DUNLEE

SERVICE INFORMATION

CG500 Technical Manual / Instruction for Use

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BEYOND SOLUTIONS

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Illustrations and technical data statement

All illustrations of the equipment in this accompanying document are examples only. Differences in detail can occur in your product because of the installed options, configurations and constant development progress of the product. Reproduction of illustrations can cause loss of detail. Thus, illustrations in this accompanying document do not give an indication of the image quality.

All technical data are nominal or typical values unless specific tolerances are stated.

1 Conditions of acceptability

The information of this section "CONDITIONS OF ACCEPTABILITY" is for the company that puts the CT System that includes this X-ray generator on the market only.
The "Conditions Of Acceptability (COA)" must become part of the risk management of the respective CT System. The company that puts the CT System that includes this X-ray generator on the market has the responsibility for the implementation of these COA to the CT System.

- Only technically qualified and appropriately trained and instructed Field Service Engineers (FSE) must do the service procedures of this CT System generator. The FSE must be authorized to work with radiography equipment in medical applications.
- Use only supplied high voltage cable rated for 75 kV.
- Provide and use the no load plug when performing a no load test.
- Use generator only with closed gantry covers which can only be opened with tools (except during service).
- Ensure adequate connection to protective earth conductor (PE) for all generator components.
- Cables have to be routed and fixed carefully and protected against abrasion (for example, deburred edges, or edge guards).
- Power cycle th generator daily and foresee regular sanity checks to detect generator malfunctions.
- For cyber security: System decision to use firewall at system controller.
- Supply with specified mains supply including correct dimensioned fuses (3 phase mains: 80A slow blow, 120 V auxiliary power: 10A slow blow).
  - The 3 phase mains supply must be fused by a circuit breaker of type B with a rating of 100 A according to IEC60947-2 Ed. 5.1.
  - The circuit breaker shall provide the capability to disconnect all three phases of the mains voltage supply from the generator.
- Cleaning and disinfections with gas is not allowed.
- Do not switch on/off more than 2 times / minute.
- Provide and use adequate lifting tool for heavy components.
- Use the generator within specified environmental conditions.
- EMC filter required to fulfill IEC 60601-1-2.
- The generator must not be disposed with industrial or domestic waste.
- Expected service lifetime is 10 years. This requires that the X-ray generator is subject to service maintenance according to the requirements of the respective generator Service Information.
- The CT System is responsible for the insulation between the "120 Vac" and the "380/400 Vac" supplies outside the generator.
- The CT System System shall ensure a minimum safety area to stationary parts of the CT gantry as follows:
  - Power Block: 20.5 mm
  - Any other component: 15 mm

  This safety area shall prevent collisions with stationary system components on the gantry.
- The generator air inlets, outlets, and fans shall not be covered or blocked. Additional parts attached to or close to these are to be approved by the generator manufacturer. The direction of airflow inside the Gantry shall not be contradictory to the airflow of the generator components.
- The customer is responsible for adequate fixation of the generator components on the rotating gantry. The customer is responsible for the design of the mechanical connection to the generator components.

– The CT System manufacturer shall analyze the risk of no X-ray during examination and interventional usage because of high voltage generator failures.
– The use in presence of a flammable anesthetic mixture with air or oxygen rich environment or nitrous oxide according to IEC 60601-1 is not allowed.

To be considered on system level

– The system will further analyze the risk, that no images are available when the generator should fail.

2 Instruction for use

The information of this section "Instructions For Use" is for the organization that is responsible for the operation and the operator itself.
The company that puts the CT System that includes this X-ray generator on the market is responsible for the supply of the information of this section in the official language of the country of sale. The supplied information must agree with all local and transregional legal requirements.

Read me, understand me, and obey me!

2.1 Intended purpose

Intended use

The X-ray high-voltage generator is intended to supply high voltage to the X-ray tube housing assembly to initiate emission of X-ray radiation by the X-ray tube that enables the creation of diagnostic images of human patients.

The X-ray high-voltage generator is only used as integrated part of an imaging system and has no medical purpose by its own. The intended treatment, duration and treatment parameters are not defined on X-ray High Voltage Generator assembly level. This is defined by the manufacturer of the imaging system in accordance with the intended use, the intended purpose and the medical purpose as described in the technical documentation of the imaging system.

Intended user population

The X-ray high-voltage generator is remotely controlled by the imaging system, which itself is operated by qualified clinical users only. Further details regarding the intended user and patient population are defined by the manufacturer of the imaging system in accordance with the intended use, the intended purpose, and the medical purpose as described in the technical documentation of the imaging system.

The X-ray high-voltage generator must be installed, repaired and maintained only by technically qualified Field Service Engineers who have received the appropriate instructions and training and who are authorized in particular for the installation and commissioning of radiography equipment in medical applications.

Intended context

The X-ray high-voltage generator is intended to be used in a non-condensing, climate controlled, indoor, clinical environment and is not intended to be used for home care or by lay persons. The X-ray high-voltage generator is intended to be used in permanently installed stationary imaging systems. The use frequency is not limited within the expected service lifetime.

This X-ray high-voltage generator is intended to be used with multiple patients without any special treatment of the X-ray high-voltage generator between examinations. Additional treatment for use with multiple patients may be required and verified by the manufacturer of the imaging system for specific applications.

Operating principles

Contraindications are not defined on X-ray high-voltage generator level, because this is defined by the manufacturer of the imaging system in accordance with the intended use, the intended purpose and the medical purpose as described in the technical documentation of the imaging system.

Specific warnings are provided within the accompanying documents of the X-ray high-voltage generator. The expected service lifetime is referenced in the risk management file and stated in the accompanying documents of the X-ray high-voltage generator.

Essential performance

The X-ray high-voltage generator does neither have essential performance per se. Nor is any function of the X-ray high-voltage generator intended to contribute to the essential performance of the X-ray systems in which it is integrated.

2.2 Safety information

These Instructions For Use are made to make it possible to work safely with the X-ray generator. Operate the X-ray generator only in compliance with the safety instructions in this document. Do not use it for purposes other than for that it is intended.
Additionally, obey the safety instructions of the respective CT System and the respective X-ray tube assembly.

- If the X-ray generator has electrical, mechanical, or radiological defects, do not use it. This fact particularly applies to faulty indicators, displays, warnings, and alarms.
- Do not install the X-ray generator to other medical devices than the CT System that is supplied.
- The manufacturer of the X-ray generator is responsible for the safety features of its products. The responsibility only becomes effective if the manufacturer exclusively does maintenance, repairs, and modifications on the X-ray generator.
- For the X-ray generator correct operation and regular, competent maintenance are necessary. Refer to chapter Maintenance on page 14.
- Do not operate this X-ray generator along with combustible anesthesia substances.
- Make sure that the oxygen content of the ambient air during operation is less than 25 %.
- Do not switch on/off more often than 2 times per minute.
- Be careful with hot temperatures of surfaces.
- The X-ray generator is suitable for a professional healthcare facility environment.
- The emissions characteristics of this equipment make it suitable for use in industrial areas and hospitals (CISPR 11 class A).
  If it is used in a residential environment (for which CISPR 11 class B is normally required) this equipment might not offer adequate protection to radio-frequency communication services. The user might need to take mitigation measures, such as relocating or re-orienting the equipment.
- Too high EMC disturbances can lead to: unwanted X-ray, interrupted X-ray, wrong X-ray, unexpected status changes, error messages or component defects.
- Any serious incident that occurs in relation to the High-Voltage generator, must be reported to the manufacturer and the competent authority of the Member State in which the user and/or patient is established.

WARNING

Portable RF communications equipment (including peripherals such as antenna cables and external antennas) should be used no closer than 30 cm (12 inches) to any part of the X-ray generator. Otherwise, it could result in degradation of the performance of this equipment.

If you do not obey these instructions, there is a risk of death or serious injury.

2.2.1 Electrical safety

Warning: Electricity

To prevent a possible electrical shock, connect this X-ray generator to a mains supply with a protective earth conductor!
Use this X-ray generator only in medical rooms that obey the requirements of relevant local or transregional standards and laws.

- To stop power supply, use the emergency stop switch of the CT System!

2.2.2 Radiation protection

Warning: Ionizing radiation

The CT System gives you information about active radiation / "radiation ON".
The CT System gives you information about active radiation parameters, for example, kV, mAs.
Before you make an X-ray exposure, put all necessary radiation precautions into effect. You can find information about radiation precautions in the Instructions For Use of the applying CT System.

- Before you start with radiation, make sure that the CT System supplies sufficient proof of a correct image quality.
- To stop radiation, use the emergency stop switch of the CT System!

2.2.3 Thermal safety

To prevent damage because of thermal overloading, make sure that you do not operate the X-ray generator outside its specified load parameters. This prevention decreases the risks to the patient, operating staff, third parties, and the environment.
The X-ray generator is a component in a CT System. The user interfaces of the CT System show the thermal state of the X-ray generator.

2.2.4 Insulation/cooling media

- Do not swallow media that spills!
- Do not let media or its vapors to go into your sewerage system!
- Do not breathe the media vapors!
- Make sure to supply closed rooms with fresh air!
- If swallowed, do not cause vomiting!
- Remove spilled media. Use a liquid-absorbent material.
- Discard the cleaning materials. Obey the local environmental laws and regulations!

2.2.5 Limits for Operation, Storage, and Transportation

Safe operation of the X-Ray Generator is only made sure when you use the X-Ray Generator within the limits of its specifications.
If you ignore the operation limits, there is the danger of coolant that flows out. The X-Ray Generator becomes too hot. Component parts that are too hot can blow up as a result of an implosion or explosion. Refer to the respective operation limits of the applying X-ray system.

- Do not operate the X-Ray Generator in presence of a flammable anesthetic mixture with air or oxygen or a nitrous oxide.
- Do not use detergents and disinfectants, also the detergents and disinfectants used on the patient, that can create explosive gas mixtures.
- The oxygen content of the ambient air during operation must be less than 25%.
- Obey the specified environmental limits for the X-Ray Generator.
  See section chapter Environmental data of the generator on page 72.

2.2.6 Decommissioning

Obey the disposal regulations!

The take-back obligation, correct disposal, and recovery of the X-ray generator refer to the European Waste Electrical and Electronic Equipment (WEEE) directive. It also refers to the requirements of local and transregional legal requirements.
The manufacturer of the X-ray generator assembles state-of-the-art X-ray generators in terms of safety and environmental protection. If no parts of the X-ray generator are opened and if the X-ray generator is used correctly, there are no risks to persons or the environment.
To obey regulations, some times it is necessary to use materials that are harmful to the environment. Discard these materials in a correct manner.

IMPORTANT

This X-ray generator contains materials that are toxic.
Do not discard the X-ray generator together with industrial or domestic waste. Discard the X-ray generator, the attached parts, the cable connectors, and the cables in a way that refers to the local environmental laws and regulations!

The manufacturer

– supports you in the disposal of the X-ray generator in accordance with valid legal requirements.
– takes back the X-ray generator.
– returns re-usable parts to the production cycle via certified disposal companies. Extensive test and quality assurance procedures as well as detailed checks of the components guarantee the same high level concerning quality and functionality that is expected from new materials.
– makes a contribution to the protection of the environment.

If you have questions concerning safe disposal, please consult the manufacturer in full confidence.

2.3 Conformity

The X-ray generator that is shown in these instructions for use puts the provisions of the following standards into effect:

– CSA Marking

If you have further questions that refer to local or transregional legal requirements, make a contact to:

Philips Healthcare (Suzhou) Co., Ltd.
No. 258, ZhongYuan Road, Suzhou Industrial Park
215024 Suzhou, Jiangsu province
PEOPLE'S REPUBLIC OF CHINA

For further help see different contact options on:
www.dunlee.com

2.4 Compatibility

Only technically qualified Field Service Engineers who have received the appropriate instructions and training for the equipment in medical applications and in particular for the installation and commissioning of this X-ray generator are allowed to install and repair this equipment. The installation, calibration, and testing of the X-ray generator must be performed in accordance with the respective instructions of the applying X-ray system.
To make sure that the X-ray generator and the X-ray system are compatible, refer to the technical instructions of the X-ray system. If necessary, make a contact to the manufacturer of the applying X-ray system.
The company that puts the X-ray system that includes this X-ray generator on the market is responsible for the installation of the X-ray generator to the X-ray system. The installation must agree with all local and transregional legal requirements.

2.5 Product Identification Label

The performance characteristics of the device are defined on the product identification label as part of the accompanying documents.

No.	Label	Designation
01	DUNLEE	Registered trade name / trade mark of the manufacturer
02	#	Name of the product
03	Type	Type number of the product
04	REF	Reference Number

No.	Label	Designation
05	SN	Serial Number of the product
06	UDI	The Unique Device Identification [UDI] Data Matrix Code consists of the Global Trade Item Number [GTIN], Serial Number [SN], and Type Number [TN] of the product.
07	**(01)xxxxxxxxxxxxxx**	Global Trade Item Number [GTIN]
08	**(21)xxxxxxxx**	Serial Number [SN] of the product yy50xxxx yy : last two digits of the year of manufacture 50 : CG500 xxxx : numerical sequence
09		Address of the legal manufacturer
10	Philips Healthcare (Suzhou) Co., Ltd. No. 258, ZhongYuan Road, Suzhou Industrial Park, 215024 Suzhou, Jiangsu Province PEOPLE'S REPUBLIC OF CHINA	Address of the legal manufacturer
11	yyyy-mm-dd	Country and date of manufacture yyyy: year of manufacture mm: month of manufacture dd: day of manufacture
12	C US	CSA symbol
13	CE 0123	CE symbol and the number of the notified body
14	EC REP	Authorized representative in the European Community
15		Disposal symbol
16		Safety Instructions in the instruction manual must be read
17	MD	Medical device product

2.6 Maintenance

The company that puts this X-ray generator on the market recommends measurements for the preventive and planned maintenance. This company has the responsibility to obey the local and transregional legal requirements.

Corrective maintenance by the service personnel

Only the manufacturer of the X-ray generator is permitted to do corrective maintenance on the X-ray generator.
Replace defective components of the CT system that have an unwanted effect on the safety of the X-ray generator with genuine spare parts only.
Make sure that the X-Ray generator has no obvious damages.

Planned maintenance by the operator

WARNING

Hazard of injury
Do not open the covers of the CT system!

If you do not obey these instructions, there is a risk of death or serious injury.

This X-ray generator requires regular planned maintenance:
– Regular checks by the operator.
– Regular planned maintenance by the service personnel.

Planned maintenance makes the operability and the operational safety of the X-ray generator safe. The operators of medical devices are committed to do planned maintenance. This planned maintenance must refer to the regulations for the prevention of industrial accidents, national medical product laws, and further regulations.

Only qualified persons are permitted to operate the CT system.
Only qualified personnel who got an applicable training is permitted to do the planned maintenance on the X-ray generator.

This X-ray generator contains mechanical components that wear in operation.
The correct settings of the mechanical and the electronic parts make sure that the function, image quality, electrical safety is at best. The correct settings make sure that the exposure of people to radiation is at a minimum.

To keep the value and safety of your X-ray device go into an agreement with the company that puts this X-ray generator on the market.
The company does all the necessary maintenance at regular intervals. The maintenance contains the safety tests to avoid the hazards. It contains the necessary settings for optimum image quality and the minimizing of exposure to radiation at regular intervals. The company agrees on these intervals with you and put all local and transregional legal requirements into effect.

If operational defects or other deviations from the normal operational behavior occur, set the CT system to OFF.
Tell the company that puts this X-ray generator on the market about the defects or deviations.
Continue the operation of the CT system only when it is repaired. An operation that uses defective components increases safety risks and high exposure to radiation.

The X-ray generator wears in operation. Regular maintenance cycles decrease the probability of a spontaneous failure. You cannot prevent spontaneous failures completely. If it is necessary to have the guaranteed availability of the X-ray equipment, make sure that replacement of X-ray equipment is available.

The manufacturer of the X-ray generator recommends:
• Do the planned maintenance regularly.

Make sure that the company that puts this X-ray generator on the market does planned maintenance at least **once a year**. These precautionary measures prevent personal injury and make sure that the operator puts all commitments into effect.

2.6.1.1 Planned Maintenance schedule

1. Do the check of the X-ray generator for apparent defects. Do the checks unless they are contrary to the configuration of the CT System.
2. Do not open the covers of the X-ray system!

Planned maintenance schedule

Interval	Scope of work	Method
As for each relevant national and international standards and laws or the local regulations.	Do the stability test.	Inspection
Yearly	Do the visual check of the identification labels and the safety labels on the label bracket of the CT System.	Inspection
Weekly	Do the check for unusual noises.	Inspection
Weekly	Do the check for coolant leaks.	Inspection

Error message check

Error type	Description	Required action
Warning	The X-ray generator is thermally overloaded and does not operate further without a rest period.	Maintain rest intervals before you make another exposure.

3 Introduction

3.1 Safety and general information

3.1.1 Schematic overview of the X-ray generator

The CG500 X-ray generator consists of the power block (PB) including the power block fan, the anode drive unit (ADU), and the system interface unit (SIU).

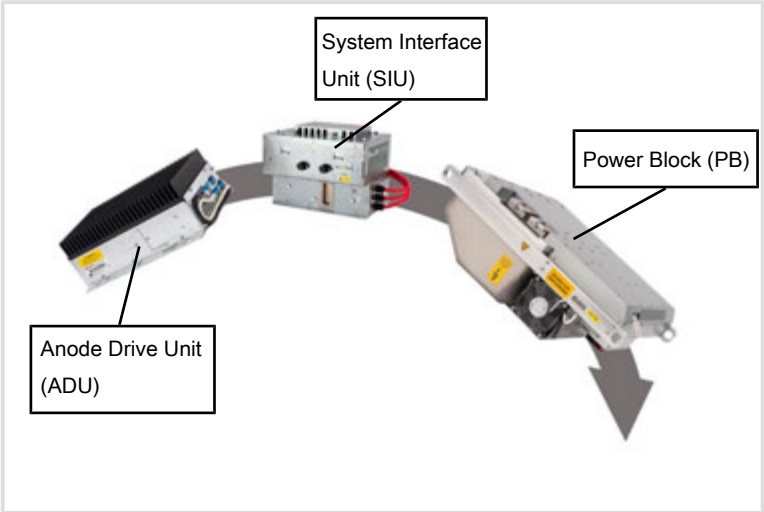


Fig. 1: Schematic overview of the X-ray generator

3.1.2 Safety information

Although you previously did service procedures on a similar product, service procedures are changeable. Changes in service procedures are usual. Read, understand, and obey the instructions about the service procedures in this manual.

3.1.2.1 Symbols used in this manual

Safety Messages

WARNING

This symbol combined with the signal word **WARNING** indicates a hazardous situation which, if not avoided, could result in death or serious injury.

If you do not obey these instructions, there is a risk of death or serious injury.

CAUTION

This symbol combined with the signal word **CAUTION** indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

If you do not obey these instructions, there is a risk of minor or moderate injury.

Material Damage

NOTICE

This symbol combined with the signal word **NOTICE** indicates a situation which, if not avoided, could result in damages such as material damage. This damage is not related to personal injury.

If you do not obey these instructions, there is a risk of property damage.

Other Messages

IMPORTANT

This symbol combined with the signal word **Important** indicates an important advice that points out that certain guidelines, parameters, conditions or restrictions must be observed.

TIP

This symbol combined with the signal word **Tip** indicates a helpful advice that suggests how to improve the operating procedure or how to save time.

3.1.2.2 General safety precautions

3.1.2.2.1 Precautions for people

- Only qualified Field Service Engineers (FSEs) are permitted to operate the CT System! Each FSE must have the necessary expertise in radiation protection. Only the FSE who got an applicable training in the operation of the applying CT System is permitted to operate the CT System.
- Only qualified FSEs are permitted to do service procedures of the X-ray generator and the applying CT System! Each FSE must got an applicable training in the service procedures of the X-ray generator and the applying CT System. To work with radiography equipment in medical applications and to set this X-ray generator into operation, the FSE must have the authorization.
- Always when you do service on the X-ray generator and the corresponding CT System make sure that no unauthorized person has access to the CT System!
- Obey the safety information of the applying CT System!

- Modifications on this X-ray generator and on the configuration of this X-ray generator are strictly not permitted!
- To stop power supply and radiation, use the emergency stop switch of the CT System!
- Do all service procedures in compliance with the provided safety instructions!
- Do all service procedures in compliance with the local regulations that refer to safety, health, accident prevention, environment protection, and medical X-ray devices!
- Discard material in accordance with the requirements of national legislation!
- Make sure that the electrical installations of medically used rooms are in compliance with the requirements of each country!
- Never let problems unsolved that can have unwanted effects on the safety of the CT System!

Precautions against radiation

- Do not remove radiation protection covers from the X-ray generator!
- Before an X-ray exposure, make sure that you take all necessary radiation precautions. You can find information about radiation precautions in the Instructions For Use of the applying CT System.
- The CT System must supply sufficient proof of a correct image quality before you start a scan.
- Do not expose yourself or others directly or indirectly to the X-ray beam!
- Protect yourself and others from scattered radiation!

Precautions against electrical hazards

- Set the power of the CT System to OFF each time before you do service procedures on the X-ray generator. Make sure that voltages are below 50 V AC / 60 V DC before you do service procedures. Make sure that no other person can set the power of the CT System to ON accidentally! Only set the power to ON, if it is necessary for the service procedure!
- If the high-voltage socket of the X-ray generator (Power Block) is open or the high-voltage cable is not connected correctly on both sides, you must not start high voltage.
- Connector terminals, plugs, sockets, and conductors can have dangerous voltages. To make sure that these parts are free of voltage, use a correct multimeter before you do service procedures!
- If an uninterruptible power supply (UPS) is installed in or with the applying CT System, make sure to set the UPS to OFF!
- To prevent a possible electrical shock, make sure that all function units of the X-ray generator are grounded to protective earth conductor!
- Make sure that all accessible internal and external protective earth conductors are connected correctly after service work!
- Use the protection service kit for electro static discharge (ESD) when you touch electrostatic devices that are electrostatically sensitive!
- To prevent short circuits, remove all jewelry, such as bracelets, watches, or rings!
- Do not make changes on the X-ray generator! To prevent short-circuits or corrosion, keep away water or other liquids from the inside of the X-ray generator!
- Do not open the units of the X-ray generator!
- Do all relevant safety checks before you hand the CT System over to the operator and customer!

Precautions against combustion

- Do not operate the X-ray generator along with flammable substances!
- Do not operate the X-ray generator in presence of a flammable anesthetic mixture with air or oxygen or a nitrous oxide!
- The oxygen content of the ambient air during operation must be less than 25%!

