

XR200 X-RAY SOURCE



OPERATOR'S MANUAL

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1.0 INTRODUCTION

The XR200 produces high levels of radiation and must be operated by qualified personnel who must read the Warning and Operations section of the manual before operating the device.

The XR200 is a small, lightweight x-ray generator that operates on its own removable battery pack. The XR200 is a pulsed x-ray device that produces x-ray pulses of very short duration (60 nanoseconds). It produces a relatively low dose rate comparable to a 1.0 ma constant potential machine. The energy produced by the XR200 is up to 150KVP, which makes it possible to radiograph up to ½ inch (1.3 cm) of steel.

XR200 standard accessories are two keys, two battery packs, and one battery charger. Remote cable, carrying case, and film developing equipment are also common accessories.

2.0 WARNINGS

2.1 The XR200 is an industrial type x-ray generator that produces hazardous radiation when energized.

2.2 It is unlawful to use this equipment to intentionally expose humans or to use it for medical radiography.

2.3 *The XR200 is subject to state regulation and registration. Contact your state board of health before operating equipment.*

2.4 The operator of the XR200 must be properly trained to safely operate the unit.

2.5 Unauthorized personnel should not have access to the XR200.

2.6 Develop and closely follow a safe operating system for using the XR200.

The safe operating system must ensure that no one is exposed to radiation above the permissible limits which are 2 mR (0.02 mSv) per hour or 100 mR (1 mSv) per year for a member of the public. (Refer to Specifications, page 20, for X-ray output and Exclusion Zone, page 4, for stand off distances.)

The safe operating system must ensure the XR200 is used within federal and state guidelines.


2.7 All operators and users of the XR200 x-ray machine must wear a personal radiation monitoring device, such as a TLD (thermoluminescent dosimeter), film badge, and/or a pocket dosimeter **consistent with the appropriate federal, territorial or provincial standards** (note: an electronic dosimeter will not detect the XR200 radiation pulses).


Due to the short pulse width of the XR200, survey meters of the Geiger-Mueller and scintillator type do not accurately detect the radiation emitted from the x-ray source.


Survey meters should be of the ionization type and should be used in the integration mode. Survey meters must not be used in the rate mode because the XR200 does not produce constant radiation. The XR200 produces very high rates of radiation for very short periods of time resulting in either unrealistically high readings or no readings for a survey meter in rate mode.


2.8 The XR200 has no explosion proof rating and should not be used in an explosive atmosphere. The Spark Gap is vented to the air and could be a source of ignition.

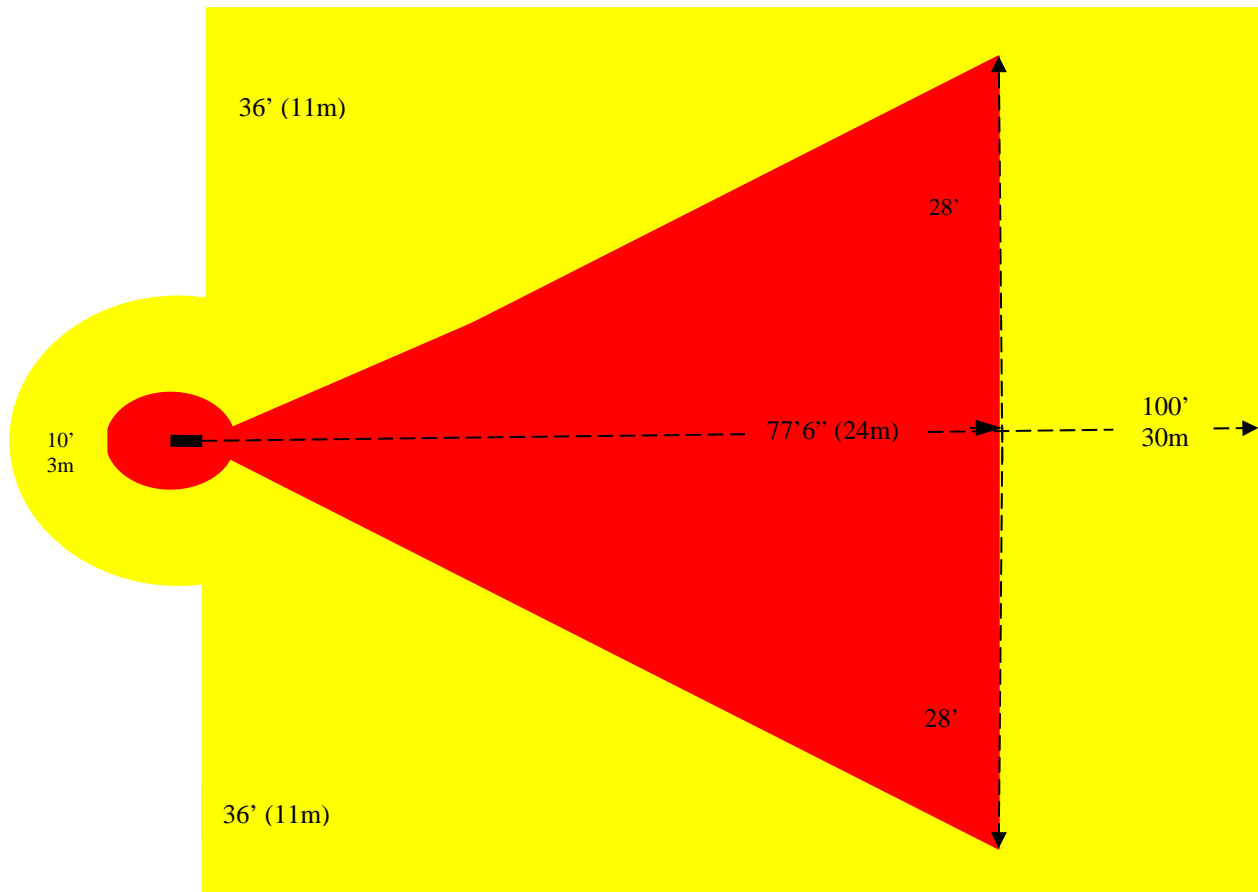
XR200 EXCLUSION ZONE

 State Maximum exposure limits
2 mR per hour (3000 pulses)

