

User Manual

CP Series

Version 3.1 – June 2020



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REVISION HISTORY

Rev.	Date	Comment	§	Name
1.0	01/11/2012	Initial release	All	JB
1.1	21/12/2012	Review according to software version 0.0.3	All	AP
1.2	10/01/2013	Laser safety warning, Accessories pictures	1, 7	JB
1.3	22/01/2015	Add of the airstream requirement to reach the 100% duty cycle	2.1.2 p. 13	JL
1.4	15/04/2015	Add of recycling recommendations	§8 p. 55	JL
1.5	19/04/2015	Add of CP160D and CP225D	ALL	JL
1.6	05/08/2015	Maintenance of the carousel added	3.1.3	JC
1.7	16/02/2016	Junction box for dual flashing light added	7	JC
1.8	24/03/2016	Languages added – Terminal gen modified	5.4.7 & 5.4.1 3	JC
2.0	28/04/2016	Software version 02	5; 8; 9	JC
2.1	17/08/2016	Safety warnings modified	1	JC
2.2	24/11/2016	Junction box for dual audible flashing light added	7.12	JL
2.3	11/01/2017	Noise protection warning	1	JC
2.4	31/01/2017	Conditioning description added	4.2.3	JC
2.5	28/02/2017	USB and RS422 remote control added	3.3.7 ; 3.3.8 ;9	JC
2.6	07/06/2017	CP300D added – Operating range reviewed – Technical specification reviewed – Connector position change added	2.1;3 .1	JC
2.7	26/01/2018	Super User code added – Frames and settings added	5; 9	JC
2.8	20/12/2018	CP275D Added	All	JC
2.9	27/02/2019	Door contact connection with flashing light added	7.1	JC
3.0	12/02/2020	CP300C Added	All	EJM
3.1	16/06/2020	CP200DS Added	All	EJM

Note:

The information contained in this User Manual is correct at the time of writing. Further developments on the equipment may however be implemented at a later stage and may lead to changes in the manipulation of the equipment. Also, additional features may become available which are not described at all in this version of the User Manual. TELEDYNE ICM will update this User Manual to incorporate these changes at its own discretion and without prior notification. It is therefore recommended to contact TELEDYNE ICM or your local distributor to obtain the latest version of the User manual if you see behavioral changes or new functionalities after a repair or upgrade.

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1. WARNINGS

1.1 SAFETY WARNINGS

The Goods can cause **death, personal injury or property damage** if they are used, operated, maintained, stored or disposed of improperly.

In particular, the Goods may emit **x-ray radiation**, so adequate safety precautions must be taken to minimize exposure. At a minimum, Buyer should adhere to the **ALARA** (as low as reasonably achievable) principle and should comply with all applicable regulations relating to protection against x-ray emissions.

The Goods may also contain **pressurized gas** which is **explosive** and/or a **Class II laser device** which can cause **eye injury**.

Buyer is solely responsible for ensuring that the Goods are used, operated, maintained, stored and disposed of by trained and qualified personnel who understand the risks and required safety precautions.

The Goods must be operated **in accordance with the User Manual**, and proper heating and cooling procedures must always be strictly followed .

The noise of the cooling fan at maximum power reaches 86dB. You may need or want to wear ears protection in respect to the local regulation or your personal well-being.

The Goods may also contain **hazardous substances**, such as lead and beryllium. Buyer must comply with all applicable regulations relating to use and disposal of the Goods, including the Restriction on Hazardous Substances Directive adopted by the European Union (2011/65/EU), as hereafter amended.

The Goods must be repaired or disassembled by Seller or its authorized service provider only.

The Goods are intended to be used for non-destructive testing and security applications only and are **not intended for use on human beings or animals**.

Seller is not liable for death, personal injury, or property damage that may be sustained, directly or indirectly, by any person as a result of Buyer's failure to use, operate, maintain, store or dispose of the Goods properly or to implement the requisite safety precautions.

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2. INTRODUCTION

2.1 THE CP SERIES, POWERBOX AND POWERMODULE

The CP160D/CP200D/CP225D/CP300D/CP300C or CP SERIES is a new series of ICM's famous Site-X portable X-ray generators.

With it, ICM extends its range and brings a range of constant potential generator to the market, from 160kV up to 300kV. The CP160D/CP200D/CP225D/CP300D has a maximum power output of 900Watt and 600Watt for the **CP300C** and with its super lightweight and rugged design, the CP SERIES generator will be very easy to handle, even in the roughest conditions.

With the new CP SERIES also comes a new control unit, the PowerBox, which will provide a 380 DC voltage supply from which the CP SERIES's Power module will generate the required power signals to achieve the high voltage as well as a highly configurable interface to interact with the user and 3rd party devices.

The PowerBox has a wide range of measurement, control and security features, is the powerhouse of the generator set. It will provide all required power to the CP generator's PowerModule and communicate with it via a high-speed serial interface. This PowerModule will convert a 380Vdc provided by the PowerBox into a usable signal to generate the high kV and will be the muscles of the CP generator. The brains come in the form of a memory which will be unique for each CP generator. This memory will store vital information such as the CP generator's serial and model number, exposure listing, operational parameters and even failure data. Thanks to this memory, it is possible to change the PowerBox and even the Power Module with any other one without any need for configuration or calibration. This unique feature will enable easy "in the field" repairs and minimize transportation cost to the repair center in case of a breakdown since each part can be diagnosed and changed individually in the field and only the defect part will have to be returned for service.

Furthermore, it will be possible to extract all the data that is stored on the CP generator's memory and copy it to a USB pen drive. This information can then easily be carried from the field and sent to ICM for failure analyses.

2.1.1 OPERATING RANGE

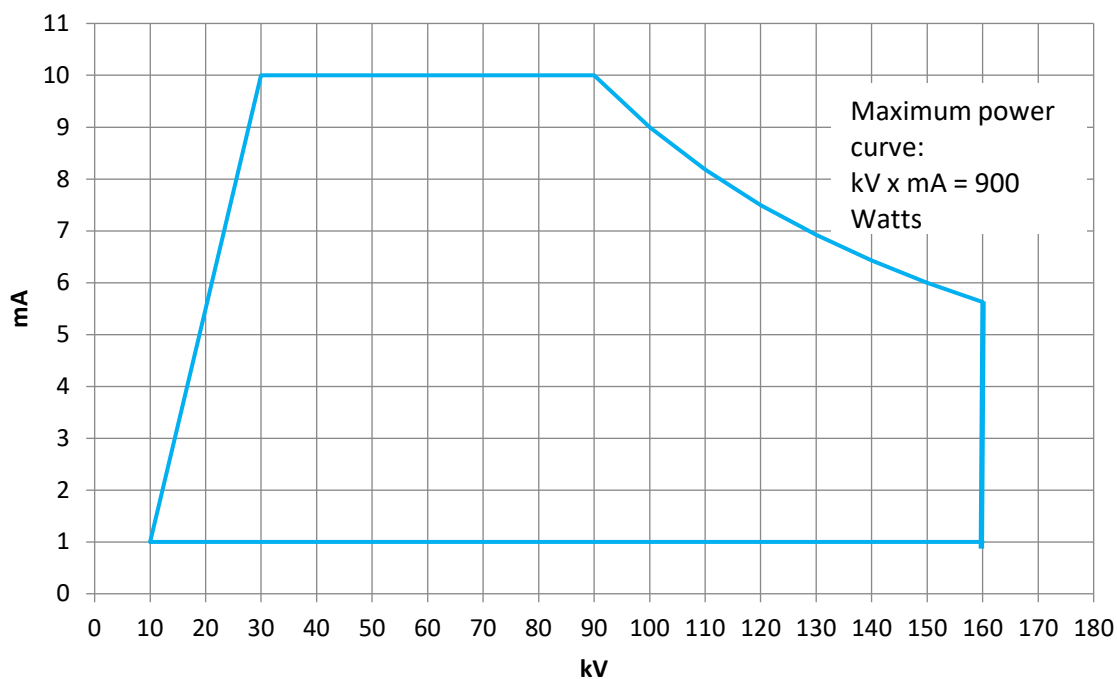
The below figures give a visual representation of the CP SERIES generator's operating range. (the selectable mA and kV) The maximum current is limited between 90 and maximum kV by the maximum anode power dissipation of 900 Watt for the CP160D/CP200D/CP225D/CP300D. For the CP300C, the maximum current is limited between 60 and maximum kV by the maximum anode power dissipation of 750 Watt. For the CP200DS, the maximum current is limited between 75 and maximum kV by the maximum anode power dissipation of 750 Watt.

When selecting a mA and kV setting outside this operating range, the PowerBox will give a warning and automatically correct the mA or kV setting to the closest possible value. Pressing the Constant Power button ('Pct' on the PowerBox front panel) will automatically set the mA to the maximum possible value for the selected kV.

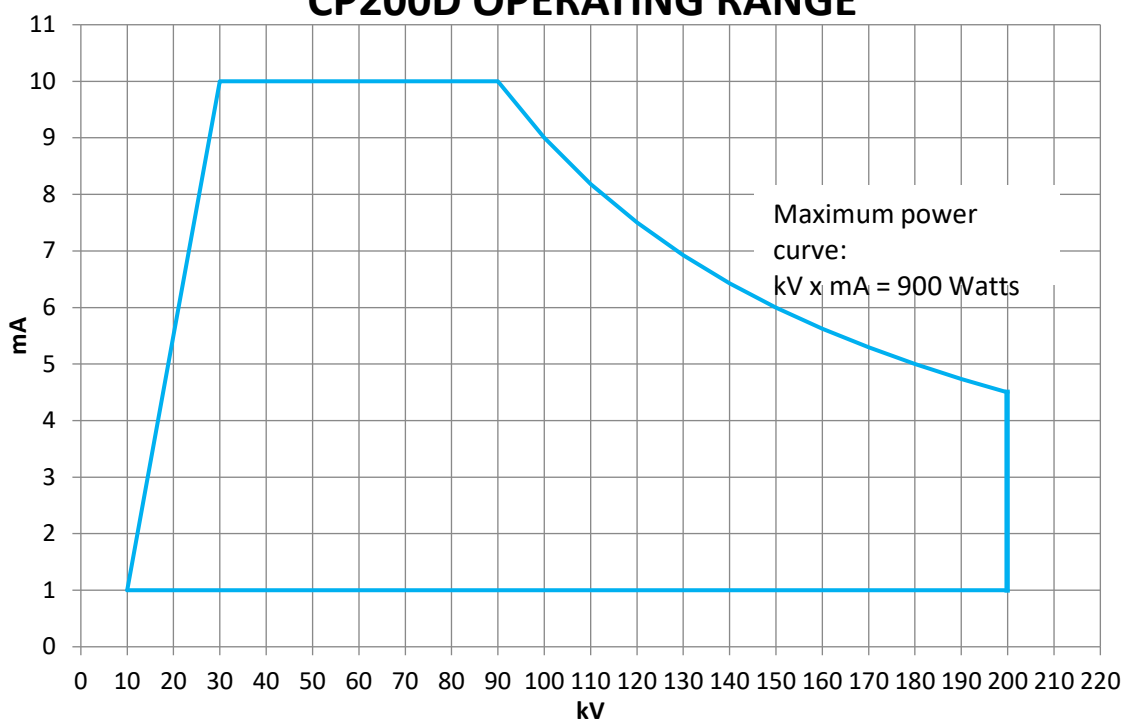
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CP160D OPERATING RANGE

