GE
Sensing & Inspection Technologies

The ISOVOLT *Titan E* X-ray Generator

GE imagination at work

Robust, Reliable and Highly Accurate Stationary X-ray Generators for the Widest Range of Applications.

The Reference Class for X-ray generators is based on the proven ISOVOLT platform, which offers more than 25 years experience with thousands of installations across the world.

Designed for radiography, radioscopy, radiometry and life-science applications, which place the highest demands on reliability and exposure quality, the range of *Titan E* generators and accessories meets the different degrees of automation and customization, required throughout the industrial and scientific sectors.

A wide range of systems is provided. Generators and tubes can be 160 kV, 225 kV, 320 kV, 420 kV or 450 kV, and can be operated from as low as 5 kV or a current range exceeding up to 45 mA*.

Titan E control is a modern, state-of-the-art industrial control module for fail-safe and intuitive system operation.
A powerful range of suitable accessories complements the integration and application capabilities for all facets of industrial or scientific environments.

Unique Features at a Glance

Highest exposure quality

A reproducibility of ± 0.01 % for tube current (mA) and tube voltage (kV) provides highest possible stability of radiation dose rate with fluctuations < 0.05 %.

This excellent dose reproducibility fits both, *Titan E* applications that demand the highest accuracy, such as calibration of detectors or dosimeters, as well as radiography applications.

Extremely low ripple ensures outstandingly stable High Voltage for optimized material penetration with excellent efficiency factors.

The extended tube range of 5 kV to 450 kV in conjunction with the excellent maximum current of 45 mA*, ensures optimized imaging contrast and very high penetration power. This results in short exposure times in various operation modes for different material.

Highest device performance

Rugged generator design with intelligent tube integration and permanent system monitoring, ensure highest performance, from peaked intermittent, up to permanent 24/7 operation**. This results in consistent performance over various exposure modes and operation conditions.

Unmatched ramp-up times (< 1.5 sec) support applications requiring fast inspection cycles*.

100% duty cycle, for continuous operation in in-line systems**.

Optimized equipment performance results in increased productivity and reduced total cost of ownership.

Highest device availability

Continuous improvements on critical system parameters to increase robustness and resistance against external influences, guarantee high system up-times that give the operator steady revenue streams and perfect time utilization.

Stackable and modular design allows easy field service.

Automatic event recording provide instant information for process control and system diagnosis either on site or via optional remote access.

Selected tubes feature maintenance-free High voltage connections, ensuring highest productivity, while minimizing operational risks.

Fully automated tube warm-up procedures safeguard tube operation and ensure maximum tube life.

Flexible usage

Built for a wide range of applications in different environmental conditions, *Titan E* generator solutions are for all NDT needs, life science applications and also measurement and calibration tasks.

Titan E is available in 3-phase, 400 V or single-phase, 230 V input power rating. As a result easy integration into different power environments without regional limitations is possible.

*) depending on permissable tube data
**) subject to optional generator cooling

Smart user interaction

The stand-alone control module is available in both, a rugged and ergonomic desktop housing, and also as 19" adapter version, for easy control-desk integration.

The design permits intuitive and fatigue-proof operation through a large graphical display, rotary knob control, function keys and a keypad for fast and direct inputs.

The control interacts with the operator in clear text with four international character sets and 16 languages.

Intelligent and safe operation

Automatic tube configuration in conjunction with real time clock powered automated warm-up procedures enhance operational safety and maximize equipment lifetime.

On board electronics feature reserved memory for up to 250 programmable operation modes, records of the last 128 warm-up cycles and 512 operation event-logs and a structured setup menu for individual performance settings.

Built in safety features such as redundant interlock monitoring, cooling flow rate watchdog signals, operating temperature and other system status information are visible on the operation display.

This leads to instant recognition of system status and health.

Easy to integrate

The *Titan E* considers typical OEM needs, providing kits, interfaces and protocols for all kinds of industrial system integration (RS 232, Profibus).

It allows full external control of X-ray equipment and simplifies remote visualization – even without connecting the control module.

