GE Healthcare

Optima™ CT660
Product Description march2010

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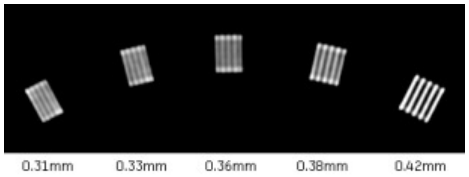
Primary Benefits

Innovation in Image Quality and Dose Optimization

40mm-sub-Millimeter Imaging:

Routine use of sub-millimeter slices without coverage compromise can be achieved.

Isotropic 0.35mm microvoxel enables multiplaner equivalent IQ in all plans compared to non-isotropic microvoxels.



Example of 0.35mm resolution with CATPHAN™ Phantom

0.625mm FWHM at Helical:

GE's exclusive helical reconstruction technologies, crossbeam correction, conjugate ray interpolation and hyper plane helical reconstruction with alpha smoothing method, allow "Scan Thin 0.625mm, and Recon Thin 0.625mm".

IQ Enhance

Up to 90% helical pitch acceleration which can provide higher helical pitch at same IQ level (based on artifact index).

Use of IQ enhance (IQE) allows faster pitch scanning covering more anatomy at same image quality. This scan coverage is equivalent to that of wider detectors (120 slice equivalent: 0.625mm*120 slice equivalent) at same table speed. (Equivalent IQ means equivalent helical artifact level)

Neuro 3D filter

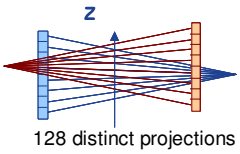
Up to 20% IQ improvement or Up to 36% Dose reduction for same IQ level (based on image noise SD).

Volara™ XT Digital Data Acquisition System (DAS):

Volara XT enables true 64-slice acquisition with an 8-to-1 miniaturization of conventional multi-slice technology, and a dramatic reduction in electronic noise for improved image quality at low dose and is capable of faster sampling rates.

Conjugate Cone-Beam Back Projection

Utilizes 2 sets of counter-opposed projections to provide 128 distinct projection measurements per rotation for axial and a helical acquisition mode.



3D Dose Modulation utilizing SmartmA™ and AutomA

Before the scan, operator can select the desired Noise/IQ: CT then tailored automatically exposure parameters, patient to patient and real time X-Y-Z during each scan. 3D mA modulation reduces dose up to 40% compared with fixed mA.

Short geometry design:

If distance from iso center to detector is same, the "Short Geometry Design" makes Optima™ CT660 72kW generator power can be equivalent to 89kW relative to conventional long geometry scanners.

Outstanding Optima™ CT660 Workflow

Xtream Display:

Xtream Display is multi purpose LCD display.

Xtream Display can show basic patient information on monitor on Gantry, and user can confirm patient information in scan room improving workflow and reduces the opportunity for error.

Xtream Display provides workflow improvement by preset positioning (Default patient positioning) on new gantry display.

Xtream Display has Movie function that user can explain CT examination for patients, and make patients to concentrate on CT examination before scanning.

Asterisk*: Option

Emergency patient mode:

Optima™ CT660 series has dedicated UIF for emergency cases to start examination quickly.

Xtream Injector*:

Provides one handed synchronized start of the scan and injection from the CT Operators console or from the scan room providing consistent simultaneous start of contract injection and scan acquisition protocols.

Optima™ CT660 ecomagination claims

Optima™ CT660 was designed as green product and was recognized officially as ecomagination product in GE.

Claim1: Energy saving

With its Energy Saving Mode activated, GE's Optima™ CT660 Series scanner is designed to reduce electricity consumption for operation and ambient cooling by more than 33,000kWh per machine annually, a energy savings of more than 60% compared to prior GE technology.

Claim2: CO2 reduction

With its Energy Saving Mode activated, GE's Optima™ CT660 Series scanner is designed to reduce electricity consumption for operation and ambient cooling by more than 33,000kWh per machine annually, a CO2 savings of more than 60% compared to prior GE technology.

-Avoid 20 metric tons of CO2 emissions per year on the U.S.
-Avoid 14 metric tons of CO2 emissions per year on the Japan.
-Avoid 15 metric tons of CO2 emissions per year on the UK.

Claim3: Short foot print design

Because of its smaller footprint, GE's Optima™ CT660 Series scanner reduces siting requirements by 2.8 - 4.6 m2 per machine, or 12 - 24%, compared to prior GE technology.

Optima™ CT660 Increased Coverage

Volume Shuttle™*:

Optima CT660 provides the single-injection 80mm (2* wider coverage, 128 slice-width) Volume Shuttle acquisition scan.

Volume Shuttle is a repetitive axial scan mode where the table shuttles back and forth between two consecutive imaging locations (X-ray is off during table movement). Each location covers 40 mm in the Z-direction for a total of 80 mm of axial coverage in Z. The shuttle action repeats over a defined duration to enable evaluation of tissue changes over time.

Volume Shuttle is available for 500 pounds table only.

Asterisk*: Option

Volume Helical Shuttle*:

Volume Helical Shuttle covers up to 312.5mm or 500 slices (0.625mm*500slice) for 4D imaging.

Volume Helical Shuttle provides data to support up to 120mm of coverage repeatability within 3.2sec.

Dynamic Pitch Reconstruction extends z-coverage and improves temporal sampling by utilizing acquired scan data during table acceleration and de-acceleration.

Volume Helical Shuttle is available for 500 pounds table only.

Optima™ CT660 Cardiac capability

5-Beat Cardiac™*:

Optima CT660™ have the ability to cover the heart in 5 beats
The following calculation is based on a patient heart rate of 60bpm, and a total coverage of 120mm (nominal scan length to cover the heart). Using a helical pitch of 0.22:1 and a rotation speed of 0.35s/rotation, the table speed in mm/s is given by:

$$Table_Speed = \frac{0.22*40mm/rotation}{0.35s/rotation} = 25.14mm/s$$

$$Total_Scan_Time = \frac{120mm}{25.14mm/s} = 4.8s$$

$$Number_of_Beats = \frac{60beats/\min}{60s/\min} * 4.8s = 4.8beats$$

SnapShot™ Pulse*:

Prospectively Gated SnapShot™ Pulse is an electrocardiogram (ECG) gated acquisition that activates the X-ray to the ON state during a specified window of the projected cardiac cycle. The x-ray then remains in the OFF state while the table advances to the next cine location and awaits the desired timing of the cardiac cycle to return to the ON state and repeats until the desired range in Z-locations is covered.

Prospective Gating based SnapShot Pulse achieves up to 83% dose reduction compared to ECG gated helical acquisition mode

44 msec cardiac temporal resolutions with 0.35* second rotation and SnapShot scan algorithm. Optima™ CT660 not only offers fast acquisition speed, it builds on GE's exclusive variable speed technology that has now been expanded for cardiovascular imaging to include 0.35*, 0.375*, 0.40, 0.425, 0.45, 0.475 and 0.50 second scans – so you have the power to customize rotation speed to your patients' heart rates.

Editable ECG:

The ECG Editor improves acquisition rate by enabling users to modify the R-R intervals and the location of the triggers.

Optima™ CT660 Family Main Features

Optima™ CT660 introduces Volume CT capabilities while extending the following features of today's Optima™ CT660 series scanners.

