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PREMIUM OPEN-BORE MRI SYSTEM
MRT-3010/A5

Vantage Titan™ 3T

Product Data
No. MPDMR0251EAA

APPLICATION

Toshiba is proud to announce the addition of the Vantage Titan 3T (MRT-3010/A5) to its MR product line. The Vantage Titan 3T combines the features of Atlas technology with Open-Bore technology, making patient comfort a priority. To offer an enhanced level of performance, we are crossing over to Toshiba's new 3T Conform Technology. Vantage Titan 3T features a patient aperture of 71 cm and Pianissimo™ noise reduction technology. It comes with a new, fully functional, state-of-the-art interface designed for ease of use.

ADVANTAGES

Open-bore 3T system: Applying a comfortable scanning space and uncompromised imaging
Featuring the industry's shortest magnet in the 3T class, the Vantage Titan 3T maintains Vantage Titan's 71-cm patient aperture and comes with Toshiba's proprietary noise-reduction technology Pianissimo. The Vantage Titan 3T system incorporates a Super Slim Gradient coil design and slim whole-body coil design without compromising image quality.

New Conform technology includes advances in Toshiba hardware technology
Toshiba's advanced Conform technology maintains a 71-cm open bore aperture without compromising image quality. Due to the new Multi-phase Transmission RF capability, it greatly improves homogeneity, optimizing image conditions.

Simple operation: User-friendly, fast, and convenient
In addition, Toshiba's Atlas SPEEDER™ parallel imaging technology offers outstanding diagnostic versatility with streamlined workflow. Setup and acquisition can be easily performed for all clinical studies. Moreover, the simplicity of Toshiba's new "M-Power" user interface increases the efficiency of the new Vantage Titan 3T.

COMPOSITION

Standard composition (Model: MRT-3010/A5)
- 3-tesla actively shielded magnet with an active shield gradient coil
- Patient couch
- Filter Cabinet
- Control cabinet and gradient power supply
- Refrigerator
- Console[1)]
  - Host CPU (with built-in terminal for external Ethernet connection)[2)]
  - Wide LCD color monitor
  - Keyboard and mouse
  - Control pad
  - Control box
  - Microphone
- RF cabinet with integrated array platform
- Transformer cabinet
- Fan box
- Software
  - System software (M-Power platform)
  - DICOM software (Standard)
    - · DICOM Basic License
    - · Storage SCU kit
    - · Print SCU kit
    - · DICOM Media kit
    - · MWM SCU kit

- Full set of accessories
  - Operation manual
  - Service manual
  - Phantom
  - Patient observation camera
  - Patient call system
  - Support devices for scanning (couchtop mats, wedge mats, pads, belts)
  - Intercom system
  - Safety training video
  - Warning plates
  - Oxygen monitor
  - Speaker × 2
  - Flow switch (for gradient coil)

Optional items

- SuperFASE package (MSSW-FASE/S1) [3)]
- MRA package (MSSW-MRA/S1) [3)]
- DRKS package (MSSW-DRKS/S1) [3)]
- EPI package (MSSW-EPI/S1) [3)]
- DTI package (MSSW-DTI/S1) [3)]
- JET™ package (MSSW-JET/S1)
- RF coils
  - Atlas SPEEDER Head (MJAH-142A/S1)
  - Atlas SPEEDER Spine (MJAS-152A/S1)
  - Atlas SPEEDER Body (MJAB-172A/S1)
  - Shoulder SPEEDER (MJAJ-172A/S1)
  - Wrist SPEEDER (MJAJ-162A)
  - ϕ100 Flex coil (MJLC-102F/S1) [4)]
  - ϕ150 Flex coil (MJLC-152F/S1) [5)]
  - QD head coil (MJQH-142A/S1)
  - Array electronics kit for 32ch (MKPA-GP3001/S1)
  - Coil holder for TMJ imaging (MJCA-147A/S1)
- Interactive cardiac gating unit (MKSU-ECGU04/S1)
- Waveform display kit (MKSU-LCDK01/S1)
- Peripheral gating package (MKSU-PPGK02/S1)
- Respiratory gating package (MKSU-RSPK03/S1)
- Additional patient CAMERA package (MMPM-GP3001/S1)
- High-active shim kit (MZKT-HOSK06/S1) [6)]
- DICOM software
  - Storage Commitment kit (MSSW-DCCOV/C1)
  - MPPS SCU (MSSW-DCPPU/C1)
  - Query & Retrieve SCP (MSSW-DCQRP/C1)
  - Query & Retrieve SCU (MSSW-DCQRU/C1)

1) The desk for the monitor, keyboard, and mouse is not included in the standard configuration.
2) The DVD-RAM disk drive is installed inside the CPU cabinet.
3) The requirements for each package are listed in the options list.
4) In the application for FDA approval, the coil name "Phi 100 Flex coil" is used.
5) In the application for FDA approval, the coil name "Phi 150 Flex coil" is used.
6) Factory option.

HARDWARE SPECIFICATIONS

Magnet

The Vantage Titan 3T uses the industry's shortest (1.6 m) self-shielded superconducting magnet. The system combines slim and compact design with a wide patient aperture of 71 cm.[1)] This minimizes patient anxiety, ensuring a comfortable examination environment for all patients.
Field strength: 3 T
Length: 163 cm

- Homogeneity (with passive shimming)
  - 1.4 ppm or less at 400 mm DSV
  - 4.0 ppm or less at FOV 50 cm × 50 cm × 45 cm
    24 plane plot method (24 points per plane)
- Shimming method
  - Passive shimming
    Homogeneity is optimized on site by the addition of ferromagnetic material inside the magnet bore during installation using a computerized procedure. This is a very stable optimization method that does not require regular maintenance.
    · AAS (Auto-Active Shimming): available
    When a patient is placed in the magnet, the patient's body will affect the magnetic field homogeneity. AAS adjusts the homogeneity to ensure the optimal field uniformity for each patient and/or pulse sequence such as FatSAT, PASTA, and EPI.
- Magnet mass (including 70% liquid helium):
  Approx. 6,375 kg or less
- Fringe field
  The magnet employs active shielding. The fringe field line at 0.5 mT (5 gauss) is at 2.6 m in radial distance and at 4.6 m in the axial direction from the center of the magnet. This permits flexibility in magnet siting.
- Stability of the magnetic field (bare magnet)
  The superconducting magnet provides an extremely stable magnetic field. Stability is 0.1 ppm/hr or better.
- Cryogen
  The high-performance refrigerator allows the magnet to be operated with zero helium boil-off.
- Operating panel on the magnet
  The operating panel supports the following operations to facilitate patient set-up and scanning: scan start, abort, and pause/resume, emergency table stop, laser light localizer ON/OFF, ventilation adjustment, lighting adjustment, and patient couch operation. The panel is also provided with a couch position display, interlock display, and system ready LED.

