TECHNICAL MANUAL

Faxitron Specimen Radiography System
Model MX-20

CONTENTS **SECTION**

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REVISION RECORD

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9	2321A1108		9	9	9	9	9	9	9	9	9	May 1, 2009
10												

MAINTENANCE WARNING

TO BE SERVICED BY QUALIFIED PERSONNEL ONLY

Serious injury (both physical and genetic) can result if all X-ray shielding is not properly replaced or interlocks are not operating after maintenance. Proper shielding replacement and interlock operation can only be confirmed by performing a radiation survey before placing the system in operation, and before use whenever the system is moved or serviced.

INSTALLATION WARNING

Faxitron X-Ray LLC employees can perform a radiation leakage survey during installation of your FAXITRON system. These persons are competent but may not be considered qualified experts. Check with your state radiation control authority to determine what the particular survey requirements are in your state. It might be required, that a qualified expert must survey the installation before placed in routine operation.

SAFETY SUMMARY

The following general safety precautions must be observed during all phases of operation, service, and repair of this system. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture and intended use of the system. Faxitron X-Ray LLC assumes no liability for the customer's failure to comply with these requirements.

To ensure personnel safety, it is necessary that a radiation meter be used to check for radiation leakage during installation, after extensive maintenance, periodically (not to exceed six months), and after moving the system. The radiation meter must have adequate accuracy at maximum kVp and beam quality of the X-ray unit surveyed..

Geiger-Mueller and certain other scintillation-type radiation meters can be useful for making qualitative measurements of radiation from FAXITRON Systems, such as determining the location of "hot spots". However, these types of meters should only be used for quantitative measurements when they have been calibrated to the energies in question. It is recommended that the user consult their Radiation Protection Professional for guidance on these measurements.

Faxitron X-Ray LLC Service Centers can perform this survey upon initial installation as well as provide operational checks and user instructions. This should be an essential part of every sale in order to validate the system's warranty and ensure maximum radiation protection. The manufacturer considers the National Bureau of Standards Classification of FAXITRON Systems a Protective Installation.

Y2K PRODUCT COMPLIANCE

The MX-20 Specimen Radiography System has no date related processing ("NDRP") and is therefore Year 2000 Compliant.

GOVERNMENT REGULATIONS

The MX-20 Specimen Radiography System conforms to standards set by the US Food and Drug Administration, Center for Devices and Radiological Health, (21 CFR-1020.40) and as such it does not require an installation report. However, as an X-ray source it may require to be registered in your state.

This product complies with 21 CFR 1040.10 and 1040.11 except for deviations pursuant to Laser Notice No. 50, dated July 26, 2001. Also complies with IEC 60825-1.

This product is classified by Underwriters Laboratories Inc. in the U.S. and Canada with respect to electrical fire, shock, and mechanical hazards and has been tested to comply with the European Low Voltage and EMC directives.

Certain states in the U.S. have radiation control regulations that require registration of radiation sources with cognizant state and/or local jurisdiction public health agencies. Registration normally must be made immediately or within 30 days of acquiring each such source. Please telephone or write your state or local public health agency for registration information pertinent to this installation.

OPERATOR SAFETY

FAXITRON Systems should be operated only by personnel who have been instructed in radiation safety and in operating instructions set forth in this manual. Faxitron X-Ray offers a Interactive Radiation Safety Training course on a CD. This CD describes what ionizing radiation is and its different types, the biological effect of ionizing radiation and associated risks, the basic principles of radiation protection and the different types of radiation monitors and their use. Please contact Faxitron X-Ray for more information. In addition, Faxitron X-Ray LLC recommends the use of a radiation film badge service for cumulative individual personnel monitoring. To obtain a film badge service and a radiation meter, contact the State Board of Health, a large hospital or an X-ray laboratory.

MOVING THE SYSTEM

It is permissible to move a FAXITRON System after initial installation. However, due to possible mishandling, it is essential that a radiation survey be performed after any move to prevent hazards to personnel.

DO NOT OPERATE IN AN EXPLOSIVE ATMOSPHERE

Do not operate the system in the presence of flammable gases, fumes, or suspended dust particles. Fire or explosions could result because of ignition from electrical arcing.

GROUND THE SYSTEM

To minimize shock hazard, the system chassis and cabinet must be connected to an electrical ground. The instrument is equipped with a three-conductor AC power cable. The power cable must be plugged into an approved three-contact electrical outlet.

CHECK FOR PROPER WALL PLUG POLARITY

To retain optimum safety of the system in the event of improbable but possible electrical failures, it is important that the system be connected to a properly wired outlet. A properly wired outlet should give the following readings when checked with an AC voltmeter:

Neutral to Ground = 0 volts

Line to Ground = 120 volts

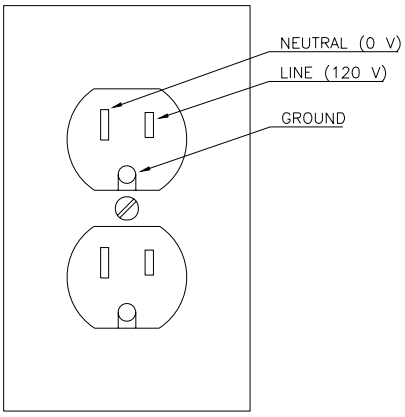

Figure 0-1. Power Receptacle

DO NOT SUBSTITUTE PARTS OR MODIFY SYSTEM

Because of the danger of introducing hazards, do not install substitute parts or perform any unauthorized modification to the system. Request assistance from a Faxitron X-Ray LLC Sales and Service Office for service and repair to ensure that safety features are maintained.

NOTE: The laser energy source provided with this product is compatible only with the lasers used and specified in Section 9 of this manual. Any adjustments made to this product, other than those specified in this manual, may result in non-compliance with 21 CFR 1040.10 and 1040.11.

KEEP AWAY FROM LIVE CIRCUITS

Operating personnel must not remove instrument covers. Component replacement and internal adjustments must be made by qualified maintenance personnel. Do not replace components with power cable connected.

DO NOT SERVICE OR ADJUST ALONE

Do not attempt internal service or adjustment unless another person, capable of rendering first aid and resuscitation, is present.

AVOID ENVIRONMENTAL EXTREMES

The MX-20 is designed to be operated and stored in controlled environments only. This system should not be exposed to extremes in temperature or humidity.

DANGEROUS PROCEDURE WARNINGS

Warnings, such as the example below, precede potentially dangerous procedures throughout this manual. Instructions contained in the warnings must be followed.

WARNING

During some maintenance procedures, dangerous radiation and high voltages, capable of causing death, are present in the system. Use extreme caution when handling, testing and adjusting.

CAUTION

CARE SHOULD BE TAKEN WHEN OPERATING THIS MACHINE WHEN HIGH ELECTROSTATIC POTENTIALS ARE PRESENT. ELECTROSTATIC DISCHARGES MAY CAUSE LOSS OF FUNCTION AND/OR FILM ARTIFACTS TO OCCUR.

FAXITRON® LIMITED WARRANTY STATEMENT

Faxitron X-Ray LLC (FX) warrants this Faxitron® X-ray Product against defect in material and workmanship for a period of one year from the date of first sale. If FX receives notice of such a defect during the warranty period, FX shall, at its option either repair or replace materials which prove to be defective.

If FX is unable, within a reasonable time, to repair or replace any product to a condition as warranted, Buyer shall be entitled to a refund of the purchase price upon return of the Product to FX at Buyer's expense.

LIMITATION OF WARRANTY

The limited warranty shall not apply to defects in the Product resulting from:

1. Improper or inadequate maintenance by Buyer;
2. Buyer-supplied software for interfacing;
3. Unauthorized modification or misuse;
4. Operation outside of the environmental specifications for the Product; or
5. Improper site preparation and maintenance.

THE LIMITED WARRANTY SET FORTH ABOVE IS EXCLUSIVE AND NO OTHER WARRANTY, WHETHER WRITTEN OR ORAL, IS EXPRESSED OR IMPLIED, IS INTENDED. FX SPECIFICALLY DISCLAIMS ANY IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. IN NO EVENT SHALL FX BE LIABLE UNDER THIS LIMITED WARRANTY FOR ANY CONSEQUENTIAL DAMAGES INCURRED BY ANY PERSON BY REASON OF USE OR DEFECT IN THE PRODUCT NOR SHALL FX BE LIABLE HEREUNDER FOR MORE THAN THE PURCHASE PRICE PAID FOR THE PRODUCT.

May 2009

SECTION 1

GENERAL INFORMATION

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SECTION 1

GENERAL INFORMATION

1.1 INTRODUCTION.

The MX-20 is a Cabinet X-ray Unit specially designed for high detail radiographic imaging of medical specimens. The exceptionally high magnification capability from the 0.02 mm focal spot with optimized cabinet geometry and the superior contrast available from the low kV capability provides enhanced image performance.

Due to its compact size, the MX-20 can be placed away from patient areas, such as directly outside the operating room or in a non-patient area of the radiology department to provide rapid verification that the correct tissue is excised during biopsy. When used in the pathology laboratory, the MX-20 may serve a number of applications essential to the efficient processing of tissue and bone specimens for accurate diagnosis.

The standard MX-20 is equipped with simple and convenient manual controls for selection of exposure time and X-ray tube kilovoltage. Included is also a Laser Locator using two crossed narrow beams to indicate the center of the X-ray beam. This makes position of samples precise and convenient.

An optional automatic exposure control, AEC, is also available. With this option, the standard manual or the automatic exposure control can be selected. The automatic exposure control helps the operator to select the optimum kVp and determine correct exposure time. An ionization chamber (exposure sensor) under the film shelf, monitors the X-rays penetrating the object and reaching the film, and terminates the X-ray when the proper exposure has been achieved. With the automatic exposure control, good pictures are more consistently obtained by inexperienced operators.

Other options include the different Digital Cameras as shown in 1.2 System Description. The Digital Camera options provide digital imaging capability to the standard MX-20 system. The different cameras available with field of view of 2 x 2, 2 x 4, 4 x 4 or 4.7 x 4.7 inches. The cameras has up to 10 lp/mm resolution and provides instant on-screen viewing of specimen x-ray images.

As with all x-ray generating devices, proper care is required to ensure that the MX-20 is operated and maintained within the guidelines established by the manufacturer and government regulatory agencies. This manual contains the guidelines to be used to obtain optimum performance as specified by the manufacturer, as well as procedures to be followed should service become necessary.

1.2 SYSTEM DESCRIPTION

MX-20	**FAXITRON Specimen Radiography System;** 10 - 35 kV constant potential output voltage; 0.3 mA continuous current; X-ray tube with 0.02 mm focus; shielded cabinet; safety interlocks; 100 - 120 or 180 - 240 VAC, 50/60 Hz operation.

OPTIONS

A02X	**Automatic Exposure Control.** Regulates exposures based on absorbed dose rather than time. Film densities can be repeatable achieved through the use of the ACE sensor which is placed under the film cassette or envelope. Note: A02X can not be installed together with a Digital Camera.
DC2	**Digital Camera.** Dalsa, CCD type. 50 x 50 mm (2" x 2") field of view.
DC4	**Digital Camera.** Dalsa, CCD type. 50 x 100 mm (2" x 4") field of view.
DC22	**Digital Camera.** Bioptics, CMOS type. 50 x 50 mm (2" x 2") field of view.
DC24	**Digital Camera.** Bioptics, CMOS type. 50 x 100 mm (2" x 4") field of view.
DC44	**Digital Camera.** Bioptics, CMOS type. 100 x 100 mm (4" x 4") field of view.
DC5	**Digital Camera.** Hamamatsu, CMOS type. 50 x 50 mm (2" x 2") field of view.
DC10	**Digital Camera.** Hamamatsu, CMOS type. 100 x 100 mm (4" x 4") field of view.
DC12	**Digital Camera.** Hamamatsu, CMOS type. 120 x 120 mm (4.7" x 4.7") field of view.

1.3 SPECIFICATIONS.

RADIATION SAFETY

- Radiation shielded cabinet.
- Compartment door equipped with dual safety interlocks.
- Radiation: Less than 0.1 mR/hr at 5 cm (2 in.) from exterior surface at maximum kV.
- Certified to comply with standards set by the US Food and Drug Administration, Center for Devices and Radiological Health, (21 CFR-1020.40).
- Complies with 21 CFR 1040.10 and 1040.11 except for deviations pursuant to Laser Notice No. 50, dated July 26, 2001.
- Classified by Underwriters Laboratory in the US and Canada.

X-RAY TUBE

Focal spot size	0.02 mm
kVp	10-35
mA	0.3
Beryllium window thickness	0.25 mm
Target material	Tungsten
X-ray beam divergence	40 deg.

BEAM COVERAGE (BC) AND SOURCE TO OBJECT DISTANCE (SOD) AT DIFFERENT SHELF POSITIONS/MAGNIFICATIONS FACTORS

Shelf Position/ Mag. Factor	BC diameter cm (inches)	SOD cm(inches)
5	8.3 (3.3")	11.4 (4.5")
4	10.4 (4.1")	14.3 (5.6")
3	13.9 (5.5")	19.1 (7.5")
2	20.8 (8.2")	28.6 (11.3")
1.5	27.7 (10.9")	38.1 (15.0")
1 (bottom)	41.6 (16.4") see note b	57.2 (22.5")

Note: a. Radiation intensity exhibits normal “heel” effect, typical charts available upon request.
b. Beam coverage limited to the inside size of the cabinet, 35.5 x 40.6 cm (14" x 16").

RADIOGRAPHIC MAGNIFICATION: Up to 5 times

ENERGY RANGE: 10 - 35 kV, Constant Potential

X-RAY TUBE CURRENT: 0.3 mA

EXPOSURE CONTROL: a. Standard: Manual timer 0.1 to 999 seconds
b. Option A02X: Automatic and manual.

LASER INFORMATION: Peak Power 2 mW, Wavelength 670 nm.

POWER REQUIREMENTS: 100 - 120 or 180 - 240 VAC, ±10%, 50/60 Hz, 150 VA

SPECIFICATIONS (cont'd)

ENVIRONMENTAL CONDITIONS: This equipment is designed for the following conditions:

- Indoor use
- Altitude up to 2000 meters
- Temperatures 5°C to 40°C
- Maximum relative humidity 80%
- Pollution Degree 2
- Over-voltage Category II

FUSES

All fuses are 250 Volt, Slow Blow, 5 x 20 mm.

Location	Circuit	Fuse Value	Type Number
Power Receptacle	AC Power Input	5 Amp	T5A/250V
Power Receptacle	AC Power Input	5 Amp	T5A/250V
Power Supply, FS1	+5 VDC Supply	8 Amp	T8A/250V
Power Supply, FS2	+12 VDC Supply	5 Amp	T5A/250V
Power Supply, FS3	-12 VDC Supply	2 Amp	T2A/250V
Gun Board, F1	-12 VDC Supply	0.5 Amp	T500mA/250V
Gun Board, F2	+12 VDC Supply	2 Amp	T2A/250V
Gun Board, F3	+24 VDC Supply	2 Amp	T2A/250V
Camera Board (Optional), F1	+5 or +21 VDC *	1 or 0.5 Amp *	T1A or T500mA/250V *
Camera Board (Optional), F2	+5 0r -21 VDC *	1 or 0.5 Amp *	T1A or T500mA/250V *

***** Depends on the type of Camera and Camera Pwr Board used.

EXTERIOR DIMENSIONS (Approximate)

	Without Digital Option		With Digital Option	
	mm	inches	mm	Inches
Height	737	29	864	34
Width	432	17	432	17
Depth	470	18.5	470	18.5

COMPARTMENT INTERIOR DIMENSIONS (Approximate)

	mm	inches
Height	480	18.9
Width	356	14
Depth	406	16

WEIGHT (Approximate)

	Without Digital Option		With Digital Option	
	kg	lbs	kg	lbs
Net	62	135	70	155
Shipping	77	170	88	195

1.4 DIGITAL CAMERA OPTIONS

1.4.1 Computer System Requirements

Processor	Pentium 4 or better with spare ISA slot
Speed	3 GHz or faster
Operating System	Windows XP
Hard Drive	80 GB, SATA, 7200 RPM min.
System RAM	2.0 GB min.
Video RAM	256 MB, 64 bit Video Display w/ DVI
CD ROM	48X32 or faster CDRW/DVD Combo
Network Connectivity	Ethernet capable 10/100/1000
USB	2.0 compatible
Removable Mass Storage	Read/Write CD ROM
Monitor	17 - 21", 1280 x 1024 Resolution 0.25 mm max. dot pitch
Printer	Medical Grade Imager, DICOM capability recommended, Codonics NP-1660M or equivalent

Note: Software upgrades, telephone and modem support are currently offered free of charge. Please contact Faxitron X-ray LLC for additional information.

1.4.2 Dalsa and Bioptics Cameras.

Interface Software Handshake Protocol

The MX-20 uses the following control signals to communicate with the Dalsa/Bioptics interface PCB:

XREQ: Active low output signal from the MX-20 to the computer which indicates that the operator wishes to make an exposure.

CCD: Active low input signal to the MX-20 which indicates that the camera has cleared the CCD and is ready for X-ray.

PREP: Active low output signal from the MX-20 to the computer which indicates when X-ray has begun. Returns to high state at the end of the exposure.

AEC: Input signal to the MX-20 from the computer which indicates that a camera is present and is also used to terminate the exposure in progress by going to a high state. Prior to exposure the signal should be in a low state.

The startup and exposure sequence are as follows:

1. Upon power up the MX-20 looks for the AEC input signal to be in a low state indicating that the camera is present and the imaging software has been started. If not present the MX-20 will display “nc” in the kV display indicating “No Computer”. The Ready light on the MX-20 front panel will also be off. Once the imaging software has started the kV display should indicate the operating kV and the ready light will come on provided the 90 second warm-up time has completed and the door is closed.

2. With the imaging software is ready to make an exposure the operator presses the start button on the front of the MX-20. The MX-20 sets the XREQ output signal low and enters a 400 msec loop looking for a active low CCD ready signal. If at the end of the 400 msec loop no CCD signal is detected the exposure process is terminated with no x-ray being produced. If a CCD signal is present the MX-20 starts the process of turning on the kV and enabling tube current. At that moment the PREP output signal is brought low for the duration of the exposure.

3. Once an exposure has begun the MX-20 looks for the AEC input signal to go high indicating that the camera has finished integrating. The MX-20 turns off x-rays and sets the XREQ and Prep signal to their high states. The computer should place the AEC signal to an active low state for the next exposure. A ten second backup timer is used in the MX-20 that will terminate the exposure if the proper AEC signal is not received. This will also happen if the operator presses the stop button or opens the door during the exposure.

1.4.3 Hamamatsu DC5, DC10 and DC12 Cameras.

The MX-20 uses the following control signals to communicate with the application software used with the Hamamatsu DC5, DC10 and DC12 digital cameras:

The communication between the software and the X-Ray control unit consists of a Serial Port (RS232) connection. The software can set values and query values from the X-Ray Unit using the following protocol:

A. The X_REQUEST protocol

- The Software shall provide a mode of operation that allows it to monitor the X_REQUEST protocol of the X-Ray hardware handshake interface by listening to the serial interface for events to determine when the X-Ray unit has requested an exposure.
- The Unit shall send an ‘X’ character to the software, which will cause an event to prepare the camera for acquisition.
- Once the Software has prepared the camera for acquisition, it will send a ‘C’ character to the Unit telling it to begin X-Ray generation.
- The Unit will send a ‘P’ character back to the Software to indicate that the X-Ray generation has begun. At this point the software will begin exposure on the camera and present the user with a ‘Busy’ dialog telling them that the Unit is generating X-Rays.
- After the exposure time, the Software will send an ‘A’ character to the Unit telling it to stop generating X-Rays.
- The Unit will then send an ‘S’ character to the Software to reset the process.

1.4.3 Hamamatsu DC5, DC10 and DC12 Cameras, cont'd

B. Setting and Querying of Data

The Setting and Querying of Data to/from the Unit is defined as follows:

a. Data Request messages are of the form:
?<Command Character><Carriage Return> (Example: ?D\r)

b. Data Set messages are of the form:
!<Command Character><ARGS><Carriage Return> (Example !MF\r)

The allowable Command Characters are:

Command Character: **V** - kV voltage display.
!Vnn\r – Set the kV to a value
?V\r – Response is à ?Vnn\r

Command Character: **M** - Operating Mode
!M<F = Film Mode, R = Remote Mode>\r
?M\r – Response is à ?M<F, M>\r

Command Character: **D** - Device Type
?D\r – Response is à ?Dxx-xx\r Where xx-xx can be one of:
DX-50
LX-60
MX-20
Note: It is no way to set this value.

Command Character: **R** - EPROM Version
?R\n – Response is à ?Rnn.n\r
Note: It is no way to set this value.

Command Character: **S** - Device Status
?S\r – Response is à ?Sx\r Where x can be one of:
W – Device is in warm up mode.
D – Device door interlock is open.
R – Device is ready.
Note: It is no way to set this value.

Command Character: **T** - Exposure Time.
!Tnnnn\r will set the exposure time to a specified time setting (formatted as below).
?T\r – Response is à ?Tnnnn\r Where nnnn is the time setting in tenths of a second.
Examples: 100 Seconds will appear as 1000
78.5 seconds will appear as 0785
!B\r will ask the unit to start an exposure (same function as pressing the start button on the device).

1.5 DECALS AND LABELS

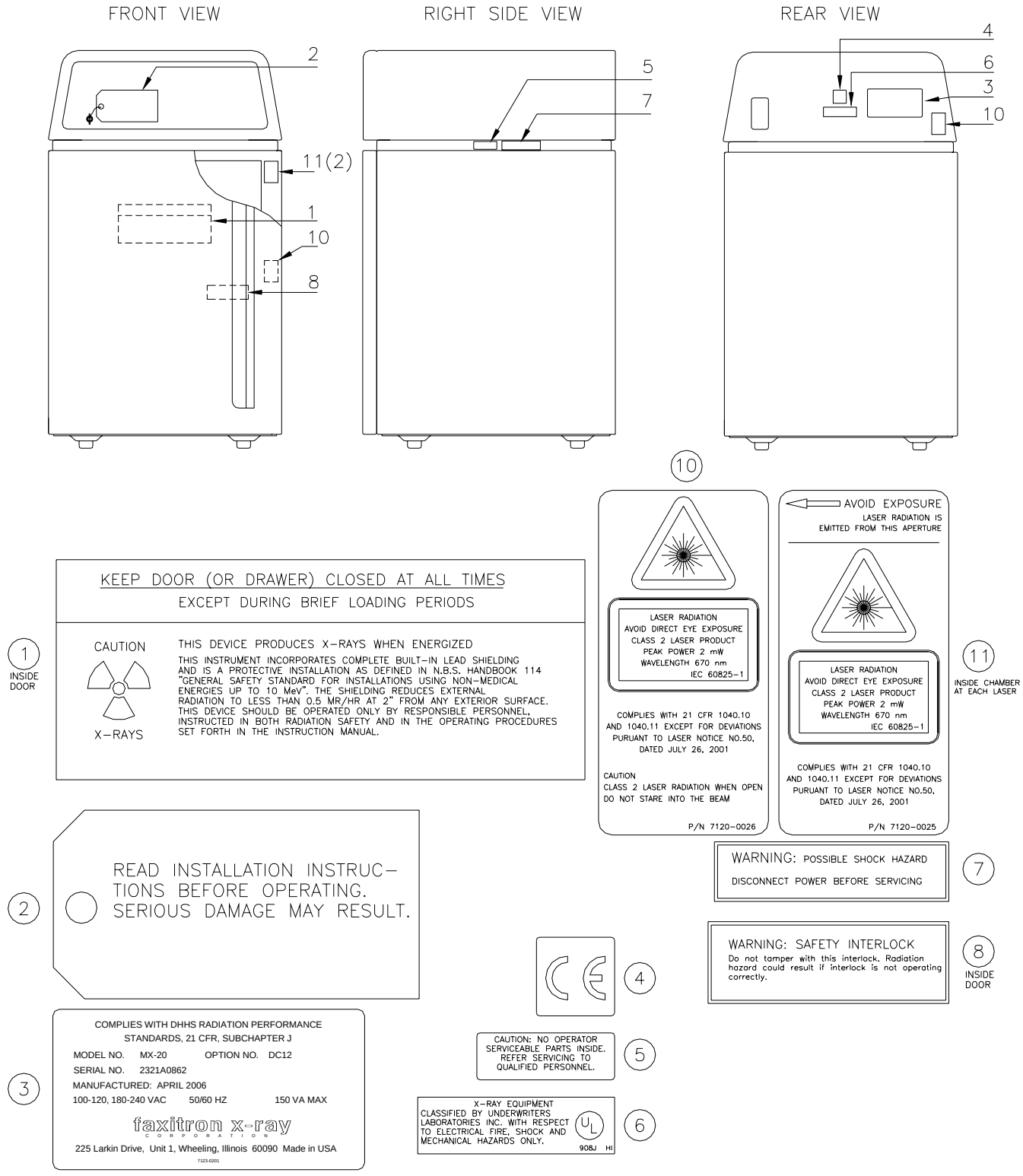

Figure 1-1. Location of Decals and Labels

SECTION 2

INSTALLATION

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SECTION 2

INSTALLATION

2.1 INTRODUCTION.

This section contains information and instructions necessary for installing Faxitron Model MX-20 Specimen Radiography System. Included are initial inspection procedures, power and grounding requirements, environmental information, installation procedures and instructions for repackaging for shipment.

2.2 INITIAL INSPECTION.

Each Faxitron system is carefully inspected both mechanically and electrically before shipment. It should be free from scratches and in perfect operating order upon receipt. To confirm this, the system should be inspected for physical damage incurred in transit. If damage is found, refer to the claims paragraph in this section. Retain the packing material for possible future use.

2.3 PREPARATION.

The MX-20 should be handled with care to prevent injury to personnel and/or damage to the equipment. The MX-20 system has a shipping weight of about 77 kg (170 lbs).

WARNING

Read the Safety Summary at the front of this manual before installing or operating the system.

NOTE. In the Continental United States, Hawaii, Alaska, Canada and certain European Countries, you can get assistance with installation from an FXC field engineer by contacting the nearest Faxitron X-Ray LLC Sales/Service Office. The field engineer will also perform or arrange for a radiation safety survey, and he will assist in training customer personnel in proper operation and use of the system.

2.4 UN-CRATING THE MX-20.

1. Cut strap band(s) and remove top cover and shroud. See Figure 2-1.Remove any accessories or documentation.
2. Remove the MX-20 from pallet. See Figure 2-2.The weight of the MX-20 is 62 kg (135 lbs) and it can therefore be lifted from the pallet by two persons. Save the packing material. Check for any damage and follow instructions in the "Claims" paragraph later in this section.

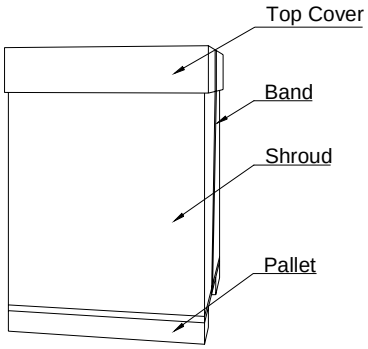


Figure 2.1
MX-20 Crated

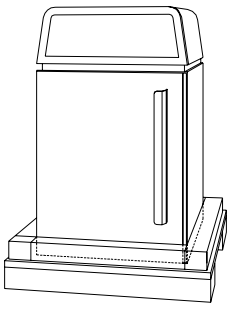


Figure 2.2
MX-20 on Pallet

2.5 INSTALLATION

Place the MX-20 on a sturdy, leveled table or bench in the area where the unit is to be operated. In areas where earth quake regulations are in effect, follow federal and local regulations to secure the system.

2.6 POWER REQUIREMENTS

1. For protection of operating personnel, Faxitron X-Ray LLC requires that instrument panel and cabinet be grounded. The instrument is equipped with a three-conductor AC power cable that, when connected to an appropriate receptacle, grounds the instrument through the offset pin. Further, check to make certain the wall outlet is properly wired. See Figure 2-3.

2. The MX-20 requires a power source of 100-120 or 180-240 VAC, ±10%, 50/60 Hz, that can deliver 150 VA.

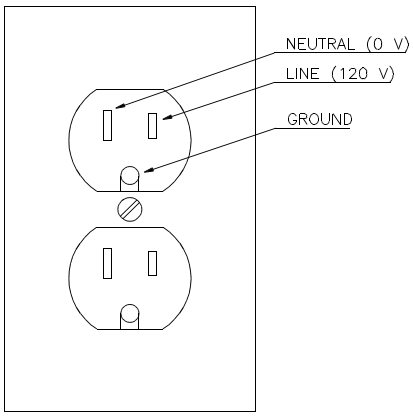


Figure 2-3. Power Receptacle

2.7 OPERATIONAL CHECKOUTS AND RADIATION SURVEY.

Perform operational checkouts and radiation survey as follows:

WARNING

A radiation meter, with adequate accuracy at maximum kVp and beam quality of the X-ray unit surveyed, is required for personnel safety during performance of this procedure.

1. Make certain that the system has been installed securely on a sturdy, leveled table or bench.

2. Check that the power cord is disconnected.

3. See Figure 2-4 and remove the top cover. After removing two screws from each side, use a screw driver and wedge out the lower edge before lifting it up and away from the unit.