- Each time you use cleaning agents such as detergents and disinfectants, make sure that they do not contain explosive substances. They can create explosive gas mixtures!
- Obey the data of the manufacturer of cleaning agents and disinfectants!

Precautions against infections because of body fluids

- Wear rubber gloves where body fluids can be present!
- Do not eat, drink, or smoke with contaminated hands or rubber gloves!
- To discard the rubber gloves, refer to the local environmental regulations!
- When you finished work, make sure to wash and to disinfect your hands!

Precautions against toxic materials

- Do not open the units of the X-ray generator!

Precautions against mechanical hazards

- The CT System has movable parts! Before you do service procedures, take precautions against injuries.
- Install the X-ray generator with CT System covers that are removable with tools only! Operate the X-ray generator without the system covers for service procedures only.
- Be careful with falling masses! They can cause bruises, lacerations, and equivalent injuries.
- Do not touch fans that are in rotation!
- If necessary, wear applicable personal safety equipment, such as safety boots, safety goggles, gloves, and hard hats!
- Be careful with hot temperatures of surfaces and insulating media! Before you do service procedures, make sure that the temperatures decreases to a comfortable value.
- Be careful with sharp edges that some components can have!
- Make sure that you always have sufficient light!

3.1.2.2.2 Precautions for property

- Do not operate a damaged X-ray generator or an X-ray generator that shows contamination of insulating media!
- The X-ray generator is a sensitive component! Protect the X-ray generator against mechanical forces.
- Make a transport of the X-ray generator only with a sufficient protection! Use the genuine re-usable transport box of the manufacturer. If you make a transport over land, use an air-ride truck.
- Make correct connections of cable connectors!
- Do not pull on cables and connectors!
- Do not make kinks in cables!
- To clean the X-ray generator, use only clean and dry lint-free cloth or clean and dry high-grade paper towels!

3.1.2.2.3 Safety labels on the X-ray generator

- Obey all safety labels on the X-ray generator!
- Do not remove or change safety labels!
- Replace illegible safety labels by genuine safety labels!
- Clean soiled safety labels!

3.1.2.2.4 Attached safety signs

Safety sign on the Power Block (PB)

This safety sign shows that there is a hazard of an electrical shock because of exposed voltage on the rail voltage terminal.

1. Each time before you do service work on the PB, wait a minimum time of 3 min.
2. To make sure that the voltage on the rail voltage terminal is less than 60 V, use a multimeter.

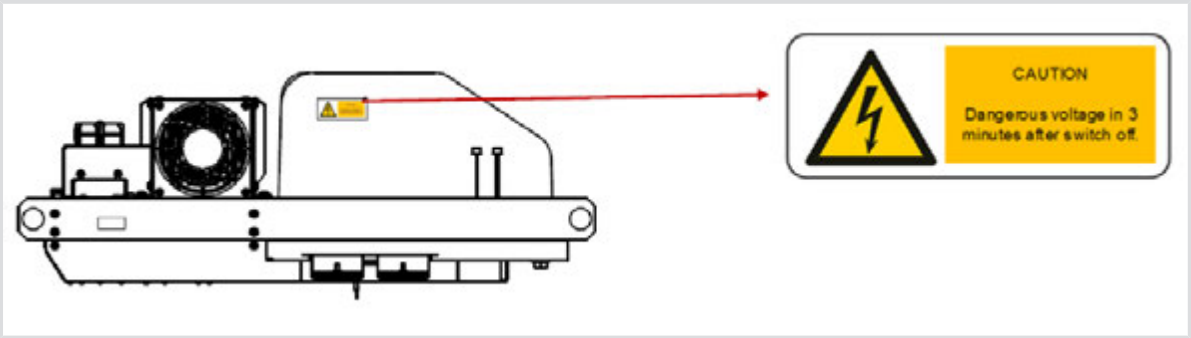


Fig. 2: Safety sign on the Power Block

Safety signs on the System Interface Unit (SIU)

This safety sign shows that there is a hazard of injuries because of exposed voltage and parts that can move within the CT gantry.

1. Each time before you do service work set the CT System to OFF.
2. Read, understand, and obey the service manual.

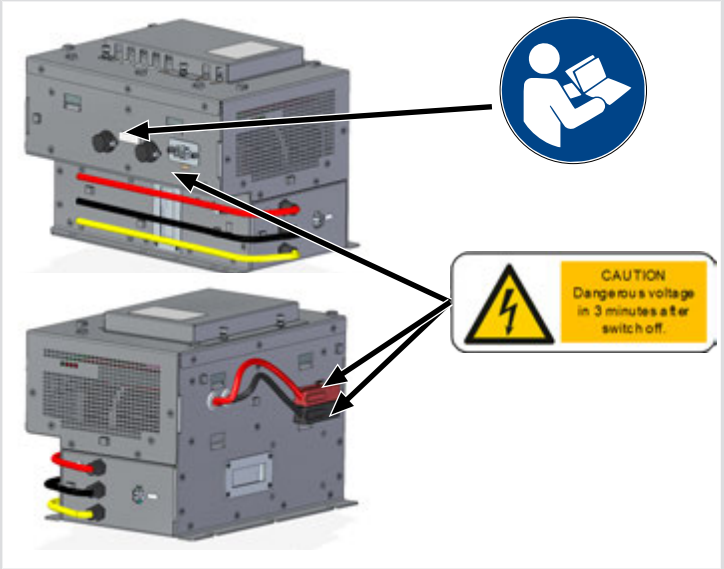


Fig. 3: Safety signs on the System Interface Unit

Safety sign on the Anode Drive Unit (ADU)

No safety sign is applicable.

3.1.2.3 Decommissioning

Obey the disposal regulations!

The take-back obligation, correct disposal, and recovery of the X-ray generator refer to the European Waste Electrical and Electronic Equipment (WEEE) directive. It also refers to the requirements of local and transregional legal requirements.
The manufacturer of the X-ray generator assembles state-of-the-art X-ray generators in terms of safety and environmental protection. If no parts of the X-ray generator are opened and if the X-ray generator is used correctly, there are no risks to persons or the environment.
To obey regulations, some times it is necessary to use materials that are harmful to the environment. Discard these materials in a correct manner.

IMPORTANT

This X-ray generator contains materials that are toxic.
Do not discard the X-ray generator together with industrial or domestic waste. Discard the X-ray generator, the attached parts, the cable connectors, and the cables in a way that refers to the local environmental laws and regulations!

The manufacturer

- supports you in the disposal of the X-ray generator in accordance with valid legal requirements.
- takes back the X-ray generator.
- returns re-usable parts to the production cycle via certified disposal companies. Extensive test and quality assurance procedures as well as detailed checks of the components guarantee the same high level concerning quality and functionality that is expected from new materials.
- makes a contribution to the protection of the environment.

If you have questions concerning safe disposal, please consult the manufacturer in full confidence.

4 Installation guide

The information of this section "Installation guide" is for the installation personnel only.
The company that puts the CT System that includes this X-ray generator on the market is responsible for the correct execution of all measurements shown in this section. The supplied information must agree with all local and transregional legal requirements.

Read me, understand me, and obey me!

The factory of the CT system installed and aligned the X-ray generator.
Additional installation and alignment work at the X-ray generator is not necessary during the installation of the CT system.

4.1 Safety information

4.1.1 Safety messages and other messages used in this manual

4.1.1.1 Symbols used in this manual

Safety Messages

WARNING

This symbol combined with the signal word **WARNING** indicates a hazardous situation which, if not avoided, could result in death or serious injury.

If you do not obey these instructions, there is a risk of death or serious injury.

CAUTION

This symbol combined with the signal word **CAUTION** indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

If you do not obey these instructions, there is a risk of minor or moderate injury.

Material Damage

NOTICE

This symbol combined with the signal word **NOTICE** indicates a situation which, if not avoided, could result in damages such as material damage. This damage is not related to personal injury.

If you do not obey these instructions, there is a risk of property damage.

Other Messages

IMPORTANT

This symbol combined with the signal word **Important** indicates an important advice that points out that certain guidelines, parameters, conditions or restrictions must be observed.

TIP

This symbol combined with the signal word **Tip** indicates a helpful advice that suggests how to improve the operating procedure or how to save time.

4.2 Tools and test equipment

Items	Tools/Description
Standard Tool kit	 Fig. 4: TC129
Digital Multimeter For example, Fluke 287	 Fig. 5: TC091-25

- Torque wrench
- Lifting tool
- Loctite 243
  Do not use auxiliary materials after their expiration date!
- ESD protective device

4.3 Load limit values

The X-ray generator has sensors which check certain parameters in operation. The sensors prevent a possible overload or damage of the X-ray generator.

1. Do not change any safety devices.
2. Obey the product-specific load limit values that are shown in this manual.

4.4 Insulation/cooling media

- Do not swallow media that spills!
- Do not let media or its vapors to go into your sewerage system!
- Do not breathe the media vapors!
- Make sure to supply closed rooms with fresh air!
- If swallowed, do not cause vomiting!
- Remove spilled media. Use a liquid-absorbent material.
- Discard the cleaning materials. Obey the local environmental laws and regulations!

4.5 Spare parts

1. Replace defective components which have the risk of unwanted effects on the safety or the function of the CT System by genuine spare parts, only!
2. To get genuine spare parts, refer to the company that puts the CT System that includes this X-ray generator on the market!

4.6 Identification numbers

Identification numbers CG500 (30000633085x)

Initial delivery as a function unit (FU)		Delivery as a field replaceable unit (FRU)	
FU	**Identification number**	**FRU**	**Identification number**
CG500 High-Voltage Generator	30000633085x	--	--
--	--	FRU CG500 Power Block Unit	30000633988x
--	--	FRU CG500 System Interface Unit	30000633989x
--	--	FRU CG500 Anode Drive Unit	30000633990x
--	--	FRU, Fuse kit of System Interface Unit	45980114000x
--	--	FRU CG500 Fan of Power Block Unit	45980113999x
			x = a digit from 1 to 9

Identification numbers CG500 (30000653439x)

Initial delivery as a function unit (FU)		Delivery as a field replaceable unit (FRU)	
FU	**Identification number**	**FRU**	**Identification number**
CG500 High-Voltage Generator	30000653439x	--	--
--	--	FRU CG500 Power Block Unit	30000746871x
--	--	FRU CG500 System Interface Unit	30000746873x

Initial delivery as a function unit (FU)		Delivery as a field replaceable unit (FRU)	
FU	**Identification number**	**FRU**	**Identification number**
--	--	FRU CG500 Anode Drive Unit	30000746872x
--	--	FRU, Fuse kit of System Interface Unit	45980114000x
--	--	FRU CG500 Fan of Power Block Unit	45980113999x
			x = a digit from 1 to 9

Identification numbers CG500 (30000653440x)

Initial delivery as a function unit (FU)		Delivery as a field replaceable unit (FRU)	
FU	**Identification number**	**FRU**	**Identification number**
CG500 High-Voltage Generator	30000653440x	--	--
--	--	FRU CG500 Power Block Unit	30000746878x
--	--	FRU CG500 System Interface Unit	30000746881x
--	--	FRU CG500 Anode Drive Unit	30000746879x
--	--	FRU, Fuse kit of System Interface Unit	45980114000x
--	--	FRU CG500 Fan of Power Block Unit	45980113999x
			x = a digit from 1 to 9

Identification numbers CG500 (30000934969x)

Initial delivery as a function unit (FU)		Delivery as a field replaceable unit (FRU)	
FU	**Identification number**	**FRU**	**Identification number**
CG500 High-Voltage Generator	30000934969x	--	--
--	--	FRU CG500 Power Block Unit	30000935136x
--	--	FRU CG500 System Interface Unit	30000935153x
--	--	FRU CG500 Anode Drive Unit	30000935155x
--	--	FRU, Fuse kit of System Interface Unit	45980114000x
--	--	FRU CG500 Fan of Power Block Unit	45980113999x
			x = a digit from 1 to 9

4.7 Compatibility

The X-ray generator CG500 is compatible with
CT4000 X-ray tube housing assembly set
CT4000 X-ray tube housing assembly
High voltage cable set

4.8 Function units

4.8.1 Power Block (PB)

The Powerblock

- generates the tube voltage and the filament current to operate the X-ray tube.
- generates the grid voltage for the tube's beam deflection (X direction) to control the position and the shape of the focal spot in the X-ray tube.
- provides a closed loop control for the tube voltage, the tube's emission current and the filament current.
- provides a test function for the internal measurement of the generated output high voltage. The test is started by a message from the Control & Interface Unit (CIU) and controlled by the Powerblock.
- provides a calibration function for the internal measurement of the generated output high-voltage. The calibration is started by a message from the Control & Interface Unit (CIU) and controlled by the Powerblock.
- provides a calibration function for the internal measurement of the tube's emission current. The calibration is started by a message from the Control & Interface Unit (CIU) and controlled by the Powerblock.
- provides the measured actual value data of the tube voltage, the emission current and the filament current to be requested by the Control & Interface Unit (CIU).
- communicates with the Control & Interface Unit (CIU) via SPI.
- is cooled by a fan. This fan is a field replaceable unit (FRU).
- insulates the high voltage output interfaces, the high power and auxiliary voltage interfaces and the control interface.
- the filament driver's outputs are protected against short circuit on the end of the high voltage cable on the tube's side as well as open driver failures (no load).

Item	Designation
1	Fan
2	Rail voltage input from MIU
3	Mechanical interface to the lifting device

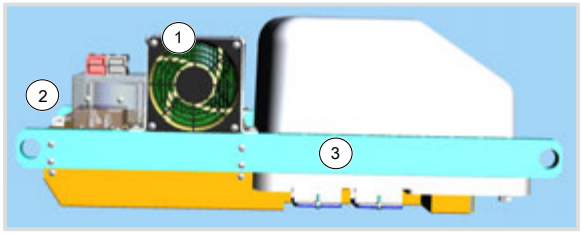


Fig. 6: Overview of the Powerblock

Item	Designation
1	High-voltage socket O3
2	High-voltage socket O4
3	PB CAN ground screw

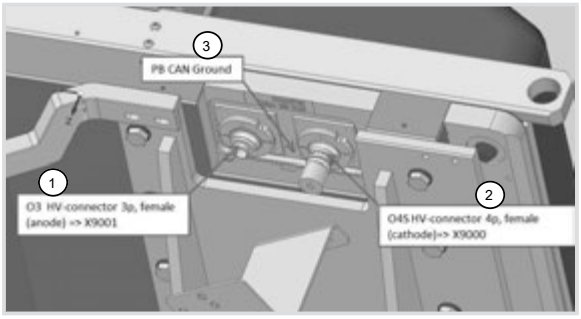


Fig. 7: PB HV connections

Item	Designation
1	Input DC Rail voltage VN
2	Input DC Rail voltage VP
3	PB XDEF
4	PB 24V low voltage supply
5	PB Control

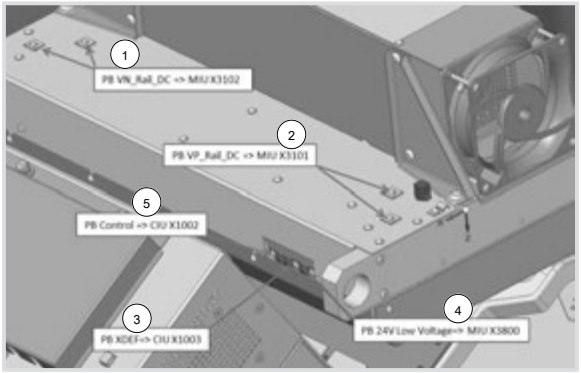


Fig. 8: PB connections

4.8.2 System Interface Unit (SIU)

The SIU is one function unit. It includes the PCBs of the sub-function units:

– Mains Interface Unit (MIU)

– Control Interface Unit (CIU)

The PCBs are installed in one housing. Only the whole SIU is available as a spare part. The base on the top of the housing includes identification, approbation and safety data on labels.

The CIU

– is the main controller of the CG500 X-ray generator.

– gets a power supply of 24 V DC from the CT System.

The main tasks of the CIU are

– to be the interface between the CT System and all function units of the CG500 X-ray generator

– to control the X-ray exposure

– to make the filament adaptation

– to support tube protect functionality

– to make checks of the state of the CG500 X-ray generator

– to apply an error handling

– to start safety measurements

The MIU

– is designed to supply power for other units and house CIU (Control Interface Unit).

– to supply the operating DC rail voltage

– to supply 24V DC

Item	Designation
1	Input cable clamps
2	Low voltage supply
3	ADU fuses
4	Rail voltage connector

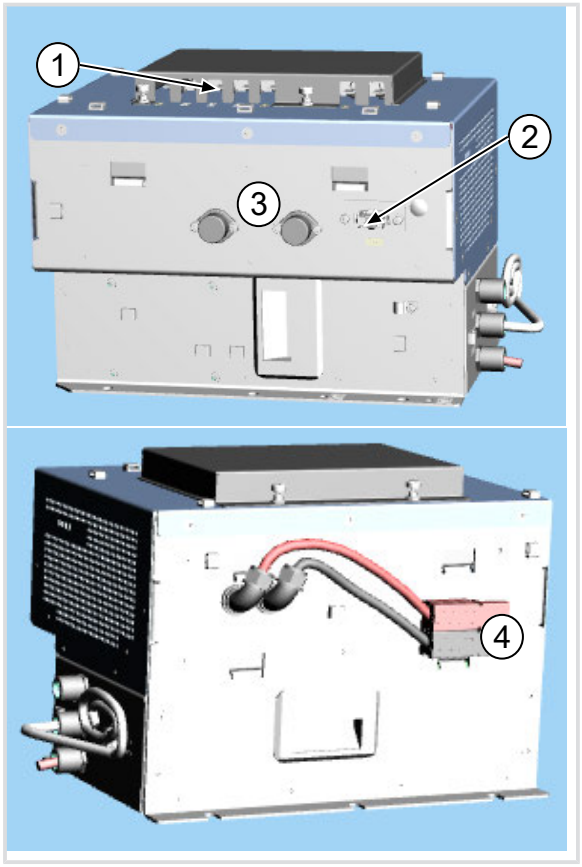


Fig. 9: Overview of the System Interface unit

4.8.3 Anode Drive Unit (ADU)

The ADU

- starts and operates the anode motor of the X-ray tube assembly.
- controls and monitors the status and the speed of the anode of the X-ray tube:
  - anode acceleration
  - anode rotation with a constant speed
  - anode coasting
- gets a power supply of 450 V dc nominal rail voltage from the SIU (MIU) system.
- supplies a power of 350 V ac nominal to the stator coils of the anode motor of the X-ray tube assembly.

Item	Designation
1	Terminal for the protective earth conductor from CT
2	Mechanical interface to the CT gantry
3	Heat sink
4	Rail voltage input from MIU

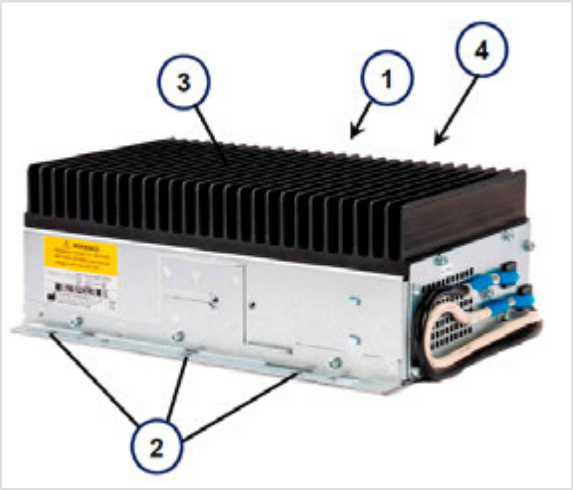


Fig. 10: Overview of the Anode Drive Unit

4.9 Electrical protection

Protective earth

All metal housing parts are grounded.
Apply green / yellow protective earth conductors from the protective earth terminal of the metal housings to the central protective earth terminal of the gantry rotor of the CT system.

Shield grounding

Also metal housing ground is connected to the shield of the

- high-voltage cable between the PB and the X-ray tube housing assembly (XRTA)
- stator cable between the ADU and the XRTA
- control cable between the SIU and the XRTA
- control cable between the SIU and the PB
- control cable between the SIU and the ADU

4.10 Setting-to-work

4.10.1 High voltage (HV) connectors

WARNING

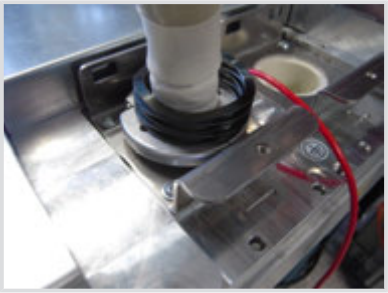
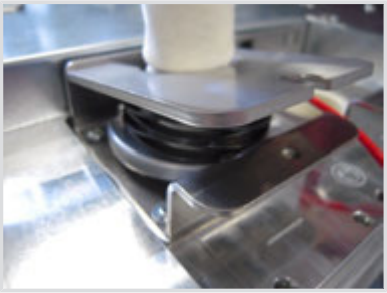
Hazard of electrical shock because of exposed voltage
High-voltage cables are like capacitors.
a) Each time you disconnect a high-voltage plug, remove the voltage from the contact pins. The minimum waiting time after you set the CT system to OFF is 5 seconds.
b) To make sure that the contact pins are free of voltage, use a multi meter.

If you do not obey these instructions, there is a risk of death or serious injury.

The HV sockets are part of the Power Block. It connects the Power Block with the internal power generation.
In operation, the anode HV-socket holds an O3 HV cable plug, the cathode HV-socket holds an O4/S HV cable plug.

Connection on Power Block side

1. Connect both HV cables from tube to PB as shown in the pictures.
   HV sockets are marked by + and -.
2. Use silicon washers for HV plugs.
   Correct force is ensured by springs.

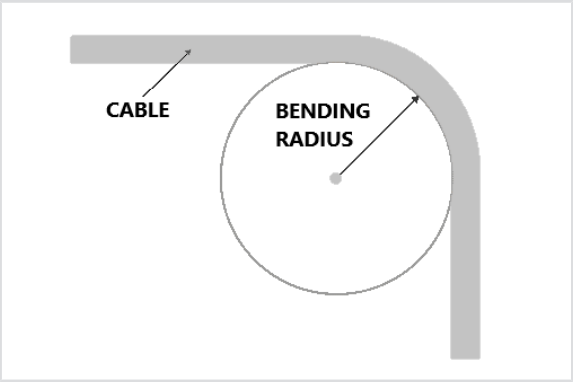




The O3 HV cable plug supplies high voltage to the anode of the X-ray tube.
The minimum bending radius of the HV cable is 60 mm.