1) The diameter of the narrowest part of the patient bore is 69 cm.

RF coils (T: Transmit RF, R: Receive signals)

Atlas SPEEDER COMPASS can be used in systems in which an Atlas SPEEDER coil system is installed. This is an automatic receive coil setting function that determines the position of the connected Atlas SPEEDER coil and automatically turns ON the coil sections that are positioned near the magnetic field center. This function is useful for spine imaging and body imaging in which the coil sections to be selected differ depending on the coil setting and target region and for scanning in which data is acquired at multiple couchtop positions.

- Standard RF coils
  The Vantage Titan 3T features a full range of RF array coils to cover a wide range of clinical requirements.
  – QD whole-body coil (T/R)
    This coil is integrated into the magnet cover. It provides a uniform RF field with QD transmission and a high SNR with QD reception. The internal diameter of this coil is 69 cm.
- Optional RF coils
  – Atlas SPEEDER Head (R) (MJAH-142A/S1)
    16-element array design that is suitable for head and neck studies with optimal SNR.
  – Atlas SPEEDER Spine (R) (MJAS-152A/S1)
    40-element array design that is suitable for spine studies with optimal SNR. This integrated coil design features the unique ability to slide up to 380 mm to permit routine feet-first imaging of the lumbar and thoracic spine.
  – Atlas SPEEDER Body (R) (MJAB-172A/S1)
    16-element array design that is suitable for abdominal studies with optimal SNR.
  – Shoulder SPEEDER (R) (MJAJ-172A/S1)
    6-element array design that is suitable for shoulder studies with optimal SNR.
  – Wrist SPEEDER (R) (MJAJ-162A)
    This array coil permits up to 6 elements to be selected, providing an optimal SNR.
  – ϕ100 Flex coil (R) (MJLC-102F/S1)
    The diameter of the coil loop is 100 mm. The circular loop section is cushioned and flexible.
  – ϕ150 Flex coil (R) (MJLC-152F/S1)
    The diameter of the coil loop is 150 mm. The circular loop section is cushioned and flexible.
  – QD head coil (T/R) (MJQH-142A/S1)
    Provides a uniform RF field with QD transmission and optimizes SNR with QD reception. A detachable mirror is provided to minimize patient anxiety.

Controller

The controller features a wide LCD color monitor, permitting multiple windows to be clearly displayed for true multitasking operation. It is ergonomically designed to allow operation in both the standing and sitting positions by a single technician.

- Display monitor
  The controller features a high-resolution 24" LCD color monitor. The display matrix is 1,920 × 1,200 with 256 B/W gradation levels.
- Control pad and control box
  The following operations can be performed using the hardware controls at the console: power ON/OFF, emergency stop, scan start, scan abort, scan pause/resume, couchtop movement and intercom talk and volume.
- Mouse
  Optical two-button scroll mouse. All interfaces can be accessed by simple point-and-click operation except for registration of patient information and comments for image annotation.
- Keyboard
  The keyboard is used to register patient information and comments for image annotation.

Patient couch

The patient couch is ergonomically designed to maximize patient comfort as well as patient throughput. The couchtop can be lowered to 430 mm from the floor. The usable scanning range is 205 cm. Hydraulic drive ensures smooth and quiet vertical couchtop movement.
Maximum patient load: 200 kg

Computer system

The computer system is designed to provide outstanding multitasking performance, permitting image reconstruction and advanced image processing to be performed simultaneously with scanning. This helps to increase examination productivity. In addition, the computer system is provided with network connectivity for expandability.

- Host computer
  System manager (SM)
  CPU: Dual-core, Dual-CPU system (4 CPUs)
  Clock speed: 3.0 GHz or more
  Main memory capacity: 8 GB or more
  Hard disk drives: 2
  For system use: 146 GB (unformatted storage)
  For image data: 146 GB (unformatted storage)
  Image capacity: Approximately 560,000 images
  (256 × 256 images, raw data not saved)
- Hardware control system
  Real-time manager (RM)
  CPU: 32 bit
  Memory capacity: 32 MB
  System control method: Distributed control

- Reconstruction system
  Maximum reconstruction speed : 4,400 images/second or more (256 × 256, FFT, potential)
  CPU: Quad-core, Dual-CPU system (8 CPUs)
  Clock speed: 2.93 GHz or more
  Main memory capacity: 24 GB or more[1)]
  Hard disk drive capacity: 1.3 TB (RAID 10)
  Reconstruction matrix: 1,024 × 1,024 (maximum)
  Simultaneous image reconstruction during scanning: Possible
- DVD drive unit
  Storage capacity: 4.6 GB (unformatted, single-sided)
  9.2 GB (unformatted, double-sided)
  Saved image capacity: Approximately 44,000 images (256 × 256 images, raw data not saved)
- Connection with external devices
  Interface: Ethernet (100BASE-TX/1000BASE-T)
  DICOM 3.0

1) 48 GB (option)

RF system

The Vantage Titan 3T system has only one RF cabinet that houses three electronic systems, the digital RF system, and the RF power amplifier, which is a compact design with a water cooling system.

- Digital RF system 16
  The Digital RF system consists of a digital transmitter and wideband 16-channel [1)] analog/digital receivers supporting array acquisition. The digital transmitter provides the precise RF phase control needed to employ advanced pulse sequences. The high-frequency data sampling capability supports fast scan techniques.
- RF power amplifier
  An output rating of 36 kW [2)] ensures that the system can generate the short pulses required for advanced pulse sequences. To ensure patient safety, RF power is emitted only when the SAR calculated by the system is below a preset limit.

1): It can be upgraded to 32 channels without the need to add a new cabinet. (option)
2): Independent 2-channel output function, 18 kW each, maximum 36 kW.

