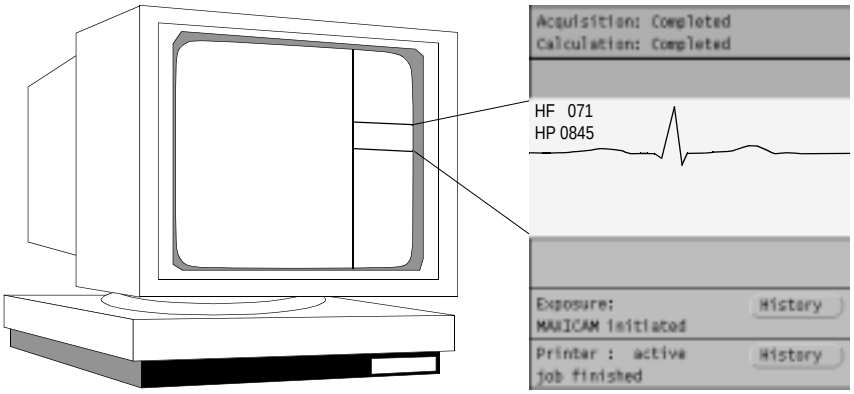
Audible signal You can activate and deactivate the audible signal of the ECG with this button.

ECG leads Select ECG leads 1 to 6 with this button.



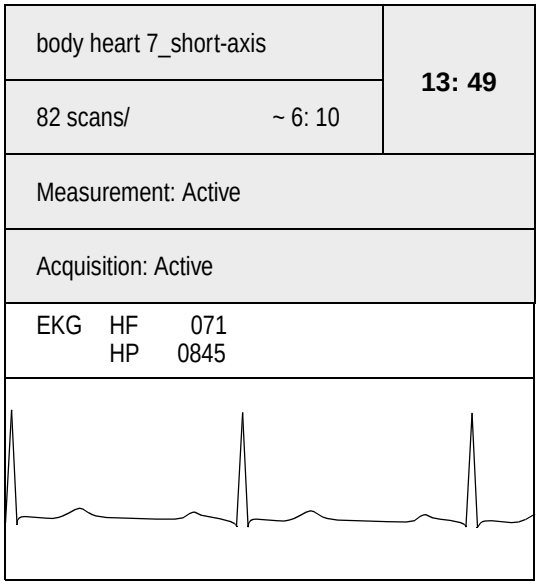
On-screen display

The physiological signal is displayed in the measurement text field on the screen.



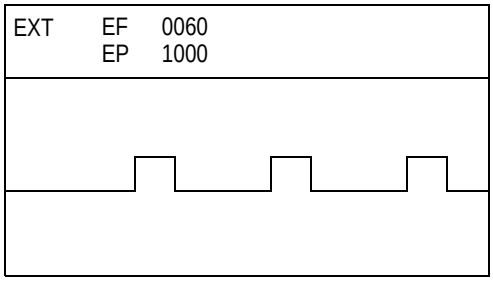
Measurement time

The measurement time is not known before the actual triggering. For this reason, the remaining number of scans and estimated measurement time are displayed in the measurement text field.