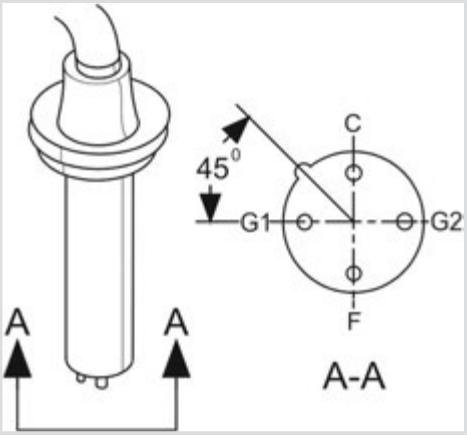
The O4S HV cable plug supplies:

– Filament current,
– Grid voltage,
– High voltage to the cathode of the X-ray tube.

The minimum bending radius of the HV cable is 75 mm.



C = Common connected terminal
F = Filament terminal
Inseide the Power Block, the common wire (C) is connected to both free wires.



Pin assignment for both O4/S versions

Item	Designation
C	Common
F	Filament
G1	Grid 1
G2	Grid 2

NOTICE

Risk of a damage of the X-ray tube housing assembly due to burned and damaged contact surfaces

a) When you install and reconnect a HV plug to a HV socket, always use new silicone disks and do the cleaning and the greasing procedure again.
b) When you install and replace an X-ray tube housing assembly, always use new silicone disks and do the cleaning and the greasing procedure of the HV plug again.
c) Do not use silicon disks again even after you clean and grease the silicon disks again.

If you do not obey these instructions, there is a risk of property damage.

IMPORTANT

Silicon paste is not a good insulator
Use silicone paste to
a) make the HV plug installation into the ceramic HV socket easy.
b) keep the entrapped air to a minimum.
c) make a zero seam between the HV plug and the HV socket.

O4/S high-voltage plug on the cathode side

The accessory of the X-ray tube housing assembly or the HV cable contains a tube of silicone paste and silicone disk.
Do not use any lubricant other than the silicone paste that is part of the accessory.

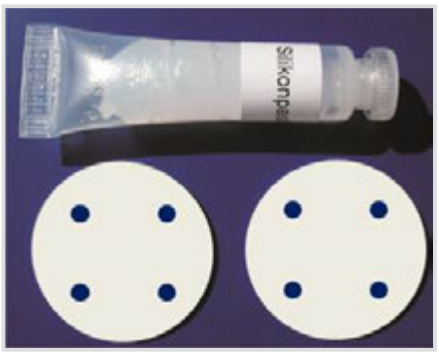


Fig. 11: Silicone paste and two silicone disks

O3 high-voltage plug on the anode side

The accessory of the X-ray tube housing assembly or the HV cable contains a tube of silicone paste and silicone disk.
Do not use any lubricant other than the silicone paste that is part of the accessory.

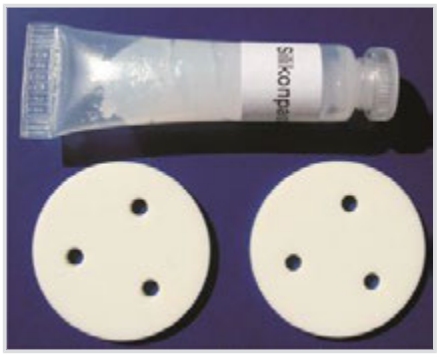


Fig. 12: Silicone paste and two silicone disks

4.10.1.1 Preparation of O3 and O4S HV cable

1. Clean the HV plug thoroughly with isopropyl alcohol. The alcohol content is at least 90 %.
   Use a clean lint-free cloth or a clean high-grade paper towel.
   Do not use solvents, lubricants, or oil to clean the HV plug.
2. Apply a pea-sized amount of the silicone paste on the front face of the HV plug.
   Do not apply the silicone paste on the contact pins.
   Do not apply the silicone paste on the cylindrical surface of the HV plug.

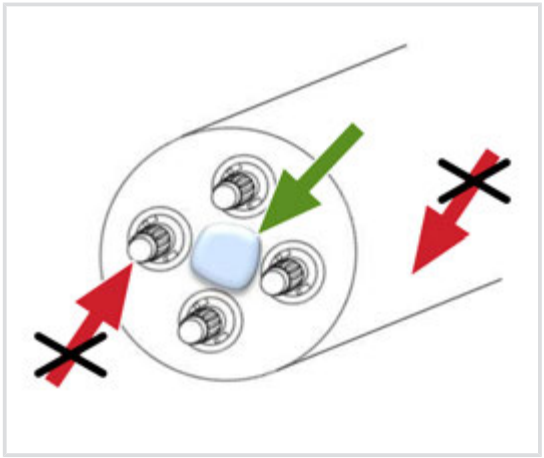


Fig. 13: Silicone paste on the front face

3. Put the silicone disk over the contact pins on the front face of the HV plug.
   Do not clean the bead of the silicone paste.

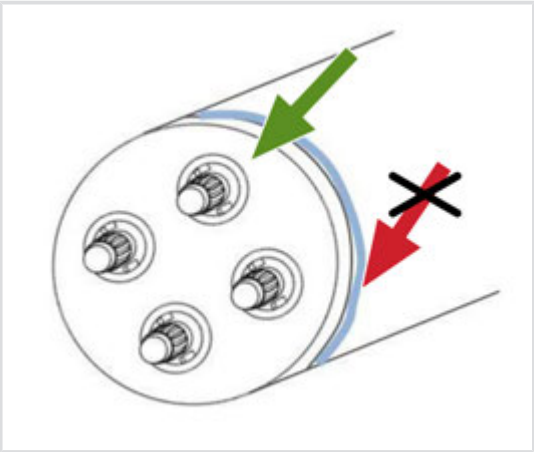


Fig. 14: Silicone washer on the HV plug

4. Apply a pea-sized amount of the silicone paste on the front face of the silicone disk.
   Do not apply the silicone paste on the contact pins.
   Do not apply the silicone paste on the cylindrical surface of the HV plug.

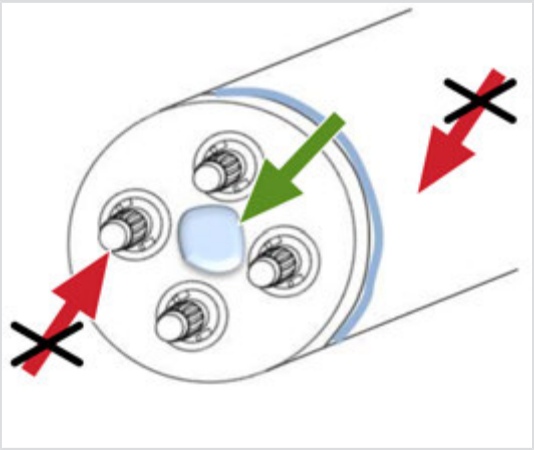


Fig. 15: Application of silicone paste

Installation of the O3 and O4/S high-voltage cable

1. Obey the correct polarity of the HV cables. Align the feather key (1) of the HV plug with the keyway (2) of the HV socket.
2. Put the HV plug in the HV socket of the X-ray tube housing.

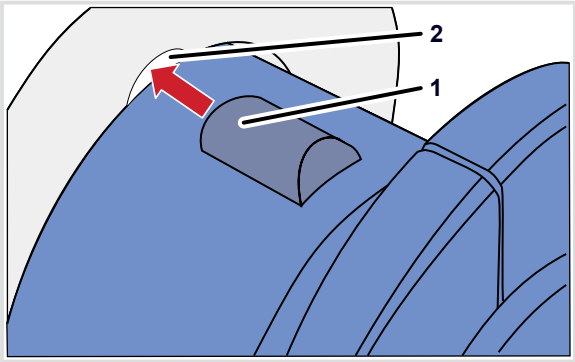


Fig. 16: Align the feather key and keyway

3. Tighten the cap nuts of the HV connector hand tight. The use of tools in this area may damage silicon disks and connector pins!

IMPORTANT

Make sure that the high voltage cables are secured properly.
- with the radial set screw.
- any other mechanical mechanism which can be removed by use of a tool only.

4.10.2 Connection to the sliprings of the CT gantry

Power supply from slipring

Item	Explanation
1	3 Phase 380/400 Vac +/-10%, 50/60 Hz voltage to the: – Mains Interface Unit (MIU)
2	2 Phase 120 Vac, 50/60 Hz auxiliary voltage to the: – Mains Interface Unit (MIU)
3	Protective earth to the: – Mains Interface Unit (MIU) – Power Block (PB) – Anode Drive Unit (ADU)

Data transfer from and to the sliprings

The interface for the data transfer is the rotating interface board of the CT gantry named RHOST. The Generator Control Interface consists of two dedicated interfaces named:

– System Data Interface

– System Control Interface

4.10.3 Electrical connections and functional overview

Generally diagnostic X-ray systems are composed out of several subsystems. The number and nature of these subsystems depend on the intended application of the X-ray system. However the X-ray tube as the X-ray source and the High-voltage generator as its power supply are always necessary. The High-voltage generator itself is composed from several units as shown in the figure.

The High-voltage generator consists of functional units. Additionally, cables and hoses are needed to interconnect the units and to link them with the CT system. The functional units as well as their interconnections and their connections to the relevant units of the CT system and the X-ray tube housing assembly are shown in the figure below. Components shown in light colors with a green border are part of the CT system and not in the responsibility of the generator manufacturer.

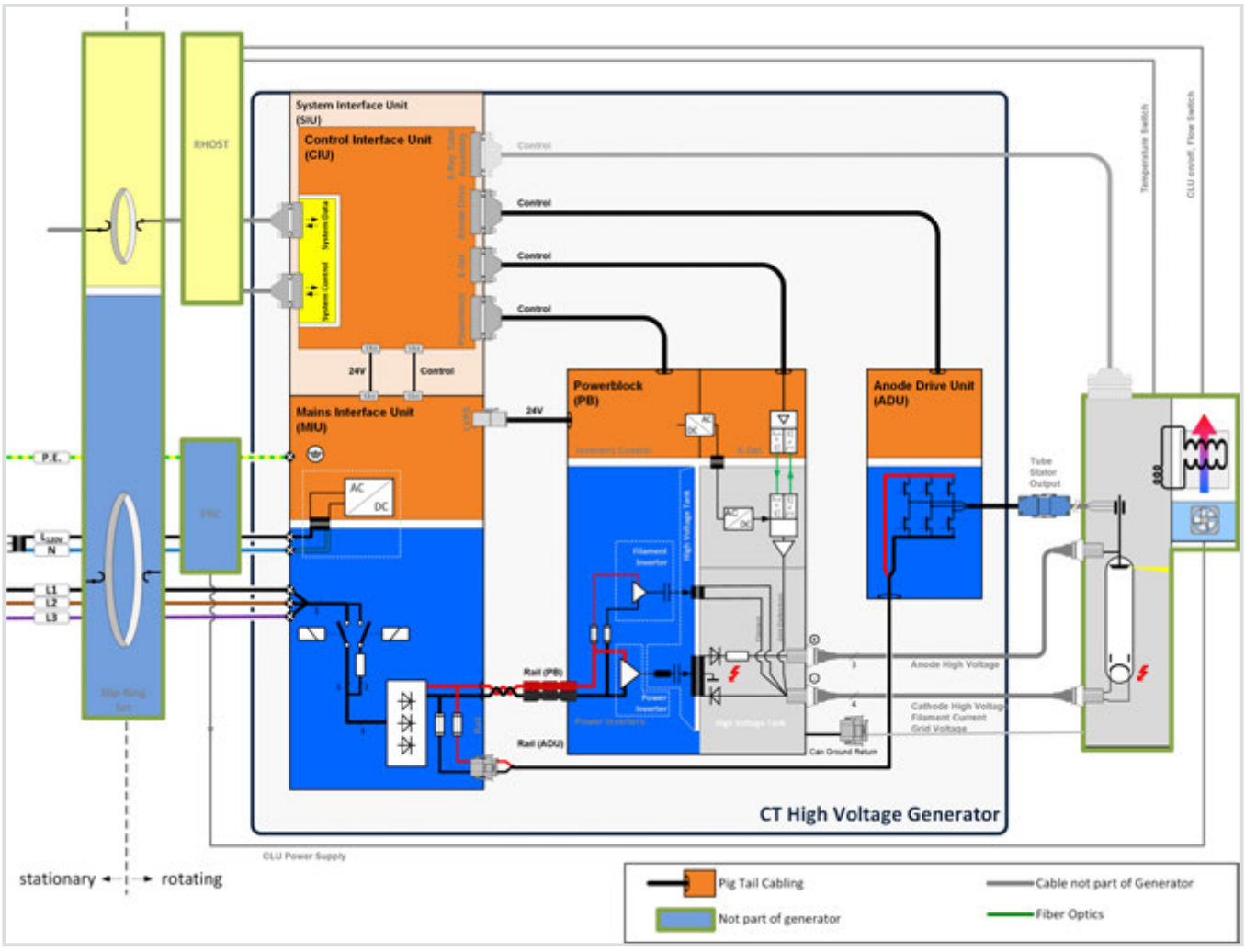


Fig. 17: Connection diagram

Sections in color	Explanation
Dark blue	Power electronics components directly connected to the three phases mains supply
Orange	Control electronics components insulated against mains
Gray	High-voltage components
Light blue	Components directly connected to the single-phase mains supply

4.10.4 Wiring diagram

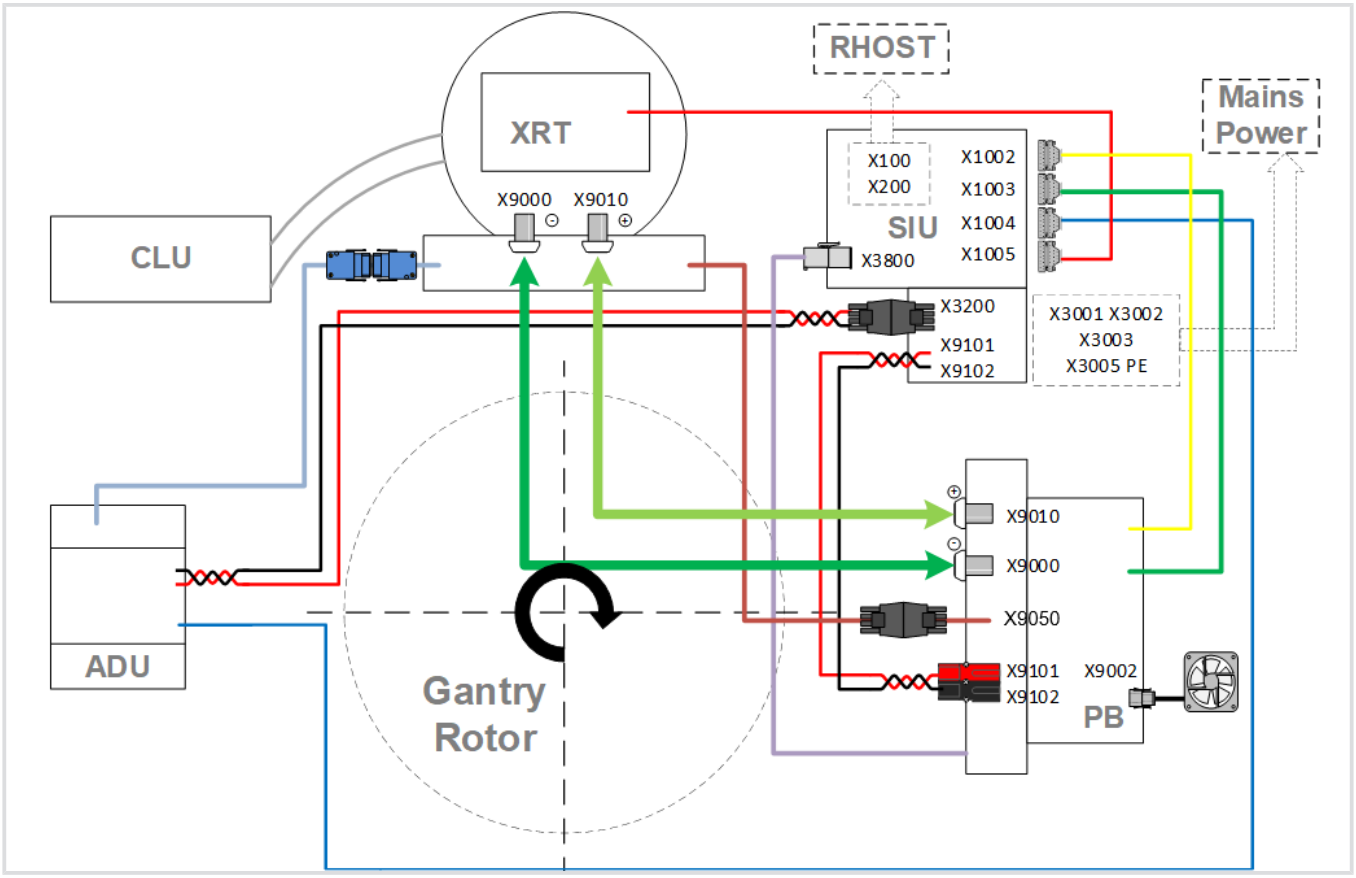


Fig. 18: Wiring diagram

Legend of Wiring diagram

Item	Description		Item	Description
SIU			**Power Block**	
X1002	CIU Control Cable to PB		X9000	PB Cathode HV Cable to XRTA
X1003	CIU Control Cable to PB X-deflection		X9002	Fan
X1004	CIU Control Cable to ADU		X9010	PB Anode HV Cable to XRTA
X1005	CIU Control Cable to XRTA		X9050	PB Can Return Cable from XRTA
X3200	MIU Rail Voltage Cable to ADU		X9101	PB Rail - Cable
X3800	MIU 24V Voltage Cable to PB		X9102	PB Rail - Cable
X1	Stator Control Cable		**Mains Power**	
X100	System Control		X3001	Mains Power L1
X200	System Data		X3002	Mains Power L2
			X3003	Mains Power L3
			X3004	Power L 120V
			X3005	Power N (Protective earth)

4.11 Final work

4.11.1 Test before putting the X-ray generator into operation

These tests include all functions units (FU) of the X-ray generator.
The tests refer to the IEC 62353.

- Set the CT system to OFF.

WARNING

Hazard of injuries because of exposed voltage and a CT gantry that turns

a) Set the CT System to OFF, before you do any maintenance work.
b) Make sure that no other person can set it to ON accidentally.
c) Only set the power to ON, when it is necessary for the service procedure.

If you do not obey these instructions, there is a risk of death or serious injury.

Make a visual inspection of the Powerblock (PB), the System Interface Unit (SIU), and the Anode Drive Unit (ADU):

Visual inspection

1. Do a check whether the safety-related markings and the labels are complete, legible, not damaged, and clean.
2. Do a check whether the mechanical parts are not damaged.
3. Do a check whether the cables are not damaged.
4. Do a check whether the cable connectors and the cable shields are correctly connected.
5. Do a check whether all strain reliefs of the cables are complete, in correct position and not damaged.
6. Do a check whether there is an indication of damage or contamination, for example oil leakage.
7. Do a check whether the accessories are complete and not damaged.
8. Do a check whether the necessary documentation is available and up-to-date.

Recording of the results

1. Fill in the test record that refers to IEC 62353. Use the test record that follows or the test record in the System Reference Manual /System logbook of the X-ray system.

4.11.2 IEC 62353 Test Report

IEC 62353 Test Record

Type and Serial number of the medical equipment:					
Type and Serial number of the measuring equipment:					
Tests	Max. value	Measured value	Pass	Fail	N/A
Visual inspection	N/A	N/A	☐	☐	☐
Protective earth resistance	N/A	N/A			N/A
Equipment Leakage current	N/A	N/A			N/A
Functional test	N/A	N/A	☐	☐	☐
Overall assessment:					
☐ No safety or functional faults were detected.					
☐ No direct risk is present. Repair the faults on a short term.					
☐ Set the equipment out of operation until the faults are repaired.					
☐ Equipment is not in compliance with the IEC 62353. A modification, replacement of components, or the setting out of operation is recommended.					
Name: _____		Date / Signature: _____			

5 Service guide

The information of this section "Service guide" is for the field service personnel only.
The company that puts the CT System that includes this X-ray generator on the market is responsible for the correct execution of all service measurements shown in this section.

Read me, understand me, and obey me!

5.1 Planned maintenance

The company that puts this X-ray generator on the market is responsible for the planned maintenance of this product in accordance with all local and transregional legal requirements.
The planned maintenance instructions of the manufacturer of the CT system show the procedures for the planned maintenance on the X-ray generator. Obey these planned maintenance instructions.

Only the manufacturer of the X-ray generator is permitted to repair the spare parts of the X-ray generator. For replacement, only use genuine spare parts! It is necessary to do the maintenance work regularly.

The maintenance work of the X-ray generator includes:

– Regular maintenance work the operator must do.
– Regular maintenance work the service organization must do.

This X-ray generator contains mechanical components that wear because of operation. The correct settings of the mechanical and electrical parts make sure that the function, image quality, and electrical safety are of good quality. The settings make sure that exposure of the patient and medical personnel to radiation is at a minimum.

5.1.1 Planned maintenance by the operator

For the planned maintenance instructions for the operator, refer to chapter Maintenance on page 14 and the Instructions For Use of the CT System.

5.1.2 Planned maintenance schedule

Do the planned maintenance work **once a year**.

5.1.3 Planned maintenance procedure

Tools

– Vacuum cleaner
– Clean lint-free cloth or clean high-grade paper towels

Turning OFF the system

WARNING

Hazard of injuries because of exposed voltage and a CT gantry that turns

a) Set the CT System to OFF, before you do any maintenance work.
b) Make sure that no other person can set it to ON accidentally.
c) Only set the power to ON, when it is necessary for the service procedure.

If you do not obey these instructions, there is a risk of death or serious injury.

- Turn OFF the system.

Cleaning

Do not

– use solvents or detergents to clean the X-ray generator!
– disinfect the X-ray generator!
– sterilize the X-ray generator!

Use

– a vacuum cleaner.
– a clean and dry lint-free cloth, or use a clean and dry high-grade paper towel.

1. Make the blower of the Power Block free from dust.
2. Clean the surfaces of the function units of the X-ray generator and the attached parts.
3. Make sure that all screws that lock the position of the X-ray generator and the installed parts are in position. Make sure that all screws are correctly tightened and locked.
4. Make sure that the X-ray generator has no obvious damages. Example: Dents, scratches, tears, soiling, wear, coolant leaks, unusual noises.
5. Make sure that all cables and connectors have no mechanical damage, burned areas, scratches, and soiling.
6. Make sure that all cables have tight connectors, tight strain reliefs, and legible target designations.
7. Make sure that the function units have legible labels.

