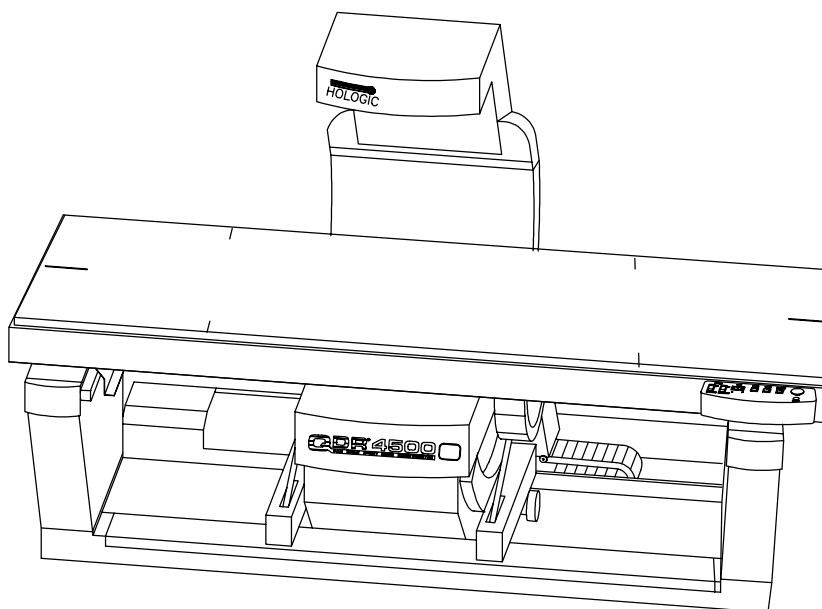
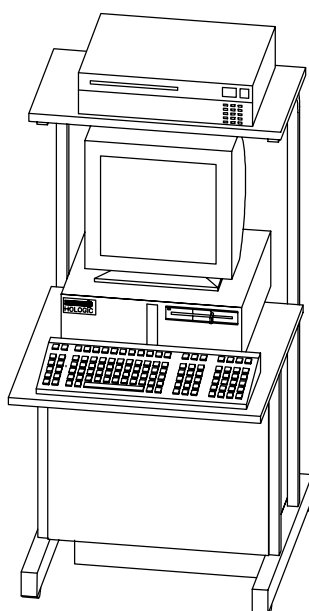




MODEL QDR® 4500

FAN BEAM X-RAY BONE DENSITOMETER

TECHNICAL MANUAL



Hologic Inc.
35 Crosby Drive
Bedford, MA 01730 USA

Phone in US: 800-321-4659
Fax (Domestic): 781-280-0670
Fax (International): 781-280-0671

Document # 080-0462
Revision E

NOTICE

The information contained in this Manual is confidential and proprietary to Hologic, Inc. This information is provided only to authorized representatives of Hologic's customers solely for the purpose of facilitating the use of Hologic's products. No information contained herein may be disclosed to any unauthorized person for any purpose whatsoever without the prior written consent of Hologic, Inc.

Hologic QDR 4500 and the Hologic logo are registered trade marks of Hologic, Inc. All other products and company names, used in this manual, are trademarks and registered trademarks of other manufacturers.

The procedures described in this document are intended solely for use by direct employees of Hologic, Inc. or authorized Hologic Equipment Resellers and their trained technicians. Any unauthorized or untrained persons performing these procedures may affect the warranty of the Hologic Model QDR 4500.

Exercise proper caution when servicing the system. There are dangerous and potentially lethal voltages accessible within the QDR 4500 system. To avoid exposure to shock hazards, the Main circuit breaker should be switched off, and the power cord removed, before working inside any part of the system.

The QDR 4500 Fan Beam X-ray Bone Densitometer produces ionizing radiation in the form of X-rays. It may be dangerous to the patient, operator or service technician unless safe exposure factors and operating instructions are observed. To avoid unsafe exposure, do not attempt to service this equipment unless you are a Hologic, Inc. certified service technician. Exercise proper caution when servicing the system. A dosimeter (film badge) should always be worn while on site. Dose and scatter radiation measurements must be taken after each service call to ensure that these parameters are still within specifications.

Hologic, Inc. has made all reasonable effort to ensure that the information in this manual is accurate and complete. Hologic, Inc. shall not, however, be liable for any technical or editorial errors or omissions contained herein, or for incidental, special or consequential damages in connection with the furnishing or use of this material. The information contained in this manual is subject to change without notice.

Printed in U.S.A.

Copyright© 1998, 1999 by Hologic, Inc., All rights reserved

RECORD OF REVISIONS

Document # 080- 0462

Date:	Revision:	Description:
3/95	A	Release document per ECO 2501.
5/95	B	Revised to include information about models QDR 4500W and QDR 4500C per ECO 2597
12/96	C	Revised per ECO 3279
6/98	D	Add FDA required information about system specifications (Section 1). Add new Leakage Testing Procedure on page 3-25. Add Reproducibility Test on page 3-27. Add information about Radiation Measurement Report on page 3-28. Other revisions per ECO 3822.
4/99	E	Revise per ECO 4221.

