SIEMENS

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MAGNETOM Family

Operator Manual – MR System

syngo MR B19

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syngo MR B19

Legend

	Indicates a hint Provides information on how to avoid operating errors or information emphasizing important details
»	Indicates the solution to a problem Provides troubleshooting information or answers to frequently asked questions
■	Indicates a list item
✓	Indicates a prerequisite A condition that has to be fulfilled before starting a particular operation
◆	Indicates a single-step operation
1 2 3	Indicates steps within operating sequences
Italic	Used for references and for table or figure titles
→	Used to identify a link to related information as well as previous or next steps
Bold	Used to identify window titles, menu items, function names, buttons, and keys, for example, the Save button
Blue	Used to emphasize **particularly** important sections of the text
Courier	Used for on-screen output of the system including code-related elements or commands
`Courier`	Identifies inputs you need to provide
Menu > Menu Item	Used for the navigation to a certain submenu entry
<variable>	Identifies variables or parameters, for example, within a string
⚠ CAUTION	CAUTION Used with the safety alert symbol, indicates a hazardous situation which, if not avoided, could result in minor or moderate injury or material damage. CAUTION consists of the following elements: ■ Information about the nature of a hazardous situation ■ Consequences of not avoiding a hazardous situation ■ Methods of avoiding a hazardous situation

WARNING

Indicates a hazardous situation which, if not avoided, could result in death or serious injury.

WARNING consists of the following elements:

- Information about the nature of a hazardous situation
- Consequences of not avoiding a hazardous situation
- Methods of avoiding a hazardous situation

WARNING

Legend

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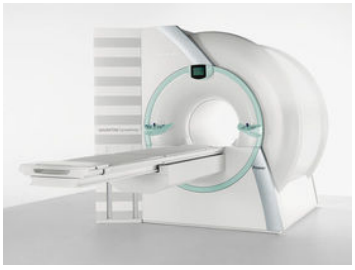
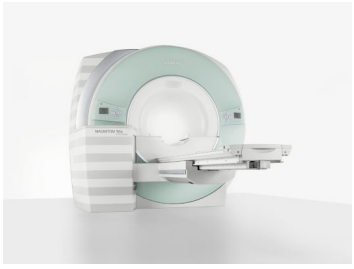
1 Introduction

The MR system operator manual covers safety information and general system information.

This manual is valid for the following systems:		
 MAGNETOM Avanto (1.5T)	 MAGNETOM Espree (1.5T)	 MAGNETOM Symphony a Tim System (1.5T)
 MAGNETOM Trio a Tim System (3T)	 MAGNETOM Verio (3T)	

Not all MR systems are released for all countries! Contact your Siemens Sales Organization about the systems available in your country.

In order to operate the MR system accurately and safely, the operating personnel must have the necessary expertise as well as knowledge of the complete operator manual. The operator manual must be read carefully prior to using the MR system.

1 Introduction

1.1 Documentation overview

Your complete operator manual is split up into a number of individual manuals to improve readability. Each of these individual manuals covers a specific topic or addresses a specific user group:

- Hardware components (system, coils, etc.)
- Software (measurement, evaluation, etc.)
- System owner manual

The extent of the respective operator manual depends on the system configuration used and may vary.

All components of the complete operator manual may include safety information that must be adhered to. The intended use of the system is stated in the operator manual MR System.

1.1.1 Contents

The operator manuals include information on frequently used functions for safe and proper use. They may include descriptions covering standard as well as optional hardware and software. The description of an option does not infer a legal requirement to provide it. To find out what hardware and software is available for your system, contact your Siemens Sales Organization.

The graphics, figures, and medical images used in the documentation are examples only. Their actual display and design may be slightly different on your system.

The operator manuals for hardware and software address the authorized user. Basic knowledge in operating PCs and software is a prerequisite.

For the sake of simplicity, male and female patients are referred to as “the patient”.

1.2 Intended use

Your MAGNETOM system is indicated for use as a magnetic resonance diagnostic device (MRDD) that produces transverse, sagittal, coronal and oblique cross sectional images, spectroscopic images and/or spectra, and that displays the internal structure and/or function of the head, body, or extremities. Other physical parameters derived from the images and/or spectra may also be produced. Depending on the region of interest, contrast agents may be used. These images and/or spectra when interpreted by a trained physician yield information that may assist in diagnosis.

Your MAGNETOM system may also be used for imaging during interventional procedures when performed with MR compatible devices such as in room display and MR Safe biopsy needles.

The MAGNETOM system is not a device with measuring function as defined in the Medical Device Directive (MDD). Quantitative measured values obtained are for informational purposes and cannot be used as the only basis for diagnosis.

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

Your MR system is a medical device for human use only!

1.3 Authorized operating personnel

The MR system must be operated according to the intended use and only by qualified persons with the necessary knowledge in accordance with country-specific regulations, e.g. physicians, trained radiological technicians or technologists, having received the necessary user training.

This user training must include basics in MR technology as well as safe handling of MR systems. The user must be familiar with potential hazard and safety guidelines and emergency and rescue scenarios. In addition, the user has to have read and understood the contents of the operator manual.

Please contact Siemens Service for more information on available training options and suggested duration and frequency of such training.

1.3.1 Definitions of different persons

Term used	Explanation
User/Operator/ Operating personnel	Person who operates the system or software, takes care of the patient or reads images Typically physicians, trained radiological technicians, or technologists
System owner	Person who is responsible for the MR environment. This includes legal requirements, emergency plans, employee information and qualifications, as well as maintenance/repair.
MR worker	Person who works within the controlled access area or MR environment User/Operator as well as further personnel (for example, cleaning staff, facility manager, service personnel)
Siemens Service/service personnel	Group of specially trained persons who are authorized by Siemens to perform certain maintenance activities References to “Siemens Service” include service personnel authorized by Siemens.

2 Safety

2.1 Preface about safety

2.1.1 Hazards and risks

An MR system may present various hazards. Some occur only during the examination, while others exist permanently and thus are also relevant to non-users (e.g. cleaning personnel).

The various hazards and the corresponding safety instructions are explained in the safety chapter of this operator manual.

2.1.2 Common causes of accidents

Despite safety instructions, some hazards lead to accidents time and again. In particular, this includes magnet accidents and RF burns/loop formation, as well as the use of incompatible devices and the wearing of clothing with electrically conductive materials. A detailed patient screening ensures that the patient is free of metallic objects and clothing with metallic yarns or appliqués.

The following sections provide information on how to avoid the most common mistakes and the resulting safety risks. These sections were prepared based on the long-time experience of Siemens.

2.1.3 Responsibility

Siemens accepts no responsibility for the safety, reliability, and performance of the MR system, if the MR system is not used in accordance with the instructions for use (Operator Manual, System Owner Manual). Siemens is also not responsible for any direct or indirect damages caused by incorrect operation. This includes, but is not limited to, accidents with ferromagnetic objects. This applies even if the consequences only become obvious at a later point in time.

2.2 Common/permanently existing hazards

The frequency at which the potential hazards mentioned in this section lead to accidents is still too high. Therefore, it is especially important to observe the instructions on how to avoid these dangerous situations.

The most significant hazards include:

- Electromagnetic fields
- Contraindications
- Mechanical hazards
- Incompatible devices

2.2.1 Electromagnetic fields

In the examination room, there are different kinds of electromagnetic fields and the resulting risks.

Fields	Most serious hazards
Static magnetic field	Movement by implants and prostheses in the body Attraction, alignment, and projectile-like acceleration of magnetizable objects (→ Page 17 *Safety instructions on the static magnetic field*)
Gradient fields	Peripheral nerve stimulation (→ Page 19 *Safety instructions on RF and gradient fields*)
RF fields	Warming of body tissue (→ Page 19 *Safety instructions on RF and gradient fields*)

All persons (e.g. patients, physicians, operating and cleaning personnel, accompanying persons, and rescue personnel/fire fighters) are exposed to these fields in the examination room. Therefore, all limits and safety measures regarding electromagnetic fields equally apply to patients and MR workers.

- Observe prohibition signs in the area near the entrances to the MR system and the controlled access area.

Static magnetic field/controlled access area

The static basic field is generated by a superconductive magnet and may extend beyond the examination room (walls, ceilings).

In order to minimize the hazards mentioned, the controlled access area of the basic field is identified on the floor (0.5 mT line). Outside the controlled access area, the magnetic flux density is less than 0.5 mT. See: **System owner manual**

Gradient fields

Linearly rising additional fields of variable strength - gradient fields - are superimposed on the static main magnetic field in three different orientations. They may cause shifts in charge in the patient's tissue and lead to peripheral nerve stimulation.

RF fields

The nuclear spins of the body tissue are stimulated via pulsed electromagnetic RF fields. These RF pulses are generated by an RF transmit amplifier and transferred via RF coils to the object to be measured.

RF fields lead to warming of the body tissue. In this context, an important value per body weight is the specific absorption rate or SAR. (→ Page 114 *Physiological effects*)

Side effects

Possible undesirable side effects for MR are dizziness, heating, claustrophobia and nerve stimulation.

2.2.2 Safety instructions on the static magnetic field

The list of objects in this chapter is not exhaustive. It only serves as an illustration of objects that present hazards in the presence of magnetic forces.

- Only use equipment specified or recommended for use in the controlled access area.

WARNING

Movement and/or alignment of implants and prostheses in the body, as well as attraction, alignment, and projectile-like acceleration of magnetizable objects may result in very serious hazards!

Injury to patient and operating personnel

- Do not use resuscitation devices - for example, defibrillators or oxygen bottles - in the examination room.
- Do not use transport trolleys, movable beds, stretchers, etc. that consist of magnetizable parts.
- Do not wear or carry any magnetizable objects on your person - for example, watches, pens, scissors, etc..
- Use only proven MR Safe or MR Conditional accessories, parts subject to wear and tear, and disposable articles with the MR system.
- Use only MR Safe or MR Conditional tools and devices.
- Service work on the MR system may only be performed by Siemens Service.
- Ensure that only authorized personnel enter the controlled access area (0.5 mT exclusion zone), for example, electricians or cleaning personnel trained in MR safety.
- Keep the door to the examination room closed.

WARNING

Magnetizable objects introduced into the magnetic field become projectiles!

Injury to patient and operating personnel

- Inform the operating personnel about the effect of forces on ferromagnetic parts or implants, especially on systems with a high field strength. Explain that the forces increase with the field strength of the magnet!

For China only: In 3-T systems medical supervision is required for all patients according to IEC 60601-2-33 (2nd edition).

Dizziness during exposure

When persons (e.g. MR workers or patients) are exposed to the static magnetic field, possible effects are dizziness, light-headedness, or metallic taste, especially in 3-Tesla magnetic fields.

1 Ask the patient to lie still during the measurement.

2 Keep a sufficient distance to the magnet and avoid rapid movements of the head.

⚠ CAUTION

Dizziness, light-headedness or metallic taste in the patient's mouth during measurements and/or table movements in a 3-Tesla magnetic field!

Reaction of fear by the patient

- Prior to the examination, inform the patient about the possible occurrence of these symptoms.

Device malfunctions

Magnetic flux densities exceeding 0.5 mT can interfere with electronic implants or other devices. The main magnetic field may either affect or destroy electronic data carriers such as check or credit cards, hard disks, ID cards with magnetic strips and/or magnetic tapes, diskettes or pocket calculators, as well as RFID chips (Radio Frequency Identification).

2.2.3 Safety instructions on RF and gradient fields

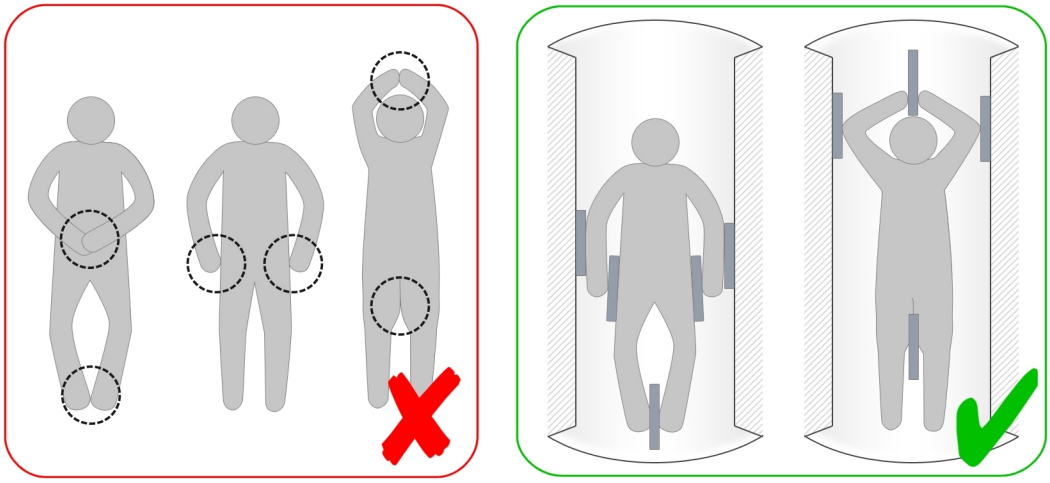
Patients at risk

- Do not examine patients unable to communicate potential overheating effects (e.g. small children, seriously ill, paralyzed, unconscious, sedated, or handicapped patients).

Current loops and bore wall contact

Dangerous current loops may be generated when parts of the patient's body touch. These loops may lead to burns or increase the probability of stimulation.

Current loops are also generated when the patient's skin contacts the tunnel lining or RF coil cables.



Ensure to prevent potential current loops as shown in the red labeled illustration.

Ensure the patient is positioned with proper distance (5 mm) to magnet tunnel as well as proper distance between parts of the body as shown in the green labeled illustration.

- To lower the effects of gradient fields or RF fields, keep a sufficient distance from the RF coils and the magnet tunnel (gradient coils), and reduce the time of exposure during measurements.

⚠ CAUTION

The patient is wearing electrically conductive material! Incorrect patient positioning!

Formation of electric current loops

Peripheral nerve stimulation of the patient

- Ensure that the patient does not wear clothing that is wet or dampened by perspiration.
- Ensure that the patient is free of metallic rings, chains, or electrically conductive materials worked into items of clothing (for example, brassiere support wires, metallic appliqués or woven metallic yarns).
- Always position the patient so that the patient's arms are aligned with the torso and ensure that hands, arms, and legs do not touch (minimum distance: 5 mm).
- Ensure that the minimum distance of 5 mm is maintained between patient and tunnel covering.
- To ensure this distance, use positioning aids, e.g. blankets made of linen, cotton, or paper, or dry material that is permeable to air.
- Ensure sufficient ventilation.

⚠ CAUTION

Heating up/ignition of synthetic blankets via the RF field during the measurement!

Patient burns

- Use only covers made of paper, cotton or linen.

CAUTION

Heating up of RF blankets or shields used to avoid aliasing artifacts!

Patient burns

- Never use RF blankets or other conductive sheets within the magnet bore.

MAGNETOM Epree only

CAUTION

Warming of the tunnel lining during operations exceeding 70 minutes may reach a maximum of 47 °C during pulse sequences with high gradient performance (e.g. EPI_BOLD)!

External warming of patient/reddening of the skin

- Keep the patient from contacting the tunnel lining.
- Add a number of pauses (approx. 15 minutes) when using examinations involving high gradient performance.

2.2.4 Contraindications

This chapter contains very important information about MR safety: In principle, a qualified physician must evaluate the risk/benefit ratio of the MR examination for every patient.

To date, there is no scientific proof that MR examinations are harmless for pregnant women, the unborn (embryos or fetuses) and children under two years of age.

In general, an MR examination is contraindicated for patients with electronic or electronically conductive implants or metals, especially those containing ferromagnetic foreign matter.

Typical contraindications for MR examinations are:

- Electronic implants: e.g. pacemakers, stimulators, insulin pumps
- Artificial heart valves, aneurysm clips

- Metal splinters in the eye (danger of retinal detachment)
- Artificial anus (anus praeter) with magnetic closure
- Transdermal drug patches with metallic backings
- Electrically conductive implants and prostheses
- Metallic spirals for contraception (IUDs = Intrauterine Devices)
- Transdermal or other similar implants (for example, body piercings as well as magnetic piercings)

WARNING

Electronic and/or electrically conductive implants and magnetizable inclusions in static and low-frequency magnetic fields and RF fields!

Risk of patient death/patient injury

- Ask the patient about implants and inclusions.
- Do not perform MR examinations on patients with electronic or electrically conductive implants and magnetizable inclusions.
- Ensure that patients wearing such implants and/or inclusions remain outside the exclusion zone (0.5 mT line).

Exceptions: Certain implantable medical devices have been cleared, approved and/or licensed by the Competent Governmental Authorities and/or labeled by the device manufacturer as “MR Conditional”. For such implantable medical devices, the previously mentioned list of general contraindications and the warning may not be applicable in its entirety.

It is the responsibility of the device manufacturer to declare an implantable medical device as MR Conditional if appropriate and to define the conditions (constraints) for safe MR scanning. The MR operator must be aware of any such conditions for MR scanning. It is the obligation of the MR operator to assure that these conditions are strictly adhered to. To obtain these specific conditions the MR operator may refer to the labeling of the implantable medical device or contact the device manufacturer. Siemens MR does not assume responsibility or liability for the operation of the MR system with any implantable medical device. Especially, Siemens MR is not responsible for controlling technical parameters of the MR system other than those defined by the normal operating mode, the first level controlled operating mode and the data provided in the system owner manual, such as spatial gradient field plots.

CAUTION

Eddy currents induced by low-frequency magnetic fields!

Patient burns

- Do not examine patients with electrically conducting implants or prostheses.

⚠ CAUTION

Electrically conducting objects!

Injury to patient due to warming

Incorrect diagnosis due to artifacts

- Request that the patient removes all electrically conducting objects, e.g. necklaces, rings, braces, rubber bands for long hair, piercings as well as jewelry.
- Request that the patient removes all clothing including electrically conducting material, for example, bras, metallic appliqués or woven metallic yarns.
- Inform patients that eyeliners and tattoos may contain ingredients causing artifacts or skin irritations during MR examinations. In some cases, patients have been burned.
- To prevent injuries, instruct patients to remove makeup prior to the examination.
- Instruct patients to seek medical attention in case of discomfort during or following the MR examination.

2.2.5 Mechanical hazards

Collision and points of injury

Collisions and injuries are more prevalent when using the exchangeable tabletop, the patient table or when performing maintenance activities.

- Observe the warning and prohibition signs as well as the safety information.

⚠ CAUTION

Accidental patient table movement!

Injury to the patient

- If you plan an intervention outside the magnet, activate the **Table Stop** button to avoid accidental patient table movement, or injury to the patient. After completing the intervention, the table can be unlocked.

⚠ CAUTION

Vertical and horizontal movement of the patient table!