- Routine use of **sub-millimeter slices** without image noise or coverage compromise.
- GE's **OptiDose** philosophy provides the following built-in dose reduction capabilities:
  - **ECG Dose Modulation**: For cardiac applications, prospective ECG dose modulation automatically adjusts the mA to minimize the patient's exposure to X-rays – reducing dose during systolic phases of the cardiac cycle. This provides clear images and allows you to reduce dose primarily in the systolic phases of the cardiac cycle – yet gives you enough power to obtain quality images for functional analysis.
  - **CT 4Kids** Dose-optimized procedure based protocols for pediatric imaging provide more options for ensuring balanced radiation dose and image quality for specific pediatric applications. Protocols are based on patient size (up to 200 pounds) and scan type and available at gehealthcare.com.
  - **Color Coding for Kids,** winner of a National Heroes Award from the Emergency Medical Services for Children, provides pediatric scan protocols based on the Broselow-Luten™ Pediatric System. This Color Coding system is incorporated into the protocol selection on the operator's console and is designed to facilitate pediatric emergency care and reduce medical errors.
  - **SmartTrack™** advanced hardware and software for X-ray beam tracking minimizes patient dose.
  - **SmartBeam™** hardware and software optimizes X-ray beam filtration independently for body, head, and cardiac applications.
  - **$CTDI_{vol}$, DLP** (Dose Length Product), and Dose Efficiency display during scan prescription provides patient dose information to the operator.
  - **Dose Reporting** provides access to the $CTDI_{vol}$ and DLP with the patient record prior, during and post exam. DICOM Structured Dose Report is also supported.
- **Productivity features** designed for the CT Technologist: In-Room Start, Remote Gantry Tilt, Breathing Lights with countdown timer, and an Integrated IV Pole* at the foot of the table plus table tray*.
- **Standard set of clinically proven protocols** derived from leading luminary sites around the world. Up to 6840 protocols can be edited, modified and stored on the system.
- **Remote Gantry Tilt** from the Operator's Console to increase exam speed, including built-in safety features to prevent accidental contact of the gantry with the patient.
- Built-in **patient breathing lights** and digital counter provides a goal-oriented approach to coach the patients in holding their breath during an exam.
- **SmartStart™** gantry-mounted start scan button and countdown display, facilitates single-technologist operation by allowing start of scan at the gantry, with a visual reminder of time until X-ray initiation.
- **Direct MPR**: Direct MPR with Auto-Batch feature, affording automatic real-time direct reconstruction and transfer of fully corrected multi-planar images, in any plane.
- **DVD interchange**: DVD interchange capability, for archiving of up to 7168 uncompressed 512*512 images.
- **Data Export**: Data Export capability, ensuring the relevant images and reports can be visualized by the referrals in PC friendly format (JPEG, PNG, AVI, MPEG and MOV)
- **Auto Transfer by Series**: Auto Transfer by Series to distribute images where you need them when you need them.
- **Exam Split***: Exam Splits allow multi-anatomic exams to be read in separate anatomic sections. This allows specialists to review only those images needed for a given requisition.
- **Grayscale Presentation State**: It saves display presentation of WW, WL, flip, rotate, and zoom, user annotation and measurements for transfer to a remote viewing station using DICOM GSPS object.
- **Direct Connect**: Direct connect allows remote Advantage Workstation (AW) access to True in One console's thin-slice data, eliminating unnecessary network traffic and storage duplication. (AW4.3* or later)
- **Graphic Retro**: Graphic Retro allows users to prescribe retro recon graphically on appropriate prospective image by mouse. Visual adjustment parameters such as DFOV, AP/RL, center improves retro recon productivity.
- **SmartPrep™**: SmartPrep can automatically play the prerecorded messages after the operator triggered the scan phase. With Auto Minimum Delay function enables, the diagnostic delay time is set automatically to the minimum time.
- **Copy PMR & Series**: Automatically copy the parameters of existing series when "Copy series" is selected. The series parameters include: start location, end location, interval, DFOV, A-P center, and R-L center.
- **DICOM Structured Dose Report**: DICOM Structured Dose Report creates a machine-readable record to be saved with each CT exam. This allows a hospital's radiation tracking system/RIS/HIS to retrieve the Dose information for a given CT study.
- **Series number for Retro Recon**: The system will automatically specify the series number for Retro Recon series. A new series number can be automatically assigned when a new series is created.
- Large breadth of **Advanced Software Applications*** (AW or Xtream): Autobone Removal, Advanced Lung Analysis, CT Colonography, Advanced Vessel Analysis, Neuro and Multi-Organ Perfusion, Cardiac Analysis, Cardiac Function, Cardiac Electrophysiology, Coronary Calcium Scoring, DentaScan, Advantage 4D CT, and Advantage Sim.

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The following options are available for Cardiac CT scanning:

- **SmartScore Pro*** provides ECG-gated hardware for both prospective and retrospective gating.
- **SnapShot Imaging** provides software and hardware to perform retrospective helical ECG-gated reconstructions of the heart with three SnapShot-imaging modes.
  - **SnapShot Segment** is a single sector protocol using information from one heart cycle to generate an image with temporal resolution of 175 to 200msec.
  - **SnapShot Burst** is a multi-sector protocol using up to two sectors from two different heart cycles to produce an image with temporal resolution of 88 to 100msec.
  - **SnapShot Burst Plus** is a multi-sector protocol using up to four sectors of data from four different heart cycles to produce images with temporal resolution of 44 to 50msec.

- **Cardiac Image Filters** provides users the capability to reconstruct filtered images using three steps of noise reduction for helical and axial cardiac imaging, allowing reduced dose while maintaining an acceptable level of image noise.
- **ECG Waveform on the Console** will allow users to visualize the ECG waveform directly on the CT scanner console during the scan. The waveform data can be viewed to determine where prospectively created images are located with respect to the heart cycle to better understand and avoid motion artifacts like blurring or mis-registration.
- **ECG Viewer / Editor** provides users the capability to view and retrospectively modify intervals and adjust location of triggers for cardiac cycles based on ECG waveform displayed on the console.

Optima™ CT660 Interactive CT Technology

The Optima™ CT660 supplies exceptional computer and image processing power that enhances clinical productivity, building upon the strength of the Optima™ CT660 family - true interactive CT technology.

Interactive CT embodies a variety of design choices all striving to enhance operator and department productivity. A truly interactive CT system will:

- Provide a user interface beyond "intuitive" to become purely "natural" - from the screens to the console hardware itself;
- Allow users to review cases side-by-side, with minimal interference;
- Supply a truly multi-tasking environment where even advanced image processing can take place quickly and simultaneously with other processes underway;
- Operate with a very high degree of automation, yet allow patient-specific changes to be easily made, with virtually no restrictions;

One key element of this design is to combine some of the best features from several product families into one state-of-the art CT system. For example, the Optima™ CT660 combines:

- SmartTools productivity software to automate every step of the examination, critical for ensuring the highest productivity and throughput possible with the Optima™ CT660
- Large screen interface for controlling scan acquisition easily, with virtually everything at a single glance;
- Excellent simultaneity and multi-tasking performance;
- Completely protocol-driven scan control with a dramatic reduction in number of screens;
- Highly flexible editing tools that allow easy tailoring of the exam to the patient;
- Large, 1024 color display;
- Leading edge, real-time image processing (MPR, MPVR, Volume Viewer 3.1*).