TABLE OF CONTENTS

SECTION 1 INTRODUCTION	1-1
SYSTEM OVERVIEW	1-1
X-RAY SCANNING THEORY	1-2
FUNCTIONAL OVERVIEW	1-4
PRODUCT SPECIFICATIONS	1-8
BMD Precision:.....	1-10
Duty Cycle:	1-10
Leakage Technique Factors	1-10
Minimum Beam Filtration	1-10
Measured Half Value Layer (HVL) At Different Operating Potentials	1-11
Line Voltage and Maximum Line Current	1-11
Technique Factors for Maximum Line Current	1-11
Maximum Deviation.....	1-11
Measurement Criteria for Technique Factors	1-11
SECTION 2 FUNCTIONAL DESCRIPTION	2-1
COMPUTER	2-1
COMMUNICATIONS CONTROLLER BOARD.....	2-1
Interface Connections.....	2-1
DISTRIBUTION BOARD.....	2-3
Power	2-3
Interface Connections.....	2-4
MOTOR CONTROLLER BOARD	2-5
Power	2-5
Interface Connections.....	2-6
TZ DRIVE BOARD	2-7
Service Switches.....	2-7
Power	2-8
Interface Connections.....	2-8
CONTROL PANEL CONTROLLER BOARD	2-11
Power	2-11
Interface Connections.....	2-12
C-ARM INTERFACE BOARD.....	2-15
Continuity Daisy Chain	2-15
Power	2-15
Interface Connections.....	2-16
X-RAY CONTROLLER ASSEMBLY.....	2-18
Interface.....	2-18
X-Ray Controller Assembly Boards	2-20
I/O and Logic Board	2-20
Low Voltage Power Supply	2-20
Power Factor Regulator (PFR) Substitution Board.....	2-21
Duty Cycle Regulator.....	2-21
H-Bridge Board.....	2-21
Interface Connections	2-21
X-RAY SOURCE UNIT.....	2-26
DATA ACQUISITION SYSTEM	2-26
Solid State Detector.....	2-27
Power	2-27
Interface Connections	2-27
INTEGRATOR/MULTIPLEXOR BOARD	2-28
Power	2-29
Interface Connections	2-29
Analog To Digital Board.....	2-30
Power	2-31

Interface Connections.....	2-31
POWER MODULE	2-32
SECTION 3 INSTALLATION.....	3-1
REQUIRED TOOLS.....	3-1
REQUIRED DOCUMENTATION.....	3-1
ROOM AND DOORWAY SIZE.....	3-2
ARRANGE FOR HELP.....	3-4
INSPECT FOR VISIBLE SHIPPING DAMAGE	3-4
UNCRATE UNIT	3-5
INSPECT FOR HIDDEN SHIPPING DAMAGE	3-6
TAKE INVENTORY.....	3-6
MEASURE PATH TO FINAL DESTINATION	3-6
Short Doorway.....	3-6
Narrow Hallway.....	3-7
REMOVE TABLE TOP (IF NECESSARY).....	3-7
REMOVE QDR 4500A, OR SL, C-ARM (IF NECESSARY)	3-8
PREPARING THE TABLE TOP FOR MOVING (SL only)	3-10
MOVE UNIT TO DESTINATION (VERTICAL POSITION).....	3-10
MOVE UNIT TO DESTINATION (HORIZONTAL POSITION).....	3-11
SET UP UNIT.....	3-13
INSTALL QDR 4500A, OR QDR 4500SL, UPPER C-ARM	3-15
INSTALL QDR 4500W, OR QDR 4500C, C-ARM.....	3-16
INSTALL COMPUTER	3-17
INSTALL CABLES	3-17
SAFETY PRECAUTIONS	3-18
CHECK POWER LINE VOLTAGE.....	3-18
Measure Line Voltage	3-18
Measure Isolation Transformer Secondary Voltage.....	3-18
CHECK TUBE KV PEAK POTENTIAL.....	3-19
CHECK TUBE CURRENT	3-21
CHECK BELT TENSION	3-23
ADJUST C-ARM Y BELT	3-23
CALIBRATE MOTORS.....	3-23
CHECK X-RAY BEAM ALIGNMENT.....	3-23
CALIBRATE APERTURE (QDR 4500A AND SL)	3-23
CHECK LASER POSITIONING OFFSET	3-24
ADJUST A/D GAIN CONTROL.....	3-24
PERFORM BEAM FLATTENING	3-24
PERFORM LATERAL ALIGNMENT TEST	3-24
MEASURE X-RAY DOSE TO PATIENT.....	3-24
CHECK HVPS/S (TANK) FOR RADIATION LEAKAGE.....	3-25
CALIBRATE FOR AREA, BMD AND BMC.....	3-26
TEST SCAN MODES	3-26
FINISH ASSEMBLING UNIT.....	3-26
MEASURE X-RAY SCATTER FROM PHANTOM.....	3-27
PERFORM QC	3-27
RUN REPRODUCIBILITY TEST	3-27
THE RADIATION MEASUREMENT REPORT.....	3-29
SECTION 4 ALIGNMENT AND CALIBRATION	4-1
TABLE ALIGNMENT	4-1
Checking Table Alignment.....	4-1
Aligning Table.....	4-1
Table Edge to T-Rail ("A" Dimension) Adjustment	4-1
Front to Back T-Rail and Table Edge/Rail Gap Adjustment.....	4-3
C-ARM PARALLELISM ADJUSTMENT (A and SL only).....	4-3
X-RAY BEAM ALIGNMENT (A and SL only)	4-4
X-RAY BEAM ALIGNMENT (C and W only)	4-8