Gradient subsystem

The combination of a powerful gradient power supply unit and a high-precision active shield gradient coil ensures stable image quality with all sequences, eliminating eddy currents.

	Vantage Titan 3T
Gradient strength:	30 mT/m
Slew rate:	203 mT/m/ms
Gradient duty cycle:	100%

Toshiba's innovative Pianissimo technology is a patented gradient acoustic noise reduction technology that dramatically reduces scanning noise.

Patient comfort and safety

- The industry's shortest open gantry (1.6-m magnet) with the large clinical FOV significantly reduces patient anxiety and ensures comfort during examination.
- Pianissimo
  Pianissimo technology dramatically reduces the level of acoustic gradient noise, thus substantially enhancing patient comfort, especially during scanning with fast sequences.
- Lighting/Ventilation of the patient bore
  Adjustable lighting/ventilation improves patient comfort in the magnet during scanning.
- SAR calculation
  The system always calculates SAR before scanning. If the calculation result indicates that the preset limit will be exceeded, scanning cannot be started.
- Patient call system
  The patient call system allows the patient to signal an emergency during scanning. The system includes a handswitch that is actuated by the patient.
- Intercom system
  The integrated intercom system allows two-way communication between the patient and the operator.
- Patient observation system
  A CCD camera is used to observe the patient during scanning.
- Oxygen monitor
  The oxygen monitor automatically activates the customer-supplied ventilation system if the oxygen level falls in the scan room.
- Emergency rundown unit
  This safety switch allows automatic ramp-down of the magnetic field in the event of an emergency.

PERFORMANCE SPECIFICATIONS

Acquisition parameters

The Vantage Titan 3T digital architecture offers extremely flexible acquisition parameters for optimizing image quality and scan times.

- Imaging method [1] : 2DFT and 3DFT
- Imaging nucleus: Proton (hydrogen nucleus)
- Slice orientations [1] : Axial, sagittal, coronal, oblique (single and double)

Refer to the scan parameter table.

Scan parameters [1] [2] [3]	Specifications	Note
FOV [mm]	5 to 500 [4]	Adjustable in increments of 1 mm.
Min. SliceThickness2D [mm]	0.5	Adjustable in increments of 0.1 mm.
Max. SliceThickneess2D [mm]	100	
Min. SliceThickness3D [mm]	0.05	Adjustable in increments of 0.1 mm.
Max. SliceThickness3D [mm]	50	
Min. ETS (Echo Train Spacing)		
EPI	0.4	
FSE	2.6	
Max. Matrix	1,024	Independently adjustable in 16 or 32 steps in both the frequency and phase encoding directions.
– Frequency encoding:	64 to 1,024	
– Phase encoding:	32 to 1,024	
Highest In-Plane Resolution [µm]	20	
Maximum number of slices (2D)	128	
Maximum number of slices (3D)	256	
Number of acquisitions (NAQ):		
– Integer NAQ:	From 1 to 64	Adjustable in increments of one (1, 2, 3, 4, 5, 6, and 7, etc.)
– Variable NAQ:	Available	Adjustable increments of 0.1 from NAQ=1 (NAQ = 1.1, 1.2, etc.)
– AFI (Advanced Fourier Imaging)	Available	Scan time reduced by approximately NAQ=0.5
TI (Inversion time):	10 ms to 10 s	
Flip angle:	1° to 180°	
Flop angle:	30° to 180°	

SPEEDER function

Speed-up factor: Max. 16X [5]

1) Specifications vary depending on the pulse sequence.
2) With optional MRA package.
3) With optional EPI package.
4) Depending on the application, the maximum FOV along the Z direction may be restricted to 450 mm.
5) The factor depends on the coil and the number of RF channels used.

Imaging techniques and parameters

A wide range of imaging techniques are provided to complement the Vantage Titan 3T's precise and powerful digital RF system, computer platform, and high-performance gradient subsystem.

- Conventional pulse sequences
  - SE (spin echo)
  - FE (field echo)
- Fast scan techniques
  - FastSE
    The flop angle for 180° RF pulses can be varied to reduce saturation transfer contrast (STC) effects and the specific absorption rate (SAR) to ensure patient safety. FastSE is compatible with both 2DFT and 3DFT. Flow compensation and presaturation are available.
  - FastIR
    An inversion pulse is added to the 2DFT FastSE technique to enhance T1 contrast. This results in a much shorter scan time than in conventional IR. Multislice is available.
  - FastFLAIR (fluid-attenuated IR)
    Increases contrast between fluids, such as CSF, and lesions to improve specificity using FastIR with a long TI, TE, and TR. This results in a much shorter scan time than in conventional IR. Multislice is available.
  - FastSTIR
    Suppresses fat signals using FastIR with a short TI. This results in a much shorter scan time than in conventional STIR. Multislice is available.
  - FastFE
    A pre-pulse is applied prior to FE pulse sequences to enhance T1 contrast with short scan times.
    Segmentation of scans is available to increase spatial resolution.
    FastFE is applicable to both 2DFT and 3DFT.
- Advanced fast scan techniques
  - FASE (fast advanced spin echo)
    This pulse sequence, which is based on FastSE with a large number of echoes (max. 276 ETL), is combined with advanced Fourier imaging (AFI) to reduce the scan time significantly with an echo factor of 512 (scan time reduction factor) in the standard configuration or 1,024 with optional software. A single shot is sufficient to generate an image in a few seconds. A pre-pulse is available for fat suppression. This technique is compatible with both 2DFT and 3DFT.
    T2-weighted images with short scan times can be used to clearly depict the gallbladder, hepatic ducts, and pancreatic duct without contrast agent. FASE expands the range of clinical applications of MRI, supporting magnetic resonance cholangiopancreatography (MRCP), MR urography, and MR myelography.
  - The optional SuperFASE package supports an expanded range of clinical applications such as fresh blood imaging (FBI) or swap phase encode extended data acquisition (SPEED).
  - Multi-Shot EPI
    Utilizes gradient echoes for EPI, which are divided by up to 15 echo factors for one acquisition. Multislice is available.
  - Single-Shot EPI
    Both SE type and FE type are available. FE-type Single-Shot EPI requires the optional EPI package.
  - TrueSSFP*
    T2-/T1-contrast images can be obtained quickly using the steady-state free precession technique. This is suitable for scanning relatively longer T2 tissues and vascular structures during breath-holding. Fat saturation is possible by dividing scans into multiple segments.
  - FSE/FASE T2 Plus*
    By promoting transverse magnetization recovery in FSE and FSE 2D, the scan time can be reduced and the resolution can be increased with no loss of T2 contrast and SNR.
  - SSFP*
    T2-/T1-contrast images can be obtained quickly using the steady-state free precession technique. This is suitable for imaging relatively longer T2 tissues such as CSF and synovial fluid. The slice thickness can be reduced by 3DFT scanning.
- Vascular imaging techniques
  - 2D-TOF (time of flight)
    The time of flight effect is induced by the in-flow of fresh spins into the imaging slice to differentiate blood flow from tissue. Slices are acquired sequentially through the imaging volume. This technique functions optimally when the vessels are perpendicular to the acquired slices. It depicts relatively slower blood flow and is suitable for cervical, abdominal, and extremity applications. Maximum intensity projection (MIP) images can be displayed from multiple viewing angles. An overlapping scanning technique improves the visualization of vessels. A moving presaturation band can also be applied to differentiate between arterial and venous flow in certain body areas. ECG gating is applicable for 2D-TOF*.
  - 3D-TOF (time of flight)
    3DFT with TOF is used to depict multidirectional vascular structures and faster blood flow. MIP images can be displayed from multiple viewing angles. SORS-STC and ISCE RF pulses can be combined with 3D-TOF to improve vessel detail.
  - 3D-CE (contrast enhanced [5])
    Contrast agent is injected in order to enhance blood signals, followed by a 3D-FE or 3D-FastFE sequence.