Injury to patient and other persons

Damage to the patient table

- Ensure that there are no obstacles (e.g. extending or overhanging body parts, hair, clothing, straps) between table and the magnet, or that the additional equipment (e.g. IV tube, respirator or ECG) does not get caught and remains in and on the patient when moving the tabletop.
- Secure the patient's arms and legs with straps so that the patient is not caught between the tabletop and the magnet cover. Remain in the MR examination room with helpless patients (e.g. children and patients who are either seriously ill, paralyzed, unconscious, sedated, handicapped or medicated), even if the patients are secured during the examination.
- Keep the patient under visual or acoustic control.
- In case of hazardous conditions, press the **Table Stop** button.
- Explain the significance of protocol-controlled table movements to the patient.

2.2.6 Compatibility

Combinations with other systems, accessories

Among other things, the following hazards or complications may occur through the use of third-party products during MR examinations:

- Heating of system cables or connection cables
- Interference with MR image quality
- Malfunctioning of third-party products

Auxiliary equipment, which has not been specifically tested and approved for use in the environment of the MR equipment, may result in burns or other injuries to the patient.

If the MR system is combined with other systems or components, it must be ensured that the planned combination and cable routing do not affect the safety of patients, personnel, or the environment.

Ensure that the devices used in the examination room are compatible with the field strength of the MR system. For example, devices compatible with 1.5 T systems may be unsuitable for 3 T systems, and vice versa. See also MR Conditional: (→ Page 27 *Labeling*)

- Contact Siemens Service prior to combining the MR system with other devices.

Interferences

Peripheral equipment (e.g. patient monitoring, life support or emergency care equipment) which is not specified or recommended for use in the MRI environment, including the controlled access area, may be disturbed by the RF field or the magnetic fringe field of the MR system. This equipment may also disturb the proper function of the MR system.

Labeling

ASTM International developed a new classification system for implants and ancillary clinical devices. The following definitions apply:

MR Safe 	An item that poses no known hazards in all MR environments. MR Safe items include nonconducting, nonmagnetic items such as a plastic petri dish. An item may be determined to be MR Safe by providing a scientifically based rationale rather than test data.
MR Conditional 	An item that has been demonstrated to pose no known hazards in a specified MR environment with specified conditions of use. Field conditions that define the specified MR environment include field strength, spatial gradient, dB/dt (time rate of change of the magnetic field), RF fields, and SAR. Additional conditions, including specific configurations of the item, may be required. MR Conditional devices (for example, RF communications equipment) may present hazards as well. Observe the manufacturer's operator manual to avoid potential hazards and injuries.
MR Unsafe 	An item that is known to pose hazards in all MR environments. MR Unsafe items include magnetic items such as a pair of ferromagnetic scissors.

Technical data

Detailed information on B_0 values, gradient and RF data, as well as graphic representations of the spatial distributions are included in the MR compatibility data sheet. See: **System Owner Manual**

2.3 What else must be observed?

2.3.1 Ambient conditions

As the ambient conditions and SAR have a considerable effect on the patient's body temperature, you must regularly check the ambient conditions.

Regulating the room temperature

The patient's ability to dissipate surplus heat is increasingly affected as the room temperature and relative humidity increase.

- Ensure that the room temperature is at or below 22°C and the relative humidity does not exceed 60%.

2.3.2 Access to the examination room

Free access to and exit from the examination room must be ensured at all times.

1 Regularly check the correct functioning of the door to the examination room.

2 Ensure that the door to the examination room opens and closes correctly.

2.3.3 Noise development

By switching the currents in the gradient coils for imaging purposes, the mechanical forces lead to noise development (humming, knocking noises) during the MR examination which can exceed 99 dB(A) in the bore.

⚠ CAUTION

Noise development during the MR examination!

Injury to patient and people in the examination room (hearing impairment)

- Provide the patient with appropriate hearing protection that lowers noise to at least 99 dB(A).
- Mandatory provide anesthetized or unconscious patients with hearing protection. Ear protection for these patients should not be omitted even at moderate sound levels.
- Ensure that personnel and accompanying persons in the examination room wear hearing protection during the examination that lowers noise to at least 85 dB(A).

- For required level of hearing protection, see: **System Owner Manual, Technical data: Hearing protection data**. All hearing protection devices must provide the required level of sound attenuation.

Adequate attenuation levels can be achieved by using, for example, ear plugs. Ear plugs offering sufficient hearing protection can be found in the Siemens Accessories catalog.

The standard Siemens headphones are intended for communication with the patient and can be used in combination with ear plugs.

- For appropriate sound attenuation, the proper use of hearing protection is important. All personnel should be trained to correctly apply the hearing protection.
- Special attention and training of the operator is required for proper positioning of the hearing protection for neonates and infants. In addition this applies to any other condition where an alternative form of hearing protection might be necessary.
- For MR examinations of infants special hearing protection may be required.
- Due to increased anxiety the permissible sound pressure level may be a reason for concern for pregnant women and their unborn, for newborns, infants and small children as well as older persons.

2.3.4 Patient care

Patient information

Patients must be informed about the hazards and safety measures during MR examinations. Before doing so, it must be confirmed that an MR examination is permissible and/or checked if increased precautions are necessary.

CAUTION

Patient received insufficient information!

Injury to patient

- Explain to the patient the conduct expected and possible risks involved.
- Inform the patient about the monitoring and communication equipment e.g. squeeze ball, intercom.
- Instruct the patient regarding possible heat development during the MR examination.
- Inform the patient about noise developing during the MR examination.
- Prior to the MR examination, instruct patients of possible stimulations during the examination i.e. twitching muscles, tingling sensation.

Patient monitoring

Patients may be acoustically as well as visually and physiologically monitored in the MR system.

- The viewing window or a video system is used for visual monitoring.
- The intercom can be used to acoustically contact the patient. (→ Page 70 *Description*)
- Medical supervision: MR Conditional monitoring devices are used to monitor the patient's vital parameters, provided the conditions for safe operation are observed.

Medical supervision means adequate medical management of patients who can be at risk from some parameters of exposure to the MR equipment, either because of the medical condition of the patient, the levels of exposure or a combination.

All patients should receive at least routine monitoring. For some (e.g. sedated, physically unstable) patients, monitoring of the vital parameters is mandatory. In the First Level Controlled Operating Mode medical supervision is also mandatory.

CAUTION

Incompatible monitoring devices!

Patient burns

- Use only monitoring devices, for example, ECG electrodes and pulse sensor, that meet the conditions for safe use (MR Safe or MR Conditional).

2.3.5 Interventional procedures

Risk of stumbling

The risk of stumbling is related in particular to the unfavorable routing of cables/hoses of interventional components.

CAUTION

Cable/hoses of interventional components!

Injury to patient and operating personnel

- Route cables/hoses of interventional components so that it is not possible to trip over them.

2.3.6 Artifacts and imaging errors

Due to their magnetizability, foreign objects in the area of the magnet bore cause strong local distortions of the basic field and lead to considerable image artifacts. Depending on the level of distortion, diagnosis may be difficult, impaired or completely impossible.

Causes: Artifacts and imaging errors are listed according to their source for error:

- System-related artifacts/imaging errors
- Patient-related artifacts/imaging errors
- User-related artifacts/imaging errors, see: **Software operator manual**

User-related and patient-related artifacts/imaging errors can be largely avoided through patient instructions and proper conduct of patient and personnel.

System-related artifacts/ imaging errors

The MR image may show system-related artifacts/imaging errors despite careful preparation.

- If the same artifact/imaging error appears repeatedly, document and submit it to Siemens Service.

Stripe artifacts

CAUTION

RF-signal interference caused by incompatible accessories e.g. patient monitoring devices!

Streaks and bright spots in the MR image

- Use only accessories tested and approved for the MR system.
- Keep the door to the examination room closed.
- Vary the bandwidth of the MR sequence.
- Whenever possible, use local coils for the MR examination.

Incorrect slice positioning

CAUTION

Phasing of MR signal is not set correctly!

Structure is shown in the wrong position

- Repeat the measurement for the structure in question by using a second orthogonal slice and check whether the position of the structure is reproducible or not.

Variations in brightness

CAUTION

Local variation in the sensitivity of local coils!

Continuous fluctuations in MR image brightness

- Whenever possible, use a local coil with transmit characteristics that are more suitable for the field of view desired.
- Use the normalization filter.

CAUTION

Static and/or stationary brightness errors on the LCD monitor due to aging!

Incorrect diagnosis

- Scroll through the images to ensure that the MR image does not show differences in brightness, spots, or cloudiness and check bright objects for afterglow.
- Keep your eyes always in central monitor position with a vertical view angle towards the screen surface for best image quality.

Variations in signal and contrast

CAUTION

Inhomogeneous RF field!

Asymmetry of contrast in the MR image

- Whenever possible, use a local coil with transmit characteristics that are more suitable for the desired field of view.

Distortions/signal obliteration along the edges

CAUTION

Spatial non-linearity of the gradient field and inhomogeneity of the static magnetic field!

Pin-cushion and barrel-shaped distortions and/or loss of signal in the margins of the MR image

- Go through a distortion correction.
- Position the region to be examined as close to the magnet isocenter as possible.
- Use phantoms for the control measurements.

Localization errors due to distortion

CAUTION

Incorrect localization data due to spatial non-linearity of the gradient field and inhomogeneity of the static magnetic field!

Incorrect diagnosis

- Take localization errors into account while planning interventions or biopsies.

Potato chip artifact

CAUTION

Distorted slice edges in the margin due to spatial non-linearity of the gradient field and inhomogeneity of the static magnetic field!

Incorrect diagnosis

- Take into account slice distortion at the margins of the MR image. This applies in particular to graphic slice positioning (GSP) as well as other graphic slice displays and slice positioning data independent of the possible use of distortion correction.

DIXON swapping

WARNING

When using the DIXON method, water and fat swaps might occur!

Incorrect diagnosis

- Diagnosis should be confirmed by a second contrast and/or a different orientation.

Patient-related artifacts/ imaging errors

CAUTION

Poor image quality! Wrong image position!

Incorrect diagnosis

- Prior to the examination, inform patients about movements and their negative effects on the measurement.
- Ensure that the patient does not move during the measurement.
- Monitor the patient during the MR examination.

CAUTION

Imprecise localization due to patient movement during functional MR imaging (fMRI)!

Incorrect diagnosis

Incorrect assignment of active brain areas

- Prior to the examination, inform patients about movements and their negative effects on the measurement.
- Use Siemens scan protocols with motion correction.
- Monitor the patient to ensure that the task is performed correctly.

2.3.7 Maintenance/repair

WARNING

High voltage and currents inside the electronics cabinets!

Risk of death by electrocution

- Electronics cabinets should only be opened by Siemens Service.

Daily checks

Windows, doors, and emergency flaps must not be blocked.

Safety-relevant accessories

The following safety-relevant accessories should be checked:

- All RF coils for the transmitting and receiving system
- ECG and respiratory sensor
- Disposable electrodes
- Pulse sensor

Maintenance

For detailed information about maintenance of the MR system, see: **System owner manual**

Serious malfunctions

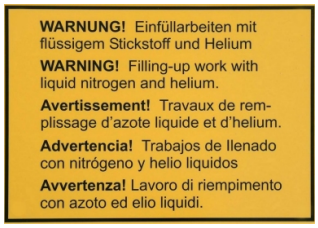
In case of serious malfunctions, shut down the MR system immediately and notify Siemens Service.

2.3.8 Signs and symbols

Warning signs

 Magnetic field	 RF field	 Observe operator manual
 Potential injury to persons	 Risk of injury	 Laser radiation

Risk of breaking



Refilling with liquid nitrogen and helium

Attention, magnetic part, observe operator manual: this label is located on the cover of the MR system (bottom left).

Laser

Laser (for the US only)

Prohibition signs The following objects are prohibited in the examination room:

Implants susceptible to electromagnetic effects

Open flames, no smoking

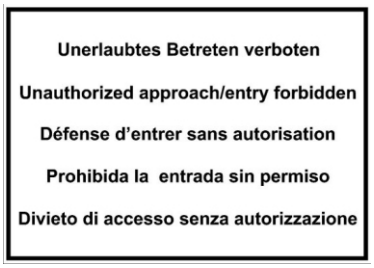
Metallic implants and other metallic objects inside the body

Mechanical watches and electronic data carriers

Fire extinguishers with magnetizable metal housing

Metal parts, e.g. tools

Electronic data carriers



Unauthorized access

Implants susceptible to electromagnetic effects

Further symbols

Sign requiring mandatory hearing protection

Protective class symbol B for application parts

Protective class symbol BF for application parts

2.3.9 System owner-related advices

Some safety instructions address the system owner. They are included as "Safety information" in a separate operator manual, see: **System owner manual**. This manual also contains the technical description of the system.

2.3.10 Coils/quality assurance

Safety instructions covering the intended use of coils and measurement phantoms are included in a separate operator manual. See: **Coil operator manual**.

2.4 In case of emergency

1 Before working with the system, familiarize yourself with the location and functionality of the emergency switches installed.

2 Report all accidents resulting in personal injury immediately to the appropriate authorities.

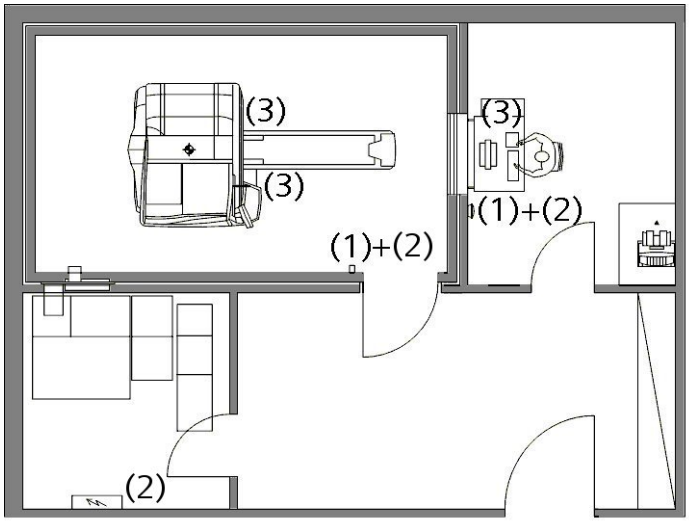
3 Observe the established emergency plans (e.g. emergency plan in case of coolant accidents, emergency plan for fire fighting).

2.4.1 Emergency switches

The MR system has different types of emergency switches.

Switch	Effect	Emergency
Magnet Stop	Shutting down the static magnetic field (quenching)	E.g. in case of accidents with attracted metal parts or in case of fire
Emergency Shut-down	Electric power of the entire MR system is switched off, but magnet remains at field	E.g. in case of fire
Table Stop	Motorized table movement is stopped	In case of accidents or injury due to table movement

In case of emergency, the relevant switch should be pressed.



(1) **Magnet Stop** switch

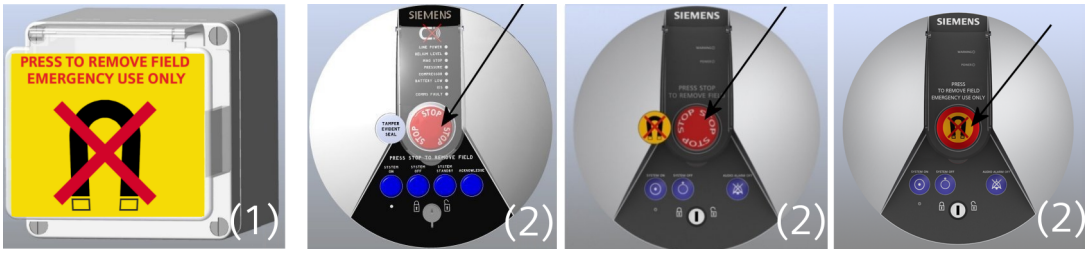
(2) **Emergency Shut-down** switch

(3) **Table Stop** button

Magnet Stop switch

The **Magnet Stop** switch triggers a controlled magnet quench (shutting down the magnetic field). The MR system is not disconnected from the power.

There are two different versions of the **Magnet Stop** switch on the MR system: as an individual switch or as an integral part of the alarm box. The switches may also be installed in other places of the MR system.



(1) **Magnet Stop**, example individual switch: “Press to remove field. Emergency use only.”

(2) **Magnet Stop** on the different versions of the alarm box: “Press to remove field. Emergency use only.”

After the **Magnet Stop** switch has been pressed, an alarm is triggered at the alarm box. The **MAG STOP** or **WARNING** LED will light up and an alarm signal will sound.

As a rule, Siemens Service must be called following a quench. The magnet must only be put back into operation by Siemens Service personnel.

WARNING

Formation of droplets due to condensation during quenching!

Personal injury (for example, frostbite)

Risk of fire

- Do not touch the exhaust line / quench pipe.
- Do not stand under the exhaust line.
- Avoid open flames and do not smoke.

WARNING

System indicates **Magnet Stop** error!

Hazardous conditions because the magnet cannot be quenched in case of emergency

- Immediately remove the patient from the magnet.
- Restrict the access to the examination room.
- Notify Siemens Service.

Emergency Shut-down switch

Typically there are two **Emergency Shut-down** switches installed: one near the alarmbox and another one in the examination room. The switch is used to switch off the electric power of the entire MR system.

Depending on your configuration, there might be no such **Emergency Shut-down** switch at your system. If available, use the **Mains power supply** switch. If none of both switches is installed, please use the **System Off** switch at the alarm box to switch off the electric power of the entire MR system.

WARNING

Fire or electrical accidents!

Personal injury

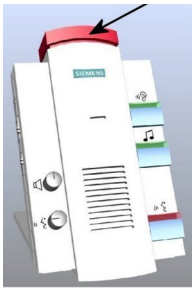
- Press the **Emergency Shut-down** switch immediately.
- Contact your fire department.

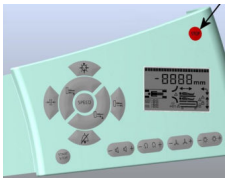
Table Stop button

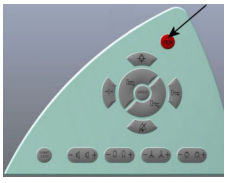
A button to stop table movement is located on the intercom and on the control unit (red button). As soon as the button is activated, table movement and the current measurement are stopped immediately.

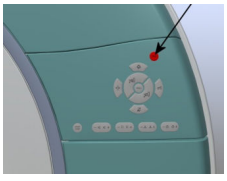
Stop symbol and variants of the Table Stop button on the control units of the different systems

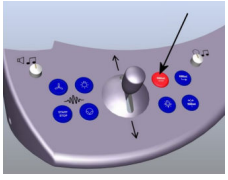
Stop symbol:











2.4.2 Medical emergency

WARNING

Medical emergency during MR measurements!