APERTURE CALIBRATION (A and SL only)	4-9
MOTOR CALIBRATION	4-9
MOTOR\$TZ (QDR 4500A and SL)	4-10
MOTOR\$AY (all QDR 4500 models)	4-12
MOTOR\$TY (QDR 4500A and W)	4-16
MOTOR\$TX (all QDR 4500 models)	4-19
MOTOR\$AR (QDR 4500A and SL)	4-22
LASER POSITIONING OFFSET ADJUSTMENT	4-27
A/D GAIN CONTROL ADJUSTMENT	4-27
BEAM FLATTENING	4-28
X-RAY BEAM ALIGNMENT "AIRSCAN" TEST	4-30
Machines using Body Composition Analysis (BCA)	4-31
Machines using BMD Whole Body Analysis	4-31
LATERAL ALIGNMENT TEST (QDR 4500A AND SL)	4-31
AREA, BMD AND BMC CALIBRATION	4-33
Scan Thickness Measurement & Calibration (QDR 4500A and SL)	4-33
Scan Thickness Measurement & Calibration (QDR 4500W and C)	4-36
Calibration of Area and BMC, for Array Scan Modes	4-38
Adding Array AP Scans to the QC Database	4-39
SECTION 5 REMOVE AND REPLACE PROCEDURES	5-1
RECOMMENDED TOOLS	5-1
ELECTRONICS TRAY FRUS	5-1
Electronics Tray Printed Circuit Boards	5-1
C-Arm Y Belt	5-2
C-Arm Y Motor or Gearcase	5-3
C-Arm Y Encoder	5-4
CONTROL PANEL AND TABLE Y FRUS	5-4
Control Panel	5-5
PCBs Under Right-Side of the Table	5-5
Table Y Belt	5-6
Table Y Motor or Gearcase	5-6
Table Y Encoder	5-7
TABLE X FRUS	5-8
Table X Motor Controller PCB	5-8
Table X Belt	5-9
Table X Motor or Gearcase	5-10
Table X Encoder	5-10
TABLE Z FRUS (A and SL only)	5-11
Pedestal	5-11
Linear Potentiometer (Encoder- Obsolete)	5-13
The Linear Rotary String (Encoder)	5-13
Installation	5-13
ARM R FRUS	5-15
Motor Controller Board	5-15
Arm R Belt	5-16
Arm R Motor, Gearcase, Encoder or Encoder Belt	5-16
Gas Spring	5-18
LOWER C-ARM FRUS	5-18
C-Arm Interface Board	5-18
X-Ray Controller Assembly	5-18
Filter Drum Assembly	5-20
Tank Assembly	5-21
UPPER C-ARM FRUS	5-23
Integrator/Multiplexor Board	5-23
Detector Boards	5-24
Laser Assembly	5-25
REAR C-ARM FRUS	5-26

Analog to Digital Converter Board.....	5-26
POWER MODULE FRUS.....	5-27
28 Volt Power Supply	5-27
±15 Volt Power Supply	5-28
Line Filter	5-29
Isolation Transformer	5-29
Power Controller Board.....	5-29
OPERATOR'S CONSOLE FRUS	5-30
APERTURE ASSEMBLY FRUS	5-32
Aperture Stepper Motor.....	5-32
Aperture Motor PCB	5-33
Aperture Position Belt.....	5-33
Rotary Potentiometer.....	5-34
DRUM ASSEMBLY FRUS	5-34
Drum Encoder PCB.....	5-34
Drum Belts	5-35
Stepper Motor Assembly	5-36
Drum Bearings.....	5-37
REPLACING EMI CABLES.....	5-39
FRU LISTS	5-41
Figure 5-1. Electronics Tray FRUs.....	5-41
Figure 5-2. Control Panel and Table Y FRUs	5-41
Figure 5-3. Left Side Table Y FRUs.....	5-41
Figure 5-4. Table X FRUs	5-42
Figure 5-5. Table Z FRUs.....	5-42
Figure 5-6. Installing the Rotary String Encoder.....	5-42
Figure 5-7 C-Arm R FRUs (Outside View).....	5-42
Figure 5-8. C-Arm R FRUs (Inside View)	5-43
Figure 5-9. Lower C-Arm FRUs.....	5-43
Figure 5-11. Upper C-Arm FRUs.....	5-43
Figure 5-12. Detector Assembly Mounting	5-43
Figure 5-13. Laser Assembly.....	5-44
Figure 5-14. Rear C-Arm FRUs	5-44
Figure 5-15. Power Module FRUs	5-44
Figure 5-16. Power Control Panel FRUs.....	5-44
Figure 5-17. Operator's Console Assemblies.....	5-45
Figure 5-18. Computer Assemblies	5-46
Figure 5-19. Aperture Assembly FRUs (QDR 4500A and SL)	5-46
Figure 5-22. Front Drum Assembly FRUs.....	5-46
Figure 5-23. Drum Outer Bearings.....	5-47
Figure 5-24. Drum Inner Bearings.....	5-47
Cables.....	5-47
Miscellaneous	5-47
Mobile	5-48
Special Tools	5-48
SECTION 6 FAULT ISOLATION.....	6-1
BEFORE STARTING.....	6-1
SOFTWARE CONFIGURATION.....	6-1
HARDWARE CONFIGURATION	6-1
POWER PROBLEMS	6-1
MOTION PROBLEMS.....	6-2
CONTROL PANEL PROBLEMS	6-5
DISPLAY PROBLEMS.....	6-5
Vertical Stripe.....	6-6
Horizontal Stripe	6-6
Noise.....	6-6
No Display.....	6-7

