



**XR 3700 Real-Time
X-Ray Inspection System**
(PN 8007-0542, 120V)
(PN 8007-0546, 230V)

**XR 3500 Real-Time
X-Ray Inspection System**
(PN 8007-0540, 120V)
(PN 8007-0544, 230V)

**This manual operation is for PACE's XR 3500 50kv unit and
PACE's XR 3700 70kv unit.**



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1. XR 3500/3700 Safety Information

IMPORTANT: READ THIS FIRST

It is essential that the operator of the XR 3500/3700 read and understand the following safety warnings **PRIOR** to operation.

The XR 3500/3700 is designed to provide safe and efficient operation. However, any equipment producing ionizing radiation (X-rays) must be considered hazardous and should be treated accordingly. When operating this equipment, observe the following:

- PACE strongly recommends that all maintenance be performed by a qualified service technician.
- The XR 3700 x-ray tube produces high voltages of up to 70,000 volts. The XR 3500 X-ray tube produces high voltages of up to 50,000 volts. Under no circumstances should the case be disassembled or modified as severe electrical shock may occur.
- The XR 3500/3700 is designed to ensure adequate radiation shielding. Even so, always be aware that the ionizing radiation (x-rays) can constitute a distinct hazard if not employed in strict accordance with instructions provided in this manual for maximum operator safety.
- Exposure to excessive quantities of radiation can be dangerous to your health. Avoid not only direct radiation exposure, but also to secondary or scattered radiation which occurs when an x-ray beam strikes or has passed through any material.
- Do not insert any part of the body into the inspection chamber while x-rays are on. Although the XR 3500/3700 operates at a low x-ray dose, unnecessary radiation exposure should be avoided. If an item becomes jammed or lodged in the inspection area, the XR 3500/3700 should be turned off before any attempt is made to clear the inspection chamber.
- PACE strongly recommends that all personnel operating the XR 3500/3700 wear a radiation film dosimeter badge. This badge records an exposure history for the operator and acts as a constant reminder to the operator to use caution and safe work practices when operating the XR 3500/3700.

- The radiation exposure dosage received by personnel working with x-ray inspection equipment should not exceed those limits set by local regulations relating to ionizing radiation.
- Adequate warning signs and symbols should be displayed in the vicinity of the XR 3500/3700 warning of possible x-ray exposure. Any warning lamps and signals should be checked prior to operating the XR 3500/3700.
- The electrical circuits of the XR 3500/3700, although enclosed for operator protection, must be considered as a potential hazard. Strict observance of safety practices pertaining to operation and maintenance is essential. Proper electrical grounding must always be used.
- Before operating the XR 3500/3700, all personnel designated or authorized to operate the unit, as well as those supervising its operation, should have a full understanding of how it works. Additionally, they should be familiar with established radiation safety exposure practices sanctioned by the National Bureau of Standards Handbook, "X-ray Protection" HB93, pertaining to x-ray protection.
- Service personnel should read this manual and be familiar with its contents before attempting to adjust or repair this equipment.

2. Radiation Safety Information

Federal, State and Local Radiation Regulations (US ONLY)

This cabinet x-ray system was designed to conform to U.S. and Food and Drug Administration (FDA) requirements as stated in the Code of Federal Regulations, Title 21 (21CFR). These requirements (often referred to as the CDRH or BRH regulations) govern the design and manufacture of all equipment that produces ionizing radiation. Such equipment includes television sets and microwave ovens, as well as cabinet x-ray systems. In fact, the maximum allowable radiation emission for cabinet x-ray systems is the same as that set for television sets and microwave ovens.

Warning: Failure to adhere to the following warnings may result in exposure to radiation:

- Do not operate the x-ray system unless all system components and features are in good repair.
- Never attempt to remove any system component or bypass any system function.

Several features are included in the system design to provide for radiation safety. The controls (including key switches), control circuitry, leaded components (including the leaded acrylic windows), physical barriers, interlocks, and status and warning indicators each contribute to overall radiation safety.

The Federal Aviation Administration (FAA), Occupational Safety and Health Administration (OSHA), most state and some local government agencies typically have specific standards regarding operational safety and constraints regarding the modification of x-ray systems conforming to 21CFR (mentioned above).