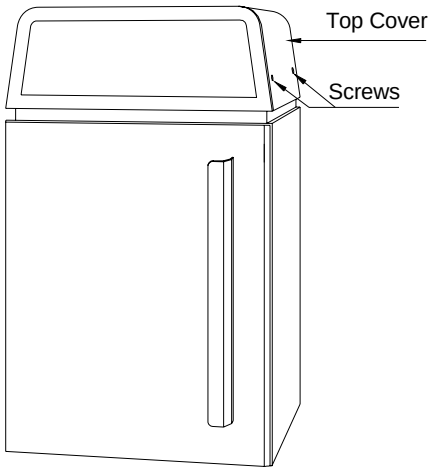


Figure 2-4
Removing Top Cover

Operational Checkouts and Radiation Survey (cont'd)

4. When the top cover has been removed, inspect all components visible in the power and control sections. See Figure 2-5. Pay special attention to connectors etc. which could come loose during shipment of the unit.

5. Locate the key for the On/Off Key Switch and place it in the Key Switch (see Figure 3-1 in the Operating Section). Make certain that the Key Switch is in its off position.

> **WARNING**
>
> During some maintenance procedures, dangerous radiation and high voltages, capable of causing death, are present in the system. Use extreme caution when handling, testing and adjusting.

6. Locate the power cord and attach it to the receptacle located on the back panel. Make certain that the switch built into the power cord receptacle is in the off position. Connect the power cord to a properly grounded AC power source of 100-120 or 180-240 VAC, ±10%, 50/60 Hz and turn on the switch built into the power cord receptacle.

7. Make certain that the cover for the high voltage unit, as shown in Figure 2-5, is secured in its place. Also, in the following steps, be careful not to come in contact with any live circuits exposed in the power and control sections.

8. Read through the operating section of the manual and then follow the step-by-step operating instructions for the manual mode.

9. Set 20 kV and 300 seconds, then make an exposure.

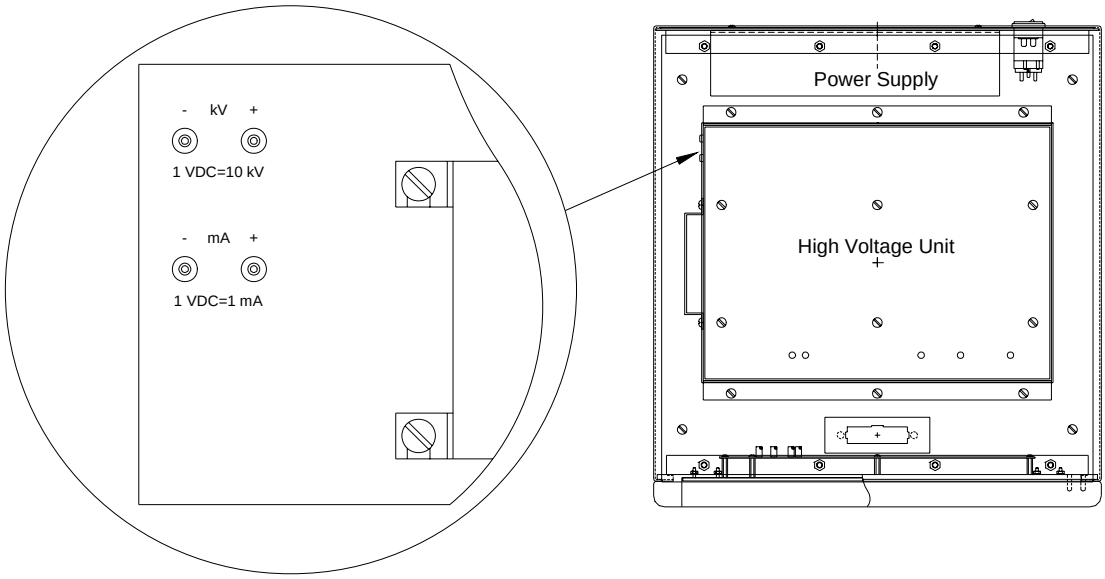


Figure 2-5. Power and Control Sections

Operational Checkouts and Radiation Survey (cont'd)

10. Check kV and mA calibration by connecting a digital voltmeter to the calibration points shown in Figure 2-5 and making 30 seconds exposures at 10, 20 and 35 kV. Record the values in Table 2-1 for future reference. If the values recorded are not within the reference values, contact your Faxitron X-Ray LLC Sales/Service Office for assistance.

kV	kV Calibration Voltage		mA Calibration Voltage		Notes
	Measured VDC	Reference VDC	Measured VDC	Reference VDC	
10		0.95-1.05		0.285-0.315	
20		1.90-2.10		0.285-0.315	
35		3.33-3.67		0.285-0.315	

Table 2-1

11. Perform a radiation survey as described in section 8 of this manual.

12. Start an exposure at 20 kV and 300 seconds. Open the Exposure Chamber Door slowly and check that the exposure is terminated and the Door Indicator **3**, X-RAY ON Indicator **4**, Ready Indicator **5**, and X-RAY ON Indicator **11** goes off. See Figure 3-1 in the operating section of the manual.

13. Close the Exposure Chamber Door and make certain that both X-RAY On Indicators **4** and **11** remain off.

14. For units delivered with the optional Automatic Exposure Control (AEC), check the response time in the following way:
    a. See the step-by-step operating instructions for the AEC and set the controls as follows: 20 kV, AEC Mode, Density to 100% and Film to F5.
    b. Without any object or shelf in the exposure chamber, make an exposure and confirm that the exposure terminates instantly.

15. If the unit is delivered with the Digital Camera Option, connect it to the computer system, install the software and check the operation according to the operation section of this manual.

16. Finally, if the unit has the optional Laser Locator, check that it is properly aligned and that the center of the cross is centered with the center beam marker in the bottom of the cabinet. If the Digital Camera Option is installed, the center of the cross should be centered with the camera opening.

17. This completes the installation check. Turn off the unit, disconnect the power cord and install the top cover.

18. Fill out the Installation Report supplied with this manual and return the top copy to:

    Faxitron X-Ray LLC
    Customer Service manager
    575 Bond Street
    Lincolnshire, IL 60069, U.S.A.

Retain the bottom copy and place it in the manual for permanent record.

2.8 CLAIMS.

The warranty statement applicable to the system is included after the title page of this manual. Save all packing material. If physical damage is found or if operation is not as specified when the instrument is received, notify the carrier and the nearest Faxitron X-Ray LLC Sales/Service Office immediately.

If reshipment is required, consult your nearest Faxitron X-Ray Sales/Service Office for assistance. If the original shipping crate is not available, use of padded van is recommended. After moving the system, a radiation survey and incoming inspection per the Maintenance Table in Section 7 is required.

SECTION 3

OPERATION

CONTENTS **PAGE**

SECTION 3

OPERATION

3.1 CONTROL PANEL, (see Figure 3-1).

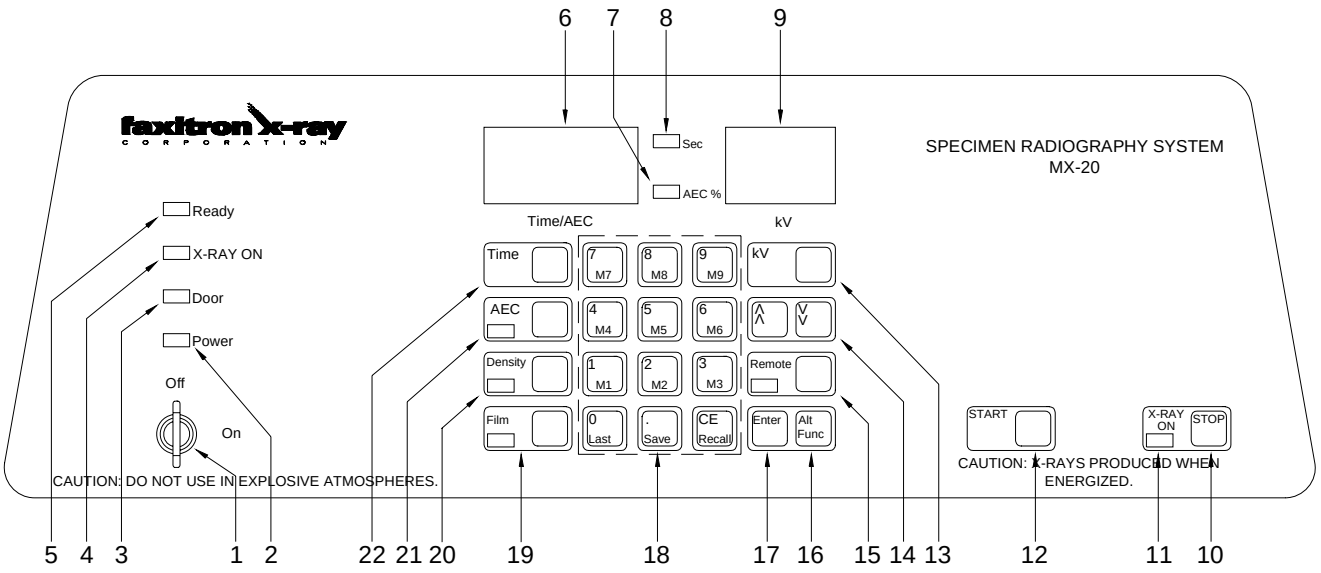


Figure 3-1. Control Panel

The functions of the individual controls and displays are as follows:

1. **On/Off Key Switch**. With this key-operated switch, the unit is turned on and off. The switch prevents unauthorized use of the X-ray equipment and complies with UL and regulations set forth by the US Food and Drug Administration, Center for Devices and Radiological Health. Note that the key is captive in the On position and can only be removed in the Off position.

2. **Power Indicator** . This indicator is on when the unit is connected to the proper power source and the On/Off Key Switch **1** is in its On position.

3. **Door Indicator**. This indicator is on when the Exposure Chamber Door is closed. It confirms the proper operation of the cabinet door interlock switch.

4. **X-RAY ON Indicator** . This indicator is on when X-ray tube current is produced, indicating X-ray generation.

5. **Ready Indicator**. This indicator is on when an exposure can be started from the X-ray Start Key **12**. This means that all required parameters have been selected, the Exposure Chamber Door is closed, etc.

6. **Time/AEC Display**. This 3-digit display is showing exposure time in seconds during manual mode operation and the % of the completed exposure during AEC mode. The functions are as follows
   Manual Mode.
   a. When turning on the unit, the display will show a default value of 10 (sec), non flashing.
   b. When the Time Mode Key **22** is pressed, the display starts flashing. This will indicate that selection from the Up/Down Keys **14** or from the Numerical Key Pad **18**, can be made.
   c. After the time has been selected, the Enter Key **17** is pressed. This makes the display stop flashing.
   d. During an exposure, the time will count down, one second at a time.
   e. After the exposure is completed, the display will return to the setting in effect prior to the exposure.

CONTROL PANEL, cont'd

AEC Mode.

a. When the AEC Mode Key **21** is pressed, the display will show a non flashing zero. The AEC % Indicator **7** will light, indicating that the zero in the display means zero %.
b. If the Density Mode Key **20** is pressed, the display will show a flashing 100 (%). This can now be changed with the Up/Down Keys **14** to another value between 75 and 125 (%). If the Density Mode Key **20** had not been pressed, a default value of 100 % density would have been selected.
c. After the density has been selected, the Enter Key **17** is pressed. This switches the display back to zero and the light next to the Density Mode Key **20** goes off.
d. If the Film Mode Key **19** is pressed, the display will show F5, which is the default value for film selection. This can now be changed with the Up/Down Keys **14** to another film selection value from F1 to F8.
e. After the film has been selected, the Enter Key **17** is pressed. This switches the display back to zero and the light next to the Density Mode Key **20** goes off.
f. During an exposure the display will count up from 0 to 100 (%). When it reaches 100 (%), the exposure will terminate and the display goes back to indicate 0 (%).

7. **AEC % Indicator** .This indicator will turn on when the AEC Mode Key **21** is pressed. It will turn off when the Time Mode Key **22** is pressed.

8. **Sec Indicator**. This indicator will turn on when the Time Mode Key **22** is pressed. It will turn off when the AEC Mode Key **21** is pressed.

9. **kV Display**. This 2-digit display is calibrated to show X-ray tube voltage in kilovolts (kV). The functions of kV Display are as follows:
   a. When turning on the unit, the kV Display will show a default value of 18 (kV), non flashing.
   b. When the kV Mode Key **13** is pressed, the display starts flashing. This will indicate that kV selection (10 - 35 kV) can be made from the Up/Down Keys **14** or from the Numerical Key Pad **18**.
   c. After the kV has been selected, the Enter Key **17** is pressed. This makes the display stop flashing.
   d. During and after an exposure, the display will show the selected kV value in a non flashing mode.

10. **STOP Key**. If this key is pressed during an exposure, the exposure will terminate and production of X-ray will cease.

11. **X-RAY ON Indicator**. This indicator is on when input power is connected to the high voltage supply for the X-ray tube. It is therefore indirectly indicating X-ray generation.

12. **START Key**. Providing that the unit is turned on, the technique parameters selected and the Ready Indicator **5** is on, X-ray generation will start when the Start Key is pressed. If the start key is pressed during the warm-up period, the remaining time will count down on the Time/AEC Display **6**.

13. **kV Mode Key**. When this key is activated, the kV can be set by using the Up/Down Keys **14** or the Numerical Key Pad **18**.

14. **Up/Down Keys**. The Up/Down Keys will control any value shown by a flashing display.

15. **Remote Key**. This key activates a remote controlled mode which can be used by an optional imaging camera etc. When pressed, it toggles between on and off as shown by an indicator light next to the key.

16. **Alt Func Key**. When this key has been pressed, the alternate functions for the keys on the Numerical Key Pad **18** are valid.

17. **Enter Key**. This key is used to store selected values of kV, Time, Density and Film into memory and to exit the respective mode of operation.

18. **Numerical Key Pad**. This is a standard numerical key pad used for entering kV and Time values. Each key also has an alternate function as shown on the lower portion of the key.

CONTROL PANEL, cont'd

19. **Film Mode Key**. This key is used in AEC mode to enable film selection. When Film Mode is active, eight different film speeds (F1-F8 according to Table 3-1), can be selected by using the Up/down Keys **14**. The values selected are shown by the Time/AEC Display **6**. If the Film Mode Key is not pressed, the default value of the film speed is F5.

Film Selection	Relative Film Speed	Relative Exposure Time
F1	6.25	1600
F2	12.5	800
F3	25	400
F4	50	200
F5 (Default)	100	100
F6	200	50
F7	400	25
F8	800	12.5

Table 3-1. Film Selection in AEC Mode.

20. **Density Mode Key**. This key is used in AEC mode to enable density selection. When Density Mode is active, density values between 75 and 125% can be selected by using the Up/down Keys **14**. The values selected are shown by the Time/AEC Display **6**. If the Density Mode Key is not pressed, the default value of the density is 100%.

21. **AEC Mode Key**. This key activates the Automatic Exposure Control (AEC) mode of operation. When the AEC mode is active, the AEC % Indicator **7** is on and the Time/AEC Display **6** is showing % of the X-ray exposure completed. Also, when AEC Mode is selected, the Film Mode Key **19** and the Density Mode Key **20** can be activated. When pressed, it toggles between on and off as shown by an indicator light next to the key.

22. **Time Mode Key**. When this key is activated, Manual Mode is selected and the Time/AEC Display **6** starts flashing. Exposure time can now be selected by using the Up/Down Keys **14** or the Numerical Key Pad **18**. When in the AEC mode of operation, holding down the Time Mode Key, will display the exposure time used in a completed AEC exposure.

3.2 CABINET

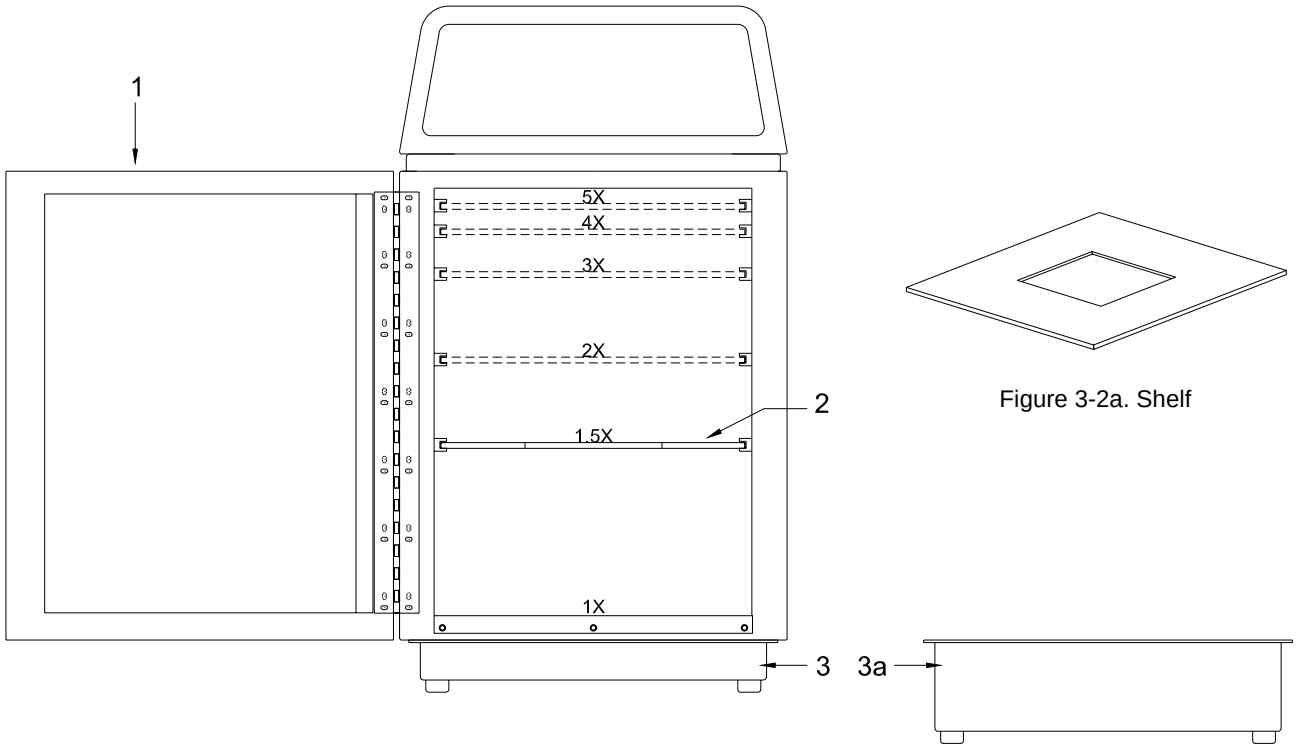


Figure 3-2a. Shelf

Figure 3.2. Cabinet

1. **Exposure Chamber Door.** The exposure chamber door has electrically independent interlocks which open before the door is open far enough to allow the escape of radiation. Opening either of these interlocks causes X-ray production to cease.

2. **Removable Shelf**. The removable shelf (see Figure 3-2a) can be placed in any of five different levels. When the object is placed on the shelf and the recording device is at the bottom of the cabinet, different magnification factors, depending on the shelf location, are obtained. This is indicated in Figure 3-2. Please note that if the object is placed on the shelf in the top position, 5X magnification is obtained and if it is placed directly on the bottom of the cabinet, 1X (no magnification) is obtained.

3. **Normal Base.** This base is used except when the MX-20 is delivered with the optional Dalsa Digital Camera.

3a. **Alternate Base.** This base is used when the MX-20 is delivered with the optional Dalsa Digital Camera.

3.2 CABINET, cont'd

3.2.1 AEC Sensor and Digital Camera Options

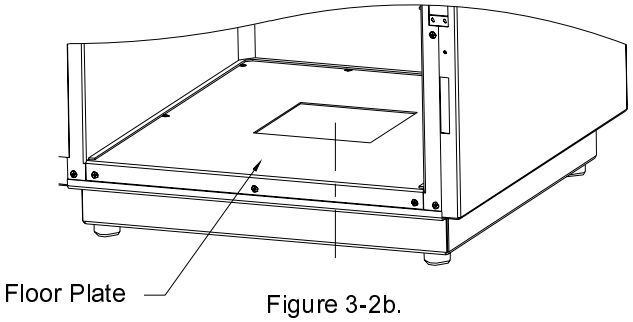


Figure 3-2b.
MX-20 with Floor Plate

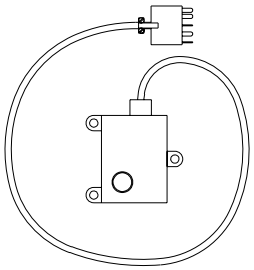


Figure 3-2c. AEC Sensor
with Connector

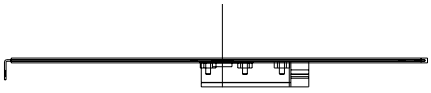


Figure 3-2d. AEC Sensor
Mounted on Floor Plate

Figure 3-2e. Digital Camera, Alt. 1
Mounted on Floor Plate

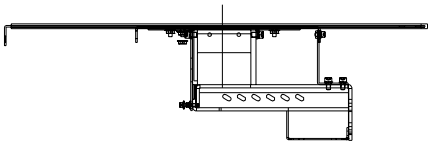


Figure 3-2f. Digital Camera, Alt. 2
Mounted on Floor Plate

- **Optional AEC Sensor.** See Figures 3-2b, 3-2c and 3-2d.
  This sensor is installed in units with the Automatic Exposure Control (AEC) option A02X. The sensor shown in Figure 3-2c is mounted to the MX-20 floor plate as shown in Figure 3-2d. The radiation during an exposure pass through the specimen being examined, the film and through a small hole in the bottom of the exposure chamber, to the AEC sensor. When the sensor receives enough radiation for a properly exposed film, the circuit terminates the exposure.

- **Optional Digital Cameras.** See Figures 3-2b, 3-2e and 3-2f.
  These cameras provides digital images from a 2 x 2, 2 x 4, 4 x 4 or 4.7 x 4.7 inch field of view for instant viewing of specimen X-ray images. The digital cameras, power supplies and signal processing boards are located in this lower section of the cabinet.
  Figure 3-2e shows the DC12 camera installed. The DC22, DC24, DC44, DC5 and DC10 cameras are similar.
  Figure 3-2f shows the DC4 camera installed. The DC2 camera is similar.

Note: Only one of the above options can be installed.

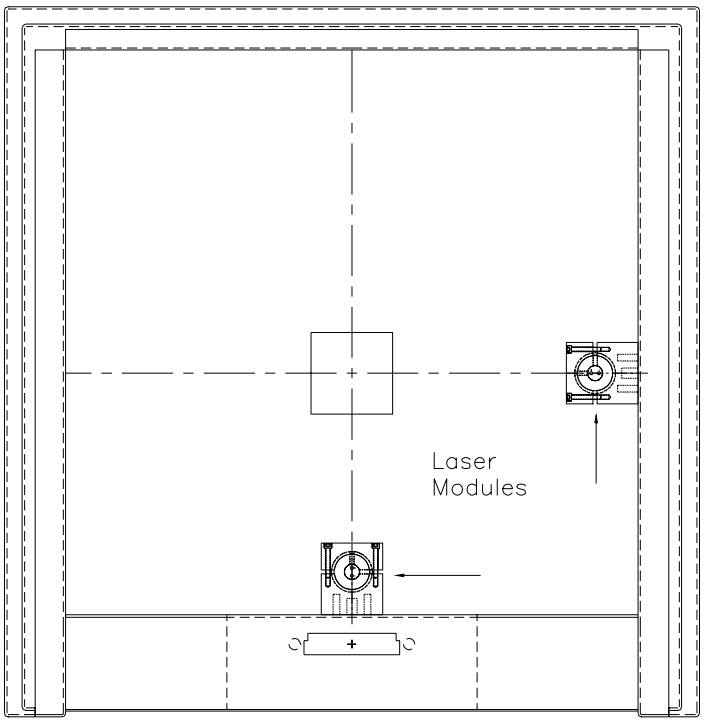
3.2 CABINET, cont'd

3.2.2. Laser Locator.

The Laser Locator uses two crossed Laser Beams to locate the X-ray beam center. It makes position of the samples precise and convenient.

Two Laser Modules are mounted inside the exposure chamber, near the top as shown in Fig. 3.2g. Each module contains a line generator which projects a 1 mm wide line down and across the exposure chamber.

The Laser Locator is turned on when the exposure chamber door is opened and turned off when the door is closed.



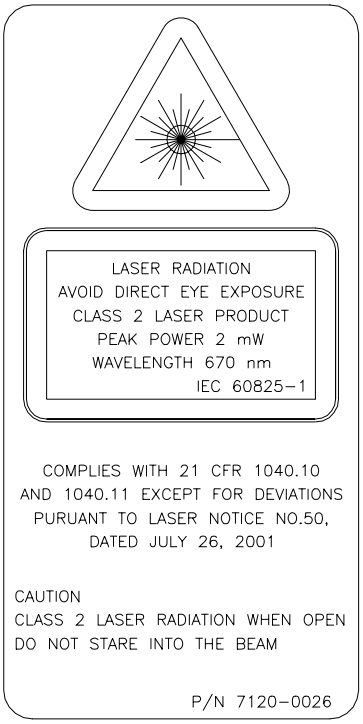


Figure 3-2g. Laser Locator

3.3 OPERATING CONSIDERATIONS.

1. General.

The Faxitron Specimen Radiography System combine applications versatility and office machine simplicity so that personnel can X-ray specimen with convenience in their own laboratory. Automatic exposure control (Option A02X) provides high quality radiographs (X-ray photographs), usually on the first try over a range of film speeds and voltages (10-35 kVp).

2. Radiation Protection.

The Faxitron Specimen Radiography System has been designed to conform to the standards for cabinet X-ray systems as specified by US Food and Drug Administration, Center for Devices and Radiological Health, (21 CFR-1020.40). A certification decal along with the date of manufacture is placed on each system.

Each system is checked prior to shipment to ensure that radiation leakage is below 0.1 mR/hr at 5 cm from any external surface. Further, Faxitron X-Ray LLC requires units to be checked for leakage upon installation.

In order to assure proper performance and safety of the system, the schedule in the maintenance section of this manual must be followed. In addition, portions of this schedule must be performed after maintenance and after system relocation.

Internal shielding reduces external radiation and safety interlock switches minimize the possibility of exposure if the Exposure Chamber Door is not completely closed. Radiation is shut off when the door opens. Restart is not possible until the door is closed and the X-ray Start button is pressed again.

3. Safety Considerations.

The following steps will minimize the possible risks that undetected radiation might create for you and other personnel:

a. Keep the Exposure Chamber Door closed at all times except during brief loading periods.

b. Turn Power Switch to Off position whenever the system is not going to be used for an extended period (approximately ten minutes or more).

c. Always monitor the X-ray On Indicators to be certain they are off after each exposure.

d. A radiation survey should be performed, by competent personnel, every six months and when unit is moved or serviced. Proper calibrated instrument should be used.

4. Increasing X-ray Tube Life.

When the unit is first turned on, there is a pre-heating time for the X-ray tube filament of two minutes. An exposure can not be made before the filament pre-heating is completed. Before taking exposures at above 20 kV, however, it is suggested to further warm up the X-ray tube to normal operating temperature. This can be accomplished by making a 5 minute(300 sec) exposure at 20 kV.

3.4 STEP-BY-STEP OPERATING INSTRUCTIONS, MANUAL MODE. See Figure 3-1.

WARNING

The Faxitron Specimen Radiography System produce X-rays when energized. It should be operated only by personnel who have received proper instructions in radiation safety and in the correct use of the equipment. Read the Safety Summary in front of this manual before attempting to operate the equipment.

The X-RAY ON Indicator **4** (Figure 3-1) is a direct indication that X-rays are being produced. Hence, when the exposure is complete, the X-RAY ON Indicator must be off. If it is not off when the exposure cycle is completed, turn the Power switch Off, remove the key, and unplug the AC power cord. Notify your Faxitron X-Ray LLC Sales/Service Regional or Local Office for assistance.

To operate the Faxitron Specimen Radiography System (including the AEC option A02X) in manual mode, perform the following steps:

1. Verify that Exposure Chamber Door is closed.

2. Insert key in On/Off Key Switch **1** and turn to On position. The Power Indicator **2**, the Door Indicator **3**, the Time/AEC Display **6** and the kV Display **9** will light. Also, the two minutes warm-up time for the X-ray tube filament will start.

3. Open the Exposure Chamber Door.
   a. For non-magnification work, place object on film at the desired source to image distance (SID) and position it for best radiographic view.
   b. For magnification work, place object on shelf at the level corresponding to the magnification factor desired and place the film on the bottom of the Exposure Chamber.
   Close the Exposure Chamber Door.

4. Consult an exposure table. Based on the size and type of specimen, the distance between the focus of the X-ray tube and the film (SID) and the speed of the film, select kV and time as shown in the following steps.

5. Press kV Mode Key **13**, then use the Up/Down Keys **14** or the Numerical Key Pad **18**, to select desired kV (10 - 35 kV). Press the Enter Key **17**.