TARGETING/LASER PROBLEMS	6-8
DATA COMMUNICATIONS PROBLEMS	6-8
AREA /BMD/BMC/CV SPECIFICATION PROBLEMS	6-9
X-RAY PROBLEMS.....	6-9
No X-Rays.....	6-9
X-Ray Alignment Problems	6-10
Beam Flattening Problems	6-11
LASER PROBLEMS.....	6-12
OIL LEAKAGE.....	6-13
The Torque Specifications.....	6-13
Tank Top Cover Components and Screw Location.....	6-13
Tightening the Lexan Cup Screws.....	6-14
Tightening the Bladder Gasket Screws.....	6-14
Tightening the Transformer Seal Screws.....	6-14
Tightening the Tank Cover Gasket Screws.....	6-15
MISCELLANEOUS PROBLEMS	6-16
MESSAGES	6-16
NO A/C LINE INTERRUPTS	6-17
ERROR MESSAGE LIST	6-19
SECTION 7 PREVENTIVE MAINTENANCE.....	7-1
CUSTOMER PREVENTIVE MAINTENANCE	7-1
FIELD SERVICE PREVENTIVE MAINTENANCE.....	7-1
Guide Rail and Bearing Maintenance.....	7-2
SECTION 8 PCB SUMMARY INFORMATION	8-1
Power Distribution	8-1
ADC	8-1
Signal Distribution	8-2
Communications Controller	8-2
Detector Array Assembly	8-3
TZ Drive.....	8-3
Stepper Motor Controller	8-4
Control Panel Controller	8-4
SECTION 9 SOFTWARE TOOLS.....	9-1
SUSQ	9-1
SQKEYPAD	9-4
APPENDIX A SOFTWARE DEINSTALLATION/INSTALLATION.....	1
APPENDIX B CROSS-CALIBRATION	1

TABLE OF FIGURES

Figure 1-1. QDR® 4500	1-2
Figure 1-2. Q Scan Plot.....	1-3
Figure 1-3. QDR 4500 Block Diagram (Operator's Console).....	1-4
Figure 1-4. QDR 4500 Block Diagram (Scanner Unit)	1-5
Figure 1-5. QDR 4500 Block Diagram (C-Arm Subsystem)	1-6
Figure 2-1. Communications Controller Board/Distribution Board Interconnection Diagram	2-3
Figure 2-2. Distribution Board High Level Interconnection Diagram.....	2-4
Figure 2-3. Distribution Board/Motor Controller Board Interconnection Diagram	2-6
Figure 2-4. Distribution Board/TZ Drive Board Interconnection Diagram.....	2-9
Figure 2-5. Control Panel Controller Interconnection Diagram	2-12
Figure 2-6. Distribution Board/C-Arm Interface Board Interconnection Diagram	2-16
Figure 2-7. C-Arm Interface Board High Level Interconnection Diagram.....	2-18
Figure 2-8. C-Arm Interface Board/X-Ray Controller Assembly Interconnection Diagram....	2-19
Figure 2-9. X-Ray Controller Assembly High-Level Interconnection Diagram.....	2-21
Figure 2-10. Low Voltage Power Supply Board Interconnections	2-22
Figure 2-11. PFR Substitution Board/I/O and Logic Board Interconnection Diagram	2-24
Figure 2-12. I/O and Logic Board/H-Bridge Board Interconnection Diagram.....	2-24
Figure 2-13. I/O and Logic Board/Duty Cycle Driver Board Interconnection Diagram	2-25
Figure 2-14. H-Bridge Board/Duty Cycle Driver Board Interconnection Diagram.....	2-25
Figure 2-15. Integrator/Multiplexor Board/Solid State Detector Boards Interconnection Diagram	2-27
Figure 2-16. Analog Digital Converter Board/Integrator Multiplexor Board Interconnection Diagram.....	2-29
Figure 2-17. C-Arm Interface Board/Analog/Digital Converter Board Interconnection Diagram	2-31
Figure 2-18. Power Module Block Diagram.....	2-33
Figure 3-1. Room Layout (4500A)	3-2
Figure 3-2. System Dimensions (4500SL).....	3-3
Figure 3-3. System Dimensions (4500W).....	3-3
Figure 3-4. System Dimensions (4500C).....	3-4
Figure 3-5. Crated Unit (QDR 4500A and QDR 4500SL)	3-5
Figure 3-6. Uncrated Unit (QDR 4500A and QDR 4500 SL)	3-7
Figure 3-7. Table X Drive.....	3-8
Figure 3-8. Tipping Unit	3-9
Figure 3-9. Moving and Tilting the Unit Down.....	3-11
Figure 3-10. Auxiliary Horizontal Caster Installation	3-12
Figure 3-11. Shipping Bracket Locations (QDR 4500A and SL)	3-13
Figure 3-12. Shipping Bracket Locations (QDR 4500A and SL)	3-14
Figure 3-13. Shipping Bracket Locations (QDR 4500W and C)	3-14
Figure 3-14. Shipping Bracket Location (QDR 4500W and C).....	3-15
Figure 3-15. Repositioning the Belt Tensioning Mechanism	3-16
Figure 3-16. Isolation Transformer Taps	3-17
Figure 3-17. Peak Potential Mode 4.....	3-20
Figure 3-18. Peak Potential Mode 3.....	3-20
Figure 3-19. Tube Current Mode 1	3-22