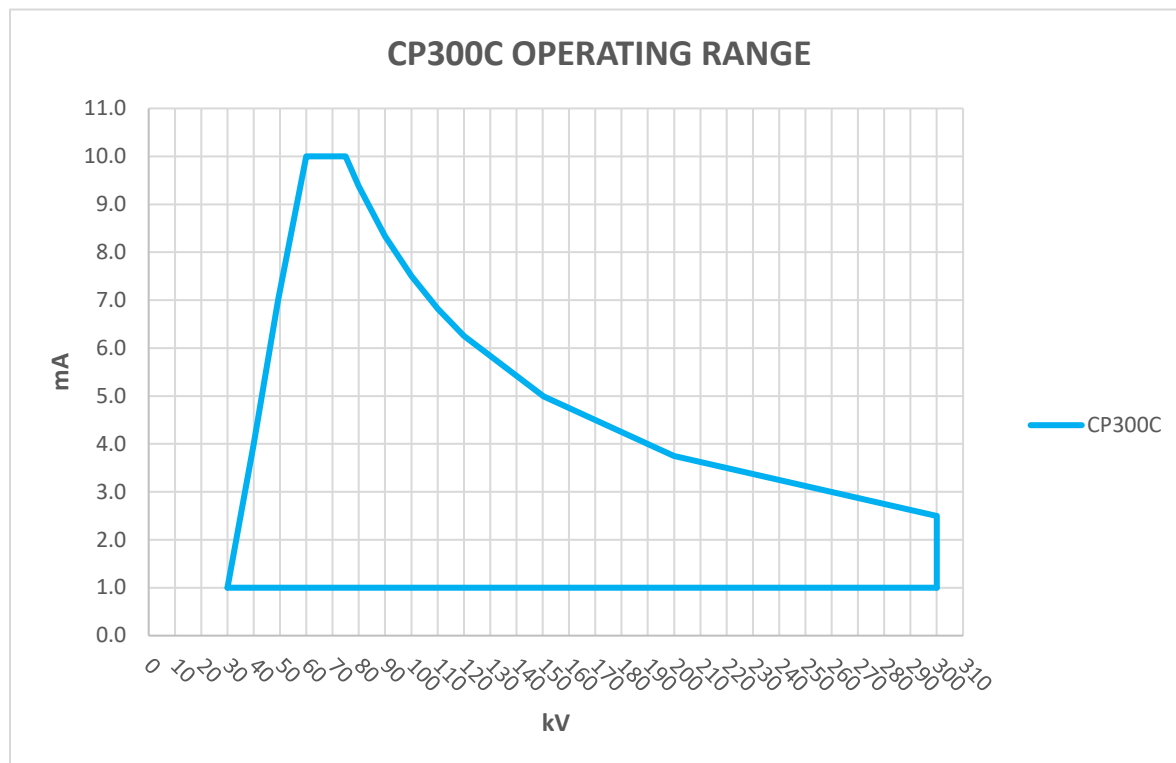
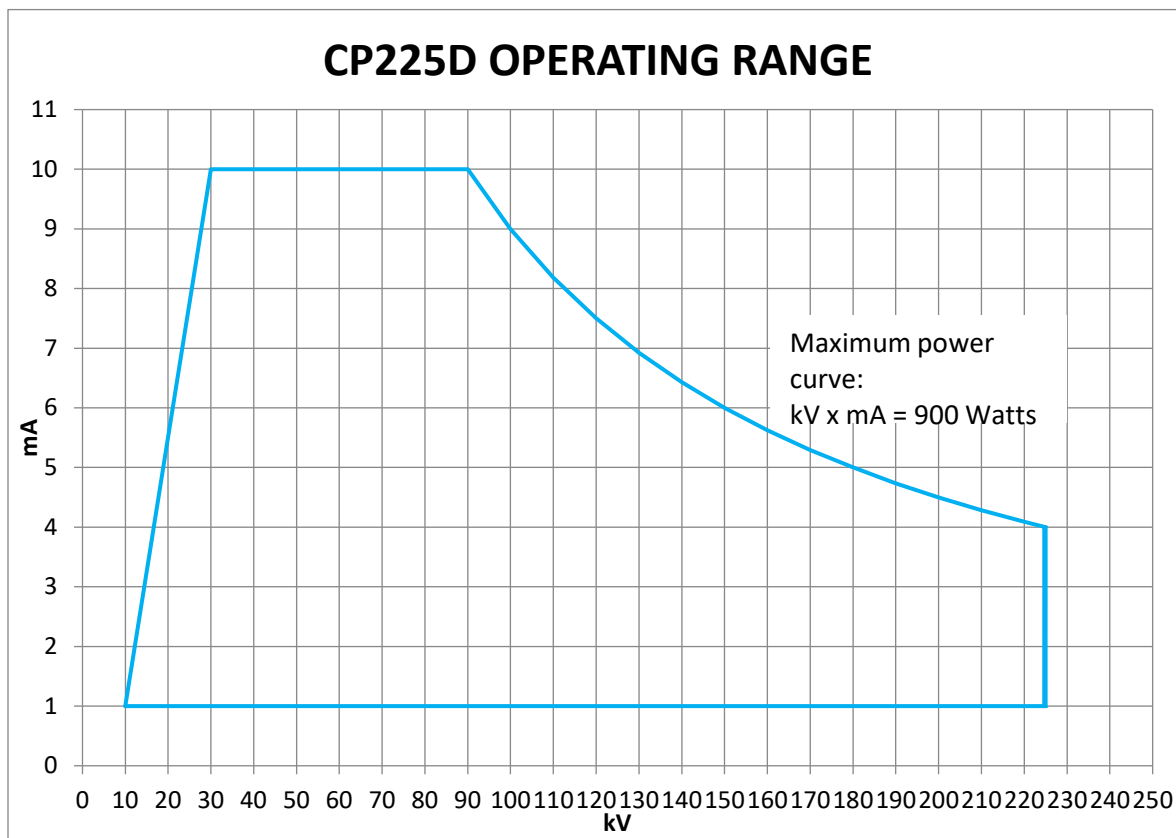


CP200D OPERATING RANGE



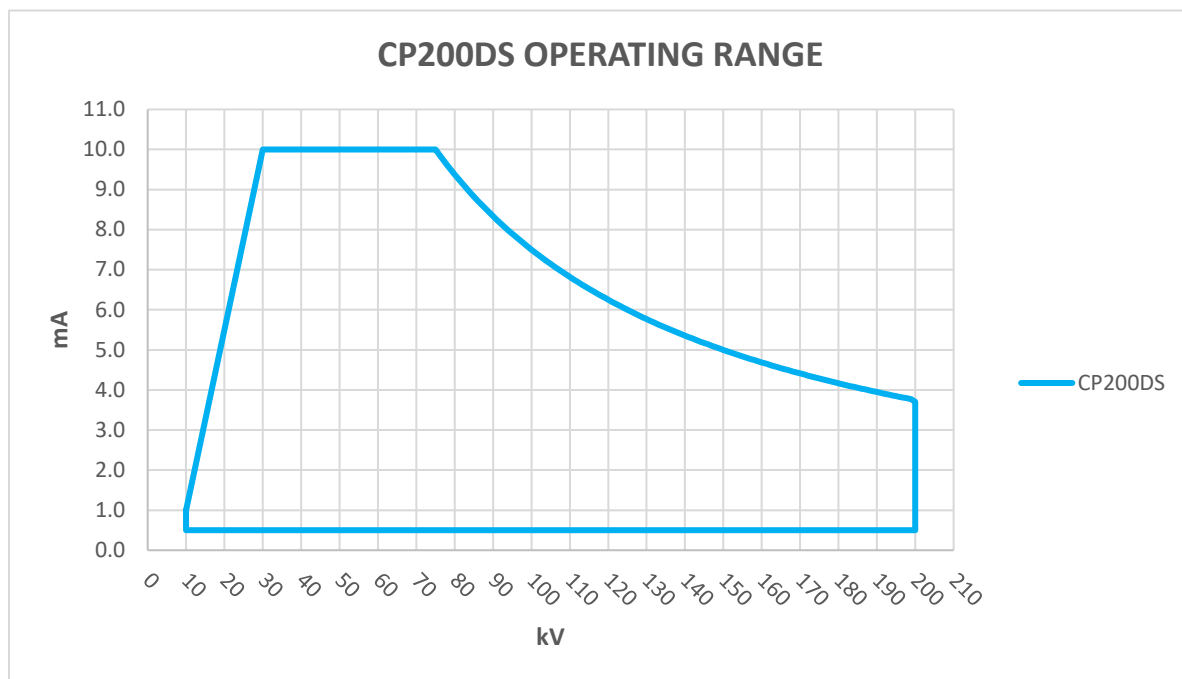
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2.1.2 TECHNICAL SPECIFICATIONS

Technical specifications	Units	CP160D	CP200D	CP225D	CP300D	CP300C	CP200DS
Output kilovolt range	kV	10 to 160	10 to 200	10 to 225	30 to 300	30 to 300	10 to 200
Tube milliamps range	mA	1 to 10	1 to 10	1 to 10	1 to 10	1 to 10	0.5 to 10
Maximum anode power dissipation	Watt	900	900	900	900	750	750
Tube current at max kv	mA	5.6	4.5	4.0	3	2.5	3.7
Tube current and kilovolt stability	%	<0.5%	<0.5%	<0.5%	<0.5%	<0.5%	<0.5%
Duty cycle at 30°C ambient temperature **	%	100	100	100	100	100	100
Steel penetration at maximum kV and power (*)	mm Fe	29	42	47	66	56	42
Total weight (excluding hand rings)	kg	11.9	12	12.1	23	27.6	15.9
Overall dimensions (excluding hand rings)	mm	Ø 140 x 695	Ø 140 x 715	Ø 140 x 725	Ø 180 x 862	Ø 180 x 835	Ø 140 x 669
Leakage dose at 1 m at full output	mSv/h	2.0	2.0	2.0	<5.0	<5.0	<2.0
Dimension of optical focal spot EN12543	mm	3.0 (~1.5 IEC 336)	3.0 (~1.5 IEC 336)	3.0 (~1.5 IEC 336)	3.0 (~1.5 IEC336)	Diameter 5.5 x 0.5	1.0 (~0.5 IEC 336)

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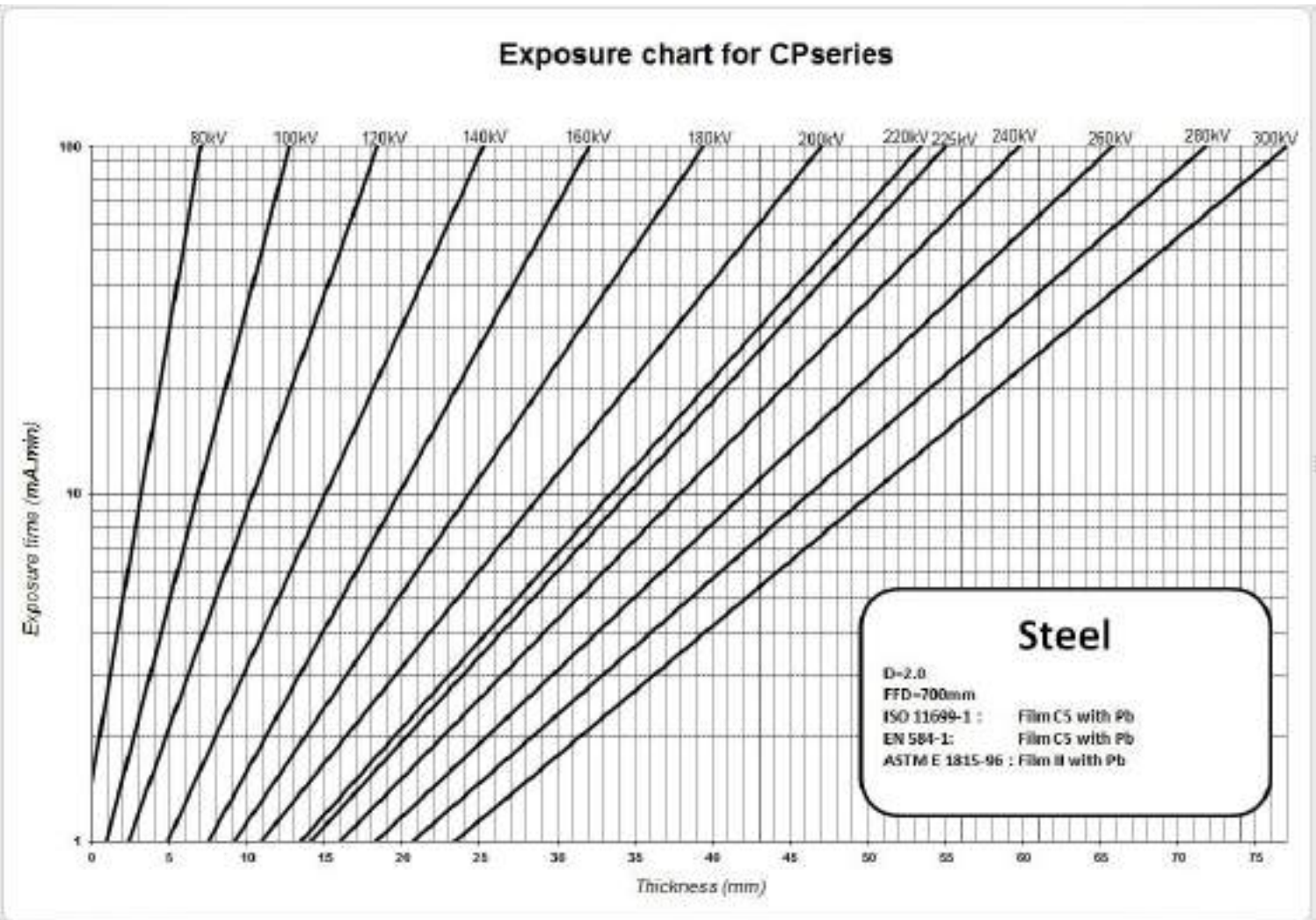
Maximum useful angle of X-ray directional beam	(°)	60 x 40 elliptical	60 x 40 elliptical	60 x 40 elliptical	60 x 40 elliptical	N.A.	60 x 40 elliptical
Maximum useful angle of X-ray panoramic beam	(°)					360 x 40	
Tube inherent filtration Nickel	mm	0.8(Be)	0.8(Be)	0.8(Be)	0.8(Be)	0.4(Ni) + 3.5 (Al)	0.8(Be)
Weather protection	-	IP65	IP65	IP65	IP65	IP65	IP65
Working temperature range	°C	-30 to +60	-30 to +60	-30 to +60	-30 to +60	-30 to +60	-30 to +60
Storage temperature range	°C	-40 to +70	-40 to +70	-40 to +70	-40 to +70	-40 to +70	-40 to +70

** In Open Air with a minimum airstream of 5 m / sec

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2.1.3 EXPOSURE CHARTS



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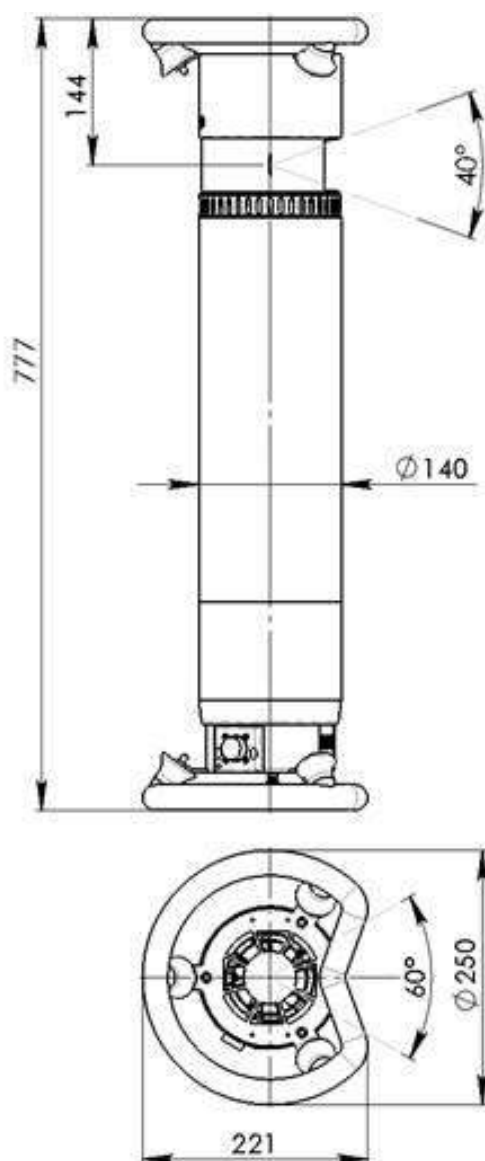
3. COMPONENT DESCRIPTION