7. Check that AEC mode is off, then press Time Mode Key **22**. Use the Up/Down Keys **14** or the Numerical Key Pad **18**, to select desired time (0.1 - 999 sec). Press the Enter Key **17**.

8. Verify that Ready Indicator **5** is on. Please note that the Ready Indicator will not turn on before the two minutes pre-heating time for the X-ray tube filament is completed.

9. Press START Key **12**. The two X-RAY ON Indicators **4** and **11** should now be on, indicating that exposure is in progress. The Time/AEC Display **6** will start to count down in one second steps until it reaches zero. At this point, the exposure will terminate. If the START Key is pressed during the warm-up period, the remaining warm-up time will count down on the Time/AEC Display. If for any reason one would like to terminate the exposure before it is completed, this can be accomplished by pressing the STOP Key **10**.

10. Verify that the two X-RAY ON Indicators **4** and **11** are off.

11. Open Exposure Chamber Door, remove specimen and film and close the Chamber Door.

12. Process film in normal manner.

Note: a. After the exposure is completed, the kV Display **9** and the Time/AEC Display **6** will indicate the values selected before the exposure.
b. If an exposure is interrupted, either by pressing the STOP Key **10** or by opening the Exposure Chamber Door, the exposure is terminated and everything resets as described above.

3.5 STEP-BY-STEP OPERATING INSTRUCTIONS, AUTOMATIC EXPOSURE CONTROL MODE (OPTION A02X). See Figure 3-1.

To operate the Faxitron Specimen Radiography System in AEC mode, perform the following steps:

1. Verify that Exposure Chamber Door is closed.

2. Insert key in On/Off Key Switch **1** and turn to On position. The Power Indicator **2**, the Door Indicator **3**, the Time/AEC Display **6** and the kV Display **9** will light. Also, the two minutes warm-up time for the X-ray tube filament will start.

3. Open the Exposure Chamber Door.
   a. For non-magnification work, place object on film at the desired source to image distance (SID) and position it for best radiographic view.
   b. For magnification work, place object on shelf at the level corresponding to the magnification factor desired and place the film on the bottom of the Exposure Chamber.
   Close the Exposure Chamber Door.

4. Consult an exposure table to determine the correct kV value.

5. Press kV Mode Key **13**, then use the Up/Down Keys **14** or the Numerical Key Pad **18**, to select desired kV (10 - 35 kV). Press the Enter Key **17**.

6. Press AEC Mode Key **21**. This turns on the AEC % Indicator and the Time/AEC Display **6** is now showing % of the X-ray exposure completed.

7. Press Density Mode Key **20**. The Time/AEC Display **6** is now flashing showing a density value of between 75 and 125 %. Change the density value by using the Up/Down Keys **14**, then press the Enter Key **17**. If no selection has been made, the default value is 100 %.

8. Press Film Mode Key **19**. The Time/AEC Display **6** is now flashing showing a film selection value of F1 through F8. Change the film selection value by using the Up/Down Keys **14**, then press the Enter Key **17**. If no selection has been made, the default value is F5.

9. Verify that Ready Indicator **5** is on. Please note that the Ready Indicator will not turn on before the two minutes pre-heating time for the X-ray tube filament is completed.

10. Press START Key **12**. The two X-RAY ON Indicators **4** and **11** should now be on, indicating that exposure is in progress. The Time/AEC Display **6** will start to count up from 0%. When it reaches 100%, the exposure will terminate. If the START Key is pressed during the warm-up period, the remaining warm-up time will count down on the Time/AEC Display.
    If for any reason one would like to terminate the exposure before it is completed, this can be accomplished by pressing the STOP Key **10**.

11. Verify that the two X-RAY ON Indicators **4** and **11** are off.

12. Open Exposure Chamber Door and remove specimen and film.

13. Close Exposure Chamber Door.

14. Process film in normal manner.

Note:
   a. After the exposure is completed, the kV Display **9** and the Time/AEC Display **6** will indicate the values as shown before the exposure.
   b. The actual exposure time for the completed AEC exposure can be displayed by holding down the Time Mode Key **22**.
   c. If an exposure is interrupted, either by pressing the STOP Key **10** or by opening the Exposure Chamber Door, the exposure is terminated and everything resets as described above.

3.6 STEP-BY-STEP OPERATING INSTRUCTIONS, OPTIONAL DIGITAL MODE

Note: For step-by-step operating instructions in the optional digital mode, follow the instructions included with the software.

3.7 ENTERING EXPOSURE DATA. See Figure 3-1.

When any of the mode keys (kV Mode Key **13**, Time Mode Key **22** and when in AEC mode, Density Mode Key **20** and Film Mode Key **19**) are pressed the respective displays start flashing, prompting to enter data.
When the Enter Key **17** is pressed, the data is accepted and the display stops flashing.

3.8 STORING EXPOSURE DATA. See Figure 3-1.

Exposure data, which includes all the settings for an exposure, can be stored in any of nine different memory locations M1-M9. The procedure for storing exposure data is as follows:

1. When all the settings have been completed (non flashing indicators), press Alt Func Key **16**.
2. Press the Save Key on the Numerical Key Pad **18**..
3. Press desired memory location key M1-M9 on the Numerical Key Pad **18**. Two short beeps will be heard, indicating that the exposure data has been stored in memory.
4. Keep a record indicating the specific procedure and the memory location.

3.9.1 RETRIEVING EXPOSURE DATA. See Figure 3-1.

The procedure for retrieving exposure data is as follows:

1. Consult your records showing where in memory exposure data for a specific procedure has been stored.
2. Press Alt Func Key **16**.
3. Press Recall Key on the Numerical Key Pad **18**.
4. Press the memory key M1-M9 for the location where the desired exposure data is stored. This will bring up the exposure data, flashing on the displays. If no data has been stored in the memory location selected, dashes will be displayed. At this point it is also possible to search any of the other memory locations.
5. When the desired exposure data has been found, press the Enter Key **17**. This will return the displays to a non flashing mode.

3.9.2 RETRIEVING LAST EXPOSURE DATA. See Figure 3-1.

When the unit is first turned on, the last exposure data from a previous session can be retrieved as follows:

1. Press Alt Func Key **16**. Both displays starts to flash.
2. Press Recall Key on the Numerical Key Pad **18**.
3. Press Last Key on the Numerical Key Pad **18**.
4. Press Enter Key **17**.

3.10 APPLICATIONS INFORMATION.

This section provides applications information and basic radiographic techniques recommended for operation of Faxitron Systems, with additional comments relating to specific problems that can occur.

3.10.1 X-ray Damage - Radiographic Samples.

Most components and samples, are not affected by the X-ray dose required for normal radiography but may be damaged by high radiation doses. You may wish to determine, by literature survey, data or by direct experiment, how such radiation may affect the sample you are radiographing. Note that live biological specimens are likely to be affected. The delivered dose can be minimized by:

a. Using radiation beam filters and the highest kVp possible consistent with necessary resolution.

b. Using the fastest film speed consistent with necessary resolution.

3.10.2 Magnification (see Figure 3-3).

Magnification is obtained anytime the object is placed between the X-ray source and the film. Referring to Figure 3-3, the magnification factor MF is defined as follows:

MF = SID/SOD = IS/OS were

SID = Source to Image Distance
SOD = Source to Object Distance
IS = Image Size
OS = Object Size

Magnification can be used to enhance the resolution of a radiograph, but one must consider the limitations caused by geometrical unsharpness discussed in the following paragraph.

Note that if the object is very thin and it is placed directly on the film, the magnification factor is 1.

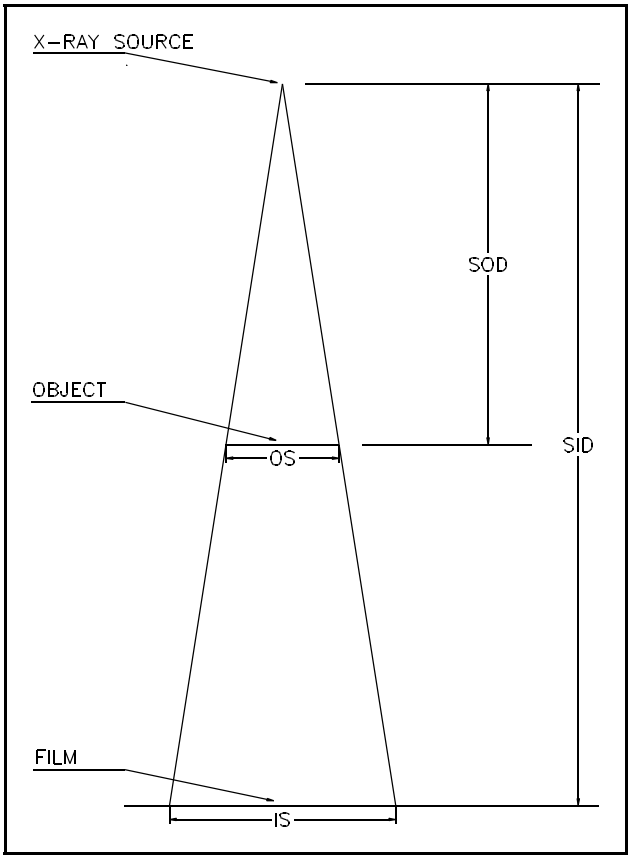


Figure 3-3. Magnification

3.10.3 Geometric Unsharpness (see Figure 3-4).

Geometric unsharpness is a result of the size of the focal spot and the amount of magnification used. This is illustrated in Figure 3-4. For better clarity in the illustration, please note that the size of the focal spot is shown larger than normal.

The nominal focus spot on the X-ray tubes used in the Faxitron systems measures as low as 0.02 mm. At maximum load on the X-ray tube the effective size of the focal spot will normally be somewhat larger than the nominal size.

Examining thick objects can cause, what is normally referred to as "un-wanted" magnification. This, in combination with using a large focus spot size, may result in geometric unsharpness. The problem can usually be minimized by selecting a larger Source to Image Distance, (SID), thus decreasing the amount of un-wanted magnification..

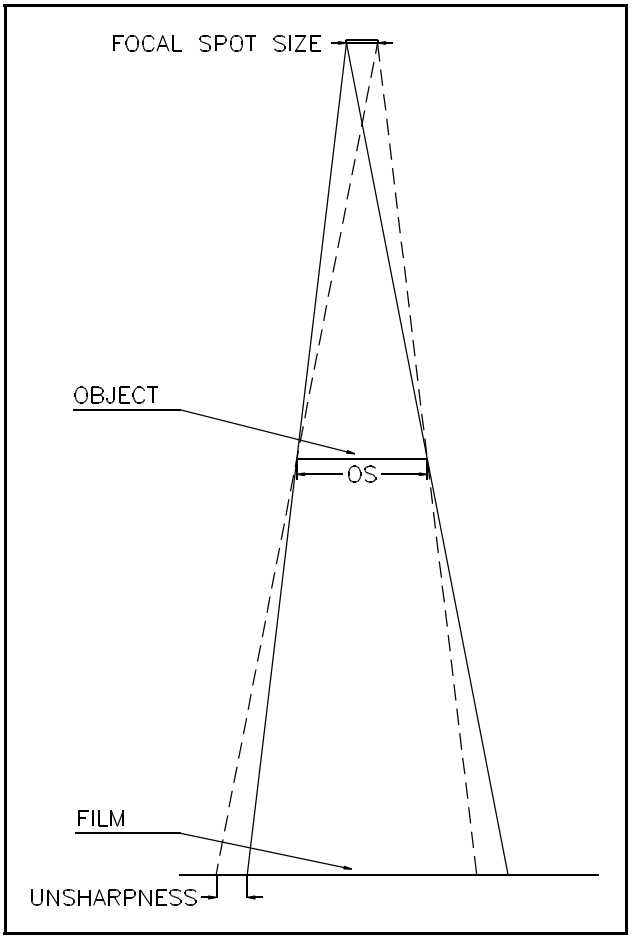


Figure 3-4. Geometric Unsharpness

3.10.4 Scatter Radiation

Scatter radiation (also referred to as secondary radiation) is caused by X-rays being re-radiated at various angels when the primary beam is passing through an object. When the scatter radiation reaches the film from any angle different from the primary beam, the quality of the image will decrease.

Figure 3-5 shows scatter radiation originating from the object itself, the shelf, the cabinet floor and from the sensor assembly used with the optional Automatic Exposure Control (AEC). The problem with scatter radiation is greater at higher kVp and with radiographically "thick" subjects. Under these conditions, proportionally greater amounts of scatter is generated by the items in the primary beam.

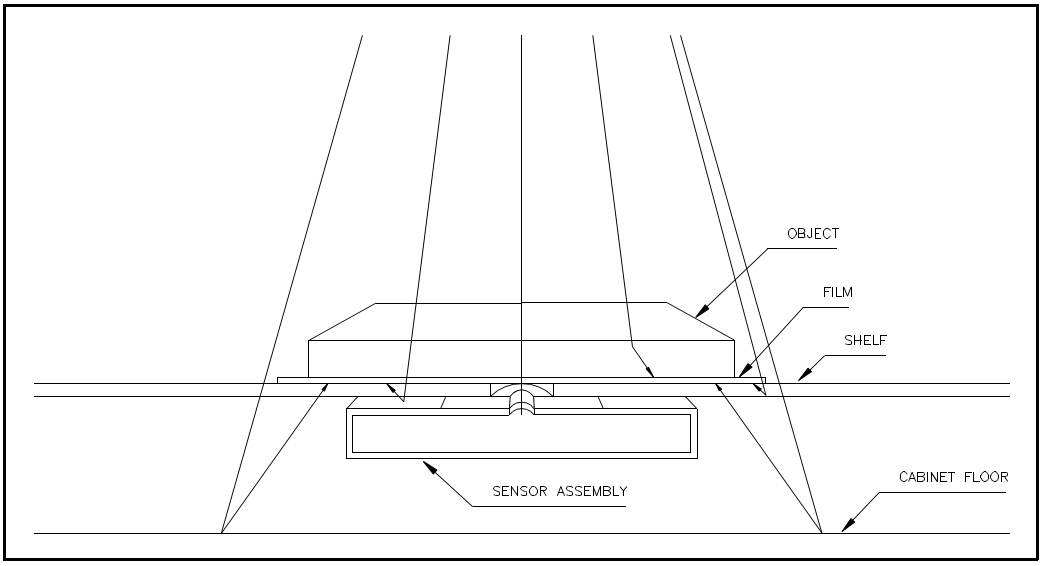


Figure 3-5. Scatter Radiation

cont. Scatter Radiation

Reducing the amount of scatter radiation reaching the film.

For optimum radiographic quality, the use of adequate "masking" as shown in Figure 3-6, is recommended. The masking is essential at high kVp and/or in radiography of thick objects. "Masking" using 1.5 mm lead can be placed around the object and should be sufficient for most items. A "masking" using 3 mm lead should be used for radiography of steel items exceeding 6 mm in thickness. It also may be desirable to cover holes or thin sections (not of direct interest) in the subject with thin lead strips or lead pellets.

For radiographs involving long exposure times and voltage exceeding 90 kVp, lead film pack are recommended since these also filter out much of the scatter radiation from the object, thus improving the contrast and the resolution. Primary beam copper filters with 0.2 or 0.5 mm thickness can also be used to reduce the effect of scatter radiation.

When using the Automatic Exposure Control option, also, consider the following:

The film holder shelf incorporates design features which will permit ideal radiographs to be obtained under most exposure condition. It is, of course, necessary to have a hole in the shelf which allows the X-ray beam to reach the sensor assembly. This hole does not always backscatter X-rays in exactly the same pattern as the shelf. An occasional radiograph may show a ring or disc, with the same diameter as the hole in the shelf. The area of the hole will be either darker or lighter than adjacent areas.

The referenced ring or disc can normally be eliminated by using sufficient masking or if higher kVp is used, by means of lead film packets. If the problem occurs at low kVp, it may be necessary to record the kVp and time with an AUTO exposure, and use this data to set kVp and time in the MANUAL mode. When making the exposure in MANUAL mode, one should use a sheet of copper or steel to completely underlay the film.

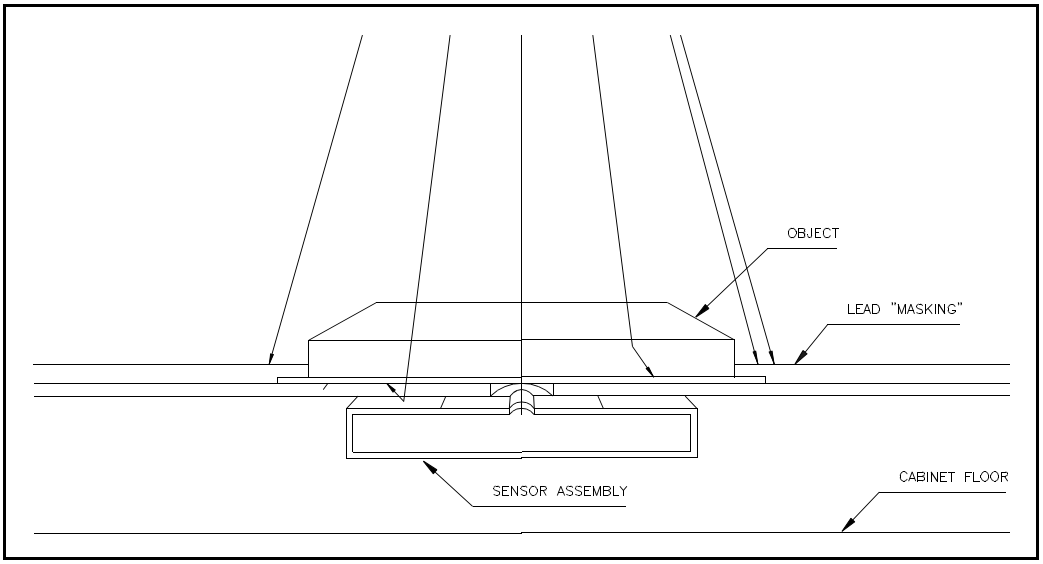


Figure 3-6. Masking

3.10.5 Low kVp Operation.

When operating at 10 - 20 kVp, consider the following:

a. The absorption in the film and the film holder at this low kVp can be a problem. Use single coat high resolution film, or high resolution plates and where practical, avoid the use of a film packet or holder by using the system in a darkroom with the object placed directly on the emulsion side of the film.

Small objects or wet objects such as biological specimens, which are difficult to handle in the dark, may be placed on a very thin polyethylene film (0.01 mm), such as a section from a typical dry cleaners bag. For handling ease, it may be convenient to make a cardboard frame, stretching the polyethylene film across it. This relatively simple device will facilitate object handling and protect the film emulsion.

b. With the Automatic Exposure Control, option, the absorption in the film and film holder will reduce the amount of radiation reaching the sensor assembly. This will cause the film to be overexposed. To overcome this problem, insert the object alone (without film and holder), and expose it as if taking a normal radiograph. Record the kVp and time, and use this data for a MANUAL exposure (with film and holder).

3.10.6 Positioning the Object - Automatic Exposure Control, option.

When using the Automatic Exposure Control option, it is very important to position the light and dense areas of the object correctly over the sensor aperture. Figures 3-7 and 3-8 illustrate an extreme situation where part of the object is of plastic and part of it is of steel. If one wants to examine the steel part of the object, positioning should be according to Figure 3-7. If the area containing the plastic is to be examined, position should be according to Figure 3-8.

Positioning according to Figure 3-7 will result in overexposure under the plastic part, while positioning according to Figure 3-8 will result in underexposure under the steel part.

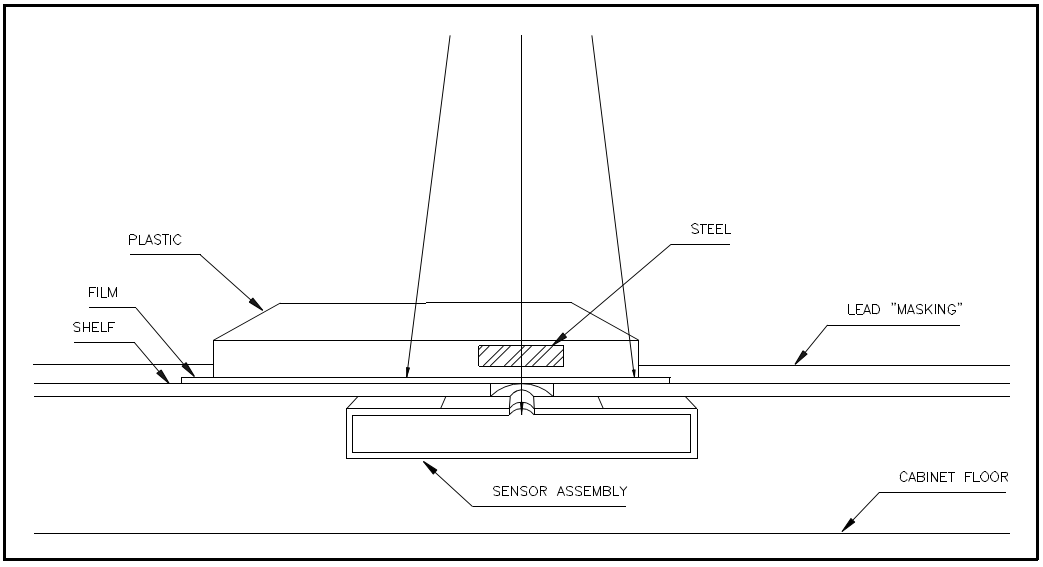


Figure 3-7. Dense Object over Sensor Aperture.

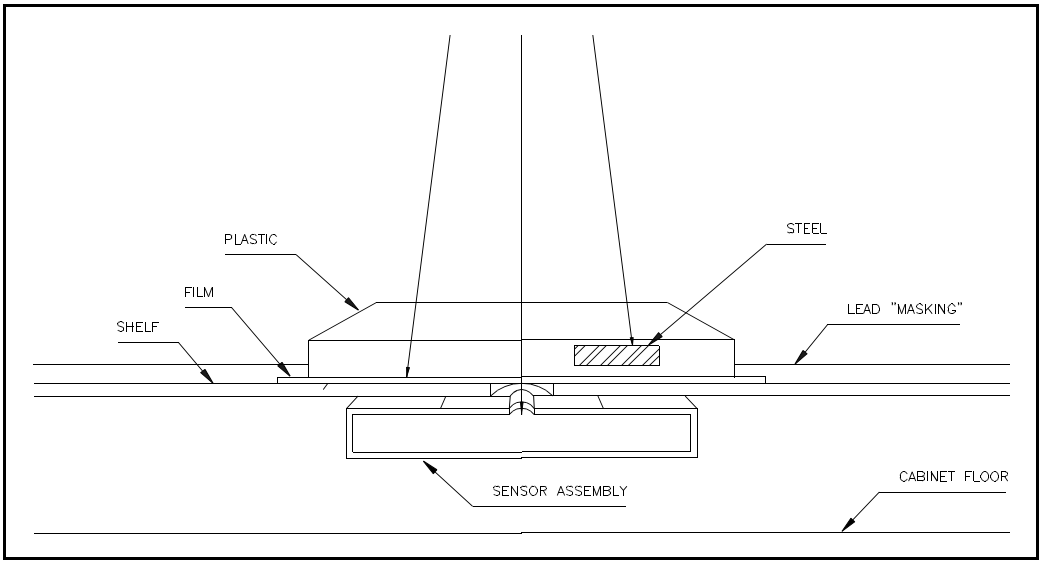


Figure 3-8. Light Object over Sensor Aperture.

SECTION 4

SERVICE

CONTENTS **PAGE**

SECTION 4

SERVICE

WARNING

Serious injury (both physical and genetic) can result if all X-ray shielding is not properly replaced or interlocks are not operating after service. Proper shielding replacement and interlock operation can only be confirmed by performing a radiation survey before placing the system in operation, and before use whenever the system is moved or serviced.

4.1 INTRODUCTION

The MX-20 is designed to require minimum service and maintenance. Major operating components of the MX-20 incorporates integrated circuits which are very reliable, but are not user serviceable. In addition to the checking and adjustment procedures, described in the maintenance section, service and repair is therefore mostly limited to replacement of major components. For available parts and their location in the unit, see the part section of this manual.

4.2 COMPONENT REPLACEMENT

Please note that after replacement of components, calibration may be required as described in the maintenance section of the manual.

4.2.1 Removing the Top Cover.

In order to reach most of the components described below, it is necessary to remove the top cover. Proceed as follows (see Figure 4.1).

1. Turn off the On/Off Key Switch and unplug the power cord.
2. Remove two screws from each side.
3. Use a screw driver and wedge out the lower edge on one side. Then lift that side up at the same time as disengaging the other side.
4. Move the cover away from the unit.

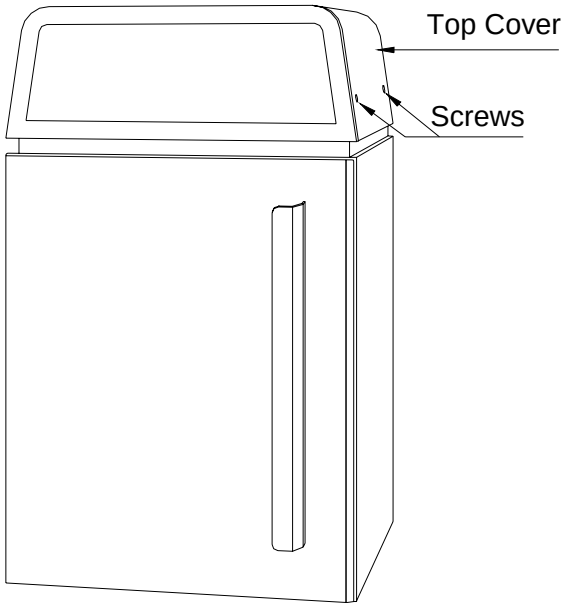


Figure 4-1
Removing Top Cover

4.2.2 Fuse Replacement.

There are ten fuses, located as shown in Figure 4-2. The fuses should be replaced with the exact type and value shown in Table 4-1. All fuses are 5 x 20 mm and of the slow blow type.

Before checking and replacing fuses, **disconnect the power cord.**

Gun Board.
Remove top cover (see 4.2.1) and the cover for the high voltage unit.

Power Supply.
Remove top cover (see 4.2.1).

Power Receptacle.
With a screw driver, open the cover as shown in Figure 4-3, step a. Please note that the power cord has to be removed from the receptacle, before the cover can be open. The fuse holders can now be pulled out as shown in Figure 4-3, step b.

Optional Camera Board.
This board is installed in the base of the MX-20. To access it, remove the floor plate with the camera mounted underneath and tilt it up against the right inside of the cabinet.

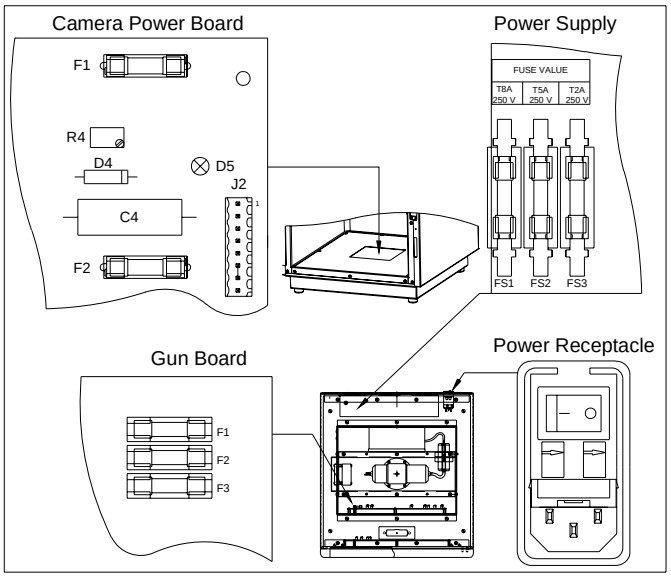


Figure 4-2. Fuse Locations

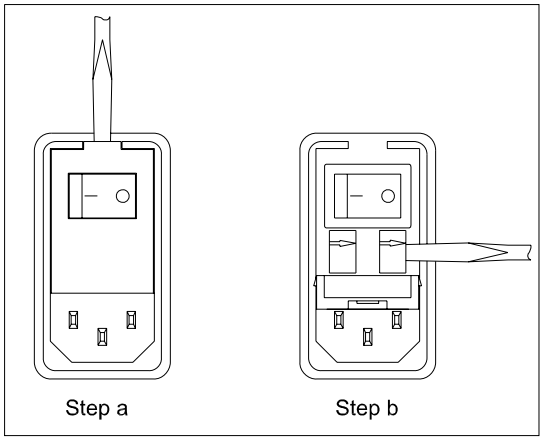


Figure 4-3
Opening Power Receptacle

Location	Circuit	Fuse Value	Type Number
Power Receptacle	AC Power Input	5 Amp	T5A/250V
Power Receptacle	AC Power Input	5 Amp	T5A/250V
Power Supply, FS1	+5 VDC Supply	8 Amp	T8A/250V
Power Supply, FS2	+12 VDC Supply	5 Amp	T5A/250V
Power Supply, FS3	-12 VDC Supply	2 Amp	T2A/250V
Gun Board, F1	-12 VDC Supply	0.5 Amp	T500mA/250V
Gun Board, F2	+12 VDC Supply	2 Amp	T2A/250V
Gun Board, F3	+24 VDC Supply	2 Amp	T2A/250V
Camera Board (Optional), F1	+5 or +21 VDC *	1 or 0.5 Amp *	T1A or T500mA/250V *
Camera Board (Optional), F2	+5 0r -21 VDC *	1 or 0.5 Amp *	T1A or T500mA/250V *

***** Depends on the type of Camera and Camera Pwr Board used.

Table 4-1

4.2.3 Replacing High Voltage Unit.

The high voltage unit contains critical components which are calibrated to work together (see illustration for the high voltage unit in the part list). Should a failure occur of any of the critical components (x-ray tube, high voltage power supply or gun board) it is advisable to replace the complete high voltage unit. To replace the high voltage unit, proceed as follows (see Figure 4-4):

1. Disconnect power cord.

2. Remove top cover (see paragraph 4.2.1).

3. There are two cables coming out from the high voltage unit. Disconnect one cable from in-line connector and the other one by removing its connector from the control board.