Figure 3-20. Tube Current Mode 3	3-22
Figure 3-21. Leakage Test Shield (099-0566)	3-25
Figure 4-1. Table Alignment	4-2
Figure 4-2. Pedestal (covers removed)	4-3
Figure 4-3. X-Ray Alignment Fixture (010-0923)	4-4
Figure 4-4. Inserting The X-Ray Alignment Fixture	4-5
Figure 4-5. The Alignment Fixture Properly Installed	4-6
Figure 4-6. Filter Drum Adjustments - Top View	4-6
Figure 4-7. Array Assembly - Top View, Partial	4-7
Figure 5-1. Electronics Tray FRUs	5-3
Figure 5-2. Control Panel and Table Y FRUs	5-5
Figure 5-3. Left Side Table Y FRUs	5-7
Figure 5-4. Table X FRUs	5-9
Figure 5-5. Table Z FRUs	5-12
Figure 5-6. Installing the Rotary String Encoder	5-14
Figure 5-7 C-Arm R FRUs (Outside View)	5-15
Figure 5-8. C-Arm R FRUs (Inside View)	5-17
Figure 5-9. Lower C-Arm FRUs	5-20
Figure 5-10. Top View of Tank	5-22
Figure 5-11. Upper C-Arm FRUs	5-24
Figure 5-12. Detector Assembly Mounting	5-25
Figure 5-13. Laser Assembly	5-26
Figure 5-14. Rear C-Arm FRUs	5-27
Figure 5-15. Power Module FRUs	5-28
Figure 5-16. Power Control Panel FRUs	5-30
Figure 5-17. Operator's Console Assemblies	5-31
Figure 5-18. Computer Assemblies	5-32
Figure 5-19. Aperture Assembly FRUs (QDR 4500A and SL)	5-33
Figure 5-20. Aperture Assembly Removal (QDR 4500A and SL)	5-35
Figure 5-21. Rear Drum Assembly FRUs	5-36
Figure 5-22. Front Drum Assembly FRUs	5-37
Figure 5-23. Drum Outer Bearings	5-38
Figure 5-24. Drum Inner Bearings	5-39
Figure 5-25. The EMI Compliance Cable	5-40
Figure 6-1. Scanner Motion Directions	6-3
Figure 6-2. Checking C-Arm Parallelism	6-10
Figure 6-3 Tank Assembly Top view	6-13
Figure 6-4 Lexan Cup Screw Tightening Order	6-14
Figure 6-5. Bladder Gasket Screws	6-14
Figure 6-6. Transformer Screws	6-15
Figure 6-7. Tank Cover Gasket	6-16
Figure 7-1. Guide Bearing and Rail	7-3
Figure 9-1. SUSQ Screen—X-Rays OFF	9-2
Figure 9-2. SUSQ Screen—X-Rays ON	9-2
Figure 9-3. SUSQ Screen Settings	9-3

SECTION 1

INTRODUCTION

SYSTEM OVERVIEW

The Hologic QDR®4500 X-ray Bone Densitometer (Figure 1-1) estimates the bone mineral content (BMC) and bone mineral density (BMD) of selected areas of the body, or of the entire skeleton. It does so using X-rays of two different energy levels. This dual-energy scheme allows soft tissue within the selected area to be subtracted out, leaving only bone to be scanned and estimated.

Note: This manual uses "QDR 4500" to refer to all models in the QDR 4500 series systems. Information presented in this manual, that applies only to a particular model, or models, will be noted as such.

The patient lies face up on the table and, with the aid of a cross-hair laser, the operator positions the scanning arm over the region of interest. After entering patient data and selecting the type and size of scan desired, the operator initiates the scan with a single keystroke.

The operator is not required to select technique factors, as tube current and voltage are pre-selected and fixed. Since testing is performed by fan beam method rather than by flooding the area as in conventional radiography, the scanning time is a function of the dimensions of the area to be measured, the desired resolution and the desired precision.