3.1 THE CP SERIES X-RAY GENERATOR

3.1.1 MECHANICAL DIMENSIONS

CP160D/CP200D/CP225D

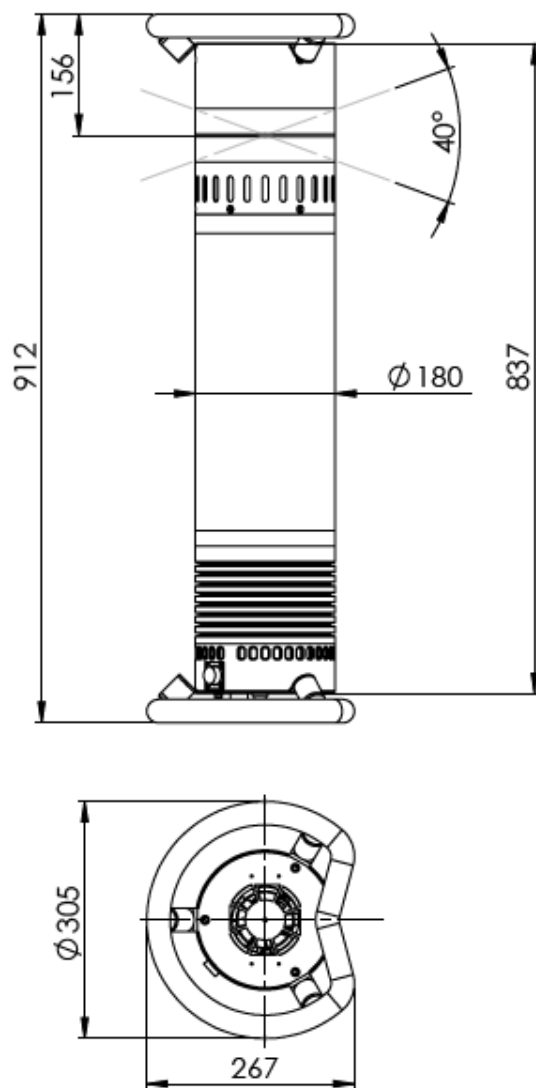
CP300D



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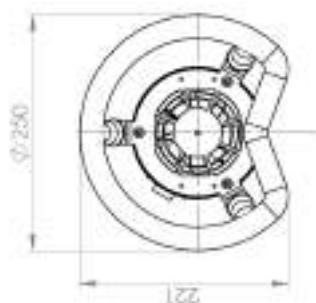
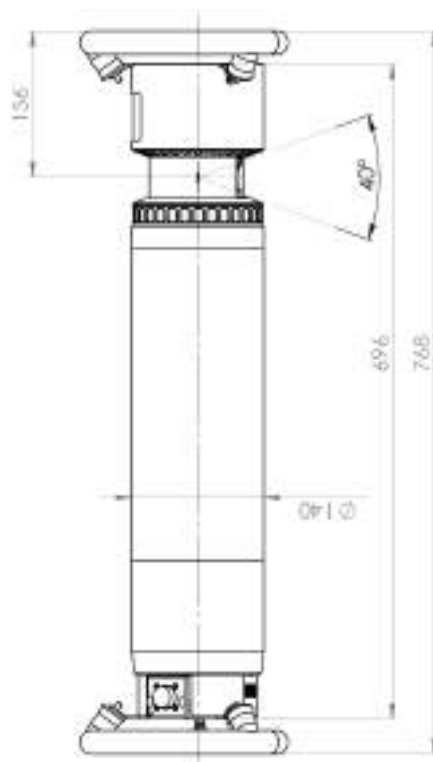
CP300C



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CP200DS



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3.1.2 GUARD RINGS

The guard rings provide handles to easily manipulate and position the generator but more importantly they provide shock absorption in case the generator is dropped.

3.1.3 CAROUSEL/DIAPHRAGM (NOT FOR CP300C)

There are 5 positions available on the carousel.

4 Positions are standard: Shutter, Laser pointer, Beryllium window, and full open with 3mm aluminum filter. The 5th position can fit any window size desired but is populated with a 480x100 window by standard if no other size was specified during the order process.

You can switch between positions by simply rotating the carousel wheel. The generator will automatically detect which carousel position is selected and communicate this information to the PowerBox.

No exposure will be possible if the carousel is set between two positions, or if it is set in the pointer position.

No exposure is possible above 50kV if the Beryllium window is set.

A warning will be displayed on the PowerBox if the shutter is not set during the preheating, or if it is set during a normal exposure.

The laser pointer can be switched on and off by pressing the red power button for more than one second. It will switch off automatically after 20 seconds. The laser pointer is powered by a 3 Volt coin battery which can be replaced at the back of the laser pointer module. Please refer to the Maintenance chapter on further information on how to change the coin battery.



Carousel position



Function

Shutter

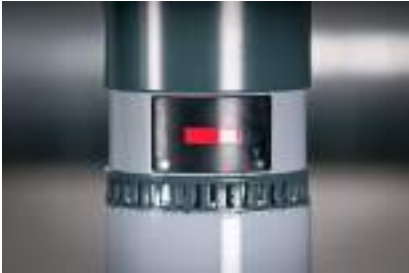
The shutter is a lead cover which closes the X-ray output. Use this position to reduce the radiation produced during preheating.

Full open

A 3mm aluminum filter is applied for the full 60°x40° opening of the X-ray output.

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Custom diaphragm

By standard, a 480x100@700mm film shape is provided. This will reduce the shape of the X-ray beam to match the used film and consequently reduce the leakage radiation.

Custom shapes with different sizes can be ordered from ICM to match your application.



Beryllium window

A full open position without aluminum filter for use at low kV settings. Exposure above 50 kV are not allowed in this position. A warning message will be displayed on the PowerBox.



Laser pointer

A red laser light will be emitted from the center of the laser pointer.

CAUTION: on CP300D, the laser turns on automatically when on position. Avoid direct exposition with the eyes.

For CP160-200-225D press the button for more than 1 second. The laser will automatically shut down after 20 seconds or when the red button is pressed again.

The laser pointer can be used to align the generator to target the area under inspection.

3.1.4 MAINTENANCE OF THE CAROUSEL

In case of seizure of the carousel, clean it with compressed air to blow the dust that may have entered.

Warning: You shouldn't, in any case, use any lubricant of any kind. The parts used for the carousel had been permanently impregnated with lubricant. Adding some lubricant will cause the dust to stick on the parts and will create additional damages.

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3.1.5 INTERCONNECTION SOCKET

The interconnection cable connects the PowerBox with the CP SERIES generator. The socket of the interconnection cable on the generator side can easily be switched between an axial or radial connection position. Below is the procedure explaining how to switch from one position to another:

CP160-200(DS)-225D

Unscrew the 4 screws fixing the connector



Slide down the connector



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Rotate the connector 180°



And screw back the 4 screws.

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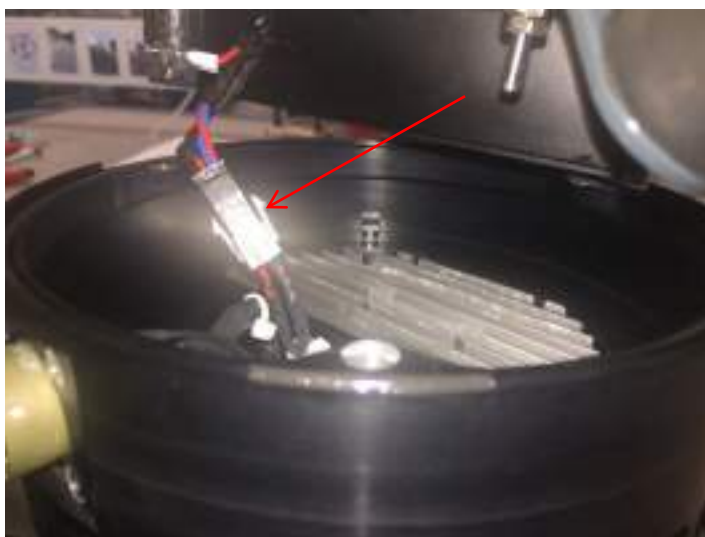
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CP300D/300C

Remove the 3 screws fixing the cover



Lift gently the cover and disconnect the fan connector



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Remove completely the cover and unscrew the cap



Unscrew the connector, and switch its position with the cap

Make sure to replace the cap at the previous location of the connector and fix everything with the screws.

Do not forget to reconnect the fan's connector and fix the cover back in place.



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3.1.6 COOLING FAN

The main cooling fan is a very high-power fan providing the required cooling to the CP SERIES generator's anode. Due to the high speed and high air displacement volume when the fan is working at maximum speed, a siren-like sound will be generated. When working in open air conditions, this can be desirable as it provides for an audible warning when X-rays are emitted. When working in a bunker or closed environment, this sound can become disturbing. Therefore, the speed of the fan can be controlled by the PowerBox and 3 setting are made available to the user:

Maximum cooling

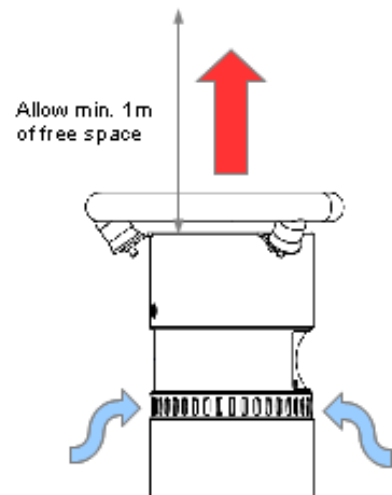
The fan will always run at full speed whenever X-rays are generated. The fan will make a continuous sound and maximum cooling performance is guaranteed.

Medium

The fan will always run at a medium speed producing a minimal amount of sound. In this mode, the cooling is however not working at optimal performance and the generator will interrupt the exposure to cool down when overheating is eminent.

Silent

The fan will start at a minimal speed, producing almost no sound at all. During an exposure, as the generator is getting hotter, the fan speed will increase to satisfy the generator's cooling requirements. In this mode, you will notice the sound generated by the fan increase to its maximum in several steps throughout the exposure.



For optimum performance of the cooling system, allow a free exhaust of air from the main cooling fan and foresee an obstruction-free area of at least 1 meter from the cooling fan.

If dust has accumulated on the cooling fan or underlying heat-sink, clean it with compressed air.

3.1.7 MEMORY AND IDENTIFICATION

The CP SERIES generator is equipped with an electronic memory which can store exposure and system information of up to 5000 exposures. This memory is kept on the CP SERIES generator itself and also contains the electronic serial number of that generator. The content of the memory is accessible via the menu of a PowerBox and gives the user access to the complete exposure history of that CP SERIES generator as well as any error or fault information that may have been stored in it. The contents can be downloaded to a USB pen drive and sent to ICM for failure analyses. This memory is independent of the PowerBox or PowerModule that is used so this record can still be accessed even when the PowerBox and PowerModule the CP SERIES generator was working with failed.

The information stored in this memory are, among other: date and time, the exposure parameters, measurements of kV, mA and external power source and any error states detected by the PowerBox. This

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information will be very helpful to ICM's service centers to in diagnosing any failures and assist in determining the cause of a defect.

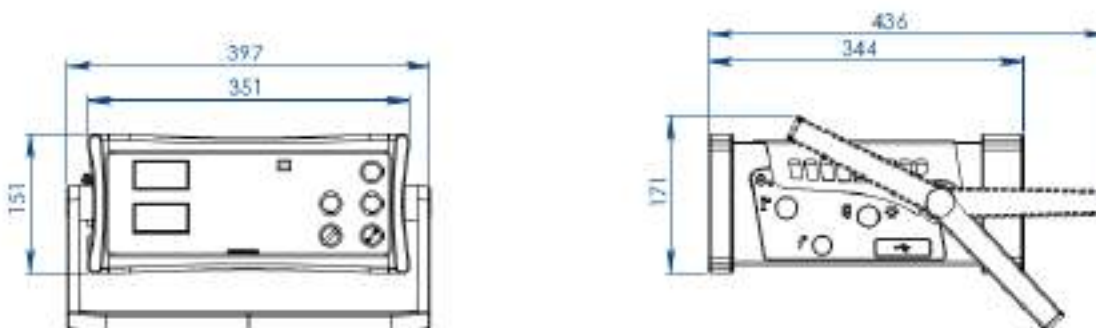
3.2 POWERMODULE

The PowerModule converts a 380Vdc power supplied by the PowerBox into a signal that will generate the requested kV and mA in the CP SERIES generator. This PowerModule is a standard component and is identical for all **Site-X CP** generators. It can easily be replaced, and no further configuration or calibration is required, even on site.

Required in some countries, ICM makes a flashing light on the generator available by standard. The flashing light is positioned on the PowerModule next to the interconnection socket. The behavior of the lamp (when it should flash or when it should be ON) can be programmed from the PowerBox Menu.