Planned Maintenance work comprises the following X-ray generator function units and their interconnection cables and protective earth conductors:

– Power Block
– Anode Drive Unit
– System Interface Unit

For further information about Planned Maintenance work, refer to the System Service Manual of the CT System.

5.1.4 Recurrent tests

These tests refer to the IEC 62353 standard.

1. For the test descriptions and the test reporting, see chapter Test before putting the X-ray generator into operation on page 36.
2. Do the same tests.
3. Report the test results in the same way.

5.1.5 Additional tests

IMPORTANT

Additional tests
For the X-ray generator special technical checks that refer to the generally accepted standards of engineering practice can be necessary.

5.2 Corrective maintenance

5.2.1 Fault finding

The corrective maintenance instructions of the manufacturer of the CT System show the procedures for the corrective maintenance on the X-ray generator including check of proper connection of shielding.
Obey the corrective maintenance instructions. Only the manufacturer of the X-ray generator is permitted to repair the Field Replaceable Units (FRUs) of the X-ray generator.
To replace the FRUs, use genuine spare parts.

Fault isolation procedure

These steps are typical for fault finding:

- To start the fault finding, perform the general troubleshooting procedures via the CT System Service Tools Framework. These procedures are described in the Service Tools User Guidelines of CT System.
- Check the status of all LEDs.
- Perform electrical tests.
- Check error logs.

5.2.1.1 Status of the LEDs

Power Block

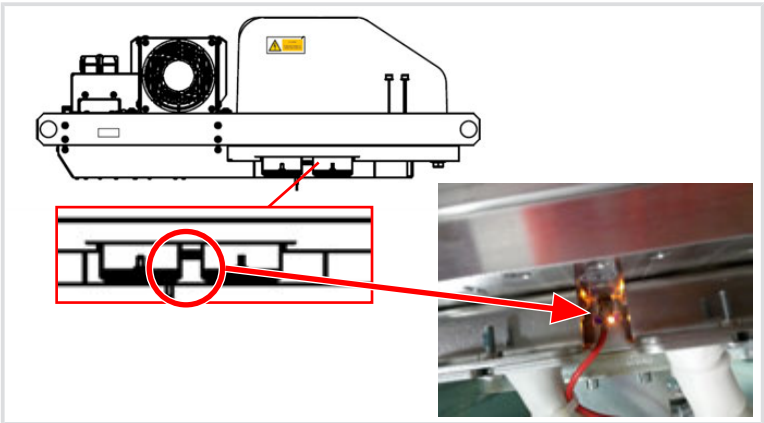


Fig. 19: LEDs of the Power Block

LEDs of the PB

LED name	Color	FRU function	Status and description
Power	red	PB status	OFF: No power. ON: Connected to SIU.

System Interface Unit

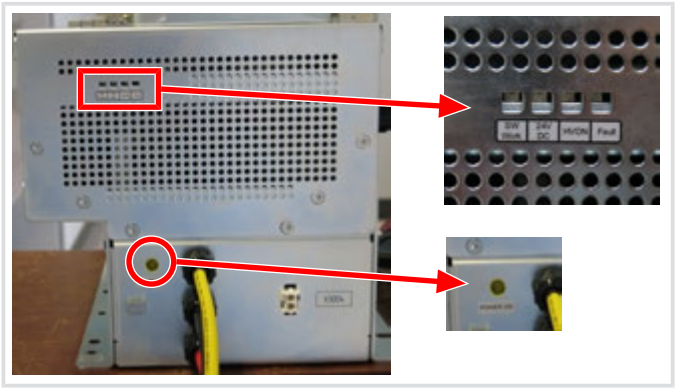


Fig. 20: LEDs of the SIU

LEDs of the SIU

LED name	Color	FRU function	Status and description
Rail voltage	yellow	Rail voltage	OFF: Contactor state is open. ON: active if V_{rail} ≥ 60 V. Contactor is closed.
SW Work	yellow	CIU Software Work	Blinking with 4 Hz: operating. Blinking with 1 Hz: loading an update.
24 Vdc	green	24 Vdc	OFF: Input voltage is ≤ 18 V. ON: 24 V supply voltage V24P_Ctrl is present.
HVON	yellow	HV ON START	ON: X-ray active.
Fault	red	Generator Error	ON: Generator error, for example unit disconnected. Check system log file.

Anode Drive Unit

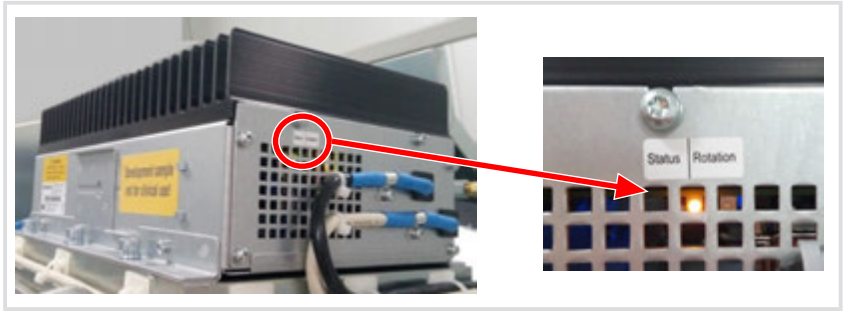


Fig. 21: LEDs of teh ADU

LEDs of the SIU

LED name	Color	FRU function	Status and description
Status	 yellow	Unit Status	OFF: The ADU is OFF.
			Blink dark: The loader software is active.
			Blink bright and slowly: The application software is active. The ADU has no communication link to the SIU.
			Blink bright and fast: The application software is active. The ADU has a communication link to the SIU.
			ON: The loader software is not active, or The application software is not active, or The PB controller is defective, or The reset is active.
Rotation	 green	Tube Anode Rotation State	OFF: The X-ray tube anode does not turn.
			Blinking: The rotation speed of the X-ray tube anode changes.
			ON: The X-ray tube anode turns with a constant rotation speed.

5.2.1.2 Fault isolation tests

5.2.1.2.1 No-Load test

1. Disconnect the HV Plug from PB to XRTA (X-ray tube housing assembly).
2. Connect Dummy Plug to PB.
3. Perform “No-Load test” via Service Software of the CT System.

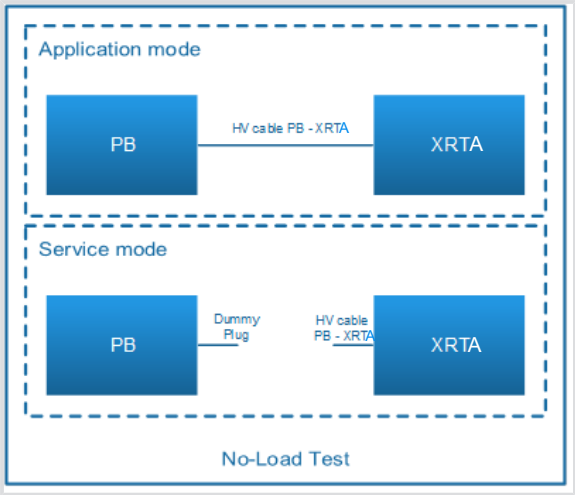


Fig. 22: No-Load test

5.2.1.2.2 Emission current test

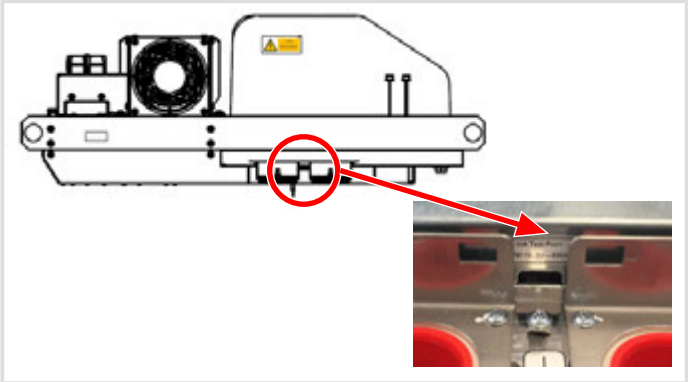


Fig. 23: Emission current test point

- Measure the emission current at the test point (1) of the Power Block.

Test point	Measuring relation	Accuracy
Emission current	1 V ≙ 500 mA	± 20%

5.2.1.3 Error messages

Error identification numbers

IMPORTANT

Error Identification
The error identification number shows the FRU which detected the error. It does not show coincidentally the faulty FRU!

Error IDs

Error ID	Error detection unit
31xxx	Power Block
34xxx	ADU
37xxx	SIU and GM
38xxx	X-ray tube

Error types

Error type	Description
Warning	A deviation of a required value is detected. This deviation is within the limits of the value.
Normal	means “Normal Error” A deviation of a required value is detected. The limits of the value are exceeded.
Fatal	means “Fatal Error” The concerning component of the FRU or the FRU itself is broken down. An exchange of the FRU is required.
Info	The Info Type is a status information

5.2.1.3.1 Error handling

Error handling

ID	Error type	Message	Description	Service procedure
31200	Error	PwrBlk: Life tick missing	The CIU stopped sending life tick messages to Power Block.	1. Power cycle X-Segment. 2. Replace SIU.
31211	Error	PwrBlk: HV symmetric fault	Absolute difference between cathode and anode high voltage was too high.	1. Power cycle X-Segment. 2. Replace Power Block.
31213	Error	PwrBlk: HV out of range	Unexpected difference between actual and expected high voltage.	1. Power cycle X-Segment. 2. If this error comes together with arcing errors, resolve as described for error 31364 (multiple arcs) . 3. Replace Power Block.
31216	Error	PwrBlk: Internal inverter fault	Error in Powerstage detected.	1. Power cycle X-Segment. 2. Replace Power Block.
31219	Error	PwrBlk: Boost backup timer expired	The maximal time for the filament boost current was exceeded.	1. Power cycle X-Segment. 2. If this error comes together with arcing errors, resolve as described for error 31364 (multiple arcs). 3. Replace SIU. 4. Replace Power Block.
31223	Error	PwrBlk: Temperature fuse tripped	The Power Block internal thermo fuse irreversibly opened because of a critical overtemperature.	1. Power cycle X-Segment. 2. Replace Power Block.
31224	Error	PwrBlk: Small filament regulation fault	Small filament current control loop frequency out of tolerance.	1. Insert no-load-plug into generator 2. Send a dataset with minimal tube voltage, filament current, and emission current. 3. Sent the filament-on command 4. Read the filament current measurement values. If there is no filament current with the tube, but there is filament current with the no-load plug, replace the X-ray tube If there is no filament current with both the tube and the no-load plug, replace the Power Block.
31226	Error	PwrBlk: Small filament plausibility fault	This error appears when the filament inverter does not get its supply voltage. This can be because there is no rail-voltage for the Power Block or because of an internal problem in the Power Block.	1. Power cycle generator. 2. Check if rail-voltage supply to Power Block is working. Check cables and if possible measure rail-voltage. 3. If the error persists and the rail-voltage is OK, replace Power Block.

ID	Error type	Message	Description	Service procedure
31350	Error	PwrBlk: Ie maximum exceeded	Emission current rise could not be stopped by a closed control loop.	1. Power cycle X-Segment. 2. Replace X-ay tube.
31354	Error	PwrBlk: Inverter overtemperature	The tank temperature exceeded the error level. It can be caused by a cooling failure.	1. Check environmental temperature of CT System. 2. Check ambient temperature of the X-Segment. 3. Check the CT System fans, if necessary. 4. Clean the heat-sink and fan of the Power Block. 5. Replace Power Block.
31355	Error	PwrBlk: Tank overtemperature	The tank temperature exceeded the error level. It can be caused by a cooling failure.	1. Check environmental temperature of CT System. 2. Check ambient temperature of the X-Segment. 3. Check the CT System fans, if necessary. 4. Clean the heat-sink and fan of the Power Block. 5. Replace Power Block.
31356	Error	PwrBlk: Resonance current too high	The inverter resonant current exceeded the error level.	1. Power cycle X-Segment. 2. Check HV cables. 3. Replace Power Block.
31357	Error	PwrBlk: Resonance frequency too low	The resonant frequency exceeded error level.	1. Power cycle X-Segment. 2. Replace Power Block.
31358	Error	PwrBlk: Resonance frequency too high	The resonant frequency exceeded error level.	1. Power cycle X-Segment. 2. Replace Power Block.
31359	Error	PwrBlk: Gate driver fault	The gate driver circuit signaled an error condition	1. Power cycle X-Segment. 2. Replace Power Block.
31360	Error	PwrBlk: EN_X_C deadtime violation	The time between activation of EN_X_C and CTRL_X_C was too short.	1. Power cycle X-Segment. 2. Replace SIU.
31362	Error	PwrBlk: Inverter temp sensor failure	The internal inverter temperature sensor does not provide plausible indications.	1. Power cycle X-Segment. 2. Replace Power Block.
31363	Error	PwrBlk: Tank temp sensor failure	The internal inverter temperature sensor does not provide plausible indications.	1. Power cycle X-Segment. 2. Replace Power Block.

ID	Error type	Message	Description	Service procedure
31364	Error	PwrBlk: Multiple arcs	The exposure had to be ended because too many arcs occurred.	1. Perform a short X-ray tube conditioning procedure (STC). 2. If the X-ray tube is still arcing, repeat STC for a maximum of two times. 3. If a no-load plug is available, perform a no-load test procedure. a) If the arcing error occurs during no-load test, replace the Power Block. b) If the arcing error does not occur during no-load test, check and replace the HV cable, if required. 4. In case of continuous arcing, perform a long X-ray tube conditioning procedure (LTC) for several times. 5. Repeat the filament calibration procedure (AKA adaptation) 6. Replace the X-ray tube.
31365	Error	PwrBlk: Emission current regulation fault	Even though the maximum allowed filament current was applied, the emission current did not rise fast enough. Exposure was ended to protect the tube.	1. Power cycle X-Segment. 2. Replace the X-ray tube.
34200	Error	ADU: Life tick missing	The CIU stopped sending life tick messages to ADU. This can be caused by interrupted communication / CIU malfunction / too slow startup of the CIU after a reset.	1. Power cycle X-Segment. 2. Replace SIU.
34201	Error	ADU: Internal supply out of range	One of the ADU internal power supplies is not working. ADU seems to be defective.	Replace ADU.
34204	Error	ADU: Undervoltage on ADU rail voltage	The rail voltage supplied by MIU to ADU is insufficient.	1. Power cycle X-Segment. 2. Check the rail voltage (supply) of the CT System (PDU and slip-ring). 3. Check the power cables between SIU and ADU. 4. Replace ADU. 5. Replace SIU.
34205	Error	ADU: Overvoltage on ADU rail voltage	The rail voltage supplied by MIU to ADU is too high.	1. Power cycle X-Segment. 2. Check the rail voltage (supply) of the CT System (PDU and slip-ring). 3. Check the power cables between SIU and ADU. 4. Replace ADU. 5. Replace SIU.

ID	Error type	Message	Description	Service procedure
34206	Error	ADU: Phase undercurrent	One of the phase currents from the ADU to the tube stator is too low. This is typically caused by a defective. tube stator or wrong tube installation (Defects in stator cable or ADU hardware should be found by ADU self test).	Replace the X-ray tube.
34207	Error	ADU: Phase overcurrent	One of the phase currents from the ADU to the tube stator is too high. This is typically caused by a defective tube stator or wrong tube installation. (Defects in stator cable or ADU hardware should be found by ADU self test.)	Replace the X-ray tube.
34209	Error	ADU: Phase check failed rotation too slow	Feedback signals from the tube indicate that the anode rotational speed is too low. This is caused by a defective tube.	Replace the X-ray tube.
34210	Error	ADU: Overtemperature	The IGBT module internal temperature is too high. This is caused by insufficient external cooling of the ADU.	1. Check airflow at the ADU, remove dirt from ventilation openings and heat sink. 2. Check the environmental temperature of the CT System. 3. Check the ambient temperature of X-Segment. 4. Check the CT System fans. 5. Replace ADU.
34213	Error	ADU: Stator output overcurrent	A short circuit in the stator cable or the tube motor was detected	1. Check stator cable from ADU to X-ray tube. 2. Replace ADU. 3. Replace the X-ray tube.
34214	Error	ADU: EEPROM fault or Real-time clock fault	The internal ADU EEPROM or RTC is not working. ADU seems to be defective.	Replace ADU.
34217	Error	ADU: Thermo fuse open	The ADU internal thermo fuse opened because of a critical over temperature (permanent defect).	Replace ADU.
34218	Error	ADU: Internal hardware defect	The self test found a hardware defect within the ADU power part. ADU seems to be defective.	Replace ADU.
34219	Error	ADU: Stator connection problem	Stator cable not plugged or electrical connection problem in stator cable or tube stator	1. Check stator cable from ADU to X-ray tube. 2. Replace the X-ray tube. 3. Replace ADU.

ID	Error type	Message	Description	Service procedure
37103	Error	CIU: safety-chain from ADU is broken	Part of safety chain, from CIU to ADU or ADU to CIU, is opened. ADU temperature switch is also in the chain.	1. Power cycle X-Segment. 2. Check the environmental temperature of CT System. 3. Check the ambient temperature of X-Segment. 4. Replace ADU. 5. Replace SIU.
37106	Error	CIU: the 24-V power for CIU is too low	The24V supplied for CIU is too low.	1. Check the system power input. 2. Replace SIU.
37107	Error	CIU: the 24-V power for CIU is too high	The24V supplied for CIU is too high.	1. Check the system power input. 2. Replace SIU.
37108	Error	CIU: failed to control safety-chain to PB	CIU was not able to activate EN_X_C for Power Block.	1. Power cycle X-Segment. 2. Replace SIU.
37109	Error	CIU: precharge error	CIU precharge failed. MIU error or short circuit in DC-BUS.	1. Power cycle X-Segment. 2. Check the system power input. 3. Replace SIU.
37200	Error	CIU: failed to communication to grid	This can be caused by interrupted communication / CIU malfunction / GM malfunction.	1. Power cycle X-Segment. 2. Check the cable from CIU to Power Block. 3. Replace SIU. 4. Replace Power Block.
37201	Error	CIU: connection between CIU and MIU is broken	Connection between CIU and MIU is broken.	1. Power cycle X-Segment. 2. Replace SIU.
37202	Error	CIU: failed to communication to PB	This can be caused by interrupted communication / CIU malfunction / PB malfunction/ too slow startup of the PB after a reset.	1. Power cycle X-Segment. 2. Check the cable from CIU to Power Block. 3. Replace SIU. 4. Replace Power Block.
37203	Error	CIU: failed to communication to ADU	This can be caused by interrupted communication / CIU malfunction / ADU malfunction/ too slow startup of the ADU after a reset	1. Power cycle X-Segment. 2. Check the cable from CIU to ADU. 3. Replace SIU. 4. Replace ADU.
37204	Error	CIU: Data setting from CT System is out of range	Data setting, including kV, mA, filament, and KW, from CT System is out of range.	1. Check the data setting from the CT System. 2. Replace SIU.
37208	Error	CIU: Filament over current	CIU finds the actual filament current is too large out of exposure	1. Power cycle X-Segment. 2. Check the data setting from the CT System. 3. Replace Power Block.
37209	Error	CIU: HVG Ie overcurrent	CIU finds the actual Ie current is too large during normal exposure. No supervise in VMA and NOLOAD mode.	1. Power cycle X-Segment. 2. Replace Power Block.

ID	Error type	Message	Description	Service procedure
37210	Error	CIU: mA is not maintaining regulation	CIU finds the PB can't maintain the mA(Ie) with setting value during normal exposure.	1. Power cycle X-Segment. 2. Replace Power Block.
37211	Error	CIU: kV is not maintaining regulation	CIU finds the PB cannot maintain the kV(Ie) with setting value during normal exposure.	1. Power cycle X-Segment. 2. Replace Power Block.
37212	Error	CIU: unexpected exposure without HV_ON command	CIU find the actual kV is exist or X_ACT* signal is active, with out CT HV_ON* command	1. Power cycle X-Segment. 2. Replace Power Block. 3. Replace SIU.
37213	Error	CIU: reserved	Reserved for future use.	
37214	Error	CIU: exposure conditions are not met	Exposure start command (HV_ON* signal) is active, while some other conditions are not met, including X_PREP* signal, MIU status, ADU status, Filament status, safety-chains, and so on.	1. Power cycle X-Segment. 2. Check the exposure sequence from the CT System.
37215	Error	PB Calibration failed	PB calibration failed. And CIU stop to start anode and the exposure is inhibited.	1. Power cycle X-Segment. 2. Replace Power Block.
37216	Error	PB Test failed	PB Test failed and the exposure is inhibited.	1. Power cycle X-Segment. 2. Replace Power Block.
37300	Error	CIU: either of QFC FIFOs is full	There are two FIFOs used to send QFC messages to PB and ADU. Either of them is full triggers this error. This might be CIU SW defect.	1. Power cycle X-Segment. 2. Replace SIU.
37301	Error	CIU: failed to write tube data to ADU	CIU failed to write tube data to ADU. CIU malfunction / ADU malfunction	1. Power cycle X-Segment. 2. Replace SIU. 3. Replace ADU.
37302	Error	CIU: the HCS file is lost	HCS files of CIU are lost / CIU malfunction.	1. Power cycle X-Segment. 2. Replace SIU.
37303	Error	CIU: PLD firmware is unavailable	PLD firmware of CIU is unavailable / CIU malfunction.	1. Power cycle X-Segment. 2. Replace SIU.
37304	Error	GM: Grid data settings from CT System are out of range	Grid data settings from CT System are out of range. CIU forwards it to CT System. GM malfunction / CT system malfunction	1. Power cycle X-Segment. 2. Check the data setting from the CT System. 3. Replace SIU. 4. Replace Power Block.
37305	Error	GM: B_POS from CT System changes too quickly	B_POS from CT System changes too quickly. CIU forwards it to CT System. GM malfunction / CT System malfunction	1. Power cycle X-Segment. 2. Check the B_POS signal from the CT System system. 3. Replace SIU. 4. Replace Power Block.
37306	Error	GM: Grid output error after stable time	Grid output error after stable time.CIU forwards it to CT System. this might be caused by Arcing or GM malfunction	1. If the error occurs together with arcing, resolve the arcing errors first. 2. Check the HV cable. 3. Check the tube. 4. Replace Power Block.