Risk of death to patients

- Terminate the measurement immediately.
- Remove patients from the examination room for treatment unless it is certain that the medical equipment required is appropriate for use inside an MR room.
- Do not store or operate oxygen bottles, defibrillators, or other auxiliary tools for resuscitation in the examination room.

CAUTION

Squeeze bulb is defective!

Risk of injury to patient because emergencies cannot be communicated

- Check the functionality of the squeeze bulb daily.

2.4.3 Coolant accidents

First aid in case of shortness of breath

During a quench, a person might become unconscious due to severe shortness of breath:

1. Remove unconscious persons immediately from the examination room.
2. Start adequate first aid measures and contact a physician immediately.

First aid in case of frostbite

Direct contact with subzero liquids, gases, and surfaces (e.g. pipes) may lead to frostbite. The eyes and mucous membranes are especially vulnerable.

CAUTION

Improper handling of liquid helium!

Skin damage caused by frostbite

- Do not rub frostbitten skin areas.

1. Remove clothing carefully from the locations involved.
2. Rinse frostbitten skin with lukewarm water.
3. Cover frostbitten skin with sterile bandages.
4. Do not apply powder or creams.
5. Contact a physician immediately.

2.4.4 Fire/Fire fighting

The following devices/materials may be used for fire fighting:

- Non-magnetic CO_2 extinguisher
- Self-contained, anti-magnetic compressed-air breathing apparatus (or hose connection)
- Airtight chemical protective suit

3 MR system components

3.1 Overview system

3.1.1 About function

A detailed specification of the system hardware and software is provided in the **Info** dialog box (main menu **Help > Info**).

The **Info** dialog can be used in combination with the information provided in the System Owner Manual (MR compatibility data sheet) to determine the specification of the static magnetic field, the gradients and the RF.

3.1.2 Super-conducting magnet

Magnetic field

The super-conducting magnet generates a strong homogeneous magnetic field with the following field strength:

Field strength	System
1.5T	MAGNETOM Avanto, MAGNETOM Espree, MAGNETOM Symphony a Tim System
3T	MAGNETOM Verio, MAGNETOM Trio a Tim System

Cooling system

The magnet is filled with liquid helium as a coolant. Following installation, it is adjusted to the desired operating field strength. The ramped-up magnet does not require additional electric power to maintain the magnetic field. Under normal operating conditions, there is no helium boil-off.

On the MAGNETOM Trio a Tim System and the MAGNETOM Symphony a Tim System, under normal operating conditions, liquid helium boils off slowly so that Siemens Service has to refill it once a year.

Shielding To minimize the effects of the magnetic fringe field on the environment, the magnet of the MR system is equipped with active super-conducting shielding.

Gradient system The gradient system provides precise localizing slice positions.

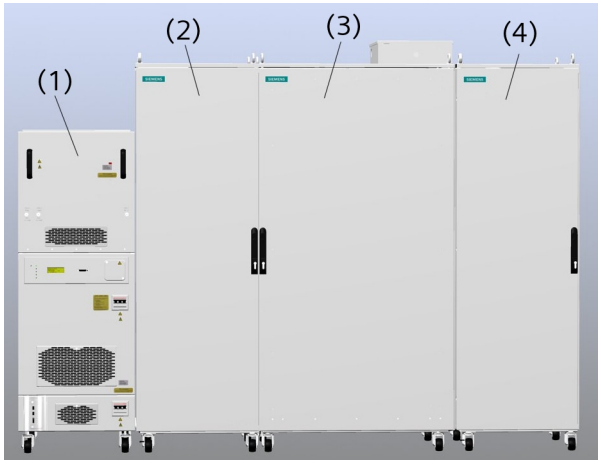
For details on the gradient system, please refer to the **System owner manual**.

For research purposes, the MAGNETOM Trio a Tim System may be additionally prepared for use with a head gradient coil. The switch-over for both gradient systems is installed at the wall behind the MR system.

The MR system is exclusively approved for use with whole-body gradient systems. This approval is no longer valid when the system has been switched over to the *head gradient* coil. Ensure that the switch-over is in the horizontal position during standard patient operation (GC whole-body operation).

3.1.3 Electronics cabinets

The electronics cabinets are located in the equipment room or the control room.



(1) RF power amplifier (3T systems only)

(2) Gradient cabinet

(3) Control cabinet

(4) System separator

Gradient cabinet

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

Control cabinet

The control cabinet includes different electronics components for operating the MR system, for example, the MARS (measurement and reconstruction system).

The control cabinet includes a sequence-programmable, optical trigger signal output which can be made externally accessible by Siemens Service via installation of a fiber optic cable.

Please note that Siemens provides customers with the optical trigger signal output for research purposes only. No devices connected to this output have been tested by Siemens. Before connecting devices to the MR suite using the optical trigger signal output, they must be tested for safety by trained personnel.

Before using devices in the proximity of the magnet, their non-magnetic properties and clinical operation in the magnetic field have to be confirmed.

The use of devices connected to the optical trigger signal output has to comply with any applicable governmental or local hospital Institutional Review Boards (IRBS).

Siemens will not be held responsible for the use of any device and resulting consequences in connection with the optical trigger signal output.

System separator

The system separator contains electronics components and cooling-equipment to deliver an adequate cooling power for the system. If a special cooling system (chiller) is installed, the system separator is not necessary.

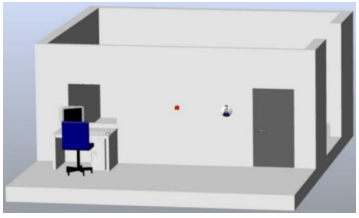
RF power amplifier (3T systems only)

The RF power amplifier provides the radio frequency signals for the MR measurement.

3.1.4 RF coils

The description, handling and quality measurements for RF coils are included in a separate operator manual. See: **Coil operator manual**

3.2 *syngo* Acquisition Workplace



The workplace (desk) in the control room is known as the *syngo* Acquisition Workplace (*syngo* Acq WP) and is used to operate the software. It includes the host processor with the operating elements monitors, keyboard, and mouse.

An additional component of the *syngo* Acquisition Workplace is the intercom. (→ Page 70 *Description*)

For details about software operation, see: **Operator Manual *syngo* MR**

3.2.1 Host

Among other things, the host processor includes the following functions:

- Patient management
- Image selection and storage
- Measurement sequence management

Measured MR images may be transferred to other systems or computers via the network connection (for example, PACS or RIS systems). MR images from other systems or computers can be received via the network as well.

Processes that require substantial computing power (for example, image reconstruction) are performed on the separate MARS (measurement and reconstruction system), which is connected to the host computer. The MARS is installed in the electronics cabinets and is located in the equipment room.

3.2.2 Data recording

The MR system provides the following drive for data recording:

- CD/DVD burner

An interface (for example, USB connection) for a paper printer is also available.

The burn and read process is started via the software. See: **Operator Manual System and data management**

Please take into account the handling, care, storage of CDs/DVDs and CD-Rs/DVD-Rs as specified by the respective manufacturers.

3.2.3 Monitor

The monitor is used to display both MR images and user dialogs. It is switched on or off as part of the overall MR system.

Do not touch the surface of the screen using sharp, pointed objects.

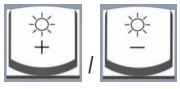
Follow the cleaning instructions, see chapter **Cleaning**.

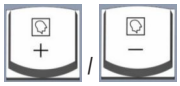
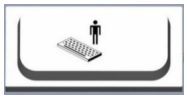
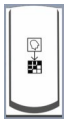
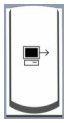
As the monitors are optimally configured by Siemens Service, all monitor adjustments are blocked.

3.2.4 Keyboard

The *syngo* Acquisition Workplace is equipped with an original Siemens keyboard. This keyboard is a modified Windows keyboard where the numeric keys have been replaced with symbol keys.

The symbol keys are used to access frequently used functions. The **F4**, **F5**, **F6**, **F7**, and **F8** function keys enable you to access the individual task cards. The **F1** function key lets you access the Online help.

Function	Original Siemens key	Windows key
Increase/decrease image brightness (set window position)		**NUM / /**
Increase/decrease contrast (set the window width)		***** / **-**
Automatically set contrast and brightness		**9**

Function	Original Siemens key	Windows key
Page forth/back in the examination		**8** / **7**
Page forth/back in the series		**5** / **4**
Page forth/back image by image		**2** / **1**
Open patient registration		**Ins**
Selecting the Patient Browser		**Del**
Copy to film sheet		**Enter**
Highlight		**3**
Send to node 1		**+**

If the computer system is connected to a clinic-wide processor network (HIS/RIS), use the **Examination** task card to send images to other network addresses via node 1.

3.2.5 Mouse

The system is equipped with a wheel mouse.

- Left mouse button:
  - Selecting or moving objects
  - Starting applications
  - Executing commands
- Center mouse button/wheel:
  - Changing the window values of patient images
  - Scrolling (for example, through the Patient list)
- Right mouse button:
  - Opening the context menu (depending on the position of the mouse pointer)

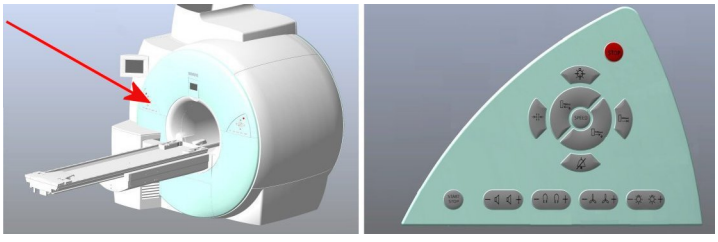
3.2.6 *syngo* MR Workplace (optional)

The *syngo* MR Workplace allows for evaluation, documentation and post-processing of previously measured images while acquiring images at the *syngo* Acquisition Workplace. It accesses the database of the host processor.

It is not possible to perform measurements at the *syngo* MR Workplace. It is not connected to the MR scanner or the image reconstruction system.

3.3 System control

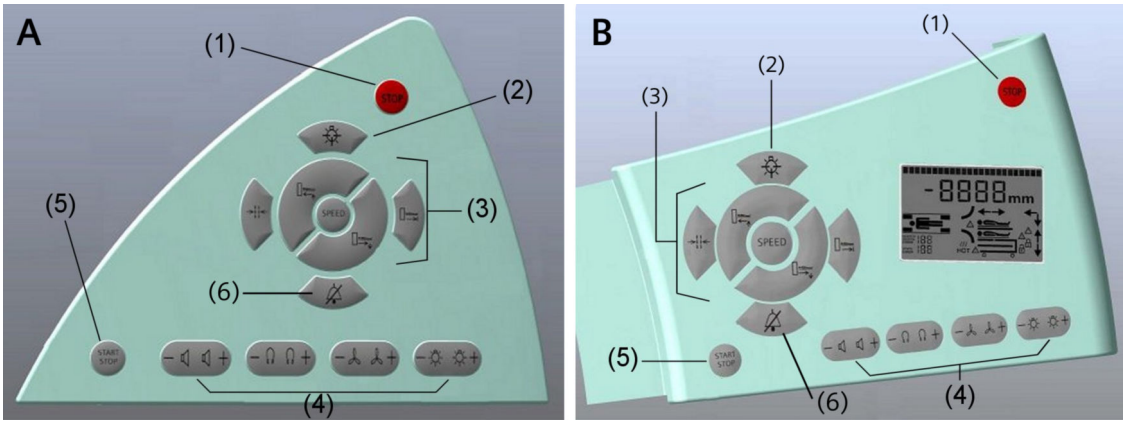
You can use the system control to operate the system and the patient table. It comprises control units and the table display.



Example: System control on the MAGNETOM Avanto

3.3.1 Control units

The control units are located at the right and the left side of the patient table at the front of the magnet cover. Optionally, additional control units are located at the rear side of the magnet.



Control unit on the MAGNETOM Avanto (A) and on the MAGNETOM Espree and MAGNETOM Trio a Tim System (B)

(1) **Table Stop** button

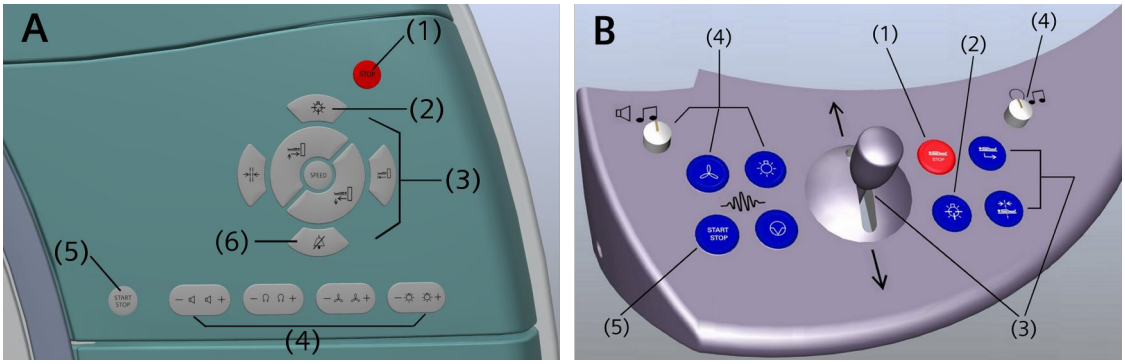
(2) **Laser-Light Localizer** button

(3) Buttons for moving the table

(4) Buttons for setting the tunnel light, volume of music and headphones and tunnel ventilation

(5) **Start/Stop** button

(6) **Reset patient alert** button



Control unit on the MAGNETOM Verio (A) and on the MAGNETOM Symphony a Tim System (B)

(1) **Table Stop** button

(2) **Laser-Light Localizer** button

(3) Buttons/joystick for moving the table

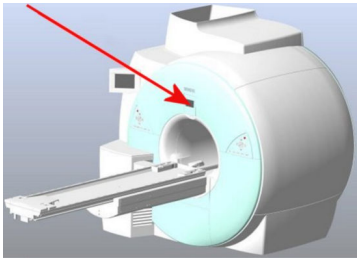
(4) Buttons for setting the tunnel light, volume of music and headphones and tunnel ventilation

(5) **Start/Stop** button

(6) **Reset patient alert** button

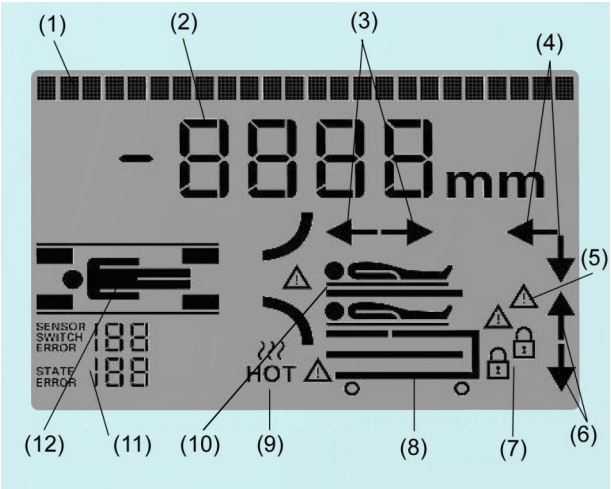
For better user guidance, the buttons are backlit.

3.3.2 Table display



The table display shows the status of the functions executed via the control units.

The table display is located above the magnet bore opening at the front of the magnet cover. On the MAGNETOM Espree and the MAGNETOM Trio a Tim System the table displays are located on the right and left side as a part of the control unit. Optionally in back of the magnet, a second display can be installed for the third control unit.



(1) Text output line

(2) Table position (+/-)

(3) Direction arrows for horizontal table movement

(4) Combined directional arrows (vertical, horizontal)

(5) Collisions when moving the table in the vertical direction

(6) Direction arrows for vertical table movement

(7) Locking mechanism for exchangeable tabletop

(8) Exchangeable tabletop (optional) and trolley (optional)

(9) Overheating brake

(10) Patient on table

(11) Error codes patient table

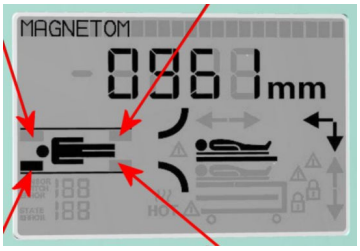
(12) Coil socket assignments

Text output line

The text output line of the table display shows the following information:

- Brightness of tunnel lighting, fan for tunnel ventilation, volume of intercom and of headphones
- Name of the last connected coil (displays briefly after establishing the connection)
- Error indications

Coil sockets



The current coil socket assignments are indicated by the corresponding icons on the table display.

Blinking icons indicate coil malfunctions or incomplete coil assembly.

Relative table position

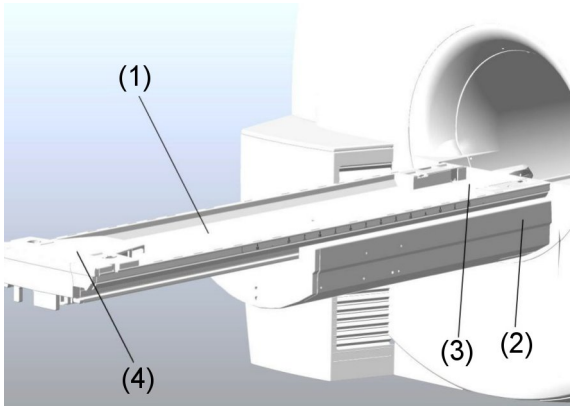
The relative position of the tabletop is shown in mm.

0000 mm on the display indicates that the slice to be measured is positioned in the magnet isocenter (center position). This is a prerequisite for obtaining optimal image quality.

3.4 Patient table

3.4.1 Description

The patient table is used for positioning the patient and the coils. The table comprises several sockets and connections.



(1) Tabletop

(2) Supporting frame

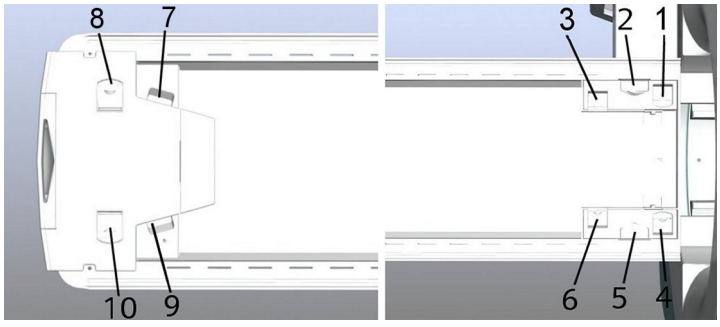
(3) Head end

(4) Foot end

The tabletop can be moved horizontally into the magnet bore. When moved completely out of the magnet, the tabletop may be moved vertically as well.

Max. patient weight: This label is located on the patient table.