Typically, an x-ray system must be registered with the appropriate state agency, by the physical possessor of the system, regardless of the legal owner. Frequently, registration must occur prior to the x-ray system being placed into service. Regulations may require initial and periodic inspections by a government agency or a qualified vendor. In addition, the regulations may require the implementation of standardized operating procedures, specialized training, the distribution and use of exposure monitoring badges and posting of radiation exposure warnings and other special notices. Radiation safety requirements may differ slightly from one jurisdiction to another. **It is the user's responsibility to ensure that the x-ray system is installed and operated in compliance with all applicable governmental regulations.** Failure to comply may result in substantial penalties.

3. Radiation Safety Guidelines

To ensure the health and safety of the operator and all others in the vicinity of operating x-ray inspection equipment, the following guidelines are recommended for establishing a basic radiation safety program.

Note: Federal, State, and some local government agencies may have more stringent regulations concerning the operation and use of equipment that produces ionizing radiation (x-rays). The requirements of these governing agencies supersede the recommendations made by the manufacturer.

1. A copy of the operating instructions should be kept at the machine at all times.
2. Personnel operating the equipment should be trained in the proper and safe operation of the machine.
3. Radiation surveys should be performed periodically to ensure that the amount of radiation being emitted by the machine is less than 0.5mR/hour. We recommend performing a radiation survey:
 - Following initial installation – before placing the x-ray system into service.
 - Whenever the x-ray system is relocated.
 - Whenever the x-ray system receives a strong jolt (e.g., being dropped ore than one inch or struck sufficiently hard to dent or deform the exterior cabinet).
 - Whenever a leaded component (such as the x-ray generator, shielding, inspection tunnel curtains, LXDA or collimator cover) is removed for any reason or period of time.
 - Annually – from the date of the most recent radiation survey
4. All controls and indicators should be checked daily to ensure proper operation.
5. Do not operate the x-ray system if it is not in good repair. Do not attempt to remove or bypass any controls (e.g. foot pedals and key-switches), interlocks, status indicators, leaded components (including the inspection tunnel curtains) or physical barriers. In the event of failure or breakage, these

6. Service of the equipment should only be performed by or under the instruction of trained PACE personnel.

Many users choose to issue periodic radiation film badges to assure employees that they are not being exposed to significant levels of radiation and to provide added assurance that radiation emissions are well within regulatory limits.

4. XR 3500/3700 Specifications

XR 3500: X-Ray tube: 10-50kv

XR 3700: X-Ray tube: 10-70kv

Power Requirements: 115 VAC, 60 Hz

Color camera: High resolution with 7-40x zoom

Maximum PCB size: 760mm x unlimited mm(30" x unlimited")

Focal spot: 0.2mm (0.008")

Focal spot to image plane distance: 124mm (4.875")

Adjustments: Live or Capture video signal, Frame averaging up to 32000 frames, & Video Gain adjustment

Spatial Resolution: 20lp/mm

X-Ray Actuation: Foot Pedal

Opening Clearance: 40mm (1.5") 120VAC, 19mm (0.75") 230 VAC

PCB Fixture Device: Standard

Small PCB Carrier: Standard

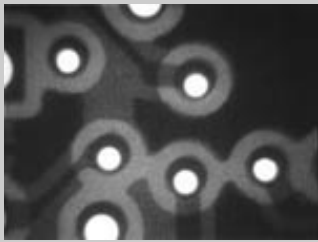
Dimensions: 394mm H x 457mm W x 585mm D (15.5" H x 18" W x 23" D)

Weight: 39 Kg (86lbs.)

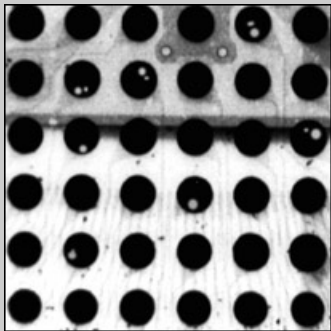
5. Features

- Real-time affordable bench top X-Ray Inspection
- High Resolution camera with outstanding zoom capability
- Images can be viewed, stored and managed through software or viewed on a stand-alone monitor
- Real-time X-Ray image gives you immediate feedback