 Golden Engineering suggested
standoff distance

 = 2'5" (73 cm) to the side
= 3'9" (114 cm) behind

 = XR200 X-ray unit



3.0 PHYSICAL DESCRIPTION

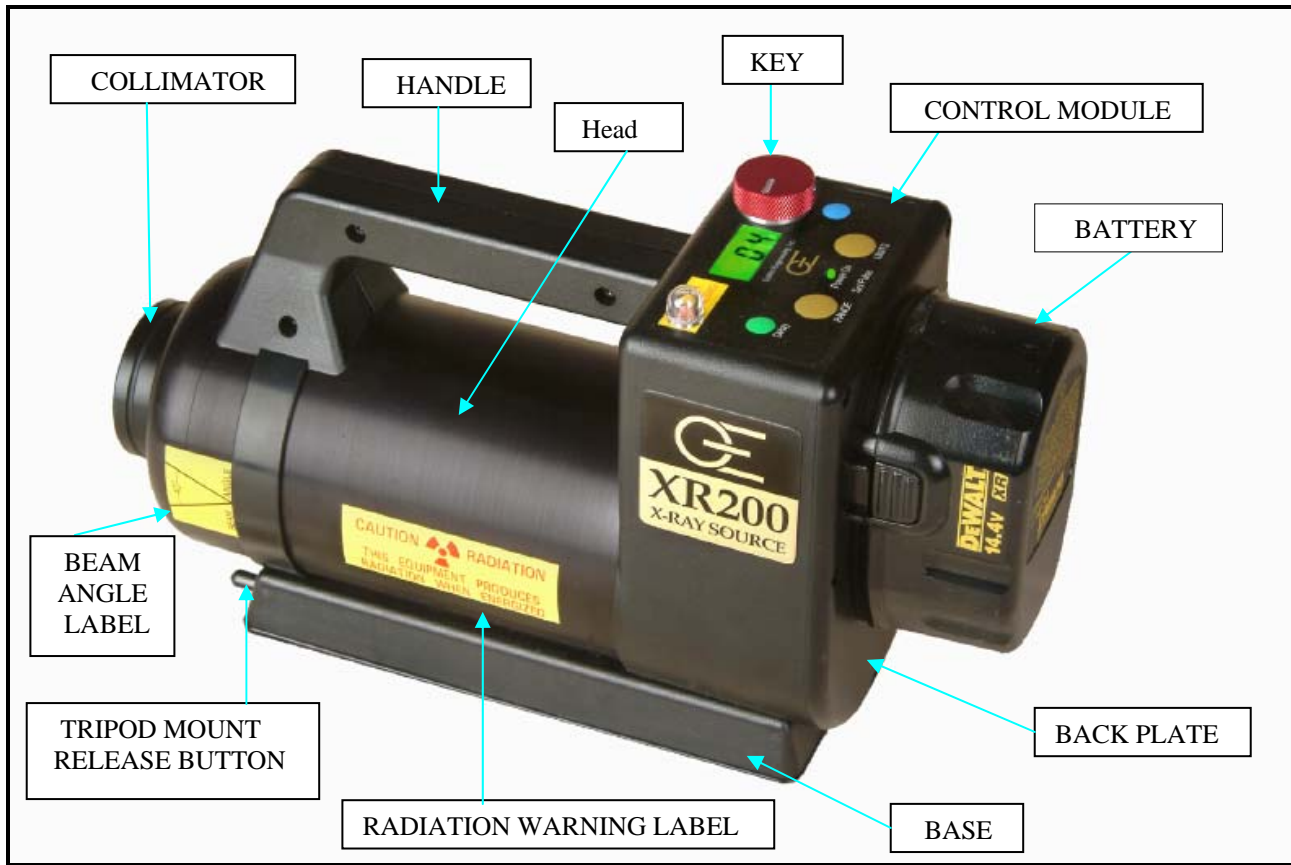


Figure 1: XR200 X-ray Unit

3.1 HIGH VOLTAGE PULSER/TUBEHEAD. The main body of the XR200 is the tube head which contains the tube cavity, cold cathode type X-ray tube, spark gap, high voltage capacitor, and transformer. The collimator located on the front of the head holds the tube in the tube cavity and limits the X-ray beam to 40 degrees.

3.2 BASE. The base of the XR200 contains the base plate, tripod mount, tripod mount release button, and identification label. The tripod mount contains threaded ¼-20 insert that can be attached to a standard camera tripod. The release button allows the tripod mount to stay on the tripod head, while removing the XR200. A label identifying the model, manufacturer, and serial number is located on the bottom of the XR200 base.