Coil sockets

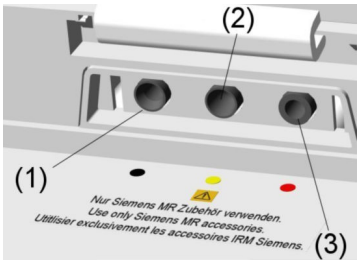


For more information about assignment of the coil sockets, see: **Coil operator manual**

Make sure that no liquids such as contrast medium, blood, or cleaning agents get into the table connections.

Connections

The following connections are located at the foot end of the patient table:



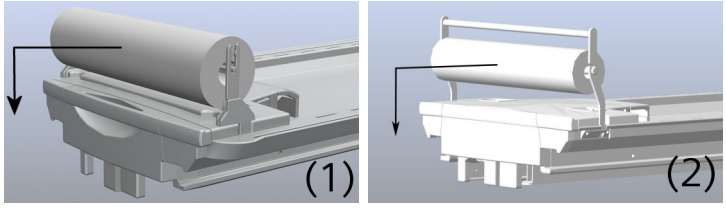
(1) Vacuum cushion

(2) Headphones

(3) Squeeze bulb

Paper roll holder

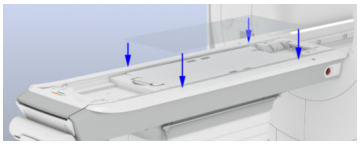
The paper roll holder is located at the foot end of the table frame. It can be swiveled.



Paper roll holder on the MAGNETOM Verio (1) and on the other systems (2)

To minimize points of injury in the area of the magnet bore, the paper roll holder on the patient table can be folded behind the foot end of the patient table.

Protective film for tabletop



You can use the protective film on the tabletop to protect the tabletop (including spine coil) against soiling.

Holder for infusion bottles

To use the holder for infusion bottles, position the rod on the left side at the head end of the patient table.

3.4.2 Operating the patient table

The patient table can be controlled via the buttons on the control unit. (→ Page 55 *Control units*)

Please note that this section only describes the operation of the patient table. For details on positioning the patient, see: **Operator Manual Coils**

To operate the patient table safely and efficiently, operating personnel must be familiar with its most important positions.

Home position	Table is at the height of moving into the magnet bore, tabletop is moved completely out of the magnet
Last scan position	If the tabletop was moved only in the horizontal direction, the tabletop can be returned into the position of the last measurement
Default position	The center of the Head Matrix is in the magnet isocenter
Center position	The body region to be measured is in the magnet isocenter
Relative position	Distance between the slice marked with the light localizer and the magnet isocenter

The relative position and the actual tabletop movement are shown on the table display.

For some measurements, the tabletop is moved automatically.

Moving the patient table

The patient table can be controlled via the buttons on the control unit.

On the MAGNETOM Symphony a Tim system, vertical movements can be controlled via the joystick.

Table Stop button: The tabletop stops immediately; both movement arrows of the current table movement on the table display flash alternately

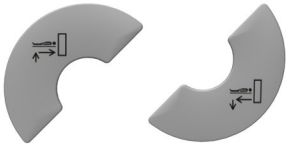
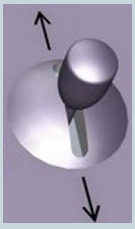


Table Up/Inward button: Raising the patient table/Moving into the magnet bore

Table Down/Outward button: Lowering the patient table/ Moving out of the magnet bore

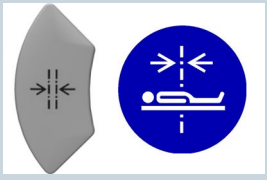


Only on the MAGNETOM Symphony a Tim system:

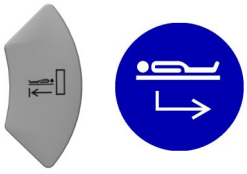
Joystick (up): Raising the patient table/Moving into the magnet bore

Joystick (down): Lowering the patient table/ Moving out of the magnet bore

Speed button: Moving the tabletop at increased speed



Center Position button: The tabletop moves into the magnet bore until the slice to be measured is located in the magnet isocenter



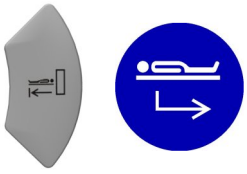
Home Position: The tabletop moves completely out of the magnet, and the measurement in progress is terminated

- Press the respective button on the control unit to move the patient table.

Rescuing the patient in an emergency

In case of accidents, for example, patient emergency situation (for example, heart attack), the tabletop and patient must be moved out of the magnet bore.

The fastest method for moving the tabletop out of the magnet bore is to press the **Home Position** button. Select this method whenever the power supply and/or motorized drive are intact.

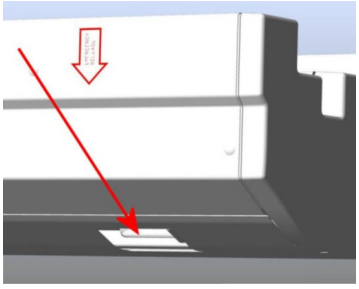


1 Press the **Home Position** button.

   The tabletop moves completely out of the magnet.

2 Rescue the patient.

Rescuing the patient manually



In case of power failure and/or defective motorized drive, pull the tabletop manually out of the magnet bore.

Depending on the configuration, an emergency unlocking mechanism may be attached to the table.

WARNING

Patient rescue during emergency situations, e.g. quench with failing quench pipe, fire with strong smoke development, emergency situation involving patient (e.g. heart attack) and simultaneous power failure!

Personal injury

- After releasing the emergency release, pull the tabletop with the patient manually out of the magnet.

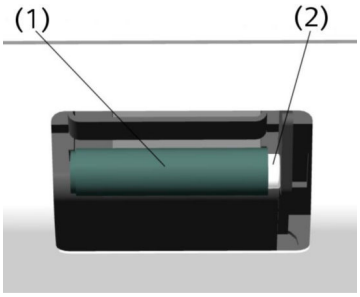
Rescue without emergency unlocking mechanism

1 Press the **Table Stop** button.

2 Pull the tabletop out of the magnet using the handle at the foot end.

3 Rescue the patient.

Rescue with emergency unlocking mechanism



(1) Unlocking handle

(2) Reset button

1 Pull the unlocking handle outward up to the end stop.

A reset button moves out of the unlocking handle.

The Table Stop function is released and the **Table Stop** button glows. The MR measurement is terminated and the table positioning is deleted. The two movement arrows on the table display blink alternately.

2 Pull the tabletop out of the magnet using the handle at the foot end.

3 Rescue the patient.

Resetting the emergency release

1 Ensure that the power supply fault and/or motorized drive fault has been eliminated.

2 Press the reset button into the unlocking handle.

The unlocking handle snaps back into its original position.

3 Shift the tabletop manually by approx. 10 cm in any direction until it audibly locks into the motorized drive unit.

4 Press the **Table Up/Inward** button.

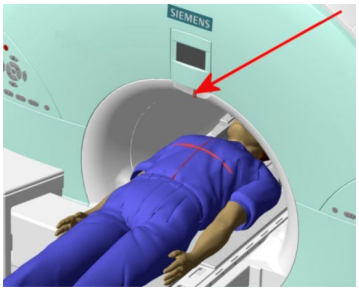
5 Press the **Table Down/Outward** button.

The Table Stop is cancelled.

6 Press the **Home Position** button on the control unit.

The tabletop drives at reduced speed into the Home Position. After reaching the Home Position, the patient table is ready for operation again.

3.5 Laser-light localizer



The laser-light localizer facilitates correct patient positioning. The laser-light localizer is located on top at the entrance to the magnet bore (red arrow in the example picture of the MAGNETOM Avanto).

All laser-relevant locations at the MR system are identified by warning labels affixed directly next to the laser opening.

3.5.1 Using the laser-light localizer

Anesthetized patients or patients who do not have an eye blink reflex must be protected against the effects of the laser beam.

✓ The patient is positioned on the tabletop.

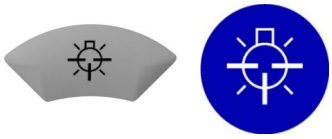
✓ The patient table is in the home position.

⚠ WARNING

Laser beam of the laser light localizer!

Eye injury caused by laser beam

- Ensure that the operating and adjustment devices as well as methods given are used as described.
- Inform the patient about the laser and request that he keeps his eyes closed during positioning.
- Ensure that helpless patients keep their eyes closed during the positioning procedure.

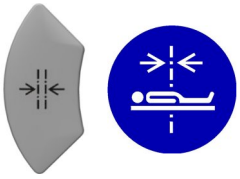


1 Press the **Laser-Light Localizer** button on the control unit.

The laser-light localizer is switched on. A crosshair is visible.

2 Move the tabletop so that the crosshairs point precisely to the region of interest.

The slice for measurement is marked. The display shows the relative tabletop position of the marked slice.



3 If the laser is correctly positioned, press the **Center Position** button for one second to move the table into the magnet isocenter.

The tabletop moves to the selected position and the laser shuts off automatically.

When the table is not moving, the laser-light localizer shuts off automatically after 60 seconds.

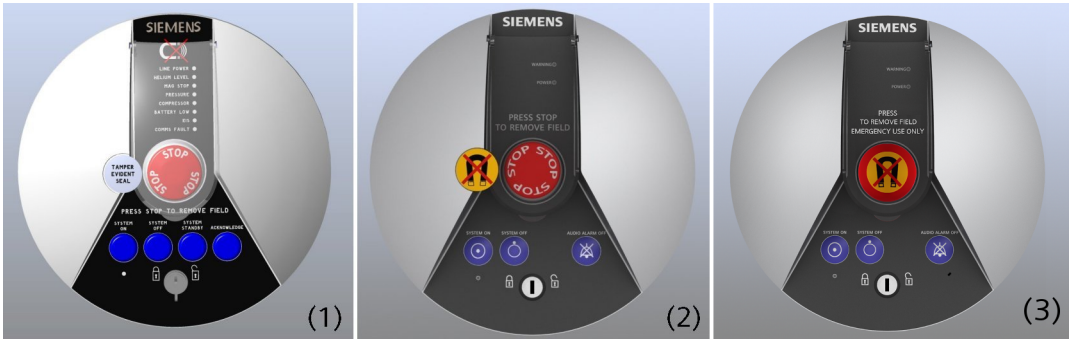
3.6 Alarm box

3.6.1 Description

The alarm box has the following functions:

- Displays alarm signals
- Switches the MR system on and off
- Magnet Stop / Magnet Quench

Depending on your system configuration one of the following alarm box versions is installed near the *syngo* Acquisition Workplace.



Alarm box versions 1-3

3.6.2 Checks

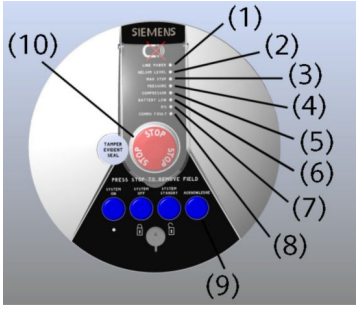
WARNING

MR system malfunction!

Hazardous conditions for patients

- Note the sounding alarm and signal.
- Do not perform MR examinations.
- Notify Siemens Service.

Checking the LEDs (version 1)



(1) **LINE POWER** LED
(2) **HELIUM LEVEL** LED
(3) **MAG STOP** LED
(4) **PRESSURE** LED
(5) **COMPRESSOR** LED
(6) **BATTERY LOW** LED
(7) **EIS** LED
(8) **COMMS FAULT** LED

(9) **ACKNOWLEDGE** button

(10) **Magnet Stop** button

LED	LEDs light up to indicate
LINE POWER	Voltage supply of MR system is satisfactory
HELIUM LEVEL	Helium fill level is too low
MAG STOP	**Magnet Stop** switch is pressed / quench triggered or: Error in the Magnet Stop circuit
PRESSURE	Pressure in super-conducting magnet is critical
COMPRESSOR	Error in the compressor
BATTERY LOW	Battery for magnet supervision is getting weaker
EIS	Error when resetting EIS
COMMS FAULT	Communication error

1 Check all LEDs (except LINE POWER) for alarm messages.

An alarm is present when a red LED lights up and/or an alarm sounds.

2 In case of an alarm, press the **ACKNOWLEDGE** button to silence the alarm, and notify Siemens Service.

3 Verify that the **LINE POWER** LED is green.

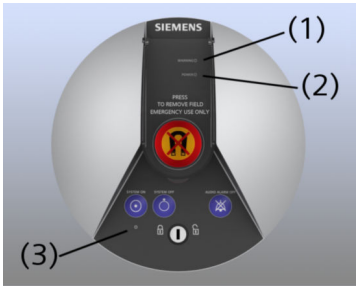
4 If the **LINE POWER** LED is not on: Check the power supply of the MR system.

»

The LINE POWER LED is off, although the power supply is functioning properly?

- Notify Siemens Service.

Checking the LEDs (version 2 and 3)



(1) **WARNING** LED

(2) **POWER** LED

(3) **SYSTEM ON** LED

LED	LEDs light up to indicate
WARNING	Error message, e.g. helium fill level is too low
POWER	Voltage supply of MR system is satisfactory
SYSTEM ON	The MR system is switched on

1 Check the **WARNING** LED for alarm messages.

An alarm is present when a yellow LED lights up and/or an alarm sounds.

2 In case of an alarm: Check the host computer for error messages. Press the **Audio Alarm Off** button to silence the alarm, and notify Siemens Service.

3 Verify that the **POWER** LED is green.

4 If the **POWER** LED is not on: Check the power supply of the MR system.

» **The POWER LED is off, even though the power supply is functioning properly?**

- Notify Siemens Service.

After a power failure, the battery powers the circuit of the magnet emergency shutdown for another 14 days. During this time, the magnet can still be quenched i.e. the magnetic field can be shut down by pressing the **Magnet Stop** switch in case of emergency.

Remote monitoring

After installing remote monitoring, various error messages can be output centrally (e.g. to the front door or gate):

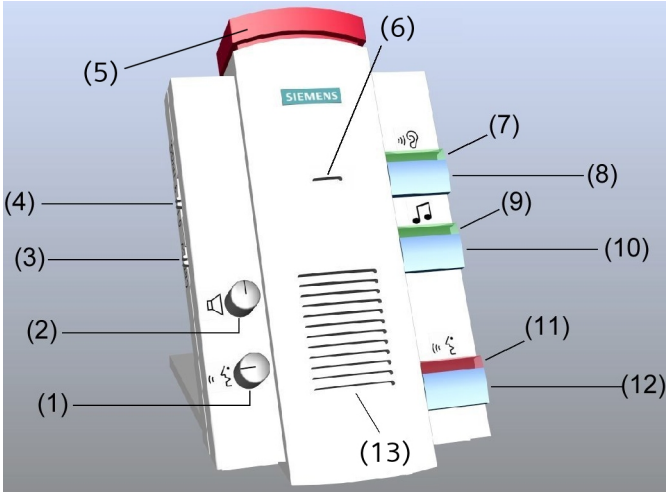
- Please contact Siemens Service regarding questions about remote monitoring.

3.7 Intercom

3.7.1 Description

The intercom allows personnel and patients to communicate during the examination. In addition, some important operations like stopping the patient table can be managed from the intercom. Optionally, music or automatic voice outputs can be played in the examination room via the loudspeaker or the headphones.

The operating unit of the intercom is located at the *syngo* Acquisition Workplace.



(1) **Patient instructions** volume control

(2) **Listen mode** volume control

(3) **CV/CBT** switch

(4) **Trigger signal** volume control

(5) **Table Stop** button

(6) Microphone

(7) **Listen** LED

(8) **Listen** button

(9) **Music on** LED

(10) **Play music** button

(11) **Squeeze bulb/announcement active** LED

(12) **Speak** button

(13) Speakers

Volume controls (1) and (2) can also be used to adjust the volume of the computer voice, even if the Listen mode is not active.

Patient alert

Patients may use the squeeze bulb to alert the operating personnel (patient alert). You will recognize the patient alert as follows:

- Acoustically:
  - Continuous tone over the intercom
  - Audio signal through the patient's headphones and through the loudspeaker in the examination room (only as long as the patient squeezes the bulb)
- Visually:
  - LED of the **Speak** button and **Listen** button on the intercom light up

You can reset the patient alert by pressing the **Speak** button or the **Listen** button on the intercom.

Patients, for example, sedated patients, who may not be able to alert the personnel must be monitored by a person present in the examination room.

3.7.2 Operating the intercom

Intercom operation is partially software based. For detailed information regarding the operation of the software, see: **Software operator manual**

As the intercom is the "terminal device", always ensure that the necessary function is activated in the software. For example, adjusting the volume at the intercom does not work if the loudspeakers are switched off in the software.

Button	Function
Listen	Allows you to listen to the patient in the examination room; resets the patient alert
Speak	Allows you to speak to the patient (as long as the button is pressed); resets the patient alert
Table Stop	Stops table movement and measurement immediately
Reset Table Stop (on the rear of the intercom)	Resets the table stop, if it was activated at the intercom. Additionally, you need to reset the table stop at the control unit by simultaneously pressing the **Table Up/ Inward** and the **Table Down/ Outward** button.
+ / -	Touch sliders to control the volume for listening or speaking to the patient.

Listening to the patient

1 Press the **Listen** button.

The LED **Listen** lights up.

Patient announcements and sounds from the examination room are transmitted to the control room (Listen mode).

2 Set the volume at the volume control **Listen mode** at the control unit of the intercom.

3 Press the **Listen** button again to end the transmission.

The LED **Listen** goes out.

Transmitting live announcements

1 Set the volume at the volume control **Patient instructions** at the control unit of the intercom.

2 Press and hold the **Speak** button.

The **Squeeze bulb/announcement active** LED lights up.

Music and automatic voice output are interrupted.

3 Speak into the microphone from a distance of approx. 30 to 40 cm.

The patient can hear the announcement via the headphones and the speaker.

4 Release the button to end the transmission.

Set the upper volume limit for automatic voice

The upper volume limit is set via software. Set once, the upper limit is not changed for every examination; it is changed as per requirement.

✓ The **Play music** button is switched off, the **Music on** LED is off.

1 Set the **CV/CBT** switch to **CV**.

2 Set the volume control **Patient instructions** to max. volume at the control unit.

3 Use the software to initiate automatic voice output, see: **Software operator manual**.

4 Increase the volume in the software to a level until you reach the desired upper limit volume in the examination room.

5 Decrease the final volume of the headset and loudspeaker to the desired level using the volume regulator **Patient instructions** at the operating unit of the intercom.

Start automatic voice output

✓ The upper volume limit is set.

✓ The **Play music** button is switched off, the **Music on** LED is off.