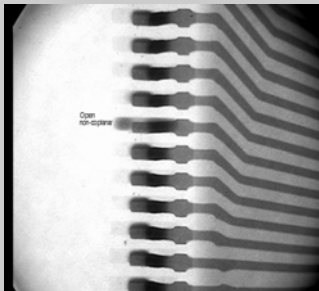
6. System Operation



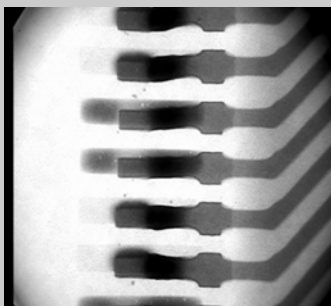
**Bare Board
Hole/Pad Offset**



BGA Voiding



**Leaded Component
Non-Co planarity**



**Leaded Component
Opens**

XR 3500/3700

The XR 3500/3700 Real Time Inspection System is a powerful tool in the quality control and process verification of all aspects of microelectronics manufacturing. The XR 3500/3700 provides rapid, real-time x-ray inspection for production and rework environments. Its self-contained console design supports easy customizing for numerous applications, including multi-layer PCBs, small hole drilling, large back-planes and assemblies with advanced components, such as BGAs, μ BGAs and chip-scale packages.

In bare board applications, it can be used to check for interlayer shift and drilled hole-to-pad offset. Inspection is performed following lamination, to determine the presence and degree of interlayer shifts. At the onset of either conventional or small hole drilling, inspection is used to qualify hole-to-pad alignment. In addition to enhancing product quality, x-ray inspection enables users to control costs by eliminating defective boards early in the production process. It can also be used to quality control incoming boards from vendors or customers so that defects can be detected before problems occur.

For surface mount components, it is used to verify lead/pad coplanarity, shorts, opens, and solder bond quality. It can be used to check resistors and capacitors as well as IC's for internal damage and verify adjustments throughout the placement and reflow processes.

For BGA's, the XR 3500/3700 can be used to check for all potential defects including: shorts, opens, mis-registration, non-wetting, solder ball voids, and delamination. X-ray is used to verify proper reflow profiles for advanced packages, and to control rework process.

6. Set Up

A. XR 3500/3700 as a stand-alone inspection station

Place the XR 3500/3700 on a stable work platform of sufficient capacity to adequately support the XR 3500/3700. The monitor used to view the images should be placed on the work surface next to the XR 3500/3700 and not on top of the XR 3500/3700, as it is not designed to support a monitor and the monitor may fall.

Locate the foot pedal, composite video cable, and power cord. These should be connected as shown in Figure 1.



Figure 1: The back of the XR 3500/3700

The other end of the composite bnc cable should be connected to the composite video input on the video monitor; a bnc-to-RCA converter might be needed. The power cord should be connected to a properly grounded 120 VAC power supply.

B. The XR 3500/3700 used with the TF 1700/2700 or IR3000 BGA/CSP Rework Center

Place the XR 3500/3700 on a stable work platform of sufficient capacity to adequately support the XR 3500/3700. The work platform can be the same as the work platform supporting the TF 1700/TF2700, or may be a separate one as long as it is close enough to allow for the connection of the composite video cable to the PC.

Locate the foot pedal, composite video cable, and power cord. These should be connected to the slots in the back of the XR machine illustrated in figure 1.

The other end of the composite video cable should be connected to the composite video input on the video capture card on the PC. See Figure 2. The power cord should be connected to a properly grounded 120 VAC power supply.



Composite Video Connection

Figure 2: Back of TF 1700/2700 PC or IR 3000.

7. XR 3500/3700 Initial Power-up and Operational Test

The system should be fully set up according to the System Setup Section before starting these procedures.

1. To turn on the power, turn the key to the ON position. The key is required to turn on the power and cannot be removed unless the key has been returned to the off position. The power light should blink when the key switch is on and the cover lock is disengaged. Then when the cover lock is engaged, the power light turns steady.
2. Make sure that there is nothing inside the inspection chamber, close the cover if open and engage the lock, and depress and hold the foot pedal. The X-ray will not come on if the cover is not locked into position. The image on the PC or video monitor should change from a flat light gray image to a brighter, slightly grainy image. This is the blank x-ray image.
3. Release the foot pedal and the image should return to its original state. To test the safety interlock circuit, disengage the cover lock, but **DO NOT OPEN THE COVER**. Now press the foot pedal and the red X-ray on light should not illuminate.