ID	Error type	Message	Description	Service procedure
37307	Error	GM: grid regulation error	Grid regulation error. CIU forwards it to CT System. this might be caused by Arcing or GM malfunction.	1. If the error occurs together with arcing, resolve the arcing errors first. 2. Check the HV cable. 3. Check the tube. 4. Replace Power Block.
37308	Error	GM: GM inner cable error	GM inner cable error.CIU forwards it to CT System. this might caused by Arcing or GM malfunction or communication malfunction	1. Power cycle X-Segment. 2. Replace Power Block.
37309	Error	MIU: Temperature switch open	The temperature switch on MIU is open.	1. Power cycle X-Segment. 2. Check the environmental temperature of CT System. 3. Check the ambient temperature of X-Segment. 4. Check CT system fans. 5. Replace SIU.
37400	Warning	CIU: Report remaining scan seconds (unit is10 ms)	15000 scan seconds before the bought scan seconds volume are used up by the operator. The X-Segment sends a warning message through the normal system interface to the system indicating the remaining scan seconds before every scan.	1. Replace SIU. 2. Replace the X-ray tube.
37401	Warning	CIU: Scan seconds reached the limitation	When reaching the volume of the bought scan seconds, the X-Segment sends a warning message through the normal system interface to the system, stating that the bought scan seconds volume is used up and that the X-ray tube needs to be replaced. A warning is sent before every following scan. Also, the system might reduce the functionality (for example reduction of peak power).	1. Replace SIU. 2. Replace the X-ray tube.
37402	Warning	Warning CIU: The last time scan	7000 scan seconds after exceeding the bought volume of scan seconds. The X-Segment sends a warning message through the normal system interface to the system, indicating that the following scan is the last one before the X-Segment does not release X-ray anymore. This warning is sent before every scan until 7500 scan seconds are exceeded.	1. Replace SIU. 2. Replace the X-ray tube.

ID	Error type	Message	Description	Service procedure
37403	Error	CIU: Invalid signature	X-ray tube detects a Signature failure at start-up.	1. Signature again. 2. Replace the X-ray tube.
37404	Error	CIU: Consistency error	1.s 2. 3.t 4.5.6.e 7.serial number in PPU table not compatible with tube serial number 1. Serial number in CIU configuration file not compatible with CIU key file. 2. CIU config file version is wrong. 3. The serial number inthe tube configuration file is not compatible with the serial number in gen key file. 4. Tube config file version is wrong. 5. EEPROM error. 6. Exposure time counter value in tube is unequal to the one in EEPROM. 7. The serial number in PPU table is not compatible with tube serial number.	1. Replace SIU. 2. Replace the X-ray tube.
37405	Error	CIU: CIU and Tube OEM Id not compatible	OEM ID is different.	Check OEM ID.
37406	Error	CIU: Scan seconds end	The tube scan seconds have already been beyond the limits plus 7500 scan seconds.	1. Replace SIU. 2. Replace the X-ray tube.
37407	Error	CIU: TUBE safe chain error	TUBE safe chain error.	1. Check cable. 2. Replace the X-ray tube.
38200	Error	TUBE: Life tick missing	The interface unit stopped sending life ticks to TUBE.	1. Replace SIU. 2. Replace the X-ray tube.
38201	Error	TUBE: TUBE Consistency Failure	TUBE detects failures in the data objects during startup. <I2C DataError> : a 1 means that data is corrupt in the I2C storage. <Initial Contract> : a 1 means that the Initial-Contract file is not valid.	Replace the X-ray tube.
38202	Error	TUBE: Tube invalid signature	TUBE detects a Signature failure at startup in the enumerated object types. <DataBlock type> : type identifier number (IDs defined as for the data transfer) of the invalid data objects.	Replace the X-ray tube.
38203	Error	TUBE: SwitchOff Limit Reached	One or more of the Pay Per Use Counters reached the Switch-Off-Limit.	Replace the X-ray tube.

ID	Error type	Message	Description	Service procedure
38204	Error	TUBE: Data Storage Failure	TUBE detects failures in the data objects during startup. <I2C DataError>: a 1 means that data is corrupt in the I2C storage. <Initial Contract>: a 1 means that the Initial-Contract file is not valid.	Replace the X-ray tube.
38300	Info	TUBE: Data Send Failure	TUBE can't accept the actual sent data object. <Invalid Signature> : a 1 means that the signature is invalid. <Invalid Header SN> : a 1 means that the leading Secure-Header serial number is invalid. <Invalid Header Version> : a 1 means that the leading Secure-Header version is invalid. <Invalid Header Type> : a 1 means that the leading Secure-Header type is invalid.	Replace the X-ray tube.
38301	Info	TUBE: Contract Parsing Failure	TUBE cannot accept the sent contract inifile.< Invalid ID> : a 1 means that the new Contract-Id is not higher than the active Contract-ID <Wrong Content> : a 1 means that the contract ini-file is not valid	Replace the X-ray tube.

5.2.2 Repair activity

Repair and replacement work of the FRUs comprises:

- Tools and equipment
- Data recording
- Removal work
- Installation work
- Calibration work
- Final tests
- Return procedure (Reshipment)

Detailed repair and replacement work of the FRUs is described in the Gantry Repair / Replacement Manual and the Calibration Manual of the CT System. In this component manual is only basic information of the FRU replacement described. All screws have to secured with Loctite243 before inserting it again.

5.2.2.1 Return procedure

Packaging of the Power Block

NOTICE

Risk of a damage of X-ray generator parts because of an incorrect packaging
Obey the packaging instructions that follow.

If you do not obey these instructions, there is a risk of property damage.

Use the re-usable transport box of the new Power Block for the return shipment of the defective Power Block.
This makes sure that the transport of the defective Power Block occurs in a transport box which is made for this purpose

1. Tighten the 4 attachment screws that attach the transport box supports on the top of the transport box.
2. Remove the 4 attachment screws from the bottom of the transport box supports.

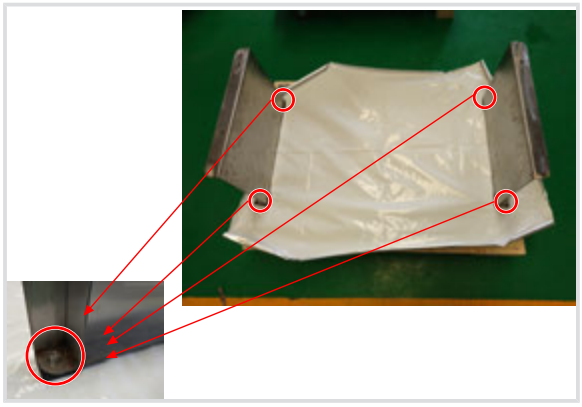


Fig. 24: Packaging of the Power Block

3. Put the defective Power Block on the transport box supports.
4. Attach the 8 attachment screws on the top of the transport box supports. Tighten the screws
5. Send the defective Power Block to the manufacturer of the Power Block. Refer to the contact address of the manufacturer.

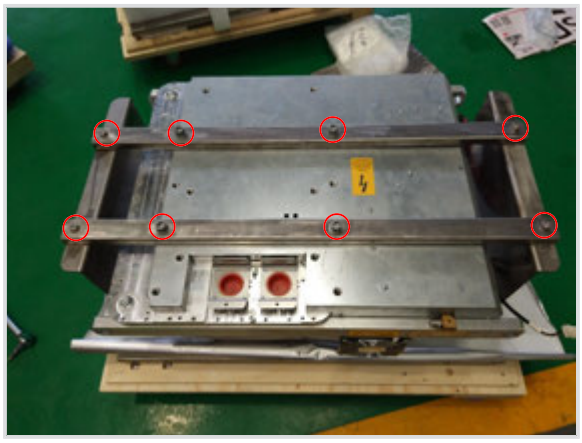


Fig. 25: Packaging of the Power Block

5.2.2.2 Field Replaceable Units (FRUs)

The Field Replaceable Units of the generator are:

– Power Block Unit [1)]
– Anode Drive [1)]
– System Interface Unit [1)]
– Power Block Fan
– Fuses for the protection of the ADU supply, mounted in the SIU

[1)] including their interconnection cables and protective earth conductors.

Defective components of the generator must be replaced by genuine spare parts, only!
Repairs and refilling of the FRUs must be carried out by the manufacturer only.

The FRUs are not repairable by a Field Service Engineer.
The FRUs are replaceable by a Field Service Engineer. They are replaceable as a whole unit only.
The FRU packaging is re-usable for the return shipment of the defective unit, except the packaging of the fan kit or fuses. Replaced fans or fuses must be disposed in a proper manner. While disposing consider all applicable national and international regulations and laws.

WARNING

Hazard of falling masses and sharp edges and corners
They can cause bruises, lacerations, and similar injuries!
a) Use appropriate lifting devices when you have to lift heavy loads or ask another person for help!
b) If necessary, wear appropriate protective clothing, such as safety boots, safety goggles, and gloves!

If you do not obey these instructions, there is a risk of death or serious injury.

5.2.2.3 Replacing the Power Block

5.2.2.3.1 Removing the Power Block

Preparation work

1. Turn OFF the system.
2. Open the gantry cover.
3. Check with a measuring device that all voltages are OFF.
   For further details, refer to the System Service Manual.

WARNING

Hazard of electrical shock because of exposed voltage
High-voltage cables are like capacitors.
a) Each time you disconnect a high-voltage plug, remove the voltage from the contact pins. The minimum waiting time after you set the CT system to OFF is 5 seconds.
b) To make sure that the contact pins are free of voltage, use a multi meter.

If you do not obey these instructions, there is a risk of death or serious injury.

Removing the high-voltage cables

1. Loosen and remove the fixing screws (1).
2. Remove the metal clamps.
3. Disconnect the high-voltage plug from the socket.
4. Do not touch the contact pins.
5. Make sure that the pressure spring does not fall apart.
6. Remove the function earth of the Power Block (2) to the tube.

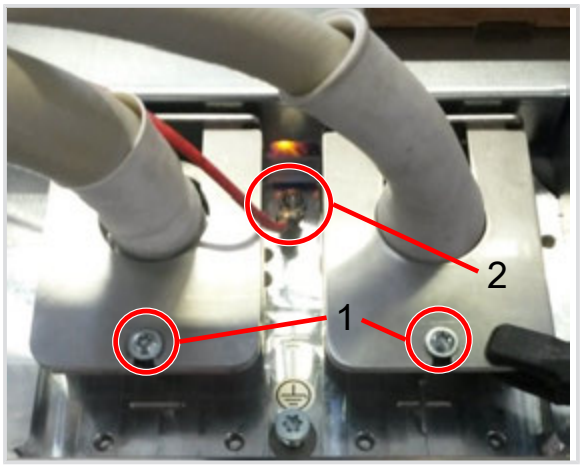


Fig. 26: Removing the high-voltage cables

7. Remove the fixing screw (1).
8. Disconnect the rail voltage connectors (2).

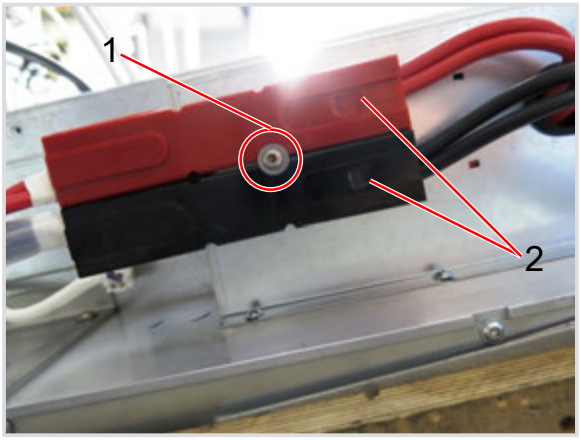


Fig. 27: Removing the rail voltage connector

9. Remove the four screws.
10. Open the cover.
11. Keep the cover. Assemble it on the new SIU when you replace the SIU.

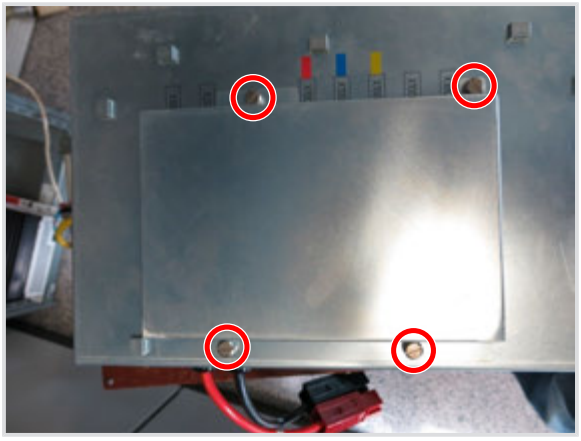


Fig. 28: Opening the SIU cover

12. Disconnect the cables X3800, X1002, and X1003.
13. Remove the cable fixing devices.

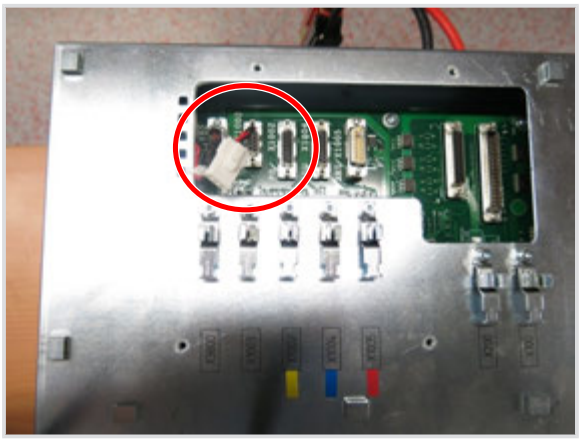


Fig. 29: SIU connections

Removing the Power Block from the gantry

1. Loosen 6 of the 8 fixing M12 bolts.
2. Install the heavy part lifting device according to the description in the system manual.
3. Remove all 8 M12 bolts.
4. Lift the Power Block out of the gantry. Details are described in the system manual.

5.2.2.3.2 Installing the Power Block

1. Use the newly delivered M12 bolts to fix the unit into the gantry.
2. Tighten the bolts with the correct torque of 62.5 Nm.
3. Secure all bolts with Loctite 243.

4. Connect all cables to the SIU.
5. Connect the rail voltage connectors.
6. For the connection of the can ground, use the adaptor with ferrite core for EMC.
7. Connect the can ground return cable from the tube to the functional earth of the Power Block.

To connect the HV cables:

8. Follow the instructions in chapter chapter High voltage (HV) connectors on page 29.
9. Fit the clamp on the high-voltage cable and fix it with the M4 torx head screw.
10. Fix the screw with a torque of 2 Nm.

EMC measurement

1. Make sure that there is a proper connection regarding EMC.
2. Measure the resistance between cover and unit. The measurement result must be close to 0 Ω.

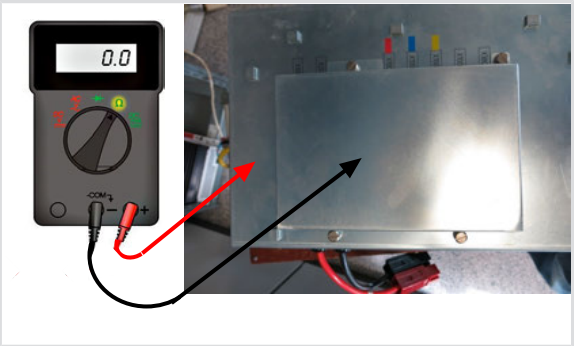


Fig. 30: EMC measurement

5.2.2.4 Replacing the Anode Drive Unit (ADU)

Removing the ADU

1. Turn OFF the system.
2. Open the gantry cover.
3. Check with a measuring device that all voltages are OFF.
   For further details, refer to the System Service Manual.
4. Remove the blue stator connector of the X-ray tube XRT X1. Open all related cable ties.
5. Remove the four screws.
6. Open the cover.
7. Keep the cover. Assemble it on the new SIU when you replace the SIU.

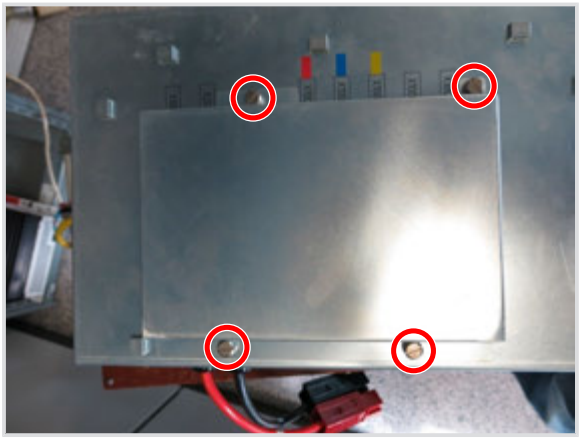


Fig. 31: Opening the SIU cover

8. Disconnect SIU X1004 ADU Control cable.
9. Remove the cable from the cable clamp.
10. Open all related cable ties.

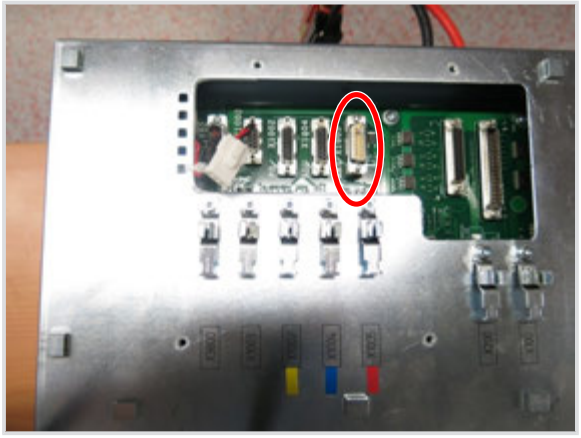


Fig. 32: SIU-ADU connector

11. Disconnect the 24-V supply connector SIU X3200.
12. Open all related cable ties.

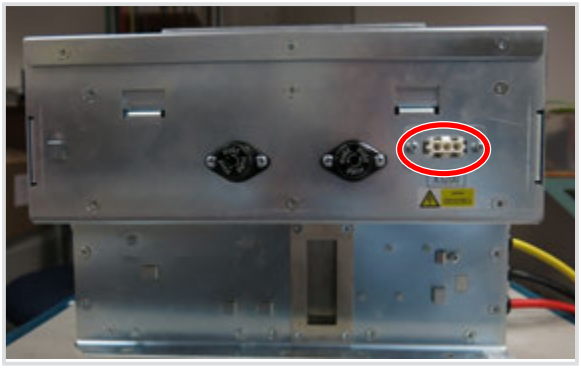


Fig. 33: Disconnect power supply

13. Loosen the 3 M8 bolts on the right side of the unit.
14. Remove the 3 M8 bolts from the left side of the unit.
15. To lift the unit from the gantry, move it to the left.

Installing the ADU

1. Position the unit on the gantry location.
2. Move it to the right below the 3 M8 bolts.
3. Insert the 3 M8 bolts to the left side of the unit.
   Tighten all bolts with a torque of 33 Nm. Secure all bolts with Loctite 243.
4. Connect the blue stator connector of the X-ray tube XRT X1.
5. Connect the 24-V supply connector to SIU X3200.
6. Connect all cables to the SIU.
7. Close the SIU cover.
8. Fix the four screws.

EMC measurement

1. Make sure that there is a proper connection regarding EMC.
2. Measure the resistance between cover and unit. The measurement result must be close to 0 Ω.

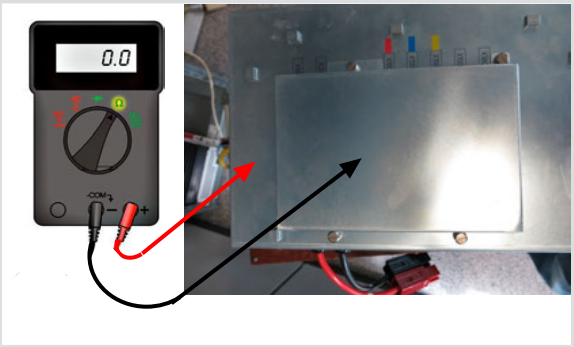


Fig. 34: EMC measurement

5.2.2.5 Replacing the System Interface Unit (SIU)

Removing the SIU

1. Turn OFF the system.
2. Open the gantry cover.
3. Check with a measuring device that all voltages are OFF. For further details, refer to the System Service Manual.
4. Disconnect X3001 L1 X3002 L2, and X3003 L3 from the rail voltage connection.
5. Disconnect the 1 phase 120V input connector SIU X3004 (1).

Fig. 35: Disconnecting power supply

6. Remove the four screws.
7. Open the cover.
8. Keep the cover. Assemble it on the new SIU when you replace the SIU.

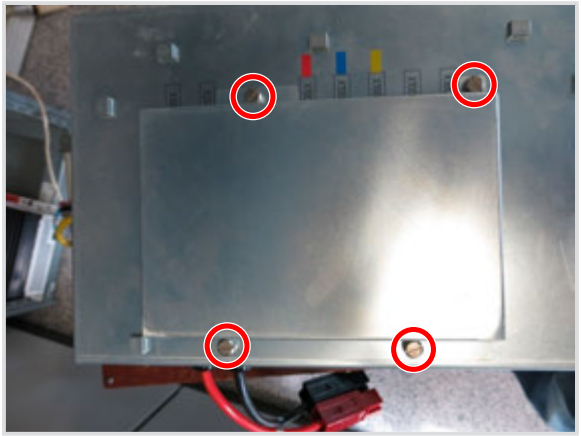


Fig. 36: Opening the SIU cover

9. Disconnect all connectors from the SIU connection field.

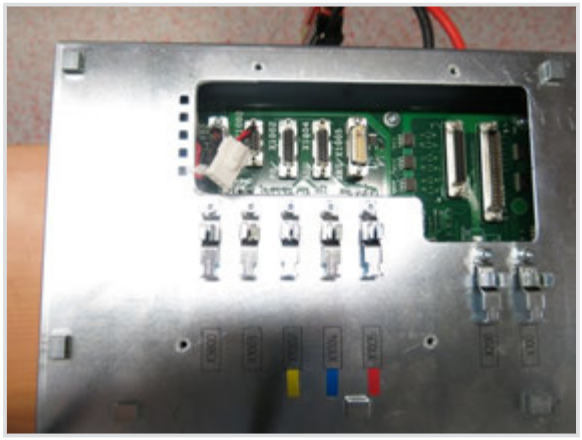


Fig. 37: Disconnecting all Siu connections

10. Disconnect the 24-V supply connector SIU X3200.
11. Open all related cable ties.

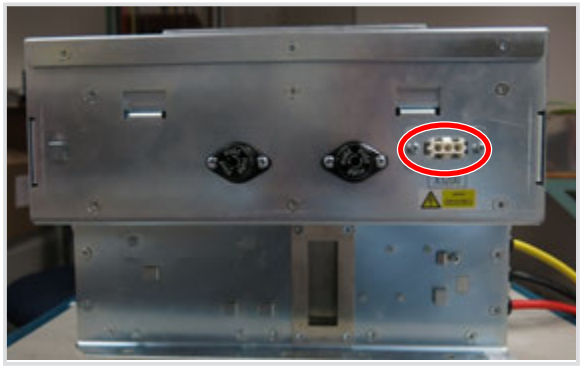


Fig. 38: Disconnect power supply

12. Loosen the 3 M8 bolts on the right side of the unit.
13. Remove the 3 M8 bolts from the left side of the unit.
14. To lift the unit from the gantry, move it to the left.