4. Remove 6 nuts, lock washers and washers holding high voltage unit to the mounting plate. The high voltage unit can now be removed.

5. Install replacement high voltage unit in reverse order.

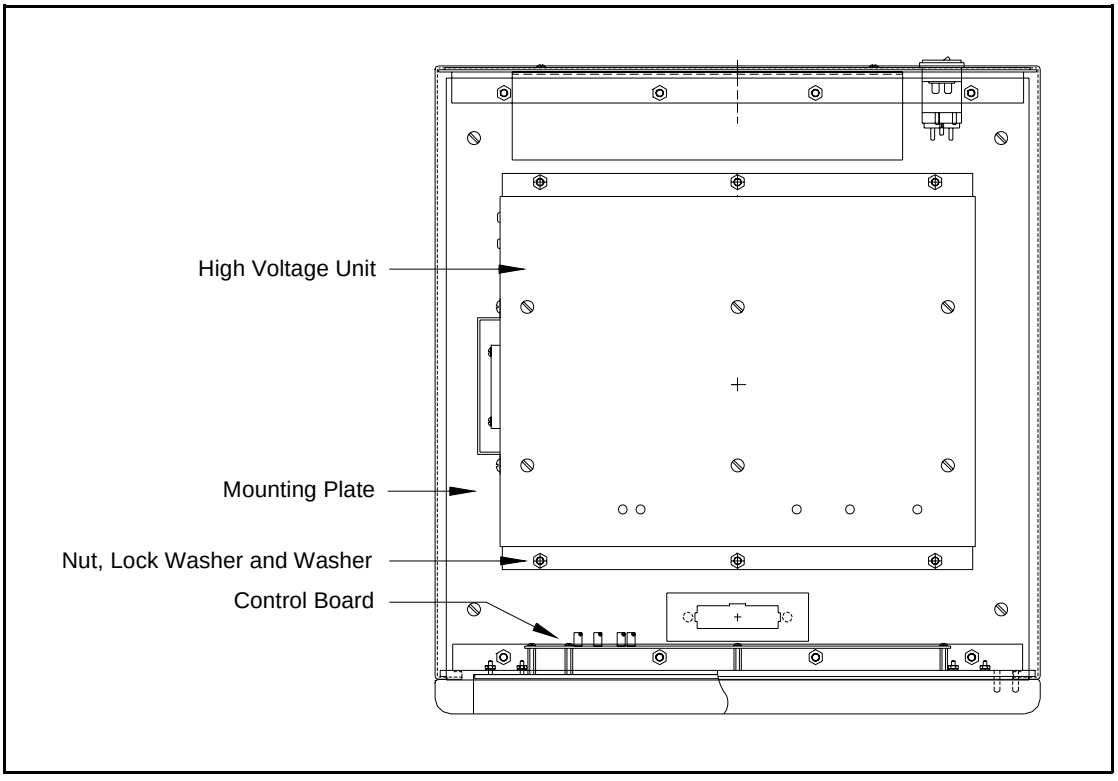


Figure 4-4
Replacing High Voltage Unit

4.2.4 Replacing Power Supply.

The power supply provides 5, -12, +12 and 24 VDC for operation of the MX-20. If replacement of the power supply becomes necessary, proceed as follows (see Figure 4-5):

1. Disconnect power cord.
2. Remove top cover (see paragraph 4.2.1).
3. From the back, remove 4 screws holding the power supply to the back cover.
4. Disconnect all wires from the terminals of the power supply and mark them with the appropriate terminal identification. Remove the connector from the power supply. If it is not enough slack in the wires to allow movement of the power supply, it may be, difficult to reach the terminals. In this case, it is suggested to first remove the high voltage unit as described in paragraph 4.2.3.
5. Install the replacement power supply in reverse order.

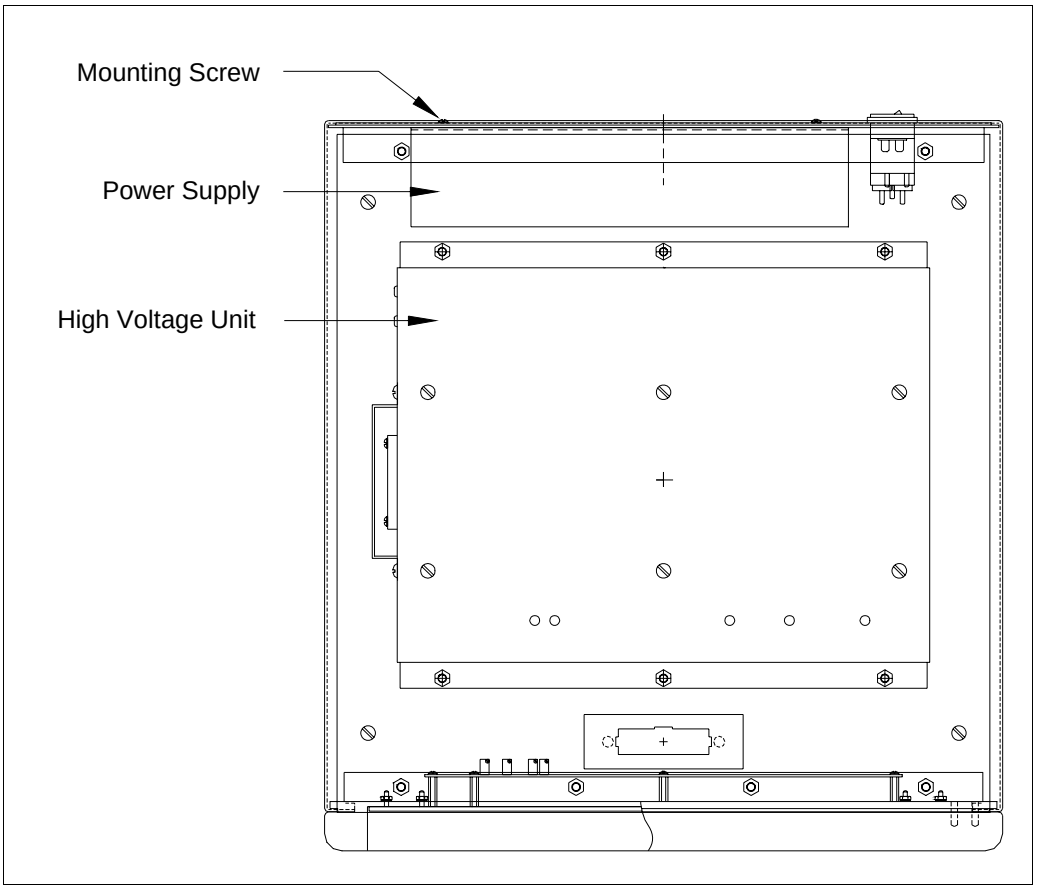


Figure 4-5
Replacing Power Supply

4.2.5 Replacing Control Board.

The control board contains micro processor, front panel interface, control circuits for gun board, etc. If replacement becomes necessary, proceed as follows (see Figure 4-6):

1. Disconnect power cord.
2. Remove top cover (see paragraph 4.2.1).
3. Remove high voltage unit (see paragraph 4.2.3).
4. Disconnect all cable connectors from the control board.
5. Remove 5 screws holding control board to threaded hex spacers and remove board.
6. Install replacement board in reverse order.
7. Perform calibration covering adjustments of control board as described in the maintenance section.

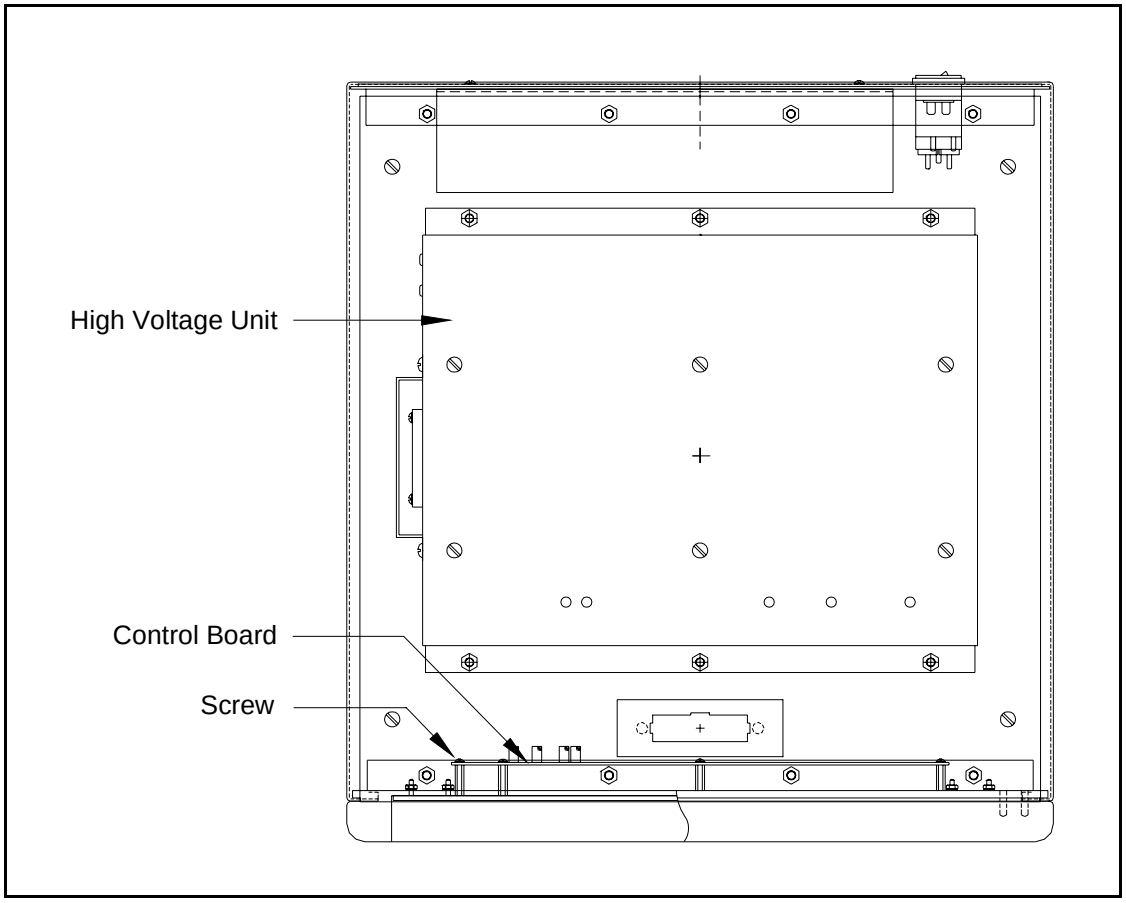


Figure 4-6
Replacing Control Board

4.2.6 Replacing Control Panel.

The control panel contains key switch, control keys and indicator lights. If replacement becomes necessary, proceed as follows (see Figure 4-7):

1. Disconnect power cord.
2. Remove top cover (see paragraph 4.2.1).
3. Remove high voltage unit (see paragraph 4.2.3).
4. Disconnect all cables from control board.
5. Remove 4 nuts holding control panel/control board to the bezel.
6. Carefully move control panel/control board assembly toward the front and out of the unit.
7. Remove control board from the original control panel.
8. Install control board on replacement control panel.
9. Install control panel/control board in reverse order.

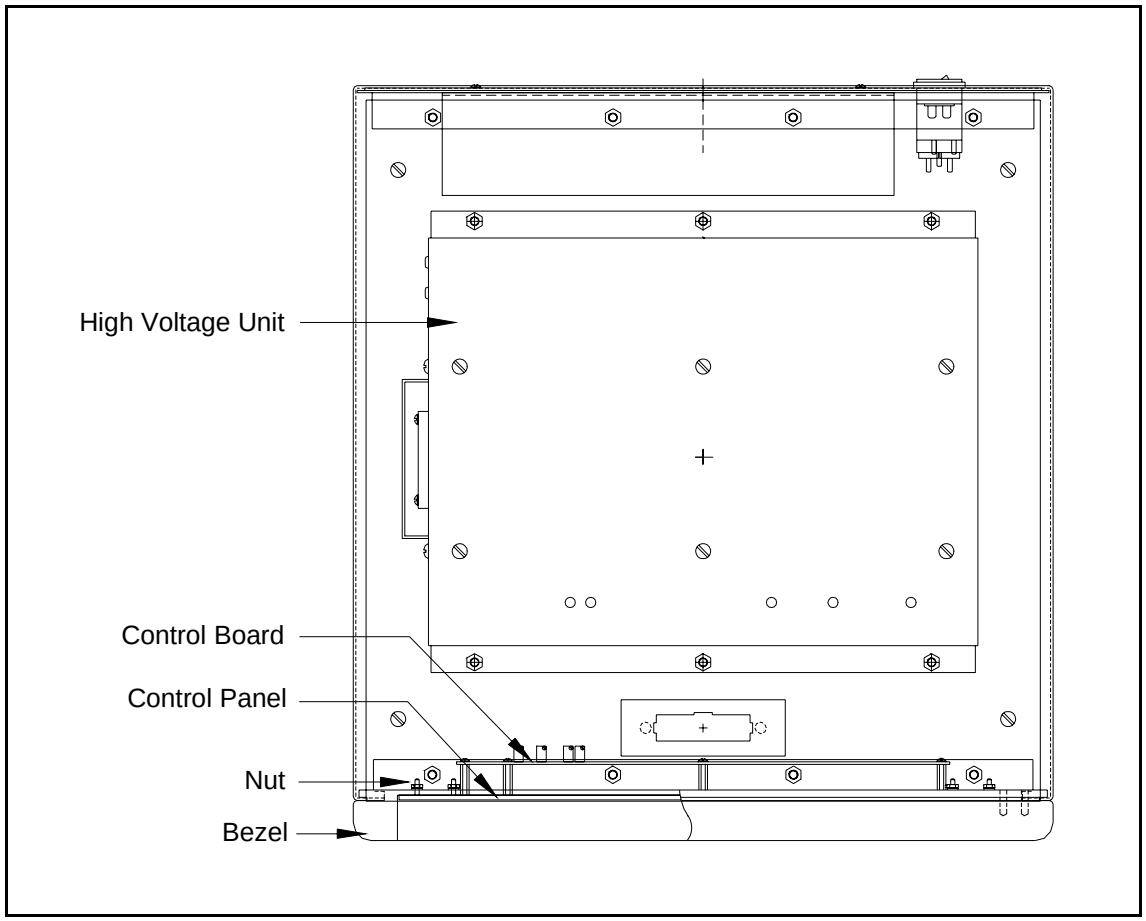


Figure 4-7
Replacing Control Panel

4.2.7 Replacing Laser Locator.

The Laser Line Generator has an expected life of 100,000 hours and it would therefore be very unlikely that it should have to be replaced. If, however, replacement becomes necessary, proceed as follows (see figure 4-8).

1. Disconnect power cord.
2. Remove top cover (see paragraph 4.2.1).
3. Locate and remove 4 screws holding the complete control unit (the entire upper part of the MX-20). Lift the control unit straight up and place it on a secure support. This should expose the inner part of the exposure chamber and the two Laser Modules as shown in Figure 4-8.
4. Locate the connector and disconnect the two leads going to the Laser Line Generator **5** in Figure 4-8.
5. Using a 3/32" hex wrench, remove 2 screws **1** in Figure 4-8 and separate the top clamp **2** from the bottom clamp **6**.
6. The brass ring **3** with the laser line generator **5** can now be removed.
7. Using a 0.05" hex wrench, loosen two set screws **4** and pull out the laser line generator **5.**
8. Install the new laser line generator **5** and follow the steps in reverse order through step 4.
9. Adjust the laser locator according to instructions in the maintenance section of the manual.
10. Complete the final assembly.

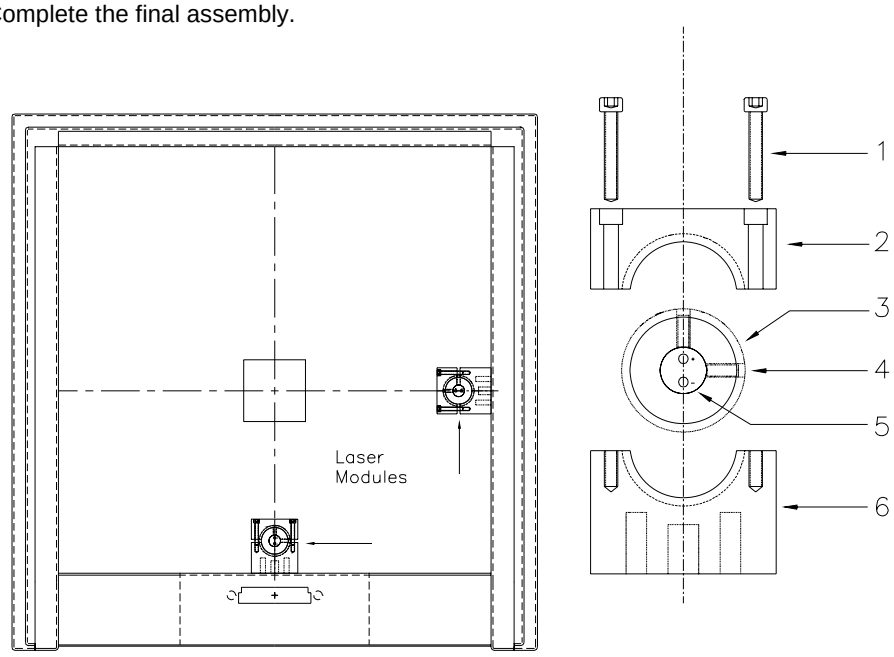


Figure 4-8. Laser Locator

1	Hex Screws (2), 4-40 x 3/4"	4	Set Screws (2), 4-40
2	Top Clamp	5	Laser Line Generator
3	Brass Ring	6	Bottom Clamp

4.2.8 Replacing Optional Camera Components

The optional camera and its components are located in the base of the MX-20. See Figures 4-9 and 4-10. If replacement becomes necessary, proceed as follows:

A. Preparations.

1. Turn off the On/Off Key Switch and unplug the power cord.
2. Open the door and locate the floor plate as shown in Figure 4-9. Remove screws holding the floor plate to the base.
3. Lift and tilt the floor plate (with the camera mounted to the bottom) over to the right side as shown in Figure 4-10. Note that the camera shown in Figure 4-10 is the DC-12 option.

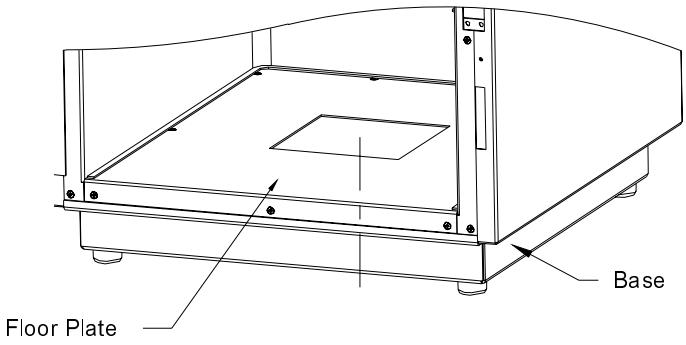


Figure 4-9
MX-20 with Floor Plate

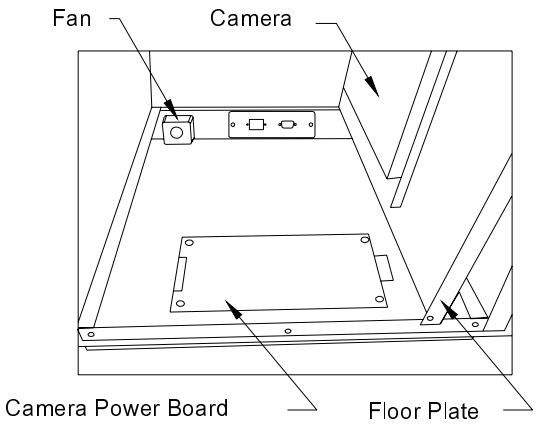


Figure 4-10
Camera Compartment

B. Replacing Camera Power Board.

1. Follow the steps outline in 4.2.8-A.
2. Unplug the two connectors from the board.
3. Remove the screws holding the board to the bottom of the base and remove the board.
4. Install the replacement board in reverse order.
5. Perform a complete calibration as described in the maintenance section of this manual.

Replacing Optional Camera Components (cont'd)

C. Replacing Camera.

Different cameras according to System Description in Section 1 are used. All cameras mount under the Floor Plate shown in Figure 4-9 and 4-11a-c. To replace the camera, proceed as follows:

1. Follow the steps outlined in 4.2.8-A.
2. Unplug the connectors from the camera unit.
3. Carefully remove the floor plate with the camera and place it on a table, camera facing up.
4. Remove the camera from the floor plate. Figure 4-11c shows how the Hamamatsu camera is secured to the floor plate using six z-shaped brackets. The Bioptics camera is mounted in a similar way.
5. Install the new camera in reverse order.
6. Calibrate the camera following instructions in the maintenance section of this manual, instructions supplied with the camera and/or instructions supplied with the software.

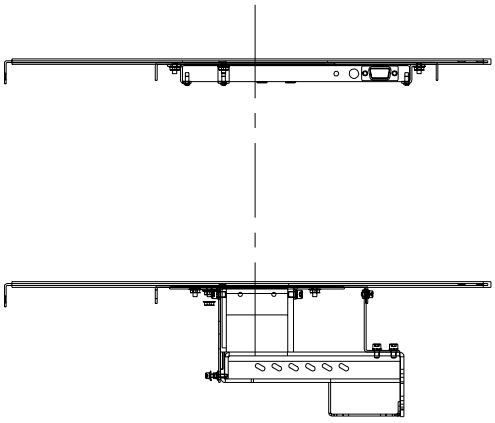


Figure 4-11a. Digital Camera, Hamamatsu or Bioptics Mounted on Floor Plate

Figure 4-11b. Digital Camera, Dalsa Mounted on Floor Plate

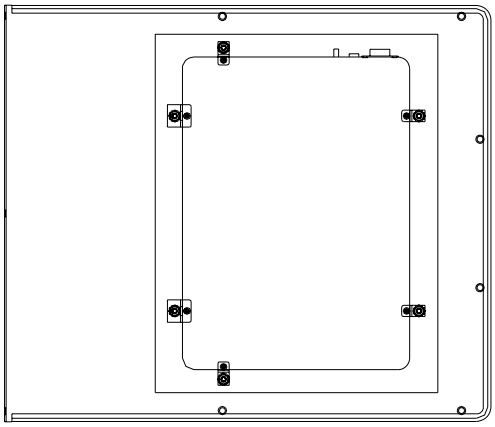
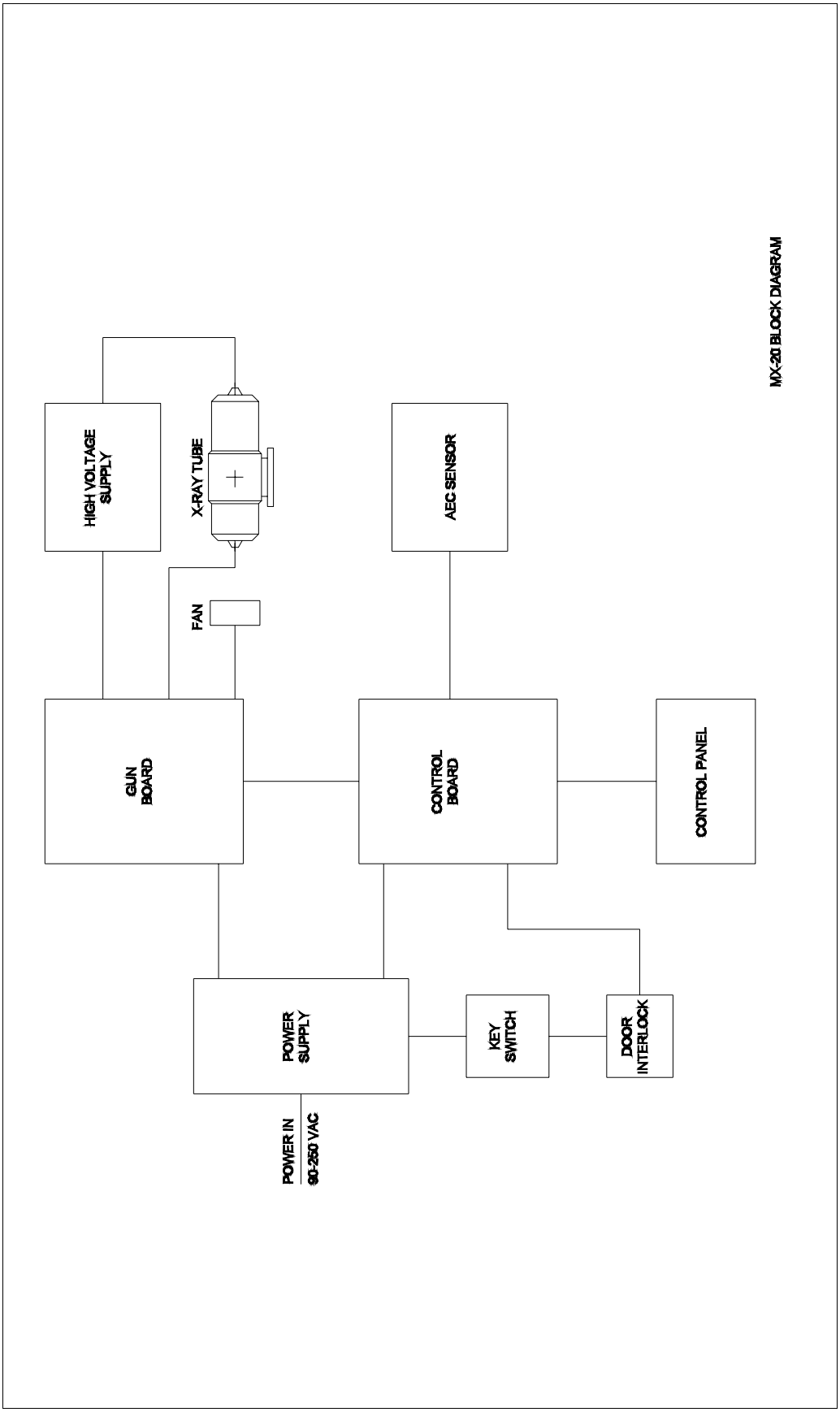


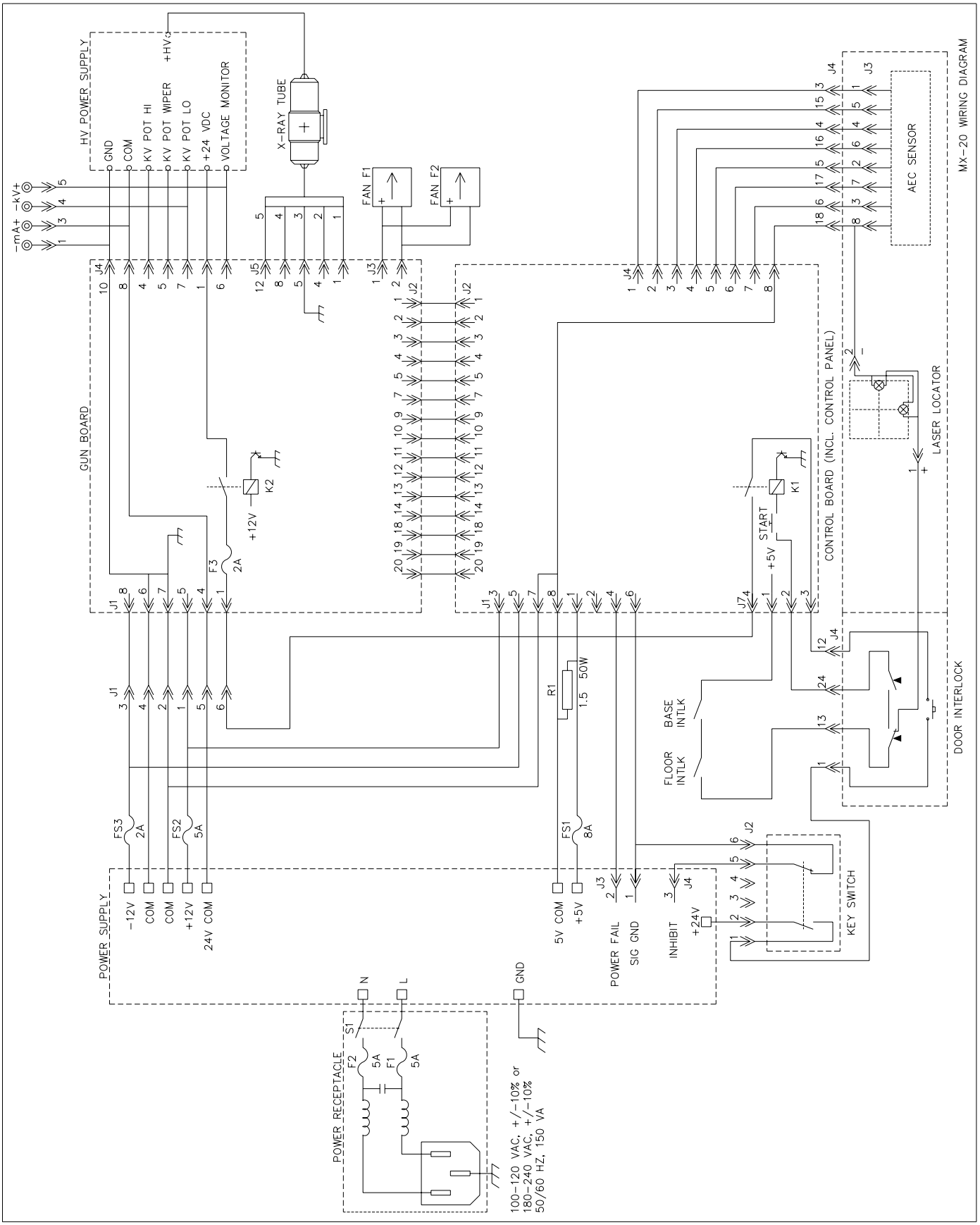
Figure 4-11c. Digital Camera, Hamamatsu or Bioptics Mounted on Floor Plate