BMC results are expressed in grams of calcium hydroxyapatite, and BMD is reported in grams/cm² of the same compound.

Note: In most cases, no additional shielding is necessary for patient, operator or room, and the QDR 4500 can be placed in any convenient non-shielded examination room. Contact your state regulatory agency for details about additional shielding requirements, if any.

The QDR 4500 employs a patented Automatic Internal Reference System, which continuously calibrates the machine to eliminate the effects of variations in temperature, tube flux, etc. No daily calibration is required. The daily scanning of a quality control phantom is required to provide assurance that the system is functioning correctly, and to aid in the detection of any long-term drift.

The X-ray scans produced by the QDR 4500, and displayed on the monitor, are intended only to locate anatomical sites for measurement, and to assure the operator that the machine is operating properly. They are not intended as a substitute for conventional film-based diagnostic scans.

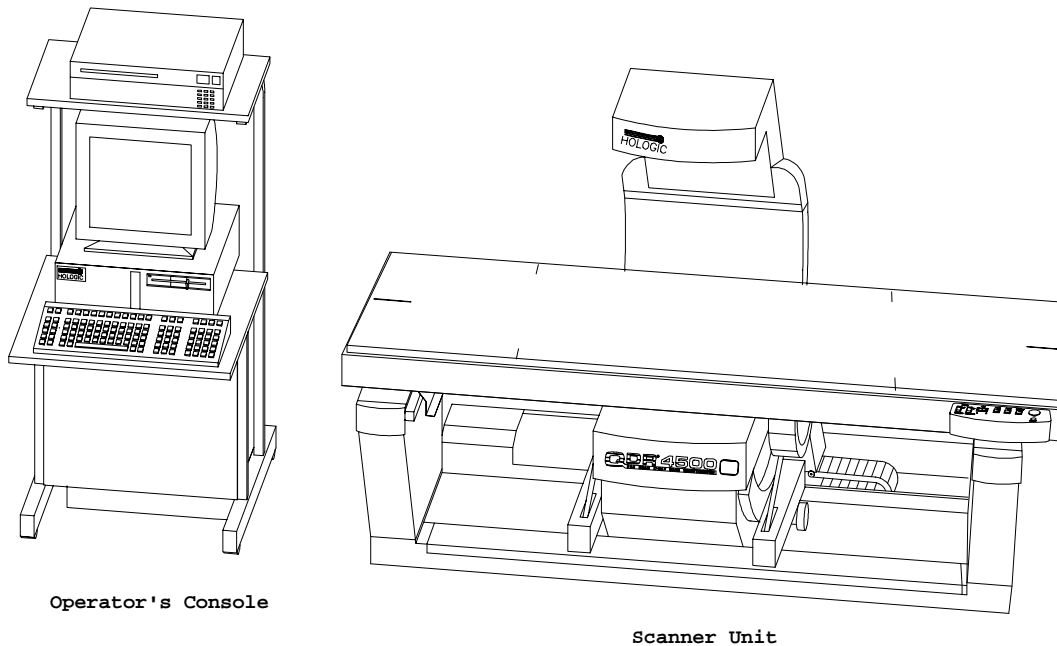


Figure 1-1. QDR® 4500

X-RAY SCANNING THEORY

An X-ray source, consisting of a generator and tube in a common, shielded enclosure, is mounted beneath the patient. It generates a narrow, tightly collimated, fan shaped beam of X-rays which alternate, at power line frequency, between 100kVp and 140kVp. The source is at one end of a C-arm. At the other end, above the patient, is a crystal/solid state detector. During a scan, the C-arm and table move under computer control to guide the beam over the desired scan area.

Before passing through the patient, the beam is filtered through a rotating drum, in which alternating segments have radio-opacities equivalent to tissue, bone and air. When finally intercepted by the detector, the beam contains information about the X-ray absorbing characteristics of both the patient and the calibration materials in the filter drum. An A/D converter, fed by the detector, supplies a complex digital signal to the computer, which uses that signal both to construct the screen display and as the basis for its computations of BMC and BMD.

The QDR 4500 computer algorithm is based on the principle that bone attenuates the X-ray beam differently at high and low energies. The bone mineral content of any sample point can be computed from:

$$Q = L - kH$$

where H and L are the logarithms of the sample attenuation at high (140kVp) and low (100kVp) energies, respectively, and the constant k depends on the tissue attenuation characteristics of the beam. In the QDR 4500, k is continuously measured using the “tissue” segment in the filter wheel.

Section 1 - Introduction

The program works in the following manner:

1. Load preliminary scan and obtain regions of interest from operator.
2. Estimate k as an average value of:

$$k = [L_{\text{tissue}} - L_{\text{air}}] / [H_{\text{tissue}} - H_{\text{air}}]$$

where L_{tissue} indicates a low-energy measurement with tissue-equivalent material interposed by the filter drum, and L_{air} , H_{tissue} and H_{air} are similarly defined.

Note: The subscript "air" designates the filter drum segment that is empty (i.e., contains neither bone- nor tissue-equivalent material).