1 Set the **CV/CBT** switch to **CV**.

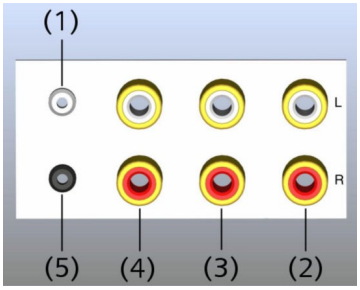
2 Use the software to initiate automatic voice output, see: **Software operator manual**.

3 Set the desired volume at the headset and loudspeaker using the volume regulator **Patient instructions** at the control unit.

Connecting the audio equipment

To play music in the examination room, an e.g. CD player or walkman is connected to the central unit of the intercom.

The connections for audio equipment are located at the central unit of the intercom in back of the *syngo* Acquisition Workplace.



(1) X10 (input, physiological monitoring signals)

(2) Music in (audio device connection)

(3) CV in (input for automatic voice output)

(4) Mic out (voice output to PC)

(5) Line out (output, active loudspeaker)

- Connect a suitable cable to the **Music in** connection of the central unit of the intercom and at the output of the headset or at the **Line out** output of the audio equipment, e.g. a CD player or a walkman.

Set the upper limit for the music volume

The upper volume limit is set at the audio equipment. Once set, changes are made to the audio equipment upon request only.

1 Go to the control unit at the magnet and set the volume control for the headphones and the loudspeaker to the highest volume possible.

2 Increase the volume at the audio device until the upper limit volume is set in the examination room.

3 Reduce the final volume of the headset and the loudspeaker to the desired value using the volume regulators at the control unit on the magnet.

Start to play the music

✓ The upper volume limit is set.

1 Press the **Play music** button.

The **Music on** LED lights up.

2 Start the music at the audio device.

The music plays through the patient's headphones or the speaker inside the examination room.

If the **Listen** button is not pressed, the music is transmitted to the operator's room as well.

If additional active speakers are connected to the **Line out** jack, the music is also played back via the loudspeakers.

3 Set the desired volume at the headset and loudspeaker using the volume regulators at the control unit on the magnet.

4 Set the **CV/CBT** switch to **CBT** to disable the music inside the examination room.

– or –

Go to the control unit and turn the volume control fully to the left (counter-clockwise).

Stopping the patient table movement

◆ Press the **Table Stop** button.

The table movement is stopped immediately.

For interventions outside the magnet, movements of the patient table can be stopped immediately by pressing the **Table Stop** button. The measurement sequence is terminated. After completion of the intervention, the control unit at the magnet is enabled again.

Terminating the measurement sequence

◆ Press the **Table Stop** button very shortly one after the other.

The measurement is terminated.

Acknowledging the patient alert

✓ The patient alert is activated. An acoustic signal sounds at the intercom. The **Squeeze bulb/announcement active** LED flashes.

◆ Press the **Speak** button.

The signal stops sounding. The patient alert is switched off. The transmission from the examination room is activated. It is now possible to speak with the patient.

Listening to physiological monitoring signals

The operating personnel may use the intercom to listen to the trigger pulses of the physiological monitoring signals.

The volume of the trigger pulses can be set to three different levels:

- Low
- Average
- High

◆ Use the **Trigger signal** volume control to set the trigger pulse volume.

The trigger pulses are transmitted at the desired volume.

3.8 In-Room *syngo* Acquisition Workplace

3.8.1 Description

The In-Room *syngo* Acquisition Workplace (In-Room *syngo* Acq WP) is an additional operating console in the examination room. It is used for image viewing and MR system operation.

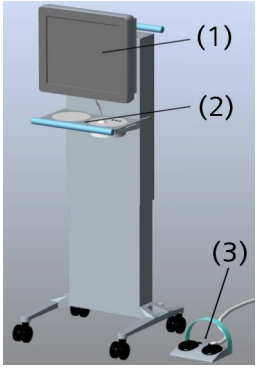
The In-Room *syngo* Acq WP is connected with the host processor and facilitates the examination process by allowing the operating personnel to remain inside the examination room between procedures.

The In-Room *syngo* Acq WP is used as follows:

- Displaying MR guided procedures
- Quickly adjusting patient positioning for survey measurements
- Immediately starting the measurement after administering contrast medium

The constant presence of operating personnel inside the examination room allows uninterrupted patient care and quick intervention in case of complications.

The In-Room *syngo* Acq WP comprises the following components:



(1) LCD monitor

(2) Tray with trackball and keys

(3) Foot switch (optional)

As an alternative, the monitor can be suspended from the ceiling. For this option, the tray with trackball and keys is not available.

3.8.2 Operating the In-Room *syngo* Acquisition Workplace

The In-Room *syngo* Acquisition Workplace (In-Room *syngo* Acq WP) is operated via the trackball and three keys. The same software functions are available as with the *syngo* Acquisition Workplace.

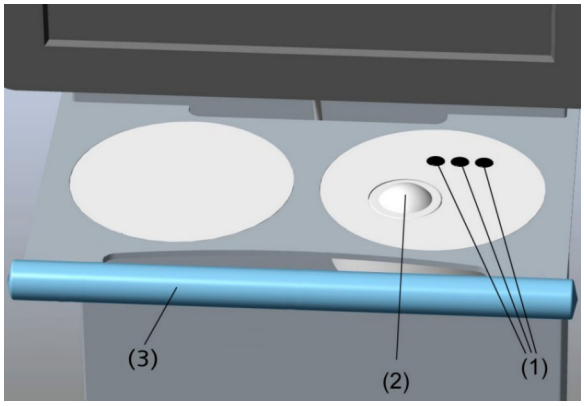
CAUTION

Diagnosis at the In-Room *syngo* Acquisition Workplace or use for interventional procedures!

Risk of patient injury; incorrect diagnosis

- Always plan appropriate emergency measures prior to starting an MR-guided or MR-monitored interventional procedure.
- Do not use the In-Room *syngo* Acquisition Workplace for diagnostic purposes.

Operating the trackball and the keys



(1) Keys

(2) Trackball

(3) Handle

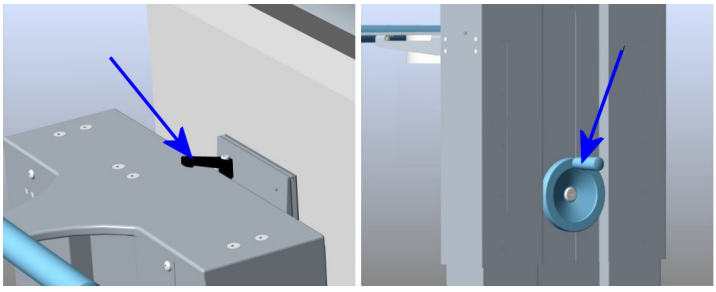
The keys have the same functions as those of the mouse.

1 Roll the trackball to move the pointer on the program interface.

2 Press the keys to execute a specific application.

Adjusting the monitor tilt

The monitor height and tilt can be adjusted for easy and comfortable operation.



1 Release the locking lever by turning it counter-clockwise by 90°.

2 Press lightly against the upper or lower edge of the display to move the monitor into the desired tilt position.

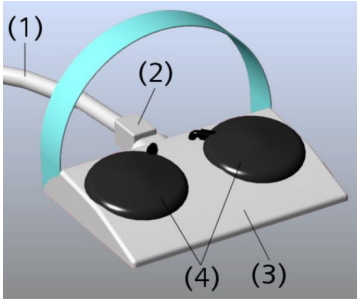
Adjusting the monitor height

1 Turn the wheel clockwise to raise the monitor.

2 Turn the wheel counter-clockwise to lower the monitor.

Operating the footswitch

The footswitch is used to start and stop the MR measurement in the examination room.



(1) Hose

(2) Hose connector

(3) Pushbutton unit

(4) Footswitch Start/Stop

For additional support, labels can be affixed to the footswitches.

Start label	START
Stop label	STOP

Performing the measurement

MR measurements with the footswitch are only possible for protocols that were configured for manual start-up. This is the case e.g. for protocols with MR measurements after administering contrast medium.

If the protocol is configured for repeated measurements, the next measurement can be started with the footswitch after completing the preceding measurement. For more information regarding the configuration of protocols, see: **Software operator manual**

1 Push the hose plug into the retaining rings of the pushbutton unit.

2 Load a suitable protocol and start it at the *syngo* Acq WP or the In-Room *syngo* Acq WP.

The MR system is waiting for the manual start of the protocol.

3 Press the **Start** footswitch to begin the measurement.

As an alternative, you can start and end the measurement via the In-Room *syngo* Acq WP or the *syngo* Acq WP.

4 Press the **Stop** footswitch to end the measurement.

3.9 Other components and accessories

3.9.1 Gradient supervision

To prevent damage to the MR system by a malfunction of the gradient system, a specially designed supervision is installed at your system.

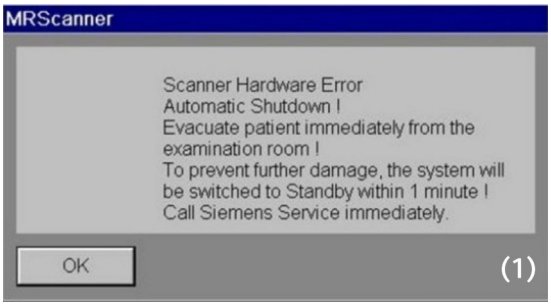
This supervision monitors that cables, connections, or other components of the gradient system do not show excessive heating. In case of a malfunction, the measurement is stopped and an alarm message is issued.

After 1 minute the system will be automatically switched to Standby.

Acting in case of an alarm

✓ Gradient malfunction is detected.

✓ An alarm message appears at the *syngo* Acquisition Workplace.



Dialog box at the *syngo* Acquisition Workplace

(1) Scanner hardware error

Automatic shutdown! Evacuate patient immediately from the examination room! To prevent further damage, the system will be switched to Standby within 1 minute! Call Siemens Service immediately.

1 Immediately move the patient out of the magnet bore by pressing the **Home Position** button.

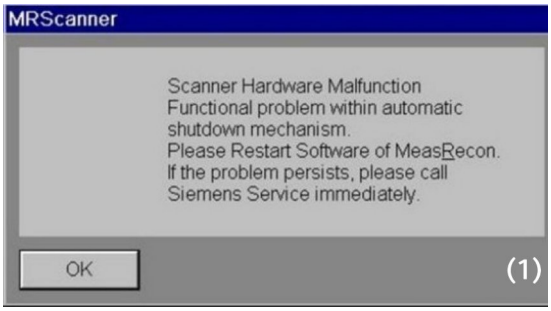
Within the next 60 seconds, the system will be switched to Standby automatically. Then, the patient table motors can not be operated any longer.

2 Call Siemens Service.

Acting in case of a supervision malfunction

✓ A malfunction within the supervision system is detected.

✓ A corresponding error message appears at the *syngo* Acquisition Workplace.



Dialog box at the *syngo* Acquisition Workplace

(1) Scanner hardware malfunction

Functional problem within automatic shutdown mechanism. Please restart software of MeasRecon. If the problem persists, please call Siemens Service immediately.

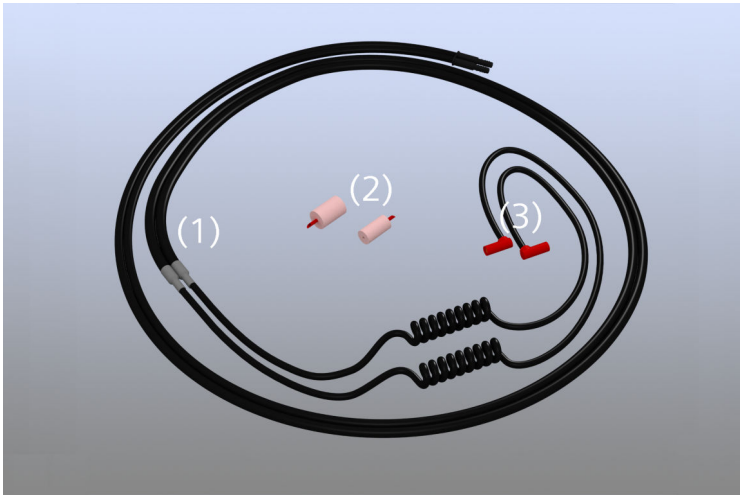
◆ Call Siemens Service.

The supervision sensitivity is potentially affected, but the operation of your MR scanner is still possible.

3.9.2 MagnaCoil™ Headset System

Overview

The MagnaCoil Headset System is an MR Conditional headphone. You can use it as an alternative headphone (for example, in head coils). The headset reduces the noise and can be used for communicating with the patient.



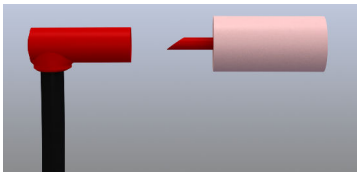
(1) MagnaCoil Headset System incl. table plug and MagnaCoil Coupler for MagnaPlugs

(2) MagnaPlugs (two sizes available: standard and mini)

(3) MagnaCoil Coupler for MagnaPlugs

The MagnaPlugs are for single-use only. Dispose of the MagnaPlugs after use.

Applying the headset



1 Connect the headphone to the corresponding connector at the foot end of the patient table.

2 Attach the plugs to the coupler. Holding the coupler, roll the plug into a tight cylinder between your fingers.

3 Apply the plugs to the patient's ears.

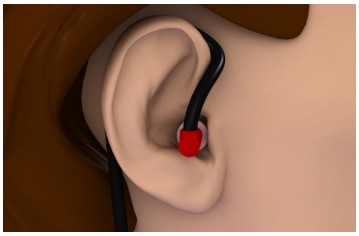
Assist patients that may need help, for example, children.

CAUTION

Wrong operation and insufficient hearing protection!

Injury to the patient

- Apply the MagnaPlugs carefully.
- Check your system owner manual for the hearing protection data and decide whether the noise reduction of about 36.7 dB Single Number Rating is sufficient.



4 Route the cable over and behind the patient's ear.

5 Use wedge cushions to position the patient's head in the head coil. Ensure that the red MagnaCoil Coupler does not touch the coil wall as this may increase the noise level.

Now you can communicate with the patient as usual via the intercom.

When using a short echo time (TE < 2 ms), parts of the PVC tubes of the MagnaCoil Headset System may be visible in the MR image! In this case ambiguity artifacts in the MR image may occur due to aliasing and folding back. The position of the artifact in the MR image may deviate from its actual location!

3 MR system components

4 Physiological imaging

4.1 Triggering methods

MR imaging procedures are sensitive to patient movement. Images may exhibit artifacts in the form of smears when motion times - for instance, during respiration or heartbeat - are short compared to measurement times. In particular, this problem occurs as a result of the patient's heartbeat during cardiac examinations or as a result of the patient's breathing during abdominal examinations.

Two different procedures are used to avoid motion artifacts in images: prospective triggering and retrospective gating. Both procedures are based on the correlation between measurement and physiological signal (ECG signal, respiratory signal, pulse signal).

4.1.1 Prospective triggering

During prospective triggering (or antegrade triggering), a measurement is triggered by using a so-called trigger signal derived from the patient's physiological signal. This signal is usually defined based on the time period during which organ movement is as low as possible. The trigger delay is, for example, set to the end of the systole for certain cardiac examinations so that the measurement is running during the akinetic diastole. For respiratory triggering during abdominal examinations, it is recommended to start the measurement at the end of the respiratory period.

To determine the start time for the measurement, an acquisition window is defined based on the signal form (e.g. R-wave in ECG, minimum of respiratory curve). For example, the size of the acquisition window is approx. 80 % of the RR interval for ECG measurements. The acquisition window defines the range in which the measurement can be triggered. The trigger time is defined by the trigger delay.

Prospective triggering can be used for ECG, pulse, or respiratory signal curves as well as for external trigger signal curves.

4.1.2 Retrospective gating

Retrospective gating fundamentally differs from prospective triggering. No actual triggering is taking place. The physiological signal and data acquisition times are recorded simultaneously. The measurement is performed completely independently of the patient's heartbeat or pulse. A temporal assignment of images to the corresponding phase (e.g. heart stimulation) is performed after the measurement (retrospectively).

In particular, retrospective gating is used to acquire images of the beating heart. As compared to measurements using prospective triggering, this technique is especially useful for displaying the late diastole. Temporal resolution is freely selectable and may be higher or lower than selected for the measurement.

Retrospective gating can be used for ECG, pulse, or external trigger signal curves.

4.2 Physiological Measurement Unit (PMU)

4.2.1 Description

The Physiological Measurement Unit (PMU) lets you control MR measurement sequences using a patient's physiological signals (ECG, respiration and pulse).

There are two versions of the PMU. In case of differences, they are each identified - but operation is nearly the same for both. Usually the graphics include PMU version 2 and the MAGNETOM Avanto, but they also apply to the PMU version 1 and the other MR systems.

The PMU consists of the following components:

- PERU (Physiologic ECG and Respiratory Unit): ECG and respiratory sensor
- PPU (Peripheral Pulse Unit): Pulse sensor
- External trigger input/output

The physiological signals are acquired with receptors - ECG electrodes, respiratory cushion and pulse sensor - directly at the patient via the PERU (ECG, respiration) and PPU (pulse). The measured data can be viewed at the PMU display in the examination room and in the **Physiological Display** dialog box at the *syngo* Acquisition Workplace.

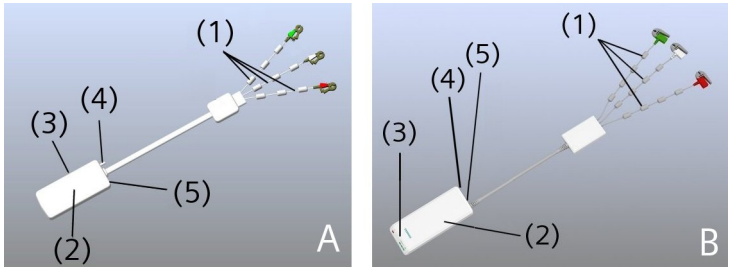
Only *one* PERU or PPU can be located in the examination room!

Two ECG and respiratory sensors in the examination room interfere with one another in signal transmission. It is not possible to determine the results.

All components of the MR system mentioned here must only be used to control MR measurement sequences. They are not approved as a patient monitoring system!

ECG and respiratory sensor (PERU)

The wireless PERU simultaneously acquires two ECG channels as well as the respiratory channel of the patient.