5) Disclaimer: In the USA, the FDA limits the use of contrast agents to certain applications.

* option

– SORS-STC (slice-selective off-resonance sinc pulse saturation transfer contrast)
Enhances blood flow and suppresses background signals by using a slice-selective off-resonance pulse.
– ISCE (inclined slab for contrast enhancement)
Provides increased vessel detail by using an RF pulse with a different flip angle in combination with 3D-TOF to enhance signals from blood flow throughout the imaging volume.
– Multi coverage
Separates the data acquisition area of 3D TOF MRA into a few regions in order to limit signal reduction due to saturation effects.
– 2D-PS (phase shift)
The phase shift effect is generated by applying a flow encoding gradient pulse. The phase shift is proportional to the flow velocity. 2D-PS can be used with a volume slice to increase coverage of vessels and shorten scan times. Selecting the flow velocity allows specific vessels to be depicted.
– Cine 2D-PS (phase shift)
2D-PS can be used with an optional cardiac-gating unit for cine imaging.
– Flow Quantification
Blood flow velocity can be measured using cine 2D-PS with an optional cardiac-gating unit.
– 3D-PS (phase shift)
The phase shift effect, when used with 3DFT, is suitable for showing multidirectional vascular structures.
Selecting the flow velocity allows specific vessels to be visualized. MIP images can be displayed from multiple viewing angles.
– BEST (blood vessel enhancement by selective suppression technique)
A postprocessing algorithm that selectively enhances small vessel detail and suppresses background tissue signals.
– Cardiac tagging*
Allows myocardial movement to be visualized by applying several presaturation bands. Optional ECG gating is required. The number and positions of tags can be selected.

• Fat suppression techniques
The Vantage Titan 3T includes a comprehensive selection of fat suppression techniques to support a wide range of applications.
– STIR (short TI inversion recovery)
A short TI 180° pre-pulse with IR suppresses fat signals to enhance water-proton images.
· FastSE, FASE: available
– WFOP (water/fat opposed phase)
An asymmetric SE technique in which image acquisition is performed at the instant. The signals from water and fat go out of phase.
– FatSAT (fat saturation)
Fat saturation pulses are applied to presaturate fat only. The multislice off-resonance fat suppression technique (MSOFT), an innovative Toshiba technology, ensures uniform fat suppression over all slices by using an offset RF pulse for each slice. Offset values are determined based on data acquired by auto-active shimming.
– PASTA (polarity altered spectral and spatial selective acquisition)
Another innovative technique for suppressing fat signals in SE sequences to obtain uniform water images over all slices. It consists of a narrow-bandwidth 90° RF pulse to separate water from fat. Opposing slice gradient polarity is used for 90° and 180° RF pulses to refocus water signals.
– SPAIR (Spectral Attenuated Inversion Recovery)
A 180° adiabatic pulse is used to invert the fat signals inside the imaging plane uniformly regardless of B1 inhomogeneity and imaging is started at the null point of fat after TI in order to obtain fat-suppressed images with minimal fat suppression nonuniformity.
– Enhanced Fat Free
Multiple fat suppression pulses are applied in order to obtain a more stable fat suppression effect.

• Imaging modes
– Multislice
Multiple slices can be acquired during a scan.
– Multi-echo
Multiple echo data can be acquired within a single TR.
– Multi-coverage
If the specified number of slices cannot be acquired within the designated TR, the system automatically repeats the scan to cover the required area.
– Interleaved scan
Excites odd slices first and even slices second to eliminate interslice interference.
– Excitation order for multislice
The user can select the order of excitation in multislices as follows.
· Forward (from small to large numbers)
· Reverse (from large to small numbers)
· Concentric (from center to outside)
– Dynamic scan
Sets up to five continuous dynamic scans in one study. Each dynamic scan is specified independently according to the delay time, scan interval, and number of scans. The minimum scan interval is zero.
– Gating
· Cardiac gating
Multislice/single-phase and single-slice/multiphase imaging techniques are available. Cardiac images can be displayed in cine mode.
· Peripheral pulse gating*
Reduces CSF pulsation artifacts.
· Respiratory gating*
Reduces respiratory motion artifacts.