3.3 POWERBOX

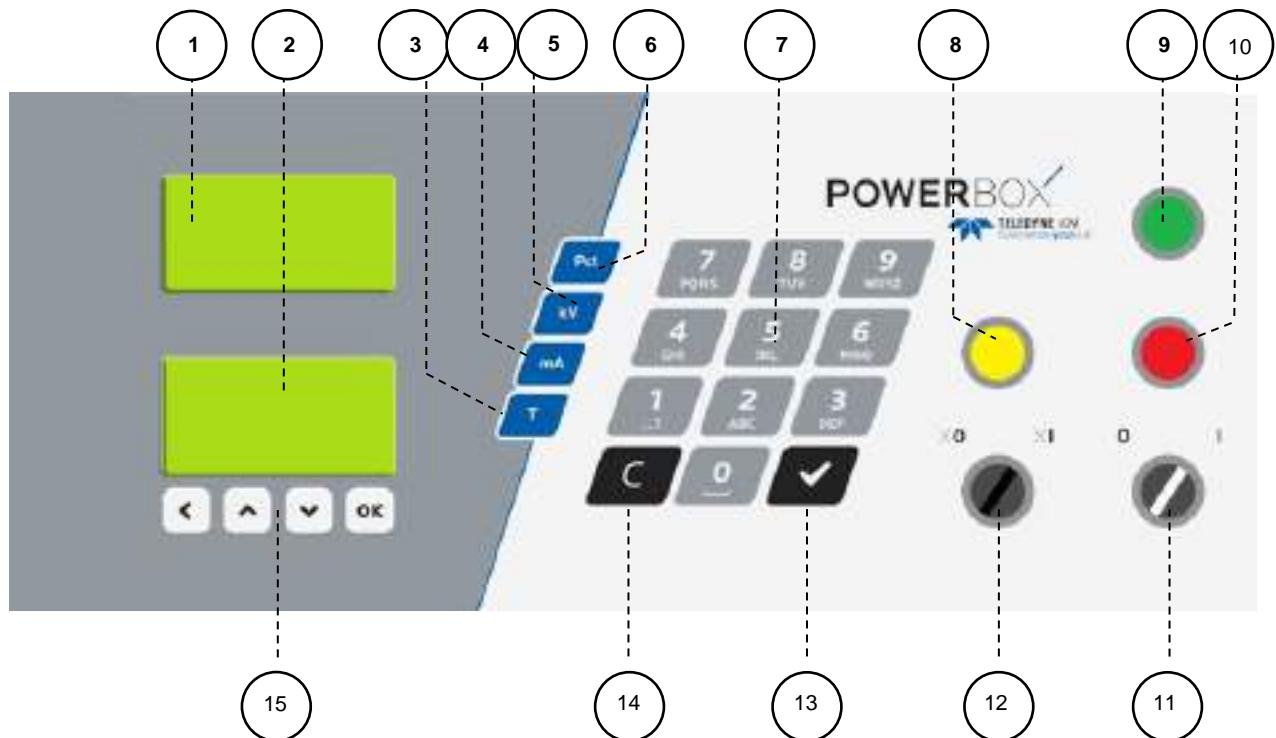
3.3.1 MECHANICAL DIMENSIONS



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3.3.2 FRONT PANEL



- 1: Main display
- 2: Secondary display
- 3: Time key
- 4: mA key
- 5: kV key
- 6: Constant Power key
- 7: Alphanumeric keys (0 to 9)
- 8: Yellow light

- 9: STOP button with built-in red light
- 10: START button with built-in green light
- 11: Main power switch
- 12: Safety key switch
- 13: Enter key
- 14: Cancel key
- 15: Menu navigation keys: Back, Up, Down, Ok

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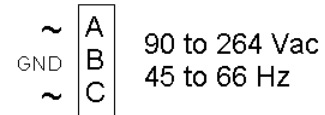
3.3.3 POWER CONNECTOR

Power is supplied through the 3 pin Cannon connector on the left side of the PowerBox.

Thanks to the use of a Power Factor Controller (PFC), the power factor of the PowerBox is close to 1. This will allow the PowerBox to be run from almost any petrol or diesel power generator without suffering from interference from voltage or frequency fluctuations.

The recommended minimum power rating of the power generator is 2kVA.

It is possible to power the CP SERIES generator set from a car or truck battery when an appropriate 12/24Vdc to 230Vac adaptor is used. The current consumption on 24V will be approximately 60A.



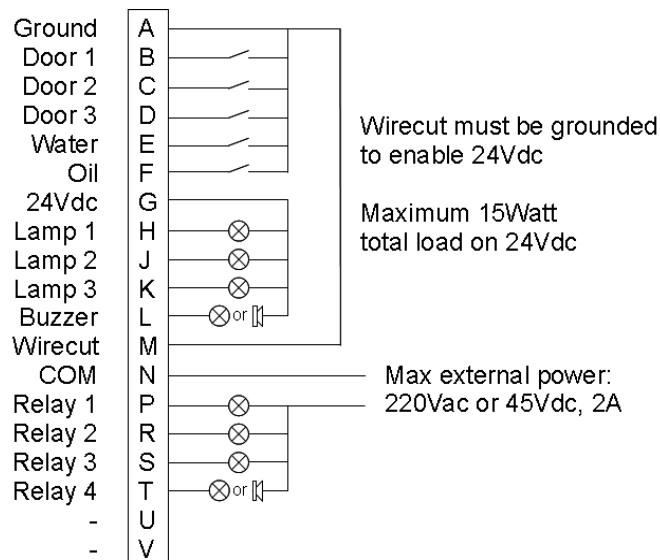
3.3.4 INTERCONNECTION CABLE

The interconnection cable connects the PowerBox to the CP SERIES generator, providing power and communication between them.

3.3.5 INTERLOCK CONNECTOR

The interlock connector provides an interface to connect up to 5 programmable input contacts, 4 programmable output contacts for use with a 24Vdc provided by the PowerBox and 4 programmable relays contacts. These interface contacts can be used for safety interlock systems such as door controls and audio visible warning systems such as sirens and warning lights but can also serve as inputs for a trigger system when integrating the X-ray into for instance cabinet systems.

The behavior of each output - when the output should be flashing, On or Off - can be programmed for each state (stand by, pre-warning, X-ray ON) via the PowerBox menu. Please refer to the PowerBox's 'Configure Interlock' chapter for more information on how to configure the behavior of the outputs.



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The maximum total power consumption for the 24V powered lamps is 15W.

The maximum total switched current of the relays is 2A.

A. WIRE CUT

The wire cut (pin M) needs to be connected to ground (pin A) to enable the PowerBox to detect if a cable is connected to the interlock connection. The external 24Vdc (pin G) is only enabled when the wire cut is connected to ground.

B. 3.3.7 24Vdc

A 24 Vdc is provided by the PowerBox to power external flashing lights and siren.

C. DOOR 1, 2, 3, WATER AND OIL

The input contacts Door 1, 2, 3, Water and Oil (pin B to pin F) are fully configurable input signals which can be used as a door contact or other relative safety interlock inputs. The Water and Oil input are foreseen for future development when water or oil cooling elements are developed for the Site-X CP range. For now, they can be treated as auxiliary door contacts.

Please refer to the PowerBox's 'Configure interlock' chapter for more information on how to configure the inputs.

D. LAMP 1 TO 4

Lamp 1 to 4 are 4 fully configurable output contacts which can be used in combination with the 24Vdc provided by the PowerBox for warning lamps, sirens or any other 24V output or warning device provided the max power consumption is respected.

The maximum total power consumption for all 4 ports combined is 15 Watt.

The respective port is internally connected to ground when the output is activated. Each port also has a consumption current detection to detect lamp failure. The alarm for this is configurable per port.

Please refer to the PowerBox's 'Configure interlock' chapter for more information on how to configure the outputs.

E. 3.3.10 COM, RELAY 1 TO 4

Relays 1 to 4 provide 4 programmable output ports with a maximum switching voltage rating of 240Vac or 30Vdc. Each relay is protected internally by a 2 Amp resettable fuse. Also, the common line is protected by a 2A resettable fuse. The total current consumption for all ports together can thus not exceed 2A.

Please refer to the PowerBox's 'Configure interlock' chapter for more information on how to configure the relays.

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3.3.6 HANDLE

The handle of the PowerBox can be locked in positions which will allow an easy to use table stand position or firm handle to carry it around. To unlock the handle press both the handle joints inward and turn the handle in the desired position. Release the joints to lock back into the selected position.



3.3.7 USB PORTS



A. MASTER PORT

The master USB port can be used to upgrade the CP SERIES generator or PowerBox software, to import new languages and download the shots and errors records stored in the PowerBox for archiving or analyses.

B. SLAVE PORT

The USB slave port allows for advanced remote control and communication with computerized systems. See §9 "Communication protocol" for more information about remote control.

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C. RS 422 PORT

This port has the same function that the USB slave port but using RS422 protocol. ¹

The RS 422 connection is made through an HIROSE HR10-7R-6S(73) connector on the Power Box. You may want to use HIROSE HR10-7P-6P connector on the connection cable side.

Pin layout is as follow:

N° du contact	Couleur de fil	Signaux
1	Noir	+15V
2	Brun	RX+
3	Blanc	RX-
4	Bleu	TX-
5	Orange	TX+
6	Rouge	GND



Pin labels 1 to 6 are printed on the connector.

See §9 “Communication protocol” for more information about remote control.

¹ In the unlikely event where both USB slave and RS422 ports are connected, the Power Box will treat them independently and answer to all requests in a chronological sequence.

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4. OPERATION

4.1 BEFORE SWITCHING ON

4.1.1 POWER SUPPLY

The **CP200** generator can be powered through the PowerBox from either the main grid, from a power generator set or even from a car or truck battery with a DC to AC power inverter. Its electronic power circuits enable it to adapt, without danger, to most fluctuations and sudden variations that may occur on some networks.

Thanks to the very good power factor, the input current is limited to 6A @230VAC or 12A @115VAC. This makes it possible to use the PowerBox with long power extension cables or small size power generators.

The PowerBox is equipped with a very accurate measurement of the power supply's voltage and frequency. It constantly monitors and analyzes the input power's square root voltage, peak voltage and frequency. If the input power goes out of the specified operating range, the PowerBox will automatically stop any ongoing exposure to prevent damage to the equipment due to out of bounds input power.

4.1.2 POWER GENERATORS

The PowerBox can be powered from electric power generator sets of nominal power equal to or greater than 2 kVA to offer the full performances of the tube head.

The excellent power factor (voltage and current are in phase) guarantees smooth operation, without any particular problems, with most existing models. The electrical power sets can be of "petrol" type with electronic regulation or "diesel" with flywheel.

Voltage and frequency fluctuations should be less than 5%.

4.1.3 PROTECTIVE EARTH CONNECTION

The CP SERIES X-ray generator produces ultra-high voltage internally. For the electrical safety shut-off devices to operate optimally in the event of failure or an accident, it is essential that the CP SERIES generator or PowerBox are effectively connected to an earth of low impedance (< 10 Ohm).

This protective earth connection can be provided by the network (single-phase + earth) via the power supply cable which comes with the equipment. You must however always check that the earth is connected to ground in the supply circuit and that it does not exceed 10 Ohm.

If there is any doubt or in the case a generator set is used, it is strongly recommended that the visible earth terminal of the PowerBox or CP SERIES generator, provided for this purpose, is connected locally to earth (for example by using an earth rod), the value of which you should carefully check before use.

This is both for the safety of the equipment as well as for the safety of the operator!

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4.1.4 VARIOUS GENERAL PRECAUTIONS TO BE OBSERVED

Observing certain simple rules will ensure that operations are performed under optimal safety conditions, both for the operator and the equipment. Some of these rules will ensure that you obtain images of the highest quality. We advise you most strongly to adopt the following recommendations:

1. Only authorized personnel shall use the CP SERIES generator set.
2. Take care that the CP SERIES generator is never used with a supply voltage exceeding 264VAC.
3. Make sure that you ALWAYS work with the equipment well earthen. Check this if in doubt.
4. Avoid exposing the CP SERIES or PowerBox to direct bright sunlight for extended periods.
5. Whenever possible, avoid switching off the power immediately after a long exposure. Allow the fan to cool the anode down during 1 minute before to switch the off the PowerBox.
6. Check that neither the air inlet nor outlet of the tube head becomes blocked.
7. Do not attempt to modify, disconnect or bridge the safety shut-off devices. Your warranty will be void.
8. Use the custom diaphragm adapted to the sizes of your films as much as possible to reduce the scattered radiation level.
9. Use the lead shutter during preheating (warm-up). The leakage dose will be become less than 2 mSv/h at one meter from the focal spot. This level is however still harmful for your health, step away from the tube head during preheating and shots and monitor your personal dose rate meter/survey meter.
10. Make sure the circular cannon jack are locked in position. (A 'click' can be heard or felt when the connector goes in the locked position and the red dots on both sides of the connector will be aligned)
11. Keep the cooling fans and heat sinks clean. Remove accumulated dust with compressed air when required.

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4.2 DAILY USE

4.2.1 CONNECTIONS

When connecting the cables to the PowerBox and CP SERIES generator, make sure to close the connector until a 'click' can be felt. This will ensure a good connection and will prevent the cables from getting disconnected while the equipment is in use.

When properly locked, a small silvery dot is visible in the connector.



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4.2.2 POWER ON

After all connections are made and all safety points have been checked, turn ON the PowerBox by turning ON the main switch (11).

The PowerBox will now start up and either one of these messages will be shown on the main display:

1. Ready to start

This message is displayed when the PowerBox is successfully initialized and a CP SERIES generator is detected and identified. You may now enter the desired kV, mA, Exposure Time (T) and start the exposure by pressing the START button (10). Please refer to the 'Setting kV, mA and Exposure time' chapter for more information on entering these values.

Make sure the carousel is in the desired position and press the START button (10) to start the exposure.

2. Key off

The Safety Key (12) is not present or not in 'XI' position. This Safety key is a supervisor key and will enable the supervisor to lockout any user interaction or accidental starting of the X-ray while the equipment is unattended.

