

ICX-1153 Three-field Ionization Chamber
Technical Manual
for
The 61154 Pre-Amplifier Board Assemblies

INTENDED USE:

A Varex Ionization Chamber is a device that is placed between the patient and an x-ray image receptor to assist the Automatic Exposure Control (AEC) in delivering the proper x-ray dose in medical radiography.

An Ionization Chamber's function is to give an output signal proportional to the amount of radiation that is transmitted through the subject to the image receptor and to provide the output signal in a compatible form to the Automatic Exposure Control (AEC) circuitry of an x-ray generator/control.

General Ionization Chamber Technical Data	
Specification	Description
Minimum Response Time	Less than 1ms.
Output Sensitivity (Gain Range)	Adjustable from 0.046V/ μ Gy to 0.91V/ μ Gy @76kV. Additional output sensitivities available upon request.
Ionization Chamber Potential	+75VDC +10V (internally generated).
Output Reproducibility	Less than ± 0.045 Coefficient of Variation.
Output	Linear ramp with no more than $\pm 5\%$ deflection in full output scale.
Field Matching	Outputs of multi-field chambers are individually adjustable to within 5% of one another.
X-ray % Transmission	No less than 85% from 50kV to 150kV with 2.5mm to 3.0mm total aluminum equivalent beam filtration from the x-ray tube and collimator.
Aluminium Equivalence	Maximum value of attenuation for the ionization chamber of 0.57mm Aluminium at 50kVp with a radiation quality with a first HVL of 2.72mm of Aluminium.
Internal Structure Imaging	Images caused by internal structures will result in gray scale variation no greater than that of 0.2mm Aluminum equivalent for exposures at 50kV, 2.5mm to 4.0mm aluminum equivalent beam filtration within a radius of 2.5mm area.
Power Supply Requirement	± 11.4 VDC to ± 15.75 VDC @ 0.1A unless specified otherwise.
Operating Temperature	+10°C to +40°C
Operating Humidity	10% to 60% relative humidity non-condensing
Operating Atmospheric Pressure	860hPA to 1060hPA
Transport and Storage Temperature Range	-40°C to +70°C
Transport and Storage Humidity Range	10% to 95% relative humidity non-condensing
Transport and Storage Atmospheric pressure	860hPA to 1060hPA
Cable Connection	Shielded 24AWG cable. Standard cable length is 45 feet (13.7 meters).

WARNING:

The ionization chamber is allowed to be modified by Varex Imaging Americas Corporation only.

Only properly trained and qualified personnel should conduct the initial installation, calibration, or be permitted access any internal parts.

The ionization chamber may be isolated from the mains by shutting off the Automatic Exposure Control. (See the manual for the x-ray system)

The following adjustments apply to the calibration of a 61154A pre-amplifier board for a stationary 3-field ionization chamber, e.g. for chest or table use. (Also valid for 61154B, 61154C, 61154G, 61154J, 61154L, 61154N, 61154S, 61154T and 61154Y)

Pre-amp Assembly	Description	Difference from 61154A
61154A	Calculated Gain Range = 1.0 to 21.0	None
61154B	Calculated Gain Range = 1.46 to 37.8	R24 = 560 ohm, R31 = 820 ohm Low-Profile Side-Turn Pots
61154C	Calculated Gain Range = 1.47 to 34.8	R24 = 1500 ohm, R31 = 2200 ohm R4 = 50K ohm
61154G	Calculated Gain Range = 1.22 to 29.0	R1, R2, R3, R4 = 50K ohm R24 = 1800 ohm, R31 = 2200 ohm
61154J	Calculated Gain Range = 1.47 to 34.8	R24 = 1500 ohm, R31 = 2200 ohm R4 = 50K ohm, Side-Turn Pots
61154L	Calculated Gain Range = 0.83 to 11.94	R24 = 1800 ohm, R31 = 1500 ohm Side-Turn Pots
61154N	Calculated Gain Range = 2.2 to 52.2	R31 = 2200 ohm R4 = 50K ohm
61154S	Calculated Gain Range = 2.68 to 63.7	R 4 = 50K ohm, R24 = 820 ohm R31 = 2200 ohm, Top-Turn Pots
61154T	Calculated Gain Range = 2.68 to 63.7	R 4 = 50K ohm, R24 = 820 ohm R31 = 2200 ohm, Side-Turn Pots
61154Y	Calculated Gain Range = 1.69 to 40.2	R 4 = 50K ohm, R24 = 1300 ohm R31 = 2200 ohm C1, C4, C7 = 470 pF

WARNING:

- Failure to heed this warning may result in injury to the service provider, operator or patient from electric shock and mechanical or other hazards.

Note: When working with the pre-amplifier assembly it is important that electrostatic discharge (ESD) prevention techniques be observed. Before touching the pre-amp assembly, attach an ESD wrist strap to yourself. Be sure to ground yourself and the ionization chamber frame to dissipate static charges.

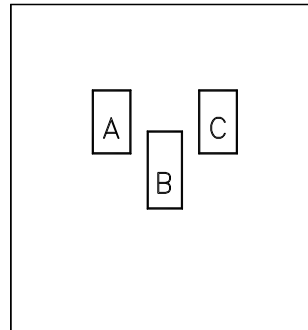
Note: The pre-amp assembly is a very delicate and sensitive device. It is important to keep it as clean as possible. Wash and dry your hands thoroughly before working with it and, when possible, use unpowdered latex or cotton gloves. Take care to touch the pre-amp board as little as possible. Take extra care to avoid touching the three air-mounted field inputs. Oils from your fingers on the air-mounts or their components can cause performance degradation.

The 61154A pre-amplifier board can be configured to operate with several different AEC systems. If specified at the time of purchase, the ionization chamber will be delivered with the pre-amplifier board already configured for a particular application. To reconfigure an ionization chamber for a different configuration, see the section on Ionization Chamber Inputs and Output and the section on Specific Configurations at the end of this document.

The procedure assumes that the installation of the Automatic Exposure Control (AEC) is complete and that the AEC and x-ray generator are in proper working condition. After making the necessary interconnections between the ionization chamber and the AEC, power up the system.

This document represents proprietary information originated by Varex Imaging Americas Corp. and which shall not be disclosed or utilized in any manner detrimental to the company's business.

This document describes the calibration of standard "V" pattern ionization chambers commonly used in medical radiographic equipment, with sensing fields located at the lung and center (spine) positions. The operator selects the field(s) desired, and positions the anatomy of interest in front of the selected field(s).