* option

- Artifact suppression techniques
  - Flow compensation
    Utilizes gradient moment nulling techniques to reduce flow artifacts.
  - Presaturation
    Up to seven presaturation bands can be set to reduce motion, flow, and wrap-around artifacts. The Vantage Titan 3T's graphical user interface allows multiple bands in the orthogonal and oblique directions to be set with ease. The following preset presaturation bands are available.
    · Anti-phase aliasing
    · Anti-frequency aliasing
    · Flow suppression
    · Leading or following slices (for 2D-TOF)
  - Skipping SAT*
    Reduces the number of presaturation pulses in order to increase the number of slices.
  - No wrap (frequency and phase directions)
    Eliminates wrap-around artifacts by increasing the sampling data points in frequency or encoding steps in phase. The no wrap function is applicable up to a 512 × 512 matrix with 3DFT.
  - Phase swap
    The phase and frequency encoding directions can be swapped to minimize flow and respiratory motion artifacts.
  - Breath-hold imaging
    An optional Auto-Voice function instructs patients when to hold their breath.
- JET technique
  JET acquires the data for the k-space in non-cartesian mode and suppresses motion artifacts by detecting and correcting for in-plane motion using the data for the central part of the k-space, which is acquired repeatedly. This application can suppress not only image artifacts in patients who are unable to remain still during scanning, but also artifacts due to involuntary motion such as CSF flow. This technique is based on FastSE 2D, and uses T2W and FLAIR contrast enhancement.

User interface

Vantage Titan 3T employs a new platform to provide user-friendly operability. The user interface is designed for intuitive operation, enabling even those with less experience to operate the system without difficulty. The interface has been created in accordance with the "universal design" concept, with the aim of reducing stress on the operator. This operability is implemented as a common standard among Toshiba medical systems. Vantage Titan 3T also employs a new image processing engine, which provides three-dimensional image processing and color fusion processing, as well as flexible support for clinical application software.

- Basic operations
  - System startup
    · System startup is possible.
    · The initial screen is displayed.
    · The system status can be checked at the time of system startup. If the system status is determined to be abnormal, data acquisition is disabled or the system is shut down.
    · The system check is executed at the time of system startup. If an abnormality is detected, system operation is disabled.
    · Registration and control of authorized users is possible.
  - Page control
    · A processing switching function that allows multiple processing tasks to be performed simultaneously is provided.
    · Display of errors and warnings is possible.
  - System shutdown
    · System shutdown is possible.
- Patient scheduling and registration
  Patient information and scanning conditions for examinations can be scheduled and registered. The scanning conditions can be registered simply by selecting a set of conditions preregistered in the database for individual anatomies (PAS function).
  - Patient Registration

· Scheduling and registration items:	Patient ID, patient name, weight, sex, birth date (automatic age calculation), date of scanning (selection from calendar is possible), time of scanning, ordering department, name of ordering physician, name of radiologist, name of radiographic technologist
· Search function:	Provided (patient name, date and time of scanning, etc.)
· Sorting function:	Provided (by patient name, by date and time of scanning, etc.)
· DICOM MWM:	IHE is supported as the standard.
– Scanning condition selection and registration:	PAS (Programmable Anatomical Scan)
· Preset items:	PAS name (name of a set of scans) Scanning region (graphic icon) Type of RF coil Scan name (names of individual scans) Scanning conditions (imaging parameters), etc.
· Customization function:	Provided Automatic sample image registration is possible.

* option

• Scanning
A pilot scan (initial scan) is performed, scans are planned using the acquired data, and the scans are run. Progress of the scans is controlled using the scan list displayed in the Sequence Queue window.
– Sequence Queue operations
· Queuing: Scans can be copied, added, or deleted, and acquisition order can be changed.
· Scan start control:
Auto: Multiple specified scans can be run in succession automatically.
Breath hold: Each scan is started by pressing the Scan Start button. Combination with the AutoVoice function is possible.
Pause/resume function, abort function
· Automatic couchtop movement: Possible
– Pilot scan
· Prescan: Automatic (manual control is possible for some types of prescan)
· Simultaneous multiplane scan: Maximum three planes (axial, sagittal, coronal) Combination with multislice scan is possible.
– Scan planning
· Multiplane scan planning: Three-plane scan planning is possible.
· Image switching during planning: Possible
· Oblique plan: Possible (sequential, multiangle)
· Graphical plan: Plan items Slice position and angle, slice thickness, slice gap, FOV, phase encode direction/readout direction, presaturation area, etc.
· Multiple scan planning: Possible (multiple scans can be planned during scanning)
· Plan duplication: A set of planned scanning conditions can be applied to the other scan by a simple operation (scan plan condition history function).
· Scan condition editing: Possible
– Scanning
· Safety functions: SAR limitation function, dB/dt limitation function
· Wide-area scanning function: The center of the target region can be moved to the magnetic field center automatically for each scan.
· Move couch function: The couchtop can be moved so that the slice center is positioned at the magnetic field center.
· Remaining scan time display function: Provided
· SAR display: The estimated SAR value is displayed before scanning and the actual SAR value is displayed after scanning.
· Gating signal display: The ECG gating, peripheral pulse gating, and respiratory gating waveforms can be displayed.
– Reconstruction and AutoView
· AutoView function: Provided (all images are displayed in the Image Matrix)
· Auto windowing function: Provided
· Automatic postprocessing: Automatic dynamic subtraction (absolute value) Possible
Automatic dynamic subtraction (complex value) Possible
Automatic MIP preview (three directions) Possible
· Automatic Diffusion postprocessing: ADC image, Isotropic image

• Image display and processing
Images acquired in scanning are displayed, various processing is applied to these images as required, and the images are printed onto film. Image Matrix, which displays thumbnails of actually acquired images, allows the user to quickly search for and select the desired images. A variety of image processing functions are provided to serve different purposes. The excellent parallel processing capability of Vantage Titan 3T allows image processing to be performed in parallel with scanning. In addition, a Direct Filming function is provided, in which the entire image window can be displayed as a film sheet.
– Image display
· Image selection: Selection from Image Matrix Skipped selection function is provided.
· Display template: Multiframe display is possible. Images for two different patients can be displayed simultaneously in separate frames.
· Automatic display function: Provided (multiple images selected in the Image Matrix are displayed in sequence)
· Window adjustment: WW/WL adjustment by mouse operation
Auto windowing: Possible
Apply Contrast function: Provided

