

GLOSSARY

X-ray tube Vacuum tube that converts electrical input into X-rays and are used in the variety of applications. In general those applications are divided in „continuous“ and „cyclic“ operation.

Continuous operation is characterized by a number of ON/OFF cycles **per day of maximum 15 times** whereas **cyclic operations** means more than **15 cycles ON/OFF per day**. In general, tubes for industrial x-ray applications are designed for continuous operation. In case of continuous operation the power rating of HP tubes as specified in the documentation can be applied.

Cyclic operation represents much higher thermal-mechanical load for the tube therefore the power rating of the HP tubes has to be reduced.

HV cable High Voltage cable that connects HV generator with the X-ray tube. While choosing the cable it is necessary to specify: terminal on the tube side, terminal on the generator side, the length of the cable and the angle of the cable respective to the axis of the tube and the generator. In addition, cable can be chosen to be spring loaded (recommended) or non-spring loaded.

The length of the cable has to be chosen in a proper way. Cable should not be exposed to any mechanical stress (no pulling, torque or shearing forces), which can influence the electrical cable properties. Therefore, it is advised, that the cable is loosely adapted with maintaining recommended bending radiuses.

In addition, the maximum voltage rating is also adapted to the cable length – longer the cable - lower the HV cable rating (refer to the table below).

Reduction of the HV at longer cable lengths is a measure to reduce the stored energy in the cable (capacitance), which can damage equipment in case of arcing.

Maximum voltage rating in kV						
STANDARD LENGTH	Cable length	XRS-100	XRS-160	XRS-225	XRS-320	XRS-450
	5m	100	160	225	320	450
	10m	100	160	225	320	450
	15m	100	160	225	320	450
	20m	100	160	220	315	440
	25m	100	160	210	310	420
	30m	95	155	200	310	400
	35m	95	155	200	310	400

Cooler/Chiller Cooler is a device allowing for the passive exchange of the heat. In case of chiller, there is active cooling of cooling medium. There are following types of the coolers/chillers available:

WA – stands for Water-Air Cooler. The water is circulating in the cooling system and it flows through radiator that radiates (with the help of fan) away the heat to the atmosphere.

WW – stands for Water-Water Cooler. In this case, the building water is needed. The water is circulating between the cooler and the tube and the heat is given away by the radiator to the second circuit – the building water. The clear advantage of this solution is the lack of noise created by the fan that is present in the WA solution.

OA – stands for Oil-Air solution. It functions the same way as WA solution with the difference of circulating oil instead of water.

OW – stands for Oil-Water solution. It functions the same way as WW with the difference of circulating Oil instead of water in the cooling system of the tube.

It is recommended that the chiller is chosen when the ambient air should not be heated up or the ambient conditions are very dusty, so that it would clog the radiator. Also, the chiller is recommended when the ambient temperature is high so the cooling capacity is limited.

Please note: Drop of pressure approx. 1bar per 10m height difference!
Therefore the maximum length of cooling hoses is reduced, if there is a height difference between cooler and tube. For details ask your local partner.

HV generator In order to properly choose the generator type, the high voltage level and power has to be selected. Generator is a modular, flexible device that can be configured towards the customer needs, both from the hardware as well as software perspective.

SOFTWARE

In case of software, the generator can be delivered with the default configuration (factory configuration) but configuration can be also customized (custom configuration). The following areas of the software can be configured: warning lights, inputs, dynamic monitoring, outputs.

- **Warning lights**
 There are three externally (electrically) monitored warning lights in the iVario generator. They can be configured as “steady” state or as a “blinking” state. The lights can be configured to display one or several states as listed (see respective table).
 By default, only the first warning light is configured as the “active in HV-ON state” as blinking. Current thresholds – low and high are set to be 40 mA and 40 mA, respectively.
Current threshold Low: the current will be measured 120ms after the lamp was turned off and must then be below this level. If it stays above this level a warning light error will be generated.
Current threshold High: the current will be measured 120ms after the lamp was turned on and must then be above this level. If it stays below that level a warning light error will be generated.