PERU version 1 (A) and PERU version 2 (B)

(1) ECG leads with clips

(2) Transmitter unit

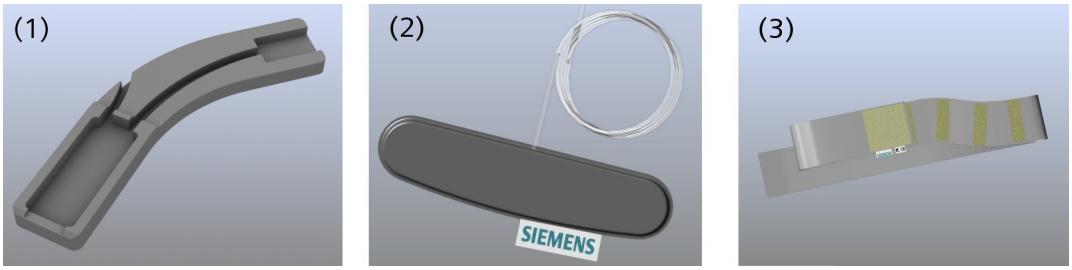
(3) Control LEDs

(4) Plug for respiration cushion

(5) Connector, charger

The ECG electrodes and respiratory cushion are connected to the PERU.

To prevent skin irritations, the PERU has to be located in the application cushion during the examination.



(1) Application cushion

(2) Respiratory cushion with pressure hose

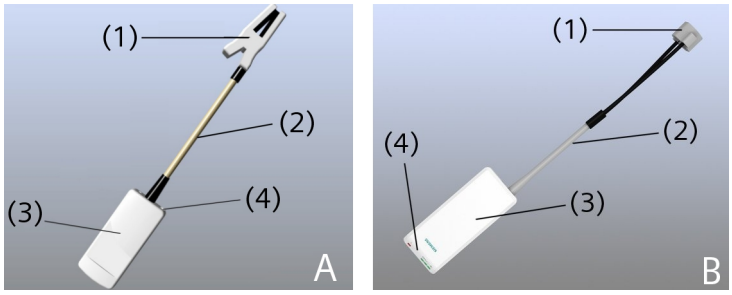
(3) Respiratory belt

Because of the PERU shape, the application cushion looks different for PERU version 1.

The respiratory cushion is attached to the patient using the respiratory belt.

Wireless pulse sensor (PPU)

The PPU acquires the patient's peripheral pulse. It consists of a transmitter unit, a fiber-optic sensor (finger clip for version 1) and a removable finger adapter (only for version 2; available in different sizes).



PPU version 1 (A) and PPU version 2 (B)

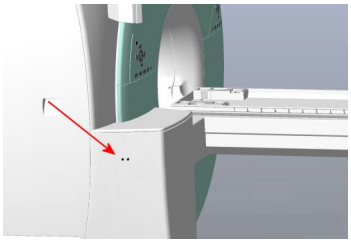
(1) Finger clip/Finger adapter

(2) Fiber optic cable

(3) Transmitter unit

(4) Control LEDs

External trigger input/output



External trigger sources (e.g. patient monitoring system) may be connected with the help of the trigger input to drive MR sequences.

To trigger external devices, the PMU has a trigger output that is currently not supported by the software.

The connections for the trigger input/output are located on the cover of the MR system. Trigger input/output are galvanically isolated with respect to the MR system.

Charging station

(A) Charging station PMU version 1

(B) Charging station PMU version 2

Both the PERU and the PPU are supplied with power via rechargeable batteries. All other components of the PMU are supplied by system-internal voltage sources. The charging station is installed separately near the *syngo* Acquisition Workplace and is used for storing both units.

The batteries should not be fully discharged before recharging them. The maximum charging time is approx. 3 hours. After being fully charged, the operating hours for the units cover approximately 12 hours for PMU version 1 and 24 hours for PMU version 2.

To charge a unit, it must be placed firmly in the charging station. The PERU and PPU can be charged together or separately in the charging station. PMU version 1: The yellow LED lights when the unit is positioned correctly and the red LED stops flashing. PMU version 2: The red LED goes out when the unit is positioned correctly and the green LEDs flash. (→ Page 92 *Control LEDs (PMU version 2)*)

Use only the charger included with delivery. Charging the units with non-Siemens equipment may destroy the PERU and PPU.

If the rechargeable batteries can no longer be properly charged, please contact Siemens Service, as the rechargeable batteries can only be replaced by Siemens.

A second set of sensors with charging station may be useful in hospitals or radiology facilities, because *one* PPU and PERU can be permanently ready for operation, while a *second* PPU and PERU are being charged.

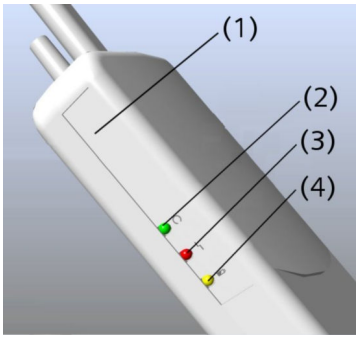
LEDs during charging

PMU version 1: The red LED stops flashing when the unit is positioned correctly in the charging station. While charging, the yellow LED lights permanently. If the battery is fully charged the yellow LED goes out.

PMU version 2: The red LED goes out when the unit is positioned correctly in the charging station. While charging, the green LEDs flash alternately as moving light. If the battery is nearly discharged, only one LED flashes at the beginning. With increasing charging status, a second green LED flashes and then also the third LED. If the battery is fully charged, the 3 green LEDs are on and stop flashing.

Control LEDs (PMU version 1)

The transmitter unit includes LEDs for signaling possible erroneous functions (e.g. during the charge).



(1) Transmitter unit

(2) **Battery status** LED

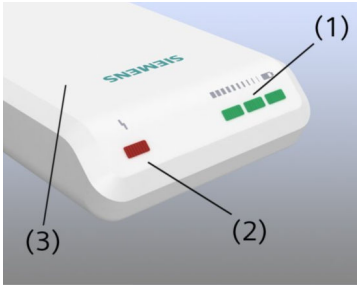
(3) **Electrode error** LED

(4) **Charge** LED

Green LED (battery status)	■ LED flashes regularly: optimally loaded battery ■ LED flashes briefly twice in a row: Battery is nearly discharged, remaining operating duration is 1 to max. 4 hours
Yellow LED (charge)	■ LED glows: Charging in progress For batteries that were nearly discharged, it may take up to half an hour before the LED begins to light ■ LED goes out: Battery is fully charged
Red LED (Electrode error)	■ LED flashes: ECG electrodes or pulse sensor were not applied correctly or fell off

Control LEDs (PMU version 2)

The transmitter unit includes three green LEDs for signaling the battery status and one red LED as fault indicator (for example, insufficient skin contact of the ECG electrodes).



(1) 3 Green LEDs (battery status)

(2) 1 Red LED (fault)

(3) Transmitter unit

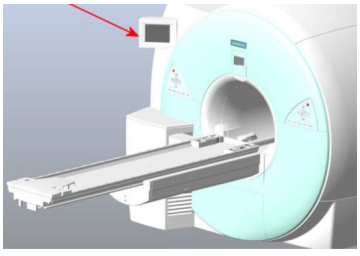
If the battery is not in the charging station, the green LEDs flash regularly and simultaneously.

If only one green LED flashes, you should charge the battery for the next patient.

3 Green LEDs flash	Fully or nearly fully (2/3) charged battery
2 Green LEDs flash	1/3 to 2/3 fully charged battery
1 Green LED flashes	Nearly discharged battery; remaining operating duration is 1 hour
Red LED flashes (as regular as the green LEDs)	Transmit function deactivated, unit is positioned outside the static magnetic field; no electrode/application fault detected
Red LED is off	Transmit function activated; unit is positioned on the patient table in the static magnetic field; no electrode/application fault detected
Red LED flashes rapidly	PERU: electrode fault - one or more ECG electrodes are not applied correctly or fell off PPU: application fault - pulse sensor is not applied correcty at the finger

PMU display

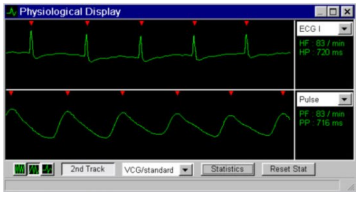
The PMU display gives you a graphical view of the patient's physiological signals.



- ECG signal and frequency
- Pulse signal and frequency
- Respiratory signal and frequency
- External trigger signal
- ECG channel selected

One ECG channel, as well as the respiratory and pulse signals, are simultaneously shown on the PMU display as real-time curves. Each rising edge of the signal on the external trigger input is displayed as a blinking * icon.

Physiological Display (at the Acquisition Workplace)



On the **Physiological Display** at the *syngo* Acquisition Workplace you can view the patient's physiological signals. For details about software operation, see: **Software operator manual**

4.2.2 General operation

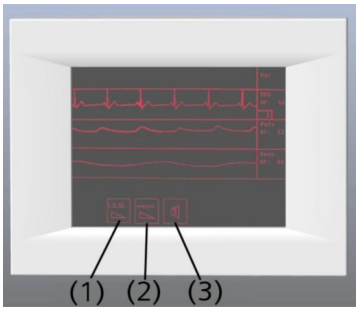
Informing the patient

1 Ask the patient to lie still during the measurement.

2 Inform the patient that the knocking sounds during the measurement are caused by switching the gradients on and off. The PERU may also vibrate slightly.

Knocking sounds may affect the heart rate of patients, either consciously or subconsciously. The resulting irregular cardiac cycles adversely affect image quality.

Operating the PMU display



The touchscreen on the PMU Display offers the following functionality:

- **ECG Channel Select** button: Selecting the ECG channel (I or AVF)

The ECG channel selection returns to channel I once you reach channel AVF.

- **Scroll Speed** button: Setting the write speed for the curves

You can choose from three different write speeds: Level 1, 2, and 3.

- **Acoustic Signal** button: Activating/deactivating the acoustic signal

WARNING

Physiological displays are not approved to monitor vital parameters!

Anomalies of the vital parameters may not be recognized or recognized too late

- Never use the physiological displays (either at the system or at the computer) to monitor the vital parameters of a patient.
- Only use suitable patient monitoring systems for monitoring vital parameters (MR Safe or MR Conditional).

- Briefly press the respective button (several times, if necessary) until you reach the requested setting.

Attaching the PERU

The PERU is used together with ECG and respiratory triggering.

✓ ECG electrodes are attached.

✓ The patient table is in the Home position.

CAUTION

Hot ECG cables!

Patient burns

- Place absorbent natural material between the ECG cables/ leads of the PERU and the patient's skin.

1 Position the patient on the patient table with the head toward the magnet bore.

2 Position the PERU in the application cushion.

Especially with respect to whole-body examinations, it should be noted that artifacts (homogeneity distortions) may occur in the direct vicinity of the PERU transmitter unit.

3 Use the application cushion and position it together with the PERU on the patient.

4 Align the PERU on the patient in the direction of the foot end of the patient table (even though the patient may have been positioned Feet First).

4.3 ECG triggering

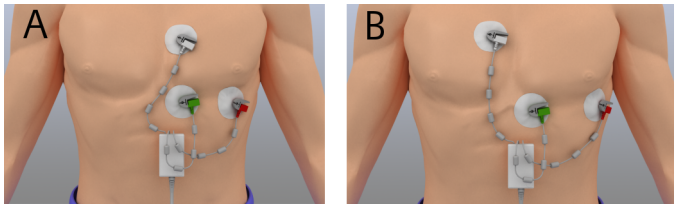
4.3.1 Description

ECG triggering is a method for measuring heart sequences including dynamic studies. It is also suitable for studies where pulse flow causes artifacts. Provided that special sequences are in use, ECG triggering can be applied in combination with respiratory-controlled methods.

A number of special sequences support retrospective gating.

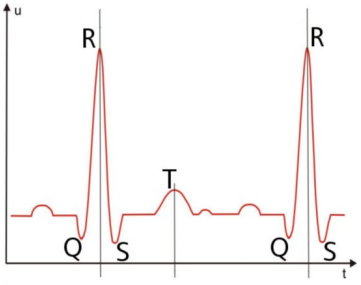
ECG leads

The ECG leads are selected according to the potential difference between the connected electrodes.



The positions of the ECG leads shown here are examples only. The best position for the electrodes must be decided for each patient individually.

The two leads I and II are used and acquired in parallel via the ECG channels. Both curves display a prominent R wave when the ECG electrodes and leads are correctly attached.



The characteristic QRS complex of the ECG signal is used as trigger signal. Simultaneous acquisition and overlaying of the orthogonal leads (vector cardiography = VCG) is used to minimize triggering errors due to gradient switching and the magneto- hydrodynamic effect (i.e., excess T-wave amplitude).

Trigger methods

In the dialog box of the **Physiological Display**, several trigger methods are available:

- **VCG/standard**: VCG activated
- **channel I only**: VCG inactive
- **channel aVF only**: VCG inactive
- **VCG/advanced 1**: improved trigger algorithm; VCG activated; default trigger method

If **VCG/advanced 1** is used, the signal characteristics can be relearned by selecting **<Relearn VCG>**.

If triggering with **VCG/advanced 1** obviously fails, **VCG/standard** should be used.

Disposable electrodes

For ECG triggering, special MR Conditional and disposable electrodes are used (the recommended ones are available through the Accessories catalog).

4.3.2 Performing

Image quality

The quality of the ECG signal for triggered measurements is enhanced by:

- Proper placement of the electrodes
- Good skin contact of the electrodes

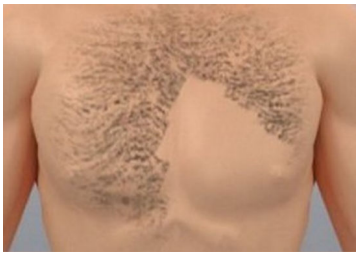
- Reduction of interference signals caused by electromagnetic induction.
  - Due to cable loops
  - Interferences from electrical potentials caused by muscle movement

Attach the electrodes so that interferences from electrical potentials caused by muscle movement and baseline drifts are minimized. Suitable contact points are therefore areas that show very little muscle or fatty tissue.

Preparing the patient

1 Prepare the patient for the examination as early as outside the examination room.

2 On the chest of the patient, select locations with minimal muscle and fat tissue for attaching the electrodes.



3 In case of hairy skin: shave the points where you intend to attach the electrodes.

Shave the patient outside the examination room to prevent accidents.

4 Thoroughly clean the patient's skin at the locations involved. However, do not use solutions containing alcohol.

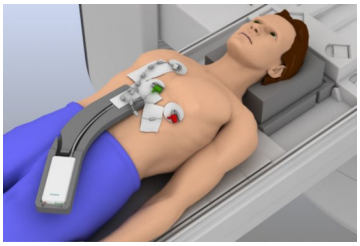
5 Then dry the skin with a paper towel.

6 Use a suitable gel to prepare the skin for better signal transmission.

Applying ECG electrodes

Finding the best position for the electrodes is a matter of trial and error. (→ Page 95 *ECG leads*)

Patients with an offset heart axis (e.g. dilatative cardiomyopathy) may require a different orientation than parallel to the spine.



1 Check the expiration date of disposable electrodes and order new ones if necessary.

2 Pull the protective foil off the electrodes and attach them.

3 Use the application cushion and position it together with the PERU on the patient. (→ Page 94 *Attaching the PERU*)

4 Connect the electrode clips of PERU to the ECG electrodes.

Performing the examination

◆ Perform the examination. See: **Software operator manual**

Evaluating the signal

Signal intensity and learning phase status of both trigger methods are shown on the table display. The signal intensity is indicated by stars. The learning phase status is indicated by a number on the right side of the stars.

For example, **I***** 10 ***AVF 4** displays "10" for the learning phase status of **VCG/standard** and "4" for the status of **VCG/advanced 1**. Both learning phases run simultaneously.

1 Check to see if the two leads I and AVF show a pronounced R-wave in the dialog box **Physiological Display** or in the PMU display.

2 Ensure that at least 2 stars are shown on one ECG channel (I or AVF) of the table display. The other ECG channel must show at least 1 star.

3 If you are using the Body Matrix, position it over the heart. Connect the coil and secure it with the belts. See: **Coil operator manual**

4 Ensure that the learning phase for both trigger methods is completed, before you move the patient table into the magnet.

5 For **VCG/advanced 1**: Wait until the status has been incremented once, for example, ***AVF 3** changes to ***AVF 4**.

6 For **VCG/standard**: Wait at least 10 heart beats, for example, till **I***** 10**.

After the learning phase has been completed, you can switch between the triggering methods.

The patient must not move during this learning phase. The patient table is in the Home position.

The red LED (fault) at the ECG and respiratory sensor is flashing (for version 1) or flashing rapidly (for version 2)?

No analyzable signal is available.

- Ensure that the ECG electrodes are attached correctly.

4.4 Pulse triggering

4.4.1 Description

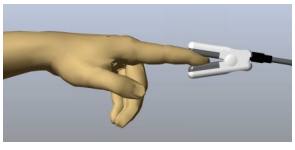
Pulse triggering uses the patient's pulse to trigger the measurement. A pulse sensor is connected to the patient's toe or finger. The first pulse wave (“premature pulse wave”) is used for triggering. This wave corresponds to the systolic blood pressure.

A number of special sequences support retrospective gating.

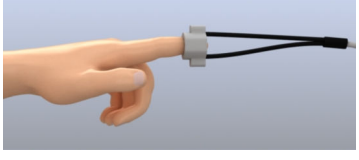
4.4.2 Performing

Attaching the pulse sensor

1 Ensure that the cable is not bent.



2 PPU version 1: When attaching the pulse sensor to a finger, attach the sensor so that the exit side of the light is located under the finger.



3 PPU version 2: Attach a suitable finger adapter and attach the pulse sensor to a finger or on a toe.

4 When using the pulse sensor on a toe, ensure that the exit side of the light is located on the underside of the toe.

5 Ensure that the pulse sensor is attached properly.

» **The red LED (fault) at the PPU is flashing (for version 1) or flashing rapidly (for version 2)?**

No analyzable signal is available.

- Ensure that the pulse sensor is attached correctly.

Performing the examination

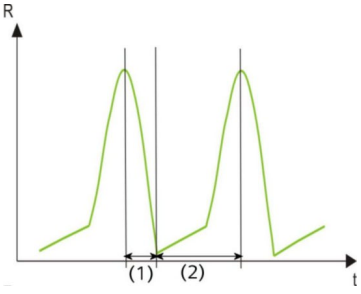
✓ The pulse sensor is attached.

- Perform the examination. See: **Software operator manual**

4.5 Respiratory triggering

4.5.1 Description

To keep respiratory artifacts to a minimum, respiratory triggering is primarily used in abdominal imaging. Data acquisition for respiratory triggering begins when the respiratory signal reaches a predefined level (approx. 20 % of the maximum value). Respiratory movement is minimal in this range.



(1) Expiration

(2) Inspiration

The respiratory signal is acquired using a respiratory cushion connected via a pressure hose to the ECG and respiratory sensor (PERU). The respiratory cushion is attached to the patient via the respiratory belt.

Retrospective gating cannot be applied.

4.5.2 Performing

Informing the patient

1 Ask the patient to lie still during the measurement.

2 Inform the patient that the knocking sounds during the measurement are caused by switching the gradients on and off. The PERU may also vibrate slightly.