Extension of diagnosis capabilities by remote access via Internet or dial-up line is available as an option.

Titan E Control

A user-friendly, multi-language control features a clear full-graphical display, that allows simultaneous readings of set and actual operating parameters. Embedded in an ergonomic and rugged desktop or optional 19" rack mounting housing, full control for X-ray operation is established. Intuitive guidance through diverse menus as well as unmistakable messages for clear interventions are provided with this module.

The operating concept provides interaction with turning speed sensitive rotary knob, function keys, a numberic keypad and safety relevant buttons for X-ray operation as well as a key switch.

The multifunctional rotary knob can be used to set kV, mA, exposure time and several configuration settings.

By a progressive change of voltage and current via rotary knob the kV and mA settings can be accurately changed with different granulations of 0.1kV / 1 kV / 10 kV respectively 0.01 mA (if enabled) / 0.1 mA / 1 mA. This allows optimized one-hand operation for radioscopy and many other applications.

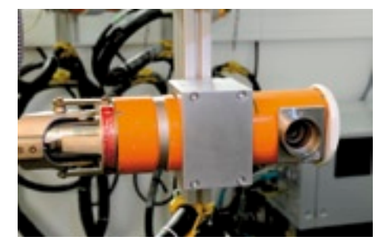
Features such as free configurable exposure programmes, or special programmes for constant power, constant current and manual operation cater for individual demands for radiographic or radioscopic inspections. The multi-lingual user display with 16 different languages and extended character sets for Japanese, Cyrillic and Chinese enables comprehensible and simple interaction. Optional, the entire system control with graphical visualization can be done via a stand-alone PC based platform.

Titan E provides automatic and manual warm-up modes for optimized tube conditioning. A special extended warm-up mode safeguards tube performance under severe conditions and setups.

Benefits

Proven platform serving broad range of applications

- Tube protection due to automatic warm-up procedures and extended warm-up modes to safeguard tube performance.
- Smart and intuitive user interaction, with several integration possibilities facilitating higher productivity.
- Excellent dose reproducability with extremely stable high voltage section for optimized exposures.
- Convenient integration into several external platforms, such as automated testing machines, leveraging different interface features for device control, monitoring and visualization.
- Excellent endurance and performance for permanent or intermittent operation.
- Less intensive maintenance combined with easier serviceability reduces total cost of ownership.
- Broad range of tubes, accessories and kits available.



Accessories

Safety devices
- Primary interlock switch
- Alarm box
- Switch box
- Flash- and warning lamps
- Country specific safety kits

HV cables
- In different standard lengths, with quick-lock or flange connections with rubbercone plugs or maintenance-free angle plugs.

Integration and solution kits
- Exposure Calculator (PC Software)
- *Titan E* PC (External PC based visualization)
- PROFIBUS Extension Kit

Dosimetry and calibration kits
- Voltage divider (incl. PTB certification)

Pumps and coolers
(See pictures below)