Installing the SIU

1. Position the unit on the gantry location.
2. Move it to the right below the 3 M8 bolts.
3. Insert the 3 M8 bolts to the left side of the unit.
   Tighten all bolts with a torque of 33 Nm. Secure all bolts with Loctite 243.
4. Connect X3001 L1, X3002 L2, and X3003 L3 to the rail voltage connection.
5. Connect the 1 phase 120V input connector to SIU X3004.
6. Connect the 24V supply connector to SIU X3200.
7. Close the SIU cover.
8. Fix the four screws.

EMC measurement

1. Make sure that there is a proper connection regarding EMC.
2. Measure the resistance between cover and unit. The measurement result must be close to 0 Ω.

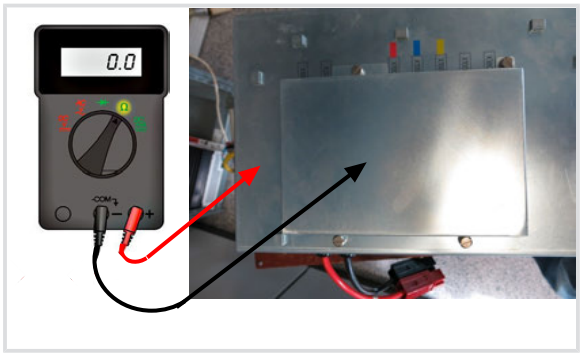


Fig. 39: EMC measurement

5.2.2.6 Replacing the Power Block fan

Removing the fan

1. Turn OFF the system.
2. Open the gantry cover.
3. Check with a measuring device that all voltages are OFF. For further details, refer to the System Service Manual.

To remove the fan connection plug:

4. To disconnect the connector (1), push the locking devices together at both sides and pull it out.
5. To remove the clamp (2), remove the screw with a torx driver T20.

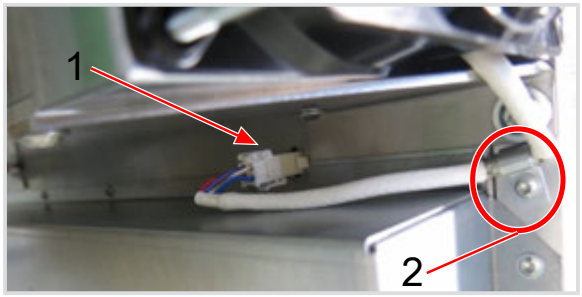


Fig. 40: Removing the fan connection

6. To remove the four fixing screws, use a torx wrench T20.

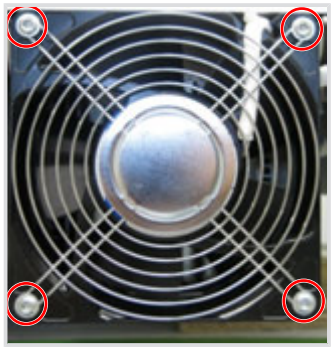


Fig. 41: Removing the screws

7. Remove the fan together with the grid from the Power Block.

Fig. 42: Removing the fan

Installing the fan

1. Use the new screws to fix the fan to the PB.
2. Tighten the screws with the correct torque of 2 Nm
3. Connect the fan connection plug (1) to connector X9002 (1).
4. Put the cable clamp to the correct position (2). Tighten the screw with a torque of 2 Nm.

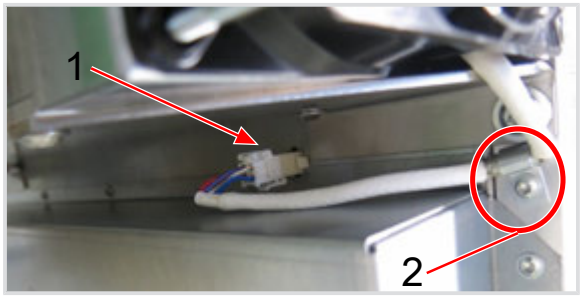


Fig. 43: Removing the fan connection

5.2.2.7 Replacing the SIU fuses

NOTICE

Risk of damage to the FRUs of the X-ray generator because of an incorrect fuse type
Only use the originally by Philips supplied fuses. The order number of the fuses is 459801140001.

If you do not obey these instructions, there is a risk of property damage.

1. Turn OFF the system.
2. Open the gantry cover.
3. Check with a measuring device that all voltages are OFF.
   For further details, refer to the System Service Manual.

If the SIU caused a short circuit or defect that requires to replace the SIU unit, the SIU fuses need to be checked.

4. To remove the SIU fuses holder, push and turn it to the left at the same time.

Fig. 44: Removing the fuse

5. Check with the EMC measuring device, whether the fuse is working properly.

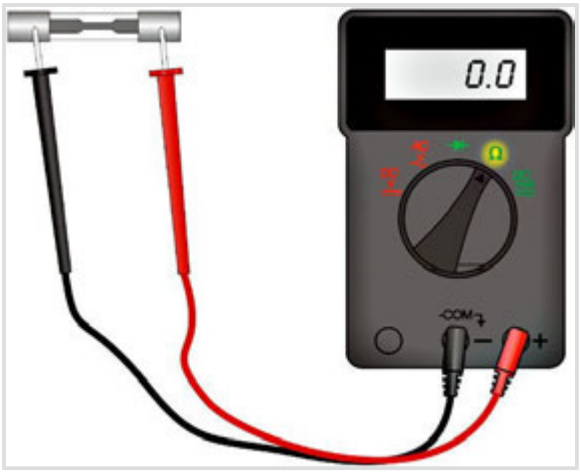


Fig. 45: Checking the fuse

6. Remove all defective fuses and insert the new fuses.
7. To install the fuse holder, push and turn it to the right at the same time.

Fig. 46: Replacing the fuse

5.2.3 End of life - decommissioning

The company that puts this X-ray generator on the market is responsible for the decommission of this product. The decommission must agree with all local and transregional legal requirements.
Obey the instructions of the manufacturer of the X-ray generator and the instructions of the manufacturer of the system.

IMPORTANT

Do not discard the X-ray generator, the attached parts, the cable connectors, and the cables together with industrial or domestic waste!
Discard the X-ray generator, the attached parts, the cable connectors, and the cables in a way that refers to the local environmental laws and regulations!

6 Technical data

Safe operation of the X-ray generator is only made sure when you use the X-ray generator in the limits of its specification. This section “Technical Data” shows you the specification limits. If you ignore the specification limits, there is the danger of coolant that flows out. The X-Ray generator becomes too hot. Component parts that are too hot can blow up as a result of an implosion or explosion.
In such cases, the manufacturer of the X-ray generator rejects the liability that refers to the use of the product. The manufacturer rejects all guarantee claims.

Read me, understand me, and obey me!

6.1 Applicable Standards

The generator complies with the following regulatory requirements and design standards:

– CSA mark

C US

Applicable standards

No.	International standard	Name
1	IEC 60601-1, 3.1 Ed:2005/AMD1:2012	Medical electrical equipment - Part 1: General requirements for basic safety and essential performance
2	IEC 60601-1-2, 4th Ed:2014	General requirements for basic safety and essential performance - Collateral standard: Electromagnetic compatibility - Requirements and Tests
3	IEC 60601-2-44, 3.2 Ed (2009/A1 :2012/ A2 :2016)	Particular requirements for the basic and essential performance of X-ray equipment for computed tomography
4	IEC 62304, 1st Ed (2006-05) + Amendment 1 (2015-06)	Medical device software – Software life cycle processes
5	ISO 14971 (2007-03)	Medical devices - Application of risk management to medical devices
6	CSA-C22.2 No. 60601-1:2014	Medical electrical equipment – General requirements for safety
7	to ANSI/AAMI ES 60601-1 2005/(R)2012, and A1:2012, and C1:2009/(R)2012, and A2:2010/ (R)2012	Medical electrical equipment - Part 1: General requirements for basic safety and essential performance

Classification according to IEC 60601-1, 3.1 edition

No.	Parameter	Classification
1	Type of protection against electrical shock (Cl.6.2, Cl.7.9.2.2)	Class 1
2	Degree of protection against electrical shock (Cl.6.2)	No applied parts

No.	Parameter	Classification
3	Degree of protection against harmful ingress of water (Cl.6.3)	IPX0
4	Mode of operation(Cl.6.6, Cl.7.9.2.2)	Continuous operation with intermittent loading
5	Creepage distances and air clearances (MOOP) (Cl. 8.5.1.3)	MOOP, two means of protection
6	Cooling condition (Cl.201.7.2.15)	Maximum heat dissipation: 3.5 kW, keep air vents clear

Equipment not suitable for use in presence of a flammable anesthetic mixture with air or oxygen or nitrous oxide (Cl 6.5.)

6.2 Emission Test Data

This part is derived from IEC 60601-1-2 and should be included in the system IFU for the end user.

Emissions test data

Emissions test	Compliance
RF emissions (CISPR 11)	Group 1 / Class A
Immunity test	Compliance level
Radiated RF (IEC 61000-4-3)	3 V/m 80 MHz to 2.7 GHz
Proximity fields from RF wireless communications equipment (IEC 61000-4-3)	Table 9 of IEC 60601-1-2:2014
Electrical fast transients/burst (IEC 61000-4-4)	±2 kV for power supply lines ±1 kV for input/output lines
Surge (IEC 61000-4-5)	±1 kV line(s) to line(s) ±2 kV line(s) to earth
Conducted RF (IEC 61000-4-6)	3 Vrms 150 KHz to 80 MHz 6 Vrms in ISM bands between 150 kHz and 80 MHz
Power frequency (50/60 Hz) magnetic field (IEC 61000-4-8)	30 A/m
Voltage dips and interruptions (IEC61000-4-11)	0 % UT; 250/300 cycle

6.3 Technical Data according to IEC 60601-2-44:2009

The data given in this chapter should be part of the system IFU for the end user.

6.3.1 Methods of measurement

Load time

Load time is measured between 75 % peak voltage of the high-voltage rise edge and 75 % peak voltage of the high-voltage fall edge.

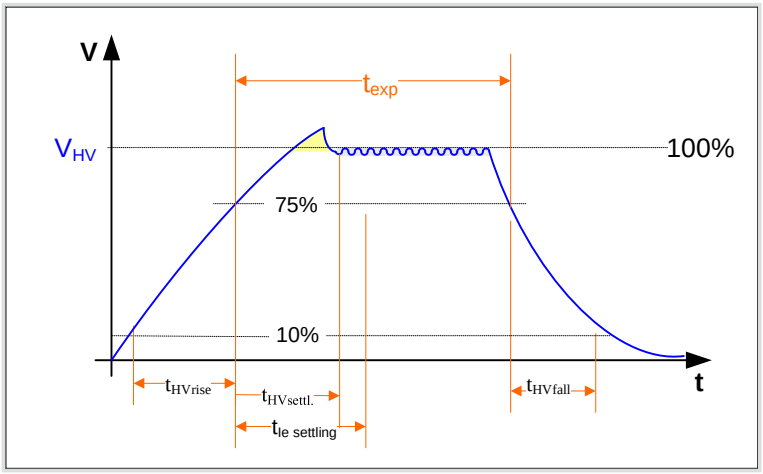


Fig. 47: Definition of terms for the scan time

High-voltage rise time

Duration of rising edge from 10% of V_{HV} to 75% of V_{HV}	
t_{HVrise} To make real use or the active ARC recovery, use < 1 ms	< 5 ms
$t_{HVsettling}$	< 20 ms

High-voltage fall time

Duration of falling edge from 75% of V_{HV} to 10% of V_{HV}	
t_{HVfall} To make real use or the active ARC recovery, use < 1 ms.	< 10 ms @ Ie ≥ 75 mA
t_{HVfall}	< 35 ms @ Ie 20 mA until 75 mA
t_{HVfall}	< 5 s @ Ie < 20 ms

6.3.2 Parameters and ranges

Applicable parameters

IEC-Norm 60601-2-44	Output Parameter	Mode	Loading Factor
§ 201.7.9.2.9	Maximum X-ray tube voltage and highest X-ray tube current at that voltage	Continuous	140 kV @ 715 mA* 140 kV @ 571 mA
§ 201.7.9.2.9	Maximum X-ray tube current and highest X-ray tube voltage at that current	Continuous	715 mA @ 140 kV* 666 mA @ 120 kV

IEC-Norm 60601-2-44	Output Parameter	Mode	Loading Factor
§ 201.7.9.2.9	Combination of X-ray tube current and X-ray tube voltage resulting in highest output power	Continuous	715 mA @ 140 kV* 666 mA @ 120 kV
§ 201.7.9.2.9	Highest constant output power at 100kV, 0.1s	Continuous	80 kW @ 667mA
§ 201.7.9.2.9	The lowest current time product or the combination of loading factors resulting in the lowest current time product	Continuous	10 mA for 500 ms
§ 201.7.9.2.9	Highest constant output power at 140 kV, 0.5 s	Continuous	100 kW @ 715 mA*
All above mentioned loading factors can also be graphically visualized to cover the complete working area including the scan time. * optional 100 kW			

6.3.3 Loading Factors

The generator shall fulfill the performance as derived from the IEC 60613, 3rd Ed (2010-01) specification. The CT anode input power is calculated as product of high voltage [kV] multiplied with emission current [mA].

Loading factors	
Power [kW]	**Scan Length @ 34°C**
100.0	0.5
80.0	0.6
80.0	1
77.6	4
74.9	5
72.5	6
70.5	7
67.5	8
62.0	10
58.8	15
55.5	20
53.4	30
49.3	40
37.7	60
25.3	90
19.0	120
15.3	150
12.8	180
11.6	200

Note:
Output power of the generator at 600 s cycle time for 12 hours.
The Duty cycle information can be calculated from the cycle time of 600 s.
Points between the tables coordinates can be linearly interpolated like in the graph.

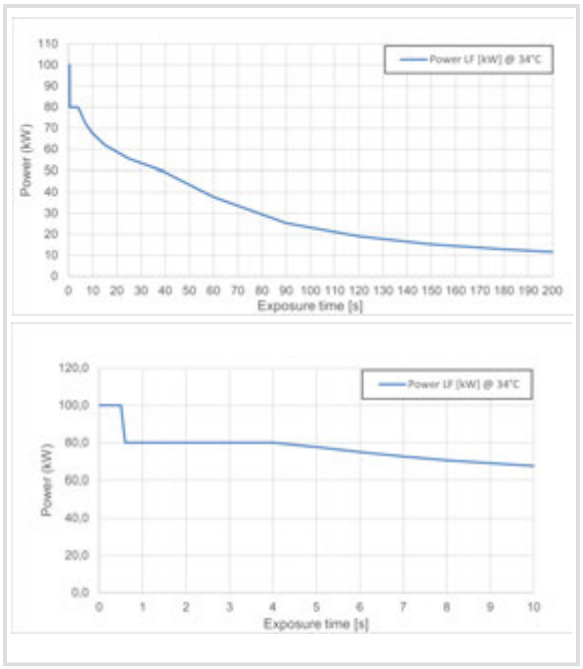


Fig. 48: Visualization of loading factors

Loading factors	
Power [kW]	**Scan Length @ 40°C**
100.0	0.5
80.0	0.6
80.0	1
80.0	3
73.0	5
70.0	6
68.0	7
67.0	8
64.0	10
59.0	15
56.0	20
53.0	25
50.0	30
43.5	40
32.0	60
21.3	90
16.0	120
12.8	150
10.6	180
9.6	200

Note:
Output power of the generator at 600 s cycle time for 12 hours.
The Duty cycle information can be calculated from the cycle time of 600 s.
Points between the tables coordinates can be linearly interpolated like in the graph.

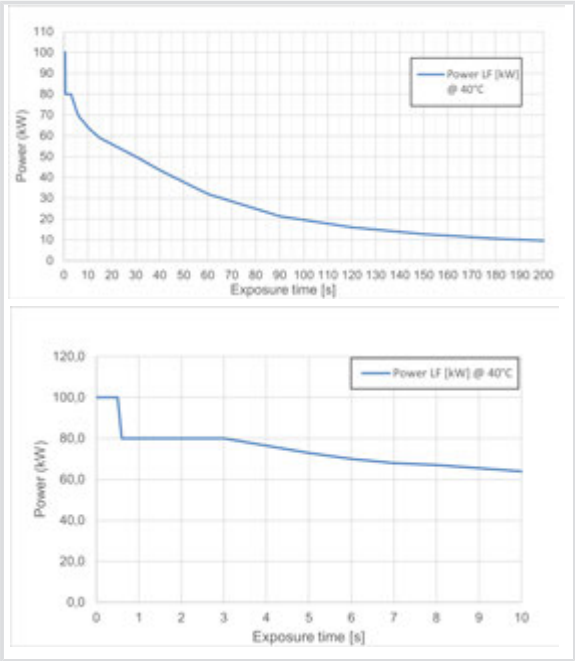


Fig. 49: Visualization of loading factors

Loading factors	
Power [kW]	**Scan Length @ 34°C**
100.0	0.5
80.0	0.6
80.0	1
75.5	4
71.1	5
67.7	6
65.1	7
63.0	8
59.7	10
54.4	15
47.5	20
38.0	25
31.7	30
23.8	40
15.9	60
10.7	90
8.0	120
6.4	150
5.3	180
4.8	200

Note:
Average power 5.5 kW for 1 hour.
Average power 4.0 kW for 12 hours.
Output power of the generator at 240 s cycle time for 12 hours.
The Duty cycle information can be calculated from the cycle time of 240 s.
Points between the tables coordinates can be linearly interpolated like in the graph.

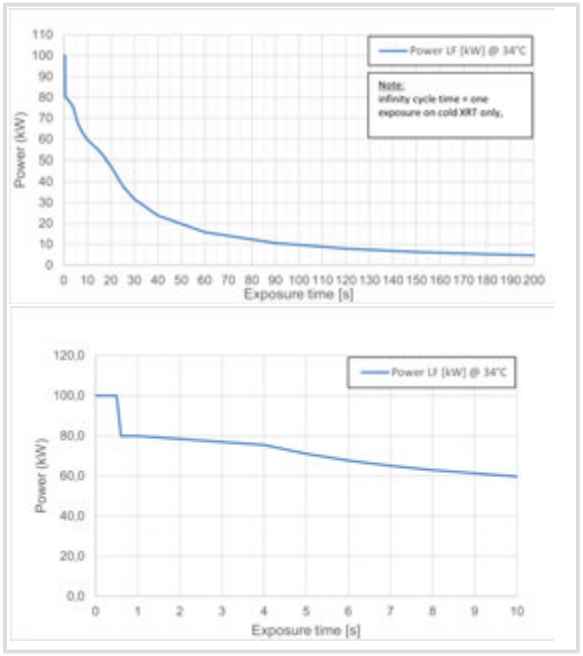


Fig. 50: Visualization of loading factors

Loading factors	
Power [kW]	**Scan Length @ 40°C**
100.0	0.5
80.0	0.6
80.0	1
74.5	3
64.5	5
60.5	6
58.5	7
57.5	8
54.0	10
49.0	15
38.4	20
30.7	25
25.6	30
19.2	40
10.0	60
7.7	90
6.2	120
5.1	150
4.2	180
3.8	200

Note:
Average power 5.5 kW for 1 hour.
Average power 4.0 kW for 12 hours.
Output power of the generator at 240 s cycle time for 12 hours.
The Duty cycle information can be calculated from the cycle time of 240 s.
Points between the tables coordinates can be linearly interpolated like in the graph.

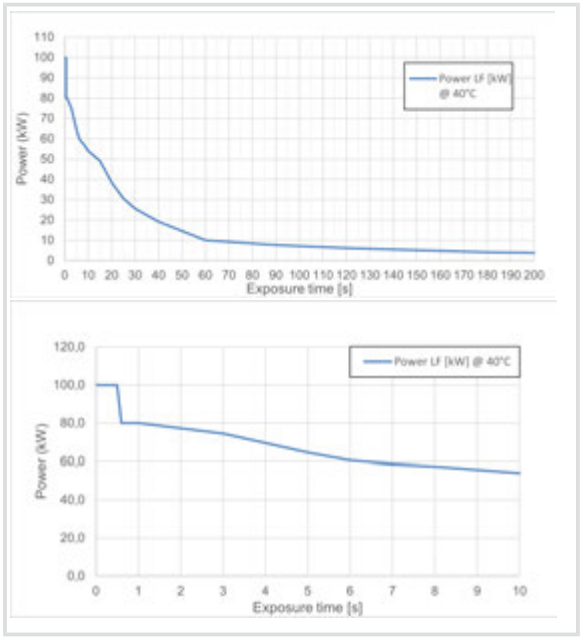


Fig. 51: Visualization of loading factors

Accuracy of loading factors

The accuracy of the X-ray tube voltage and the tube current is defined in the following table according to class 201.12.1.101.

Accuracy of loading factors

Parameter	Accuracy
Accuracy of tube voltage HV accuracy $e_{HV\ mean}$ HV accuracy $e_{HV\ peak}$	 - 2.5 % +0.5 % ± 4 %
X-ray tube current accuracy $I_{e\ actual\ value}$ $I_{e\ actual\ value}$ $I_{e\ settling}$	 < 20% for 5 mA to 10 mA emission current < ±2% ±1.8 mA for 10 mA and higher emission current < 20 ms
Exposure time	Determined by the system

6.3.4 Electrical data of the generator

Electrical data according to IEC 60601-2-44.