Attaching the respiratory cushion and belt

✓ The plug of the respiration cushion is NOT connected.

⚠ CAUTION

Incorrect MR image due to disconnected respiratory cushion!

Incorrect diagnosis

- As a last step, plug the connector of the respiratory cushion into the allocated jack.

1 Determine whether the patient is a thoracic or abdominal breather.

Women and athletes are usually thoracic breathers.

Men and obese patients are usually abdominal breathers.

2 If the patient is an abdominal breather, place the respiration belt around his abdomen.

– or –

If the patient is a thoracic breather, place the respiration belt around his chest.

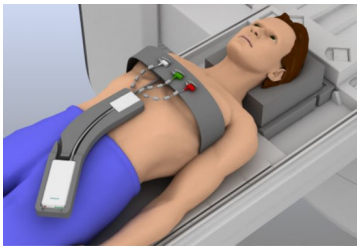
As an alternative, the respiratory cushion and belt can be used in combination with the Body Matrix.

3 Slide the respiratory cushion underneath the respiratory belt.

Connecting the respiratory cushion

✓ The respiratory cushion is attached.

1 Use the application cushion and position it together with the PERU on the patient. (→ Page 94 *Attaching the PERU*)



2 For respiratory triggering alone, position the electrode leads loosely on the respiratory belt.

3 Connect the plug for the respiratory cushion to the appropriate socket on the PERU.

4 Ensure that the pressure hose of the respiration cushion is not crimped or bent. Make sure the respiration cushion is not unduly compressed.

With quiet patients, a periodic signal will appear on-screen.

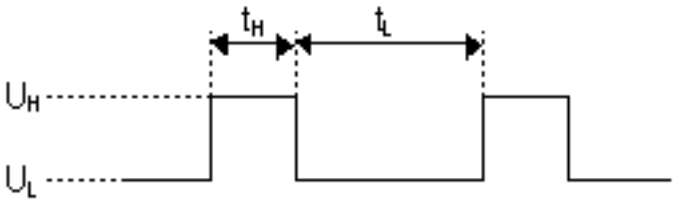
Performing the examination

- Perform the examination. See: **Software operator manual**

4.6 External triggering

4.6.1 Input for external trigger signal

The external trigger signal has to meet the following specifications:



Voltage-time diagram for external triggering of the PMU

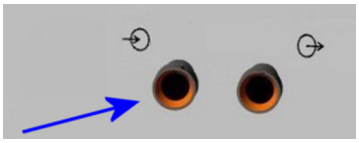
Name	Value
U_L	0 V ... 0.8 V
U_H	2 V ... 6 V
t_L(min.)	10 ms
t_H(min.)	10 ms
Input current	min. 2 mA
Input voltage	max. ±8 V

Name	Value
Internal contact	+
External contact	-

The measurement sequence is triggered by the rising edge of the external signal.

The external trigger signal can be supplied via the connections in the magnet cover.

4.6.2 Performing



1 Connect the source of the external trigger signal to the cinch jack trigger input (magnet cover, left).

2 Perform external triggering. See: **Software operator manual**

4 Physiological imaging

5 MR system operation

5.1 Daily functionality checks

Before using the MR system, the functionality and/or cleanliness of the following parts and areas must be checked:

- Alarm box
- Warning signs
- Floor
- Magnetizable materials
- Exhaust vent
- Patient table
- Squeeze bulb

5.1.1 Checking the functionality and cleanliness

⚠ WARNING

Large amount of liquid (for example, phantom fluid) spilled onto patient table and seeping into electrical connections!

System malfunction due to electrical hazards

- Immediately stop the running examination.
- Shut down the computer system and power off the MR system (**SYSTEM OFF**).
- Notify Siemens Service.

1 Check the LEDs on the alarm box.

2 Check if all warning symbols and signs are present inside and outside the examination room.

3 Check the examination room, control room, and equipment room for liquid spills and puddles on the floor.

4 Ensure that no magnetizable materials or objects such as vacuum cleaners, carts, ladders, and tools are present in the examination room.

5 Ensure that the outlet of the exhaust vent line is not obstructed.

6 Ensure that any contrast medium residue has been cleaned off the patient table.

7 Check the functionality of the squeeze bulb. The patient must be able to trigger the patient alert using the squeeze bulb.

5.2 Starting up and shutting down the MR system

There are three operating modes:

- System On (full operation)

  All MR system components are switched on. Examinations may be performed.

- System Off (system is not working)

  All MR system components except magnet and cooling are switched off.

- Standby (standby operation)

  Only the host computer is switched on. Standby is useful for patient evaluations on the computer after performing an examination.

The operating modes can be selected by pressing the corresponding button on the alarm box or by using the System Manager in the *syngo* MR software. See: **Software operator manual**

Additionally a main circuit breaker is located in the control room which should NOT be used during proper functioning of the MR system. It switches off the overall system including cooling, which leads to helium boil-off.

5.2.1 Starting the system (System On)

System start-up includes the following steps:

- Switching on the MR system at the alarm box
- Switching on the *syngo* MR Workplace
- Checking the MR system components

Do not perform preliminary examination steps (for example, moving the patient table, connecting coils) at the MR system while starting up the system.

After "system off" or Standby, wait at least 30 seconds before you switch on the system again.

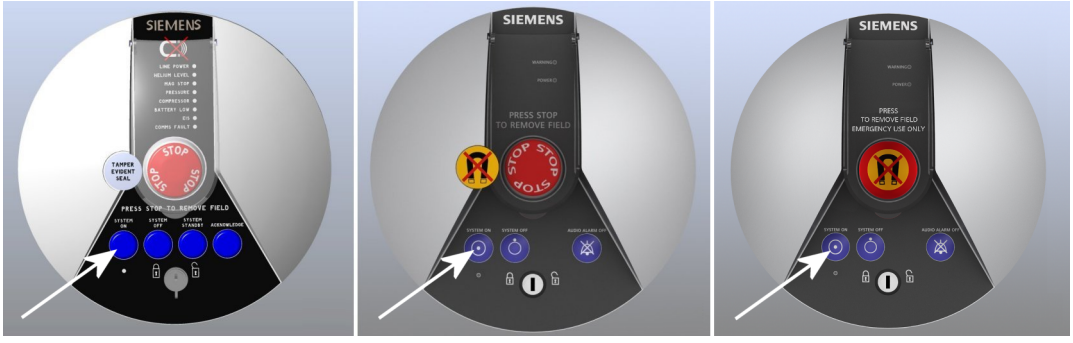
MAGNETOM Verio, MAGNETOM Trio a Tim System: Prior to starting the system, the patient table should be in the Home Position.

Switching on the MR system at the alarm box

✓ The daily functionality checks have been completed.
(→ Page 105 *Daily functionality checks*)

✓ The coils used are fully connected to the coil sockets.

✓ Coils comprising several parts (for example, head coils) are closed.



SYSTEM ON at the different versions of the alarm box

1 Turn the keyswitch to the right.

2 Press the **SYSTEM ON** button.

The **SYSTEM ON** LED lights up. The MR system is switched on.

The software automatically starts at the *syngo* Acquisition Workplace.

Switching on the *syngo* MR Workplace

Since the *syngo* MR Workplace has its own voltage supply, it is switched on separately from the *syngo* Acquisition Workplace.

- Press the Power On switch at the computer of the *syngo* MR Workplace.

The software of the *syngo* MR Workplace starts.

Checking the MR system components

MAGNETOM Verio, MAGNETOM Trio a Tim System: After switching on the *syngo* Acquisition Workplace and the *syngo* MR Workplace, the system requires approx. 18 minutes to warm up and get ready for acquisition.

To perform scans for software applications that are very B0-frequency sensitive (for example, spectroscopy) wait at least 30 minutes after system start (better 60 to 90 minutes).

1. If a dialog box is displayed at the *syngo* Acquisition Workplace informing you that the helium fill level is too low: Close the dialog box and notify Siemens Service or have the magnet refilled.
2. Check all **Table Stop** buttons (at the intercom and at the control units). Ensure that these buttons function properly and stop the table immediately.
3. Check if pressing the squeeze bulb triggers the patient alert.
4. Check if communication with the patient in the examination room works properly.
5. Check if image transmission of the video systems works properly.
6. Check if the contact spring connectors at the door frame and the door to the examination room are free of residues, such as cleaning agents, oil, grease, paint splatters, blood drops, etc.

5.2.2 Shutting down the system (System Off)

Shutting down the system includes the following steps:

- Shutting down the computer system
- Switching off the MR system at the alarm box

When shutting down the system, the software of the *syngo* MR Workplace is automatically ended as well.

To avoid possible data losses at the *syngo* MR Workplace, shut down the *syngo* MR Workplace before the *syngo* Acquisition Workplace.

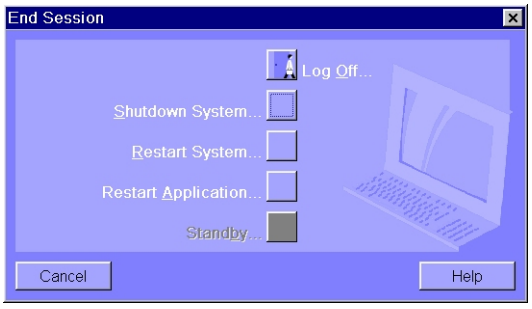
If the user is logged on, the system must be shut down using **System > Control...** or **System > End Session**. Otherwise, data are lost.

Shutting down the computer system

✓ All data have been saved, both at the *syngo* Acquisition Workplace and at the *syngo* MR Workplace.

1 Select **System > End Session** at the *syngo* Acquisition Workplace.

The **End Session** dialog box is displayed.



2 Select the **Shutdown System** option.

The computer system shuts down.

» **The software does not respond?**

- Simultaneously press the **Ctrl**, **Alt**, and **S** keys on the keyboard and shut down the system with the System Manager.

» **The System Manager cannot be opened?**

You can shut down the *syngo* Acquisition Workplace via the Windows platform, which can cause data loss.

- Simultaneously press the **Ctrl**, **Alt**, and **Del** keys on the keyboard and choose the shutdown option.

» **System Manager and Windows do not respond?**

- Switch off the *syngo* Acquisition Workplace.

Switching off the MR system at the alarm box

✓ The computer system has been shut down (indicated by a message that the system can be switched off).

1 Press **SYSTEM OFF** at the alarm box.

2 Turn the keyswitch to the left.

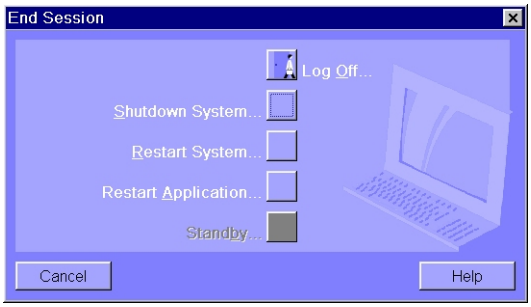
5.2.3 Shutting down the *syngo* MR Workplace

In the System On mode, you can only shut down the *syngo* MR Workplace.

1 Save your data.

2 At the *syngo* MR Workplace, select **System > End session**.

The **End Session** dialog window is displayed.



3 Select the **Shutdown System** option.

The computer system shuts down.

In case of problems during shutting down, see troubleshooting information: (→ Page 109 *Shutting down the system (System Off)*)

5.2.4 Starting/ending Standby

You can use the buttons at the alarm box or you can use the *syngo* MR System Manager to switch between Standby and System On. See: **Software operator manual**

Starting Standby

✓ The system is in the System On operating status.

◆ Press **SYSTEM STANDBY** at the alarm box.

All components except for the host computer are switched off. The **SYSTEM ON** LED goes off.

Ending Standby

✓ The system is in the Standby operating status.

1 To switch on the system: Press **SYSTEM ON** at the alarm box.

The measurement-related components of the MR system are started. The **SYSTEM ON** LED lights up.

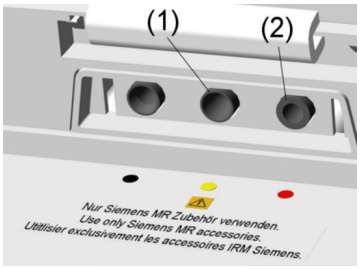
2 To switch off the system: Press **SYSTEM OFF** at the alarm box.

3 Turn the keyswitch at the alarm box to the left, to lock the MR system.

5.3 Preparing the MR system

The holder for infusion bottles can be attached to the magnet cover to the left above the patient table.

5.3.1 Connecting the squeeze bulb and the headset



(1) Connection for headphones

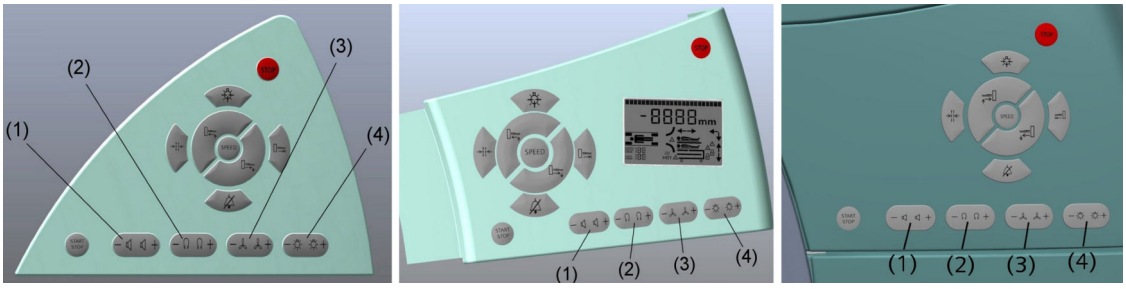
(2) Connection for squeeze bulb

1 Connect the hose connector of the squeeze bulb to the corresponding connector at the foot end of the patient table.

2 Connect the headset to the corresponding connector at the foot end of the patient table.

5.3.2 Setting tunnel conditions

Use the switches at the control unit to set the conditions in the magnet tunnel.



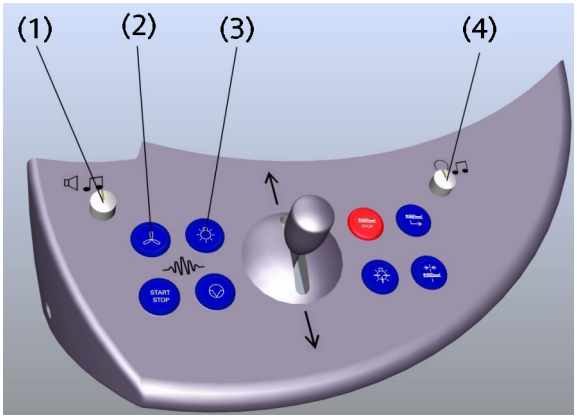
Control units at the MAGNETOM Avanto, MAGNETOM Espree, MAGNETOM Trio a Tim System, and MAGNETOM Verio

(1) Toggle switch **Room – music volume**

(2) Toggle switch **Headphones – music volume**

(3) Toggle switch **Tunnel ventilation**

(4) Toggle switch **Tunnel lighting**



Control unit at the MAGNETOM Symphony a Tim System

(1) Volume control for wall speaker

(2) Tunnel Ventilation button

(3) Tunnel Lighting button

(4) Volume control for headphones

- Press the + or– symbol of the respective switch.

  The table display shows the current level selected in the form of a bar in the text output line. Except for the MAGNETOM Symphony a Tim System, all switches of the other systems have an auto repeat function, that is, if you press a switch for longer than one second, the function of the switch is automatically repeated.

The setting of the music volume has no effect on the voice volume of patient announcements.

5.4 Preparing the patient

CAUTION

Heat development during the examination!

Patient burns

- Instruct patients to press the squeeze bulb in case of strong heat sensations.

WARNING

Use of unapproved fMRI stimulation devices for the given magnetic field strength!

Injury to patient and operating personnel

- Ensure that the stimulation devices are approved for the field strength of your MR systems. For example, devices approved for low and medium field systems (0.2 – 1.5T) must not be used on a 3T system.

5.4.1 Informing the patient

1. Please note the safety instructions.
2. Inform the patient about the possible effects of MR examinations and the risks associated with the magnetic field.
3. Show the patient how to activate the patient alert by pressing the squeeze bulb.
4. Ensure that the patient holds the squeeze bulb in his/her hand during the measurement.

5.5 Physiological effects

Due to the presence of alternating electromagnetic fields, patients may experience various physiological effects during MR measurements:

- **SAR**: warming of body tissue through RF fields of the RF transmitter coil (→ Page 117 *SAR: Exposure to RF electromagnetic fields*)
- **Stimu**: peripheral nerve stimulation through low-frequency fields of the gradient coils (→ Page 121 *Stimu: Exposure to low frequency electromagnetic fields*)

These physiological effects can be evaluated by the technical quantities dB/dt (stimulations) and SAR (warming) respectively.

You can access information about **SAR** and **Stimu** in the software at any time. This chapter provides background information. For details about the operation in the software, see: **Software operator manual**

It is generally accepted that no published evidence supporting the occurrence of cumulative and/or long-term effects after exposure to EMF emitted by the MR equipment exists.

5.5.1 Operating modes

To prevent health risks during MR measurements, several international organizations (for example, IEC) and various national health organizations have published guidelines and limit values (for example, IEC 60601-2-33 as the international safety standard for MRI). In compliance with country-specific approval guidelines, they are the basis for the monitoring functions integrated in the MR system with respect to stimulation and warming effects. The limits against too intense stimulation and warming effects (for example, dB/dt limits and SAR limits) are based on current scientific literature related to safety.

Two different operating modes are available depending on the patient's tolerance. With respect to stimulation and warming effects, the operating modes are defined independently of each other and can be selected separately.

Normal Operating Mode

The *Normal Operating Mode* can be used safely for all patients. This is the standard mode. Routine patient monitoring is required.

Scanning of pregnant patients with the Body coil must be limited to the *Normal Operating Mode* with respect to the SAR level.

First Level Controlled Operating Mode

In the *First Level Controlled Operating Mode*, patients may experience noticeable stress levels depending on the measurement programs selected. The decision to change to the *First Level Controlled Operating Mode* must be based on a medical consideration of the potential risks and benefits for the patient.

⚠ CAUTION

Exposure to RF electromagnetic fields in the *First Level Controlled Operating Mode*!

General or local hyperthermia of the patient

- Do not examine patients with restricted thermoregulatory capability (e.g. small children, elderly, sick, or medicated patients).
- Do not examine patients unable to communicate potential overheating effects (e.g. small children, seriously ill, paralyzed, unconscious, sedated, or handicapped patients).
- Ensure that patients wear light clothing (e.g. light pajamas or nightgown).
- Remove all additional insulation, e.g. blankets which could interfere with heat dissipation.
- Carefully observe the patient and advise the patient once again about the squeeze bulb.