Figure 2: Base

3.3 CONTROL MODULE The control module contains the following indicators and switches.

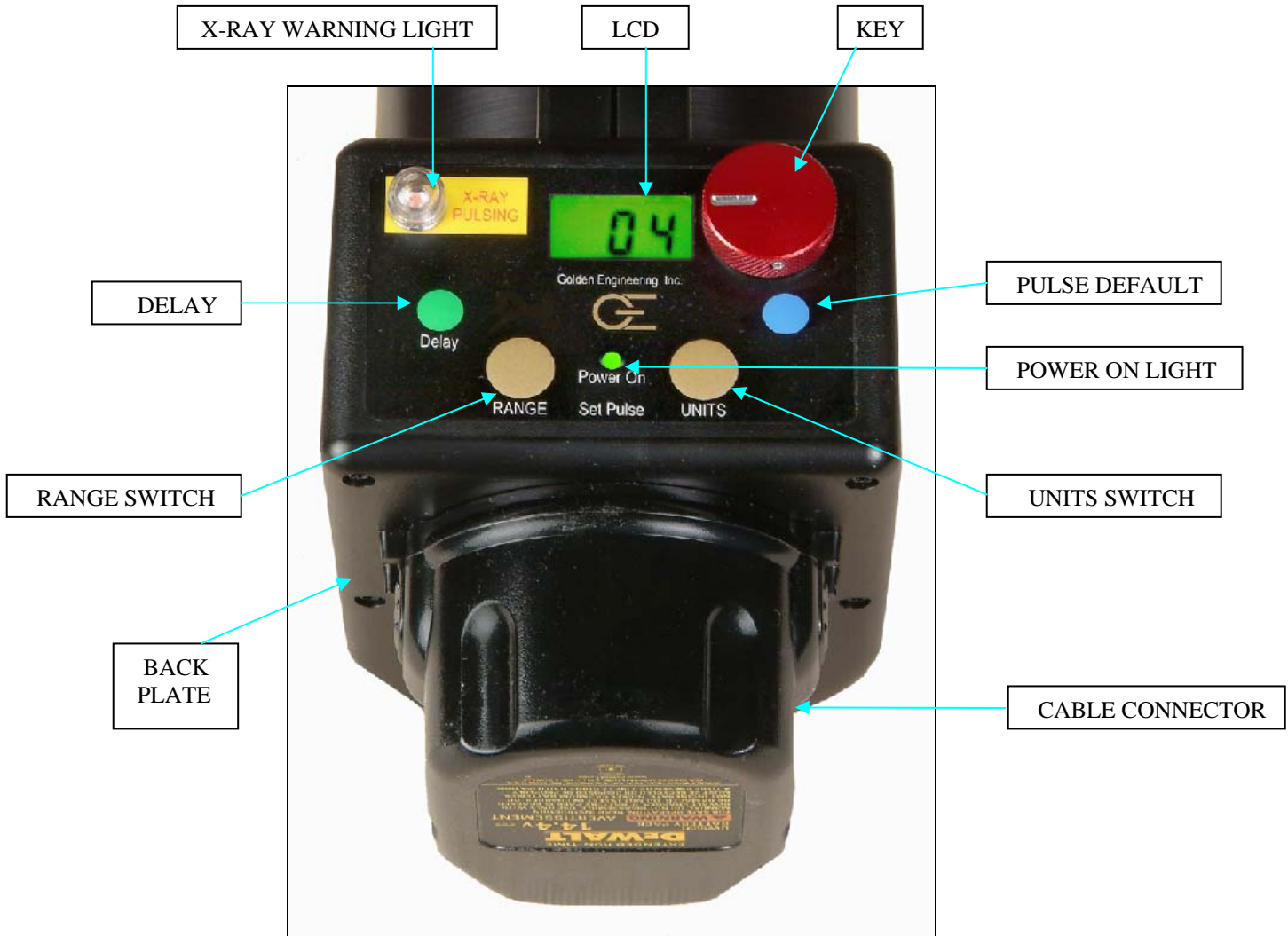


Figure 3: Control Module

- GREEN LED: Power on light. Illuminates when the battery voltage is applied to the control module.
- RED X-RAY WARNING LIGHT: Blinks after the time delay button or remote cable button is pressed to warn that the XR200 is going to pulse. The light stays on continuously while the XR200 is pulsing.
- LIQUID CRYSTAL DISPLAY (LCD): Displays 2 digits showing the number of pulses selected. If the X-ray Warning Light is blinking, then the LCD displays the number of seconds remaining until the XR200 begins pulsing. The LCD is backlit so it can be viewed in the dark.

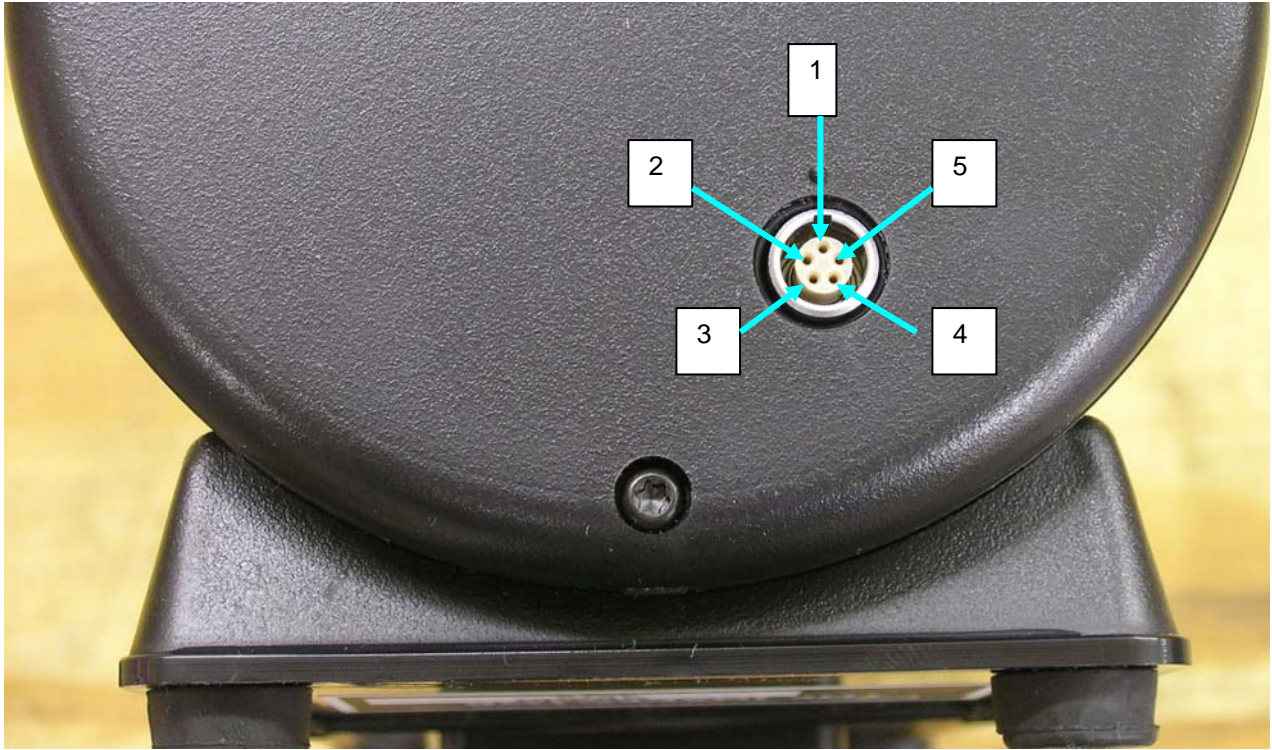
- **Input Switches:** The two gold push button switches are labeled Range and Units.
 - RANGE SWITCH is used to alternate LCD between tens digit and ones digit when entering pulses.
 - UNITS SWITCH changes the reading of the tens digit or units digit to any number from 0 to 9. The Units Switch is also used with the blue switch to change the default pulse setting.
- **DELAY SWITCH:** This green push button switch is used to initiate delay mode.
- **BLUE SWITCH:** This switch is pressed with the units switch to alter the default pulse setting.
- **REMOTE CONNECTOR:** This connector located on the back of the control module beneath the battery receives the remote cable or imaging system cable. The diagram on the following page shows more details for the Remote Connector.
- **BACK PLATE:** Covers the Oscillator board and contains battery terminal connectors.