In summary, primary benefits of Interactive CT include:

- A natural scan control user interface
  - Reduction in the number of screens; only 2 screens to set up first scan and 1 screen for real-time monitoring while scanning;
  - Easier and more flexible protocols
  - Flexible and intuitive graphic prescription process with a 1024 Localizer;
  - **View/Edit Wizard™** intuitively adjusts dependent parameters automatically in response to operator-initiated changes and highlights them for quick review; also alerts the operator to incompatible dependencies requiring operator intervention;
  - **DynaPlan Plus™** full screen display illustrates scan status pictorially, with real-time feedback.
- Large color screen
  - Extensive use of picture icons and color cues enhance ease of use;
  - Large on-screen controls and attractive color palette provide comfortable viewing over extended periods.
- Enhanced multi-tasking allows operators to review more than one exam simultaneously, independently - even with AutoView and AutoFilm on
  - **BrightBox™*** dedicated controls for image next, prior, manual paging and trackball W/L helps make two person image review practical;
  - Up to four 512x512 images from four different exams can be viewed on a large 1024 color display.
- **SmartmA™** User Interface - automatically optimizes mA to maintain constant image noise when collimation/detector configuration, scan mode, scan rotation speed, table speed, or image thickness changes. It takes the guesswork out of setting scan technique when changing parameters (note: user must select initial Noise Index as well as maximum mA setting). Noise index enable Image Quality reproducibility from one patient to another and from one user to another.
- **Protocol Pro™** protocol manager - provides operator control of automated features (like AutoFilm, and AutoTransfer) on per exam, series or image basis.
- Patient demographics and exam protocols can be preprogrammed in advance of patient arrival through the Schedule Patient feature. Common inputs for new patient include: physician, radiologist, technologist and contrast type (oral and IV).
- A preprogrammed selection of AutoView and Image Review Layouts allow simple customization of the image presentation to match the anatomical area of interest - without the complexity of free-form "windows".
- **ImageWorks™** provides instant access to advanced image processing features such as MIP, MPR, MPVR, Volume Viewer3.1, AVA Xpress*, CT Perfusion 4* – Neuro or Multi-Organ, DentaScan*, CardIQ Xpress 2.0 Plus*, Advantage CTC Pro*, CardEP*, Add/Subtract and AutoBone Xpress*.

Asterisk*: Option

- Background filming allows use of the full screen for AutoView and image review/processing without interruption when auto or batch filming. Special "one-touch" controls provide on-screen viewing of camera progress during AutoFilm without disrupting other image processes in progress.
- **ProView™** visualization algorithms available to enhance anatomical structures without additional image reconstruction time.
- Operator console convenient to place in suite.
  - Computer, image processor and image reconstruction hardware completely integrated in base of console - no separate computer cabinet to site;
  - Split console table top allows unrestricted patient viewing while still supporting 2 large color LCD monitors;
  - Front and back work surfaces can be set during installation within a range of vertical heights that help accommodate a variety of siting requirements - especially surrounding the height of the console relative to the window into the scanning suite.
- Direct network connection means a multi-suite Ethernet card is not required for a gateway out of the suite - saving costs and simplifying installation.
- The Optima™ CT660's "Fast Calibration" is calculated to reduce calibration time by 33%, compared to prior GE technology.
- **Learning Solutions** provides an on-line Operator manual detailing system operation via a multi-media CD-ROM player integrated into the media tower. Learning Solutions can also be accessed on a stand -alone PC providing flexibility and productivity for on demand learning of system operation.

Scan Modes

The Optima™ CT660system can perform virtually any clinical application due to its wide variety of scan modes.

Helical:

- Continuous 360° scanning with table incrementation and no interscan delay.
- Scans can be acquired in a wide variety of speeds.

Axial:

- Up to 64 contiguous axial slices acquired simultaneously with each 360° rotation, with the time between scans set by the user-selected interscan delay (ISD) or intergroup delay (IGD).
- Scans may be easily clustered in groups to allow multiple scans in a single breath hold.
- Minimum scan-to-scan cycle time of only 1.0 second with table moves of ≤ 10 mm (any scan time).

Cine:

- Up to 64 contiguous axial slices acquired simultaneously with each 360° rotation.
- Minimum scan-to-scan cycle time of only 1.0 second with table moves of ≤ 10 mm.
- Half-scan imaging and segmented reconstruction is supported with acquisitions times of 0.65 times that of the scan speed.

Scout™:

- Single radiographic plane for scan localization and graphical prescription of prospective reconstruction;
- Extended range matches helical scannable range.

Typical scan protocols include with 500 pounds (227.5kg) Table.

		Chest/Abd/ Pelvis	Peripheral Run-Off	High-Res Chest	ECG-Gated Cardiac
Coverage	(mm)	600	1000	200	120
Rotation	(s	0.5	0.6	0.5	0.35
Mode	(mm	64 x 0.625	64 x 0.625	64 x 0.625	64 x 0.625
Pitch		1.375	0.984	1.375	0.22
mA		400	350	380	450
mAs		216	210	190	158
Speed	(mm/s)	110	65.6	110	25
Scan Time	(s	6.04	15.94	2.41	5.37

Note: Table speed faster than 100mm/sec are not supported for 450 pounds table.

Note: Scan time that is displayed on Optima™ CT660 system.

Helical Scans

Slip ring technology has advanced axial scanning by enabling scans with zero interscan delay and simultaneous table movement.

Helical Multi-Slice Modes

Multi-slice acquisitions and short intergroup delays significantly reduce potential mis-registration between scans by increasing the number of scans possible in a patient breath hold.

Helical protocols are almost identical to "classical" axial scan protocols. At the beginning of a study, the operator selects the type of exam with the anatomical programmer, and indicates the desired scan range - either manually, or from a Scout.

After completing the prescribed exam, the system remains ready to continue with additional helical scans or a set of axial scans.

The operator may reconstruct helical scans prospectively with up to 90% overlap, and retrospectively, at any arbitrary table location in 0.1 mm increments.

Prospective Multiple-Thickness Reconstruction

For all helical scan modes, the operator can choose to reconstruct images prospectively in any of the defined nominal slice thicknesses.

In addition to the initial reconstructed slice thickness, the operator has the option to prospectively specify additional images to be reconstructed from a single raw data set. These images can be reconstructed at any of the defined nominal slice thicknesses available for a given table speed and scan mode.

This effectively facilitates later, more detailed image analysis without additional patient scans and subsequent dose and image registration concerns.

Asterisk*: Option

64-SLICE HELICAL MODES Table Speed (mm/rotation)			
Slice Thickness (mm)	Nominal Pitch 0.516:1	0.984:1	1.375:1
0.625 1.25 2.5 3.75 5 7.5 10	20 mm/rot	40 mm/rot	55 mm/rot

Table speed faster than 100mm/sec are not supported for 450 pounds table.

Generating images at fine intervals, as small as 0.1mm, enables reconstructed images that exceed 128slices (images) per gantry rotation. The number of slices able to be generated per gantry rotation is a function of rotations and coverage.

Rotations	Z Coverage (mm)	Generated Sliced (Images)/Rotation*
1.71	30	176
2.00	46	230
3.00	101	337
4.00	156	390
5.00	211	422
6.00	266	443

* 64*0.625mm&1.375:1 helical pitch

Helical Scan Parameters

Scan Speeds: Full 360° rotational scans in 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 1.0 seconds (0.4 is for Pediatric only); Cardiac application: 0.35*, 0.375*, 0.40, 0.425, 0.45, 0.475, and 0.50.

Helical Pitch (nominal): 0.516:1, 0.984:1, 1.375:1

Cardiac Pitch: 0.16:1 to 0.325: 1 for 0.35*second gantry speed. Up to 0.325:1 for slower gantry speeds.

Scan Technique:

- kVp: 80, 100, 120, 140
- mA: 10 to 560mA , 5mA increments
- Power: 0.8 to 72kW
- Focal Spot Selection
  - Small spot for up to 24kW
  - Large spot for greater than 24kW

Single Acquisition: 60-second scan maximum.

Multiple Acquisition Maximum Scan Time: Multiple scans may be acquired in one series to produce up to 3,000 contiguous helical images. Up to 3,000 rotations helical coverage is possible in multiple series.

Minimum Inter-Group Delay (IGD): 1 second between adjacent helical scans

Maximum Scan Fields of View:

- 32cm for pediatric head
- 32cm for pediatric body
- 32cm for head
- 32cm for body, small
- 50cm for body, large
- 32cm for cardiac – small
- 50cm for cardiac – large

Helical Scan Enhancements

Full simultaneity allows complete image display, processing and analysis, as well as image archival and filming, concurrent with scanning and reconstruction -- even when acquiring helical images in a multi-slice mode.

Confirm Rx to X-Rays on: < 18 seconds, for any state of tube and gantry; < 10 seconds, with the gantry rotating.