- **Pre-warning time**
 While configuring the lights in different states, it is also necessary to set the Prewarning state time: the time before the HVPS ramps up voltage and current. There are two pre-warning times: normal and long pre-warning time. The long pre-warning time is usually exercised in the situation when the Customer Interlock 1 or 2 has been cycled (typically when a side door or a door allowing personal to access inside the x-ray cabinet was opened).
 The normal prewarning time is exercised in the situation of normal operation (the main door of the cabinet was opened, or no door just X-ray off).
 The prewarning time values can be set the following way:.

Time Length	Possible Values
1 to 10s	1,2,3,...,10
10 to 20s	10, 12, 14,...,20
30s	30
60s	60

- **Inputs signals**
 There are few input signals that are present in the hardware interface: HV Enable button, Stop button, Interlocks 1&2 and Messages 1&2.

 HV Enable Button: In the default configuration it will be “HV Enable button”: therefore clearance of the module for switching ON the high voltage, after closing the interlocks. Switching ON the high voltage occurs then by sending the HV ON command at the software interface.
 In the Customer configuration the following functions will be configured: HV Enable/Start Button is not required, does not need to be cycled for the clearance of the module. As soon as the interlocks are closed, the generator can be switched ON by sending the HV ON command at the software interface.
 There are also Interlocks 1&2 which are signals of locking contact or an additional locking device that is communicated to the module. This has a function of message, not a safety function.

 Message 1&2, where every change in the state of the input contact is entered in the LOG file of the Interface Controller (IFC) with a time stamp and its state. No influence on the Ready X-ray on function.

- **Dynamic monitoring**
 Dynamic Monitoring shall be used to monitor external warning devices.
 The input contact is monitored during one or a combination of several working states configured in the software.
 Through configuration, the contact can be monitored either on opened or closed state. This allows for instance the connection of several lights either in series or in parallel. Also the monitoring contact of a guard-locking switch can be checked; in this case, select “Active in HV-ON State”. If the contact is not in the correct state during the active monitoring phase,

the x-ray generator will switch OFF with the corresponding error code.
Monitoring occurs during the ON state of the warning lights.

- **Outputs**

These outputs can indicate various pre-set states (or combination of states) of the machine as listed in the table. The output can be blinking or steady.

The outputs are not performing safety function. The signals are processed by non-safety-certified software.

For clarity the descriptions of the following states are provided:

- NOT READY state
- SAFETY READY: interlocks are closed, cooler check is OK. This signalisation stays valid also during READY, PREWARN and HV ON
- READY state: start button was cycled (closed-opened), Mains is ON, the x-ray generator is ready to switch ON. This signalization stays valid also during PREWARN and HV ON
- PREWARN state: pre-warning time BEFORE the HVPS ramps up volt-age and current
- HV ON state: high voltage is ON or still present at the output
- IMMINENT state: MAINS power is ON

The default configuration is indicated in the checklist; but customer configuration is also possible.

GENERATOR SETTINGS

As you might have seen in the Checklist, for the software it is possible to choose the “Factory Configuration” or “Custom Configuration”. If the “Custom Configuration” is chosen, means specific settings have to be provided. In case the “Factory Configuration” is being chosen, the generator will be delivered with the following settings:

Warning Lights

S – Steady; B - Blinking

Function	Warning Lamp 1	Warning Lamp 2	Warning Lamp 3
Enable (Warning Light Connected)	✓	not used	not used
Active in Not Ready state	not used		
Active in Safety Ready state	not used		
Active in Ready state	not used		
Active in Prewarn state	not used		
Active in HV-ON state	✓ B		
Active when Imminent (Mains on)	not used		
Current threshold Low (off state) [mA]	40		
Current threshold High (on state) [mA]	40		

Pre-warning time

Function	Value
Pre-warning time	2 s
Pre-warning time long*	10 s

Dynamic Monitoring HV Enable / Start button

Disabled

Enabled

Outputs

Function	Output 1	Output 2	Output 3	Output 4
Enable	✓	✓	✓	✓

S- Steady; B – Blinking (when choosing the state, please circle the type as well)

Active in Ready state	✓ S			
Active in Prewarn state		✓ S		
Active in HV-ON state			✓ S	✓ S
Imminent	not used	not used	not used	not used

Additional Hardware

In case of the generator configuration, apart from the Voltage and power that needs to be selected in the purchasing process, there is also number of hardware add-ons that can complete the system configuration. Here are listed and described the options that complete the installation.