3.4 BATTERY PACK. The battery pack is a DeWalt 14.4V nickel-cadmium battery. See enclosed instruction manual from DeWalt for safety and warranty information.

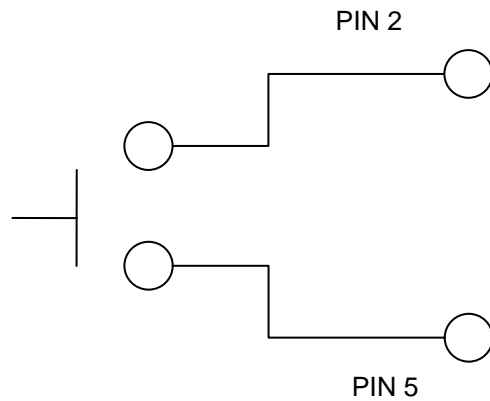
3.5 BATTERY CHARGER: The standard battery charger is the DeWalt DW9116 (110V) charger or DE9108 (220V) charger. It takes about one hour to completely charge a battery. See charger manual for additional instructions and warnings.

XR200 REAR VIEW/CABLE CONNECTOR

PIN #	DESCRIPTION
1	+5 VOLTS 100 ma MAXIMUM
2	REMOTE SWITCH
3	REMOTE SWITCH – NO DELAY
4	X-RAY ON SIGNAL
5	COMMON 0 VOLTS



REMOTE CONNECTOR: LEMO EPG.0B.305.HLN
 MATING CABLE PLUG: LEMO FGG.0B.305.CLAD 56Z



Remote switch inputs are activated when grounded.

4.0 DESCRIPTION OF OPERATION

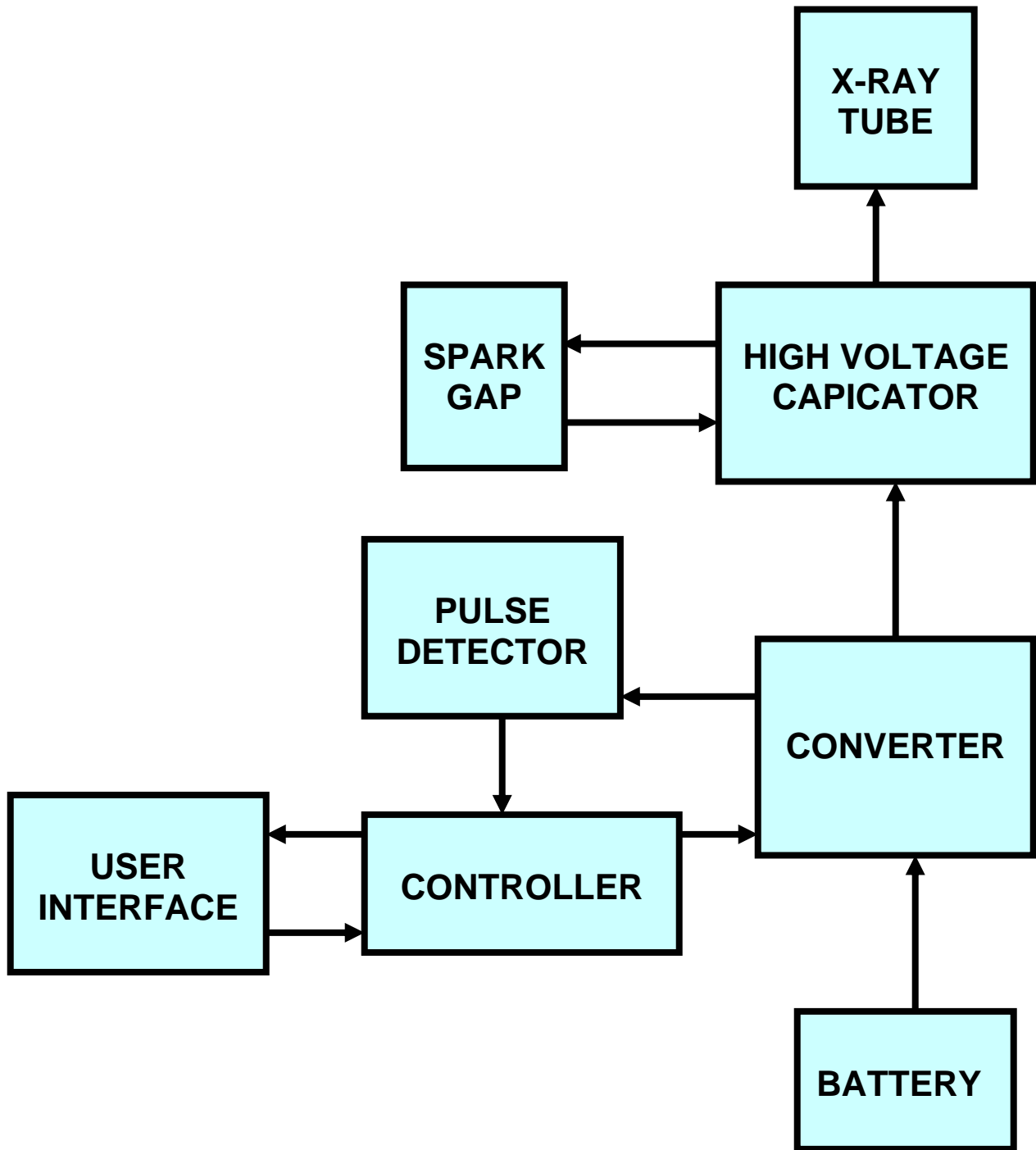
The block diagram on page 9 illustrates how the XR200 functions. The following sequence of events takes place each time the XR200 is fired.

1. User initiates operation of the machine.
2. The control section sends a signal to the converter section to begin oscillating.
3. Once oscillating, the converter section changes the 14.4 volts DC to 22Khz AC.
4. The transformer charges the High Voltage Capacitor to about 8000 volts.
5. The spark gap arcs after the High Voltage Capacitor reaches proper voltage.
6. The pulse detector signals the control block that the unit has pulsed.
7. As the High Voltage Switch is closed, a high voltage transient of about 150,000 volts and 50 nanoseconds in duration is applied across the x-ray tube generating x-rays.