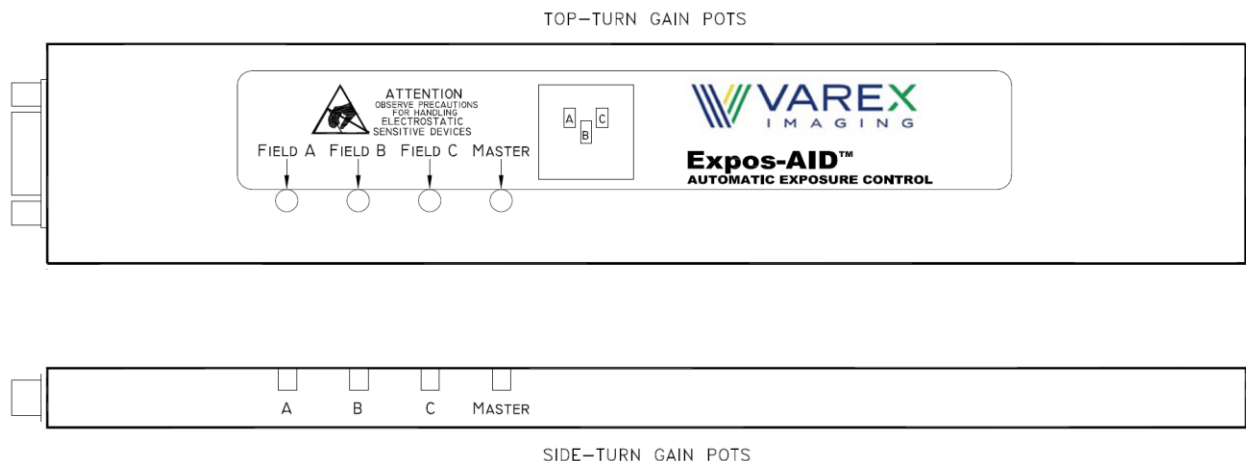


"V" pattern

Calibration/Test Set Up:

Select the center field of the ionization chamber. Set the generator for 100 kVp and maximum backup time. For 100 kVp use 8 to 10 inches (20 to 25 cm) of water or plastic for a phantom. Metals such as copper, aluminum or lead are not suitable for use as phantoms. Make sure the phantom is homogeneous and completely covers all fields equally. Center the x-ray beam on the center field. Collimate the x-ray beam so that it completely covers all three fields but does not extend beyond the limits of the phantom.

Adjustment Potentiometers:



All necessary adjustment potentiometers are accessible through the pre-amp chassis cover. There is no need to open the pre-amp cover during normal calibration procedures.



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Master Gain Adjustment:

Typically, the master gain adjustment is the only adjustment needed when installing ICX series ionization chambers. Use the master gain adjustment to match the overall chamber sensitivity to that of the other stationary chambers connected to the system. Note that the master gain adjustment is a multi-turn potentiometer. A clockwise adjustment to the master gain potentiometer will increase the sensitivity of the chamber, causing the length of the exposure (mAs) to decrease. Make exposures and process the films. Adjust the master gain for the desired optical density. Make the master gain adjustment for each stationary chamber being installed.

Field Balance Check:

Using the AEC post-exposure mAs display or other calibrated mAs meter check the individual fields to see that they are balanced, that is, that they produce the same mAs reading. If mAs readings are not stable from exposure to exposure for an individual field, then it will be necessary to expose films and make these adjustments based upon optical density.

If necessary, adjust the individual gain potentiometers to balance the outputs to give the same mAs reading for each field selected individually. Note that individual gain adjustments are multi-turn potentiometers. A clockwise adjustment to a field gain potentiometer will increase the sensitivity of that field, causing the length of the exposure (mAs) to decrease.

Offset Adjustment:

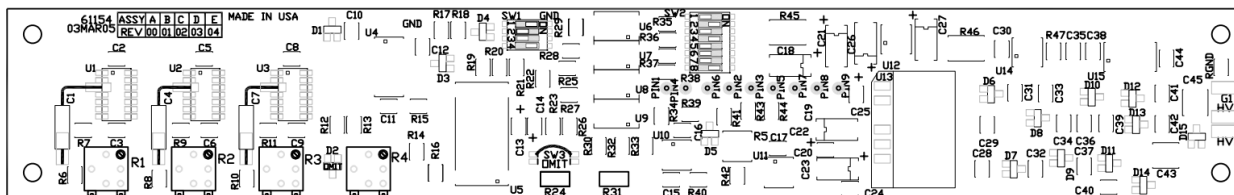
Monitor the output of each field (pin 5 of the 9-pin Sub-D connector) with a DVM and find the field with the median value. Select the field with median value and adjust the offset pot to obtain $0 \pm 10\text{mVdc}$ at the output (pin 5 of the 9-pin Sub-D connector).

Ionization Chamber Pin-outs:

61154A Pre-amp Board Pin-out	Function	9-Pin Sub-D Pin-Out
1	NONE	1
2	FIELD 2 SELECT	2
3	FIELD 1 SELECT	3
4	RESET	4
5	OUTPUT	5
6	FIELD 3 SELECT	6
7	NEGATIVE SUPPLY	7
8	POSITIVE SUPPLY	8
9	GROUND	9

Acceptable Power Supply Ranges for 61154A Pre-amp:

Supply Voltage	Measurement Point	Acceptable Range
External +12VDC	61154A pin 8 (referenced to 61154A pin 9)	+11.4VDC to +15.8VDC
External -12VDC	61154A pin 7 (referenced to 61154A pin 9)	-11.4VDC to -15.8VDC
Internal +12VDC	Measure across 61154A C23	+10.8VDC to +12.5VDC
Internal -12VDC	Measure across 61154A C22	-10.8VDC to -12.5VDC
Internal +5VDC	Measure across 61154A C17	+4.7VDC to +5.3VDC
Internal +75VDC	Measure across 61154A C45 (HV1 to G1)	+65.0VDC to +85.0VDC



Pre-amplifier PCB

Ionization Chamber Inputs and Output:

Signal	Switch	Comments
Positive Supply +12VDC	None	+11.4VDC to +15.75VDC less than 85 mA.
Negative Supply -12VDC	None	-11.4VDC to -15.75VDC less than 85 mA.
Low-Active Commands Reset & Field Selects	SW1-3 OFF SW1-4 ON	Pulling the Reset line to ground (≤ 6 VDC) beginning at exposure start and lasting for the entire duration of the exposure allows the integrator to operate. Pulling the field select lines to ground (≤ 6 VDC) will select the field.
High-Active Commands Reset & Field Selects	SW1-3 ON SW1-4 OFF	Driving the Reset line high (≥ 8 VDC) beginning at exposure start and lasting for the entire duration of the exposure allows the integrator to operate. Driving the field select lines high (≥ 8 VDC) will select the field.
Field Configuration A=1, B=2, C=3	SW2-1,5 & 8: ON SW2-2,3,4, 6 & 7: OFF	Field selects 1, 2 and 3 select left (A), center (B) and right (C), respectively, as viewed from the x-ray tube-side of the ionization chamber.
Field Configuration A=2, B=1, C=3	SW2-2,4 & 8: ON SW2-1,3,5, 6 & 7: OFF	Field selects 2, 1 and 3 select left (A), center (B) and right (C), respectively, as viewed from the x-ray tube-side of the ionization chamber.
Field Configuration A=3, B=1, C=2	SW2-3,4 & 7: ON SW2-1,2,5, 6 & 8: OFF	Field selects 3, 1 and 2 select left (A), center (B) and right (C), respectively, as viewed from the x-ray tube-side of the ionization chamber.
Field Configuration A=3, B=2, C=1	SW2-3,5 & 6: ON SW2-1,2,4, 7 & 8: OFF	Field selects 3, 2 and 1 select left (A), center (B) and right (C), respectively, as viewed from the x-ray tube-side of the ionization chamber.
Positive Output	None	Time integrated signal ramping from 0VDC to a maximum of at least 80% of the supply voltage (+9.6VDC for +12VDC supply). The slope of this signal is directly proportional to the amount of x-ray flux received.

Power Supply Isolation:

Signal	Switch	Comments
Power Supply Isolation Defeated	SW1-1 ON	Connects external ground (61154A Pin-9) to pre-amp chassis and ionization chamber frame. Default Setting.
Power Supply Isolation Enabled	SW1-1 OFF	Separates external ground (61154A Pin-9) from pre-amp chassis and ionization chamber frame to prevent ground loop.

Specific Configurations:

Unless specified otherwise, ICX ionization chambers are delivered with an Expos-AID™ compatible jumper configuration. Expos-AID™ compatible means that the input and output signals will interface with Varex's Expos-AID™ Automatic Exposure Control. This same configuration will also interface with Acoma, Control-X, CPI, Del Medical (Gendex), DR GEM, Electromed (EMD, Triton), OEC, Quantum Medical Imaging, Sedecal (Innerscan), Summit Industries, etc.

Varex (Expos-AID™) Compatible jumper configuration:

Function	Switch Setting
Defeat: Power Supply Isolation	SW1-1 ON
Enable: Alternate Field Selection	SW1-2 OFF
Low-Active Commands: Start Integrate & Field Selects	SW1-3 OFF SW1-4 ON
Field Configuration: A=2, B=1, C=3	SW2-2,4 & 8 ON SW2-1,3,5, 6 & 7 OFF
Positive Output	None

Alternate configurations are listed below.

GE, Fischer, Varian Compatible jumper configuration:

Function	Switch Setting
Defeat: Power Supply Isolation	SW1-1 ON
Enable: Alternate Field Selection	SW1-2 OFF
High-Active Commands: Start Integrate & Field Selects	SW1-3 ON SW1-4 OFF
Field Configuration: A=1, B=2, C=3	SW2-1,5 & 8 ON SW2-2,3,4, 6 & 7 OFF
Positive Output	None

GTR Labs Compatible jumper configuration:

Function	Switch Setting
Defeat: Power Supply Isolation	SW1-1 ON
Enable: Alternate Field Selection	SW1-2 OFF
Low-Active Commands: Start Integrate & Field Selects	SW1-3 OFF SW1-4 ON
Field Configuration A=3, B=1, C=2 (= GTR Labs fields 1-2-3)	SW2-3,4 & 7 ON SW2-1,2,5, 6 & 8 OFF
Positive Output	None

Trex Medical - Continental, Keithley, Ratheon, Xonics Compatible jumper configuration:

Function	Switch Setting
Defeat: Power Supply Isolation	SW1-1 ON
Enable: Alternate Field Selection	SW1-2 OFF
Low-Active Commands: Start Integrate & Field Selects	SW1-3 OFF SW1-4 ON
Field Configuration: A=1, B=2, C=3	SW2-1,5 & 8 ON SW2-2,3,4, 6 & 7 OFF
Positive Output	None

Ren Inn Med/Philips Compatible jumper configuration:

Function	Switch Setting
Defeat: Power Supply Isolation	SW1-1 ON
Enable: Alternate Field Selection	SW1-2 OFF
High-Active Commands: Start Integrate & Field Selects	SW1-3 ON SW1-4 OFF
Field Configuration: A=2, B=1, C=3	SW2-2,4 & 8 ON SW2-1,3,5, 6 & 7 OFF
Positive Output	None

Remote Pre-amp Installation Procedure:

1. Install the ICX series ion chamber as required and route the remote pre-amp cables to the pre-amp chassis mounting location.
2. Remove the cover from the remote pre-amp chassis by removing the four (4) 4-40 X 3/16 screws.
3. Route the remote pre-amp cables through the strain relief in the remote pre-amp chassis and secure the strain relief using the two (2) 2-56 hex nuts. Refer to Figure 1.
4. Connect the shield ground of the remote pre-amp cable to the 4-40 stud on the remote pre-amp chassis using the 4-40 hex nut provided.
5. Note that the conductor wires from the ion chamber are marked with tags that match the mating wires inside the pre-amp assembly. Connect the wires as follows.

Tag	Remote Cable Wire Color	Pre-amp Assembly Wire Color	Description
A	White	White	Field A Output
B	Black	Black	Field B Output
C	Red	Red	Field C Output
HV	White Coaxial	Blue	Bias Voltage
GND	Coaxial Shield	Green	Bias Reference

6. Mount the remote pre-amp assembly as required. The pre-amp chassis offers four (4) 0.156-inch diameter mounting holes and two (2) 0.188-inch diameter mounting holes as shown in Figure 2. Optional mounting plate is also available upon request (refer to Figures 3 & 4)
7. Reinstall the cover to the remote pre-amp chassis using the four (4) 4-40 X 3/16 screws removed in Step 2.
8. Calibrate the pre-amp according to the calibration instructions in this document.