Electrical data of the generator

Parameter		Value
Power Supply		380 V -10 % to 400 Vac + 10 %, 50 Hz ± 3 Hz or 60 Hz ± 3 Hz switched and fused (100 A slow blow) by system PDU
Input power		115 kVA (max. output 80 kW) 150 kVA (max. output 100 kW optional)
Mains resistance / max. current input 400 V		≤ 0.12 Ω / 200 A (max. output 80 kW) ≤ 0.12 Ω / 230 A (max. output 100 kW optional)
Radiography	Max. voltage	140 kV
	Nominal electrical power	80 kW (120 kV; 4 s)
	Maximum electrical power	100 kW/0.5 s at 140 kV (optional)
Continuous output		4.0 kW (12 h at 34 °C air inlet temperature.)
High-voltage generation		Converter
High-voltage generation Converter Ripple		DC voltage
Auxiliary Power Supply		120 Vac + 10 % - 15 %, max. 10 A 50 Hz ± 3 Hz or 60 Hz ± 3 Hz, 1–phase switched and fused (10 A slow blow) by system PDU

6.3.5 Environmental data of the generator

Environmental parameters of the generator

Parameter	Value
Safety classification IEC 60601-1	Class 1
Ingress protection (IP) rating	IPX0
Pollution degree classification IEC 60601-1	Pollution degree 2
Electromagnetic compatibility IEC 60601-1-2	CISPR11 Group 1 Class A: -3 dB
Maximum rated leakage current: PB plus SIU plus ADU IEC60601-2-44 (normal conditions)	3.5 mA (measured with a frequency weighted device)
Maximum rated leakage current: PB plus SIU plus ADU IEC60601-2-44 (single fault conditions)	7.0 mA (measured with a frequency weighted device)

Parameter	Value
Heat dissipation considering a mean load of 2,000 W at the X-ray tube	3,500 W

Environmental conditions of the generator

Parameter	Operation	Stock / Transport
Temperature conditions	Indoor, temperature controlled	N/A
Ambient temperature [°C]	Minimum: +18 Maximum: +40	Minimum: -25 Maximum: +70
Maximum temperature inside the gantry with full performance [°C]	+34	N/A
Humidity conditions in % (non-condensing)	Minimum: +10 Maximum: +90	Minimum: +5 Maximum: +95
Ambient atmospheric pressure [kPa]	Minimum: 70 corresponding to a height above the sea level of 3,000 m Maximum: 110	Minimum: 50 Maximum: 110
Vibrations and shock conditions		
Vibrations range [Hz]	Minimum: 10 Maximum: 150	Minimum: 10 Maximum: 150
Vibrations [g]	≤ 2	≤ 10
Vibrations amplitude [mm]	≤ 0.15	≤ 0.75
Shock acceleration [g]	≤ 10	≤ 25
Shock pulse duration [ms]	Minimum: 6 Maximum: 10	Minimum: 6 Maximum: 10

6.3.6 Functional units

The generator consists of the following units:

Functional units

Name	Abbreviation	Unit	FRU	Remarks
Power Block incl. Fan	PB	x	x	
Power Block Fan only	PBF	x	x	
Control & Interface Unit	CIU	x	x	Combined to ‘System Interface Unit’ (SIU)
Mains Interface Unit	MIU	x		
Anode Drive Unit	ADU	x	x	
High Voltage Generator Software	Gen SW			

The X-ray tube housing assembly (incl. cooling unit) is not part of the generator and therefore not described in this manual.

6.4 Technical Data of the Power Block

Fig. 52: Power Block overview

Technical data of the Power Block

Parameter	Value
Nominal input voltage	420–623 Vdc
Nominal input voltage fan and driver	24 Vdc
Maximum output power	100 kW
Nominal output power	80 kW
Average output power	3 kW
Efficiency of the power chain	79 %

Parameter	Value
Output voltage range	70 kV to 140 kV, step = 10 kV
Output current range	5 mA to 715 mA
Output current filament range	2 A to 8 A
Maximum rated leakage current (IEC 60601-2-44)	7.0 mA
HV cable socket	HV + O3 / HV - O4S
Mass	76 ± 0.3 kg

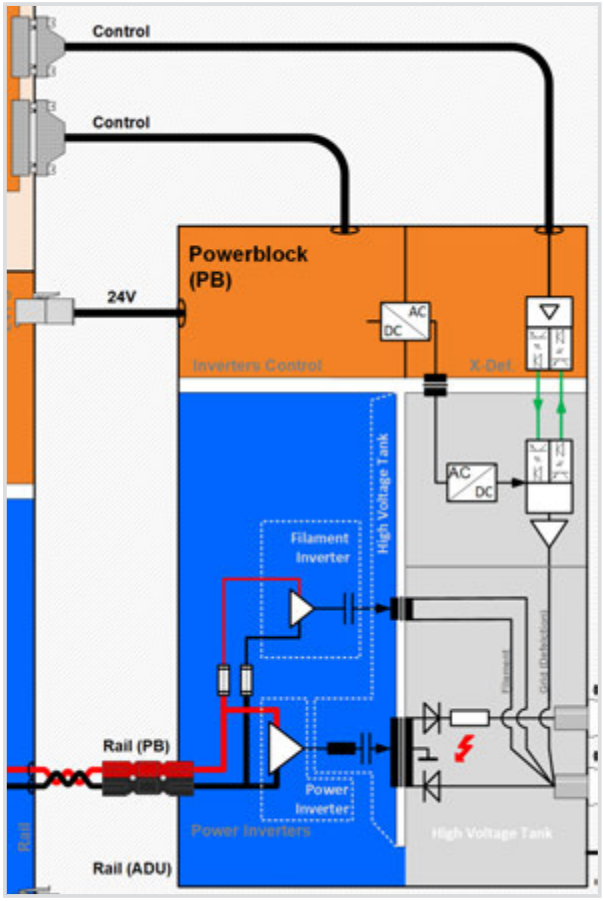


Fig. 53: Functional diagram of the Power Block

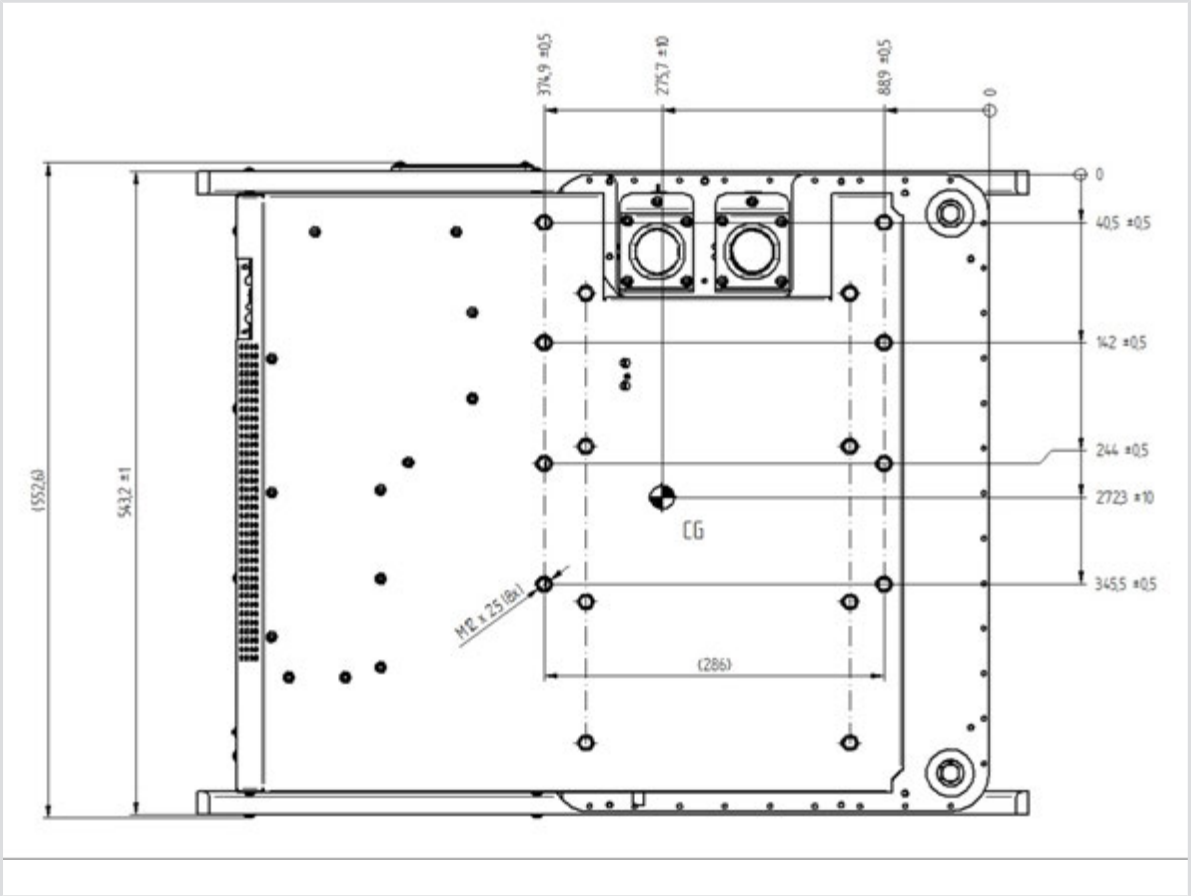


Fig. 54: Mechanical dimensions of the Power Block (top view)

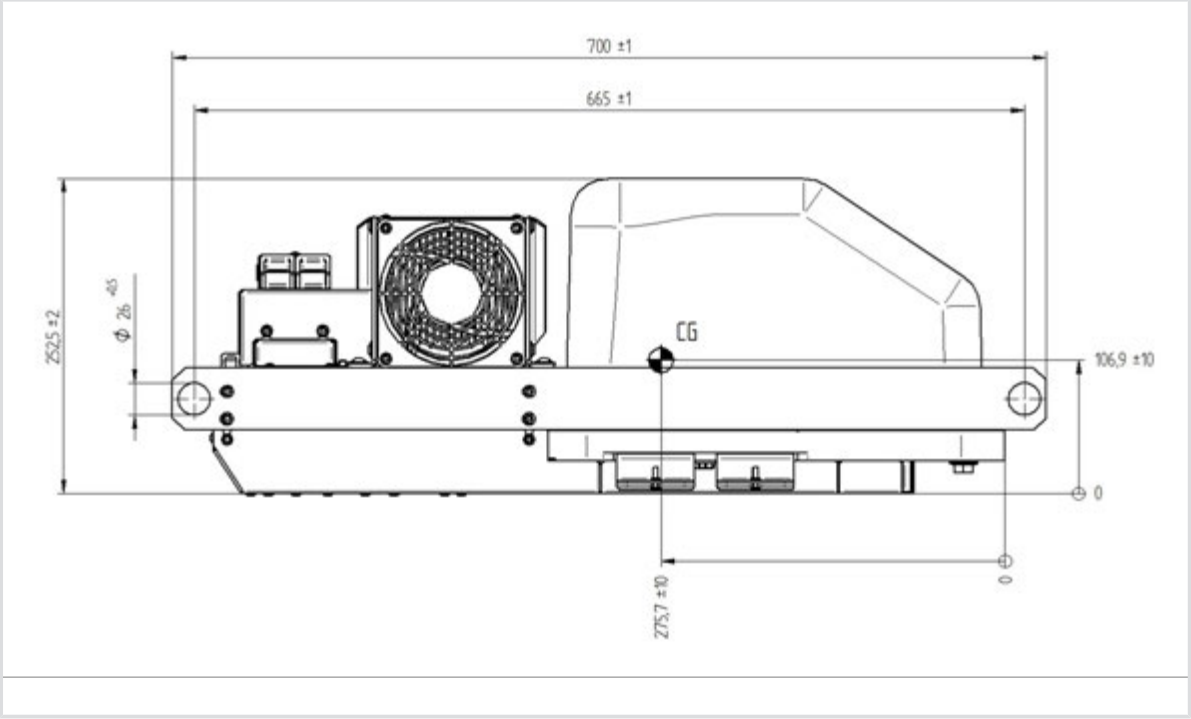


Fig. 55: Mechanical dimensions of the Power Block (side view)

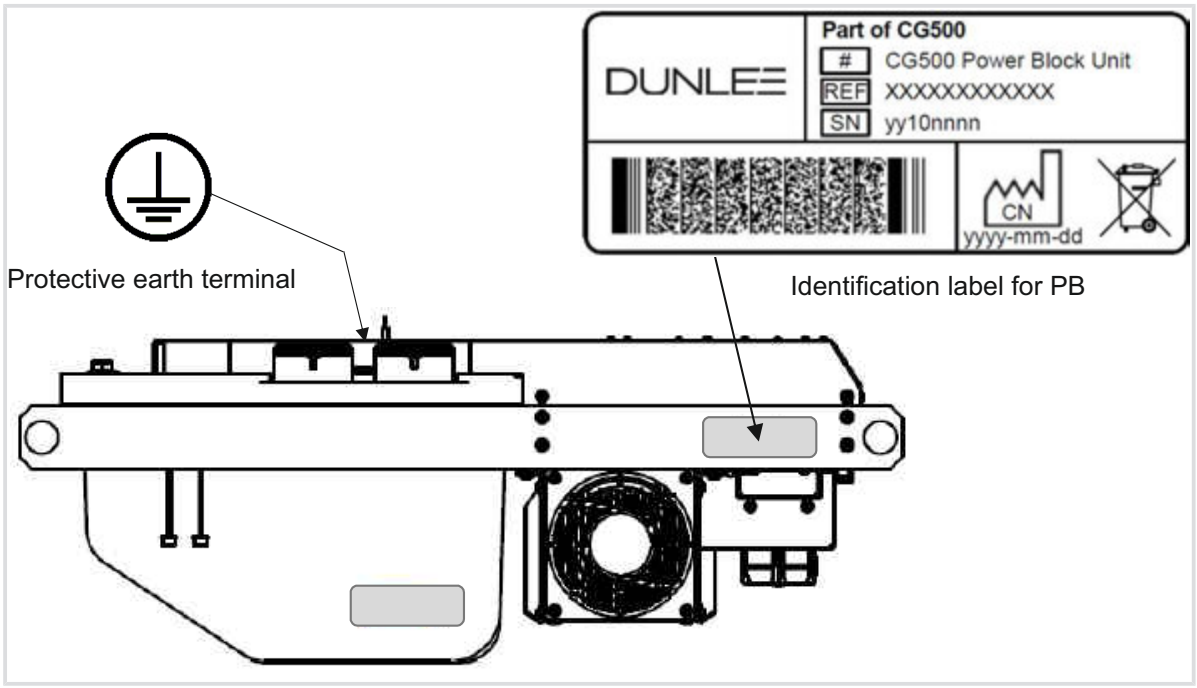


Fig. 56: Labels of the Power Block

Technical data of the Power Block fan

Technical data of the Power Block fan

Parameter	Value
Nominal input voltage	24 Vdc
Power consumption	22 W
Airflow	310 m^3 / h
Sound pressure level	68 dB (A)
Mass	0.39 kg
Dimension	119 mm x 119 mm
Maximum speed	6000 rpm

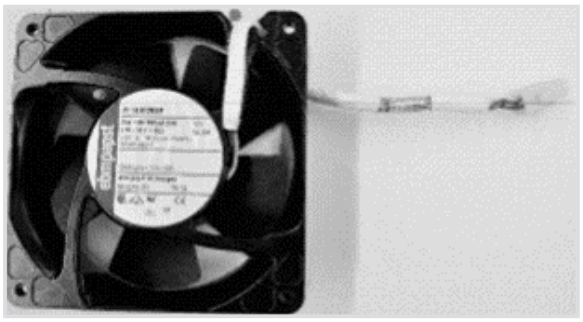


Fig. 57: Power Block fan

6.5 Technical Data of the System Unit Interface

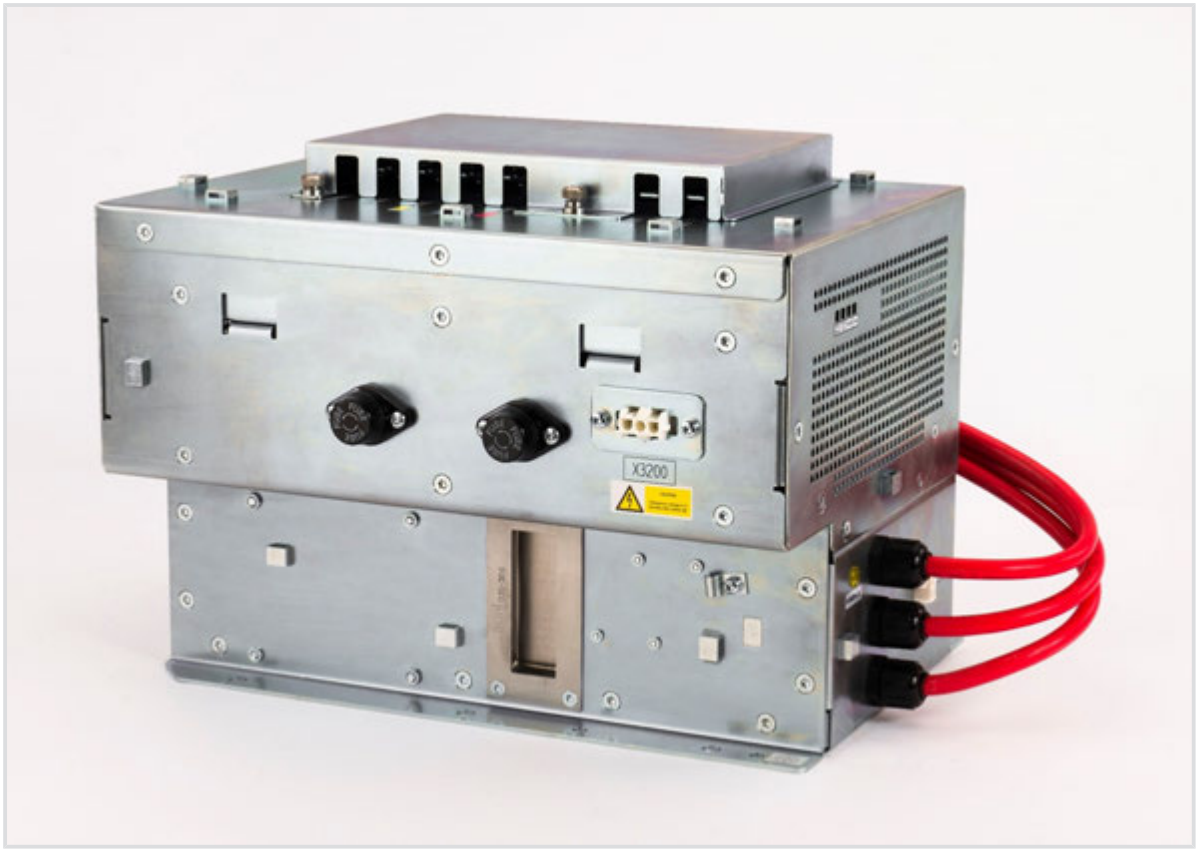
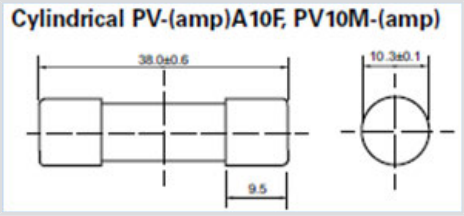


Fig. 58: System Unit Interface

The System Interface Unit (SIU) consists of the mains interface unit (MIU), the Control and Interface Unit (CIU), and the fuses.

Technical data of the System interface unit

Parameter	Value
Mass	18.0 to 22.0 ± 0.3 kg, depending on the cable length
MIU	
Nominal input voltage, for 80-kW support	3 Phase 380 -10% - 400 +10% Vac
Auxiliary input voltage	1 Phase 120 -10% +15% Vac
Nominal Rail voltage output, depending on input voltage	420–623 Vdc
Maximum rated leakage current (IEC 60601-2-44)	7.0 mA
CIU	
Nominal input voltage	24 Vdc
Maximum rated leakage current (IEC 60601-2-44)	7.0 mA
Fuse	
Volts	1000 Vdc
Current rating	10 A
Interrupting current	50 kA

Parameter	Value
Dimension	38 mm x 10 mm  Fig. 59: Fuse diameter

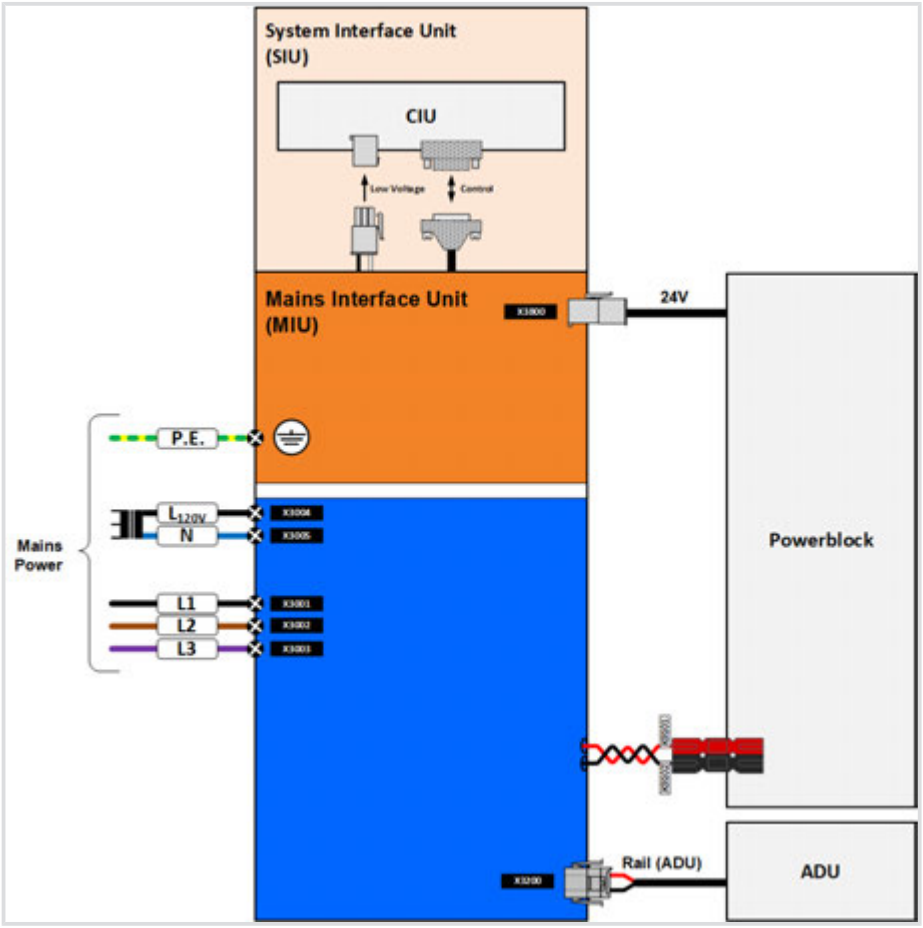


Fig. 60: Functional diagram of the Mains Interface Unit (MIU)