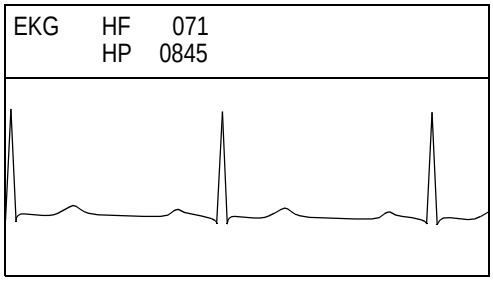
External signal representation

EF External rate
EP External interval



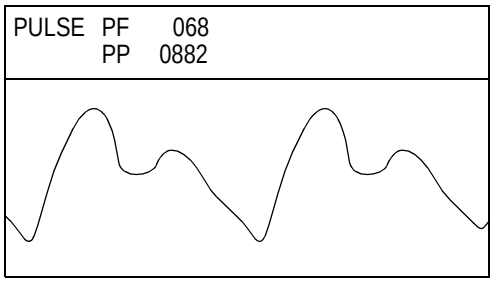
ECG signal representation

HF Heart rate
HP Heart interval



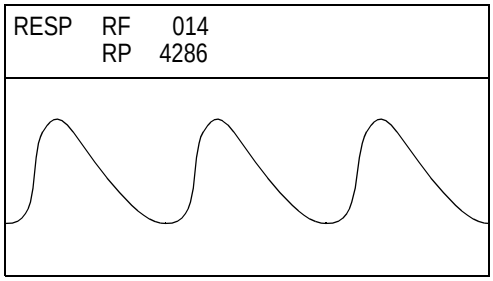
Pulse signal representation

PF Pulse rate
PP Pulse interval



Respiratory signal representation

RF Respiration rate
RP Respiration interval



Cleaning and disinfecting receptors

Clean accessories with a damp cloth dipped in a 10% GIGASEPT solution (by Schülke+Mayr) or a 1.3% INCIDIN CG solution (by Henkel and Cie GmbH). Other cleaning agents which do not contain alcohol or ether may be used as well.

Pulse sensor / danger of destruction

CAUTION

Do not use ether.
Do not sterilize the accessories in boiling water, hot steam, or air (gas sterilization is permitted).

Do not use hard or pointed objects like knives or tweezers to remove residues.

Respiratory belt

Clean the respiratory belt including the tube with a damp cloth.

Do not immerse the belt into liquid cleaning agents.

ECG cables

After each use, the cables should be cleaned with a damp cloth.

Do not immerse the cables into liquid cleaning agents.

Pulse sensor

Clean the pulse sensor with cotton swabs or a soft cloth.

Cleaning

CAUTION

Do not bend the pulse sensor cable.

It is made of fiberglass and is easily damaged.

ECG cable replacement

Danger of burning / ECG cables

WARNING

Use only the ECG leads provided by Siemens specifically for use with MAGNETOM.

Use of other ECG leads may cause skin burns to the patient.

You can connect four standard diposable electrodes.

Disposable electrodes

You can order disposable electrodes via SPH 3 with SNR 9715335.

E.2 Using Physiologically-Controlled Procedures

Triggered measurements

You can choose one of the following procedures:

- ❏ ECG triggering
- ❏ Pulse triggering
- ❏ Respiratory triggering
- ❏ External triggering
- ❏ Retrospective gating

ECG triggering

ECG triggering is recommended for cardiac sequences including dynamic studies. In addition, it can be used for studies where the pulsating blood flow leads to artifacts, e.g. for sagittal images of the cervical or thoracic spine or sagittal knee studies.

Respiratory triggering

Respiratory triggering keeps artifacts caused by respiratory motion to a minimum. However, this function does prolong the measurement time.

ECG triggering

Reliable and interference-free ECG triggering depends to a large extent on the correct arrangement of the ECG leads.

Danger of burning / ECG cables

WARNING

Use only the ECG Cable Set MR provided by Siemens.

Use of other ECG leads may cause skin burns to the patient.

Defibrillators

WARNING

The ECG cables and leads are not suitable for use with defibrillators.

They must be removed from the patient before using defibrillators.

Connecting the ECG cable

Connect the Siemens ECG Cable MR to the green socket at the foot-end of the patient table.

The lead arrangements shown on the next page function only as general guidelines. It may be necessary to deviate from these guidelines to obtain optimal signal quality.

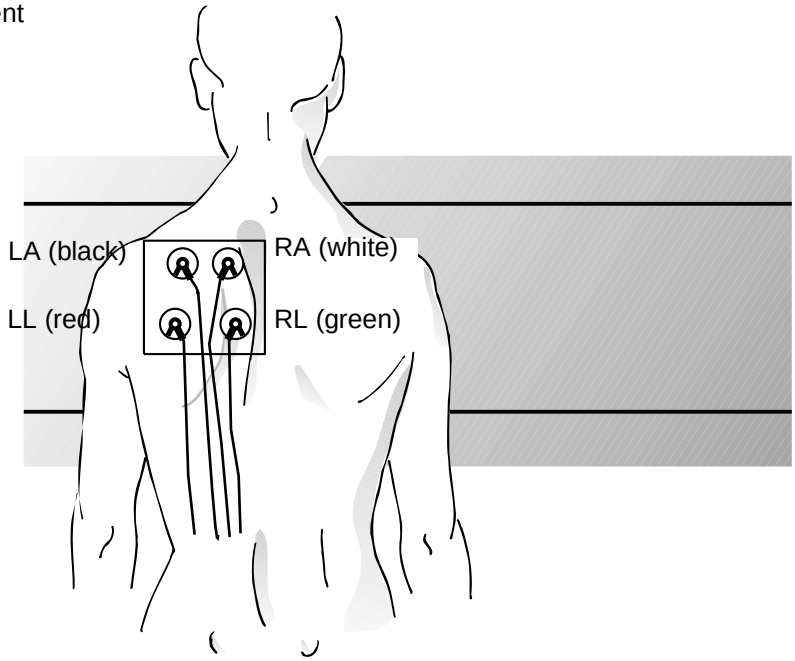
Attach the leads to the patient's back to avoid superimposition of the ECG signal by electrical voltages induced in the magnetic field due to thoracic motion.