WL 3000 SE

OW 4002

OL 4503

OLK 50

Voltage Divider

ISOVOLT

Selection of unipolar Tubes*

	ISOVOLT 160 M2 0.4-1.5	ISOVOLT 160 M2 0.4-3.0	ISOVOLT 160 M2 0.4-0.4HP	ISOVOLT 160 MM2/ HP	ISOVOLT 160 MC2	ISOVOLT 160 M1	ISOVOLT 225 M2 0.4-3.0	ISOVOLT 225 M2 0.4-1.5	ISOVOLT 225 MM2/ HP
Max. Tube Voltage (kV)	160	160	160	160	160	160	225	225	225
Tube Current (mA) (at Max. Tube Voltage)	10	19	6	11	6	15,6	13	7.0	8
	4	4	6	5		5.6	3.0	3.0	3.5
Max. Anode Dissipation (W)	1600	3000	1000	1800	1000	2500	3000	1600	1800
	640	640	1000	800		900	640	640	800
Nom. Focal Spot Value IEC 336	1.5	3.0	0.4		0.3 x 3		3.0	1.5	
	0,4	0.4	0.4				0.4	0.4	
Focal Spot Size EN 12 543 (mm)	3.00	5.50	1.00	1.00	0.40 x 4.00	3.00	5.50	3.00	1.00
	1.00	1.00	1.00	0.40		1.00	1.00	1.00	0.40
Inherent Filtration (mm)	1.0 / Be	1.0 / Be	1.0 / Be	1.0 / Be	0.5 Ti + 2.0 H_2O + 2.0 Al	1.0 / Be	1.0 / Be	1.0 / Be	1.0 / Be
Emergent Beam Angle	40°	40°	40°	30° x 40° Asym.	40° x 360° Sym.	40°	40°	40°	30° x 40° Asym.
Weight (kg (lbs))	8.5 (18.7)	8.5 (18.7)	8.5 (18.7)	8.5 (18.7)	8.0 (17.6)	8.5 (18.7)	11.9 (26.2)	11.9 (26.2)	11.9 (26.2)

Selection of bipolar Tubes*

	ISOVOLT 320/7	ISOVOLT 320 M2 4.5 - 13	ISOVOLT 320/13	ISOVOLT 320 M2 0.4 - 1.0 HP	ISOVOLT 420/5	ISOVOLT 450/5	ISOVOLT 450/10	ISOVOLT 450 M2/10	ISOVOLT 450 M2 0.4 - 1.0 HP
Max. Tube Voltage (kV)	320	320	320	320	420	450	450	450	450
Tube Current (mA) (at Max. Tube Voltage)	7	13	13	5.6	5.3	5	10	10	3.3
	3	4.5	5	2.5	2.3	2.1	3.7	2	1.5
Max. Anode Dissipation (W)	2240	4200	4200	1800	2240	2240	4500	4500	1500
	960	1500	1680	800	960	960	1680	900	700
Nom. Focal Spot Value IEC 336	1.8	4.0	3.5		1.5	1.5	3.5	3.0	
	0.8	1.5	1.5		0.8	0.8	1.5	1.2	
Focal Spot Size EN 12 543 (mm)	3.60	5.50	6.30	1.00	3.60	3.6	6.30	5.50	1.00
	1.90	3.00	3.00	0.40	1.90	1.90	3.00	2.50	0.40
Inherent Filtration (mm)	7.0 / Be	3.0 / Be	7.0 / Be	3.0 / Be	7.0 / Be	7.0 / Be	7.0 / Be	5.0 / Be	5.0 / Be
Emergent Beam Angle	20° x 40°	40°	40°	30° x 40° Asym.	20° x 40°	20° x 40°	40°	40°	30° x 40° Asym.
Weight (kg (lbs))	40 (88)	40 (88)	40 (88)	40 (88)	90 (198)	90 (198)	90 (198)	90 (198)	90 (198)

* The ISOVOLT *Titan E* series can be equipped with various types of tube housing to suit your application. Ask your GE v representative for an application specific consultation and a full list of tube housings