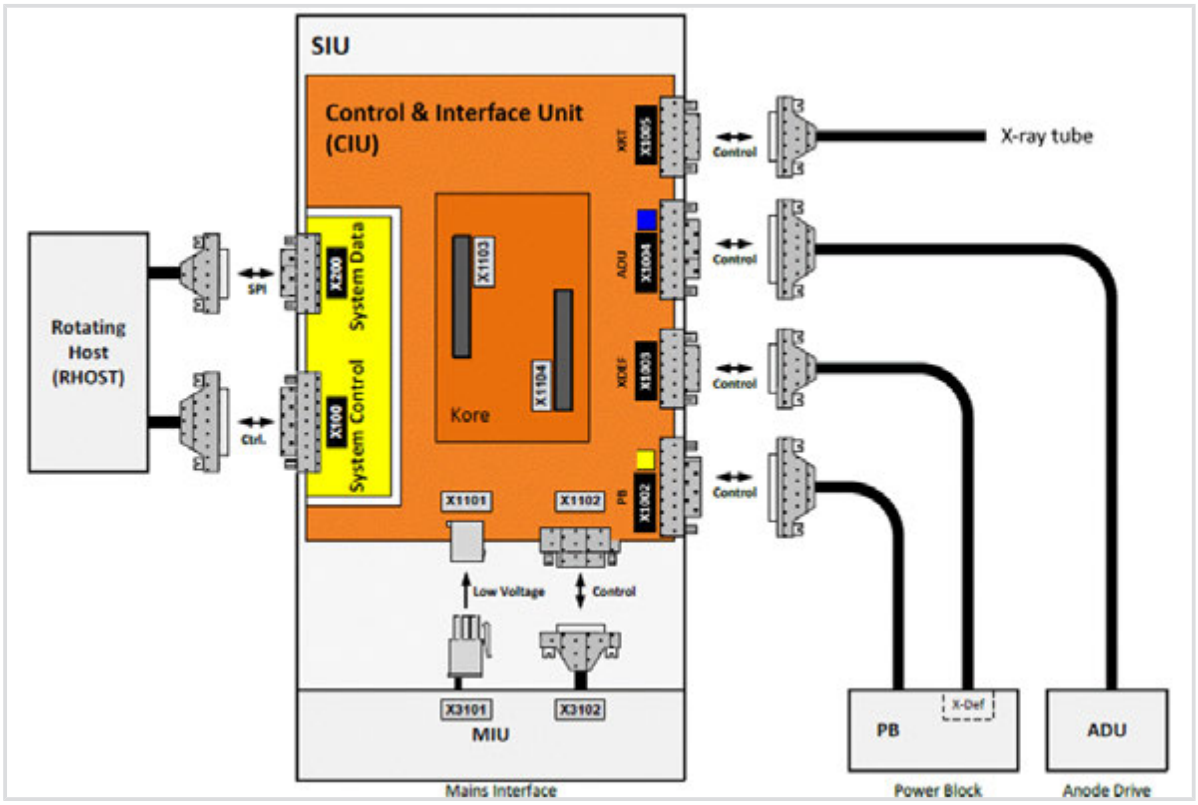


Fig. 61: Functional diagram of the Control and Interface Unit (CIU)

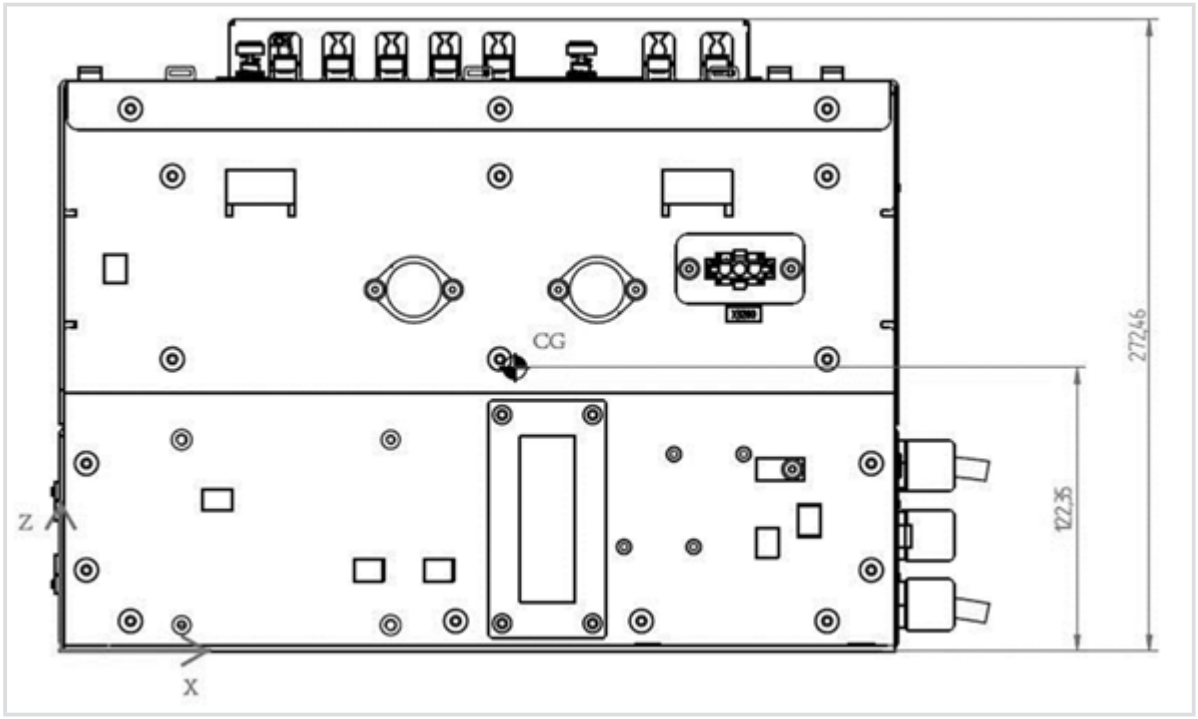


Fig. 62: Mechanical dimensions of the System Interface Unit (side view)

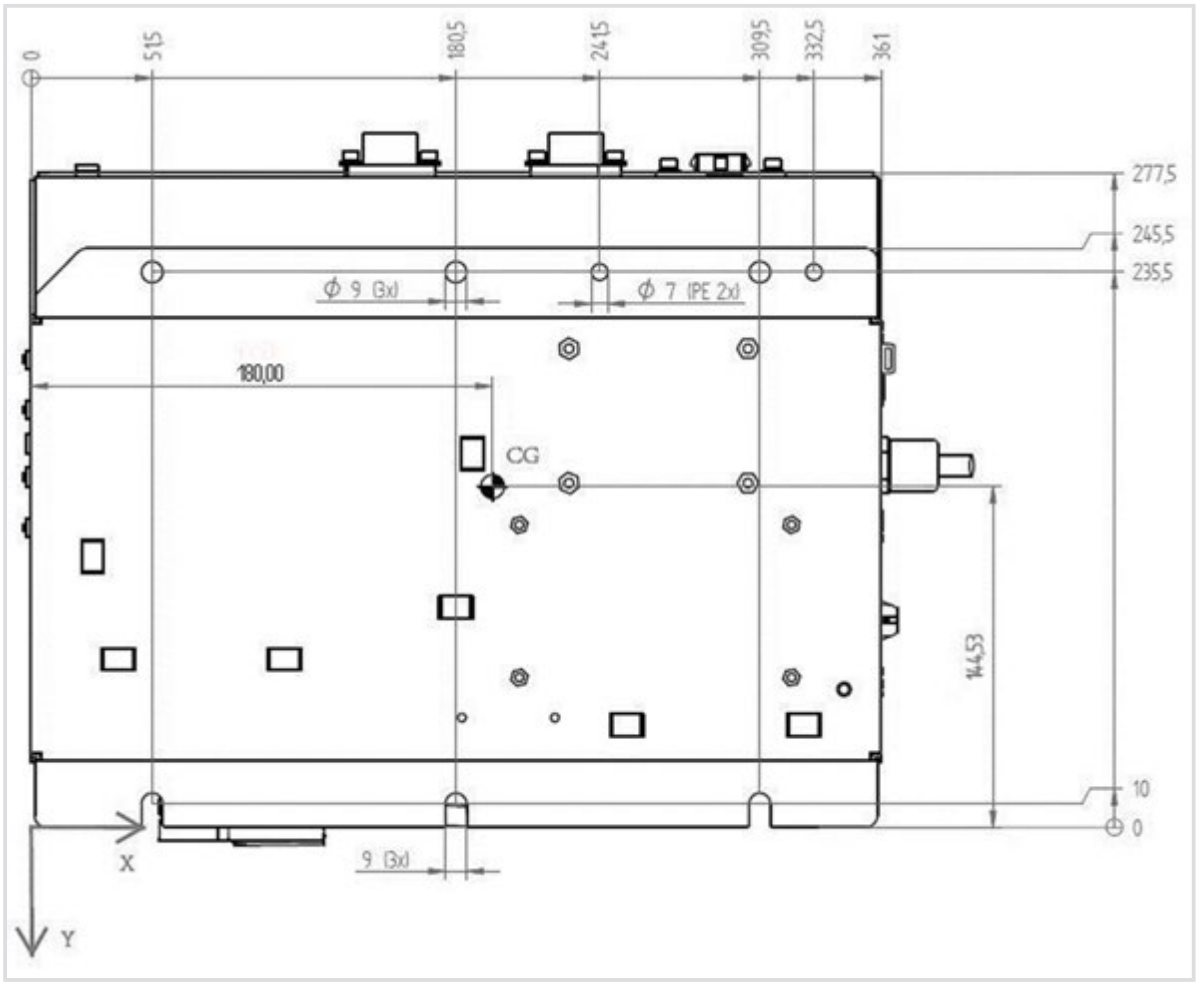


Fig. 63: Mechanical dimensions of the System Interface Unit (top view)

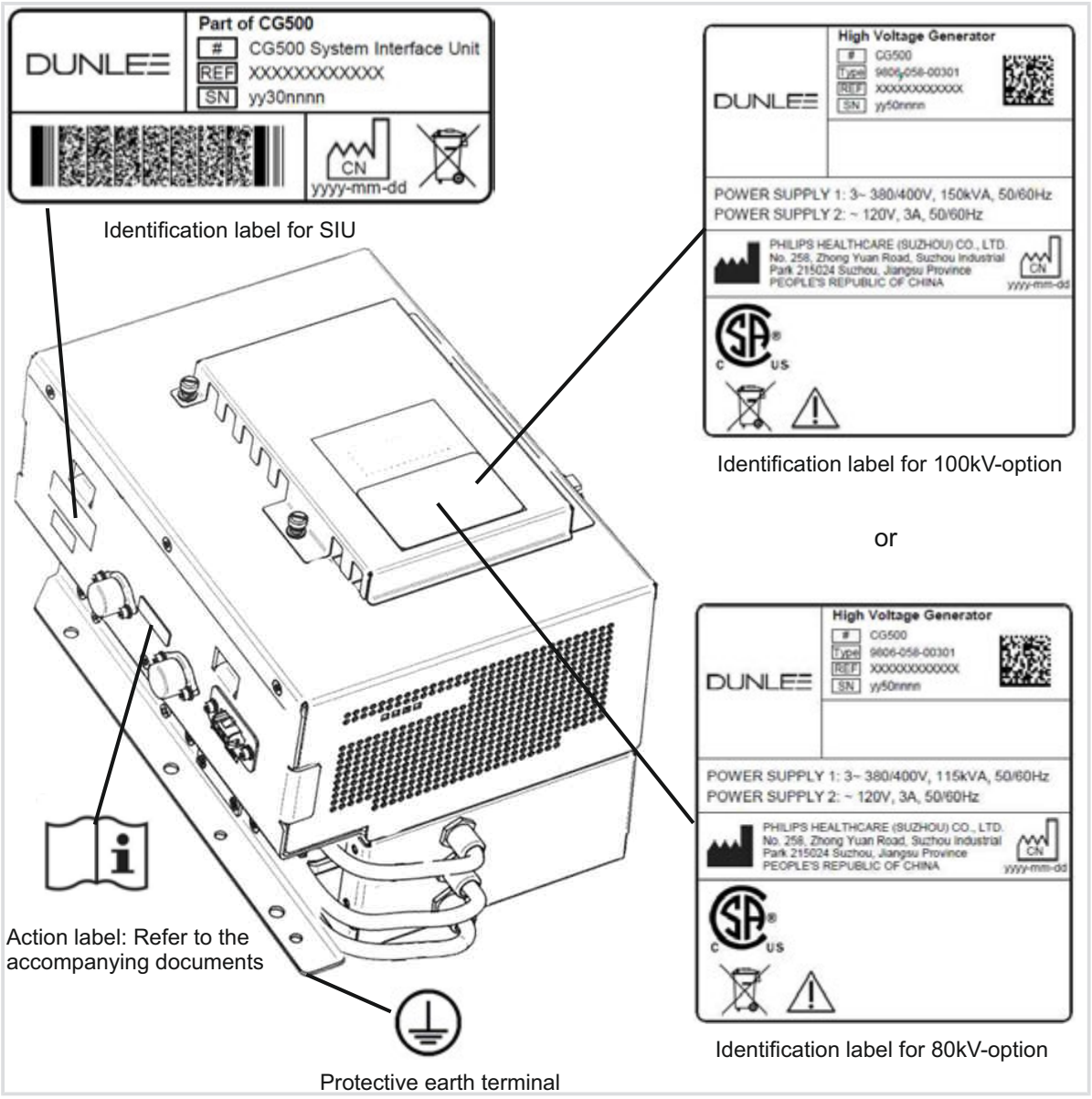


Fig. 64: Labels of the System Interface Unit

6.6 Technical Data of the Anode Drive Unit

Fig. 65: Anode Drive Unit

Technical data of the Anode Drive Unit

Parameter	Value
Nominal input voltage	420–623 Vdc
Nominal input power	maximum 1500 W
Mass	7.0 to 8.2 ± 0.3 kg, depending on the cable length

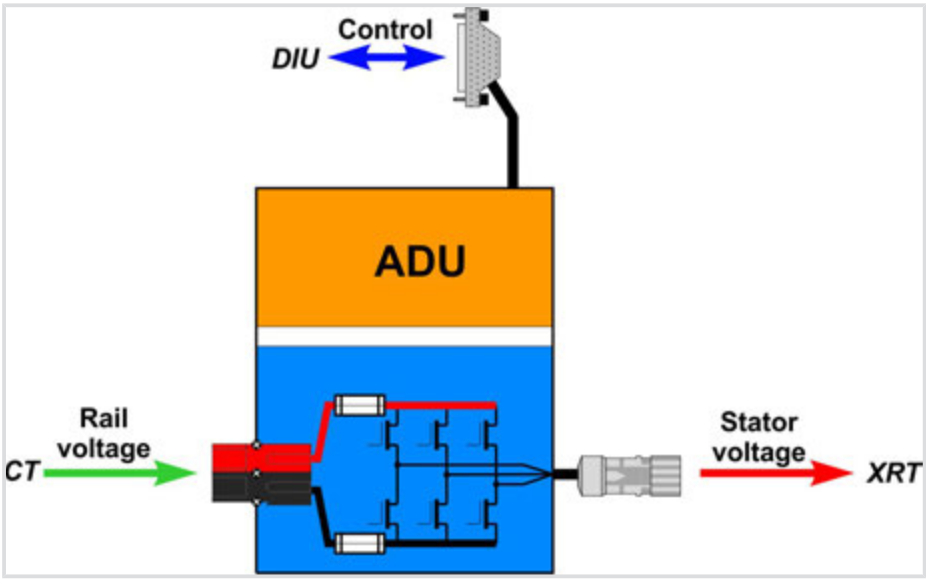


Fig. 66: Functional diagram of the Anode Drive Unit

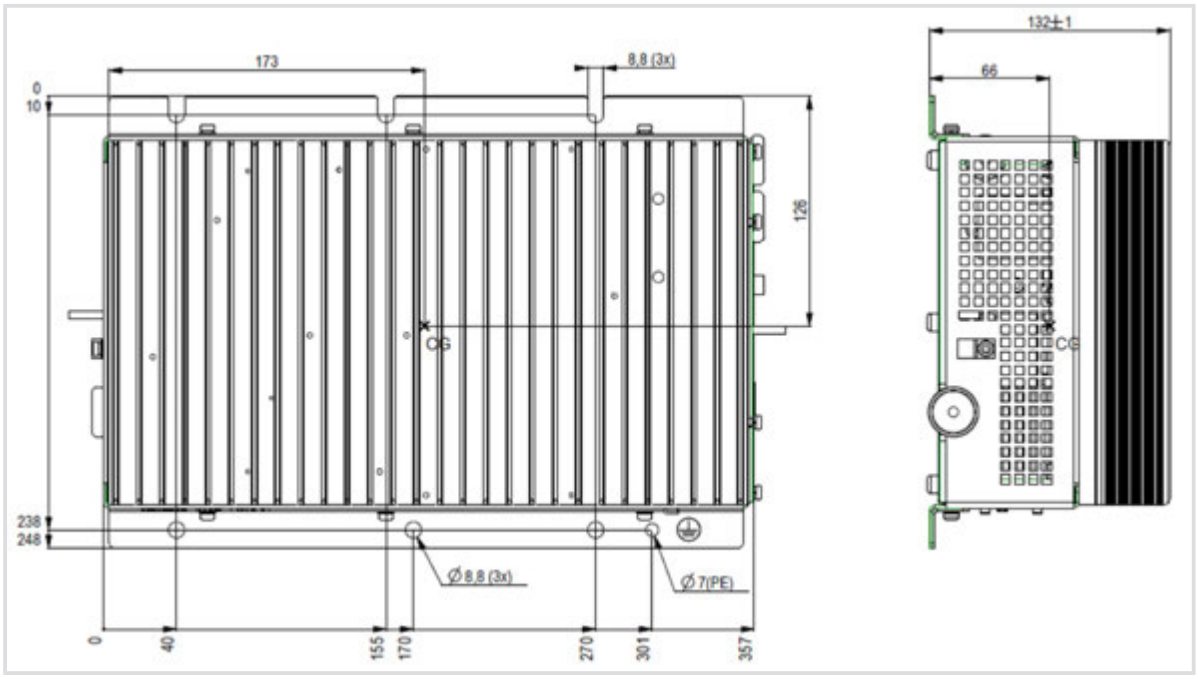


Fig. 67: Mechanical dimensions of the Anode Drive Unit

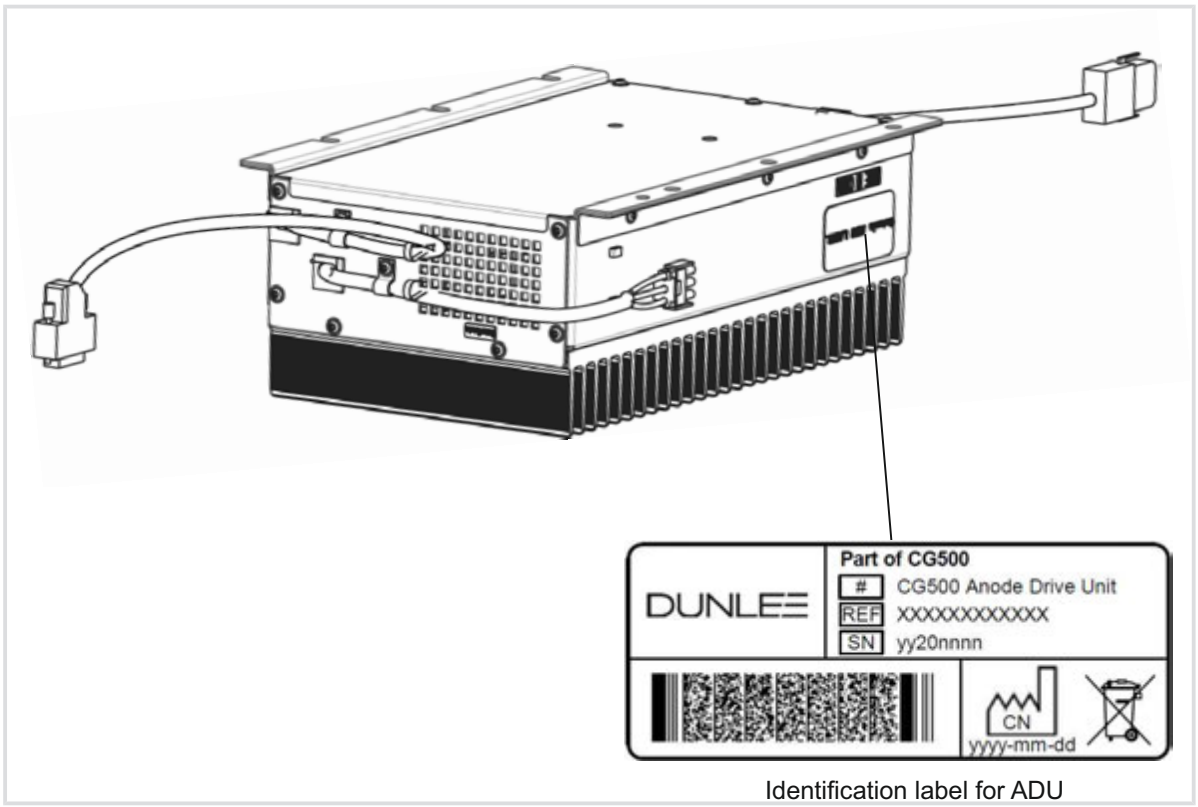


Fig. 68: Labels of the Anode Drive Unit

6.7 Technical Data of the High-Voltage Cables

The CG500 X-ray generator is compatible with the following cables:

HV anode cable	O3 connector	9890-000-5507x
HV cathode cable	O4S connector	9890-000-5508x

Technical data of the HV cables

Parameter	Value	
	9890-000-5507x	**9890-000-5508x**
Nominal voltage	75 kVdc	75 kVdc
Bending radius	70 mm	105 mm
Capacity	155 pF / m	144 pF / m
Connector	O3 – O3	O4S – O4S
Cable mass (without connectors)	0.3 kg / m	0.8 kg / m
Cable length (without connectors)	1.79 m	1.15 m
Diameter	16.5 mm	19.7 mm

Glossary

ADU	Anode Drive Unit
CSA	Canadian Standards Association
CT	Computed Tomography
EMC	Electromagnetic Compatibility
ESD	ElectroStatic Discharge
FRU	Field Replacement Unit
FSE	Field Service Engineer
FU	Function units
HV	High Voltage
IEC	International Electrotechnical Commision
ISO	International Organization for Standardization
MIU	Mains Interface Unit
N/A	Not applicable
PB	Power Block
PCB	Printed Circuit Board
PDU	Power Distribution Unit
SIU	System Interface Unit
UPS	Uninterruptible Power Supply
XRTA	X-ray tube housing assembly

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