The closing of the High Voltage Switch produces an audible snapping sound. **The XR200 cannot produce x-rays without the snapping sound and conversely the snapping sound serves as a warning that the XR200 is functioning. The operator should become familiar with the characteristic sound.**

This unit generates x-rays through high voltage bombardment of a tungsten target. ***The XR200 does not contain radioactive materials.*** All the high voltage is contained within the aluminum canister and as long as the canister is not punctured and the collimator is on the head the operator is not exposed to dangerous voltages.

XR200 BLOCK DIAGRAM



5.0 OPERATING INSTRUCTIONS

5.1 OPERATING PRECAUTIONS: *The operator should always stand at least 10 feet behind the X-ray unit while it is pulsing and clear all personnel at least 100 ft. from the front of the unit. See the diagram on page 4 for more details regarding exclusion zone and safe operating distances. **Closely follow all procedures in the safe operating system.***

5.2 OPERATING PROCEDURES: Operating procedures vary depending on the type of imaging system used. The XR200 can be used with REMOTE CABLE or TIME DELAY when used with film based systems or Computed Radiography (Phosphor Plate) systems. The XR200 should be used in the REAL TIME MODE when used with Direct Radiography systems (CCD, Amorphous Silicon or Amorphous Selenium plates, CMOS Detectors).

5.3 REMOTE CABLE OPTION

1. Attach a fully charged battery pack into the back of the XR200.
2. Plug the remote cable into XR200.
3. Place the imaging plate or cassette with film negative directly behind the object to be X-rayed. Make sure the cassette or imaging plate is close to the object. Distance between object and cassette will distort the X-ray image.
4. Place the XR200 two to four feet in front of the object with the front of the XR200 pointing directly at the object.



Figure 4: XR200, Cassette & Object

5. Insert key into key switch located on top of the control module. Turn on the XR200 by gently turning the key clockwise 1/4 turn.

6. In order to select the desired number of pulses for the XR200 first depress the RANGE SWITCH. The unit's digit of the LCD will blink twice and then go blank. The UNITS SWITCH can then be used to adjust the unit's digit of the LCD to the desired value.



Step 1



Step 2

7. Press the RANGE SWITCH again and the tens digit of the LCD will blink twice and go blank. The UNITS SWITCH can be used to adjust the tens digit to the desired value.



Step 3



Step 4

- Press the RANGE SWITCH again after the 10's digit has been entered to take the unit out of the pulse setting mode. If the RANGE SWITCH is not pressed a second time the unit will automatically exit the pulse setting mode after six seconds of inactivity. Both the units and tens digit will blink twice to indicate the pulses have been set and unit is out of pulse setting mode.
7. Retreat behind the XR200 the length of the cable.
 8. Fire the XR200 by depressing the button on the remote cable.
 - The XR200 **delays 5 seconds** before it begins pulsing.
 - The X-ray Warning Light blinks and the LCD displays the number of seconds that remain before the XR200 starts pulsing.
 - The XR200 will stop pulsing after it has completed the selected number of pulses.
 - The operator may stop the pulsing immediately by releasing the button on the remote cable at any time. The LCD will display the number of pulses that remain on the original pulse setting.
 9. Check the XR200 to see that original pulse count is on LCD.
 10. Turn off key switch.

5.4 DELAY MODE OPTION

Follow the same steps as the remote cable option with the following changes.

1. Do not attach remote cable.
2. After the pulses have been selected and the Exclusion Zone has been cleared of all personnel press the TIME DELAY button and retreat at least 10 feet (3m) behind the unit. *The timer starts at 60 seconds. If you hold the delay button down for 1.5 seconds the time delay will change to 15 seconds.*
 - The red warning light starts to blink and the unit makes a beeping sound as soon as the time delay button is pressed.
 - **Time delay sequence can be stopped by pressing the RANGE button, UNITS button, or turning the unit off.**
 - When the time delay counts down to 00 the red light stays on continuously and the XR200 begins pulsing.

5.5 REAL TIME IMAGING OPTION

This option is for the PC based Direct Radiography (DR) systems that have a control interface between the imaging system and X-ray unit. The interface may be a connector cable from the imager to X-ray unit or it may have a wireless interface.

Follow the same steps as remote cable operation with the following changes.

1. Plug the imager cable into the XR200 rather than the remote cable.
2. Set the pulses to 99.
3. Change the pulse default setting to 99 if it is not already 99. See section 5.6 for instructions to change the default pulse setting.
4. Place imager behind object to be X-rayed and X-ray unit in front of object to be X-rayed.
5. Refer to your imaging system operating instructions for specific details on setting pulses and firing the unit.
6. There is no built in delay when used in this mode. The X-ray will fire immediately unless there is a time delay in the imaging system.

5.6 DEFAULT PULSE SETTING

The default pulse setting displayed on the LCD can be altered by the user through the following steps.



Step 1



Step 2



Step 3



Step 4



Step 5

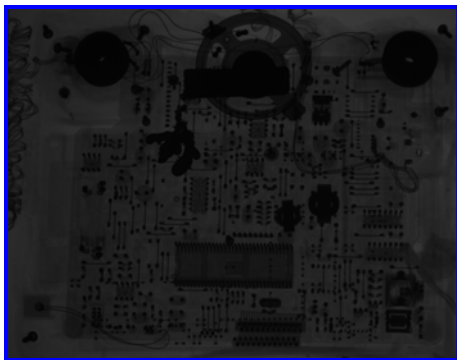
1. Set the count setting to the desired pulses as described previously and shown in steps one through four above. The digits in the LCD will blink indicating pulse setting is registered.
2. After the new pulse setting has been registered depress the UNITS SWITCH followed by the BLUE SWITCH as shown in step five above. Hold both switches down for 1.5 seconds.
3. Both digits of the LCD will blink indicating that the DEFAULT PULSE SETTING has been changed.
4. Verify the new DEFAULT PULSE SETTING by turning the power to the XR200 off and on while observing the LCD. The new setting should appear when the unit powers on.