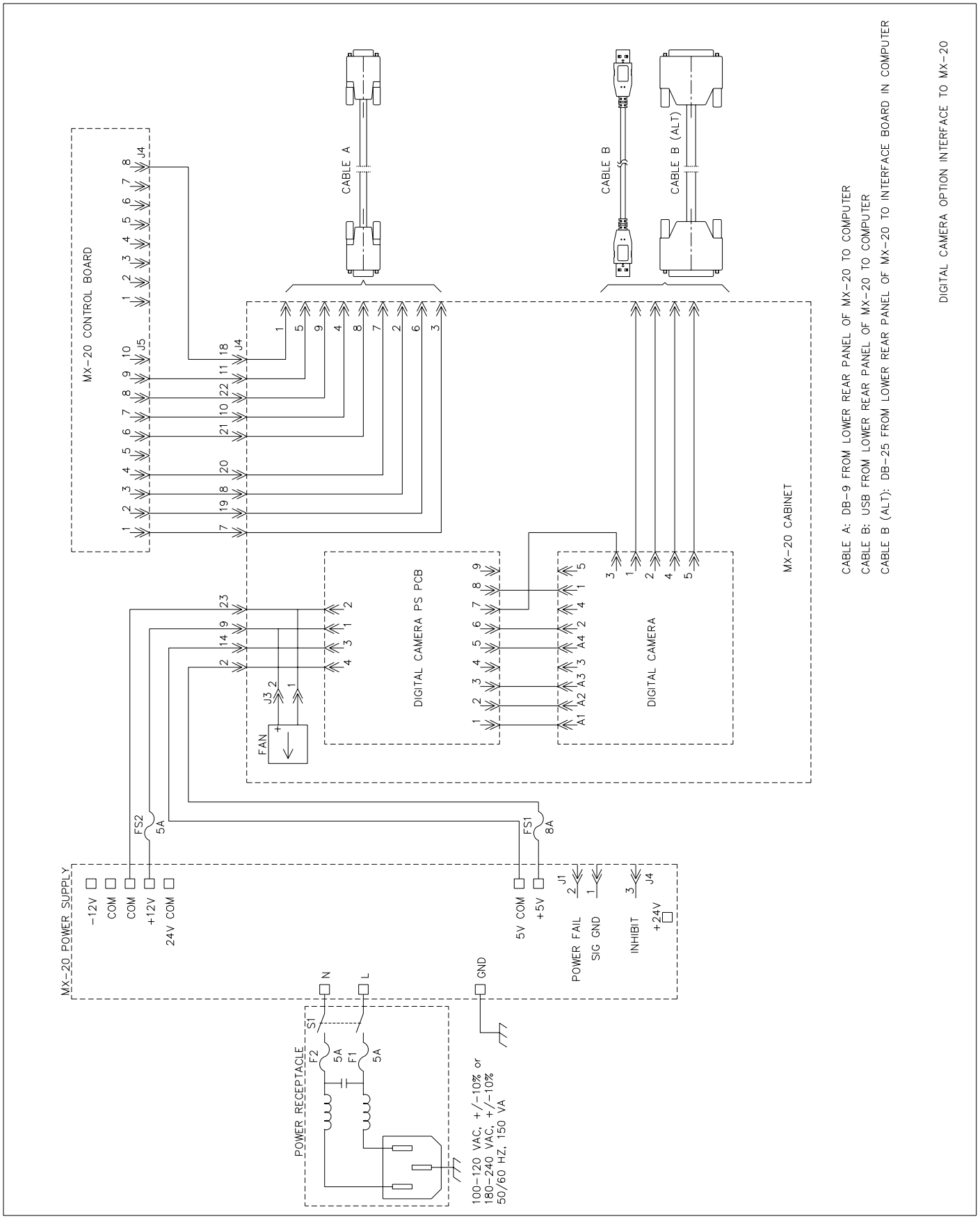
SECTION 5

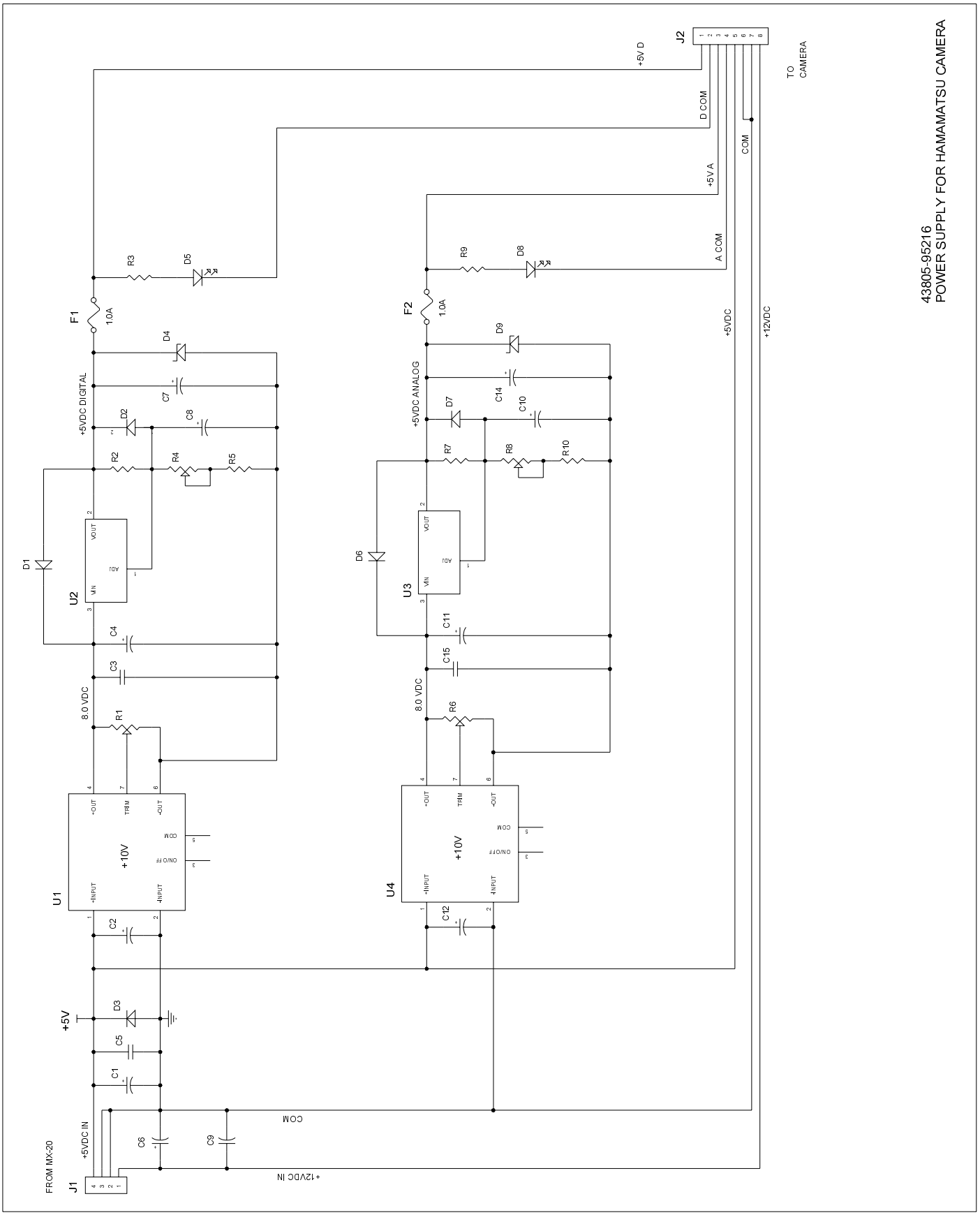
SCHEMATICS

CONTENTS **PAGE**


MX-20 BLOCK DIAGRAM
HIGH VOLTAGE SUPPLY
X-RAY TUBE
AEC SENSOR
FAN
GUN BOARD
CONTROL BOARD
CONTROL PANEL
POWER SUPPLY
KEY SWITCH
DOOR INTERLOCK
POWER IN
90-250 VAC


MX-20 WIRING DIAGRAM
HV POWER SUPPLY
GND
COM
KV POT HI
KV POT WIPER
KV POT LO
+24 VDC
VOLTAGE MONITOR
+HV
-mA+
-kV+
X-RAY TUBE
FAN F1
FAN F2
GUN BOARD
F3
2A
+12V
K2
CONTROL BOARD (INCL. CONTROL PANEL)
K1
START
+5V
AEC SENSOR
LASER LOCATOR
DOOR INTERLOCK
BASE INTLK
FLOOR INTLK
R1
1.5 50W
POWER SUPPLY
-12V
COM
COM
+12V
24V COM
FS3
2A
FS2
5A
FS1
8A
5V COM
+5V
POWER FAIL
SIG GND
INHIBIT
+24V
KEY SWITCH
POWER RECEPTACLE
S1
F2
5A
F1
5A
N
L
GND
100-120 VAC, +/-10% or
180-240 VAC, +/-10%
50/60 HZ, 150 VA


MX-20 CONTROL BOARD
J4
J5
J4
CABLE A
CABLE B
CABLE B (ALT)
MX-20 CABINET
DIGITAL CAMERA PS PCB
DIGITAL CAMERA
J3
FAN
FS2
5A
FS1
8A
MX-20 POWER SUPPLY
-12V
COM
COM
+12V
24V COM
5V COM
+5V
J1
POWER FAIL
SIG GND
INHIBIT
J4
+24V
N
L
GND
POWER RECEPTACLE
S1
F2
5A
F1
5A
100-120 VAC, +/-10% or
180-240 VAC, +/-10%
50/60 HZ, 150 VA
CABLE A: DB-9 FROM LOWER REAR PANEL OF MX-20 TO COMPUTER
CABLE B: USB FROM LOWER REAR PANEL OF MX-20 TO COMPUTER
CABLE B (ALT): DB-25 FROM LOWER REAR PANEL OF MX-20 TO INTERFACE BOARD IN COMPUTER
DIGITAL CAMERA OPTION INTERFACE TO MX-20


43805-95216
POWER SUPPLY FOR HAMAMATSU CAMERA
J2
TO CAMERA
+5V D
D COM
+5V A
A COM
COM
+5VDC
+12VDC
F1
1.0A
F2
1.0A
+5VDC DIGITAL
+5VDC ANALOG
8.0 VDC
8.0 VDC
+5V
+5VDC IN
+12VDC IN
COM
FROM MX-20
J1
U1
U2
U3
U4
+10V
+10V
D1
D2
D3
D4
D5
D6
D7
D8
D9
R1
R2
R3
R4
R5
R6
R7
R8
R9
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C8
C9
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C11
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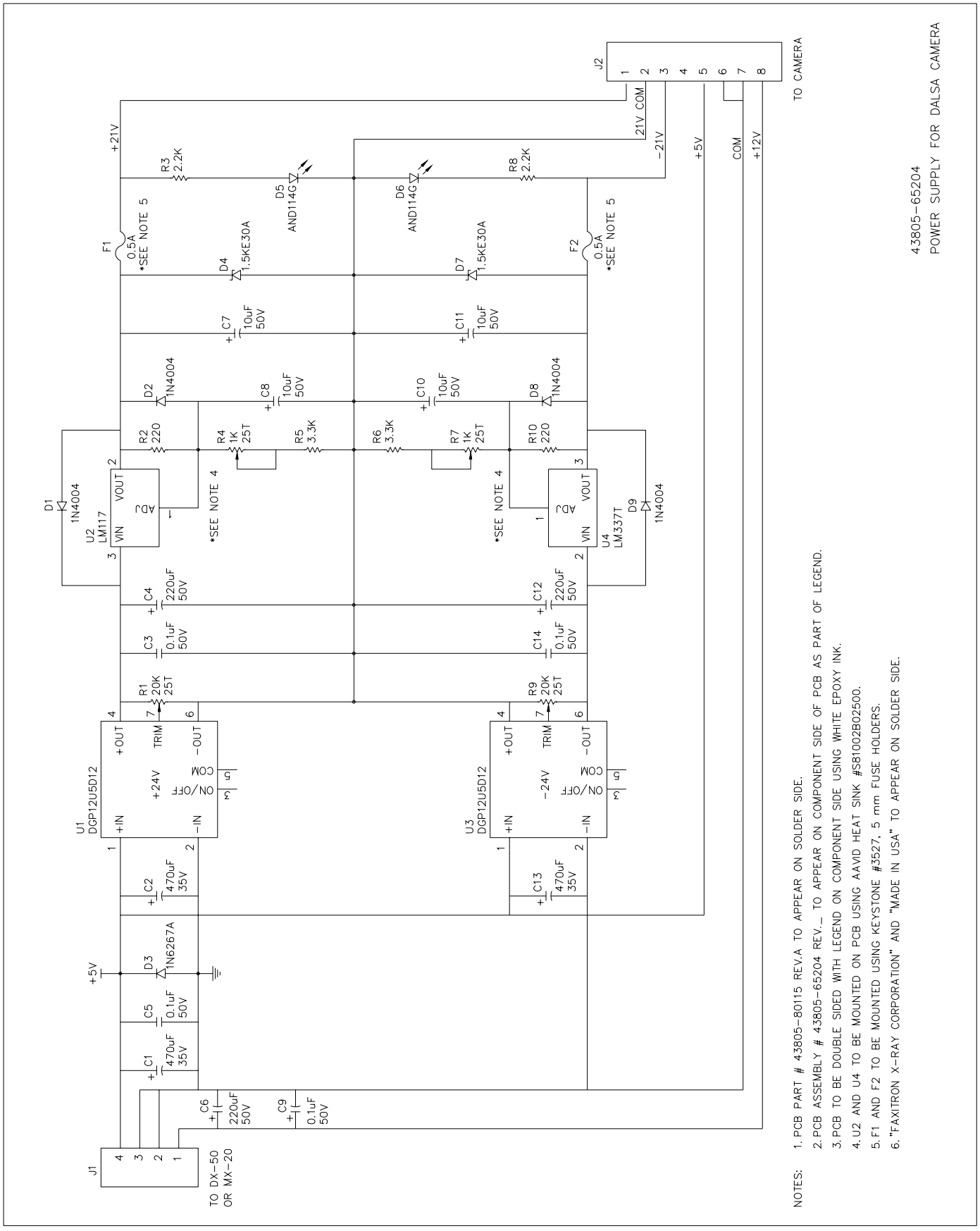
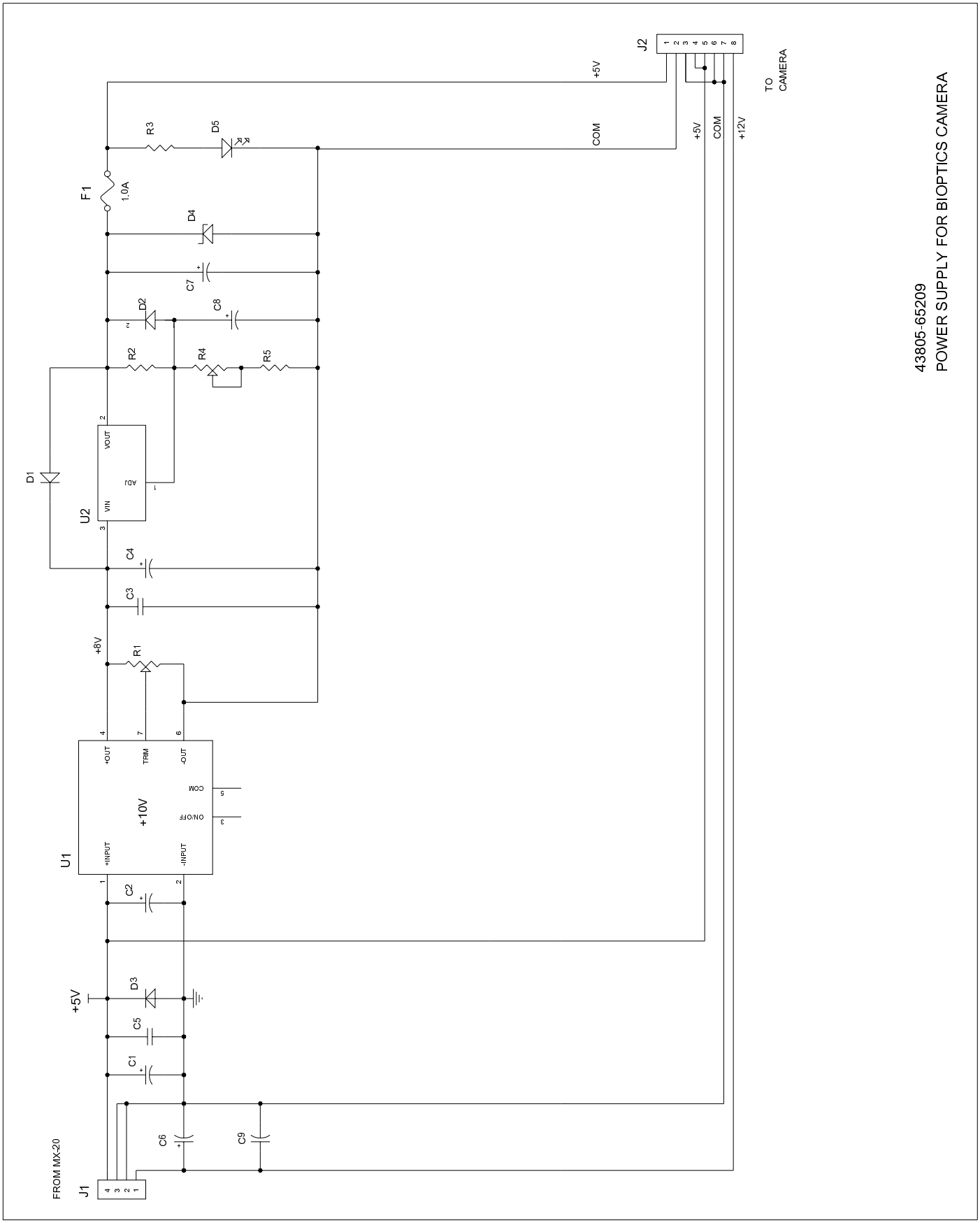
C14
C15


43805-65204
POWER SUPPLY FOR DALSA CAMERA
TO CAMERA
J2
21V COM
-21V
+5V
COM
+12V
+21V
R3 2.2K
R8 2.2K
D5 AND114G
D6 AND114G
F1 0.5A *SEE NOTE 5
F2 0.5A *SEE NOTE 5
D4 1.5KE30A
D7 1.5KE30A
C7 10uF 50V
C11 10uF 50V
D2 1N4004
D8 1N4004
C8 10uF 50V
C10 10uF 50V
R2 220
R4 1K 25T
R5 3.3K
R6 3.3K
R7 1K 25T
R10 220
D1 1N4004
U2 LM117
VIN VOUT ADJ
*SEE NOTE 4
*SEE NOTE 4
U4 LM337T
D9 1N4004
C4 220uF 50V
C12 220uF 50V
C3 0.1uF 50V
C14 0.1uF 50V
R1 20K 25T
R9 20K 25T
U1 DGP12U5D12
+IN -IN +OUT -OUT TRIM +24V ON/OFF COM
U3 DGP12U5D12
+IN -IN +OUT -OUT TRIM -24V ON/OFF COM
C2 470uF 35V
C13 470uF 35V
+5V
D3 1N6267A
C5 0.1uF 50V
C1 470uF 35V
C6 220uF 50V
C9 0.1uF 50V
J1
TO DX-50 OR MX-20
NOTES:
1. PCB PART # 43805-80115 REV.A TO APPEAR ON SOLDER SIDE.
2. PCB ASSEMBLY # 43805-65204 REV._ TO APPEAR ON COMPONENT SIDE OF PCB AS PART OF LEGEND.
3. PCB TO BE DOUBLE SIDED WITH LEGEND ON COMPONENT SIDE USING WHITE EPOXY INK.
4. U2 AND U4 TO BE MOUNTED ON PCB USING AAVID HEAT SINK #SB1002B02500.
5. F1 AND F2 TO BE MOUNTED USING KEYSTONE #3527, 5 mm FUSE HOLDERS.
6. "FAXITRON X-RAY CORPORATION" AND "MADE IN USA" TO APPEAR ON SOLDER SIDE.


43805-65209
POWER SUPPLY FOR BIOPTICS CAMERA
J2
TO CAMERA
+5V
COM
+12V
R3
D5
F1
1.0A
D4
C7
D2
C8
R2
R4
R5
D1
U2
VOUT
ADJ
VIN
C4
C3
+8V
R1
U1
+OUT
TRIM
-OUT
COM
ON/OFF
+10V
+INPUT
-INPUT
C2
D3
+5V
C5
C1
C6
C9
FROM MX-20
J1

SECTION 6

MAINTENANCE

CONTENTS **PAGE**

SECTION 6

MAINTENANCE

WARNING

Serious injury (both physical and genetic) can result if all X-ray shielding is not properly replaced or interlocks are not operating after maintenance. Proper shielding replacement and interlock operation can only be confirmed by performing a radiation survey before placing the system in operation, and before use whenever the system is moved or serviced.

This section covers maintenance, including safety product assurance checks and adjustments to be performed every 6 months. Record of the safety product assurance checks is to be recorded on the maintenance schedule in section 7 of this manual.

6.1 REMOVING THE TOP COVER.

In order to carry out the procedures described below, it is necessary to remove the top cover. Proceed as follows (see Figure 6.1).

1. Turn off the On/Off Key Switch and unplug the power cord.
2. Remove two screws from each side.
3. Use a screw driver and wedge out the lower edge on one side. Then lift that side up at the same time as disengaging the other side.
4. Move the cover away from the unit.

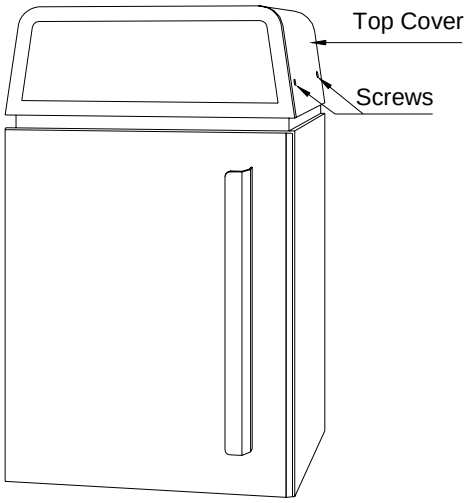


Figure 6-1
Removing Top Cover

6.2 CHECK THAT ALL DECALS AND OPERATOR SAFETY INSTRUCTIONS ARE IN PLACE.

Use Figure 1-1 (in section 1 of this manual) as a guide and verify that all decals and labels with safety instructions are in place.

6.3 CHECK RESISTANCE FROM CABINET TO INPUT POWER CONNECTOR PIN.

With the Digital Multimeter, check that the resistance from any exposed metal point of the cabinet to the power connector ground pin is less than 0.10 ohm. Make certain to check the resistance of the test leads (normally between 0.10 and 0.20 ohm) and subtract this from the reading obtained during the resistance check.

6.4 CHECK AND ADJUSTMENT OF DOOR INTERLOCK.

A dual interlock switch is installed in the door as shown in Figure 6-2. The switch will prevent X-ray from being turned on if the door is open and it will terminate X-ray if the door is opened during an exposure.

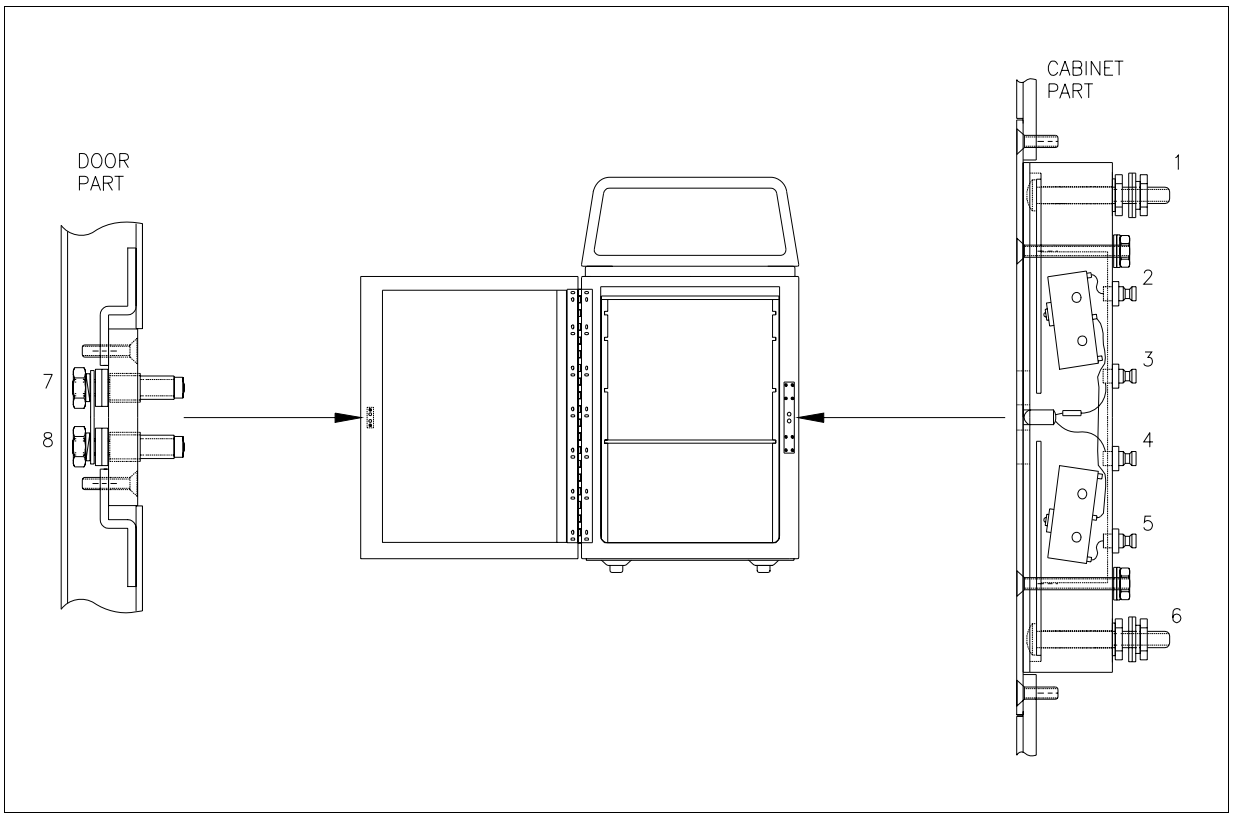


Figure 6-2. Door Dual Interlock Switch

CHECK AND ADJUSTMENT OF DOOR INTERLOCK, cont'd.

Circuit Diagram for Interlock Switches.

Figure 6-3 shows a circuit diagram for the dual interlock safety switch. The safety switch consists of two parts. The main part of the switch is mounted into the cabinet frame and the plunger part is mounted in the door. Figure 6-3 shows the door slightly open and none of the switches are activated.

The function of the switch is as follows:

a. When the door closes, the plunger contacts 7 and 8 come in contact with the leaf springs inside the main part of the switch. One leaf spring is connected to terminal 1 and the other is connected to terminal 6 of the switch.

b. Because terminals 7 and 8 are shorted together with a shorting bar, terminals 1 and 6 are now closed.

c. Terminals 1 and 6 of the switch are connected via a connector in series with the 24 volt supply going to the control board. Because the control circuit (terminals 2 and 5) has not been activated no current is going through the contacts of the switch at this time.

d. When the door closes further, the leaf springs are pushed back, activating the two micro switches. This closes the circuit between terminals 2 and 5 of the switch. Terminals 2 and 5 are connected via a connector in series with the X-ray start circuit on the control board. Only when all three switches, S1, S2 and S3 are closed, X-ray can be generated.