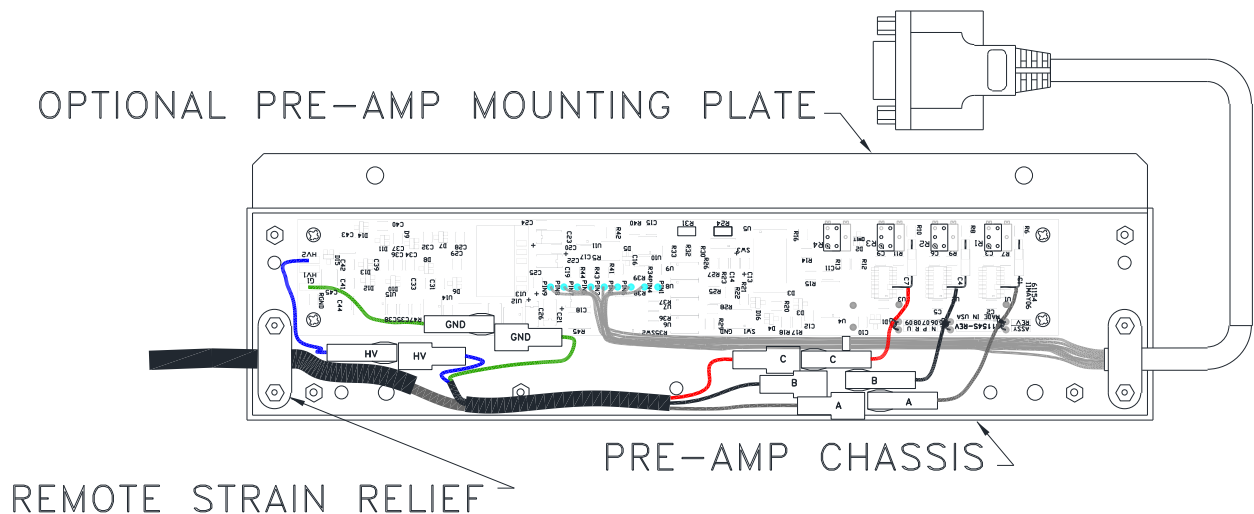


Figure 1: Step 3 - Location of remote strain relief

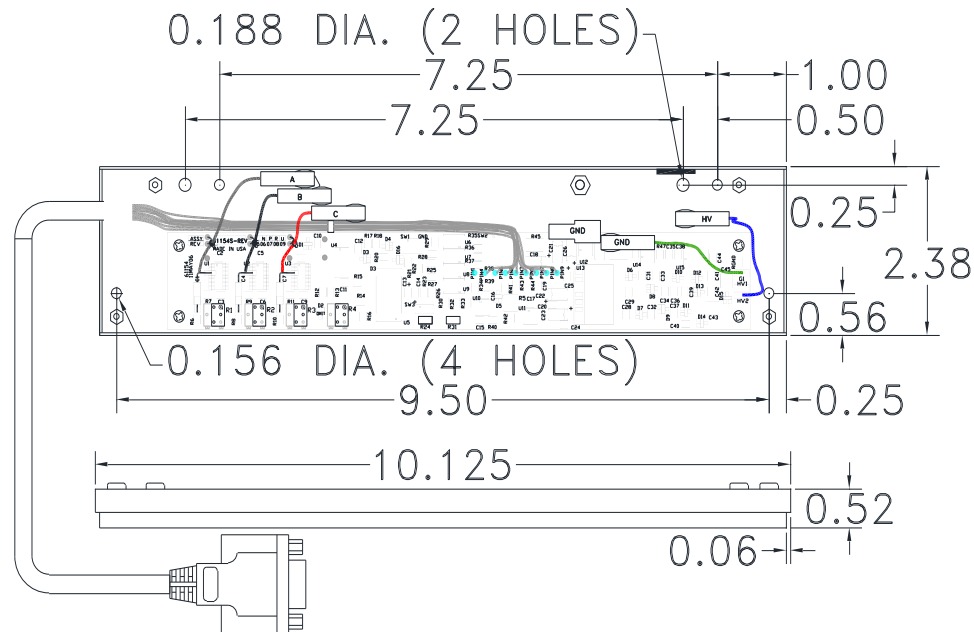


Figure 2: Step 6 - Location of mounting holes

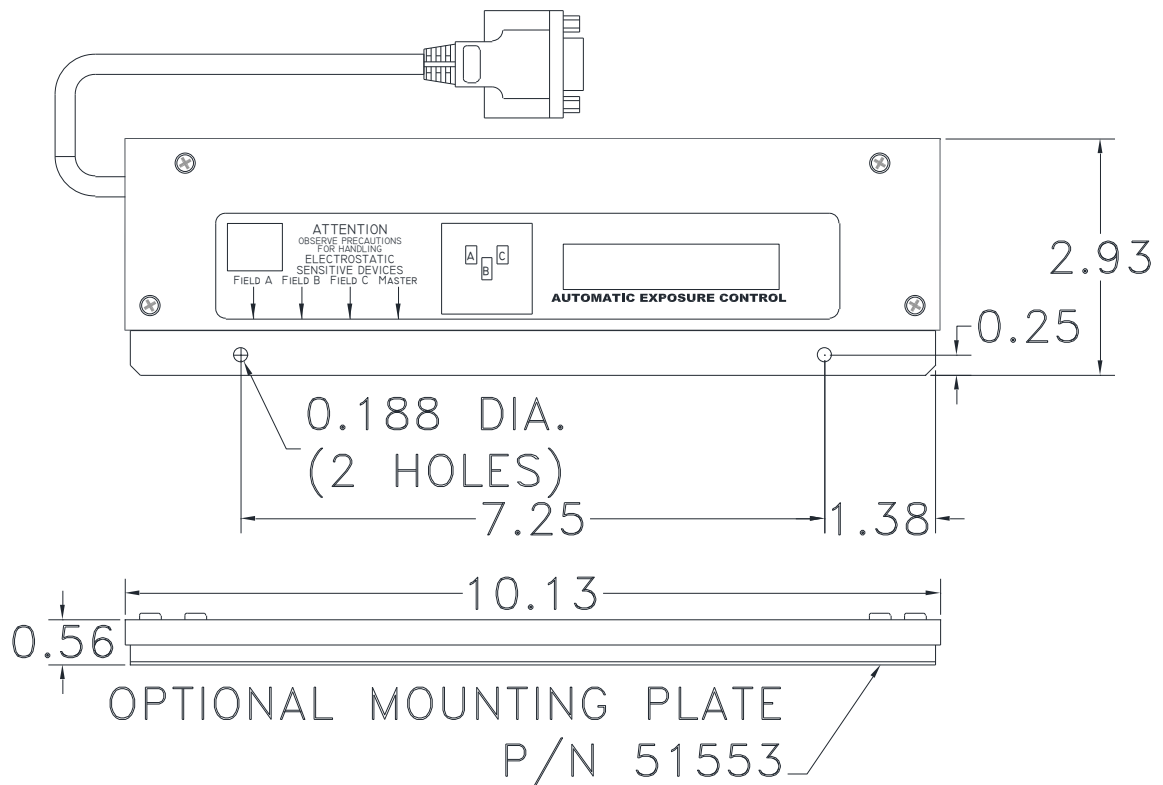


Figure 3: Mounting plate, P/N51553

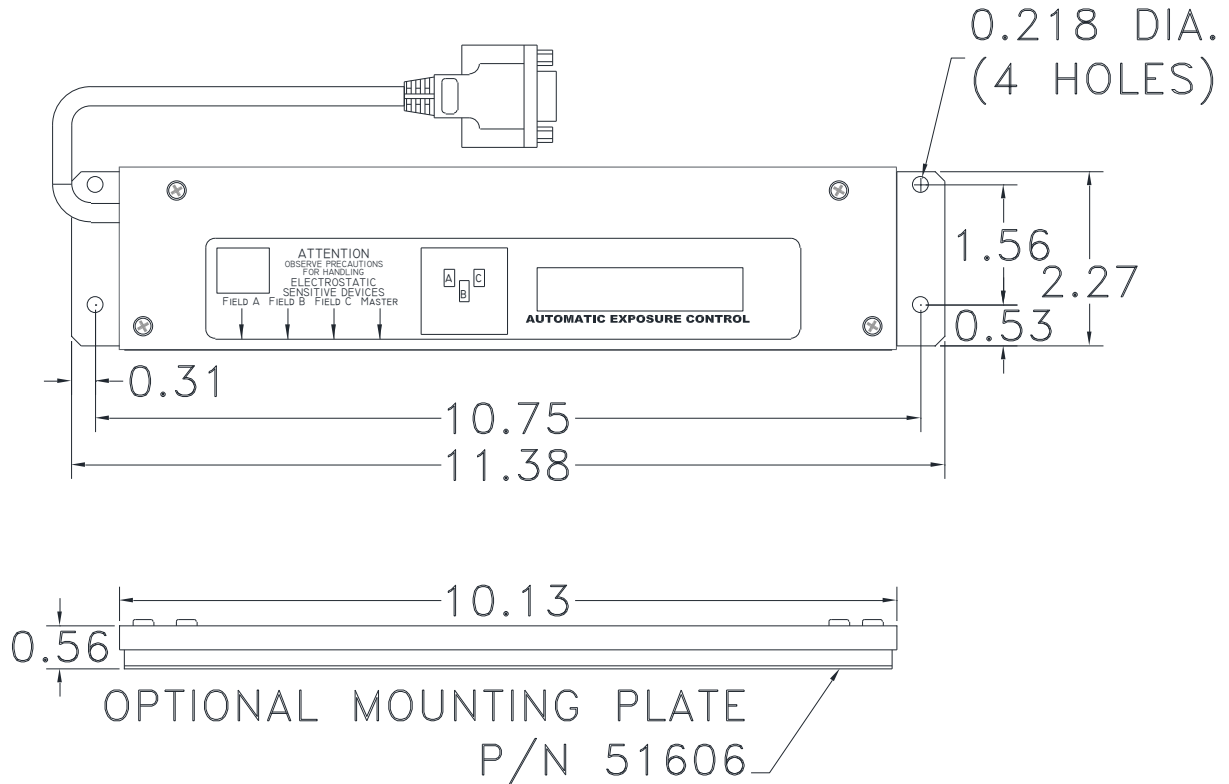


Figure 4: Mounting plate, P/N51606



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RETURN POLICY:

All material returns require a Return Authorization number (RA#). This number is obtained from the Service Department of Varex Imaging Americas Corp. (847) 279-5100, FAX (630) 271-9995 or americas.cnc@vareximaging.com

Please be prepared to supply the serial number, model number and as complete a description of the problem as possible.

Material being returned must be packaged to prevent damage during shipping (and we suggest that you insure the package). Mark the RA# on the outside of the package and ship the package, shipping prepaid to:

Varex Imaging Americas Corp.
3835 Carnation Street
Franklin Park, Illinois 60131, USA
Telephone (847) 279-5100 FAX (630) 271-9995

Material returned for credit must be in original condition with no damage and is subject to a 15% restocking fee or \$200.00 minimum. Material must be returned within sixty days of shipment from VAREX IMAGING AMERICAS, CORP.

WARRANTY RETURNS:

Warranty period:

New Ionization Chambers: Two years from date of shipment. See "Two Year Limited Warranty".

New Equipment: One year from date of shipment

Parts: 90 days from date of shipment.

Repairs: Balance of equipment warranty or 90 days, whichever is longer.

Equipment is defined as having a VCUS serial number label attached.

Parts are defined as individual components, cables or circuit boards.

Returned equipment found to have no problem is subject to a minimum labor charge.



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TWO YEAR LIMITED WARRANTY:

VAREX IMAGING AMERICAS, CORP. (VCUS) warrants new Ionization Chambers manufactured by VCUS to be free from defect in material and workmanship, for a period of two (2) years from the original date of shipment from VCUS.

If any defect in material or workmanship appears within the period of time specified above, the Purchaser shall notify VCUS immediately and VCUS shall thereupon correct the defect by repairing the defective part or product, or by supplying a replacement therefor at VCUS's expense, if VCUS finds the part or product was defective. Replacement or repair does not extend the warranty period beyond the original two (2) years warranty. At VCUS's sole discretion and direction, the defective part or product shall either be returned to VCUS for examination and repair with all transportation charges prepaid by the Purchaser or, at VCUS's discretion, the defective part or product shall be repaired or replaced in the field by a VCUS representative.

This warranty does not extend to any VCUS product which has been subject to misuse, neglect, accident, shipping damage, incorrect wiring by others, improper installation, or to use in violation of instructions furnished by VCUS, nor to products on which the serial number or identifying numbers or date code have been removed, defaced or changed, nor to accessories used therewith not of VCUS manufacture.

The conditions of any test to be made by the Purchaser shall be mutually agreed upon and VCUS shall be notified of, and may be represented at, all such tests. The liability of VCUS, except as to title, arising out of the supplying of said part or product, or its use, whether on warranties or otherwise, shall be limited to the correction of defects as aforesaid, and upon the expiration of the respective warranty periods all such liability shall terminate. In no event shall VCUS be liable for special or consequential damages.

Adjustments will not be allowed on returned parts or products, which meet VCUS inspection standards, nor on parts or products which were sold by VCUS more than two (2) years prior to return.