5.7 SUGGESTED PULSE SETTINGS

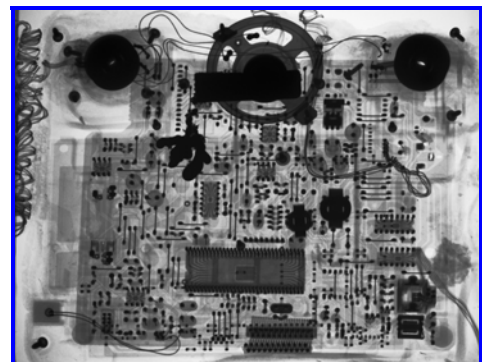
The chart on the following page lists approximate pulses necessary to penetrate various materials. Settings are based on use with Polaroid 803 film in a cassette with a Rarex regular screen. Distance between the front of the XR200 and cassette is 24 inches. **Note: Pulse settings vary depending on imaging system used and distance between X-ray unit and imaging medium.**

MATERIAL	PULSE SETTING
ENVELOPE	1-2
CARDBOARD BOX	2-3
LIGHT WOOD CONTAINER	2-4
HEAVY WOOD CONTAINER	5-6
PLASTIC BOX / APPLIANCE	4-6
LIGHT METAL CONTAINER	10
STEEL PIPE	50

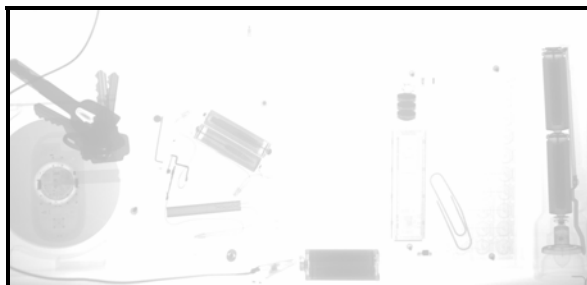
The following is true when using Polaroid positive film or digital imaging system that generates a positive image. If the radiograph is too dark, the film is underexposed. If the radiograph is too light the film is overexposed. **Underexposure** can be corrected by increasing the number of pulses and/or decreasing the distance between the imaging medium (film cassette, imaging plate, or imager) and XR200. **Overexposure** can be corrected by reducing the number of pulses and/or increasing the distance between the imaging medium and XR200.



Underexposed



Correct Exposure (Pulse Setting)



Over exposed



Correct exposure (pulse setting)

5.8 DUTY CYCLE WARNING. The maximum duty cycle for the XR200 is 200 pulses every four minutes – 3000 pulses per hour. Two consecutive pulse trains of 99 pulses can be fired then the unit should rest to cool down for at least four minutes. ***The XR200 is a light duty machine. It is not made to pulse continuously.***

6.0 SOFTWARE

The software program that controls the microcontroller can be identified by turning the key switch on while both push button switches below the LCD are depressed. The LCD displays the software version 62. After 62 is displayed the total number of pulses on the XR200 will be displayed in the LCD. Each digit represents 10,000 pulses. Example: If the LCD reads 04 the total number of pulses on the XR200 is between 40,000 and 50,000 pulses. After the total number of pulses is displayed the LCD will read 00 or the default value that was last stored on the unit.

The software program is capable of determining the state of battery charge based on the time between each pulse. As the battery loses charge the XR200 pulses slower with more time between each pulse. If there is more than .33 seconds between two consecutive pulses the following will occur:

- The XR200 continues the current pulse train to 00.
- After the XR200 stops pulsing, the LCD will go back to the original pulse setting, but the left and right digits will blink alternately.
- The condition indicates a low battery.
- The XR200 will be inoperable until the key switch is turned off and on, or the battery is replaced.

If there is more than one second between two consecutive pulses.

- The XR200 stops pulsing immediately and the LCD displays 00.
- This function prevents XR200 from pulsing continuously if there is a failure in detecting circuitry.
- This condition may indicate a low battery, electrical noise, or failure in detecting circuitry.
- The operator may need to replace the battery pack, turn key switch off and on, or send the XR200 back for repair.

7.0 MAINTENANCE

7.1 X-RAY DOSE MEASUREMENT Using a dosimeter, the average X-ray dose for new tube can be established.

- With the dosimeter located one foot from the front of the case and in line with the center of the beam angle label, the reading for 10 pulses should be between 27 and 40 mR.
- The leakage sheet illustrates the X-ray dose and maximum allowable radiation leakage levels for each X-ray unit. A completed copy of this form accompanies each X-ray.

7.2 TUBE REPLACEMENT: The XR200 tube should last at least 100,000 pulses. Under normal conditions the tube's output will decrease slowly with use. If the tube is broken or glass cracks the tube output will cease immediately. The following are tube replacement instructions.

1. Remove the battery before unscrewing the collimator. **WARNING! There is a potential of electric shock if the battery is not removed before unscrewing the collimator.**



2. To replace the tube unscrew the collimator.



3. Using needle nose pliers or your fingers grab the front of the tube and pull straight out.



XR200 Tube

4. Inspect the tube for any cracks, holes, or carbon build up.
5. Slide the new tube in the same way the old one was removed. When handling the tube do not touch the glass part of the tube. **Touch the metal part of the tube only.** Oils and dirt can deposit on the glass causing arcing and premature tube failure.
6. Screw the collimator back on the head.

8.0 TROUBLESHOOTING

PROBLEM	TEST	ACTION
No "power on" light or LCD blank with power on.	-Check battery voltage -Check battery connection -Check ¼ amp fuse.	- Replace or charge battery - Make sure battery is securely attached and battery clips are not bent or broken. - Replace fuse if necessary.
Power on lights, but X-ray does not pulse.	-Check the battery voltage. -Check the 20 amp fuse.	-Charge or replace the battery. -Replace the fuse if necessary.
X-ray pulses, but no image or black image.	-Test X-ray output with pocket dosimeter or into the screen of an open cassette. If the tube has output screen will have green glow with each pulse.	- Replace tube if necessary. - Make sure paper protecting the film negative was removed from cassette prior to firing the X-ray unit. - Make sure cassette was facing the right direction.
Unit stops pulsing in the middle of a pulse train and LCD displays 00.	-Check the battery voltage. -Check 20 amp fuse. -Check feedback line connection.	- Charge battery if necessary. - Replace the fuse if blown. - Make sure the screw holding wire to the oscillator board.
Oil leaking from unit.		Return for repair.