Please note that the optional indicator lamp, connected to terminals 3 and 4 of the switch, is not being used in this application.

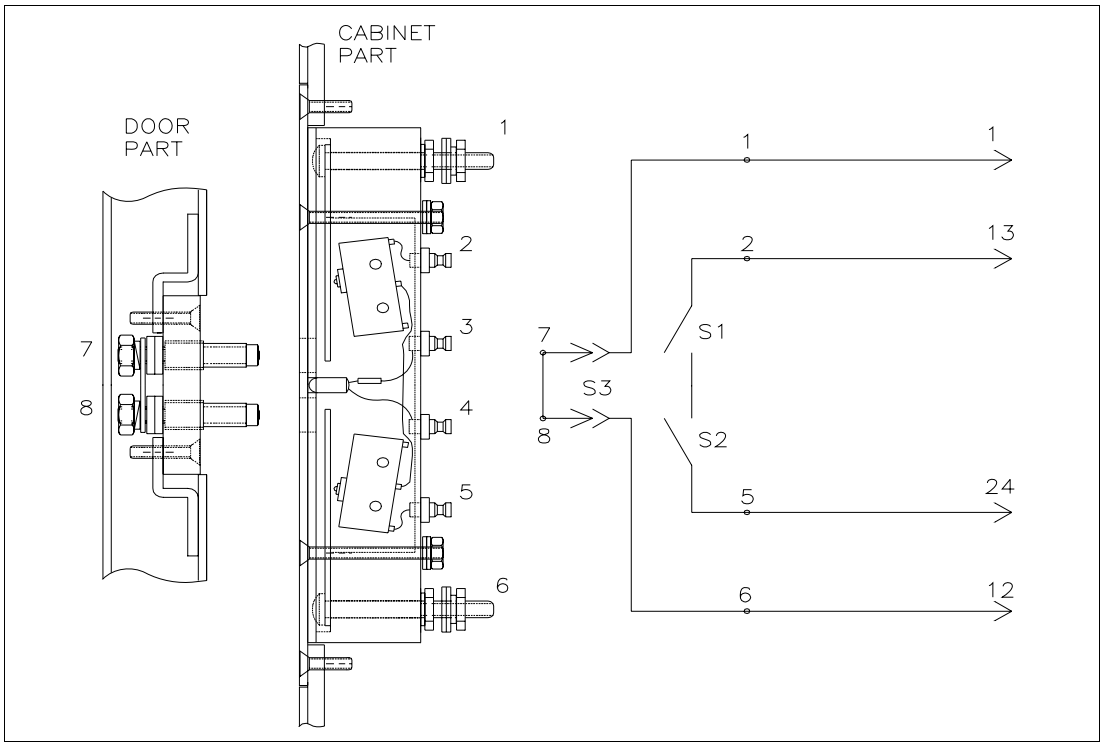


Figure 6-3. Interlock Circuit

Checking the door interlock switch.

In order to operate properly, the two plungers, which are part of the switch assembly mounted in the door, have to be adjusted in such a way that they, with only a small amount of overtravel, activate the two micro switches in the main part of the switch assembly.
Make certain that the unit is turned off and the power cord removed. Use an ohm-meter and connect it to the pins of the cabinet connector as indicated below. See Figure 6-4.

The adjustment can be checked in the following way:

a. Close the door slowly and confirm that the two plungers, which are part of the switch assembly mounted in the door, are entering the main part of the switch assembly, without hitting or rubbing against any part of the mounting bracket or the front cover of the main part of the switch assembly.

b. Cut two pieces of a standard paper to approximately 25 x 90 mm (1 x 3½").Open the door and place one piece of paper over each of the two magnetic lock plates. Secure the paper at the upper edge with a piece of tape.

c. Connect the ohm-meter to pins 1 and 12 (the plunger contact) on the cabinet connector, shown in Figure 6-4.

d. Close the door completely, and confirm that the ohm-meter shows a low resistance (normally less than 1 ohm.

e. Connect the ohm-meter to pins 13 and 24 (the micro switches) and repeat step d.

f. Locate two large steel washers (or other steel objects) approximately 1.5 mm (0.060") thick. Remove the two pieces of paper attached earlier and place one steel washer on each door magnet.

g. With the ohm-meter still connected to pins 13 and 24 close the door completely, and confirm that the resistance value remains considerable higher than the value obtained in step e.

h. Connect the ohm-meter to pins 1 and 12 (the plunger contact) and repeat step g.

If any of the above tests fail, go to the adjustment procedures next.

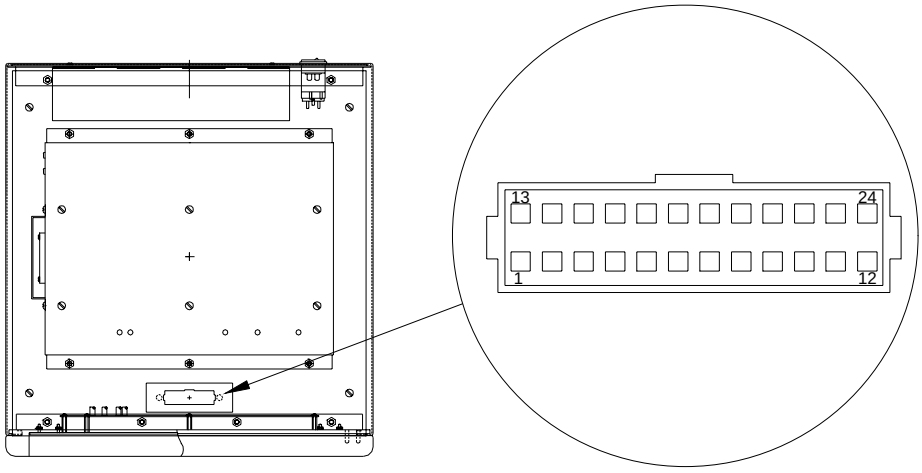


Figure 6-4. Cabinet Connector

Adjusting the door interlock switch.
Part 1. Alignment of plunger and main switch assembly. See Figure 6-5.

If the plungers are not aligned properly with the main switch assembly (see step a of the checking procedures), the parts will have to be re-aligned. Check if the Front Plate **2** is properly aligned with the main switch assembly. I this is not the case, go to "Re-positioning the main switch assembly". Otherwise, go to "Re-positioning the door". Also determine the direction of the misalignment.

Re-positioning the main switch assembly.

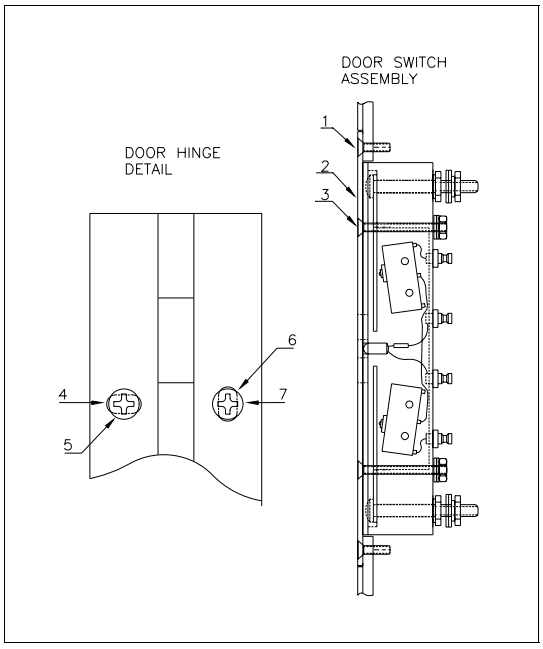
a. Remove the four Mounting Screws **1** and pull out the main switch assembly with the mounting plate.

b. Loosen the Mounting Screws **3** with nut and reposition the main switch assembly relative to the mounting plate. Tighten the screws and nuts.

c. Re-install the main switch assembly and check according to checking procedure step a.

Re-positioning the door.

Please note that the hinge has slotted holes which will allow the door to be aligned with the cabinet. Determine in which direction the door has to be moved, then loosen the appropriate screws, **5** or **6** and reposition the door. Tighten the screws securely. Make certain that the plungers are aligned properly with the main switch. Also, check that the door is opening and closing correctly. Recheck according to previous described procedures.



1. Mounting Screw (2)
2. Front Plate
3. Mounting Screw (4)
4. Horizontal Slotted Hole
5. Mounting Screw for Hinge
6. Vertical Slotted Hole
7. Mounting Screw for Hinge

Figure 6-5. Door Switch Alignment

Adjusting the door interlock switch.
Part 2. Adjusting the activating points of the switches.

To adjust the activating point of the switches, the contact plungers have to be re-positioned. See Figure 6-6 and proceed as follows:

a. Remove Mounting Screws **7** and pull out the plunger assembly.

b. Mark the position of the Nylon Bushings **8** and loosen the two nuts **1** only as much as needed to turn the Nylon Bushings. Temporarily, re-install the plunger assembly.

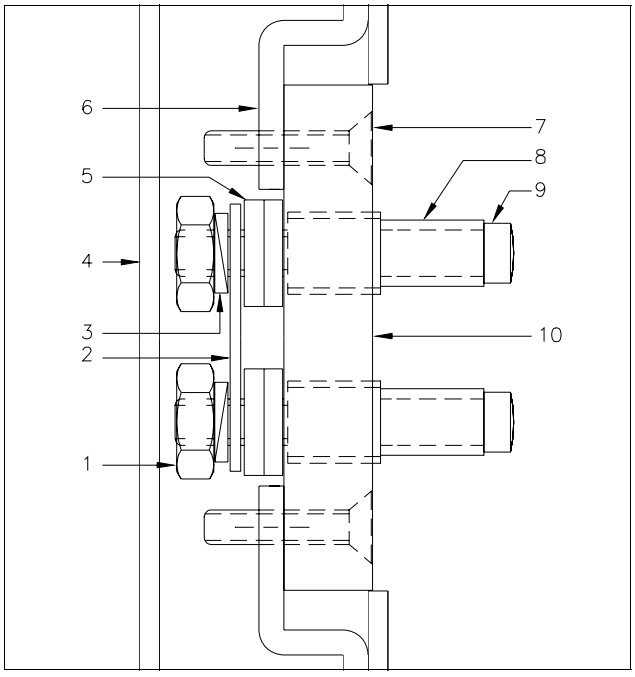
c. Remove any paper spacers from the magnetic lock plates.

d. From the result of the checking procedure, establish the direction and the amount of adjustment of the contact plungers. One turn on the Nylon Bushing **8** is equal to 0.9 mm (0.035"). By turning the Nylon Bushing ¼ of a turn each time, find the point where both microswitches just closes when the door is fully closed. From this position, turn each bushing ¼ turn counter clockwise.

e. Remove the plunger assembly and tighten the nuts. Do not disturb the position of the bushings. Make certain that it is sufficient clearance between any conductive part of the plunger assembly and the Door Bracket **6** or the inside of the door front panel **4**. Depending on the spacing between the two door brackets **6**, some units may require use of Nylon Washers **5**. The nylon washers should have ID=0.150", OD=5/16" and Thickness=0.060".

When installing a new switch assembly, the Nylon Bushings and the Contact Rods may have to be cut in length. Check that, after the adjustments have been made, the Nylon Washers **5** are resting against the Nylon Block **10**. Also check, that the Contact Rods **9** are not extending outside the Nuts **1**.

f. Repeat checking the door interlock switch as described earlier.



1. Nut
2. Shorting Bar
3. Lock Washer
4. Door Front Panel
5. Optional Nylon Washers
6. Door Bracket
7. Mounting Screw (2)
8. Nylon Bushing, Threaded
9. Contact Rod
10. Nylon Block

Figure 6-6. Door Part of Interlock Switch

6.5 CHECK AND ADJUST POWER SUPPLY

Two different power supplies, Power-One PFC375-4002 or Astec LPQ252, can be used in the MX-20. Both provide the same outputs of +5, -12, +12 and 24 volts but the physical appearance and the adjustments are slightly different. During factory calibrations the voltages have been adjusted and further adjustments should normally not be required. At the time of maintenance, however, the voltages should be checked and compared to the values shown in the table, If adjustments are required, proceed according to the instructions for the respective type of power supply.

6.5.1 Power-One PFC375-4002 Power Supply

1. With the MX-20 turned on and all system components connected, measure the voltages at checkpoints shown in Table 6-1 and in Figure 6-7. **Caution:** Because of the limited space around the output terminals, use insulated test probes, and be extra careful to prevent shortening of circuits.

2. If any of the voltages are outside the limits of minimum or maximum shown in Table 6-1, adjust the respective trim potentiometer as shown in Figure 6-7. For the adjustments, use appropriate insulated alignment tools.

Check Points		Min	Max	Adj
COM	**+5V**	4.85	5.15	5.00
COM	**+24V**	23.30	24.70	24.00
COM	**+12V**	11.65	12.35	12.00
COM	**-12V**	-11.65	-12.35	-12.00

Table 6-1
Power Supply Adjustments

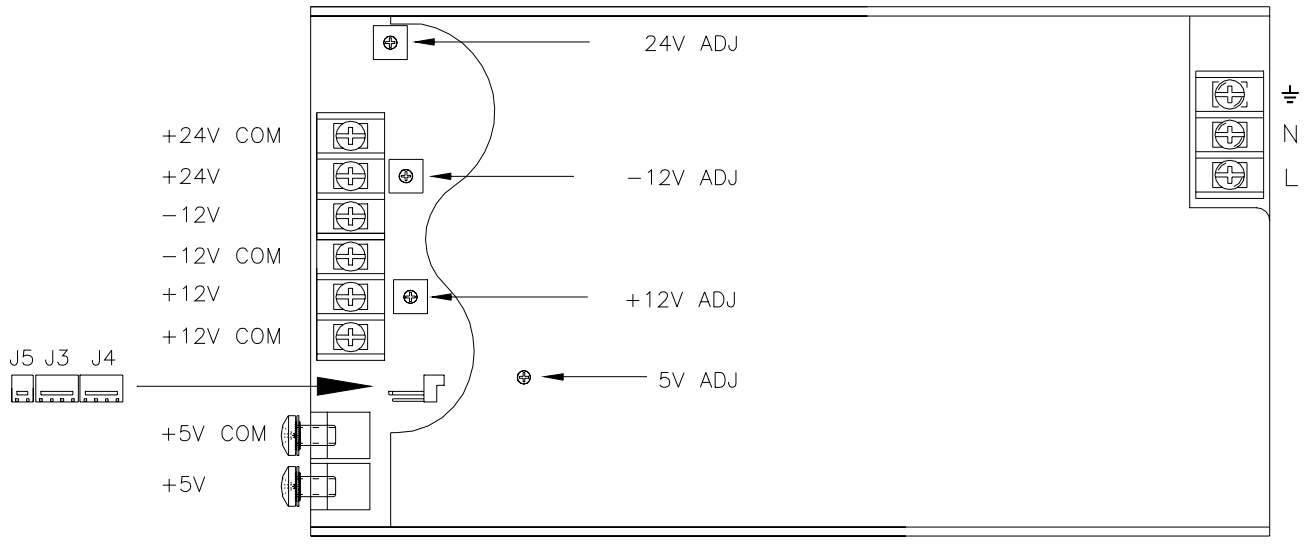


Figure 6-7
Power-One PFC375-4002 Power Supply

6.5.2 Astec LPQ252 Power Supply

1. With the MX-20 turned on and all system components connected, measure the voltages at checkpoints shown in Table 6-2 and in Figure 6-8. **Caution:** Because of the limited space around the output terminals, use insulated test probes, and be extra careful to prevent shortening of circuits.

2. If any of the voltages are outside the limits of minimum or maximum shown in Table 6-2, adjust the respective trim potentiometer as shown in Figure 6-8. For the adjustments, use appropriate insulated alignment tools.

Check Points		Min	Max	Adj
COM	**+5V**	4.85	5.15	5.00
COM	**+24V**	23.30	24.70	24.00
COM	**+12V**	11.65	12.35	Note a
COM	**-12V**	-11.65	-12.35	Note a

Table 6-2
Power Supply Adjustments

Note a: The outputs +12V and -12V on this power supply are not adjustable. If any of them are found to be outside the limits, please contact Faxitron for assistance.

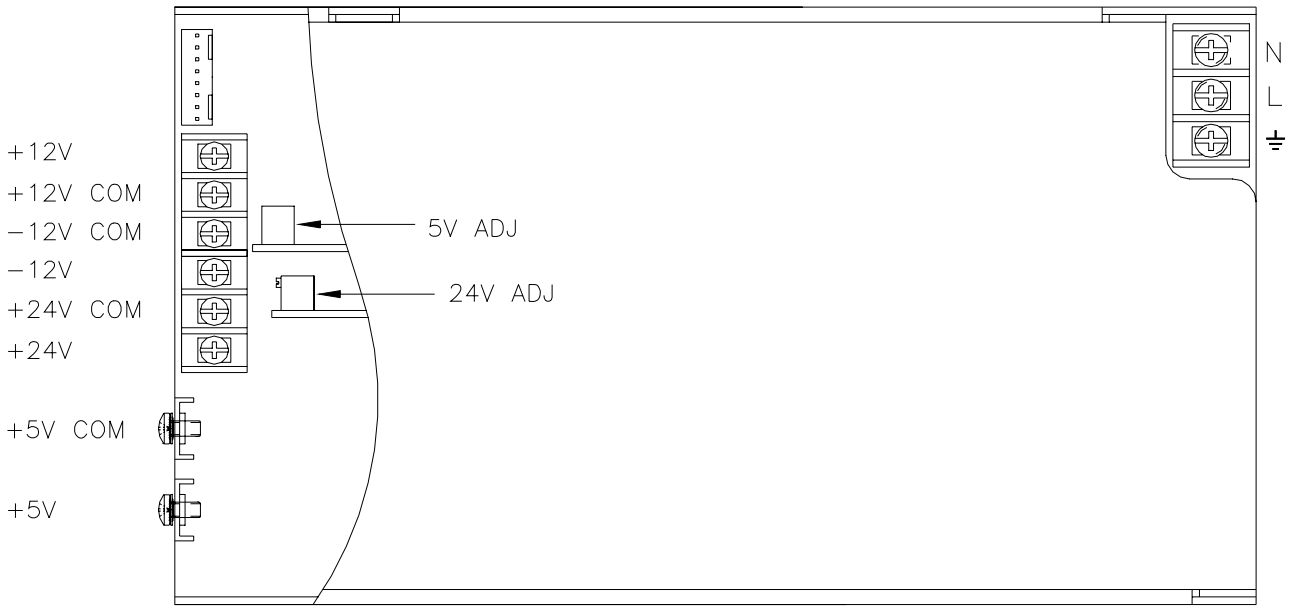


Figure 6-8
Astec LPQ252 Power Supply

6.6 CHECK kV.

To check the kV calibration, proceed as follows:

1. Connect a digital voltmeter to the kV calibration points on the side of the high voltage unit as shown in Figure 6-9.

2. Warm up the X-ray tube, by making an exposure at 20 kV and 300 seconds.

3. Make 10 seconds exposures at 10, 20 and 35 kV and check that the voltage readings on the digital voltmeter are within the range shown in Table 6-3. There are no adjustments for the kV calibration. If the values are not within the reference values, contact your Faxitron X-Ray LLC Sales/Service Office for assistance.

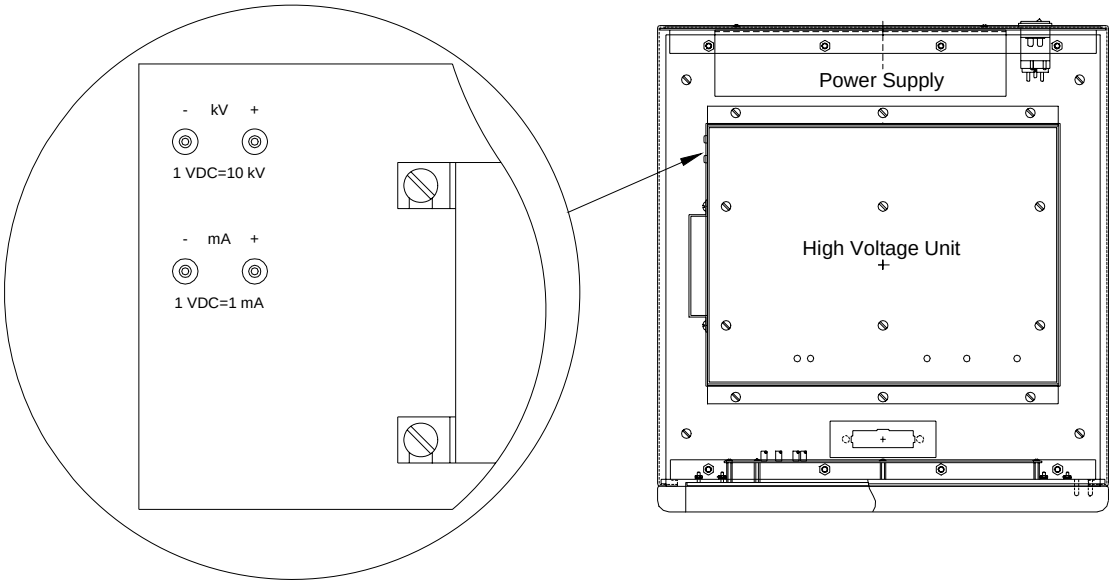


Figure 6-9. KV Calibration

kV	Reference VDC
10	0.95-1.05
20	1.90-2.10
35	3.33-3.67

Table 6-3. kV Calibration

6.7 CHECK AND ADJUST X-RAY TUBE CURRENT.

To check and adjust the X-ray tube current (mA), proceed as follows:

1. Connect a digital voltmeter to the mA calibration points on the side of the high voltage unit as shown in Figure 6-10.

2. Warm up the tube, by making an exposure at 20 kV and 300 seconds.

3. At 20 kV and 10 seconds exposure, confirm that the voltage on the digital voltmeter is between 0.285 and 0.315 VDC. Also, make exposures at 10 and 35 kV and confirm that the reference voltage is still within its limits.

Adjustment.

If the voltage is not within the range specified, adjust potentiometer R30 on the Gun-board. The potentiometer can be reached through a hole in the top cover for the high voltage unit and is marked as L2 in Figure 6.10. Use an insulated screw driver or a special trimmer adjustment tool. After the adjustment, check the reference voltage at 10, 20 and 35 kV.

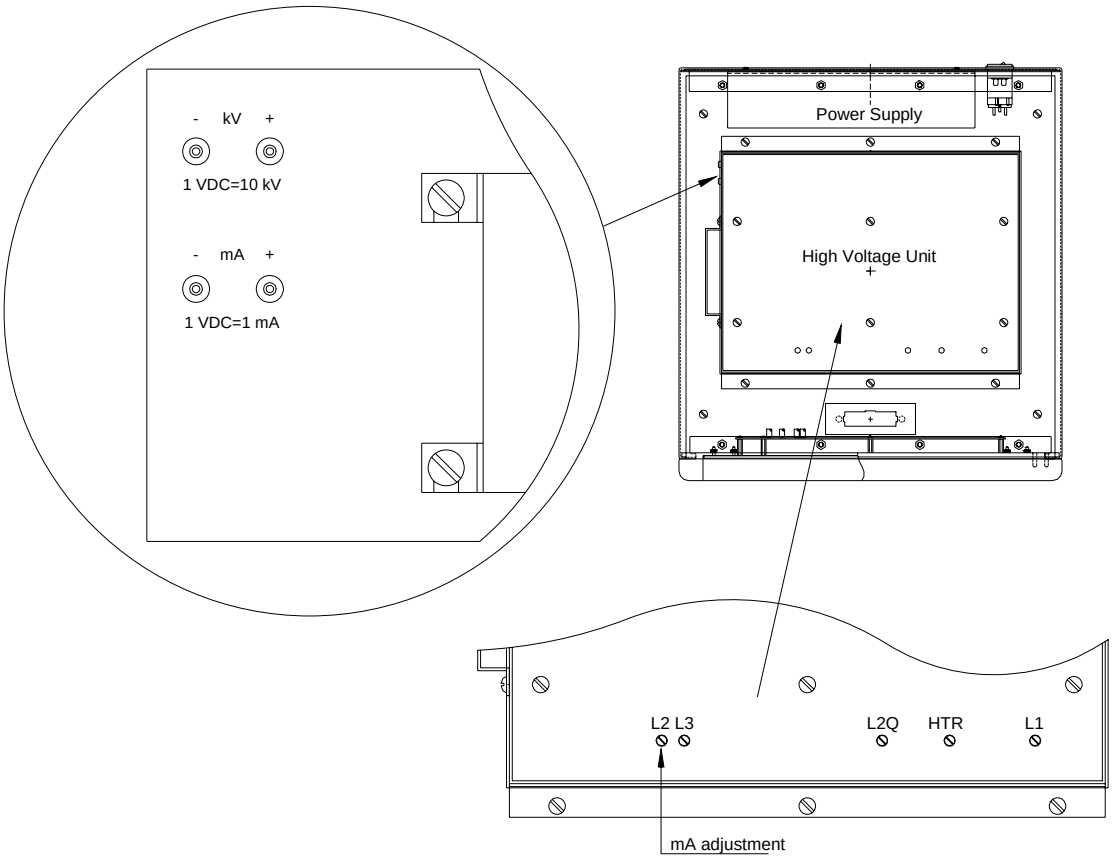


Figure 6-10. mA Calibration

6.8 VERIFY PROPER OPERATION OF MANUAL EXPOSURE CONTROL.

Follow the step by step operating instructions for manual mode operation in section 3 and verify that everything is operating properly. Pay special attention to the X-RAY ON Indicators **4** and **11**.

6.9 TAKE STANDARD RADIOGRAPH AND CHECK FOR SATISFACTORY OPERATION.

Take a standard radiograph of an object for which technique factors are known. Verify that the film is properly exposed and has the expected image quality. Save the film for future reference.

6.10 CHECK AND ADJUST AUTO EXPOSURE CONTROL.

The optional Auto Exposure Control (AEC) can be checked and if needed, adjusted as follows:

1. Remove the shelf and any other object located in the path of the central X-ray beam. Please note that film is not used for this test.

2. Locate the Calibration Sample, shown in Figure 6-11 and place it on the bottom of the exposure chamber, centering it to the center mark.

3. Follow the operating instructions for AEC Mode and select the exposure factors according to Table 6-4, "Calibration Sample Only".

4. Make an exposure. When the exposure is completed, press the Time Mode Key **22** and read the actual exposure time on the Time/AEC Display **6**. This time should correspond with the time shown in Table 6-4. If the time is not within the range specified, proceed with the AEC gain adjustment.

5. When the correct exposure time has been obtained, it is suggested that a reference film is made. For this test use Kodak MIN-RM cassette with MIN-R screen and MIN-RM film, or equivalent. Place the cassette on the bottom of the exposure chamber, centering it to the center mark. Place the calibration sample on top (and in center) of the cassette and make an exposure using the settings shown in Table 6-4, "Cal. Sample + Cass. + Screen + Film". Develop the film and check the density in the area covered by the calibration sample. The density is expected to be about 1.5, but may vary as a result of differences in film, screen, cassette and developing. Save the film for future reference. Also, check the exposure time. It should be about 10 seconds but may vary because of difference in absorption of the film, screen and cassette.

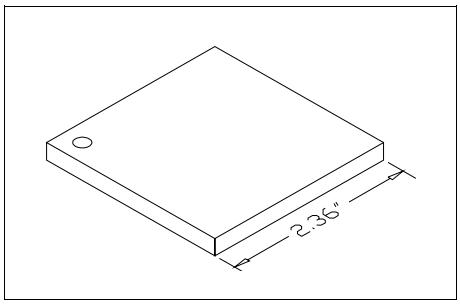


Figure 6-11. Calibration Sample

	Object	
	Calibration Sample Only	**Cal. Sample + Cass. + Screen + Film**
kV	15	20
Density	100%	100%
Film Select	F2	F5
Adjust	R61	None
Exp. Time	10.5-12.5	About 10

Table 6-4.
Exposure Factors for AEC Calibration

CHECK AND ADJUST AUTO EXPOSURE CONTROL, cont'd.

Adjustment.

a. AEC Gain Calibration.

If the exposure time during the AEC calibration was not within the range specified, make adjustment on the AEC GAIN potentiometer R61 (shown in Figure 6-12) and repeat the test.

b. AEC Sensor Zero Calibration.

The AEC circuit has a built-in automatic zero calibration which is factory adjusted. For this reason, the AEC ZERO potentiometer R62 (shown in Figure 6-12), does not require any adjustment.

Note: Kodak MIN-R and MIN-RM are trademarks of Eastman Kodak Company.