When you route the ECG cable away from the connection, ensure that it runs parallel to the Z-axis of the magnet (along the opening).

Attaching the electrodes

Route the leads of the ECG cable as shown.

Place paper, gauze or equivalent under the ECG leads (refer to the warnings well)



Danger of burning / ECG cables

WARNING

Avoid skin burns to the patient's skin.

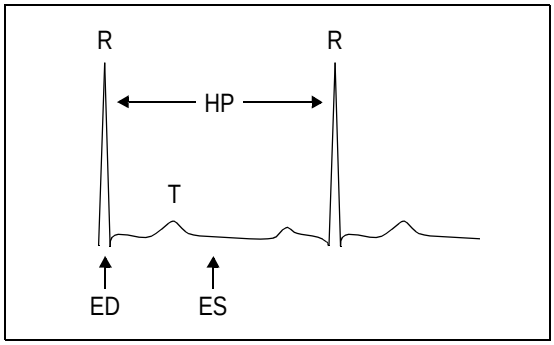
Use moisture-absorbing material made from natural fiber to keep the ECG cables away from the patient's skin.

R-wave should be large

The objective of this type of lead arrangement is to generate an R-wave with the highest possible amplitude compared to the other phases of the ECG (e. g. T-wave). The R-wave should be large and sharp as illustrated below. Inductive coupling is then kept to a minimum.

R-wave of high amplitude

R R-wave
HP Heart interval
T T-wave
ED End-diastolic phase
ES End-systolic phase



R-wave is too low

If the R-wave obtained from the position shown is too low :

Select a different lead on the PMU display (1-6). Suitable trigger signals might then result.

Patients with a displaced cardiac axis (dilated cardiomyopathy), you may have to deviate from the parallel placement to the spine.

Obtaining interference-free signals

To obtain interference-free signals:

- ❏ Avoid cable loops (because of possible induction of extraneous fields).
- ❏ The leads should be attached to areas with minimal muscular and fatty tissue so that the activation voltages generated by muscle contractions and zero line fluctuations are kept to a minimum.
- ❏ The skin of the patient at the locations intended for the leads should be cleaned with an alcohol solution.
- ❏ Heavy chest hair should be shaved off at the intended lead positions. The shaved areas should then be cleaned as described above. To avoid possible accidents, shave the patient outside the examination room.

Preparing the patient

Prior to the examination, inform the patient regarding the gradient noise during the examination. During triggering, the gradient noise can be heard in intervals corresponding to the heart rate, and may affect the heart rate of some patients. This could result in irregular cardiac cycles and degrade image quality.

Patient movement during the examination produces artifacts in the ECG and the image. The patient should be instructed to relax comfortably in the supine position.

Pulse triggering

To take the pulse from the finger or the toe, attach the receptor using the clip.