3. Using this value of k , calculate Q for each point scanned using the formula given above ($Q = L - kH$). This array of Q values constitutes a "Q scan". Displays the Q scan.
4. Compile a histogram of the Q values. Because a large portion of the scan contains soft tissue only, this histogram will have a large peak. Choose a threshold value just above this peak, and apply that value to discriminate, point by point in the Q scan, between "bone" points (whose Q is above the threshold) and "non-bone" points (whose Q is below the threshold).

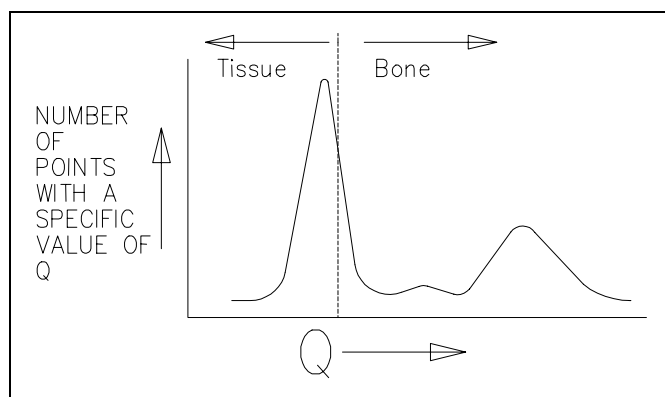


Figure 1-2. Q Scan Plot

5. Use the "non-bone" points to calculate a baseline value for each scan line. Using these points, form a new histogram and repeat steps 4 and 5 until the results converge.
6. Smooth the segment boundaries to eliminate isolated noise-generated "bone" points.
7. Display the "bone" and "non-bone" points for operator approval.
8. Determine the constant of proportionality (d_0) that relates the Q values to actual BMC (grams). That constant is determined by measuring how much Q shifts when bone-equivalent material is interposed by the filter drum.
9. Calculate the total bone mineral values by adding up the Q values for all "bone" points in each region of interest (e.g., each vertebra), and multiplying by d_0 .
10. Determine the bone areas by counting the number of "bone" points in each region of interest.
11. Calculate bone mineral density as:

BMD = BMC / area

12. Display the calculated results and print the report.

FUNCTIONAL OVERVIEW

This section provides a block diagram of the QDR 4500 system along with a brief functional overview description of each block. A detailed functional description along with interconnection diagrams and interconnection descriptions is provided in Section 2.