Maintenance free angle plug

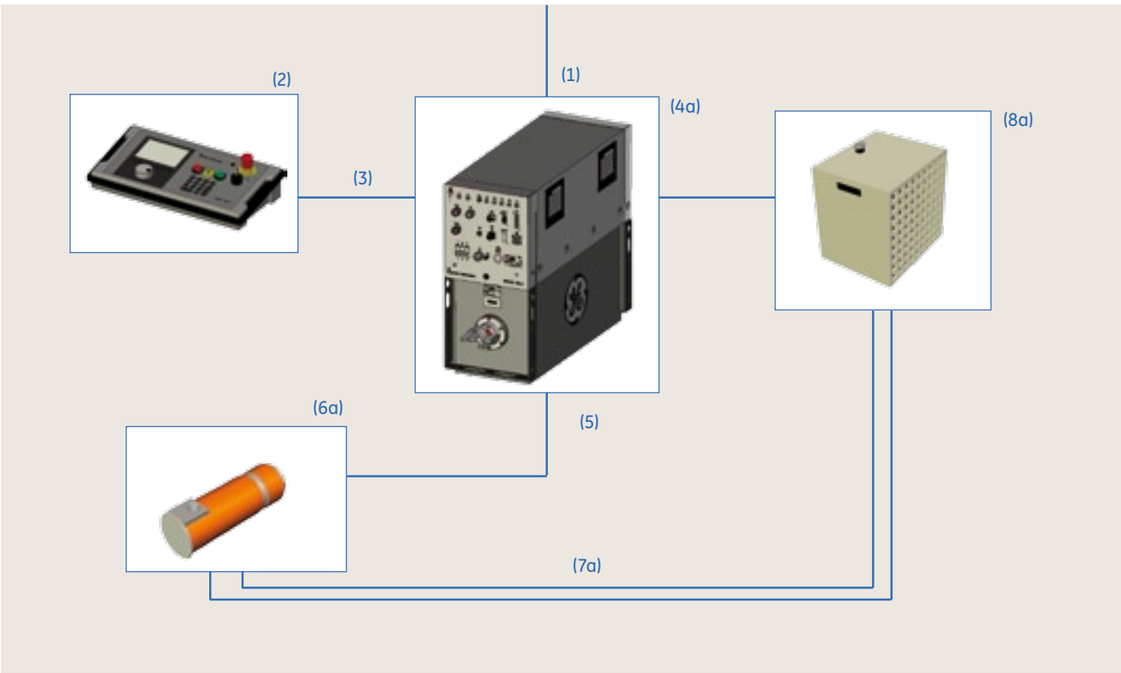
Junction Kits and Safety Devices

Diaphragms

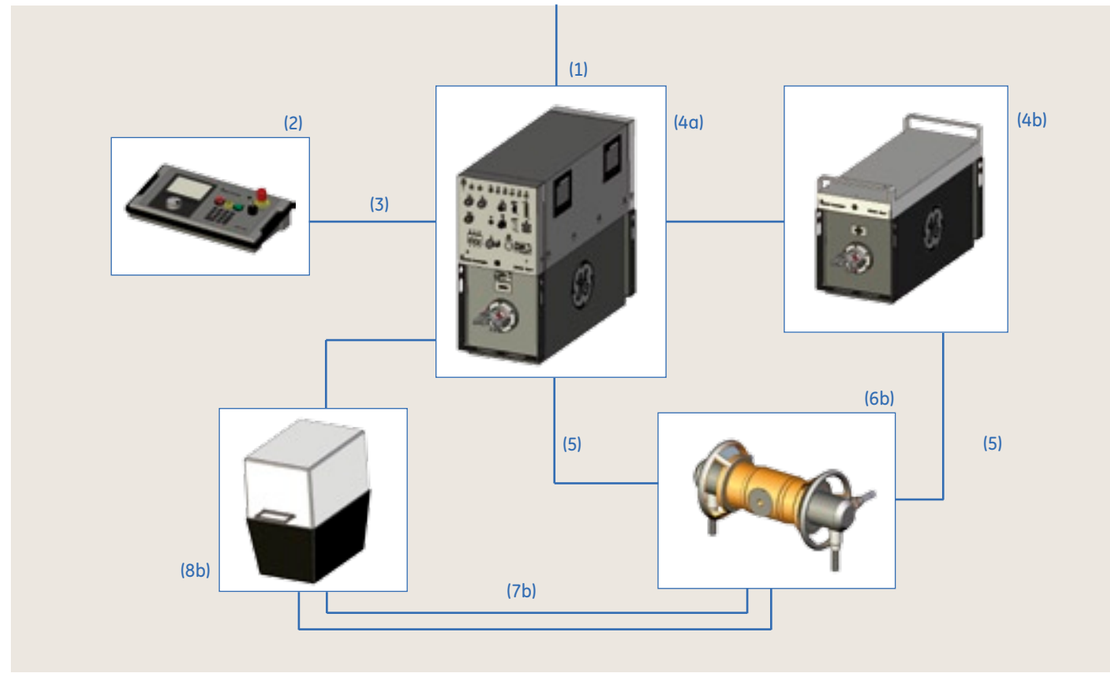
Column Stand

System Layout for Exemplary Setups

Unipolar operation



Bipolar Operation



Legend

(1) Mains connecting cable, standard length 10 m / 32 ft, with wire end ferrules

(2) Control Module ISOVOLT *Titan E* in desktop housing (optional 19" rack house)