Insert the Safety key (12) if it is not present and turn it to the "XI" position.

3. Preheat required for kVmax.

When the CP SERIES generator has not been used for more than 8 hours, a preheating is required to operate at maximum kV. The message further asks the operator if he would the maximum kV to be programmed for the preheating. Pressing the ENTER button will automatically program the maximum kV and mA and the required preheating time will be shown. When pressing cancel, the last used exposure values will be loaded. Depending on the set kV value, a shorter preheating may be required or not at all. The required preheating time is indicated. Please refer to the 'Preheating' chapter for more information about the preheating process.

Make sure the carousel is in the shutter position and press the START button (10) to start the preheating.

4. No Interlock

When a door safety contact is active and the respective door contact is open, this message will be displayed.

When working with a shielded room or containment, make sure the door is closed and there is no cabling defect. Press the START button (10) to start the exposure.

If you are not working in a shielded room or using a door contact, verify the door control settings through the secondary display (2) > Settings > Door control

5. No Generator

After initialization, the PowerBox attempts to detect and identify the connected CP SERIES generator. If this is not successful or when no generator is connected, the PowerBox will display that no generator is detected. Make sure the interconnection cable is connected and the connectors are in the 'click-lock' position on both the PowerBox and CP SERIES generator.

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6. Ready to start

This message is displayed when PowerBox has detected the connected CP SERIES generator and when it is ready to make a shot.

Note:

The START button must be pressed between 0.3 and 3 seconds to be activated. This is done so to prevent accidental activation by an object falling on the START button.

The STOP button will always respond immediately without any limitation of the duration of pressing the red STOP button. STOP button must be released to start an exposure with the START button.

4.2.3 PREHEATING / WARM-UP

The preheating, also called warm-up, is a procedure which is required to progressively re-establish the maximum vacuum level inside the X-ray insert when it has not been used for more than 8 hours. During this preheating procedure, the high voltage and insert current is gradually applied to the insert and built up to the maximum power output or the selected power output.(kV and mA) This procedure is fully automatic and the required preheating time is calculated by the PowerBox based on the kV settings during the last exposure, the idle time of the CP SERIES generator since that last exposure and the set kV. The data which is required for the calculation of the preheating time is taken from the CP SERIES's internal memory. This way, your CP SERIES will be correctly pre-heated in the minimum amount of time as possible, even when the CP SERIES generator was previously used with another PowerBox.

It is not possible for the user to avoid the preheating procedure since bypassing it would lead to serious defects and malfunction of the equipment.

The preheating time is mainly based on the kV setting and idle time of the CP SERIES generator. The calculation follows these general rules of thumb:

- no preheating is required for 8 hours or less idle time
- 5 minutes preheating is required after 8 hours
- for each additional day of idle time, 1 additional minute of preheating time is required
- the maximum duration of the preheating is limited to 60 minutes
- The required preheating time will be less if the programmed kV is lowered.
- No preheating is required for kV settings up to and including 60kV.

To start the preheating, make sure the carousel is in the preheating / lead cap position and press the START button.

Note:

It is recommended to preheat the generator up to maximum kV once a month. In case the generator has been stored unused for more than 6 months, then the preheating procedure is replaced by a conditioning procedure. The principle is the same than for a preheating, but it is divided in several step and the time to achieve it is highly expended.

When a conditioning is required, the Power Box displays "Condi 1/XX" where XX is the number of steps required, depending of the idle time. When in this case, the operator must press the "Start" button to achieve

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the first step, after what a rest time is enforced. When the rest time is elapsed, the operator must press the “Start” button to achieve the second step and so on until all the steps have been achieved.

4.2.4 SETTING kV, mA AND EXPOSURE TIME

When the “**Ready to start**” message is displayed on the main display, you can enter the desired kV, mA and exposure time values.

To enter the **kV**:

Press the ‘kV’ button on the front panel

Enter the desired kV value using the numeric keys in a 3-digit (xxx) format. Value will be validated once the 3 digits will be entered, or if the “OK” or “V” key is pressed.

To enter the **mA**:

Press the ‘mA’ button on the front panel

Enter the desired mA value using the numeric keys in a 3-digit (xx.x) format. Integer part will be validated once 2 digits will be entered, or if the “OK” or “V” key is pressed. Once the integer value is validated, the decimal value has to be entered. If desired decimal value is 0 you can validate by pressing “OK” or “V” key.

To enter the exposure time **T**

Press the ‘T’ button on the front panel

Enter the desired exposure time using the numeric keys in a 4-digit (xxmxx) format. Minutes will be validated as soon as 2 digits will be entered or if the “OK” or “V” key is pressed, and PowerBox will jump automatically in the seconds sections. Seconds will be validated under the same conditions.

When the parameters have been keyed in, press the Start button (10) to start the exposure.

Should you interrupt the exposure for any reason, just press the Stop button (9).

Note:

The START button must be pressed between 0.3 and 3 seconds to be activated. This is done so to prevent accidental activation by an object falling on the START button.

The STOP button will always respond immediately, no matter how short or how long the button is pressed.

4.2.5 USING THE CONSTANT POWER FUNCTION (PCT)

The Constant Power function will automatically set the mA to the maximum value possible according to the maximum operating range and will adjust the required exposure time accordingly.

For example:

The parameters that are set are; 120 kV, 3mA, 5 minutes exposure time. When pressing the Pct (6) button, the PowerBox will automatically increase the current to its maximum for that selected kV (ie:7.5mA) and adjust the exposure time to obtain the same result in exposure. The exposure time is thus decreased to 2 minutes.

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4.2.6 EMERGENCY STOP

The emitting of X-rays during preheating or while making an exposure, can always be stopped immediately by pressing the STOP button (9) or by turning OFF the Safety key (12).

It is however not recommended to switch OFF the power with the power switch (11).

When the STOP button is pressed or the Safety key is switched off, the remaining preheating or exposure time is kept. When the danger situation is cleared and X-ray can be emitted again, the remaining preheating or exposure time can be finished by pressing the START button again.

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5. POWERBOX MENU

5.1 INTRODUCTION

The secondary display (2) provides the user with an interface to the PowerBox extended functionalities and advanced user options. Each feature will be explained in the following chapters.

5.1.1 NAVIGATING THROUGH THE POWERBOX MENU

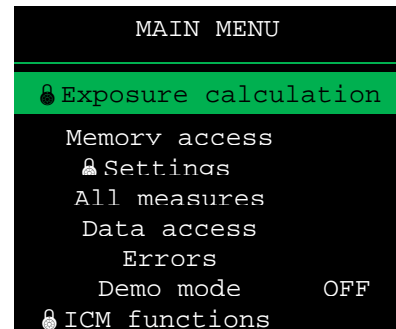


To navigate through the PowerBox menu, use the menu navigation keys (15).

Use the UP and DOWN arrow keys to browse through the menu items.

Press OK or ENTER key (13) to select a function and BACK arrow or CANCEL key (14) to go up one level in the menu structure.

Use the Alphanumeric keys (7) to enter numeric or text values and confirm with the OK or the ENTER key (13). If you wish to clear the input press the BACK arrow or CANCEL key (14).



5.1.2 PADLOCKED MENU ITEMS



Certain menu items are locked, which means they cannot be changed or accessed. In the PowerBox menu, these items are preceded by a padlock symbol.

There are 2 reasons an item can be locked:

1. The item refers to the CP SERIES generator and this one is not connected to the PowerBox. Connect the generator to have access to this item.
2. The item is password protected; enter the appropriate password to unlock the item.

Note: There are 3 types of password:

- The superuser password which give access to the Settings menu
- The Exposure calculation code which unlock the Exposure calculation software
- The ICM password which give access to the ICM functions menu

Once the Exposure calculation code is entered, the exposure calculation software is unlocked permanently.

Once the superuser or the ICM password is entered the corresponding items are unlocked until the PowerBox is switched OFF. By default, superuser password is "000000" (six times zero)

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5.2 EXPOSURE CALCULATION (OPTIONAL)

Note: This is an optional feature and will only be available when purchased.

5.2.1 CALCULATE

The exposure calculator software allows for automatic calculation of the required kV or the required exposure time (T). The type of calculation can be changed by pressing the 'OK' button (15) while the 'Calculate' menu item is highlighted.

Enter the remaining desired variables and parameter required for the calculation and press 'OK' on the 'Confirm' menu item to execute the calculation.

The remaining items that must be completed to make the calculation are:

Exposure calc	
Calculation	T
kV	200kV
mA	4.5mA
D Fe 2.0	AGFA D7
Thickness	35.0mm
FFD	700mm

Calculate	

- ▶ kV or TP: depending on the selected calculation mode, enter the desired kV or Exposure time.
- ▶ mA: the desired mA
- ▶ D: Select material, film type and desired quantity. See below for further explanation. Press 'OK' to enter the sub-menu and change the desired settings
- ▶ Thickness: the thickness of the inspected material in mm
- ▶ FFD: Film to Focal Distance in mm

[D]

When selecting the D(ensity) sub-menu you first must choose the reference chart that will be used for the calculation. Charts are divided in 2 categories, ICM charts which are already pre-loaded in the PowerBox, or Custom chart that customer can add manually.

Chart
ICM chart
Custom chart

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5.2.2 ICM CHART

Newly delivered equipment comes pre-loaded with standard ICM charts for the most used film types and materials. Custom charts for different film brand, film type or specific material can also be entered in the PowerBox and used for exposure time or kV calculations.

Please refer to the next chapter Custom charts for more information on entering custom charts.

The parameters linked to the chart to be used for the calculation are:

ICM chart	
Geometry	Dir
Material	Al
Film	AGFA D7
Film density	2.2

Confirm	

- ▶ Geometry: Generator model (currently only directional is available)
- ▶ Material: The material that will be inspected.
- ▶ Film: The film type that will be used. Press 'OK' to change the Film type or brand.
- ▶ Film density: The desired density on the film
- ▶ Confirm: Press 'OK' on the confirm item when the desired parameters are set and go back to the main calculation menu.

Note: Although the CP160D/CP200D/CP225D/CP300D/CP300C can make exposures of 10kV, a kV setting lower than 40kV will not be accepted by the calculation software. This is because the ICM exposure charts start from 40kV.

If you wish to use the calculator at lower kV, a custom chart has to be added.

5.2.3 CUSTOM CHART

For materials or film types that are not standard included in the calculation software, custom exposure charts can be made and stored in the PowerBox. Custom charts will enable easy, fast and correct calculation of the required exposure time, greatly reducing the amount of film that is used on trial and error basis.

Custom charts can be entered in the PowerBox by specifying the material thickness which results in the specified thickness for 5mA.min and 100mA.min for each kV line.

Custom chart
Add new chart
Delete chart
Choose chart

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For example:

A custom chart will be made for a material ABC using a film brand and type XYZ. The chart will result in a density of x.x at an FFD of xxx mm.

Using a step wedge made out of the material ABC, 2 exposures are made at an FFD of xxx mm; one at 5mA.min and one at 100mA.min. This is done for each of the kV lines that will be plotted on the custom chart. The thickness of the material that results in a density of x.x is recorded for each of the developed films. The result is a table of 2 thicknesses per kV line. The number and range of kV lines that will be recorded is free to choose within the operating range of the CP SERIES generator.

The table that was found by doing the density measurements on the films can now be recorded in the PowerBox.

- In the 'Custom charts' menu, choose 'Add new chart'
- Using the alphanumeric keys (7) give your custom chart a name
- Specify the lowest kV line that will be plotted. For our example 100kV.
- Specify the step between each of the kV lines. For our example 20kV.
- Select 'enter thicknesses' and press the 'OK' button (15).
- Now enter the thicknesses of 5mA.min and 100mA.min for each of the kV lines.
- Select 'continue' and press the 'OK' button to go to the next kV line.
- Select 'Finish' and press the 'OK' button to complete the entry of your custom chart.

Your custom chart is now saved and can be recalled when doing an exposure calculation with the PowerBox's exposure time calculator.

Add new chart	
Name	CUSTOM1
kV start	100kV
kV step	20kV
Enter thickness	

Thickness	
Thickness for	100kV
At 5mA.min	1.00
At 100mA.min	5.00
Continue	
Back	

Cancel	
Finish	

5.3 MEMORY ACCESS

A set of exposure setting can be stored, recalled or deleted from memory through the memory access menu of the PowerBox.

Each entry will contain the following set of items:

- Name: Name of the exposure settings set. Can be chosen freely.
- kV: kV value
- mA: mA value
- TP: Exposure time setting
- Material: Material type (Fe, Al...)
- Film: Used film brand and type
- Film density: Density on film
- Thickness: material thickness (the unit can be selected in the 'settings' menu)
- FFD: Film to Focus Distance (the unit can be selected in the 'settings' menu)

Memory access	
Add new entry	
Recall entrv	
Delete entrv	
Delete all	
Search	

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- Gen Model: Generator Model (Currently only CP SERIES is available)

Select the 'Confirm' item and press OK to store the set of entries.

5.4 SETTINGS

The settings menu gives access to various settings of parameters and equipment behavior. Superuser access rights are required to enter into this menu.

The following chapters will explain each of the 'Settings' menu items in more detail. In each of the Settings sub-menu there is a "Confirm" line that allows you to save the changes you've made. However, if you've made some changes and escape out of the submenu without confirming the changes, a message will pop-up, asking you if you want to save or cancel the modifications you've done.

5.4.1 CHANGE SU CODE

Allow to change the SuperUser code. You have to enter the old code, and twice the new code (to avoid any typo mistake). Old (or default) code will be permanently deleted so make sure you note down the new code somewhere.