- · Image-related information: Patient information, imaging parameters, RF coil type, etc. Graphics & annotation function is provided. Image-related information display ON/OFF is possible.
- · Reference display: All positioning ROIs can be displayed on the image used for scan planning. ROI corresponding to an arbitrary image slice can be displayed on an arbitrary image.
- · Inset display: Possible
  - Size change: Possible in three levels
  - Display position selection: Possible
- · Cine display: Possible. Multiframe display is possible. Playback/switching speed can be changed. Storage of moving images is possible.
- · Various display functions: Black/white reversal, rotation, flipping, grid, zooming (interactive enlargement and reduction), scrolling (interactive scroll), Apply View function

– ROI calculation
- · Calculation functions: Distance, angle, area, pixel value, profile, histogram

– Image processing
- · Gain algorithm: New denoising algorithm can be used.
- · Image filters: Smoothing, edge enhancement, etc.
- · MIP: Maximum intensity projection, minimum intensity projection
  - Projection direction: Specified using ROI (specification of multiple projection directions is possible)
  - Processing time: Approx. 1 s/projection (original image: 256 × 256 × 64) (Processing time may be longer depending on the workload of the processing that is running in parallel.)
  - Target MIP: MIP target region can be specified in three directions. Shape: Circle, ellipse, rectangle, polygon
  - Composite MIP*
- · MPR: Interactive MPR, batch MPR. Double oblique and curved surface reconstruction are possible. Slice thickness change function is provided. Image storage function is provided.
- · Image calculation: Addition, subtraction, multiplication, division, and other functions. Automatic dynamic subtraction: Subtraction image is generated automatically after dynamic scan.
- · Intensity correction: Provided as standard.
- · Distortion correction: Provided as standard.

– Filming
- · Virtual filming: The dedicated Virtual film window is provided.
- · Support of multiple imagers: Possible

• Data management

Patient data and image data are stored on magnetic disk or magneto-optical disks. Image data is transferred over the hospital network as required.
- – Temporary storage of patient data: Magnetic disk
- – Long-term storage of patient data: DVD-RAM disk
- – Patient data search: Possible
- – Network transfer of images
  - · Support of DICOM 3.0: Support of Storage SCU, Enhanced MR (volume data), Print SCU, MWM, and DICOM Media are provided as standard. Two more DICOM service classes are available (support of DICOM 3.0).
  - – Support of HIPAA: Provided as standard. The requirements of Health Insurance Portability and Accountability Act are met.
  - – Support of IHE: Provided as standard. Support of SWF, CPI, PGP, CHG, PIR, PDI, and CT are provided. (IHE: Integrating the Healthcare Enterprise, an activity aiming to establish of intersystem connectivity)

• Utilities
- – LHe level indication: The LHe level data is read from the supervisory unit. Logging is possible.
- – Quality control: Daily QA. Logging is possible.
- – Errors: Logging is possible.

* option

Image processing

The Vantage Titan 3T's platform supports a wide range of high-speed image processing capabilities.

- Reconstruction
  The maximum reconstruction matrix is 1,024 x 1,024.
  – FINE
    Doubles the reconstruction matrix to improve spatial resolution without increasing scan times.
  – Mid-Slice
    Doubles the number of slices for the same slice thickness. The slice position is shifted by one half the slice thickness to avoid partial volume effects.
  – Refine filter
    User-selectable reconstruction filter to enhance image quality.
- Batch multiplanar reconstruction
  Provides oblique and curved reconstruction as well as interactive MPR.
- Batch MIP (maximum/minimum intensity projection)
  Projects maximum or minimum pixel intensity in a volume data set to provide comprehensive anatomical detail. It can be used for vascular imaging, MRCP, etc. Batch MIP is performed with true multitasking and can be processed during subsequent scanning. An independent workstation is not required. One projection is calculated within 1 s for a 256 × 256 × 64 data set. Fine MIP (using an original image with a matrix size up to 512 × 512) and target MIP are available. Optional software provides further enhancement with the STAMD method and Composite MIP.

Networking

- DICOM 3.0
  The Vantage Titan 3T supports DICOM 3.0 for transferring image data over networks.
  The system is provided with the DICOM Basic license, Print SCU, Storage SCU, MWM SCU kit, and DICOM Media as standard. In addition, Storage Commitment and MPPS SCU are available as options.
  IHE profiles are supported.
- Laser camera
  Specified laser cameras can be connected by Ethernet using the Toshiba digital protocol based on the ACR/NEMA standard. DICOM Print is also available.

SPECIFICATIONS OF CLINICAL APPLICATIONS

TOF MRA method

Blood vessels can be visualized without contrast medium using the time of flight effect.

- 2D TOF method
- 2DFT method
  – Artery/vein simultaneous acquisition: Available
  – Artery/vein separate: MovingSAT available
  – Fat saturation method: Can be used in combination
  – Presaturation method: Can be used in combination
  – QuietScan: Standard
- 3D TOF method
  Fat saturation method: Can be used in combination
  Presaturation method: Can be used in combination
  QuietScan: Standard
  – Multicoverage method
    This is a wide-range imaging method taking advantage of the TOF effect using a thin slab.
    · Coverage joint suppression method: Available
  – SORS-STC method:
    The imaging capabilities for blood vessels are improved by selectively suppressing the signals from tissues.
    · Flip angle of SORS-STC pulse: Variable
  – ISCE method
    Degradation in peripheral blood vessel images is suppressed.
    · Selection of flip angle distribution in slab: Available
    · Combined use of SORS-STC method: Available (inclined slab for contrast enhancement)

Contrast-enhanced MRA

Blood vessels can be visualized at high temporal resolution with a short TR/TE using contrast medium.