9.0 INSTRUCTIONS FOR REPAIR

- When returning a unit for repair, include a brief description of problem incurred, contact name, phone number, and return address.
- Remove battery before shipping the unit.
- Be sure the unit is securely packaged for shipment. Wrap in plastic if there is an oil leak.
- Ship to address: **Golden Engineering, Inc.,
6364 Means Road,
Centerville, IN 47330 USA
Phone: 1-765-855-3493**

9.1 HANDLE REPLACEMENT Requires T-10 torx driver.

The Handle has two sides that are held together with four screws. Three screws are in the handle and one screw in the base holds the handle strap together under the head.

1. Remove the 3 screws on the side of the handle.
2. Remove the base plate on the bottom of the unit.
3. Remove the screw on the bottom of the unit that holds the handle strap together.

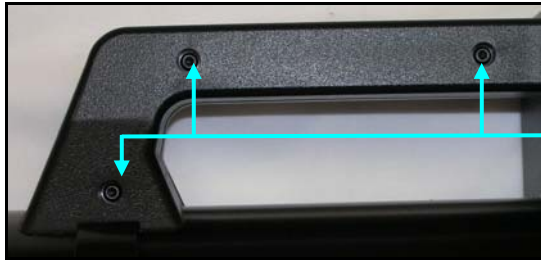


Figure 5: Handle

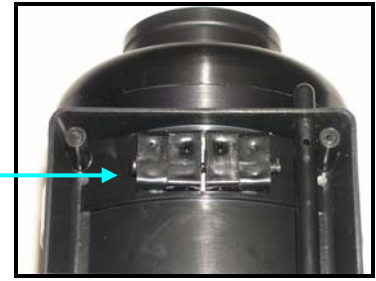


Figure 6: Handle strap base

4. Remove the half of the handle that is broken.
5. Place a small amount of glue on the protrusion from the control module.
6. Install new half of the handle.
7. Insert and tighten 3 screws in the handle and one screw in the handle strap.
8. Attach the base plate and insert all the screws that hold it in place.

9.2 FUSE REPLACEMENT Requires T-10 Torx driver & needle nose pliers.

1. Remove the back plate by first removing the 5 screws in the back plate then pulling the back plate off slowly maneuvering the battery terminal connecting wires through the opening in the oscillator board.
2. The 20 amp fuse is the white one inch long fuse on the left side of the oscillator board. The 3/4 amp fuse is a small green fuse just to the right of the 20 amp fuse. See diagram on page 20. The 20 amp fuse can be removed with fingers. The 3/4 amp fuse may require needle nose pliers to pull it out of the board. It should be pulled in a downward direction to remove from the board.

9.3 REMOVING THE BOARDS Requires T10 torx driver, Philips head screw driver, flat head screw driver, 3/32 Hex Key (Allen Wrench). Refer to the diagram on page 20 for steps 1-4.

1. Remove the five screws on the back plate. Remove the back plate slowly while maneuvering connection with the battery wires through the opening in the oscillator board. After the terminals are through the oscillator board, disconnect the red and black battery wires from the back plate.
2. Disconnect the two blue wires, red wire, and green signal wire. (Philips head screws)
3. There are three socket head cap screws holding the oscillator board in place. Two are in the middle of the board and one is at the bottom. Remove these three screws. Be aware of the 1/2 inch stand offs behind the oscillator board.
4. Remove the flat head screw in the upper left side of the oscillator board.
5. Pull the board out.
6. Disconnect the oscillator board from the counter board by pulling the bottom of the oscillator board up and away from the counter board. Disconnect the two pin white key switch connector, white three pin remote connector, and black touch pad connector.
7. Unscrew the LED bulb cover on the X-ray on LED.
8. Tilt the back of the counter board down until the LED clears the housing then pull the board out of the housing.