Anatomical Programmer: a ten-region anatomical selector allows quick and easy access to 90 user-programmable protocols per region. Separate selector for adult and pediatric exams. There are four selection tabs to select: GE, User, Service and Most Recent Patient. Copy/Paste is supported for easy modification and copying of protocols.

Ten user-defined regions, each with one default protocol displayed with the anatomical selector for very fast access to most commonly used protocols.

Protocols include preset scan time, kVp, mA, scan mode, slice thickness and spacing, table speed, scan FOV, display FOV and center, recon algorithm and special image acquisition and processing options.

Any scan parameters may be edited for each scan or all scans - either before or during an exam. The number of scans may also be easily changed.

AutoScan™: Fully automates longitudinal table movement and start of each scan.

AutoVoice™: 3 preset and 17 user-defined messages automatically deliver patient breathing instructions with a programmable delay; especially useful for multiple helical scanning.

Preset messages are supported in 9 different languages: Chinese, English (Male/Female), French, German, Italian, Japanese, Korean, Spanish, and Mexican Spanish.

Advanced Artifact Reduction (AAR) Filter significantly reduces streaking artifacts when highly absorbent objects are in the field of view – ie: large shoulders.

Helical Image Reconstruction

Reconstruction Algorithms: Soft Tissue, Standard, Detail, Chest, Bone, Bone Plus, Lung, and Edge

Reconstruction Matrix: 512 x 512

Display Matrix: 1024 x 1024

Display FOV: Freely variable center/off-center, prospective/retrospective target selection.

Preferred Viewing Orientation: Images may be reconstructed flipped right/left, top/bottom, or right/left/top/bottom for anatomical viewing.

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CT Number Scale: ±31,743 HU

Helical Reconstruction Times:

- Reconstruction time as fast as 16 images per second
- Iterative bone (IBO) processing increases time by 300 milliseconds. Iterative bone processing, which is always enabled for head scanning, reduces image artifacts in head scans stemming from X-ray beam hardening effects.

Minimum DFOV: 9.6 cm

Minimum Pixel Size: 0.1875 mm

Queued Recon: Requests will be processed continuously and simultaneously with other processes on the system including scanning. Prospective recon will be prioritized over retrospective recon.

Images annotated to indicate continuous scan acquisition with table increments: HE (helical) + Pitch, Table speed

Prospective Multiple Reconstruction (PMR): Up to 3 sets of reconstructions can be pre-programmed as part of the scan protocol prior to acquisition. The operator can select different start/end location, slice thickness, interval, reconstruction algorithms and display fields of view for each reconstruction. These parameters may be automatically copied from the first prospective reconstruction. This frees the operator from sitting at the console, directly contributes to increased productivity, and reduces the opportunity for error.

Prospective Recon: Operator may initiate full recons at any table location in increments of 1/10 the image thickness; image thickness remains constant.

Retrospective Recon: Operator may initiate full recons at any table location in 0.1 mm increments; image thickness remains constant.

Retrospective Image Decomposition: The operator has the option to retrospectively decompose the original raw data set and reconstruct additional images at any of the defined nominal image thickness available for a given table speed and scan mode.

Helical Scan Protocols

All protocols assume 120kVp scans under typical clinical conditions (maximum mA subject to system configuration).

Single Helical Scans:

Scan Time (s)	Maximum mA
3	560
5	560
10	560
20	445
30	385
40	350
50	325
60	310

Multiple Helical Scans (IGD = 5 seconds):

No. Scans	Max mA 3S Scan Time	5s Scan Time	10s Scan Time	20s Scan Time	30s Scan Time
2	560	560	460	360	315
3	560	550	425	335	285
4	560	530	405	315	240
5	560	505	390	--	--
6	545	490	365	--	--

Helical Scan Image Quality

The Optima™ CT660 is a sub-millimeter isotropic CT scanner making it possible to specify coronal and sagittal image quality.

The optimized x-ray source (focal spot shape & dynamics as well as reduced off focal radiation) allows for improved measurement methods to fully characterize the limiting resolution of the Optima™ CT660system design. In conjunction with the additional power of Optima™CT660, this has been shown in clinical images to realize more vascular and anatomical detail.

For details of scan techniques and tolerances, please refer to the Technical Reference Manual.

Visual Measurement:

Reformatted resolution is demonstrated on the Catphan High Contrast High Contrast Resolution Insert Module CTP528.

0.35 ± 0.05mm voxel size is seen in the reformatted plane.

1. 3D MTF:

Typical MTF is demonstrated on a 0.05mm tungsten wire and a 1.0mm x 0.025mm gold foil phantom for in-plane and z-plane, respectively.

	High-Resolution Algorithm X/Y lp/cm	Z lp/cm
50%	10.1	7.3
10%	13.5	12.2
4%	14.2	14.2

2. Low-Contrast Detectability:

On 8 inch (20cm) CATPHAN phantom:

Reconstruction Mode	Object Size	% Contrast	Dose Level (mGy CTDIvol) 5mm Slice	10mm Slice (Calculated)
Standard Algorithm	5mm	0.32%	15.5	7.75
	3mm	0.32%	44.3	22.2

Body Low Contrast Detectability – Statistical

On 8 inch (20cm) CATPHAN phantom surrounded by a 36cm tissue equivalent ring, 10mm (calculated) slice thickness:

5mm @ 1.3% at 17.0 mGy CTDIvol

3. Noise:

On either an AAPM water phantom or GE Quality Assurance phantom with 5mm slice thickness equivalent:

0.43% ± 0.05% at 19.9 mGy CTDIvol with Standard Reconstruction Algorithm

Asterisk*: Option

4. CTDI:

On CTDI Head and Body Dose Reference Phantoms:

$CTDI_{vol}$ expressed in mGy/100 mAs (0.984:1 Pitch):

Head 16.9 mGy/100 mAs
Body 8.7 mGy/100 mAs

Axial Scans

Multi-slice acquisitions and short interscan delays significantly reduce potential missed registration between scans by increasing the number of scans possible in a patient breath hold.

Axial Multi-Slice Prescription

Simplified scan prescriptions and easy-to-use default protocols make the Optima™ CT660fast and efficient in patient set-up. Axial protocols are nearly identical to helical scan protocols.

Axial Multi-Slice Modes

The Optima™ CT660 acquires axial scans in sets of 2 through 64 contiguous images in one 360° rotation.

For each rotation of the gantry, the Optima™ CT660 collects up to 64 rows of scan data. There are seven reconstruction modes available for creating images from the multi-slice scan data (1i, 2i, 4i, 8i, 16i, 32i, 64i). By using 1i, 2i, 4i, 8i, 16i, 32i reconstruction modes, scan data can be combined prior to image reconstruction to create slices with reduced partial-volume artifacts. This is particularly useful for posterior-fossa imaging.

Biopsy Mode: Simplified prescription for single or multiple scans around an arbitrary table position aids biopsy studies.

SmartStep*: Interventional mode providing step-and-shoot imaging with in-room viewing and manual x-ray control.

Axial Scan Parameters

Scan Speeds:

- 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 1.0, and 2.0 second full scans (360° acquisition); 0.4* is for Pediatric only, Cardiac application: 0.35*

Scan Technique:

- kVp: 80, 100, 120, 140
- mA: 10 to 600mA, 5mA increments
  600mA is available only for ShapShotPulse* study.
- Power: 0.8 to 72kW
- Focal Spot Selection
  - Small spot for up to 24kW
  - Large spot for greater than 24kW

Scan Plane Geometry:

- ± 30° gantry tilt, 0.5° increments

Asterisk*: Option

Interscan Delay (ISD): 450 pounds table and 500 pounds table

Table Movements	Minimum ISD
- 0 to 10 mm	1.0s
- 10 mm to 20 mm	1.3s
- 20 mm to 30 mm	1.6s
- 30 mm to 40 mm	1.7s

- User-selectable.

Inter Group Delay (IGD):

- Minimum IGD is the same as minimum ISD; also user-selectable.