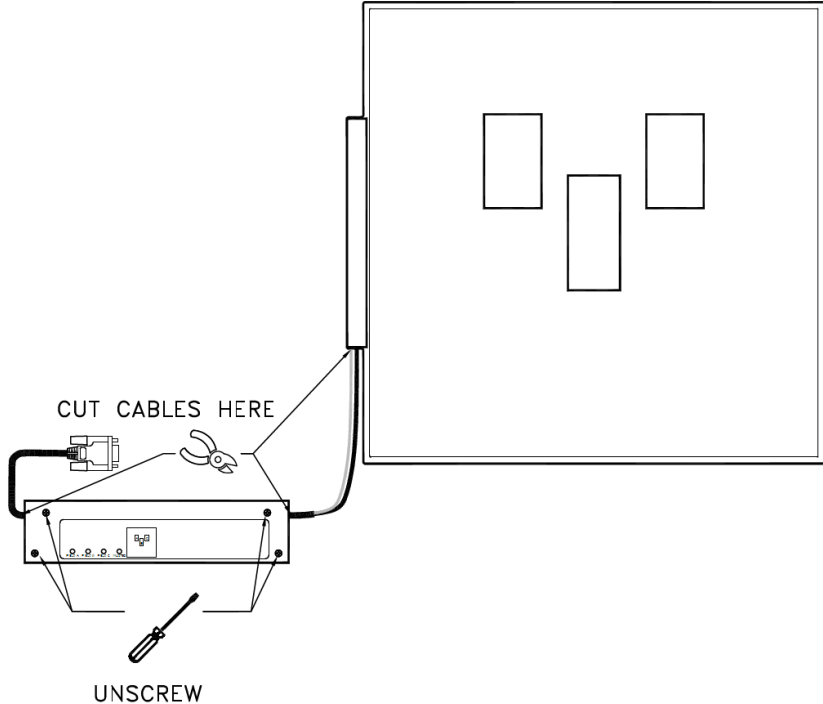
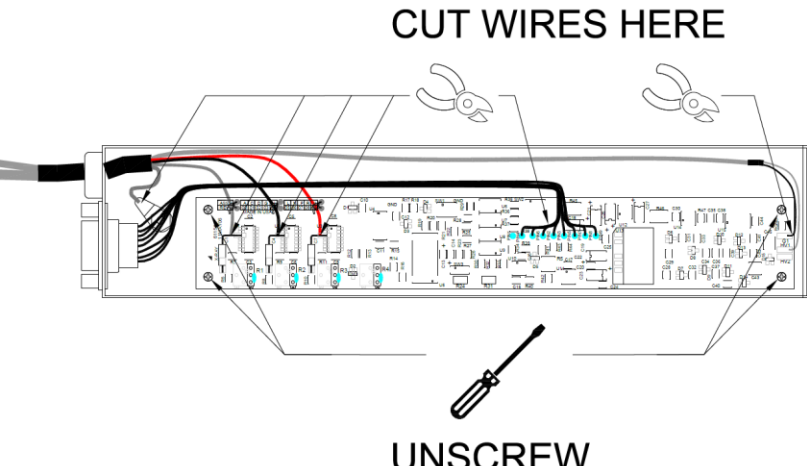
THERE ARE NO WARRANTIES WHICH EXTEND BEYOND THE WARRANTIES SET FORTH ABOVE, AND SUCH WARRANTIES SHALL CONSTITUTE THE SOLE AND EXCLUSIVE LIABILITY OF VCUS AND ARE IN LIEU OF ALL OTHER WARRANTIES, EXPRESS, IMPLIED OR STATUTORY, INCLUDING THE WARRANTY OF MERCHANTABILITY, OR FITNESS FOR PURPOSE, AND ALL OTHER OBLIGATIONS OR LIABILITIES, EITHER IN CONTRACT OR IN TORT, OF VCUS. VCUS NEITHER ASSUMES, NOR AUTHORIZES ANY REPRESENTATIVE OF VCUS OR ANY OTHER PERSON TO ASSUME FOR IT ANY OTHER OBLIGATION OR LIABILITY IN CONNECTION WITH THE SALE OF ITS PRODUCTS. THE FOREGOING SHALL CONSTITUTE THE SOLE REMEDY OF THE PURCHASER.

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DISMANTLING AND DISPOSAL INSTRUCTIONS:

Dismantling procedure:

There are no hazardous materials contained in the ionization chamber products. When handling the material, be careful of the metal corners and edges although they are free of burrs and sharp edges. See measures to be taken for cut cable locations.

Measures to be taken	Action
Detector dismantling 	- Make sure the device is disconnected. Detector dismantling* - Cut the connecting cable at the entry point of the detector - Dispose both parts according local regulations. *The image (Detector dismantling) shows an example of the remote pre-amp ionization chamber model. There may not be a cable between ionization chamber detector and pre-amp (e.g. attached preamp models).
Pre-amp dismantling 	Pre-amp dismantling - Remove the cover of the pre-amp housing - Remove the printed circuit board - Cut the connecting cable at the printed circuit board - Dispose the printed circuit board and the cable(s) according local regulations.



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Disposal instructions:

The ionization chamber should be recycled by following the local requirements for the disposal and/or the recycling of electrical medical equipment. Varex Imaging Americas Corporation will accept returns of its products labeled with the crossed out wheeled bin through our normal product return process. European Community customers should request a Return Authorization (RA) number by contacting americas.cnc@vareximaging.com. Shipping instructions will be provided along with RA number. Varex Imaging Americas Corporation will not accept shipments without a valid RA number. Please note that discarded products being returned for disposal have no cash value and no credit will be issued.



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Important information regarding Electro Magnetic Compatibility (EMC)

Applicable models: Varex Ionization Chambers models beginning with prefix "ICX" or "INX" hereafter referred to as Ionization Chambers.

The Ionization Chambers requires special precautions regarding EMC and needs to be installed and put into service according to the EMC information provided below.

Portable and mobile RF communication equipment can affect Ionization Chambers.

Medical devices should not be used adjacent to or stacked with other equipment. In case adjacent to or stacked use is necessary, the medical device should be observed to verify normal operation in the configuration in which it will be used.

Varex claims compliance with the requirements of 6.1 and 6.2 of EN 60601-1-2:2015 (IEC 60601-1-2:2014) when using an approved Varex cable (see Table) with a length of 85 feet or less with the added EMC kit containing two ferrites and a grounded P-clamp at the Ionization chamber side of the cable. The use of cables other than those specified may result in increased emissions or decreased immunity of the Ionization Chambers. It is a responsibility of the end-product user and/or installer to comply with the stated requirement in this document.