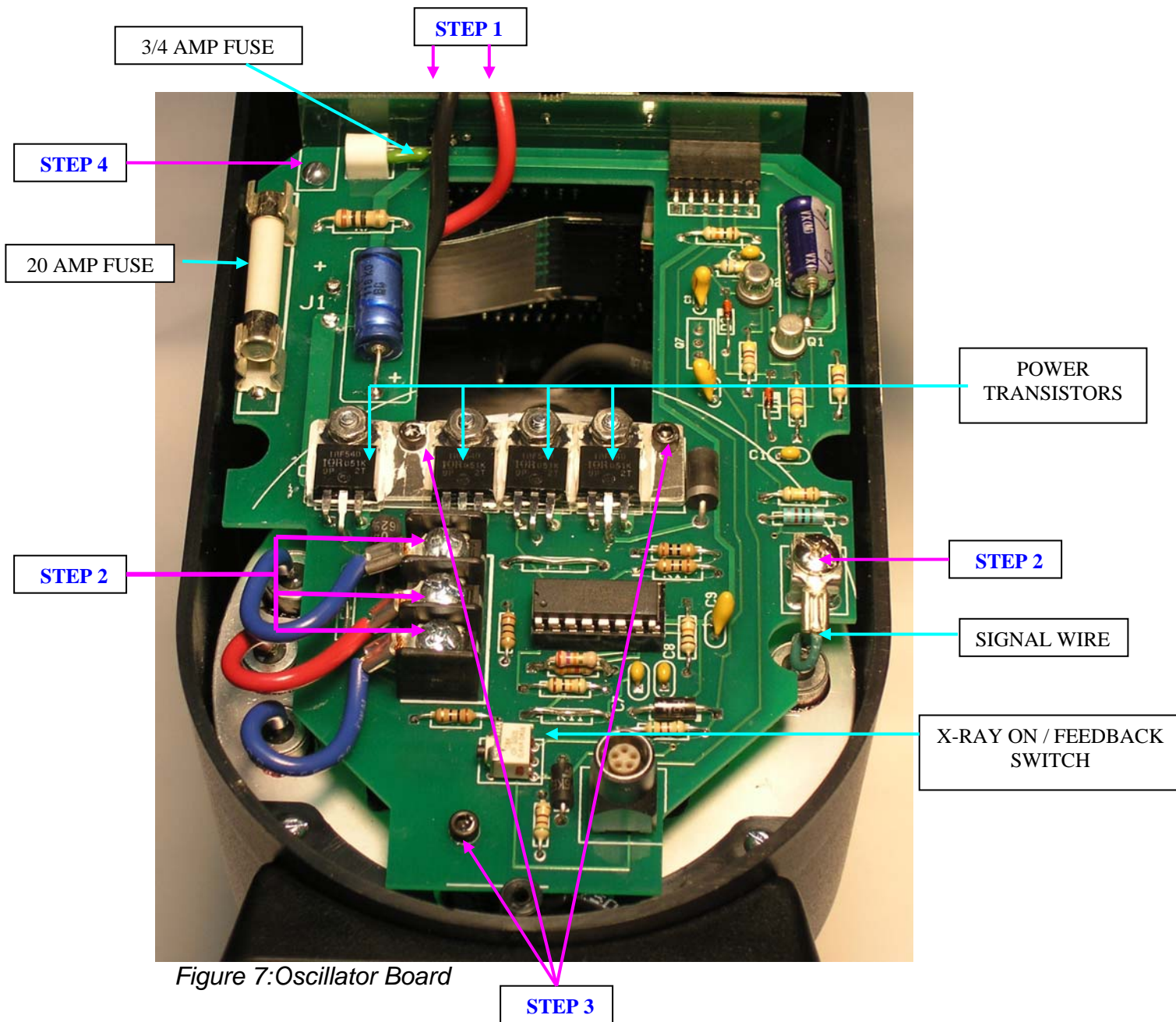


Figure 7: Oscillator Board

9.4 BOARD INSTALLATION

1. Slide counter board back into the top of the Control module housing just below the screw receptacles.
2. Push the counter board up so LED goes through the appropriate hole in the control module housing.
3. Connect the three white and one black connector.
4. Screw the LED cover back on.
5. Put the three cap screws through the oscillator board and then put the 1/2" offsets on the back of the screws.
6. Plug the oscillator board back into the counter board and push it in position.
7. Tighten the three screws holding the board in place.

8. Insert the flat head screw in upper left corner of the Oscillator board.
9. Attach the two blue wires, one red wire, and green signal line.
10. Reinstall the back plate.

9.5 HEAD REPLACEMENT Requires a small flat head screw driver.

1. Remove the boards as instructed above.
2. Remove the two screws on the bottom that attach the head to the control module.
3. Remove the screw on the upper left side of the head. Must rotate head slightly and put the screw driver through the left LED hole to remove the screw.
4. Pull the head straight out of the control module. You might need to loosen the screw in the handle to get the head out.

9.6 INSTRUCTIONS FOR BATTERY DISPOSAL Follow all federal, state, and local laws for disposal of nickel-cadmium batteries. Batteries may be returned to Golden Engineering for disposal.

10.0 WARRANTY

Certification of Warranty

XR200 Serial Number _____

Battery Charger Serial Number _____

150P Processor Serial Number _____

4"x5" Cassette/Developer Serial Number _____

Date Delivered _____

Unit Warranty

Golden Engineering, Inc. warrants the XR200 X-ray source made and sold by it or its authorized representatives to be free of defects in materials and workmanship for a period of twelve (12) months from the date of shipment to the end user. To make a claim under this limited warranty, customer must ship the entire unit (or the component believed to be defective) to Golden Engineering, post-paid. Golden Engineering, Inc. assumes no liability for units or components shipped until they are actually in the custody of Golden Engineering, Inc. Provided Golden Engineering, Inc. in its sole discretion, is satisfied that the defect is not the result of abuse, misuse, accident, modification or improper disassembly or repair, Golden Engineering, Inc. reserves the right to use reconditioned and remanufactured components that meet original specifications. The unit or component will be return shipped to customer at customer's expense. THIS EXPRESS LIMITED WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES AND GUARANTEES, EITHER EXPRESS OR IMPLIED OR CREATED BY OPERATION OF LAW.

THE XR200 X-Ray Source is manufactured by:

GOLDEN ENGINEERING, INC.

PO BOX 185

6364 MEANS RD.

CENTERVILLE, IN 47330 USA

Phone: 1-765/855-3493

Fax: 1-765/855-3492

WEB: www.goldenengineering.com

11.0 SPECIFICATIONS

11.1 PHYSICAL DIMENSIONS INCLUDING BATTERY PACK:

Length.....	12.5 inches (31.8 cm)
Width.....	4.5 inches (11.5 cm)
Height.....	7.5 inches (10 cm)
Weight.....	12 pounds (5.5 Kg) with battery

11.2 X-RAY OUTPUT.

X-ray dose per pulse.....	2.6 mR – 4.0 mR (.026-.040 mSv)*
Number of pulses per battery charge.....	4000.
Number of pulses per second.....	25 (nominal).
Expected life of XR200.....	100,000 pulses minimum.
X-ray source size.....	1/8 in. (3 mm)
Maximum photon energy.....	150 KVP.
X-ray pulse width.....	60 nanoseconds. (.00000006 seconds)

* Measured 12 inches (30 cm) in front of the unit.

11.3 ELECTRICAL AND THERMAL CHARACTERISTICS.

Battery Voltage.....	14.4 volts.
Battery Type.....	Nickel Cadmium sub C cells.
Battery recharge time.....	One hour.
Battery Charger.....	DeWalt DW9116 or DE9108 one hour charger.
Current draw.....	35 amps @ 13.4 volts.
Temperature range.....	-10 to 120 degrees F. (-23 to 50 degrees C)
Maximum duty cycle.....	200 pulses every 4 minutes. (3000 pulses per hour)
Warm-up.....	None required.

11.4 X-RAY LEAKAGE

X-ray leakage 10 mR per 100 pulses maximum
on the side of the unit, 3 inches from the center of the unit. 3 mR per 100
pulses 2 inches behind the unit.

SPARE PARTS AND ACCESSORIES FOR THE XR200

ITEM	PART#
Spare Tube	1090150
Thumbwheel Key.....	5951020
Flat key.....	5951040
DeWalt Battery DC9091	4100030
DeWalt battery charger (110V) DW9116	4100040
DeWalt battery charger (220V) DE9108.....	4100050
Remote cable.....	2006050
Tripod mount.....	2008010
Handle - left side.....	4004020
Handle – right side.....	4004021
Small Pelican® carrying case (holds X-ray, two batteries, charger, cable....	4001635
Large carrying case (holds X-ray, accessories, 150P film system).....	4001670