(3) Connecting cable control/power stage, standard length 10 m (max. 100 m) / 32 ft. (max. approx 320 ft.)

(4a) High Voltage Generator, 160 kV or 225 kV, Cathode, with integrated power module *TITAN E*

(4b) High Voltage Generator, 160 kV or 225 kV, Anode incl. Connecting cable

(5) High Voltage Cables, 160 kV or 225 kV, standard length 5 m / 16 ft (max. 20 m / 64 ft for 160 kV - 320 kV; max. 10 m / 32 ft for 420 kV and 450 kV)

(6a) Unipolar Tube Housing (see tube overview or separate product information)

(6b) Bipolar Tube Housing (see tube overview or separate product information)

(7a) Water hoses, standard length 10 m (max. 20 m) / 16 ft (max. 32 ft)

(7b) Cooling Oil hoses, standard length 6m (max. 20 m) / 19 ft (max. 64 ft)

(8a) Water Cooling Pump with built in flow rate monitor, see separate specification

(8b) Oil Cooling Pump, see separate specification

Input and output connections

- RS 232 interface for connection of machine controls
- Interlock as per DIN 54113.
- Interlock as per United States Radiation Control Act of 1968, § 1020.40.
- Additional warning output that is active during pre-warning time.
- External START/STOP.
- External EMERGENCY-STOP.
- Cooling system.
- External warning flash lamp (fail-safe).
- "Mains ON" (230V / 2A[2]).
- "High Voltage ON" (230V / 2A[2]).
- Potential-free contact, for "Mains ON" (60V AC / 75V DC / 2A[1]).
- Potential-free contact, for "Pre-warning Time ON" (30V AC/36V DC / 0.5A[1]).
- Potential-free contact, for "High Voltage ON" (60V AC / 75V DC / 2A[1]).

1) This voltage corresponds to the max. operating voltage (rating as per VDE 0110 Group B).

2) These 230 V contacts are collectively fused with 2.5 A.