- **IP54 Cover**
An optional cover can be placed on the power supply to improve the protection level against dust and water of the enclosures to the level of IP54. The cover contains the filters with fast and easy installation solution that can be easily replaced. Cover is also recommended for the use with the I/O Terminal as an electrical connection
- **Controller**
The control of the iVario generator can be realized in three different ways. One of the ways is 19`` external controller, which communication is based on the newly developed Ethernet Protocol. The controller comprises touchscreen panel, key switch, buttons and lamps as well as rotary knob such as presented on the figure. In addition, there can be emergency stop incorporated into the Controller.
- **Cooler Interface**
Cooler interface is necessary in the situation when iVario generator is working with the former type of the COMET cooler. It includes connector for the Canon plug on one side (connection for the former cooler) and two cables that are connection for the new type of cooler on the other side: one for the power supply and the second one for the control (connection to the generator). It also includes relay that after the certain time switches off the cooler if not used.
- **External Safety box**
iVario External Safety was developed with intention to provide support in integration of the functional safety necessary for operation of the industrial X-ray modules. It can be chosen to be delivered in factory configuration, or, alternatively it can be preconfigured in the factory (customer configuration).

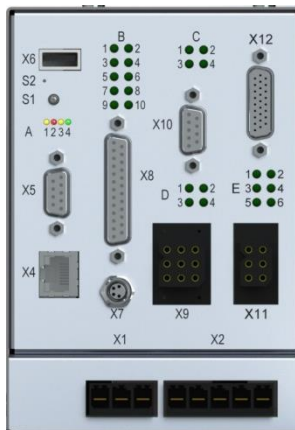
Factory Configuration	
Line Input (Phases)	3 Ps+N
iVario Controller	No
External key switch	Not enabled
Customer interlock1	Connected to 24V
Customer interlock2	Connected to 24V
Stop button	Connected to 24V
External E-mcy stop	Enabled

Protocols There are two different communication protocols available for the communication with the generator. One of them is for the Serial (RS 232) interface in order to assure backwards compatibility to the previous generation equipment. The new architecture protocol, fully developed in house, is Ethernet Based Protocol. It is recommended for the new installations, as the one that allows using the full potential of the new iVario generator.

Starter kit Starter kit includes different accessories that are helpful for the first installations.

Starter Kit content:

- X12: Dummy plug – Emergency stop D-sub 26-P
- X11: Dummy plug – Safety Interlock & Pin
- X10: Cable for warning lights D-sub 9-P, 9m + D-sub to Terminal block interface
- X8: Cable for input/output signals D-sub 25-P, 9m + D-sub to Terminal block interface
- Earth cable 10mm², 10m
- Ethernet Cable 10m
- Warning Light Red 24 V
- Ethernet adapter



	Plug	With cable	Scope of delivery
X1	Power supply (230 VAC) for Control Circuit	No	Delivered with generator or iXRS
X2	Power Supply (230 VAC) for Power Circuit	No	Delivered with generator or iXRS
X4	RJ45 – Ethernet Communication Interface	Yes	Starter Kit
X5	D9, RS-232 communication interface	Yes	Ordered separately (see section: Options)
X6	USB interface for data transfer	-	-
X8	D25, inputs and outputs	Yes	Starter kit
X9	9PIN plug for cooling system control	Yes (iXRS) No(separate cooler or iVario)	Delivered when iVario ordered alone Ordered separately for own cooler (see options) when iXRS is ordered Delivered with the COMET cooler (if cooler ordered separately)
X10	D9, Connection for 24V warning lamps with monitor	Yes	Starter kit
X11	6PIN, Safety Interlock (dummy plug)	No need	Starter kit, can be also ordered separately (see options)
X12	D26HD, control panel plug or emergency stop jumper (dummy plug)	No need	Starter kit, can be also ordered separately (see options)