Failure to comply with the instruction may result in EMC incompatibility; therefore, it is a responsibility of the end-product user/or installer to verify compliance with requirements of EN 60601-1-2:2015 (IEC 60601-1-2:2014).

Approved Varex cable list:

705339-XX	75028-XX	75049-XX	75069-XX	75086-XX
705107-XX	75029-XX	75053-XX	75070-XX	75089-XX
75006-XX	75030-XX	75054-XX	75073-XX	75090-XX
75007-XX	75035-XX	75059-XX	75075-XX	75091-XX
75013-XX	75036-XX	75061-XX	75077-XX	75092-XX
75014-XX	75043-XX	75062-XX	75079-XX	75093-XX
75015-XX	75045-XX	75064-XX	75080-XX	75102-XX
75016-XX	75046-XX	75065-XX	75081-XX	75125-XX
75018-XX	75047-XX	75066-XX	75082-XX	
75020-XX	75048-XX	75067-XX	75084-XX	

Essential performance of an Ionization chamber is that an AEC exposure is not indicated during a no x-ray simulated exposure condition and that an AEC exposure is indicated during an actual x-ray exposure condition.

Guidance and manufacturer's declaration – electromagnetic emissions		
The Ionization Chambers are intended for use in the electromagnetic environment specified below. The customer or the user of the Ionization Chambers should assure that it is used in such an environment. The EUT is classified to be used in a professional healthcare facility. Relevant exclusions to this environment are the use of active HF surgery tools, use in shielded rooms for Magnetic Resonance Imaging and Fluoroscopy examinations. The expected behavior of the EUT is that these effects can influence the measured values or result in any other unexpected behavior.		
Emissions test	Compliance	Electromagnetic environment - guidance
RF emissions CISPR 11	Group 1	The Ionization Chambers uses RF energy only for its internal function. Therefore, its RF emissions are very low and are not likely to cause any interference in nearby electronic equipment.
RF emissions CISPR 11	Class A	The Ionization Chambers is suitable for use in all establishments other than domestic and those directly connected to the public low-voltage power supply network that supplies buildings used for domestic purposes.
Harmonic emissions IEC 61000-3-2	Not applicable	
Voltage fluctuations/ Flicker emissions IEC 61000-3-3	Not applicable	
		The EMISSIONS characteristics of this equipment make it suitable for use in industrial areas and hospitals (CISPR 11 class A). If it is used in a residential environment (for which CISPR 11 class B is normally required) this equipment might not offer adequate protection to radio-frequency communication services. The user might need to take mitigation measures, such as relocating or re-orienting the equipment.

Guidance and manufacturer's declaration – electromagnetic immunity			
The Ionization Chambers are intended for use in the electromagnetic environment specified below. The customer or the user of the Ionization Chambers should assure that it is used in such an environment.			
Immunity test	IEC 60601 test level	Compliance level	Electromagnetic environment - guidance
Electrostatic discharge (ESD) IEC 61000-4-2	$\pm 8\text{kV}$ contact $\pm 15\text{kV}$ air	$\pm 8\text{kV}$ contact $\pm 15\text{kV}$ air	Floors should be wood, concrete or ceramic tile. If floors are covered with synthetic material, the relative humidity should be at least 30%.
Electrical fast Transient/burst IEC 61000-4-4	$\pm 1\text{kV}$ for input/output lines $\pm 2\text{kV}$ for power supply lines	Not Applicable	Not Applicable ^a
Surge IEC 61000-4-5	$\pm 1\text{kV}$ line to line $\pm 2\text{kV}$ lines to earth	Not Applicable	Not Applicable ^a
Voltage dips, short interruptions and voltage variation on power supply input lines IEC 61000-4-11	$<5\% U_T$ for 0.5 cycle $40\% U_T$ for 5 cycles $70\% U_T$ for 25 cycles $<5\% U_T$ for 5 s	Not Applicable	Not Applicable ^a
Power frequency (50/60 Hz) magnetic field IEC 61000-4-8	30 A/m	30 A/m	Power frequency magnetic fields should be at levels characteristic of a typical location in a typical commercial or hospital environment
Note: U_T is the a.c. mains voltage prior to application of the test level			

Guidance and manufacturer's declaration – electromagnetic immunity			
The Ionization Chambers are intended for use in the electromagnetic environment specified below. The customer or the user of the Ionization Chambers should assure that it is used in such an environment.			
Immunity test	IEC 60601 test level	Compliance level	Electromagnetic environment - guidance
Conducted RF IEC 61000-4-6	3 Vrms 150 kHz to 80MHz	3 Vrms 150 kHz to 80MHz	Portable and mobile RF communications equipment should be used no closer to any part of the Ionization Chamber, including cables, than recommended separation distance calculated from the equation applicable to the frequency of the transmitter. $d = 1,2\sqrt{P}$ $d = 1,2\sqrt{P}$ 80MHz to 800MHz $d = 1,2\sqrt{P}$ 800MHz to 2,7GHz
Radiated RF IEC 61000-4-3	3 V/m 80MHz to 2,7GHz	3 V/m 80MHz to 2,7GHz	Where P is the maximum output power rating of the transmitter in watts (W) according to the transmitter manufacturer and d is the recommended separation distance in meters (m). Field strengths from fixed RF transmitters, as determined by an electromagnetic site survey ^b , should be less than the compliance level in each frequency range ^c . Interference may occur in the vicinity of equipment marked by the following symbol: 
Note 1: At 80MHz and 800MHz, the higher frequency range applies.			
Note 2: These guidelines may not apply in all situations. Electromagnetic propagation is affected by absorption and reflection from structures, objects, and people.			
^a Testing the ionization chamber product is not applicable because it is not connected to the mains, and signal cables must not be routed together with high voltage cable insulation rating over 300V in the hospital controlled environment. ^b Field strengths from fixed transmitters, such as base stations for radio (cellular/cordless) telephones and land mobile radios, amateur radios, AM and FM radio broadcast and TV broadcast cannot be predicted theoretically with accuracy. To assess the electromagnetic environment due to fixed RF transmitters, an electromagnetic site survey should be considered. If the measured field strength in the location of Ionization Chambers is used exceeds the applicable RF compliance level above, the Ionization Chambers should be observed to verify normal operation. If abnormal operation is observed, additional measures may be necessary, such as re-orienting or relocating the Ionization Chambers. ^c Over the frequency range 150kHz to 80MHz, the field strengths should be less than 3V/m.			