Technical Specifications

Unipolar Systems

High Voltage Generator		
Max. Output Voltage	160 kV	225 kV
Max. Output Current	45 mA	45 mA
Max. Output Power	4,5 kW, Limited by Tube Specification	4,5 kW, Limited by Tube Specification
High Voltage Ripple	5 V/mA (With High Voltage Cable 10 m), 40 kHz	5 V/mA (With High Voltage Cable 10 m), 40 kHz
Insulation	Oil	Oil
Housing Dimensions (Cathode) (W x D x H)	350 x 870 x 850 mm (13.8" x 34.3" x 33.5")	350 x 870 x 850 mm (13.8" x 34.3" x 33.5")
Weight (Cathode)	189 kg (417 lbs), Including Power Module	189 kg (417 lbs), Including Power Module
Tube Voltage		
Preselection and Setting	From 5 to 160 kV in 0.1 kV / 1 kV / 10 kV	From 5 to 225 kV in 0.1 kV / 1 kV / 10 kV
Digital Display of Set and Actual Values	Simultaneous 4 Digits Each	Simultaneous 4 Digits Each
Display Resolution	0.1 kV	0.1 kV
Accuracy	< ±1%	< ±1%
Reproducibility	±0.01% at Constant Temperature Level	±0.01% at Constant Temperature Level
Temperature Drift	< 65 ppm/°C	< 65 ppm/°C
Tube Current		
Preselection and Setting	From 0.1 to 45 mA in 0.01 mA / 0.1 mA / 1 mA	From 0.1 to 45 mA in in 0.01 mA / 0.1 mA / 1 mA
Digital Display of Set and Actual Values	Simultaneous 4 Digits Each	Simultaneous 4 Digits Each
Display Resolution	0.1 mA / 0.01 mA	0.1 mA / 0.01 mA
Accuracy	± 1%	±1%
Reproducibility	± 0.01% at Constant Temperature Level	± 0.01% at Constant Temperature Level
Temperature Drift	< 65 ppm/°C	< 65 ppm/°C
Exposure Time		
Programmable Timer	Non-Volatile Memory	Non-Volatile Memory
Preselection and Setting	From 0.1 to 99.9 Minutes in 0.1 Min. Increments or from 1 to 999 Sec. in 1 Sec. Increments or as direct Min./Sec. value (up to 99'59")	From 0.1 to 99.9 Minutes in 0.1 Min. Increments or from 1 to 999 Sec. in 1 Sec. Increments or as direct Min./Sec. value (up to 99'59")
Digital Display of Set and Actual Values	The Remaining Time Is Displayed, i.e. After a Mains Failure Exposure Can Be Continued Without any Time Error	The Remaining Time Is Displayed, i.e. After a Mains Failure Exposure Can Be Continued Without any Time Error
Prewarning Time		
Preselection and Setting	Digital Setting From 2 to 250 Seconds or de-activated	Digital Setting From 2 to 250 Seconds or de-activated
Programmed Mode		
Number of Storable Programs	250	250
Warm-Up	Automatic Intelligent Tube conditioning based on Real-time Clock Extended warm-up for special conditioning	Automatic Intelligent Tube conditioning based on Real-time Clock Extended warm-up for special conditioning
X-ray Tube Setup	8 Tube selectable from a database of > 40 pre-programmed tubes	8 Tube selectable from a database of > 40 pre-programmed tubes
Operation History	512 Events (256 On/Off Events)	512 Events (256 On/Off Events)
Warm-up History	128 Events	128 Events
Control Module		
Dimensions (W x D x H)	460 x 270 x 100 mm (18.1" x 10.6" x 3.9") Built into Desk Housing	460 x 270 x 100 mm (18.1" x 10.6" x 3.9") Built into Desk Housing
Weight	4.9 kg (10.8 lbs) Including Desk Housing	4.9 kg (10.8 lbs) Including Desk Housing
Connected Loads		
Power connection	1N PE 230 V ± 10% 50/60 Hz 3N PE 400/230 V ±10%, 50/60 Hz, 3-Phase, Grounded Neutral TN-S or TN-C-S Mains (Star Connected System, Optional 3-Phase Isolation Transformer)	1N PE 230 V ± 10% 50/60 Hz 3N PE 400/230 V ±10%, 50/60 Hz, 3-Phase, Grounded Neutral TN-S or TN-C-S Mains (Star Connected System, Optional 3-Phase Isolation Transformer)
Grounding	Separate Grounding for X-ray Tube and High Voltage Generator (Minimum 6 mm^2)	Separate Grounding for X-ray Tube and High Voltage Generator (Minimum 6 mm^2)
Mains Fuses	63 A (1N PE) or 25 A (3N PE) Time-Delay Fuses, Customer-Supplied	63 A (1N PE) or 25 A (3N PE) Time-Delay Fuses, Customer-Supplied
Operating Temperature Range	0°C to +40°C	0°C to +40°C
Storage Temperature Range	-30°C to +70°C	-30°C to +70°C