Settings	
Change SU code	
Doors control	
Lamps control	
Interlock	
Bluetooth	
Date and Time	
Language	
Software	
Screen	
Carousel	
Limitation	
Gen lamp	BLINK
Fan mode	Max power
Prewarning	5s
Units	metric
Key beep	OFF

Confirm	

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5.4.2 DOOR CONTROL

A door control input enables the user to connect safety switches to the PowerBox and prevent accidental exposures. There are 5 door control inputs available on the PowerBox, each one of them can be enabled or disabled individually. The PowerBox will not start an exposure while an open contact is detected on one of the enabled door control inputs.

- All off: Disable all door controls.
- Door 1, Door 2, Door 3, Water, Oil: Change the setting for each individual door.

Doors control	
All off	
Door 1	OFF
Door 2	OFF
Door 3	OFF
Water door	OFF
Oil door	OFF

Confirm	

5.4.3 LAMP CONTROL

All lamp on the PowerBox front panel, the externally connectable lamp, siren or buzzer outputs and the warning lamp on the CP SERIES generator are equipped with a 'device failure' detection. When enabled the PowerBox will detect a failure of one or more of these devices and display an error indicating which lamp or buzzer is defect. No X-ray is emitted while the error condition exists to prevent accidental radiation due to a failing warning device.

When no external lamps or siren are connected, the device failure detection can be deactivated in this menu.

- All off: Disables the device failure detection for all devices.
- Lamp 1, Lamp 2, Lamp 3, Ext Buzzer: Enable/disables the device failure detection for the external lamp and siren outputs on the PowerBox's Interlock connector.
- Green lamp, Red lamp, Yellow lamp: Enable/disables the device failure detection for the front panel lamps of the PowerBox.
- Gen lamp: Enable/disables the device failure detection CP SERIES generator warning lamp

Lamps control	
All off	
Lamp 1	OFF
Lamp 2	OFF
Lamp 3	OFF
Ext Buzzer	OFF
Green lamp	ON
Red lamp	ON
Yellow lamp	ON
Gen lamp	ON

Confirm	

5.4.4 INTERLOCK

This menu allows programming the behavior of each warning device and output for each of the generator's states: Standby, Pre-warning, Shot, End of shot, error and preheat.

Operator can choose between 4 pre-sets of behavior²:

- Denmark: warning devices and outputs will be programmed as per the Danish regulations
- Germany: matches the German regulations

Interlock	
Manual ●●	
Denmark	○
Germany	○
Dual flash light	○
Default	○

Confirm	

² The configuration of the pre-sets is available in \$8.

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- Dual flashlight: will be programmed to work with 2 external flashing lights connected with the junction box for dual flashing light (see §7.11)
- Default: behavior will be restored back to factory settings

Additionally to those pre-sets, the user can define himself the behavior of each of the front panel lamps (Red lamp, Green lamp, Yellow lamp, Buzzer) as well as the interlock outputs (Lamp 1, Lamp 2, Lamp 3, Ext Buzzer, Relay 1, Relay 2, Relay 3 and Relay 4) in the '**Manual**' submenu. And this for each of the abovementioned states.

The different behaviors that can be programmed are:

OFF, blinking slow (BL SLOW), blinking fast (BL FAST) or continuous ON

Standby	
Red Lamp	OFF
Green lamp	BL SLOW
Yellow lamp	BL FAST
Buzzer	ON
Lamp 1	OFF
Lamp 2	OFF
Lamp 3	OFF
Ext Buzzer	OFF
Relay 1	OFF
Relay 2	OFF
Relay 3	OFF
Relay 4	OFF

5.4.5 BLUETOOTH

Allows you to connect via Bluetooth to a computer or to a Go-Scan detector.

To connect with a Go-Scan please refer to the Go-Scan manual.

To connect to a computer, you first need to set the pairing mode to ON. Under Windows 8 or later we recommend using a socket connection like <https://inthehand.com/components/32feet/>. Virtual COM ports, while still available, may lead to wrong or unstable connections.

Bluetooth	
Device name	Powerbox-18015224
Host MAC address	985FD3D68ACB
Pairing mode	OFF

5.4.6 DATE AND TIME

There is a real time clock in both the PowerBox and the CP SERIES generator indicating the UTC time and date. The CP SERIES generator's clock data will be used to calculate the required preheating time and will be recorded in the exposure listing. It is therefore fixed at UTC time and date. The ICM access is required to change the time in the CP SERIES generator.

PowerBox

On the PowerBox, the following readouts and settings are available:

- Time zone: Set your time zone relative to UTC time.

Date and Time	
PowerBox	
Generator	***** Format *****
Date	DD/MM/YY
Time	HH:MM:SS

Confirm	

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- Daily sav time: Enable or disable Daylight savings time.
- The current local time (= UTC + time zone)
- The current local date (= UTC + time zone)

Generator

The indicated time and date under the 'generator' menu item is the time from the CP SERIES generator's real time clock and are both UTC.

'Confirm' will set the real time clock in the CP SERIES generator to the UTC time of the PowerBox. This function is however reserved only for authorized After Sales service centers as changing the date in the CP SERIES generator will have an influence on the preheating time and may lead to equipment failure if used incorrectly.

Format

The time format can be changed between 12 hour (AM/PM) or 24-hour format. (HH:MM:SS)

The date format can be changed between DD/MM/YY, MM/DD/YY or YY/MM/DD

5.4.7 LANGUAGE

Select the PowerBox language.

Please contact ICM if your preferred language is not available. A complete list of the PowerBox's messages can be provided to you for translation. Once translation is finished, ICM can compile a new language file and update for the PowerBox software. Once the software in the PowerBox is upgraded, your translations will be available in the PowerBox menu.

Language	
English	●
Suomi	○
Francais	○
Italiano	○
Polski	○

Confirm	

5.4.8 SOFTWARE

'**Serial numbers**': displays the electronic identification number of the PowerBox (this number is required in case you want to receive the code to unlock the exposure calculation software), as well as the serial number of the CP SERIES generator if connected.

Software	
Serial numbers	
Versions	
Updates	OFF

'**Versions**': displays the actual software versions

'**Updates**': allow to update the software

To install an update get the required .icm file from the ICM website or from your distributor and copy it to the root directory of a USB pen drive. Plug the USB pendrive in the USB master port of the PowerBox and select the item you wish to update from the menu.

The PowerBox will now search the USB pen drive and display all suitable update files. Select the desired file and press the 'OK' button (15) to start the update progress. Follow the instructions on the PowerBox screen to complete the upgrade.

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Note: If a problem occurs while upgrading the PBB100 software it may cause the main software is get corrupted which will leave the PowerBox to become unresponsive after a restart. In this case, leave the USB pen with the upgrade files in the PowerBox's master USB port, turn off the main switch (11), press the "STOP" button (9) and keep it pressed while switching on again. Keep the "STOP" button pressed until you can see on the display that the upgrade process has restarted.

5.4.9 SCREEN

The brightness of the display can be set here. It is recommended to set a lower 'Sleep Brightness' to extend the display's lifetime. The brightness is selectable in 7 steps: Min > 2 > 3 > 4 > 5 > 6 > Max. by pressing the 'OK' button while the submenu item is highlighted.

Working bright. Select the brightness of the display when the display is active. i.e. when working in the PowerBox menu.

Sleep bright. : Select the brightness of the display when the display is in standby. i.e. when not working in the PowerBox menu and for instance you are waiting for a shot to finish.

Standby time Set the time in seconds after which the display will revert to the standby. i.e.: Sleep brightness. Value can be adjusted between 1 & 255 seconds.

Screen	
Working bright.	max
Sleep bright.	min
Standby time	10s

Confirm	

5.4.10 CAROUSEL

There are 5 positions of the carousel as illustrated in the CP SERIES generator's component description chapter.

When the '**Control**' is ON, the position of the carousel is verified by the PowerBox to ensure it is correct before allowing a shot. For example, if the carousel is on an in-between position, or on the laser pointer, it will not be possible to make a shot.

When the '**Control**' is OFF, the carousel is not monitored and the operator will always be allowed to make a shot or a preheating, regardless of the position of the carousel.

Note: When the electronic position verification is disabled, the user must verify visually if the carousel is in the correct position!

The '**Position**' submenu item shows the actual position of the carousel.

'**Be-08mm**' submenu allows or forbids the use of the beryllium window. This may be necessary if local regulations prohibit the use of such low filtration. **Please note that even when this option is allowed, shots at higher than 50kV with the beryllium window are not possible.**

'**Preheat w/o shutter**' allows or not the operator to perform a preheating if the carousel is not on the shutter position

Carousel	
Control	ON
Position	Be-0.8mm
Be-0.8mm	Allowed
Preheat w/o shutter	Y

Confirm	

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5.4.11 LIMITATIONS

'kV limitation' limits the maximum kV allowed for the connected CP SERIES generator. Please note that limiting the kV for a long period may cause irreversible downgrade of the generator. Contact ICM for more information.

'Time limitation' limit the number of hours during which the generator can be used. To add working hours enter the following values in the 'Add hours' field:

999 to remove limitations

- 9XX to delete previous limitation and set XX working hours as limit (with XX between 01 and 98)
- Any number between 1 and 899: add this amount of shot time to the remaining shot time limit. The total will be limited to 988 hours.
- To enter values in the field, a code received from ICM must be entered.

'Date limitation' block the use of the generator beyond this date. Limit date can be edited in the 'Change' field. To edit the date, a code provided by ICM must be entered.

'Code compute' displays a list of values that you should provide to ICM to receive the code to edit the time and/or date limitation.

Limitations
kV limitation
Time limitation
Date limitation
Code compute

5.4.12 GEN LAMP

Sets the behavior of the generator's lamp during the shot.

5.4.13 FAN MODE

The speed of the cooling main fan of the CP SERIES generator can be set to operate in 3 modes:

1. **Silent:** The fan speed will be kept as low as possible. During a shot, as the generator gets hotter, the fan speed will increase to match the increased cooling need of the generator.
2. **Max power:** The fan will always run at maximum power, ensuring the best cooling possible.
3. **Medium:** The fan will run at a medium power level and thus a reduced sound level. The fan will however not speed up as cooling needs increase causing the generator to heat up. When the generator gets too hot, overheating protecting will interrupt the shot and allow the generator to cool down. The remaining exposure time can be finished by pressing the START button again.

Toggle between the 3 modes by pressing the 'OK' button while the 'Fan Mode' menu item is highlighted.

Settings
Fan Mode silent

5.4.14 PREWARNING

The pre-warning time is the time where the PowerBox will emit a warning signal between pressing the START button and the actual start of X-ray.

The desired pre-warning time can be by pressing the 'OK' button (15) and using the alphanumeric keyboard (7) to enter the desired value. The PowerBox will accept any value

Settings
Prewarning 5s

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between 5 and 255 seconds. Any value below or above these limits will automatically be adjusted to the nearest limit.

5.4.15 UNITS

Set your preferred unit system, metric or imperial, by pressing the 'OK' button (15) while the 'Units' menu item is highlighted.

Settings	
Units	metric

5.4.16 KEY BEEP

An audible feedback (beep) can be enabled or disabled by selecting the 'Key beep' menu and pressing the 'OK' button (15).

Settings	
Key beep	ON

5.5 ALL MEASURES

The '**All measures**' menu displays the most important measurements in 1 screen and updates them in real time, even while making an exposure. This will allow for easy monitoring of the main environmental and generator parameters and assist in analyzing conditions that lead to warning or error conditions. The displayed measurements are:

0.1kV	0.01mA
10%	0mA
45000Hz	146192H
i 29°C	a 29°C
s 29°C	r 27°C
230.0V	50Hz
50.2V	0.27A
1.4V	0.00A
	a 34°C
	r 28°C

- Real time measurement of kV [kV] and mA [mA]
- Duty cycle of the kV inverter [%] and current drawn by the filament [mA]
- Frequency of the kV inverter [Hz] and the filament inverter [Hz]
- Temperature of the kV inverter [i°C], the ambient air in the PowerModule [a°C] and the SF6 pressure [bar]
- Temperature of the SF6 gas [s°C] and radiator of the generator [r°C]
- Input voltage (AC) [V] and frequency [Hz], ambient temperature in the PowerBox [a°C]
- Internal 50Vdc [V], current consumption [A] and radiator temperature [r°C]
- 380 Vdc High Voltage power supply [V] and current consumption [A]

5.6 DATA ACCESS

At the beginning and at the end of each shot, a series of data and measurements is registered in the **CP200** generator and the PowerBox. This data can be accessed via the PowerBox. The data stored in the PowerBox can be downloaded to a USB drive for archiving or failure analyses.

Data Access	
PowerBox	
Generator	

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5.6.1 POWERBOX

The **'View history'** menu will list all exposures recorded by the PowerBox.

Further detail of the exposure can be viewed by selecting the desired exposure with the navigation keys (15) and pressing the 'OK' button.

The contents of the list on the PowerBox will differ from that of the generator which is described in the next chapter since the generator will only record an entry if the exposure has started. The PowerBox will add a record as soon as the START button is pressed. Exposures that have been stopped in the prewarning time will thus be recorded by the PowerBox but not by the generator.

The PowerBox can be used in conjunction with different generators so records of exposures with generator with a different serial number may be listed in the PowerBox but will not be found in the listing of the generator.

The **'Export to usb'** will export the PowerBox's listing to USB when a USB pen drive is plugged in. This way the entire exposure listing can be extracted from the PowerBox for archiving or failure analyses purposes.

PowerBox
View history
Export to USB

5.6.2 GENERATOR

The **'Show all'** menu item will retrieve the exposure listing from the connected generator and list them on the display.

Further details of a particular exposure can be viewed by navigation to the desired exposure using the navigation keys (15) and pressing the 'OK' button.

If no generator is connected, no listing can be retrieved, and a padlock symbol will be shown before the generator menu item.