Scan-to-Scan Cycle:

- Minimum scan-to-scan cycle of 1.5 seconds possible for 0.5 seconds scan speed with minimum ISDs.

Maximum Scan Fields of View:

- 32cm for pediatric head	- 50cm for body, large
- 32cm for pediatric body	- 32cm for cardiac – small
- 32cm for head	- 50cm for cardiac – large
- 32cm for body, small	

Scan with no table incrementation, contiguous image location, or skipped image locations are possible. Overlapped axial scans are not possible.

Axial Image Reconstruction

Reconstruction Algorithms: Standard, Soft Tissue, Detail, Chest, Bone, Bone Plus, Lung, and Edge

Reconstruction Matrix: 512 x 512

Display Matrix: 1024 x 1024

Display FOV: Freely variable center/off-center, prospective/retrospective target selection.

Preferred Viewing Orientation: Images may be reconstructed flipped right/left, top/bottom, or right/left/top/bottom for anatomical viewing.

CT Number Scale: ±31,743 HU

Axial Reconstruction Times:

- Iterative bone (IBO) processing increases time by 300 milliseconds. Iterative bone processing, which is always enabled for head scanning, reduces image artifacts in head scans stemming from X-ray beam hardening effects.

Prospective Multiple Reconstruction (PMR): Up to 3 sets of reconstructions can be pre-programmed as part of the scan protocol prior to acquisition. The operator can select different reconstruction algorithms and display fields of view for each reconstruction. This frees the operator from sitting at the console and directly contributes to increased productivity.

Similarly, additional reconstruction supports partial-volume artifact reduction by reconstructing images with 2, 4, or 8 times the acquisition image thickness.

These reconstruction features effectively facilitate later, more detailed image analysis without additional patient scans and subsequent dose and image registration concerns.

The following table illustrates the retrospective reconstruction image thicknesses available for each acquisition thickness and mode:

Scan Mode	Slice Thickness	Recon Slice Thicknesses
64 slices/ 40mm	0.625	64i – 0.625mm* 32i – 1.25mm* 16i – 2.5mm 8i – 5mm 4i – 10mm
32 slices / 20mm	0.625	32i – 0.625mm 16i – 1.25mm 8i – 2.5mm 4i – 5mm 2i – 10mm
16 slices / 10mm	0.625	16i – 0.625mm 8i – 1.25mm 4i – 2.5mm 2i – 5mm 1i – 10mm
8 slices / 5mm	0.625	8i – 0.625mm 4i – 1.25mm 2i – 2.5mm 1i – 5mm
4 slices / 2.5mm	0.625	2i – 1.25mm 1i – 2.5mm
2 slices / 1.25mm	0.625	1i – 1.25mm

* Retro Recon Only

Axial Scan Protocols

All protocols assume 120kVp scans under typical clinical conditions (maximum mA subject to system configuration).

Standard Scans:

Scan Time (s)	ISD (s)	mA	Number of scans (xxx)	Number of scans (yyy)
1	1	560	4	16
1	1	520	8	26
1	1	480	14	37
1	1	440	18	45
1	1	400	24	55
1	1	360	32	68
1	1	320	43	86
1	1	280	58	110
1	1	240	74	135
1	1	200	94	168

xxx: 120KV scans under thermal equilibrium condition (infinitely repeatable scans with about 10 minutes ISD)

yyy: 120KV scans under cool condition (two hours past from last scan)

Axial Scan Image Quality

For details of scan techniques and tolerances, please refer to the Technical Reference Manual.

1. High Contrast Spatial Resolution:

Typical in-plane MTF is demonstrated on a 0.05mm tungsten wire.

	High-Resolution Algorithm X/Y lp/cm
50%	10.1
10%	13.5
4%	14.2

2. Low-Contrast Detectability

On 8 inch (20cm) CATPHAN phantom:

Reconstruction Mode	Object Size	% Contrast	Dose Level (mGy CTDIvol)	
			5mm Slice	10mm Slice (Calc)
Standard Algorithm	5mm	0.32%	15.2	7.6
	3mm	0.32%	42.6	21.3

Body Low Contrast Detectability – Statistical

On 8 inch (20cm) CATPHAN phantom surrounded by a 36cm tissue equivalent ring, 10mm (calculated) slice thickness:

5mm @ 1.3% at 16.7 mGy CTDIvol

3. Noise:

On either an AAPM water phantom or GE Quality Assurance phantom with 5mm slice thickness equivalent:

0.43% ± 0.05% at 19.8 mGy CTDIvol with Standard Reconstruction Algorithm

4. CTDI:

On CTDI Head and Body Dose Reference Phantoms:

CTDIw expressed in mGy/100 mAs:

Head 16.6 mGy/100 mAs
Body 8.6 mGy/100 mAs

Scout Scans

ScoutView™ scans provide excellent detail for anatomical localization in conjunction with scan prescription.

Scan locations may be prescribed at the operator console either graphically (via mouse), or explicitly (keyboard entry) from a Scout scan.

Prescription of scans with multiple gantry angles is also available on a single Scout.

Scout Scan Parameters

Aperture: 8 x 0.625 mm effective aperture

Table speed: 100 mm/s

Scout range: 1260mm with 450 pounds table
1600mm with 500 pounds table

Maximum Display FOV: 50 cm

Scouts longer than 1,000 mm are auto minified to fit the display.

Scan Technique:

- kVp: 80, 100, 120, 140
- mA: 10 to 560mA, 5mA increments

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- Power: 0.8 to 72kW

Orientation: AP, RLAT, PA, LLAT (preset); or any angle from 0° - 359° (manually selected).

Axial scan prescription lines indicate scan location to nearest 1 mm table position.

Preset Scout width/window level (WW/WL) values available in protocol management tool or during scan prescription.

User Interface

The Optima CT660 Operator Console, utilizes a computer workstation with the following user interface features:

- Two 19-inch LCD monitors
  - Scan/recon monitor for scan and recon control with no image display
  - Image monitor for image display, analysis, processing, and management
  - Each monitor provides a 1280 x 1024 high resolution, flicker-free display
- Scan control keyboard assembly with intercom speaker, microphone and volume controls
- Three button mouse with mouse pad
- BrightBox* (trackball assembly)
- Two wide work surfaces

All these devices are freestanding and can be easily moved to accommodate a large variety of working conditions and individual operator preferences.

Desktop Overview

The user interface utilizes the paradigm of managed work environments for a more intuitive clinical workflow.

Virtually, all clinical operations are managed through three "virtual desktops" or applications managers: Exam Rx, ImageWorks and Learning Solutions. Operators can effortlessly move back and forth between these environments simply by clicking on an icon. Xtream technology enhances multi-tasking architecture and maintains simultaneously all processes so no work is lost or disrupted as desktops are switched.

Exam Rx:

The Exam Rx desktop environment provides the clinical tools necessary for comfortable, efficient control of patient studies.

These tools include patient scheduling and data entry, exam protocol selection, protocol viewing and editing, scan data acquisition, image reconstruction, image display and routine analysis, AutoFilm or manual filming, and AutoTransfer.

ImageWorks:

ImageWorks is a desktop environment designed to take advantage of the Optima™CT660 System computer and image processor.

Standard features include archive, network and manual film control, as well as some advanced image processing such as multi-planar reformatting (MPR), multi-projection volume rendering (MPVR), and MR image display. It also has optional add-on packages for Volume Viewer 3.1*, CT Perfusion 4* and DentaScan*.

The ImageWorks desktop also provides a gateway for DICOM image transactions, either through a local area network.

Learning Solutions:

The Optima™ CT660provides an on-screen, on-line operator assistance via a multi-media CD-ROM/DVD player integrated into the front of the operator's console. Learning Solutions is also viewable on a stand-alone PC providing flexibility and productivity for on-demand learning of system operation.