Bipolar Systems

High Voltage Generator		
Max. Output Voltage	-160 kV (Cathode), +160 kV (Anode)	-225 kV (Cathode), +225 kV (Anode)
Max. Output Current	45 mA	45 mA
Max. Output Power	4,5 kW (Cathode) 3 kW (Anode) Limited by Tube Specification	4,5 kW (Cathode) 3 kW (Anode) Limited by Tube Specification
High Voltage Ripple	10 V/mA (With High Voltage Cable 10 m), 40 kHz	10 V/mA (With High Voltage Cable 10 m), 40 kHz
Insulation	Oil	Oil
Operation History	512 Events (256 On / Off events)	512 Events (256 On / Off events)
Warm-up History	128 Events	128 Events
Housing Dimensions (Cathode) (W x D x H)	350 x 870 x 620 mm (13.8" x 34.3" x 24.4") 350 x 870 x 850 mm (13.8" x 34.3" x 33.5")	350 x 870 x 620 mm (13.8" x 34.3" x 24.4") 350 x 870 x 850 mm (13.8" x 34.3" x 33.5")
Weight (Anode)	123 kg (272 lbs)	123 kg (272 lbs)
Weight (Cathode)	189 kg (417 lbs), Including Power Module	189 kg (417 lbs), Including Power Module
Tube Voltage (Anode)		
Preselection and Setting	From 5 to 320 kV in 0.1 kV / 1 kV / 10 kV	From 5 to 450 kV in 0.1 kV / 1 kV / 10 kV
Digital Display of Set and Actual Values	Simultaneous 4 Digits Each	Simultaneous 4 Digits Each
Display Resolution	0.1 kV	0.1 kV
Accuracy	< ±1%	< ±1%
Reproducibility	±0.01% at Constant Temperature Level	±0.01% at Constant Temperature Level
Temperature Drift	< 65 ppm/°C	< 65 ppm/°C
Tube Current		
Preselection and Setting	From 0.1 to 45 mA in 0.01 mA / 0.1 mA / 1 mA	From 0.1 to 45 mA in 0.01 mA / 0.1 mA / 1 mA
Digital Display of Set and Actual Values	Simultaneous 4 Digits Each	Simultaneous 4 Digits Each
Display Resolution	0.1 mA / 0.01 mA	0.1 mA / 0.01 mA
Accuracy	± 1%	±1%
Reproducibility	± 0.01% at Constant Temperature Level	± 0.01% at Constant Temperature Level
Temperature Drift	< 65 ppm/°C	< 65 ppm/°C
Exposure Time		
Programmable Timer	Non-Volatile Memory	Non-Volatile Memory
Preselection and Setting	From 0.1 to 99.9 Minutes in 0.1 Min. Increments or From 1 to 999 Sec. in 1 Sec. Increments or as direct Min./Sec. value (up to 99'59")	From 0.1 to 99.9 Minutes in 0.1 Min. Increments or From 1 to 999 Sec. in 1 Sec. Increments or as direct Min./Sec. value (up to 99'59")
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Prewarning Time		
Preselection and Setting	Digital Setting From 2 to 250 Seconds or de-activated	Digital Setting From 2 to 250 Seconds or de-activated
Programmed Mode		
Number of Storable Programs	250	250
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Weight	4.9 kg (10.8 lbs) Including Desk Housing	4.9 kg (10.8 lbs) Including Desk Housing
Connected Loads		
Power connection	1N PE 230 V ± 10% 50/60 Hz 3N PE 400/230 V ±10%, 50/60 Hz, 3-Phase, Grounded Neutral TN-S or TN-C-S Mains (Star Connected System, Optional 3-Phase Isolation Transformer)	1N PE 230 V ± 10% 50/60 Hz 3N PE 400/230 V ±10%, 50/60 Hz, 3-Phase, Grounded Neutral TN-S or TN-C-S Mains (Star Connected System, Optional 3-Phase Isolation Transformer)
Grounding	Separate Grounding for X-ray Tube and High Voltage Generator (Minimum 6 mm^2)	Separate Grounding for X-ray Tube and High Voltage Generator (Minimum 6 mm^2)
Mains Fuses	63 A (1N PE) or 25 A (3N PE) Time-Delay Fuses, Customer-Supplied	63 A (1N PE) or 25 A (3N PE) Time-Delay Fuses, Customer-Supplied
Operating Temperature Range	0°C to +40°C	0°C to +40°C
Storage Temperature Range	-30°C to +70°C	-30°C to +70°C

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