Generator
Show history
Export to USB

5.7 ERRORS

The error messages on the PowerBox can be split up in warnings and error messages. Warnings will inform the user but are not critical for the operation of the CP SERIES generator or PowerBox. In total there are 24 warning and error bytes for different categories.

5.7.1 CURRENT ERRORS

'Current errors' will provide a full text explanation of the current error if the PowerBox or CP SERIES generator is facing a warning or error situation. Suggestions on how to resolve the problem are displayed on the main display (1).

Errors
Current Errors
Error status
View history
Export to USB

5.7.2 ERROR STATUS

'Error status' will display the current status of all 27 warning and error bytes from all 6 categories in the form of hexadecimal codes. The warning and error categories are:

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- Sh: errors during a shot
- On: errors during pfc ignition when high kV is being generated.
- Off: errors during pfc extinction when high kV is being shut down
- No: Errors related to the PowerBox only
- Ge: Generator error
- Gw: Generator warning

5.7.3 VIEW HISTORY

‘View history’ will show a history of passed error messages sorted by date.

5.7.4 EXPORT TO USB

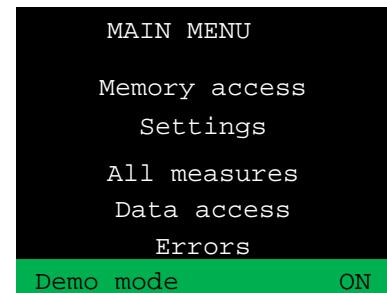
‘Export to USB’ will export the error list to USB when a USB pen drive is plugged in.

5.8 DEMO MODE

Demo mode is intended for demonstration purpose such as exhibitions or trade shows. When Demo mode is enabled, the PowerBox will simulate all operations without actually generating X-rays. The user is able to change setting of kV, mA, exposure time and go through all the PowerBox menus. When pressing the START button, the PowerBox will even simulate an exposure and indicate fake measurements of kV and mA.

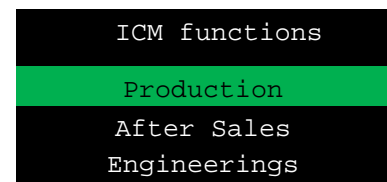
Note: To be able to enter the ‘Demo mode’ the CP SERIES generator must be disconnected.

The Safety Key Switch (12) needs to be in the XO position!



5.9 ICM FUNCTIONS

These after sales service, production and Engineering functions are reserved for authorized repair service centers and production only. A service password is required to remove the padlock symbol and gain access to the menu.



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6. TROUBLESHOOTING

6.1 ERROR AND WARNING MESSAGES

The CP SERIES generator in combination with the PowerBox is an intelligent system which offers a high level of safety and operation comfort. The high amount of feedback from the equipment is new in the industry and may lead to confusion or the impression that the equipment is defect. In most of the cases however, you will find that the equipment is not defect, but it halted due to out of bound environmental variables or a mistake of the operator. The following chapter will explain in more detail some of the message you may encounter.

Messages displayed on the PowerBox can be divided in 2 main groups: warning messages and error messages.

Warning messages are there to inform the user of a potentially dangerous situation or incorrect use of the equipment. These messages are warnings only. It will be possible to use the equipment after acknowledging the warning message.

Error messages indicate a failure situation that prevents the equipment from operating. This failure situation must be resolved before a next shot can be made.

6.2 MOST COMMON WARNING MESSAGES

6.2.1 E56: GAS LEAK

The CP SERIES constantly makes sure the pressure is high enough according to SF6 temperature. If it is too low a warning message will be displayed indicating that the gas pressure is getting low. Please schedule maintenance for the CP SERIES generator to identify any gas leaks and refill the generator with SF6.

6.2.2 E162: CAR. DESACTIV.

The carousel position detection has been disabled in the software. This may be wanted in case there is a defect in the carousel position detection system but the PowerBox will remind you that the detection system was deactivated every time the PowerBox is powered ON.

Please schedule maintenance of the CP SERIES generator as soon as possible to repair the carousel position detection system for your own safety and comfort.

6.2.3 E163: CAR. SHUTTER

When attempting to make an exposure with the carousel in shutter position a warning message 'Carousel shutter' will be displayed on the main display.

Shooting with the carousel in shutter position will not damage the equipment but X-ray emission is blocked by the shutter. The film will thus not get exposure.

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6.2.4 E164: CAR. PREHEAT

When attempting to make a preheating while the carousel is not in shutter position a warning message 'Carousel preheat' will be displayed on the main display.

It is highly recommended to put the carousel in the shutter position while preheating, in order to avoid exposing operators to high levels of radiations.

6.3 MOST COMMON ERROR MESSAGES

6.3.1 E7: PRESS MIN

The gas pressure of the SF6 gas must be between 5.0 and 7.5 bar. Typically, it should be around 6.0 bar at 25°C but varies a lot with temperature. For instance, it will rise to 7 bars at 70°C, and drop to 5.3 bar at 0°C. If the gas pressure is too low due to very low SF6 temperature, please try to increase the SF6 temperature by using heating blankets or putting the generator for some time in a heated vehicle or room. Once the gas pressure is high enough to start an exposure, the CP SERIES will keep itself warm enough as long as you use it regularly.

6.3.2 E10: T° INV MAX

The temperature of the inverter transistors in the PowerModule has become too hot. Allow the CP SERIES generator to cool down in stand-by mode before attempting to make further exposures.

6.3.3 E11: T° AMB MAX

The ambient temperature in the PowerModule of the CP SERIES generator has become too high for the equipment to operate safely. Make sure there is enough room for air circulation, move the generator to a cooler or shaded area and allow it to cool down in stand-by mode before attempting to make further exposures.

6.3.4 E12: T° SF6 MAX

The temperature of the SF6 gas inside the generator has become too high. Allow the generator to cool down in stand-by mode before attempting to make further exposures.

6.3.5 E13: T° RAD MAX

The temperature of the radiator of the anode has become too high. Allow the generator to cool down in stand-by mode before attempting to make further exposures.

6.3.6 E40: kV PREHEAT ..M..S

A preheating is required for the set kV. Put the carousel in the shutter position and press the START button (10) to start the preheating process. Allow the generator to finish the preheating before continuing.

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6.3.7 E71: PB T° RAD MAX

The temperature of the radiator of the PowerBox has become too high. Make sure there is enough room for air circulation, move the PowerBox to a cooler or shaded area and allow it to cool down in stand-by mode before attempting to make further exposures.

6.3.8 E72: PB T° AMB MAX

The temperature inside the PowerBox has become too high. Make sure there is enough room for air circulation, move the PowerBox to a cooler or shaded area and allow it to cool down in stand-by mode before attempting to make further exposures.

6.3.9 E80 THROUGH E86: DEFECTIVE LAMP

One of the lamps controlled by the PowerBox is defective. Replace the lamp or disable the lamp control if you are authorized to do so.

6.3.10 E87, E88: WATER OR OIL FLOW DEFECT

The water or oil flow control circuit detects an error. Please check the cooling circuit or disable the control if you are not using liquid cooling.

6.3.11 E89: DEFECTIVE EXTERNAL BUZZER

The external buzzer is defective. Replace it or disable the buzzer control if you are authorized to do so.

6.3.12 E90 THROUGH E92: DOOR OPEN

One of the 3 door controls is giving an error. Check the door contact or disable the control if you are authorized to do so.

6.3.13 E95: DEFECTIVE GENERATOR LAMP

The red lamp located on the generator is defective. Replace the lamp or disable the lamp control if you are authorized to do so.

6.3.14 E97: KEY OFF

The key (12) is not present or is in the X0 position. Set it to the XI position in order to enable X-rays.

6.3.15 E115: NO GENERATOR

The PowerBox cannot communicate with the generator. Make sure the interconnection cable is connected properly or try to replace it.

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6.3.16 E149: CAR. POINTER

The carousel is in the laser pointer position. Making an exposure with the carousel in the laser pointer position may damage the electronics of the laser pointer. The laser pointer would also show up in the developed film. Put the carousel in a correct position to continue with the exposure.

6.3.17 E150: CAR. UNLOCKED

The carousel is in between 2 positions. Verify that 'click' can be heard and that the carousel is in a good position.

6.3.18 E 151: CAR. BE50kV

The carousel is in the 'be window' position but a kV is selected of more than 50kV. Select a kV below or equal to 50kV or use the 'full open with 3mm aluminum filter' instead.

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7. ACCESSORIES

7.1 SINGLE FLASHING LIGHT

ICM order number 00003071.

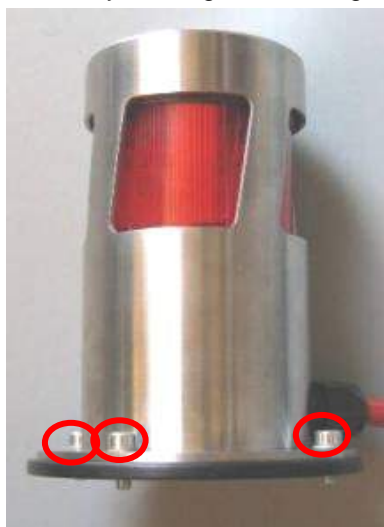
A single red warning light in a reinforced housing with a 20 m connection cable attached.



The functioning of the light – always on or flashing during X-ray active – can be controlled by the PowerBox. This accessory includes a 1/4-20UNC thread for mounting on a magnetic foot or on a tripod (order number 00003406 and 00000666, to be ordered separately).

It is possible to dismantle the flashing light to connect a door contact. However, **this feature is not available with the audible/flashing light.**

To connect a door contact, disassemble the flashing light by removing the 4 inox screws, and then remove the LED element by rotating it 90° to align the 2 white marks.



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Disconnect the 2 wires from the connecting element, and then remove the 2 screws holding it



White wire is connected to terminal 0 and red one is connected to terminal 1.

Remove the connecting element. You now have access to the wires to connect the door contact. Door contact has to be connected between the black wire and the blue/grey wire pair connected together.



7.2 AUDIBLE/FLASHING LIGHTS

ICM order number 00003072.

A red, orange and green warning light and siren in a reinforced housing with a 20 m connection cable attached.

The functioning of the 3 lights – always on or flashing during X-ray active – and the siren can be controlled by the PowerBox.

This accessory includes a 1/4-20UNC thread for mounting on a magnetic foot or on a tripod (order number 00003406 and 00000666, to be ordered separately).



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7.3 MAGNETIC FOOT FOR WARNING LIGHTS

ICM order number 00003406.

The warning lights and siren described in point 8.1 and 8.2 can be equipped with a magnetic foot, allowing them to be attached to metal objects such as pipelines, metal tank walls or support structures.



7.4 TRIPOD FOR FLASHING LIGHT

ICM order number 00000666.

The warning lights and siren described in point 8.1 and 8.2 can be mounted on a standard camera tripod.



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7.5 PELI STORM™ TRANSPORT CASE

ICM order code 00003075.

A hard plastic transport case which can hold the CP SERIES generator, the PowerBox, the 10m power cable, a 20m interconnection cable, a single red or a 3 color flashing light with built-in siren and its tripod.



External dimension: 955 x 690 x 365 mm



7.6 TRIPOD FOR GENERATOR

ICM order number 00003073.

The tripod for the CP SERIES generator allows adjustment of height and rotation in 3 axes of the generator itself. This allows the CP SERIES generator to be positioned in any position or orientation desired.



A clamping ring is mounted around the generator body which clicks into its tripod holder. To release the CP SERIES generator from pull down and 1/4 turn the locks and lift out the generator as illustrated in the pictures below.

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Total weight of the tripod (without generator): 10.9kg.



Minimum height in vertical position (focal spot)	315 mm	First image
Minimum height in vertical position (total)	935 mm	
Minimum height in horizontal position (focal spot)	675 mm	Second image
Minimum height in horizontal position (total)	770 mm	
Maximum height in horizontal position (focal spot)	2790 mm	Third image
Maximum height in horizontal position (total)	2885 mm	
Maximum height in vertical position (focal spot)	2850 mm	Fourth image
Maximum height in vertical position (total)	2995 mm	

7.7 ALUMINUM TRANSPORT CASE WITH CP TRIPOD

ICM order number 00003434.

An aluminum transport case which can hold the CP SERIES generator, the PowerBox, the 10m power cable, a 20m interconnection cable, a 3-color flashing light with built-in siren and its tripod and the CP SERIES generator tripod.

External dimensions: 1086 x 580 x 497 mm

7.8 CUSTOM DIAPHRAGM

ICM order number 99999999

When ordering a custom diaphragm, please inform ICM of the film size and FFD.

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7.9 EXPOSURE TIME CALCULATOR

ICM order number 00003074.

Unlock code for the exposure time calculator software.

7.10 INTERCONNECTION CABLE EXTENSION (PER 20M) UP TO 100M

ICM order number 00003438.

Standard extension cables for the interconnection cable are available in lengths of 20 meter.



7.11 JUNCTION BOX FOR DUAL FLASHING LIGHT

This accessory allows the user to have two single red flashing lights powered concurrently by the PowerBox. When it is used, the two flashing lights are connected respectively to “Lamp2” and “Lamp3”, as described in 3.3.5. Thus, it is necessary to adjust the interlocks in order to switch on “Lamp2” and “Lamp3” during exposure. This can be done by selecting the “Dual Flashlight” standard, as described in 5.4.4, or in manual mode. If needed, it is also possible to enable the control of both lamps as described in 5.4.3.