Exam Rx

Patient Scheduling

Patient demographics and exam protocols can be pre-programmed in advance of patient arrival by selecting Schedule Patient from the scan/recon monitor. This productivity enhancement allows entry of all or some of a patient's demographic data, as well as pre-selection of the exam protocol.

This feature is available any time a patient exam is not currently underway.

This feature uses the same interface as New Patient selection for simplified, consistent programming.

Patient information can be easily recalled to set up an immediate exam via List/Select Scheduled Patient on the scan/recon monitor. Pre-programmed patient exams can also be recalled from the New Patient screen automatically by entering the patient ID number.

Patient Data Entry

Patient data can be entered as part of New Patient set-up, or can be recalled from the list of pre-scheduled patients. Common inputs for new patient include: physician, radiologist, technologist and contrast type (oral and IV).

Trauma Patient ID allows patient scans and image display/analysis without entering patient data before scanning.

Exam Protocol Selection

One of the main contributions of the Optima™ CT660 to department productivity is its simplified exam set-up.

- Exam parameter set-up has been simplified through the exclusive use of protocols
- Protocols can be easily selected in one of three convenient ways:

Asterisk*: Option

- A large, graphical Anatomical Programmer located on the New Patient screen
- A default list of the "top 10" most commonly used protocols located near the anatomical programmer
- A numerical entry

- Two Anatomical Programmers - one for adults and one for pediatrics - provide quick and easy access to 6840 user-programmable protocols (total). Each programmer has ten anatomical regions with 90 protocols for each region
- Default protocols have been expanded through Protocol Pro - a "behind the scenes" protocol manager - that allows preselection of automated features like AutoVoice, AutoFilm, AutoStore and AutoTransfer on a per exam, series or image basis.
- Protocol Pro also provides preselection of two different window/level settings per image for AutoFilm and can automatically display the 1024 Localizer each time a new series is requested.
- Default protocols also include preset scan time, kVp, mA, slice thickness, scan mode, table speed, image interval, gantry tilt, scan field-of-view, display field-of-view and center, recon types, and breath timing parameters.
- Any scan parameter can be edited for each scan or all scans either before or during an exam. Scans can be easily added or removed from the prescription.
- Scan/recon control uses only 2 screens to set up first scan - New Patient and Protocol View/Edit.

Protocol View/Edit

- A single, full screen View/Edit table allows fast and easy examination and modification of exam parameters before scanning begins.
- Exam parameters can be changed for one scan or all scans in a series
- When used in conjunction with the 1024 Localizer, changes made in the View/Edit table that affect the number of scans, image interval, starting/ending locations, tilt, or display FOV are automatically shown on the 1024 Localizer.
- Any changes made directly on the 1024 Localizer display using the mouse and the on-screen cursor controls are also reflected automatically in the View/Edit table
- View/Edit Wizard intuitively adjusts dependent parameters automatically in response to operator-initiated changes and highlights them for quick review. It also alerts the operator to incompatible dependencies requiring operator intervention.
- Tab card groupings for Timing, Recon and Filming help organize the large number of parameters available within each protocol.
- Parameters such as Patient Position, Patient Orientation and reconstruction parameters automatically update between series to reduce the change of user error.
- As many as 6,840 protocols can be stored on the Operator Console.

Scan Data Acquisition

- Full-screen DynaPlan Plus illustrates scan status graphically, with real-time feedback while the exam is underway. Scans, programmed delays (prep, breathing, inter-group), and even AutoVoice announcements are clearly shown before and during scanning.
- AutoScan: Fully automates longitudinal table movement and the start of each scan
- AutoVoice: Preset and user-recorded messages automatically deliver patient breathing instructions, especially useful for multiple or multi-pass helical scans
- Full Simultaneity allows scan and recon to work concurrently with image display, processing and analysis (including computationally intensive features such as MPR, MPVR and 3D*/MIP) while still running image archival, filming and networking processes.

Dose Computation, Display & Reporting

$CTDI_{vol}$ (CTDI volume), DLP (Dose Length Product), and Dose Efficiency computation and display during scan prescription provides patient dose information to the operator.

$CTDI_{vol}$ is a dose index defined by IEC 60601-2-44. This index is computed automatically by the Optima™ CT660 and reported on the Exam Rx screen. $CTDI_{vol}$ is a single number consisting of 2/3 of the $CTDI_{100}$ peripheral dose plus 1/3 of the $CTDI_{100}$ central dose that is divided by the helical or axial pitch factor.

$CTDI_{100}$ is a dose index based upon CTDI dose measurements over a 100 mm volume, as defined in IEC 60601-2-44.

Dose Length Product (DLP) is given in mGy*cm and is computed and displayed for each group prior to the scan. Additionally, an accumulated DLP is displayed for the entire exam, as the exam prescription progresses. The final exam accumulated DLP provides a convenient measure for maintaining patient or procedure dose management statistics.

Dose Efficiency is automatically computed and displayed on the Exam Rx screen. The dose efficiency is a measure of how much of the Z-axis X-ray beam is used by the system, as defined in IEC 60601-2-44.

Dose Reporting saves the $CTDI_{vol}$ and DLP in the patient record. Series and cumulative exam values are saved. Saved values can be networked, filmed and archived. DICOM Structured Dose Report is also supported.

AutoView Layouts

- Eight powerful AutoView layouts provide exceptional flexibility in tailoring the 1024 image display to the user or the application at hand - without the complexity of free-form "windows."
- AutoView Layouts include:
  - 1024 AutoView image
  - 768 AutoView image (matches the image size shown on the HiSpeed Advantage 2.X Series OC monitor)
  - 512 AutoView image + 512 Localizer Scout with cut lines automatically showing the location of the AutoView image on the Scout
  - Two 512 AutoView images (same image but at different window/level settings) + 512 Localizer Scout with cut lines automatically showing the location of the AutoView images on the Scout
  - 512 AutoView image + 512 AutoFilm image
  - Last two & four 512 AutoView images
  - AutoLink which links the current series to a view port
- Basic image review features such as window/level, magnification and flip/rotate are available for AutoView images.
- Any window not used for AutoView is available to independent, simultaneous review of other exams.

Asterisk*: Option

- Special BrightBox, a three-button trackball device, provides independent control of image next, prior, manual paging and trackball window/level for any review images in focus. This helps make two-person operation practical.
- Regardless of the AutoView Layout used, AutoFilm viewing is available anytime via an on-image selection - without disrupting other image processes in progress. Background filming allows full use of the image display monitor for AutoView and image review/processing without interruption during AutoFilm.

Image Review Layouts

- Five flexible Image Review Layouts are provided for those applications where greater than 512-image display may be desired and AutoView is not required.
- Image Review Layouts include (Note - uses short notation for screen options)
  - 1024 single image display
  - 768 single image display
  - Two 512 image display, horizontal format
  - Two 512 image display, vertical format
  - Four 512 image display
- Each image display window can be further subdivided into four more images, increasing the total number of images that can be displayed at once to 16.
- BrightBox* image control is also available for Image Review Layouts.

Image Access

- Point and click interface along with a pictorial directory (browser) allows for easy selection by exam, series or image

Routine Image Display

- Image display features provided within Exam Rx:

- Zoom/Roam	- Grid On/Off
- Explicit Magnify	- Cross Reference
- Flip/Rotate	- User Annotation
- ProView	- Exam/Series Page
- Display Normal	- Hide Graphics
- List/Select	- Erase
- Ellipse ROI	- Screen Save
- Measure Distance	- Gray Scale Enhancement

-
- ProView visualization algorithms are available to enhance anatomical structures without additional reconstruction time:
  - Four Selections for enhancement of high contrast objects where fine detail is required without aliasing (such as lungs)
  - Three Selections for modifying perceived levels of noise and low contrast discrimination
- Three ways are provided to adjust window/ level of images in focus in order to meet a variety of clinical work environments and user preferences:
  - Six user-programmable keys on the scan control keyboard (F6 - F11), plus one key for returning to prior setting (F5)
  - On-image through middle mouse button
  - BrightBox trackball

Routine Measurements

Image measurement features provided within Exam Rx:

- ROI: Box, Ellipse, Trace	- Hide Graphics
- Measure Distance	- Erase
- Measure Angle	- Screen Save
- MIROI (Multiple Image ROI)	- Grid On/Off
- Report Pixels	

Display Preferences

Display settings available to tailor the overall display (settings apply to all images in all exams):

- Annotation Levels
- Inverse Video
- Next/Prior Each View Port
- Next/Prior Series Binding
- Continuous Report Cursor
- Large font for patient name, patient ID, and accession number

Auto Image Management

The Exam Rx work environment conveniently provides for selection of AutoFilm, , and AutoTransfer (across a network).