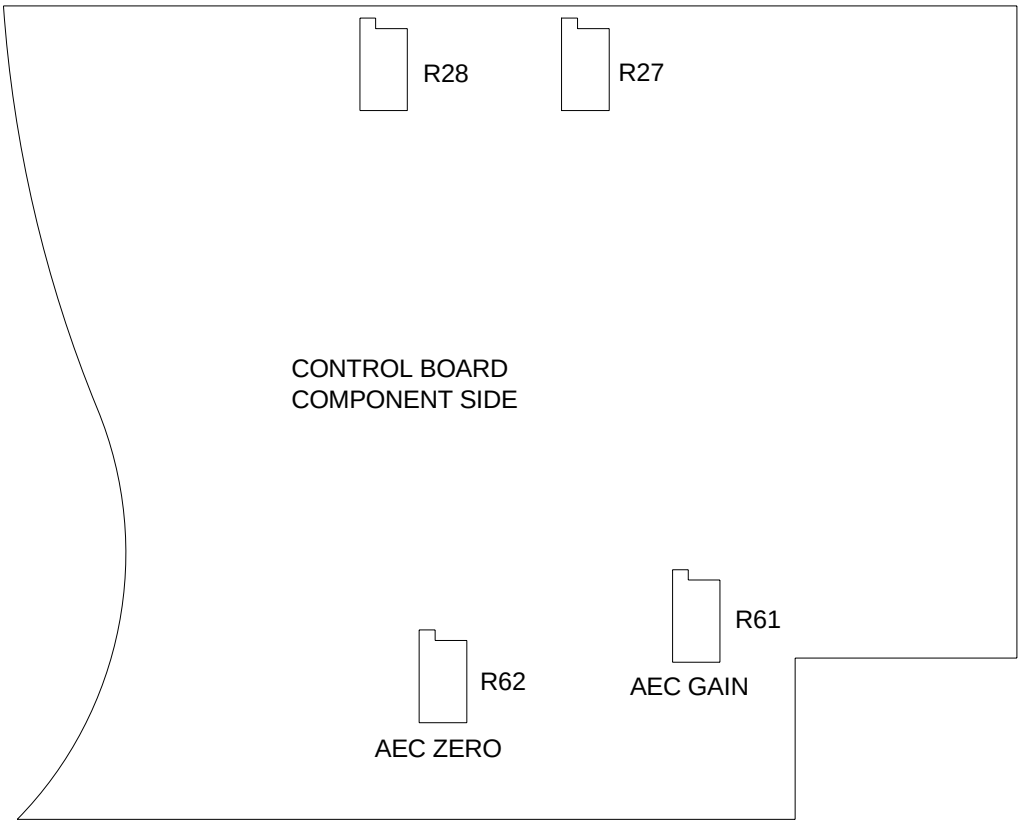


Figure 6-12. Trimming Potentiometers on Control Board

6.11 FACTORY ADJUSTMENTS OF CONTROL BOARD.

There are four trimming potentiometers on the control board (see Figure 6-12). Two of the potentiometers, R61 and R62 are adjusted at the factory as described in the previous adjustment instructions.

Potentiometer R28 is used at the factory to set the threshold voltage for turning on the X-RAY ON indicator **4** (see Figure 3-1) at a X-ray tube current of 0.15 mA. Potentiometer R27 is not used.

6.12 FACTORY ADJUSTMENTS OF GUN BOARD.

There are seven trimming potentiometers on the gun board, but adjustments for only one, the X-ray tube current (mA), is covered in this manual. The other six potentiometers are adjusted at the factory to match the individual characteristics of the high voltage power supply and the X-ray tube and should normally not have to be adjusted. Should a failure occur of any of the critical components (X-ray tube, high voltage power supply or gun board) it is advisable to replace the complete high voltage unit.

For reference, however, a short description of the potentiometers on the gun board and their adjustments are included. See Figure 6-13 and Table 6-5.

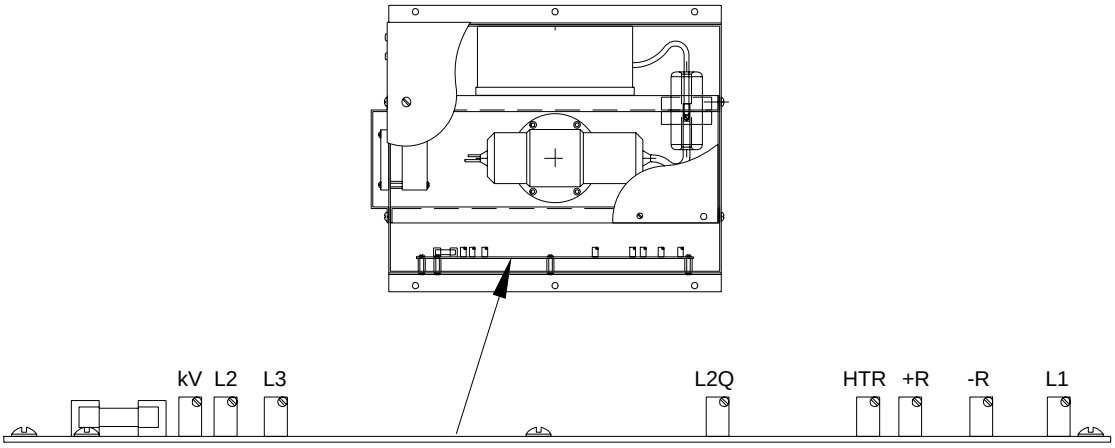


Figure 6-13. Trimming Potentiometers on Gun Board

Pot.	Function	Adjustment
L2Q	Grid 2 Cutoff Voltage	Set to about -140 Volts.*
L1	Pre-Focus	Set to about -4 Volts.*
L2	mA	Set for 0.3 mA. See paragraph 6.6
L3	Focus	Set to about 600 Volts at 20 kV.*
HTR	Heater	Set to about 6.8-7.0 Volts.*
kV	kV	Set to correct kV (see Check kV earlier in the section)
+R	Reference Voltage	Set to +5.00 Volts
-R	Reference Voltage	Set to -5.00 Volts

Table 6-5. Gun Board Adjustment

*****The voltages should be set to the actual values shown in the test sheet for the X-ray tube installed.

6.13 MAKE COMPLETE RADIATION SURVEY.

A radiation survey should be performed following the steps outlined in section 8 of this manual.

6.14 CHECK THAT OPERATING PERSONNEL HAS RADIATION MONITORING SYSTEM.

Check that the operating personnel has received information about radiation film badge service for cumulative individual personnel monitoring.

6.15 CLEAN CONTROL PANEL.

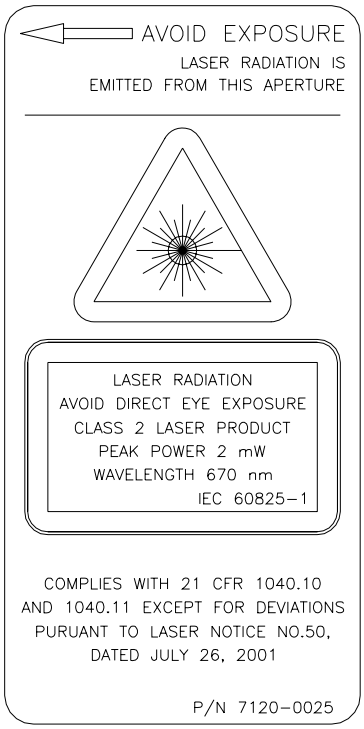
Once a year the control panel and the exterior surface of the system should be cleaned. Use a damp cloth and a water-based solution. Make certain that the unit is turned off and do not allow excess water to penetrate into the unit. Allow plenty of time for any moisture to dry before turning unit on again.

6.16 CLEAN AIR FILTER.

Once a year, the air filter, on the left side of the high voltage unit, should be cleaned. Use a vacuum cleaner and a small brush. In this does not work, it may be necessary to remove the high voltage unit and the air baffle in front of the filter. For instructions how to remove the high voltage unit, see paragraph 4.2.3 in the service section of this manual.

6.17 CHECK AND ADJUST LASER LOCATOR.

To check and adjust the laser locator, proceed as follows:



Checking.

1. Open the Exposure Chamber Door and remove the complete Shelf Assembly.

2. Turn power on and observe the two laser lines. Make certain that both lines intersects at the X-ray beam center at the bottom of the Exposure Chamber and that each line is parallel to its respective sides. The center of the X-ray beam is usually marked with a cross marker or by a 2" x 2" cutout in the bottom of the Exposure Chamber.

3. If the lines are not centered and parallel as described above, proceed with the adjustment as follows:

Adjusting.

The Laser Locator Modules are located on the upper rims inside the Exposure Chamber as shown in Figure 6-14. Power to the Laser Modules (5 VDC) is supplied from the control unit through the 24-pin connector. This means that in order to activate the laser locator, the control unit has to be in place. For greater access to the laser locator in a non operating mode, see "Replacing Laser Locator" in the service section of the manual.

The following steps describes the adjusting procedure:

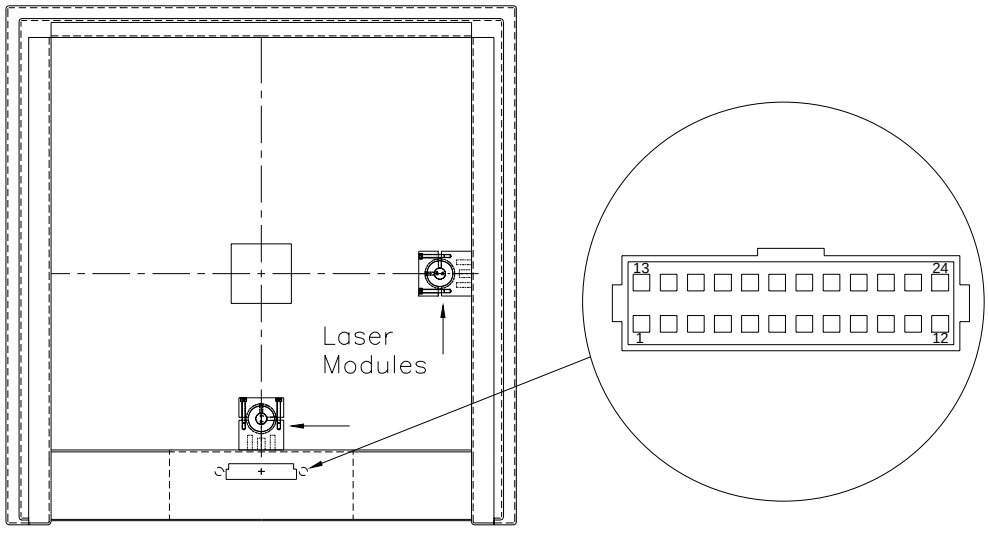


Figure 6-14. Laser Locator

Adjusting Laser Locator, cont'd

1. Open the Exposure Chamber Door and verify that the two Laser Generators are turned on.

2. Reaching through the door, use a 3/32" hex wrench and loosen the two hex screws, shown in Figure 6-15, sufficient to be able to tilt and turn the Brass Ring/Laser Line Generator assembly.

3. Tilt and turn the Brass Ring/Laser Line Generator assembly until:
   a. The line intersects at the X-ray beam center at the bottom of the Exposure Chamber.
   b. The line is parallel to the sides of the Exposure Chamber.
   c. The line covers the bottom and most of the opposite wall as determined by the 85 degrees fan angle.

4. Carefully tighten (do not overtighten) the hex screws and check that the alignment is still correct.

5. Repeat the procedure with the second Laser Module.

6. Check Laser Locator alignment and normal operation of the MX-20.

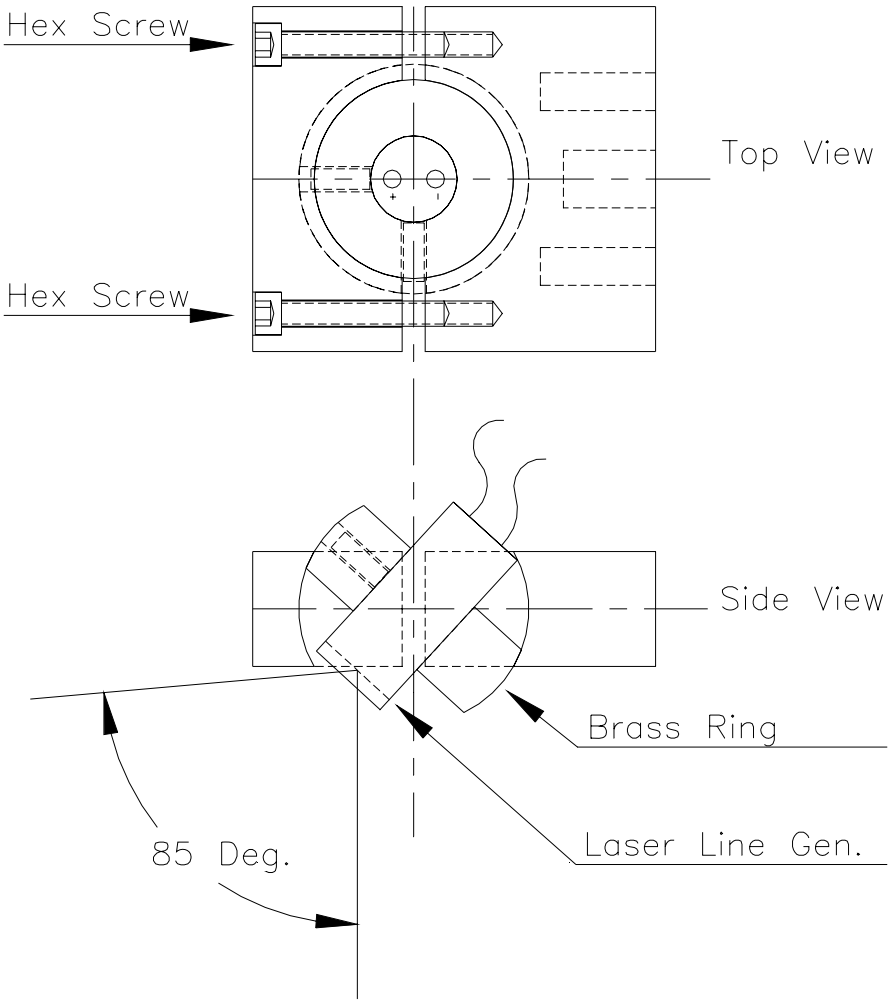


Figure 6-15. Adjustment of Laser Locator

6.18 CHECK AND ADJUST OPTIONAL CAMERA COMPONENTS.

The optional camera and its components are located in the base of the MX-20. See Figures 6-16 and 6-17. Only the camera power board needs adjustments. Different cameras from three manufacturers according to System Description in Section 1 are used. To check and adjust the camera power board, proceed as follows:

Preparations.

1. Turn off the On/Off Key Switch and unplug the power cord.
2. Open the door and locate the floor plate as shown in Figure 6-16. Remove screws holding the floor plate to the base.
3. Lift and tilt the floor plate (with the camera mounted to the bottom) over to the right side as shown in Figure 4-10. Note that the camera shown in Figure 4-10 is the DC-12 option.

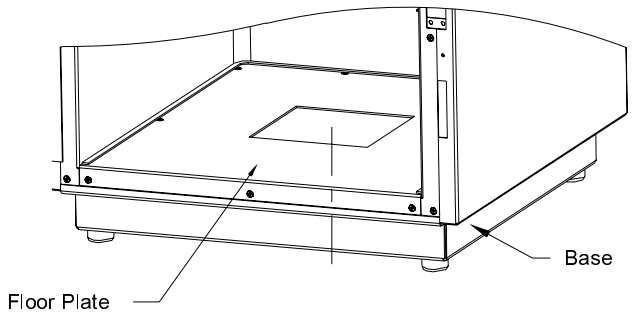


Figure 6-16
MX-20 with Floor Plate

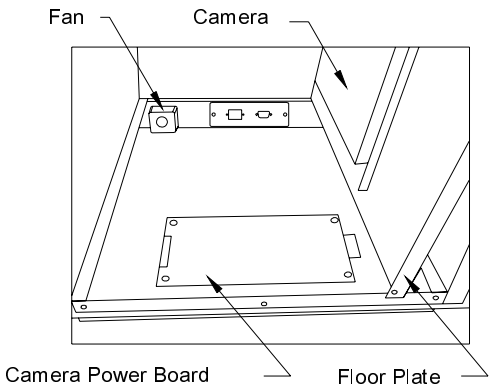


Figure 6-17
Camera Compartment

6.18.1 Check and adjust Power Board for Hamamatsu Camera.

1. Follow the steps in paragraph 6.18 Preparations.
2. Make certain that the camera unit and all systems components are connected, then turn on the unit.
3. See Figure 6-18 and measure the voltages according to Table 6-6. Adjust only if the voltages are outside the limits of minimum and maximum.

Supply	Check Points	Min	Max	Adjust to	Adjust on
+5 VDC	J2-5, J2-6	+4.85	+5.15	+5.00	No Adjustment [a]
+12 VDC	J2-8, J2-7	+11.65	+12.35	+12.00	No Adjustment [a]
+8 VDC Digital	Across C4	+7.75	+8.25	+8.00	R1
+5 VDC Digital	J2-1, J2-2	+5.20 [b]	+5.30 [b]	+5.25 [b]	R4
+8V DC Analog	Across C11	+7.75	+8.25	+8.00	R6
+5 VDC Analog	J2-4, J2-3	+5.20 [b]	+5.30 [b]	+5.25 [b]	R8

[a] Note: This adjustment is made on the MX-20 Power Supply.
[b] Note: These limits introduced in September 2006.

Table 6-6
Hamamatsu Camera Power Board Adjustments

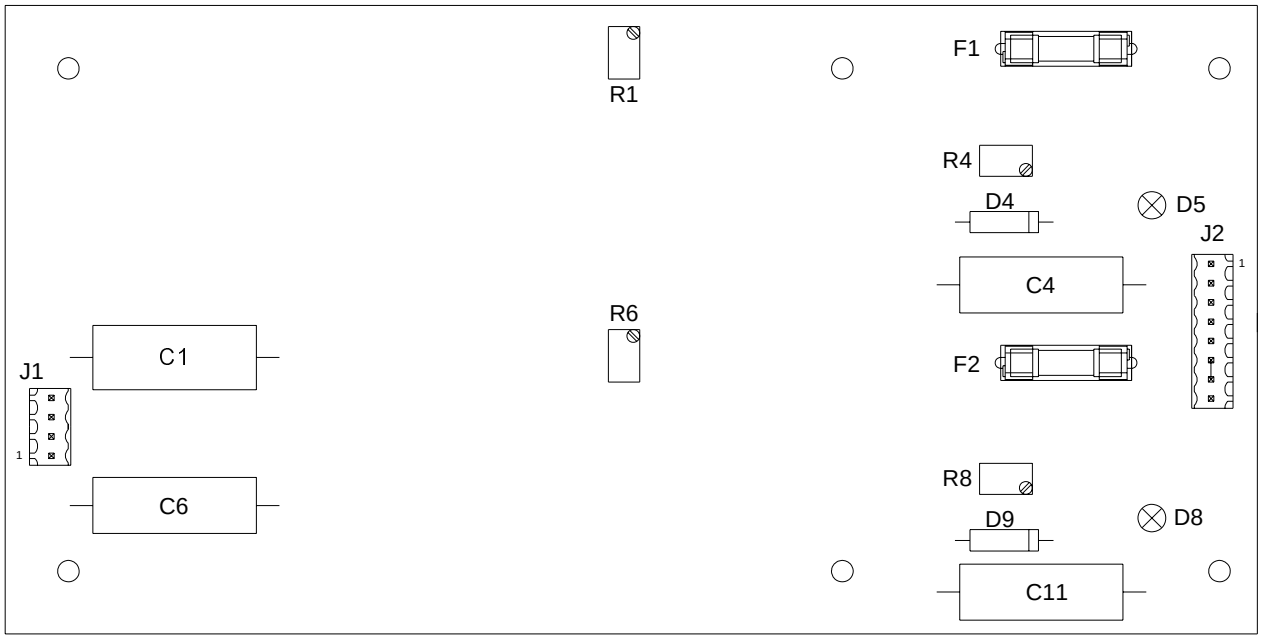


Figure 6-18
Hamamatsu Camera Power Board

6.18.2 Check and adjust Power Board for Dalsa Camera.

1. Follow the steps in paragraph 6.18 Preparations.
2. Make certain that the camera unit and all systems components are connected, then turn on the unit.
3. See Figure 6-19 and measure the voltages according to Table 6-7. Adjust only if the voltages are outside the limits of minimum and maximum.

Supply	Check Points	Min	Max	Adjust to	Adjust on
+5 VDC	J2-5, J2-6	+4.85	+5.15	+5.00	No Adjustment *
+12 VDC	J2-8, J2-7	+11.65	+12.35	+12.00	No Adjustment *
+24 VDC	D1-C, J2-2	+23.75	+24.25	+24.00	R1
-24 VDC	D9-A, J2-2	-23.75	-24.25	-24.00	R9
+21 VDC	J2-1, J2-2	+20.75	+21.25	+21.00	R4
-21 VDC	J2-3, J2-2	-20.75	-21.25	-21.00	R7

* Note: This adjustment is made on the MX-20 Power Supply.

Table 6-7
Dalsa Camera Power Board Adjustments

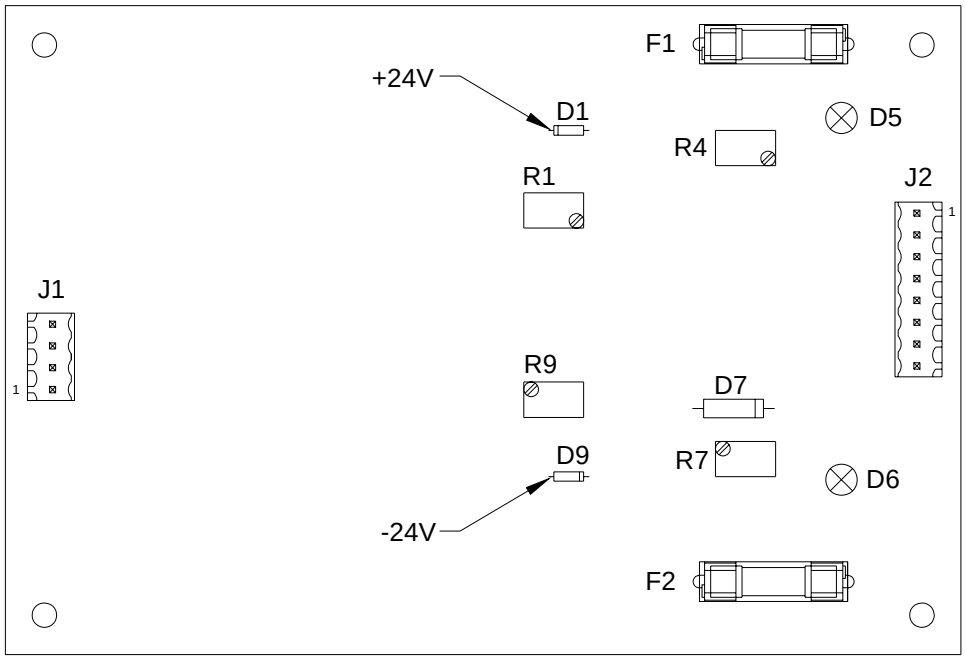


Figure 6-19
Dalsa Camera Power Board

6.18.3 Check and adjust Power Board for Bioptics Camera.

1. Follow the steps in paragraph 6.18 Preparations.
2. Make certain that the camera unit and all systems components are connected, then turn on the unit.
3. See Figure 6-20 and measure the voltages according to Table 6-8. Adjust only if the voltages are outside the limits of minimum and maximum.

Supply	Check Points	Min	Max	Adjust to	Adjust on
+5 VDC	J2-5, J2-6	+4.85	+5.15	+5.00	No Adjustment *
+12 VDC	J2-8, J2-7	+11.65	+12.35	+12.00	No Adjustment *
+8 VDC	Across C4	+7.75	+8.25	+8.00	R1
+5 VDC	J2-1, J2-2	+4.65	+5.15	+4.90	R4

* Note: This adjustment is made on the MX-20 Power Supply.

Table 6-8
Bioptics Camera Power Board Adjustments

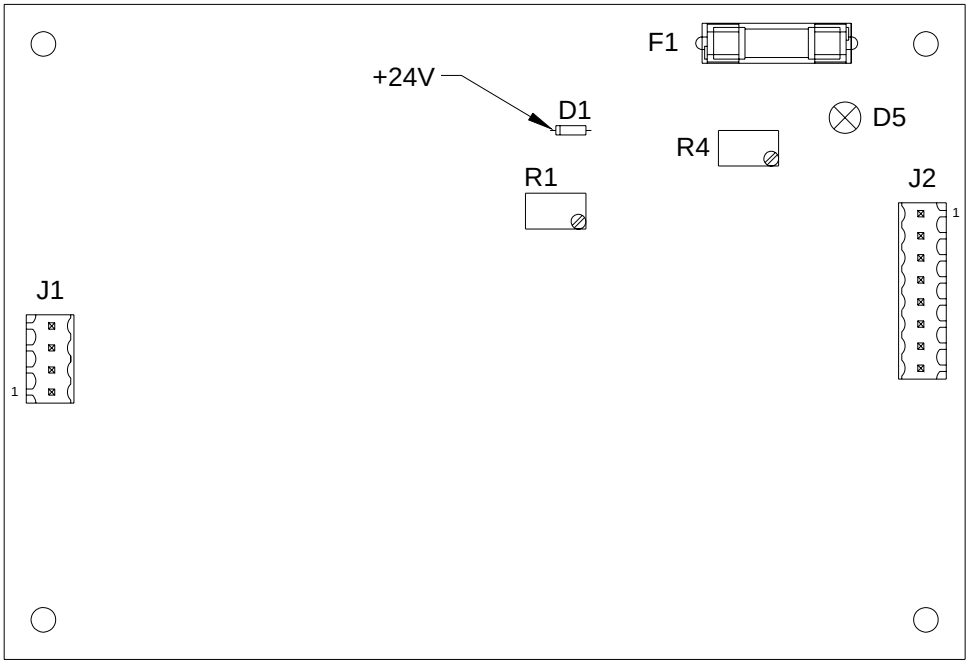


Figure 6-20
Bioptics Camera Power Board

6.19 CHECK AND ADJUST BASE AND FLOOR INTERLOCK SWITCHES.

Two interlock switches are located on the right side inside the cabinet below the floor plate as shown in Figure 6-21. The switches will prevent X-ray from being turned on if the base or the floor plate is removed. To check and adjust the switches proceed as follows:

1. Turn off the On/Off Key Switch and unplug the power cord.
2. Open the door and locate the floor plate. Remove screws holding the floor plate to the base.
3. Lift and tilt the floor plate (be careful if an optional camera is installed) over to the right side. If an optional camera is installed, unplug the connectors from the camera unit and remove the floor plate (with the camera).
4. To check that the floor interlock switch is operating properly, close the door, turn the unit on and confirm that an exposure **can not** be made.
5. Turn off the On/Off Key Switch and unplug the power cord.
6. Place the floor plate in position (do not forget to connect the camera) but do not attach the screws.
7. To check that the floor interlock switch is operating properly, close the door, turn the unit on and confirm that an exposure **can** be made.
8. If adjustment or replacement of the floor interlock switch is necessary, follow steps 1-3 above. Adjustments can be made by loosening the mounting screws and tilting the switch or by bending the switch arm.
9. If the tests in step 4 and 7 came out satisfactory, secure the floor plate with the screws removed in step 2.
10. This completes the test of the floor interlock switch. The base interlock switch has been adjusted and tested at the factory and because the base is not removed during field service of the unit, the switch should not require adjustments.

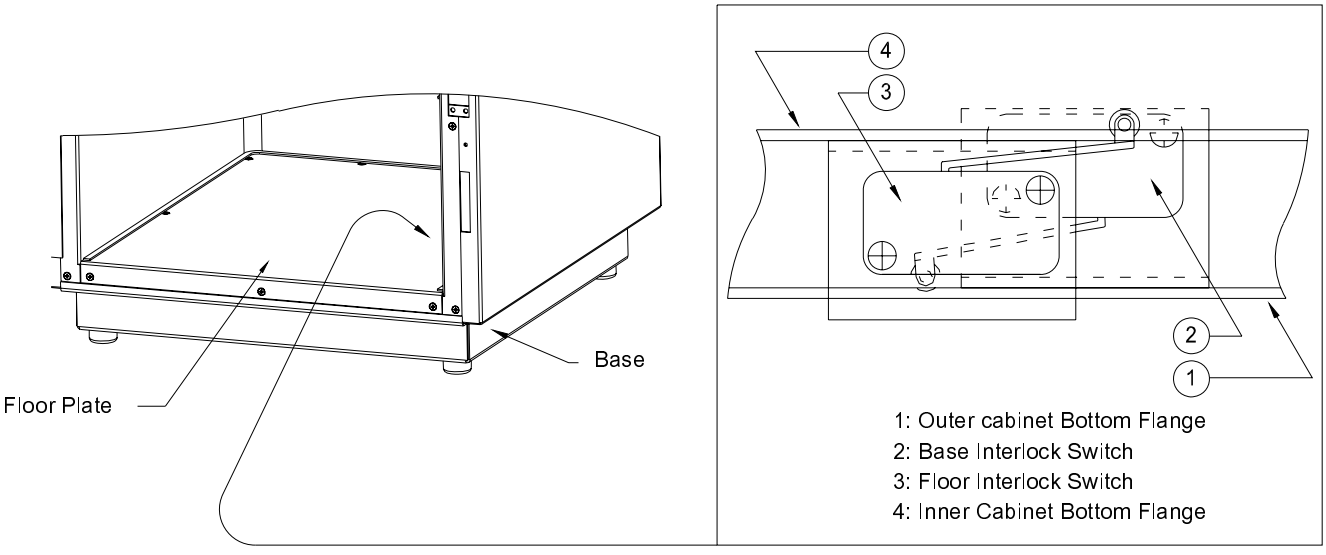


Figure 6-21
Base and Floor Interlock Switches

SECTION 7

MAINTENANCE SCHEDULE

SAFETY PRODUCT ASSURANCE CHECKS, EVERY SIXTH MONTH.