7.12 JUNCTION BOX FOR DUAL AUDIBLE-FLASHING LIGHT

This accessory allows the user to have two single red audible flashing lights powered concurrently by the PowerBox (Note that in this configuration the orange lamp of the audible flashing light is not operational). When it is used, the two flashing lights are connected respectively to “Lamp2” and “Lamp3”,

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as described in 3.3.5. Thus, it is necessary to adjust the interlocks in order to switch on “Lamp2” and “Lamp3” during exposure. This can be done by selecting the “Dual Flashlight” standard, as described in 5.4.4, or in manual mode. If needed, it is also possible to enable the control of both lamps as described in 5.4.3

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8. PRE-SETS CONFIGURATION

DENMARK												
	red	green	yellow	buzzer	lamp1	lamp2	lamp3	buzzer	relay1	relay2	relay3	relay4
Standby	OFF	ON	OFF	OFF	ON	OFF	OFF	OFF	ON	OFF	OFF	OFF
Prewarning	ON	OFF	OFF	BLFAST	OFF	OFF	ON	BLFAST	OFF	OFF	ON	BLFAST
Shot	ON	OFF	OFF	OFF	OFF	OFF	ON	OFF	OFF	OFF	ON	OFF
Endshot	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF
Error	OFF	ON	BSLOW	OFF	ON	BSLOW	OFF	OFF	ON	BSLOW	OFF	OFF
Preheat	ON	OFF	OFF	OFF	OFF	OFF	ON	OFF	OFF	OFF	ON	OFF

GERMANY												
	red	green	yellow	buzzer	lamp1	lamp2	lamp3	buzzer	relay1	relay2	relay3	relay4
Standby	OFF	ON	OFF	OFF	ON	OFF	OFF	OFF	ON	OFF	OFF	OFF
Prewarning	ON	OFF	OFF	BLFAST	OFF	OFF	ON	BLFAST	OFF	OFF	ON	BLFAST
Shot	BSLOW	OFF	OFF	OFF	OFF	OFF	BSLOW	OFF	OFF	OFF	BSLOW	OFF
Endshot	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF
Error	OFF	ON	BSLOW	OFF	ON	BSLOW	OFF	OFF	ON	BSLOW	OFF	OFF
Preheat	BLFAST	OFF	OFF	OFF	OFF	OFF	BLFAST	OFF	OFF	OFF	BLFAST	OFF

DUALFLASHLIGHT												
	red	green	yellow	buzzer	lamp1	lamp2	lamp3	buzzer	relay1	relay2	relay3	relay4
Standby	OFF	ON	OFF	OFF	ON	OFF	OFF	OFF	OFF	OFF	OFF	OFF
Prewarning	BLFAST	OFF	OFF	OFF	OFF	BLFAST	BLFAST	OFF	OFF	OFF	OFF	OFF
Shot	BSLOW	OFF	OFF	OFF	OFF	BSLOW	BSLOW	OFF	OFF	OFF	OFF	OFF
Endshot	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF
Error	OFF	ON	BSLOW	OFF	ON	BSLOW	OFF	OFF	OFF	OFF	OFF	OFF
Preheat	BSLOW	OFF	OFF	OFF	OFF	BSLOW	BSLOW	OFF	OFF	OFF	OFF	OFF

DEFAULT												
	red	green	yellow	buzzer	lamp1	lamp2	lamp3	buzzer	relay1	relay2	relay3	relay4
Standby	OFF	ON	OFF	OFF	ON	OFF	OFF	OFF	OFF	OFF	OFF	OFF
Prewarning	BLFAST	OFF	OFF	OFF	OFF	OFF	BLFAST	OFF	OFF	OFF	OFF	OFF
Shot	BSLOW	OFF	OFF	OFF	OFF	OFF	BSLOW	OFF	OFF	OFF	OFF	OFF
Endshot	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF
Error	OFF	ON	BSLOW	OFF	ON	BSLOW	OFF	OFF	OFF	OFF	OFF	OFF
Preheat	BLFAST	OFF	OFF	OFF	OFF	OFF	BLFAST	OFF	OFF	OFF	OFF	OFF

Lamp 1 = green

Lamp 2 = yellow

Lamp 3 = red

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9. COMMUNICATION PROTOCOL

9.1 FRAMES AND SETTINGS

This chapter describes the communication protocol between the PowerBox and external world (typically a PC).

Two types of connections are available: UART (RS422) or USB.

Important: the last 3 bytes of each message (sent or received) are :

1. A comma
2. A checksum: sum of all bytes before the checksum
3. A '\r' (0x0D) termination character

9.2 CONNECTION THROUGH UART (RS422)

duplex	full
bitrate	115200
data bits	8
parity	none
stop bits	1
flow control	none

9.3 CONNECTION THROUGH USB

HID protocol is used. Data from host to PowerBox is sent through IN endpoint. Data from PowerBox to host is sent through control endpoint. Messages are encapsulated into 64 bytes buffers (0 padded).

Descriptors are as follow:

Device Descriptor POWERBOX

Offset	Field	Size	Value	Description
0	bLength	1	12h	
1	bDescriptorType	1	01h	Device
2	bcdUSB	2	0200h	USB Spec 2.0
4	bDeviceClass	1	00h	Class info in Ifc Descriptors
5	bDeviceSubClass	1	00h	
6	bDeviceProtocol	1	00h	
7	bMaxPacketSize0	1	40h	64 bytes
8	idVendor	2	0403h	
10	idProduct	2	7440h	
12	bcdDevice	2	0100h	1.00
14	iManufacturer	1	01h	"ICM"
15	iProduct	1	02h	"POWERBOX"

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16	iSerialNumber	1	03h	"12345678"
17	bNumConfigurations	1	01h	

Configuration Descriptor 1 Bus Powered, 100 mA

Offset	Field	Size	Value	Description
0	bLength	1	09h	
1	bDescriptorType	1	02h	Configuration
2	wTotalLength	2	0022h	
4	bNumInterfaces	1	01h	
5	bConfigurationValue	1	01h	
6	iConfiguration	1	00h	
7	bmAttributes	1	80h	Bus Powered
	4..0: Reserved		...00000	
	5: Remote Wakeup		..0.....	No
	6: Self Powered		.0.....	No, Bus Powered
	7: Reserved (set to one) (bus-powered for 1.0)		1.....	
8	bMaxPower	1	32h	100 mA

Interface Descriptor 0/0 HID, 1 Endpoint

Offset	Field	Size	Value	Description
0	bLength	1	09h	
1	bDescriptorType	1	04h	Interface
2	bInterfaceNumber	1	00h	
3	bAlternateSetting	1	00h	
4	bNumEndpoints	1	01h	
5	bInterfaceClass	1	03h	HID
6	bInterfaceSubClass	1	00h	
7	bInterfaceProtocol	1	00h	
8	iInterface	1	00h	

HID Descriptor

Offset	Field	Size	Value	Description
0	bLength	1	09h	
1	bDescriptorType	1	21h	HID
2	bcdHID	2	0100h	1.00
4	bCountryCode	1	00h	
5	bNumDescriptors	1	01h	
6	bDescriptorType	1	22h	Report
7	wDescriptorLength	2	001Bh	27 bytes

Endpoint Descriptor 81 1 In, Interrupt, 10 ms

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Offset	Field	Size	Value	Description
	0 bLength	1	07h	
	1 bDescriptorType	1	05h	Endpoint
	2 bEndpointAddress	1	81h	1 In
	3 bmAttributes	1	03h	Interrupt
	1..0: Transfer Type	11	Interrupt
	7..2: Reserved		000000..	
	4 wMaxPacketSize	2	0040h	64 bytes
	6 bInterval	1	0Ah	10 ms

Interface 0 HID Report Descriptor Vendor-Defined 1

Item Tag (Value)	Raw Data
Usage Page (Vendor-Defined 1)	06 00 FF
Usage (Vendor-Defined 1)	09 01
Collection (Application)	A1 01
Logical Minimum (0)	15 00
Logical Maximum (255)	26 FF 00
Report Size (8)	75 08
Report Count (64)	95 40
Usage (Vendor-Defined 1)	09 01
Input (Data,Var,Abs,NWrp,Lin,Pref,NNul,Bit)	81 02
Report Count (64)	95 40
Usage (Vendor-Defined 1)	09 01
Output (Data,Var,Abs,NWrp,Lin,Pref,NNul,NVol,Bit)	91 02
End Collection	C0

9.4 MESSAGES

In the communication protocol, there are three kinds of messages:

1. Order beginning by #
2. Request beginning by ?
3. Reply or event beginning by !

Every order or request will generate a reply from the PowerBox. It is recommended to wait for this reply before sending a new sequence.

When in Remote mode, it is always possible to stop the shot by pressing the STOP button on the front panel, or by turning the key OFF. That last solution also prevents the shot to start if the key is in that position before the command to start the shot is sent.

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During the shot, a watchdog command (#XO) has to be sent every second to the PowerBox so it can make sure that everyone is up and running. The PowerBox will answer by !XO. If the watchdog is not sent, the shot will be stopped.

The answer to the command “#ON” (start shot) will always be “!ON” even in the case where the PowerBox is not able to start the shot for some reason. The answer “!ON” only means that the command “#ON” has been received and acknowledged. To check if the generator is shooting or not, always refer to the status (command “?ST”).

On the next page, you will find the complete description of the protocol.

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Command description			Fields description		
Command syntax	Description	Reply from PowerBox	Field name	Description	units
?SE	Ask for actual shot values	!SE<XXX>,<YYY>,<ZZZ>	<XXX>	Programmed kV setup value	kV
			<YYY>	Programmed mA setup value	mA/10
			<ZZZ>	Programmed time setup value	s
#kV<XXX>	Program new kV value	!kV<YYY>,<E>,<AAAA>	<XXX>	Requested new kV setup value	kV
			<YYY>	Programmed kV setup value	kV
			<E>	Error code: 0: no error (<YYY>=<XXX>) 1: no generator connected 2: generator rental date is over 3: requested kV value is below min kV 4: requested kV value is above max kV 5: kV ok but mA has to be adjusted 6 : preheat is required to shoot at this kV value	N.A.
			<AAAA>	Argument depending of <E>: If <E> = 0,1,2 → 0 If <E> = 3 → min kV value for this generator If <E> = 4 → max kV value for this generator If <E> = 5 → adjusted mA value If <E> = 6 → required preheat time	N.A. kV kV mA s
#MA<XXX>	Program new mA value	!MA<YYY>,<E>,<AAA>	<XXX>	Requested new mA setup value	mA
			<YYY>	Programmed mA setup value	mA
			<E>	0: no error 1: no generator connected 2: generator rental date is over 3: requested mA value is below min mA 4: requested mA value is above max mA 5: preheat required – mA set automatically	N.A.
			<AAA>	If <E>=0,1,2,5 → 0 If <E> = 3 → min mA value If <E> = 4 → max mA value	N.A. mA mA

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Command description			Fields description		
Command syntax	Description	Reply from PowerBox	Field name	Description	units
#TP<XXXX>	Program new exposure time value	!TP<YYYY>,<E>,<AAAA>	<XXXX>	Requested exposure time value	s
			<YYYY>	Programmed exposure time value	
			<E>	0 : no error 1 : no generator connected 2 : generator rental date is over 3 shot is in progress 4: requested value is below min TP value 5: requested value is above max TP value 6: requested TP is bigger than remaining rental time 7: preheat is required – TP is set automatically	N.A.
			<AAAA>	If <E> = 0,1,2,3,6 → 0 If <E> = 4 → min TP value for generator If <E> = 5 → max TP value for generator	N.A. s s
#ON	Start shot	!ON	N.A.	N.A.	N.A.
#OF	Stop shot	!OF	N.A.	N.A.	N.A.
#XO	Watchdog	!XO	N.A.	N.A.	N.A.
?TS	Ask for the shot type	!TS<X>	<X>	0: None (no shot actually) 1: Preheating 2: Normal shot 3: Cycles 4: Conditioning	N.A.
?SN	Ask for the serial numbers of generator and PowerBox	!SN<XXXXXXXX>,<YYYYYY YY>	<XXXXXXXX>	Serial number of generator	N.A.
			<YYYYYYYY>	Serial number of PowerBox	N.A.
?MD	Ask for the generator model	!MD<XXXXXXXX>	<XXXXXXXX>	Generator model	N.A.

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Command description			Fields description		
Command syntax	Description	Reply from PowerBox	Field name	Description	units
?ST	Retrieve current status of PowerBox/Generator	!ST<WW>,<XXXX>,<Y>,<ZZZ>...	<WW>	Status code: 0: Connecting 1: No generator 2: Ready to start 3: Error state 4: Preheating required 5: Reserved for future use 6: Prewarning in progress 7: Ramp in progress 8: Shot in progress 9: End of shot 10: Wait in progress (between cycles) 11: Shot restart? 12: Prompt message	N.A.
			<XXXX>	Remaining time (prewarning, shot, wait)	s
			<Y>	Number of errors	N.A.
			<ZZZ>	Error codes, separated by commas	N.A.
?RC	Ask the rating chart	!RC<AAA>,<BBB>,<CCC>,<DDD>,<EEE>,<FFF>,<GGGG>	<AAA>	Min mA	mA/10
			<BBB>	Max mA	mA/10
			<CCC>	kV min	kV
			<DDD>	kV max	kV
			<EEE>	kV min @ mA max	kV
			<FFF>	mA max @ kV min	mA/10
			<GGGG>	Power max	W



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10. RECYCLING

Recycling of Electrical and electronic equipment waste.

TELEDYNE ICM confirms comply with European regulations and fulfil the obligations under Directive 2012/19 / EU on waste electrical and electronic equipment.

TELEDYNE ICM supports the recycling of its products when they are end of life. The cost of collection is not included in the standard package.

Customers can return the concerned products to TELEDYNE ICM or to TELEDYNE ICM's authorized distributor.

TELEDYNE ICM specifies that substances such as lead (Pb), see Annex IV of Directive 2011/65 / EU related to the restriction of the use of certain hazardous substances in electrical and electronic equipment and beryllium (Be) are parts of its equipment.

TELEDYNE ICM specifies that X-ray generators contain pressurized gas, such as Sulphur hexafluoride (SF6).



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