An AutoFilm Composer provides a simple programming interface for automated filming set-up.

Batch Filming is accomplished through a single keystroke that automatically prints an entire series at a time.

Manual Image Filming

- On-screen filming is available for any analog or digital camera using a 3M-952 protocol.
- Images may be individually filmed manually via “drag and drop” to the on-screen Film Composer.
- Print Series permits automatic printing of an entire series with one keystroke.
- Page filming permits creation of an entire film with one keystroke.
- Multiple image formatting allows filming of multiple images in a single film frame.
- Film formats supported are 1:1, 2:1, 4:1, 6:1, 8:1, 9:1, 12:1, 15:1, 16:1, 20:1, 24:1, 25:1, 30:1, 35:1, 42:1, and 35-mm slide

Important note: The Optima™ CT660 comes standard with a DICOM Print Interface configurable for multiple DICOM Print destinations. Connections with cameras that do not support DICOM Print may require a filming interface (purchased separately).

To save further filming cost, the Operator Console can directly print to a postscript printer such as the GE Color Printer available as an option.

ImageWorks

ImageWorks software is designed to take advantage of the Optima™ CT660 computer and image processor. This desktop environment includes image management and networking.

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Because some of the image analysis and display features of ImageWorks replicate those in Exam Rx, the next section describes only features that are incremental or significantly different.

Image Analysis

- **Multi-Projection Volume Reconstruction** (MPVR): Quick and easy way to generate volumetric images for CT angiography without thresholding data or removing unwanted anatomy. An entire volume is used to generate images in any plane, creating real-time frames of reference at the same time;
- Clinical utility is extended via two additional modes:
  - MIP - enhances contrast and improves visualization of calcifications
  - Average - generates 2D radiographic images
  - Volume Rendered 3D
- **Multi-planar Reformation** (MPR): Provides real-time assessment of anatomy in offaxis planes. Sagittal, coronal, oblique and curved planar reformations available;
- **Batch reformatting** can also be defined and executed for later viewing if desired;
- Image Addition and Subtraction: Includes image addition of more than two images at a time;
- **Direct MPR** allows customer to move from routine 2D review to prospective 3D image review of axial, sagittal, coronal, and oblique planes while enabling automated protocol-driven batch reformats to be created and networked to their desired reading location, reducing total exam time and increasing technologist and radiologist productivity.
- **Exam Split*** provides customers with the capability to "split" a series of patient images into separate groups. These new smaller image groups can then be networked to desired reading stations for multiple "reads" and multiple billings on select patient exams. Virtual mode provides ability to send window level values, flip & rotate images, and compatibility with MPPS.
- **Data Export** provides CT scanner customers with a stand-alone tool to convert clinical images into PC-friendly formats like .jpeg, .mpeg, and .avi, creating more flexible report creation for both referring physicians and patients. Images can then be saved using Data Export tool to CD or transferred (FTP) to an IP destination.

Image Display

- Magnifying Glass allows quick 2X magnification window that can be moved over an image.
- Image Scroll moves an image within its' own window.
- Groupings allow application of window level values; magnification/minification; image scroll or flip and rotate to a user-defined image set.
- Save State stores user-selected image orientation and window/level with each data set.
- Window/Level values may be:
  - Preset to provide six on-screen instant window/level settings
  - Set independently for up to 16 images on the screen
  - User-modified in discrete or variable steps
  - Adjusted real-time on-image by holding down the middle mouse button and moving the mouse
- Cine mode provides paging in up to 4 view ports of up to 128 previously stored CT or MR images at full selected display frame rate. For more than 128 images, display frame rate may be reduced.
- Cine mode also provides temporal, spatial or manual playback loops.
- Text Page displays patient scan information

Image Annotation

- Image annotation and cursor are shadowed to permit ease in reading.

Image Management

- Images save to a CD-R or DVD-R with DICOM Interchange.

Direct MPR

- **Direct MPR** enables automated protocol-driven axial, sagittal, and coronal reformats. Reformatted images may be routed to multiple network destinations, eliminating the need to transfer and store all thin-slice data.
- Direct MPR provides an interactive axial review mode that can change the slice thickness reconstruction instantaneously.
- The user selects the volume to be specifically analyzed and chooses the slice thickness to be displayed as axial, sagittal, coronal and oblique images. The user can then save a number of recon images sets, viewing a large number of slices for pure axial or multi-planar review and filming.
- Batch film can typically enable you to reduce filming images by 50%, thickening the slab from 0.625 to 1.25mm or 1.25 to 2.5mm with no information loss.

Image Networking

Exams can be selected and moved between the Optima™ CT660and any imaging system supporting the DICOM protocol for network send, receive and pull/query. NOTE: Because the Optima™ CT660creates images in pure DICOM format, exams *cannot* be moved from the Optima™ CT660 to MR Signa Advantage, CT HiSpeed Advantage or the Advantage Independent Console systems.

Image transfer time using DICOM protocols is 10fps on a 1000baseT network.

DICOM Interchange allows the saving of any image from the database, along with PC viewer to a CD-R or DVD-R without marking the exam/series or image as archived for exam transfer between stations that are not networked or pass along to referring physicians or patients.

DICOM Conformance Standards

For detailed information, please reference DICOM conformance statement DOC063565r3-4_CS.

- DICOM Storage Service Class
- Service Class User (SCU) for image send
- Service Class Provider (SCP) for image receive
- Service Class User (SCU) for storage commitment
- DICOM Query/Retrieve Service Class
- DICOM Storage Commitment Class Push
- DICOM Modality Worklist

Asterisk*: Option

- DICOM Modality Performed Procedure Step
- DICOM Print
- DICOM Structured Dose Report

Filming Protocol

- 3M-952 Standard

On-line User Documentation

This innovative feature provides on-screen, on-line support of system features via a multi-media CD-ROM player and is integrated into a tower on operator console for easy access. A well-indexed table of contents helps speed access to information. The CD can be viewed on the system or on a PC.

System Component Specifications

Gantry

Advanced slip ring design continuously rotates generator, tube, detector and data acquisition system around the patient.

- Aperture: 70 cm
- Tilt: ± 30°
- Tilt Speed: 1°/s
- Focus to Detector: 95 cm
- Focus to Isocenter: 54 cm
- Maximum SFOV: 50 cm
- Rotational Speeds (s): 360° in 0.35*, 0.375*, 0.40*, 0.425*, 0.45*, 0.475*, 0.50, 0.60, 0.70, 0.80, 0.90, 1.0, and 2.0
- Remote Tilt from Operator's Console
- Breathing lights and countdown timer
- Cardiac gating indicator light
- Start scan button with countdown to X-ray on
- Scan plane toward front of gantry for improved positioning access

Biopsy and interventional studies have been facilitated through a more streamlined gantry shroud, and bilateral table/gantry controls and gantry display that maximize maneuverability while working next to the gantry.

Laser Alignment Lights:

- Define both internal and external scan planes to ± 1 mm accuracy
- Operate over full range of gantry tilt; activated any time during exam (with tube stationary)
- Coronal light remains perpendicular to axial light as gantry tilts.