4. Depress the foot pedal again and now look at the control panel. The red “x-ray on” light should illuminate and remain on for as long as you hold down the foot switch. Release the foot pedal.
5. Place a component (such as a circuit board) inside the inspection chamber directly underneath the x-ray tube.
6. Depress and hold the foot switch. The x-ray image of the component should now be visible.
7. Move the component while the foot switch is depressed. If the component is large enough to extend beyond the curtains, it is permissible to move the component while the foot switch is depressed- AS LONG AS THE CURTAINS DO NOT OPEN DURING MOTION, AS THIS WILL INCREASE X-RAY LEAKAGE. The image should move with the component. The image will display a trail behind the component, which will disappear when the component has stopped moving. This is a normal occurrence and is a function of the image processor. The video processor included with this system is preset to 8 frames averaging. Averaging makes the x-ray image less grainy and can be adjusted to improve image quality but with an increase in motion lag.
8. Images may be captured electronically when the XR 3500/3700 is used with the TF 1700/2700 PC or IR 3000 PC and software.

Your system is now ready for use

12. XR 3500/3700 Maintenance

The XR 3500/3700 system has been designed for simple maintenance. The only suggested maintenance is to keep the unit visibly clean and to keep the system's calibration up to date. The window is made of a lead-impregnated acrylic resin; NEVER allow solvents that will attack acrylic to be used near the window. If you find that your system is coming close to its calibration date, please contact **PACE** to schedule a calibration.

CALIBRATION	
BY _____	DATE _____
NEXT CAL. DUE _____	
INSTRUMENT # _____	

It is very important that you contact **PACE** early, so that we may schedule service at a convenient time.

- **Warning:** The acrylic and vinyl around the opening of the XR 3700 contain lead. Always wash your hands immediately after use. Eating and drinking without washing your hands may cause you to ingest lead. *

13. Troubleshooting

In the event that your system exhibits problems, this section will familiarize you with the basic steps to troubleshoot the problem as well as what information PACE will require in order to give you the best possible service.

Quick Tips

The first thing to do is to simply try and re-start the system. This can solve most problems right away.

1. The first step in troubleshooting is that the system must be completely shut down and re-started. You can do this by turning the keyed power switch, located on the front of the system, to the “Off” position.
2. Turn the power back on.
3. There are three categories that are used to troubleshoot the system:

Power: The power category covers all problems that include lack of power to a component or to the full system. Power problems would include:

- The system not powering up.
- The x-ray controller’s red light does not turn on.
- The system’s green light does not function.
- **Do all components power up when the main power switch is turned on?**
- **Do all power-indicating lamps turn on?**
- **Do all power outputs show the proper voltage?**
- **Is the foot pedal connected?**

Video: The video category covers the problems that affect the presence of a video signal from the x-ray camera. Video problems would include:

- No x-ray image on the monitor, but x-rays are present.
- The image processor on the system does not boot up.
- The x-ray image is fuzzy or out of focus.
- **Is the video cable attached properly?**
- **Does an X-ray image appear on the monitor when the foot switch is depressed?**

- **Does the systems image processor boot up?**
- **Does the X-ray monitor have a light gray screen or flicker?**

X-Ray: The x-ray category covers the problems that affect the tube's emission of x-rays. The x-ray category includes:

- The red "X-Ray On" light is not turning on.
- There is no image on the monitor, but video signal is present.
- There are no x-rays being emitted from the x-ray source.

- **Does an X-ray image appear on the monitor when the foot pedal is depressed?**

Does the red "X-ray on" light turn on when the cover lock is engaged and the footswitch is depressed?

14. Model XR 3500/3700 Design Safety Standards and Safe Operating Practices

Because of the low operating anode power of the XR 3500/3700, real time x-ray inspection system, it has been registered with the Center for Devices and Radiological Health Branch of the FDA as an "Analytical X-ray System". As registered, the system has a number of safety features provided to minimize any x-ray scatter reaching the operator.