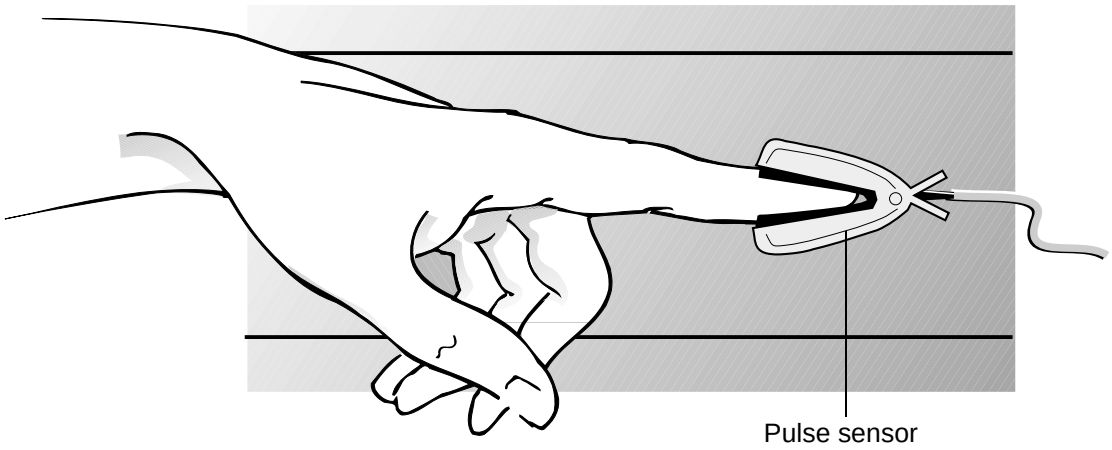
Pulse sensor / danger of destruction

CAUTION

Do not bend the pulse sensor cable.

It is made of fiberglass and is easily damaged.

Attaching the pulse sensor



Place the pulse sensor on the finger with the light outlet facing downward (facing the finger nail).

The middle finger provide the best signal.

Danger of burning / ECG cables

WARNING

Only use Siemens ECG leads and pulse sensors.

The use of any other ECG leads and pulse sensors may result in burns to the patient.

Respiratory triggering

Use the respiratory triggering technique to reduce respiratory motion artifacts to a minimum in the MR image.

Attaching and connecting the respiratory belt

The respiratory signal is measured with the respiratory belt.

Attach the belt to the chest or abdomen of the standing patient.

Locate the area of greatest respiratory movement.

Position the patient on the patient table.

Slightly retighten the respiratory belt.

Connect the respiratory belt to the appropriate socket at the foot-end of the patient table.

When the patient is at rest, a periodic signal appears on the screen.

Ensure that the rubber hose of the respiratory belt is not bent or gets caught while moving the table into the magnet isocenter.

Adjusting the pressure for subsequent patients

When scanning two consecutive patients with respiratory triggering, you have to disconnect the respiratory belt from the socket prior to attaching it to the next patient. If the belt is not disconnected, the low pressure in the belt will lead to incorrect measurement results for the second patient.

Respiratory belt

Notice

Ensure that the respiratory belt is disconnected from the socket at the patient table before you attach it to the patient.

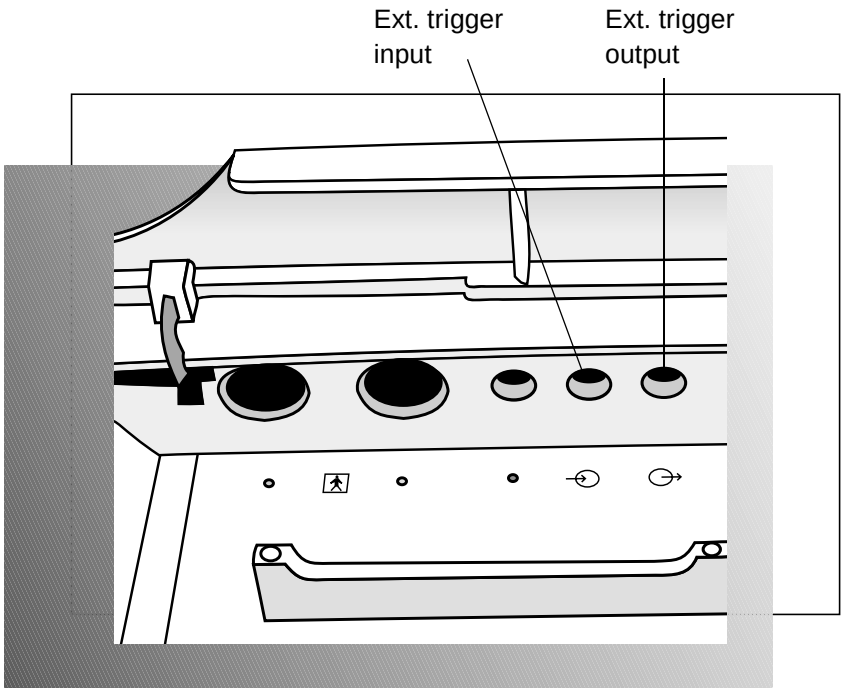
Display of measurement time

When imaging with respiratory triggering, the measurement time for scans is not previously known. Instead, the number of remaining scans and an estimated measurement time are displayed in the measurement text field.

External triggering

You can trigger pulse sequences with an external signal for research purposes.

The external signal can be input at the PMU.