Recommended separation distance between portable and mobile RF communications equipment and the Ionization chamber			
The Ionization Chambers are intended for use in an electromagnetic environment in which radiated RF disturbances are controlled. The customer or the user of the Ionization Chambers can help prevent electromagnetic interference by maintaining a minimum distance between portable and mobile RF communications equipment (transmitters) and the Ionization chamber as recommended below, according to the maximum output power of the communication equipment.			
Rated maximum output power of the transmitter W	Separation distance according to frequency of transmitter m		
	150kHz to 80MHz $d=1,2\sqrt{P}$	80MHz to 800MHz $d=1,2\sqrt{P}$	800MHz to 2,7GHz $d=2,3\sqrt{P}$
0,01	0,12	0,12	0,23
0,1	0,38	0,38	0,73
1	1,2	1,2	2,3
10	3,8	3,8	7,3
100	12	12	23
For transmitters rated at a maximum output power not listed above, the recommended separation distance d in meters (m) can be estimated using the equation applicable to the frequency of the transmitter, where P is the maximum output power rating of the transmitter in watts (W) according to the transmitter manufacturer.			
Note 1: At 80MHz and 800MHz, the separation distance for the higher frequency range applies.			
Note 2: These guidelines may not apply in all situations. Electromagnetic propagation is affected by absorption and reflection from structures, objects, and people.			

Test Frequency (MHz)	Band a) (MHz)	Service a)	Modulation b)	Maximum Power (W)	Distance (m)	IMMUNITY TEST LEVEL (V/m)
385	380 – 390	TETRA 400	Pulse modulation b) 18 Hz	1,8	0,3	27
450	430 – 470	GMRS 460, FRS 460	FM c) ±5 kHz deviation 1 kHz sine	2	0,3	28
710	704 – 787	LTE Band 13, 17	Pulse modulation b) 217 Hz	0,2	0,3	9
745						
780						
810	800 – 960	GSM 800/900, TETRA 800, iDEN 820, CDMA 850, LTE Band 5	Pulse modulation b) 18 Hz	2	0,3	28
870						
930						
1 720	1 700 – 1 990	GSM 1800; CDMA 1900; GSM 1900; DECT; LTE Band 1, 3, 4, 25; UMTS	Pulse modulation b) 217 Hz	2	0,3	28
1 845						
1 970						
2 450	2 400 – 2 570	Bluetooth, WLAN, 802.11 b/g/n, RFID 2450, LTE Band 7	Pulse modulation b) 217 Hz	2	0,3	28
5 240	5 100 – 5 800	WLAN 802.11 a/n	Pulse modulation b) 217 Hz	0,2	0,3	9
5 500						
5 785						

NOTE If necessary to achieve the IMMUNITY TEST LEVEL, the distance between the transmitting antenna and the ME EQUIPMENT or ME SYSTEM may be reduced to 1 m. The 1 m test distance is permitted by IEC 61000-4-3.

- a) For some services, only the uplink frequencies are included.
b) The carrier shall be modulated using a 50 % duty cycle square wave signal.
c) As an alternative to FM modulation, 50 % pulse modulation at 18 Hz may be used because while it does not represent actual modulation, it would be worst case.



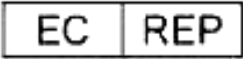
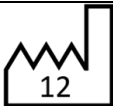
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Ionization Chamber
model number beginning with
prefix 'ICX' or 'INX'

The Table below defines the meaning of various symbols found on the device labels and accompanying documents.

	Reference number symbol used to identify the model number
	Serial number symbol
	EC Representative in the European Community symbol
	Date of manufacture symbol with the country code where the product is manufactured. The "12" shall be replaced by the two letter country code (e.g. US, NL, PH defined by ISO 3166-1)
	Manufacturer's name and address
	Warning symbol. Refer to accompanying documents for details.
	UL Recognized Component Marks for Canada and the United States
	Conformité Européenne symbol with notified body identification number. Indicates product meets European Conformity standards.
	Keep product dry symbol

	Handle with care symbol
	Temperature limitation symbol. The upper and lower temperature limits will be indicated on either side of the symbol
	The Waste Electrical and Electronic Equipment (WEEE) Directive symbol
	ESD susceptibility symbol



- For operating instructions, refer to the manual for the x-ray system. A translation of the installation and calibration instructions is available on request.
- Pour obtenir des instructions de fonctionnement, se reporter au manuel de l'appareil radiographique. Une traduction des instructions d'installation et d'étalonnage du préamplificateur de la chambre d'ionisation est disponible sur demande auprès du fabricant.
- 有关操作说明, 请参阅 X 光系统手册
电离室前置放大器的安装和校准说明书的翻译可向制造商索取。
- For betjeningsvejledning se manualen til røntgensystemet.
De kan anmode fabrikanten om en oversættelse af installations- og kalibreringsvejledningen til ionisationskammerpreforsterkeren.
- Raadpleeg voor gebruiksinstructies de handleiding bij het röntgensysteem.
Op verzoek kunt u van de fabrikant een vertaling van de installatie- en kalibratie-instructies voor de voorversterker van de ionisatiekamer krijgen.
- Für die Betriebsanweisung verweisen wir auf das Handbuch über das Röntgensystem.
Eine Übersetzung der Installierungs- und Justierungsanweisungen für den Ionenkammer-Vorverstärker steht Ihnen auf Anfrage beim Hersteller zur Verfügung.
- Per le istruzioni d'uso, fare riferimento al manuale del sistema a raggi X.
Su richiesta, è disponibile presso il produttore una traduzione delle istruzioni di installazione e di taratura per il pre-amplificatore della camera di ionizzazione.
- 操作手順については、X 線システムのマニュアルを参照してください。
イオンチェンバー前置増幅器の取り付けおよび校正手順の翻訳版は、ご要望があれば製造会社よりご入手いただけます。
- Para obtener las instrucciones de funcionamiento, consulte el manual del sistema radiográfico.
El fabricante puede proporcionar, a petición una traducción de las instrucciones de instalación y calibración para el amplificador previo de la cámara de ionización.
- Se handboken till röntgensystemet för driftanvisningar.
En översättning av installations- och kalibreringsanvisningarna för joniseringskammarens förförstärkare finns tillgänglig på begäran från tillverkaren.
- Az üzemeltetési utasításokat a röntgenrendszer leírásában találja. A telepítési és kalibrációs utasítások fordítása igény szerint rendelkezésre áll.
- Para as instruções operacionais, consulte o sistema de raios X. Uma tradução das instruções de instalação e calibração está disponível a pedido.