- Dynamic scan
  Scanning is performed automatically according to the specified time sequence.
  – Application: FE (2DFT/3DFT), FastFE (2DFT/3DFT)
  – FastFE data acquisition method:
    2DFT Interleave, Sequential
    3DFT Interleave, Slice Centric, Sequential, Swirl, Reverse Centric
- Dynamic subtraction
  Subtraction images between the image in the specified base phase and subsequent images are generated.
  – Automatic processing after dynamic scan: Available (absolute and complex)
- VisualPrep method
  Data acquisition, image reconstruction, and display are performed repeatedly for the same plane.
  – Fat suppression: Can be used in combination
  – Complex subtraction: Available

• MovingBed
The couchtop is moved between scans to allow a wide range of the patient to be acquired.
– Specification of couchtop movement distance: Available

Noncontrast MRA* by the FASE method

• FBI (fresh blood imaging) method
This is a vascular imaging method in which new blood ejected from the heart is visualized by setting an appropriate delay time from the R wave using ECG gating and peripheral pulse gating and performing data acquisition synchronized for each shot.
– ECG-Prep method
ECG-gated scanning or peripheral-pulse-gated scanning is performed with multiple delay times set in order to acquire images of the same plane in different cardiac phases so that the optimal delay time for visualizing the target vessels in FBI can be determined.
– Intermittent breath-hold method in ECG-gated scanning
ECG-gated scanning is performed during breath-holding, with the patient permitted to breathe at regular intervals corresponding to a certain number of slice-encoding steps.
– Sequential FASE method
Images for different slices are acquired sequentially to provide multislice images in the same cardiac phase.
– FlowSpoiled FBI method
The optimal dephase pulse is applied in the readout direction in order to permit the arteries and veins to be visualized separately for low-velocity blood vessels such as peripheral vessels and collateral vessels, which is difficult with standard FBI.

• SPEED (swap phase encode extended data) method
Blood vessels that run through multiple orientations are observed on one image by acquiring two images in which the phase encode direction is rotated by 90° and superimposing them using composite MIP processing.
– Automatic composite MIP

• Time-SLIP
The inversion pulse is applied space-selectively and after an appropriate wait time to permit the blood or cerebrospinal fluid flowing into or out of the slice to be visualized. This method can be used in combination with FASE or TrueSSFP.

PS MRA method

The PS (phase shift) method performs visualization based on the phase differences between moving parts and stationary parts.

• 2D PS method:
Visualizes the blood vessels in a short time.
– Scan cross section: Three orthogonal planes

• 3D PS method:
Covers the slice range continuously without slice gaps.
– Scan cross section: Three orthogonal planes

Diffusion Imaging

Isotropic diffusion-weighted images and ADC images can be obtained using the EPI.

• EPI Diffusion
– Single-Shot EPI: Available
– Three-axis continuous acquisition: Available*

• Diffusion postprocessing*
– Diffusion ADC image (apparent diffusion coefficient image)
– Diffusion isotropic image (isotropic diffusion-weighted image)
– Dynamic averaging function: Available
– Automatic postprocessing: Available (ADC, isotropic)

Diffusion Tensor Imaging (DTI)*

Continuous white matter tracts running in various directions in the head can be visualized using the EPI method.

• EPI Diffusion
– Single-Shot EPI: Available

• Diffusion postprocessing
– Fractional anisotropy image (indicating the degree of diffusion anisotropy)
– Lambda image (characteristic value image)
– Lambda image (vector image of characteristic value)
– Dynamic Averaging: Available

Perfusion Imaging

Various types of perfusion imaging are supported.

• EPI Perfusion
– Single-Shot EPI: Available

• ASL (Arterial Spin Labeling)
The ASTAR method is used to cancel out the MTC effect by setting the IR pulse application position for the control image and that for the tag image asymmetrically with respect to the imaging slice, while the blood flow signal on one side of the imaging slice is suppressed. As a result, images in which the MR signals from stationary tissues are suppressed can be obtained.
(ASTAR: Modified Signal Targeting Alternating Radiofrequency using Asymmetric Inversion Slabs)
(MTC: Magnetization Transfer Contrast)
– Control IR position: Variable
– Tag IR position: Variable
– Tag IT thickness: Variable

Cardiac Imaging

Various types of cardiac imaging can be performed by the combined use of the ECG-gating method.

• Cine imaging
Cardiac cine imaging can be performed during breath-holding.
– Application: FE method (2DFT method), FastFE method (2DFT method)
– Sequential multislice multiphase

* option

– ECG-gating
  · Prospective
  · ViewShare reconstruction: Available
– Tagging scan: Freehand setting of the tag thickness is possible.
  Setting of the parallel tag pitch is possible.
  The number of tags and tag angles for radial tagging can be specified.

• BB (black blood) method
  Images in which the MR signals from blood flow are suppressed can be obtained.
  – Application: FASE method (2DFT method)
  – Sequential multislice
  – Number of slices per breath-hold can be specified.
  – The BB pulse application time can be changed sequentially.
  – Fat saturation pulse can be used in combination.
• Delayed enhancement*
  – A T1-weighted image obtained using the inversion recovery method
  – Application: FastFE method (2DFT/3DFT method)

INSTALLATION CONDITIONS

Power requirements

A continuous and stable power supply is required for reliable operation of the system. Frequent power failures may damage the system. The power line shall be free of rapid variations and must not be shared by other equipment.

Line voltage [1)]	400 V
Phase	Three-phase
Voltage fluctuation	+6%/-10%
Frequency	50/60 Hz ±1%
Power requirements [2)]	90 kVA

1) 200 V may be supported with the use of an additional step-up transformer. Please consult with your local Toshiba representative and refer to the site planning manual for details.
2) An additional 40-50 kVA is required for the water cooling system.
   Continuous power (day and night) is required for some equipment.

Grounding

Independent grounding is required. Grounding must be provided in accordance with all applicable legal requirements for medically used electrical equipment.

Power consumption and heat dissipation (50/60 Hz)

Power consumption	70.5/71.4 kW
System heat dissipation	18.2/18.4 kW

Note: The heat dissipation value does not include the external heat exchanger.

Air conditioning

An appropriate air conditioning system is required to maintain the specified temperature and humidity. Continuous air conditioning (day and night) is required for some equipment.

Environmental requirements

• Temperature and humidity: No condensation
  – Scan room: 16°C to 24°C, 40% to 60% R.H.
  – Operator's room: 16°C to 30°C, 40% to 75% R.H.
  – Computer room: 20°C to 24°C, 40% to 70% R.H.
• Temperature fluctuation: -3°C/8 hr or less
• Magnetic field: Less than 1.0 μT peak-to-peak
• Electric field: Less than - 5 dB μV/m (0.56 μV/m) over 123.1 MHz +/- 0.5 MHz
  An RF shield room with more than 90-dB shielding is required.*1

*1 For other frequencies under 1 GHz, an RF shield room with more than 40-dB shielding is required.