Visual readout is easy to read from the tableside or from the operator console. Gantry tilt controls are located on the side of the gantry.

Asterisk*: Option

Table

Table configurations and specifications

	Table
Vertical Range*	430mm to 991mm
Vertical Scanable Range*	791mm to 991mm
Elevation Speed Full range motion	Less than 22sec (Fast) Less than 45sec (Slow)
Elevation Accuracy Position repeatability	±1.5mm
Horizontal Range	1745mm
Horizontal Scanable Range (Axial)**	1730mm
Horizontal Scanable Range (Helical)**	1580mm
Horizontal Scanable Range (Scout)**	1600mm
Cradle Speed Max Horizontal Speeds	137.5(150***) mm/sec
Cradle Speed Operator-controlled slow speed operation	5mm/sec ±3%
Cradle Speed Operator-controlled fast speed operation	125mm/sec ±2%
Position repeatability	±0.25mm
Longitudinal accumulated position error	±0.25mm±0.06%
Table Load Capability	227kg*** (500lbs)

* The distance from the Table bottom to the cradle upper side surface

** Table Height, Gantry Tilt and scanning software determine the scannable range.

*** During Move to scan operation

X-Ray Tube

Performix™ 40 X-ray Tube Unit, Design optimized for exams requiring a large number of scans without tube cooling.

- Maximum Power: 72kW
- Dual Focal Spots:

  Small Focal Spot:
  - 0.9* 0.7 IEC 60336: 2005
  - 0.7* 0.6 IEC 60336: 1993

  Large Focal Spot:

- 1.2* 1.1 IEC 60336: 2005
- 0.9* 0.9 IEC 60336: 1993

Maximum mA for each kVp selection:

kVp	Small Spot Max mA	Large Spot Max mA
80	300	400
100	240	480
120	200	600
140	170	515

- Thermal Ratings:

  - Maximum Anode Heat Content (Reference: IEC 60613):
    The maximum anode heat capacity: 4.7 MJ (6.3MHU)

- X-ray tube assembly fan angle is a minimum of 56.37°
- Average time to replace tube: ≤ 9 hours

High Voltage Generation

- High-frequency on-board generator. Continuous operation during scans.
- kVp: 80, 100, 120, 140
- Max Power: 72kW
- If distance from iso center to detector is same, the "Short Geometry Design" makes Optima™ CT660 72kW generator power can be equivalent to 89kW relative to conventional long geometry scanners
- mA: 10 to 600mA, 5mA increments
  600mA is available only for ShapShotPulse* study.

V-Res Detector

• 58,368 individual elements composed by 64 rows of 0.625 mm thickness at isocenter
• 64 rows x 912 Elements (888 active elements; other elements for reference)

• 99% absorption efficiency (at 120 kV)

Data Acquisition System

• 64 Slice configuration
• 2 - 0.35 second scan
• 2,460 Hz maximum sample rate
• 861 - 1968 views per rotationScan/Control Unit

Scan /Control Unit

Optima™ CT660's console is designed as a silent operator consol, up to 80% noise reduction compared to prior GE technology.

Host Computer	
CPU	Intel E5540 DUAL 2.53GHz Quad Core Xeon Processors QPI
O/S	64-bit
Cache	x 6MB shared L2 Cache
RAM	24GB DDR3-1333MHz
Graphics Card	Nvidia Quadro FX1800 PCI Express 16x
Reconstruction Unit	Commercial-Off-The-Shelf Graphics Processor add-in card
Storage	
Applications & Images	146GB 10,000 rpm miniSAS HDD
Image Disk	146GB 10,000 rpm miniSAS HDD
Scan Data Storage	5 x 300GB SAS 15,000rpm HDD

1,792GB Disk(system, image, scan disks) stores up to 250,000 512*2 images and 3520 scan rotations at 64 slice mode or up to 1,500 scan data files, or up to 300 exams.

Software Architecture

- Software architecture based on industry standards and client-server design

Peripherals

- Scan control keyboard assembly with intercom speaker, microphone and volume controls.
- **Color LCD monitors (2 standard)**:
  - 19 inch diagonal width
  - 1280 x 1024 dot resolution
  - Horizontal & Vertical viewing angle: 176 degrees
  - Horizontal synchronization range: 31.5 - 81.1 kHz
  - Vertical synchronization range: 50 - 85 Hz

- **DVD-RAM (Scan Data & System State):**
  - 9.4 GB total. 4.7 GB per side
  - Assigned for Scan Data and System State (Protocol files)
- **DVD-R/CD-R (DICOM Interchange):**

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- 4.7 GB capacity (DVD)
- Up to 7,168 image storage (DVD)
- Supports CD-R, DVD-R

- 3-Button Mouse
- 3-Button Trackball*

Image Networking

- Standard auto-configuring Ethernet (UTP connection) - 1000/100/10 BaseT
- Direct network connection; multi-suite ethernet card not required for gateway out of suite
- Protocols supported:
  - DICOM network send (one IP address at a time) and receive, pull/query, and storage commitment push
  - InSite point-to-point

Standard, Selectable Items

- Patient Positioning System: 500 pounds (227.3kg) table
- Keyboard: English, French, German, Italian, Spanish, Portuguese, Dutch, Norwegian, Finnish, Swedish, Danish and International English.
- Freedom Work Space standard or Optima desk
- Cable Set, STD Cable or Long Cable.

Compatible Options

The following options are available on the Optima™ CT660 and Xtream console. See Advantage Workstation (AW) product data sheet for list of available AW options.

Scanner Options:	
• ConnectPro	• Volume helical shuttle
• Exam Split	• SmartStep package
• Volume shuttle	• Enhanced Xtream Injector
Cardiac Options:	
• SmartScore pro acquisition	• 0.35sec rotation
• ECG Trace on Console	• Card IQ Snapshot
• ShopShut Pulse option	• Cardiac Enhancement Filter
Operator Console Options:	
• Volume Viewer 3.1	• Advantage CTC Pro
• AVA Xpress	• Perfusion 4 Multi-Organ
• AutoBone Xpress	• Perfusion4 Neuro
• CardIQ Xpress 2.0 Plus	• DentaScan
• CardEP	
Hardware Options:	
• **Uninterruptible Power Supply (UPS)**	• **Shallow Head Holder**

Asterisk*: Option

License

Volume Helical Shuttle™ and Cardiac scan are licensed for use with a GE x-ray tube. Use of a third party x-ray tube will require the purchase of an additional license for these features.

Siting Requirements

For siting requirements details, see Pre-Installation Manual Direction 5368510-1.

System components dimensions:

System component	Net weight kg (lb)	Overall widthx Depth mm (in.)
Gantry	1810 (3990)	2050x1039 (81x41)
Dollies (each)	114 (250)	
GT1700V table with 227kg patient	707 (1559)	660x4456 (26x175)
Power Distribution unit (PDU-80)	370 (816)	650x2347 (26x92)
Console	80 (176)	470x736 (19x29)
Monitor LCD (each)	9 (20)	420x247 (16.5x9.7)
Freedom Worskpace	44 (97)	1300x620 (51x24)
Optima desk	57 (126)	1300x895 (51.2x35.2)

Warranty

The published Company warranty in effect on the date of shipment shall apply. The Company reserves the right to make changes.

General Electric Company reserves the right to make changes in specifications and features shown herein, or discontinue the product described at any time without notice or obligation.

Regulatory Compliance

Laser alignment devices contained within this product are appropriately labeled according to the requirements of the Center for Devices and Radiological Health.

This product is a CE-compliant device that satisfies IEC 60601-1-1 and applicable collateral and particular standards, including regarding

Electro-Magnetic Compatibility (EMC) and Electro-Magnetic Interference (EMI).

The product complies with radiation performance standards 21 CFR subchapter J.

Optima™ CT660 may not be available in all markets.

General Electric Company doing business as GE Healthcare

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