Ensure medical monitoring of the patient (as required by the IEC standard). Also consider the need for breaks during the measurements, to allow the patient to cool off, for example.

CAUTION

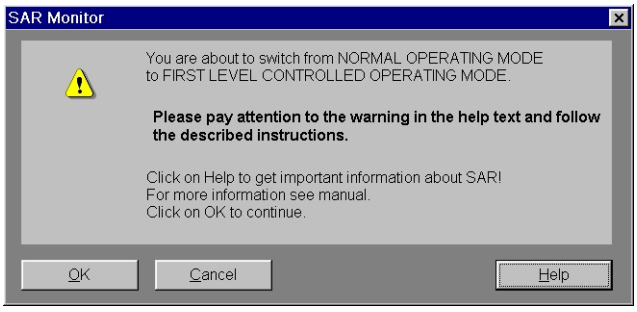
Stereotactic frames and similar devices: tips of screws may heat up considerably, especially if MR examinations are performed in the *First Level Controlled Operating Mode*!

Localized burns of the patient

- Please observe the recommendations and notes of the manufacturer of the stereotactic frame.
- If the device consists of conductive material, only perform measurements in the *Normal Operating Mode*, if possible.
- If you still need to switch to the *First Level Controlled Operating Mode*, please observe the related safety notes.

Switching operating modes

To switch from the *Normal Operating Mode* to the *First Level Controlled Operating Mode*, the user must explicitly select and confirm the change. The request appears at the *syngo* Acquisition Workplace. In the *First Level Controlled Operating Mode*, medical supervision is mandatory.



5.5.2 SAR: Exposure to RF electromagnetic fields

During the course of an MR measurement, the patient's body absorbs energy from the RF field of the transmitter coil. Depending on the type of transmitter coil used, the absorption is either concentrated locally (when using so-called "Local RF Transmit Coils") or relatively uniform across the part of the body examined (when using volume coils, for example, head, extremity, or body coil).

The *Specific Absorption Rate* (SAR), expressed as W/kg, serves as a stress indicator.

Unacceptably high local SAR values may lead to RF burns. High global SAR values (head, exposed part of the body, whole body) may lead to overstress the patient's thermoregulation and the cardiovascular system.

The B1+ rms value (root mean square value of the MR-relevant component of B1, which is indicated by the "+") is displayed at the *syngo* Acquisition Workplace for each sequence and may serve as an indication of the RF magnetic field intensity.

Warming of body tissue

The energy absorbed in the course of the MR measurement warms the tissue. The heat generated is dissipated by the thermoregulation mechanisms of the patient, e.g. through increased perspiration and blood flow.

The body temperature increases if the patient absorbs more energy per unit of time than can be dissipated through thermoregulation. The longer this condition lasts, the greater the increase in temperature.

The increase in core body temperature is usually well below 1°C during the course of the MR examination (if the SAR limits described below are maintained). Nevertheless, according to the IEC safety standard the following temperature limits must be observed.

Before starting the examination, the following maximum core temperatures of the patient apply:

- If the patient is allowed to be examined only in the *Normal Operating Mode*, the maximum core temperature of the patient (before starting the examination) is 38.5 °C.
- If the patient is allowed to be examined in the *First Level Controlled Operating Mode*, the maximum core temperature of the patient (before starting the examination) is 39.0 °C.

  If the patient is allowed to be examined in the *First Level Controlled Operating Mode* but the examination is performed only within the SAR limits of the *Normal Operating Mode*, the maximum core temperature of the patient is 39.5 °C.
- If the core temperature of the patient (before starting the examination) is higher than 39.5 °C, the patient must not be examined.

Noticeable effects on the patient

During the MR measurement, patients may experience heat sensations on the skin and, as a consequence of the RF energy absorption, patients may begin to perspire during the course of the MR examination. Their pulse rate may increase as well. The individual effects vary from patient to patient. The intensity of these effects depends on the measurement program selected. As compared to the *Normal Operating Mode*, measurement programs with considerably higher intensities may be used in the *First Level Controlled Operating Mode*. Following the examination, the body will cool off. The pulse rate will return to normal.

Temperature control inside the examination room: A temperature sensor, located near the air intake for the tunnel ventilation, monitors the room temperature. If the room temperature exceeds 25°C, the SAR limits are regulated and lowered by 0.25 W/kg per °C exceeding 25°C. As a result, the parameters of certain MR measurement sequences may need to be adjusted.

SAR limits

Considering all possible tolerances, the SAR values (quantities) are always calculated based on the worst-case assumption. This ensures that the specific SAR limit is maintained.

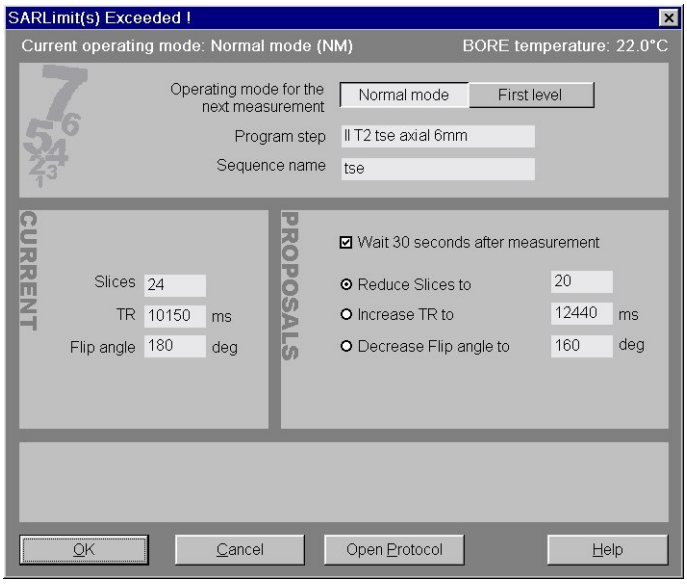
Depending on the medical question, different coils are used for the RF transmission (for example, head, extremity or body coil). The different coils lead to different RF exposure situations for the patient. Therefore, different SAR quantities and corresponding limits have been established (for example, head SAR, whole body SAR, local SAR, and SAR of the exposed part of the body). According to the guideline for monitoring SAR, the software automatically determines the SAR quantities to be monitored and applies the corresponding limits. For the actual RF exposure situation, one of the above-mentioned SAR quantities will show the highest "value to limit ratio". For example, in the case of a head examination with a typical head coil, this will be the global head SAR. If however, a transmitting coil with an inhomogeneous RF field is applied, this will be the local SAR.

SAR monitoring

SAR limits are observed by a software monitoring function.

Look Ahead monitoring: Prior to each measurement, the values of the SAR quantities to be observed are calculated (always as worst-case values) and compared with the corresponding limit values. If one of the calculated SAR values exceeds the corresponding limit, the measurement cannot be started. The following dialog box appears at the *syngo* Acquisition Workplace: **SAR Limit(s) Exceeded!**

To ensure accurate calculation of the SAR values, the weight and height of the patient must be entered correctly during registration.



The dialog box offers examination parameters that you can adapt to allow the examination to continue. You can also change the operating mode using the button provided.

In the *First Level Controlled Operating Mode*, often only minor modifications (if any) may be required.

Online monitoring: The system constantly measures the transmit power and ensures that the appropriate limit values are observed. Examinations in progress will be aborted if the limit is exceeded.

Limit values: The SAR limits used by the Look Ahead monitoring function are set according to country-specific approval guidelines at the time of the *syngo* MR installation.

Normal operating mode: In the *Normal Operating Mode*, the patient barely notices the effects of the RF field. The stress on the cardiovascular system is negligible.

First Level Controlled Operating Mode: In the *First Level Controlled Operating Mode*, patients may experience noticeable stress levels depending on the measurement programs selected. This usually includes perspiration accompanied by an increase in pulse rate. Patients with reduced thermoregulatory capability and higher sensitivity toward increases in body temperature (e.g. patients with fevers or cardiac decompression, patients with perspiratory impairments, or pregnant women) may experience additional effects.

5.5.3 Stimu: Exposure to low frequency electromagnetic fields

During the measurement, patients are exposed to an electrical field created by the time-varying magnetic fields of the gradient coils. Assuming all other conditions remain constant, the strength of the electrical field is directly proportional to the change of the magnetic flux (dB/dt).

Peripheral nerve stimulation

Stimulation threshold: The electrical field affects the patient. If the strength of the electrical field exceeds a certain threshold (stimulation threshold), the patient experiences peripheral nerve stimulation. Nerve stimulation manifests itself as e.g. tingling sensations or slight muscle spasms in the ribs, side, abdomen, hip, buttock, or thoracic regions, along the upper arms or the back muscles in the shoulder region. Depending on physiological conditions, the stimulation threshold may vary greatly from patient to patient.

Stimulation limits: So-called stimulation limits were determined by averaging the individual stimulation thresholds of test subjects during an extensive clinical trial. Based on the statistical distribution, it can be expected that up to 50 % of all patients will experience at least mild stimulations after reaching this stimulation limit.

Monitoring

The MR system software includes a monitoring feature (stimulation monitor) which monitors how close patients are to the stimulation limit.

Look Ahead monitoring: Prior to starting an MR measurement protocol, the stimulation monitor checks whether the stimulation limits may be exceeded. If so, the measurement cannot be started.

To perform the examination, the parameters of the measurement sequence must be adjusted accordingly.

Online monitoring: If the stimulation limit is exceeded while a measurement is in progress, the active measurement is aborted.

Operating modes

The MR system can be operated in two operating modes which differ with respect to different levels of stimulation.

The stimulation limits are based on stimulation models derived from the statistically determined stimulation limits. The higher the gradient output is, the higher the probability and the intensity of the effects (for example, peripheral nerve stimulation). To minimize the occurrence of peripheral nerve stimulations, it is recommended to operate the system in the *Normal Operating Mode*. However, heart stimulations can be excluded.

Normal Operating Mode: In the *Normal Operating Mode*, the limit is set to 80 % of the stimulation limit according to the IEC safety standard 60601-2-33. At the maximum performance allowed in this operating mode, the ratio of patients affected by peripheral nerve stimulation is rather low.

First Level Controlled Operating Mode: In the *First Level Controlled Operating Mode*, the performance limits are determined directly from the statistically determined stimulation limits. Accordingly, at the maximum performance allowed in this operating mode, up to 50 % of all patients may experience stimulations.

5.6 Starting/Stopping the measurement

5.6.1 Starting the measurement

✓ The measurement protocol is loaded.

✓ No MR measurement is active.

◆ Press the **Start/Stop** button on the control unit. (→ Page 55 *Control units*)

The measurement begins.

The table display is deactivated.

5.6.2 Stopping the measurement

✓ The MR measurement is active.

◆ Press the **Start/Stop** button on the control unit. (→ Page 55 *Control units*)

The measurement is stopped.

The table display is activated.

5 MR system operation

6 Maintenance

6.1 Cleaning

All instructions in the operator manual regarding cleaning and, when applicable, regarding disinfecting and sterilization must be always observed.

WARNING

Improper cleaning of the MR system (including coils and accessories)!

Risk of electric shock

Damage to the equipment

- Only clean the system and the components with a damp cloth (moist wipe, not too wet).
- Follow the cleaning instructions provided in all relevant manuals, which explicitly explain how the various components should be cleaned and disinfected.

1. Use commercially available cleaning and disinfectant solutions. Follow the manufacturer's instructions. Refer to the lists of approved detergents provided in the individual subchapters.
2. Do *not* use hard or sharp objects (e.g. knives or tweezers) to remove residue.
3. Do not pour cleaning fluid onto surfaces and do not spray fluids - always use a damp cloth for cleaning.
4. Do not immerse in cleaning or disinfectant liquid. Do not rinse with water.

For information regarding cleaning of RF coils, see: **Operator Manual Coils**

6.1.1 Cleaning system components

WARNING

Flammable cleaning or disinfection agents may cause fire or explosion!

Injury to patient

- Disinfect the system components with commercial disinfecting materials. However, do not use flammable solvents such as undiluted alcohol, benzine, or acetone. Follow the manufacturer's instructions.

The following table lists classes of active agents with concentrations that have been tested and are approved. The detergents listed under "not approved" must not be used.

Approved	Not approved
■ Aldehydes 25 vol% ■ Quaternary compounds 1 vol% ■ Guanidine derivatives 2 vol% ■ Peroxide compounds 6 wt% ■ Pyridine derivatives 2 vol% ■ Alcohol solution (for example, 70% isopropyl alcohol and 30% water) ■ Chloro derivatives 1 wt% ■ Commercially available cleaning agents, detergent substances 10 vol% ■ Alkylamine 0.5 vol% ■ Organic acids 2 vol%	■ Benzine undiluted ■ Acetone ■ Phenols

- Clean the system and its components with a damp cloth, if not specified otherwise in the individual subchapters.

Cleaning the patient table, the straps, the plugs and connectors

The following table lists classes of active agents with concentrations that have been tested and are approved. The detergents listed under "not approved" must not be used.

Approved	Not approved
■ Aldehydes 25 vol% ■ Quaternary compounds 1 vol% ■ Guanidine derivatives 2 vol% ■ Peroxide compounds 6 wt% ■ Pyridine derivatives 2 vol% ■ Chloro derivatives 1 wt% ■ Commercially available cleaning agents, detergent substances 10 vol% ■ Alkylamine 0.5 vol% ■ Organic acids 2 vol%	■ Benzine undiluted ■ Acetone ■ Alcohol solution (for example, 70% iso-propyl alcohol and 30% water) ■ Phenols

1 Carefully wipe the plugs and connectors with the cloth. Do *not* touch the contacts.

2 Wash the straps of the patient table at a temperature of 60°C.

Cleaning the control units

◆ To clean the control panels, do not use cleaners or disinfectants containing alcohol or petroleum ether ("benzine").

Cleaning the LCD monitor/ video display

The LCD monitor of the *syngo* Acquisition Workplace and the video display are cleaned in the same way.

1 Clean the LCD monitor/video display at least every two months.

2 Prior to cleaning, switch off the LCD monitor/video display and disconnect the main power plug. But if the monitor/display is under hot running conditions, please wait till the monitor/display is chilled (this can take up to one hour).

3 Clean the monitor/video display using a microfiber cloth.

4 If the LCD monitor/video display cannot be effectively cleaned with the microfiber cloth: use window cleaner. Do *not* use window cleaner on the monitor housing.

5 Immediately remove any water drops from the LCD monitor/video display.

6 Avoid scratching the surface area of the LCD monitor/video display.

7 Avoid impacts to the LCD monitor/video display.

The LCD monitor/video display are highly sensitive to mechanical damage.

Cleaning the camera lens

- Carefully clean the camera lens with a lint-free cloth and lens cleaner.

6.1.2 Cleaning accessories

Cleaning the PMU

The following table lists classes of active agents with concentrations that have been tested and are approved. The detergents listed under "not approved" must not be used.

Approved	Not approved
■ Aldehydes 25 vol% ■ Quaternary compounds 1 vol% ■ Guanidine derivatives 2 vol% ■ Peroxide compounds 6 wt% ■ Pyridine derivatives 2 vol% ■ Chloro derivatives 1 wt% ■ Commercially available cleaning agents, detergent substances 10 vol%	■ Benzine undiluted ■ Acetone ■ Phenols ■ Alcohol solution (for example, 70% iso-propyl alcohol and 30% water) ■ Alkylamine 0.5 vol% ■ Organic acids 2 vol%

- Clean the PMU and its components (except for the charging station) with a damp cloth. To clean the charging station, carefully wipe with a dry cloth.

Cleaning and disinfecting the receptors

- Do *not* use cleaners or disinfectants containing alcohol or ether.

Cleaning the MagnaCoil™ Headset System

1 Use a commercially available cleaner or disinfecting agent without TCE or acetone.

2 Use a dampened cloth for cleaning. Do not immerse the headset in any liquid.

3 Be careful not to place too much pressure on the joint where the tubing connects to the ear piece.

Cleaning the data carrier

1 Clean contaminated data carriers with a clean cloth (cotton or microfiber).

2 Follow the manufacturer's notes when cleaning CD/DVD data carriers.

6.1.3 Care and cleaning of floors

Do *not* use the following cleaning or care products:

- Sprays
- Silicone-based cleaning or care products
- Cleaning or care products with substances that release ammonia
- Cleaning or care products that destroy the anti-static properties of the floor covering

◆ Use commercially available cleaning or care products for the floor. Follow manufacturer's instructions.

6.2 Return and disposal

6.2.1 MR System

⚠ WARNING

Explosion hazard during improper disassembly!

Injury of persons

◆ Ensure that only trained personnel disassemble the MR system because the system includes a pressurized container and cryogenic helium.

1 Contact Siemens Service in case of questions about returning and disposing the MR system and/or its components and accessories.

2 Observe national regulations.

6.2.2 Packaging

Siemens is obligated to accept the return of packaging material.

1 Contact Siemens Service regarding questions with respect to the return as well as subsequent disposal of packaging material.

2 Observe national regulations.

6.2.3 Batteries and accumulators

Siemens is obligated to accept the return of batteries and accumulators and to dispose of them.

1 Contact Siemens Service with respect to questions regarding the return and disposal of batteries and accumulators.

2 Observe national regulations.

7 Appendix: regulatory information

7.1 Medical devices of other manufacturers

Please note that this manual may also contain information about medical devices that are NOT legally manufactured by Siemens. These medical devices are either only distributed by Siemens, or only mentioned for additional information.

In the following table you will find information about the medical device, the corresponding legal manufacturer and, if applicable, the authorized representative.

Product and CE	Legal manufacturer
Patient table CE	TRUMPF Medizin Systeme GmbH + Co.KG Carl-Zeiss-Str. 7-9 07318 Saalfeld, Germany www.trumpf-med.com
Respiration cushion, respiratory belt CE	Pi-Products GmbH Heinrich-Hertz-Straße 8a 92224 Amberg, Germany www.pi-products.de
Application cushion for PMU CE	Polyform GmbH & Co. KG Kunststofftechnik Braasstraße 15 DE-31737 Rinteln, Germany www.polyform.de

7.2 CE for Physiological Measurement Unit (PMU)

The PMU (PPU, PERU) bears a CE marking in accordance with the provisions of regulation 1999/5/EC of March 9, 1999 for radio and telecommunications terminal equipment.

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CE
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Manufacturer's note:

This device bears a CE mark in accordance with the provisions of Council Directive 93/42/EEC of June 14, 1993 concerning medical devices and the Council Directive 2011/65/EU of June 08, 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment.

The CE marking applies only to medical devices which have been put on the market according to the above-mentioned EC Directives. Unauthorized changes to this product are not covered by the CE mark and the related Declaration of Conformity.

Please note: For products that are not legally manufactured by Siemens but distributed, please refer to the Appendix of this manual!

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