For a complete description of the procedure, see the listed paragraphs in section 6.

Paragraph	Procedure	Date	Date	Date
6.2	Check decals and operator safety instructions			
6.3	Check resistance from cabinet to input power connector pin			
6.4	Check door interlock			
6.6	Check kV			
6.7	Check X-ray tube current			
6.8	Verify proper operation of manual exposure control			
6.9	Take standard radiograph and check for satisfactory operation			
6.10	Check Auto Exposure Control (option A02X only)			
6.13	Make complete radiation survey			
6.14	Check that operating personnel has radiation monitor system			
6.17	Check alignment of the Laser Locator			

Checked by	Date	comments

Additional Comments: . . . . . .
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SECTION 8

RADIATION SURVEY

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SECTION 8

RADIATION SURVEY

8.1 RADIATION SAFETY STANDARD.

a. For systems delivered to all countries except UK:

Less than 0.5 mR/hr at 5 cm (2 in.) from exterior surface at maximum kVp.

b. For systems delivered to UK:

Less than 0.1 mR/hr at 10 cm (4 in.) from exterior surface at maximum kVp.

8.2 MEASURING INSTRUMENT CHECK - BEFORE SURVEY.

a. Type of instrument:

Use an instrument with adequate accuracy at maximum kVp and beam quality of the X-ray unit surveyed.

b. Calibration date:

Make certain that the survey meter has been calibrated within the last three months.

c. Battery Check:

Check for proper battery condition. Replace batteries before survey if required.

d. Operational source check:

If the survey meter has a source check, check it as instructed in the operators manual for the meter.

e. All measurements should be made with the beta cap removed.

8.3 SURVEYING CABINET SYSTEM.

a. Place a 4 liter (1 gallon) plastic jug of water in the center of the bottom of the Exposure Chamber. Make certain there is no filtration in the direct beam.

b. Warm up the X-ray tube by making an exposure at 20 kV and 300 seconds (5 minutes).

c. Block or wedge the door open to a point just before the interlock actuates.

d. Set 35 kV (maximum) and start another exposure.

e. Starting around the door slowly, scan the four sides and top of the system. Scan at about 4 cm/second (about 1.6"/second) across each side at about 2 to 2.5 cm (0.8 to 1") from face of survey meter to face of side or top of the system. Scans are made in horizontal movements from one edge of face to the other edge, moving down an average of 5 cm (2") each pass. Scan in a parallel line back and forth until the whole side is scanned. Perimeter of sides are then scanned. If there is an increase while scanning, in meter reading, by leakage, or by background burst of radiation, the area of approximately 5 x 5 cm (2 x 2") shall be very slowly scanned. Go over the area two or three times until there is a stabilized reading on the meter. The highest stabilized reading (HR) is recorded for all four sides and for the top of the system.

SURVEYING CABINET SYSTEM (cont'd)

f. Determine the lowest value of background radiation, by turning the X-ray system off and waiting for the meter to stabilize to its lowest level (BG). Record this value. Actual (net) leakage values are determined by the formula:

Actual Leakage = HR - BG

NOTE: In order to obtain the reading for the top of the system, the meter was held vertically. Be certain to measure the corresponding background reading with the meter held vertically.

g. If the system is on a table, or if there is personnel on the floor below where the system is used, the bottom of the unit should also be surveyed. Before scanning the bottom of the cabinet, all attenuation in the direct beam, such as the water jug, metal shelf, filters, etc., shall be removed.

NOTE: In order to obtain the reading for the bottom of the system, the meter was held vertically. Be certain to measure the corresponding background reading with the meter held vertically.

h. When the system is placed against a wall and people occupy an area on the other side of the wall - be certain to survey the area immediately on the other side of the wall in a similar manner as specified in step e.

8.4 MEASURING INSTRUMENT CHECK - AFTER SURVEY.

a. Battery Check:

Check for proper battery condition. If battery condition is not correct, replace batteries and repeat the survey.

b. Operational source check:

If the survey meter has a source check, check it as instructed in the operators manual for the meter. If the reading is out of specification, all readings made during the survey could be incorrect. Recalibrate or replace the survey instrument and repeat the survey.

SECTION 9

PART LIST

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SECTION 9

PART LIST

ORDERING INFORMATION.

To order a replacement part, send order to or call your authorized Faxitron X-Ray LLC Sales/Service office.

Specify the following information:

1. Model number and complete serial number of the system.
2. Faxitron X-Ray LLC part number.
3. For electrical components, please give circuit reference number (R1, C1 T1 etc.)
4. Description.

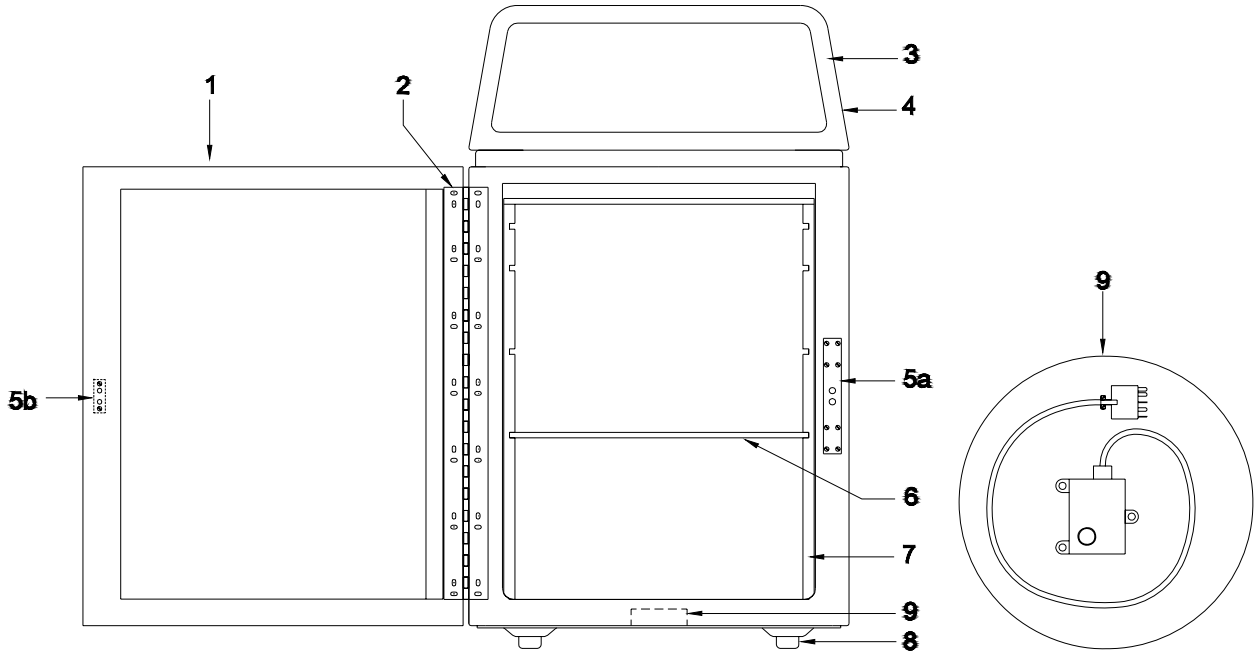
To order part not listed, give a complete description of the part and include its function and location.

Please note that service should be carried out by qualified personnel only. Replacement of parts may require recalibration using special instruments. See sections 4 and 6 of the manual.

PART LIST (cont'd)

CABINET

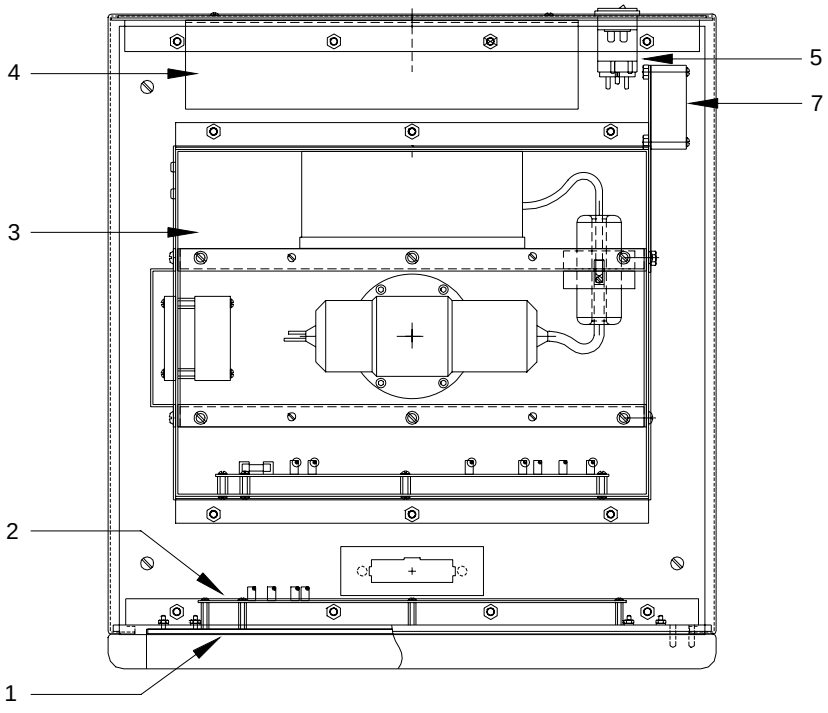
ITEM NO.	DESCRIPTION	QTY	MANUFACTURER	MFG PART NO/SPEC.	FAXITRON PART NO.
1a	Door, Complete, Short Handle	1	Faxitron	43804-63601	43804-63601
1b	Door, Complete, Long Handle	1	Faxitron	43804-63603	43804-63603
2	Hinge	1	Faxitron	100-806250	100-806250
3	Bezel	1	Faxitron	43805-00201	43805-00201
4	Top Cover	1	Faxitron	43805-04109	43805-04109
5	Door Interlock Switch, Compl.	1	Faxitron	08-1906-01	08-1906-01
5a	Door Interlock, Switch Part	1	Faxitron	Order Item No.5	Order Item No.5
5b	Door Interlock, Plunger Part	1	Faxitron	08-3982-01	08-3982-01
6	Shelf	1	Faxitron	120-804037	120-804037
7	Shelf Overlay.	1	Faxitron	120-804038	120-804038
8	Foot	4	McMaster Carr	9540K61	0403-0350
9	AEC Sensor	1	Faxitron	43805-69533	43805-69533

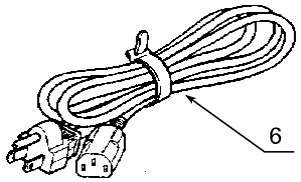


PART LIST (cont'd)

CONTROL AND POWER UNIT

ITEM NO.	DESCRIPTION	QTY	MANUFACTURER	MFG PART NO/SPEC.	FAXITRON PART NO.
1	Control Panel, Compl.	1	Faxitron	43805-65200	43805-65200
2	PC Control Board	1	Faxitron	43805-65202	43805-65202
3	High Voltage Unit, Compl.	1	Faxitron	43805-60045	43805-60045
4a	Power Supply	1	Astec	LPQ-252-C	131-20010
4b	Alternate Power Supply	1	Power-One	PFC375-4002	131-20005
5	Power Receptacle, Compl.	1	Curtis	PM8206	8130-2500
6	Power Cord, 2.4 m (8 feet)	1	Belden	17031	8120-4165
7	Fan	2	Comair	031156f12b3	3160-0365



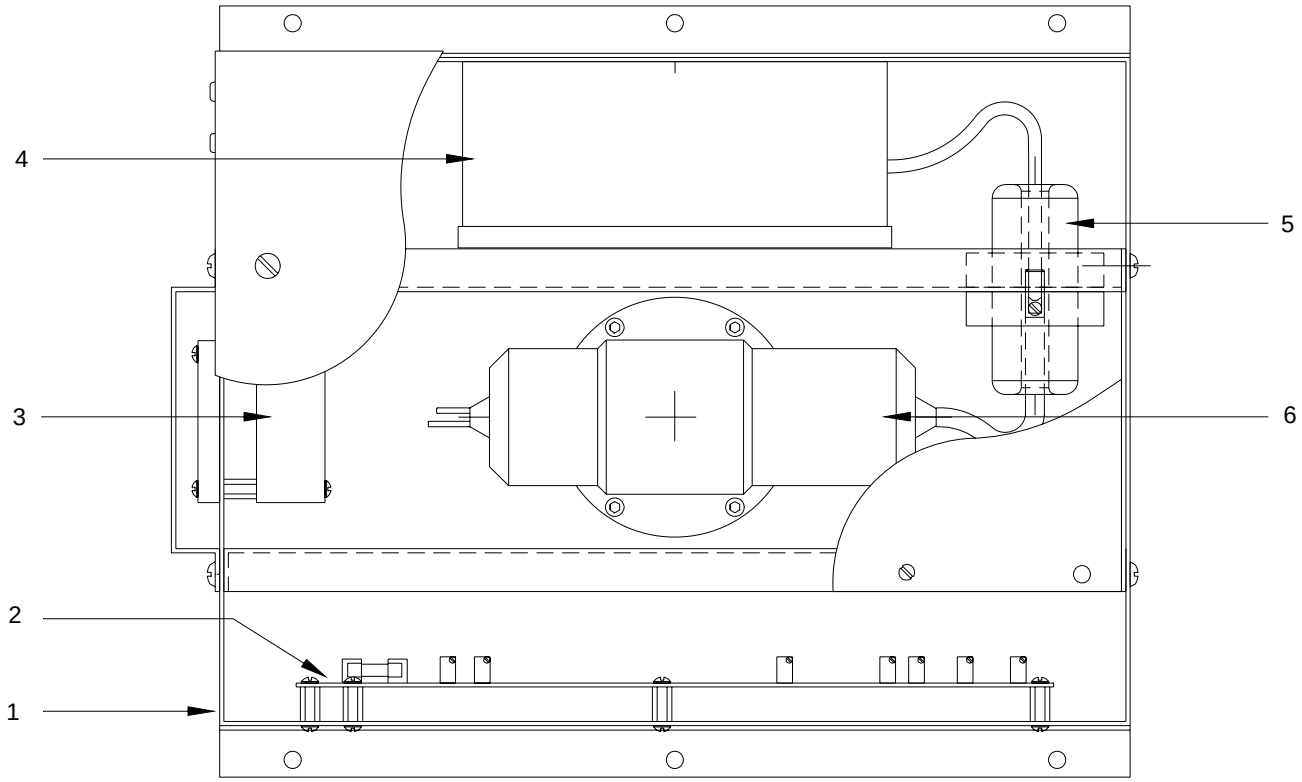


PART LIST (cont'd)

HIGH VOLTAGE UNIT ASSEMBLY

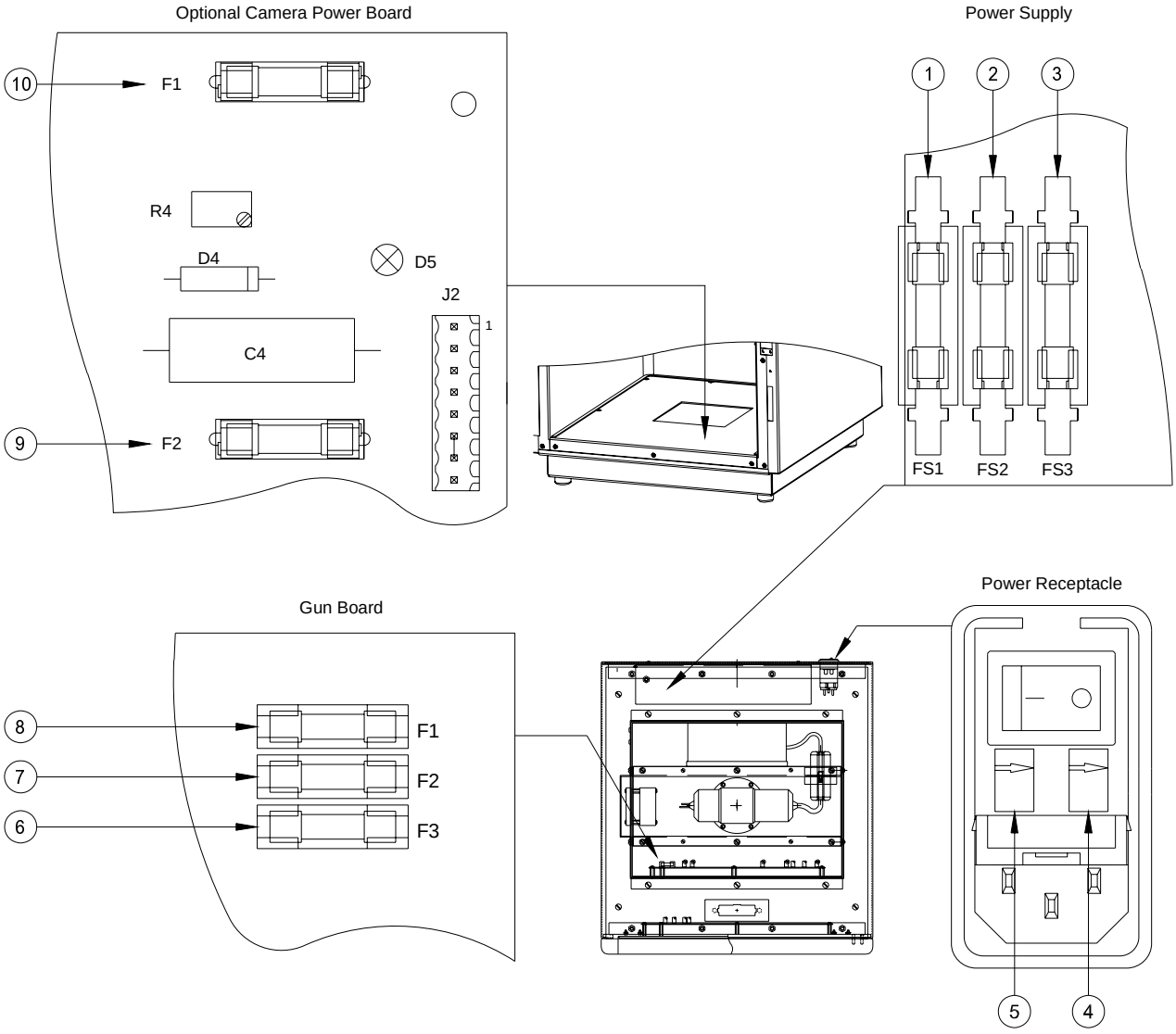
ITEM NO.	DESCRIPTION	QTY	MANUFACTURER	MFG PART NO/SPEC.	FAXITRON PART NO.
1	HV Unit Assembly, Complete	1	Faxitron	43805-60045	43805-60045
2*	PC Gun Board	1	Faxitron	43805-65201	43805-65201
3	Fan	1	Comair	031156f12b3	3160-0365
4*	High Voltage Power Supply	1	Gamma High Voltage	XR15-35P/M530A	131-10001
5	Feedthru Insulator	1	Faxitron	100-804368	100-804368
6*	X-ray Tube	1	Faxitron	130-552004	130-552004

* Note: If failure occur in items 2, 4 or 6, the complete HV Unit Assembly should be replaced.



PART LIST (cont'd)
FUSES

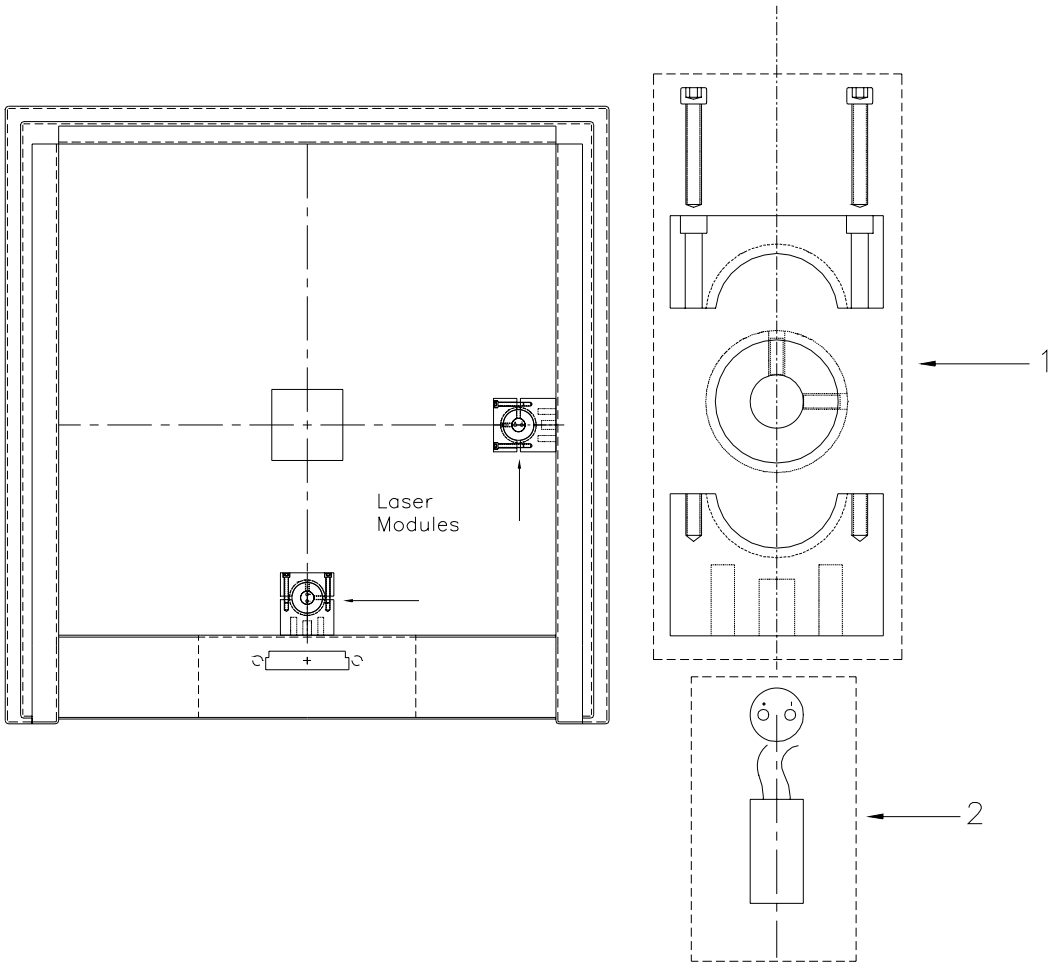
ITEM NO.	DESCRIPTION	QTY	MFG	MFG PART NO/SPEC.	FAXITRON PART NO.
1	Fuse, 8A/250V, 5 x 20 mm	1	Schurter	T8A/250V, 5 x 20	2110-0343
2	Fuse, 5A/250V, 5 x 20 mm	1	Schurter	T5A/250V, 5 x 20	2110-0796
3	Fuse, 2A/250V, 5 x 20 mm	1	Schurter	T2A/250V, 5 x 20	2110-0410
4, 5	Fuse, 5A/250V, 5 x 20 mm	1	Schurter	T5A/250V, 5 x 20	2110-0796
6, 7	Fuse, 2A/250V, 5 x 20 mm	1	Schurter	T2A/250V, 5 x 20	2110-0410
8	Fuse, 0.5A/250V, 5 x 20 mm	1	Schurter	T500mA/250V, 5 x 20	2110-0420
9a, 10a	Fuse, 1A/250V, 5 x 20 mm (for Hamamatsu and Bioptics Cameras)	1	Schurter	T1A/250V, 5 x 20	2110-0408
9b, 10b	Fuse, 0.5A/250V, 5 x 20 mm (for Dalsa Camera)	1	Schurter	T500mA/250V, 5 x 20	2110-0420



PART LIST (cont'd)

LASER LOCATOR

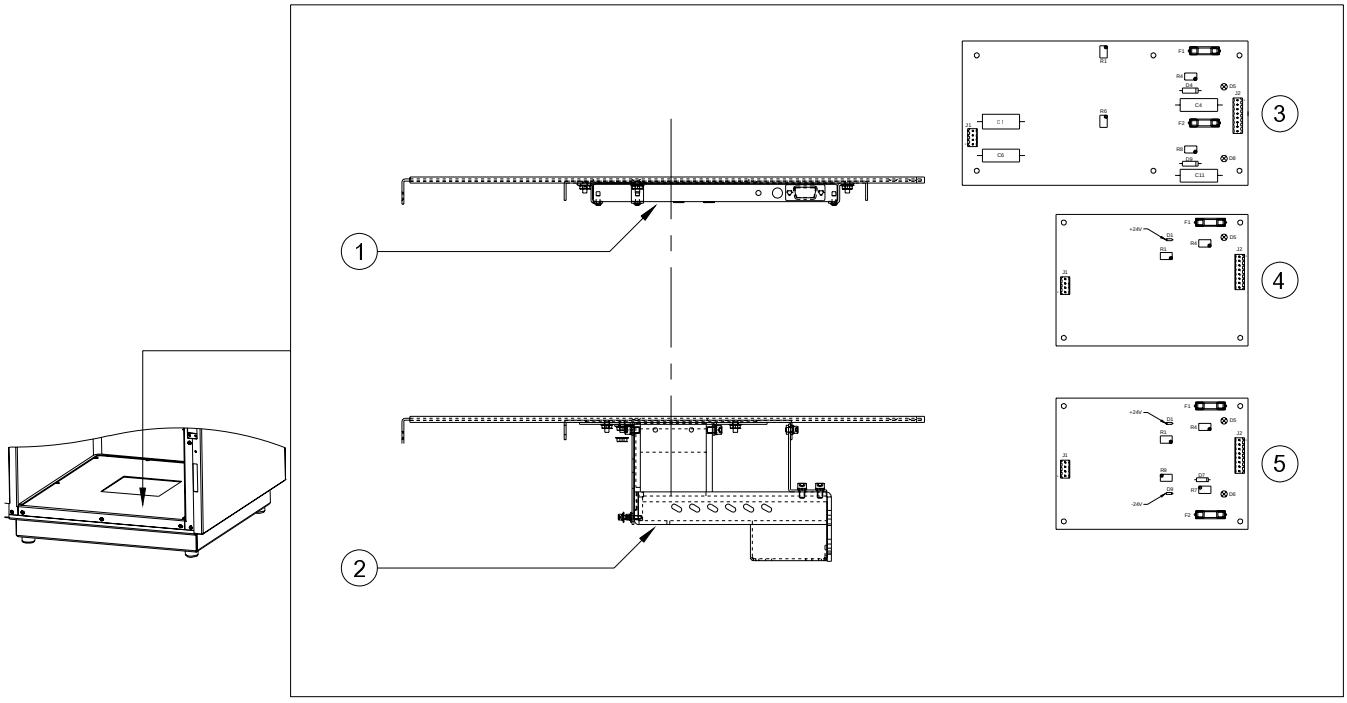
ITEM NO.	DESCRIPTION	QTY	MANUFACTURER	MFG PART NO/SPEC.	FAXITRON PART NO.
1	Laser Mounting Kit	1	Coherent, Inc.	AM-3	1451-0002
2	Laser Line Generator	1	Coherent, Inc.	0221-153-00	1451-0001



PART LIST (cont'd)

OPTIONAL DIGITAL CAMERAS

ITEM NO.	DESCRIPTION	QTY	MANUFACTURER	FAXITRON PART NO.
1a	Opt. DC5, Digital Camera 50 X 50 mm (2" x 2")	1	Hamamatsu	1070-2002
1b	Opt. DC10, Digital Camera 100 x 100 mm (4" x 4")	1	Hamamatsu	1070-2001
1c	Opt. DC12, Digital Camera 120 x 120 mm (4.7" x 4.7")	1	Hamamatsu	1070-2001
1d	Opt. DC22, Digital Camera 50 x 50 mm (2" x 2")	1	Bioptics	1070-1009
1e	Opt DC24, Digital Camera, 50 x 100 mm (2" x 4")	1	Bioptics	1070-1008
1f	Opt. DC44, Digital Camera, 100 x 100 mm (4" x 4")	1	Bioptics	1070-1007
2a	Opt. DC2, Digital Camera, 50 x 50 mm, (2" x 2")	1	Dalsa	1070-1005
2b	Opt. DC4, Digital Camera, 50 x 100 mm (2" x 4")	1	Dalsa	1070-1006
3	Power Supply PCB for Hamamatsu Camera	1	Faxitron	43805-65216
4	Power Supply PCB for Bioptics Camera	1	Faxitron	43805-65209
5	Power Supply PCB for Dalsa Camera	1	Faxitron	43805-65204



PART LIST (cont'd)

BASE AND FLOOR INTERLOCK SWITCHES

ITEM NO.	DESCRIPTION	QTY	MFG	MFG PART NO/SPEC.	FAXITRON PART NO.
1	Micro Switch, Floor Plate Interlock	1	Honeywell	V7-2B17D8-207	3101-1085
2	Micro Switch, Base Interlock	1	Honeywell	V7-2B17D8-207	3101-1085