• Ventilation: 30 m^3/min or more for the scan room
• Ventilation pipe: A ventilation pipe must be provided in the scan room for emergency quenching of the magnet.
• Rigging clearance: 2.2 m (W) × 2.7 m (H) or more
• Minimum installation area: 57 m^2 (Net 34 m^2)
  – Scan room: 7.0 m × 4.4 m = 30.8 m^2
  – Operator's room: 4.6 m × 2.4 m = 11.0 m^2
  – Computer room: 5.8 m × 2.6 m = 15.0 m^2
• Ceiling height: 2.8 m for the scan room, except for the maintenance space for the refrigerator (2.8 m)
• Maximum floor loading: 8.2 tons for the scan room
• Installation altitude: Less than 2,000 m above sea level
• Cooling water
  – Flow rate: 85 L/min or more
  – Temperature: 18°C to 22°C

* option

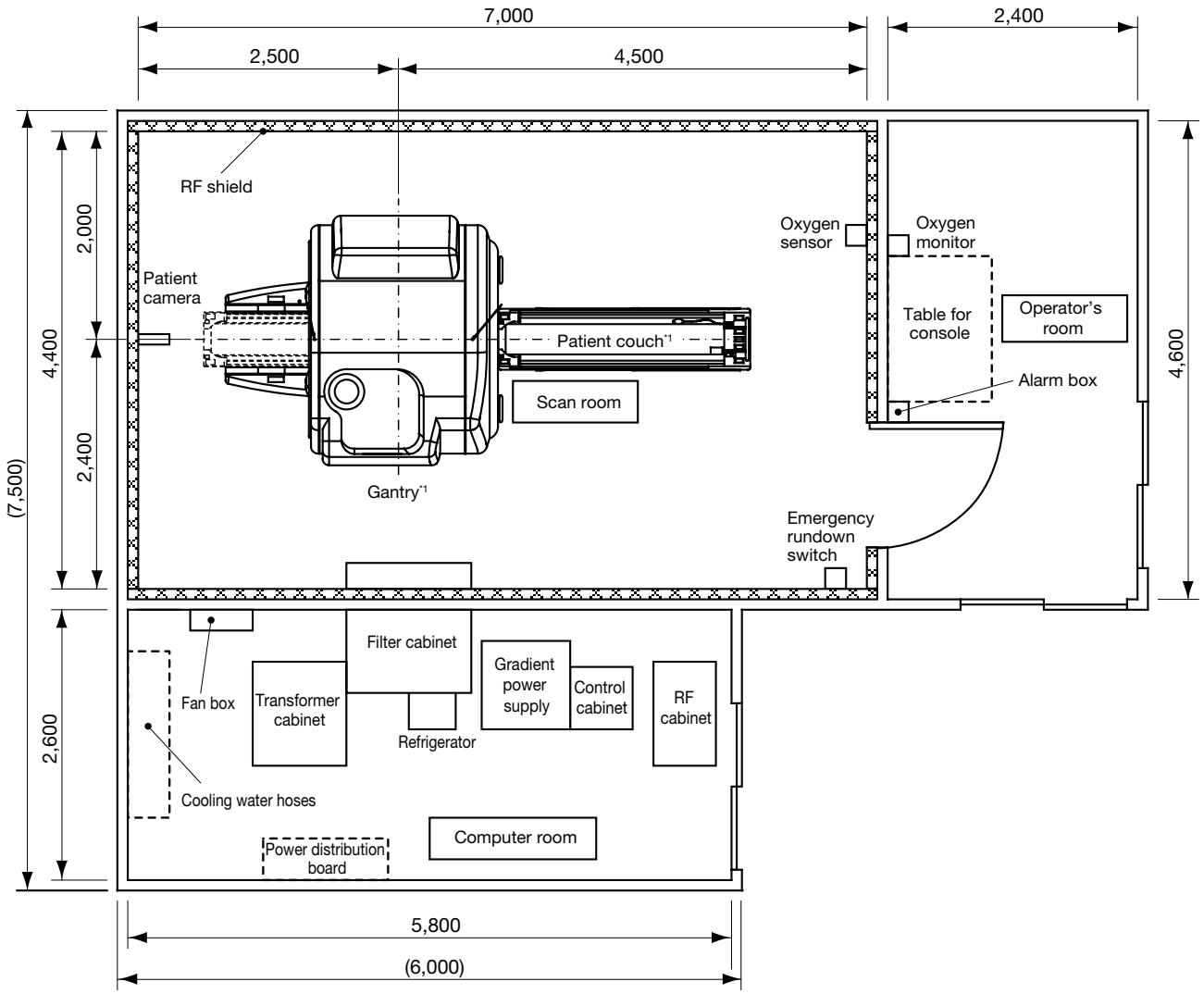
COMPATIBILITY WITH INTERNATIONAL STANDARDS

IEC60601-1: 1988 + Amd.1: 1991 + Amd.2: 1995
IEC60601-1-1: 2000
IEC60601-1-2: 2001 + Amd.1: 2004
IEC60601-1-4: 1996 + Amd.1: 1999
IEC60601-1-6: 2004
IEC60601-1-8: 2006
IEC60601-2-33: 2002 + Amd.1: 2005 + Amd.2: 2007
IEC60825-1: 2007
IEC62304: 2006
IEC62366: 2007

DIMENSIONS AND MASS

Unit	Dimensions W × D × H mm	Mass kg
Magnet assembly	2,400 × 2,620 × 2,280	7,800
Entire bore length (including covers)	1,818	
Patient bore length	1,619	
Couch	615 × 2,420 × 430 to 845	330
Filter cabinet	1,160 × 1,000 × 1,760	190
Controller		
CPU cabinet	215 × 655 × 435	25
Monitor	571 × 230 × 480	12
Control box	280 × 310 × 85	4
Control pad	130 × 145 × 75	0.3
RF cabinet	615 × 960 × 1,890	575
Gradient power supply and control cabinet	1,210 × 650 × 1,900	950
Refrigerator	450 × 450 × 600	90
Transformer cabinet	690 × 750 × 1,090	260
Accessory		490

LAYOUT EXAMPLE



*1: Applicable for use in the patient environment

Unit: mm

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Toshiba Medical Systems Corporation meets internationally recognized standards for Quality Management System ISO 9001, ISO 13485.

Toshiba Medical Systems Corporation Nasu Operations meets the Environmental Management System standard, ISO 14001.

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