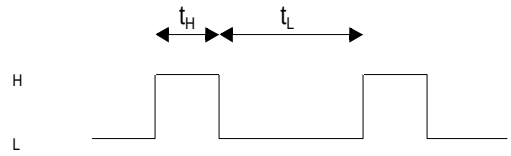


Electrical insulation for patient protection

Specification

External trigger input

The external signal must meet the following specification.



t_H(min) = 10 ms
t_L(min) = 10 ms

V_L = 0 V... 0.8 V
V_H = 2 V ... 15 V
Input current: min. 2 mA
Input voltage: max. ±20 V

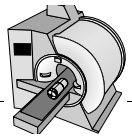
The pulse sequence is triggered with the rising edge of the external signal.

Retrospective gating

In retrospective gating the measuring sequence is not triggered (synchronized to physiological events) but runs unsynchronized.

The acquired MR images are then correlated with the progression of the physiological signal retrospectively.

The notices in previous sections regarding receptors and triggered measurements also apply here.



Safety regulations when handling MR measurement phantoms

A precise description of how to handle the MR measurement phantoms is given in this chapter. The phantoms must only be handled according to these instructions.

We emphasize that manipulations of any kind, including refilling, are prohibited in the interests of safety.

Only Siemens Customer Service can refill phantoms.

MR measurement phantoms are filled aqueous solutions of nickel sulfate and manganese chloride. Other constituents include sodium chloride, sodium phosphate buffer as well as lactates and acetates.

For use as intended of the phantoms during an MR quality measurement, there is no contact with phantom liquids. Do not drop the phantoms and return the phantoms to their proper place of storage immediately after measurement.

The fluids are securely sealed in the MR phantoms.

Phantom storing

Notice

Handle phantoms carefully. Do not drop them. Do not expose phantoms to frost. The best temperature for storage is room temperature (20°C). Make sure that the phantoms are stored securely (e.g. in a cabinet) in such a way that they cannot fall out or be damaged.

These solutions must be handled with the usual care taken when dealing with chemicals.

The solutions are not combustible and are odorless.

Nickel sulfate

WARNING

Nickel sulfate can cause skin allergies to sensitive people (e.g. nickel dermatitis).

If nickel compounds are resorbed by the body as droplets in the breath (aerosols), a carcinogenic effect cannot be ruled out.

Aerosols

However, droplets that can be breathed in only result if damage occurs, e.g. as the result of a fire or atomization caused by a very strong air current. Breathing apparatus should be worn if there is danger of aerosols forming.

Aerosols containing nickel do not result if the fluid evaporates because nickel sulfate is not volatile.

If one of the phantoms is damaged and liquid escapes, you should abide by the following safety regulations. These regulations apply to all MR phantom liquids.

Procedure for damaged phantoms

When handling phantom liquids, you must:

- ❏ not eat, drink or smoke
- ❏ wash your hands thoroughly with soap and water.

The EU safety datasheets and legal regulations and specifications do not contain any special information about possible dangers (exception: nickel sulfate).

MR phantom liquids

WARNING

Avoid any contamination to you or other people.

If fluid is seeping from the phantom,
clean up the fluid using absorbent materials
such as sand or woodshavings.
Wear protective clothing, disposable gloves,
and safety glasses during the clean-up.
Collect the material in a plastic pail.
Rinse any contaminated parts of your protective clothing or other clothing with water and change your cloths.

MR phantom liquids are not allowed in the waste water.

Procedure in case of accidents involving persons

Skin contamination

Skin contamination

Remove clothing immediately and
run water over the contaminated area.
Call physician.

Eye contamination

Eye contamination

Keep eyes half closed
and rinse them thoroughly with water.
Consult a physician

Swallowing

Swallowing of fluid

Drink a large amount of water. Induce vomiting.
Call physician.

Inhalation

Inhalation

Step outside into the fresh air immediately and call a physician if the person feels unwell. Consult a physician immediately if aerosols containing nickel sulfate have escaped.

In case of fire

If a fire occurs it is your responsibility as the operator of the system to inform the fire service about the contents of the MR phantoms.

Disposal

All liquids that have been absorbed or wiped up with a cloth must be treated as special waste.

Label the containers accordingly.

Disposal of liquids

Notice

MR phantom liquids must not be disposed of in waste water.

Dispose of the liquid according to national guidelines.

Hire an authorized company to remove the special waste.

We recommend you to contact your Siemens Customer Service and the responsible agency for environmental protection or local agencies.

If you have any additional questions, please contact your Siemens Customer Service.