A. Safety:

The X-Ray tube assembly is lead shielded with at least a ¾ inch space between collimator and image plane to minimize any x-ray scatter. The collimator insures that the x-ray beam size at the image plane is no more than a one-inch diameter circle. The table assembly employs a lead acrylic view panel and additional lead shielding. The highly sensitive x-ray camera permits the x-ray tube to operate at low power (anode voltage of 50/70 kV and anode current of 25 micro amps) resulting in minimal x-ray scatter. All these safety features result in a structure with radiation scatter at 5 cm from any exposed surface less than 0.3 mill Roentgens per hour. (Radiation exposure in an airplane at 30,000 feet during the day is greater than 0.4 mill Roentgens per hour.)

B. Radiation safety precautions for the use of XR 3500/3700 Real Time X-ray Inspection System:

It is imperative that the XR 3500/3700 be operated only by trained personnel who are familiar with the basic safety precautions to be taken when working with x-ray producing equipment.

1. The key to actuate the x-rays should not be left in the equipment when the equipment is not being used and is unattended.
2. Operators should not place hands under the leaded acrylic panel in the front.
3. The equipment should not be operated with any panels removed.
4. Operators should be familiar with the use of the Monitor-4 radiation survey meter.
5. Service of the equipment must be performed by or under the instruction of trained PACE personnel.

C. Radiation monitoring:

Specific regulations regarding the monitoring of possible radiation leakage of industrial x-ray cabinets are determined by the individual state or country. There are a number of measures, which can be taken to provide a means of cursory monitoring.

D. Radiation survey meters:

Radiation survey meters detect the presence of ionizing radiation and display a value in units of mR/hr (milli Roentgens per hour). It is generally a good idea to have, as part of a radiation safety program, a radiation survey meter. The monitor –4EC survey meter is available from PACE. The Monitor-4EX employs an energy compensated G-M tube to measure the presence of radiation. It is calibrated to Cs-137. The Monitor-4EX can be used to detect any radiation leakage from x-ray systems.

E. Radiation safety training:

PACE can provide or recommend providers of operation and radiation safety training to ensure that the facility is in compliance with all state and federal radiation regulations.

Service and Warranty

Please contact **PACE** or your local distributor for service and repair

LIMITED WARRANTY

Seller warrants to the first user that products manufactured by it and supplied hereunder are free of defects in materials and workmanship for a period of one (1) years from the date of receipt by such user. Blowers and motor pumps (which wear out during normal use) are warranted for a period of one (1) year.

This warranty does not cover wear and tear under normal use, repair or replacement required as a result of misuse, improper application, mishandling or improper storage. A consumable item such as tips, heaters, filters, etc. which wear out under normal use are excluded. Failure to perform recommended routine maintenance, alterations or repairs made other than in accordance with Seller's directions, or removal or alteration of identification plates in any way will void this warranty. This warranty is available only to the first user, but the exclusions and limitations herein apply to all persons and entities.

SELLER MAKES NO OTHER WARRANTY, EXPRESS OR IMPLIED, AND MAKES NO WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

Seller will, at its option, repair or replace any defective products at its facility or other location approved by it at no charge to user, or provides parts without charge for installation by the user in the field at user's expense and risk. User will be responsible for all costs of shipping equipment to Seller or other location for warranty service.

EXCEPT FOR THE REMEDY ABOVE DESCRIBED, UNLESS OTHERWISE REQUIRED BY APPLICABLE LAW, SELLER WILL HAVE NO OTHER OBLIGATION WITH REGARD TO ANY BREACH OF WARRANTY OR OTHER CLAIM WITH RESPECT TO THE PRODUCTS, OR LIABILITY FOR ANY DIRECT, INDIRECT, CONSEQUENTIAL, OR INCIDENTAL LOSS OR DAMAGE CAUSED BY OR OCCURRING IN CONNECTION WITH ANY OF THE PRODUCTS.

Warranty service may be obtained by contacting the appropriate PACE Company or local Authorized PACE distributor as set forth below to determine if return any item is required or, if repairs can be made, by the user in the field.

Defective products may not be returned to PACE without a Service Authorization ("SA") Number.

Any warranty or other claim with respect to the products must be made in writing delivered to PACE (or local Authorized PACE distributor for Buyers outside the USA and the United Kingdom) within a reasonable time of the expiration date of this warranty with sufficient evidence of purchase and date of receipt, otherwise user's rights under this warranty shall be deemed waived.



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