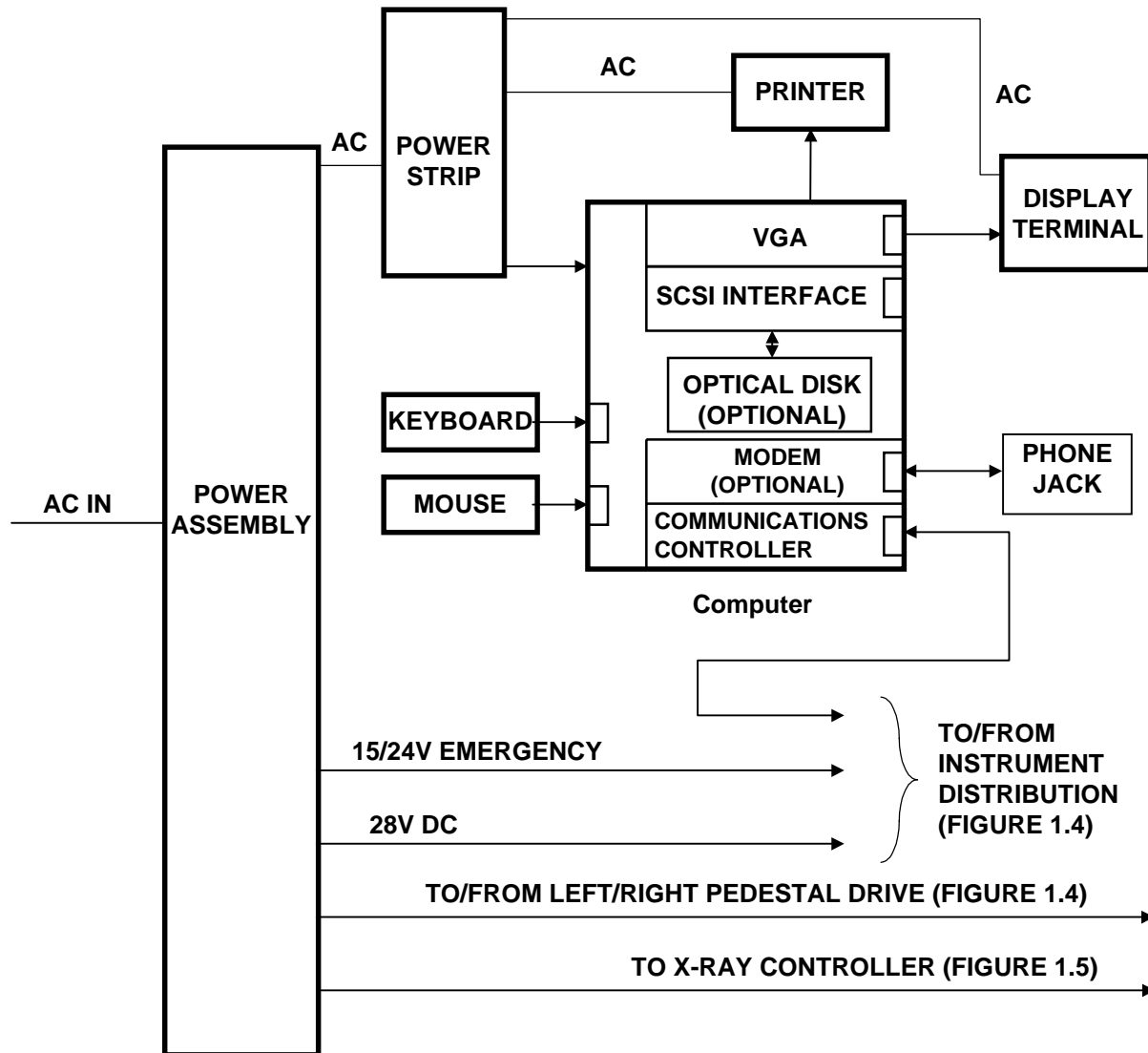


Figure 1-3. QDR 4500 Block Diagram (Operator's Console)

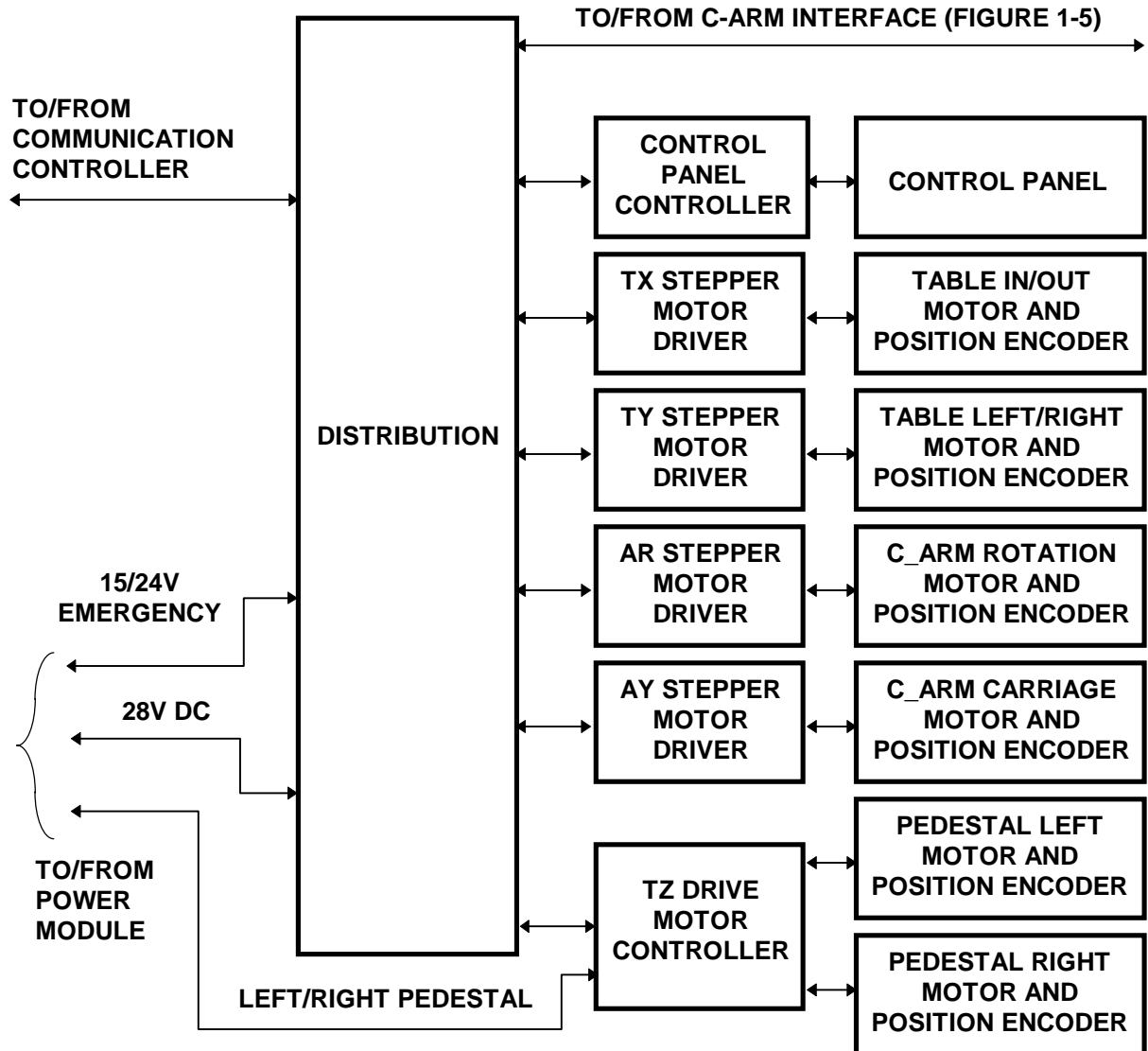


Figure 1-4. QDR 4500 Block Diagram (Scanner Unit)

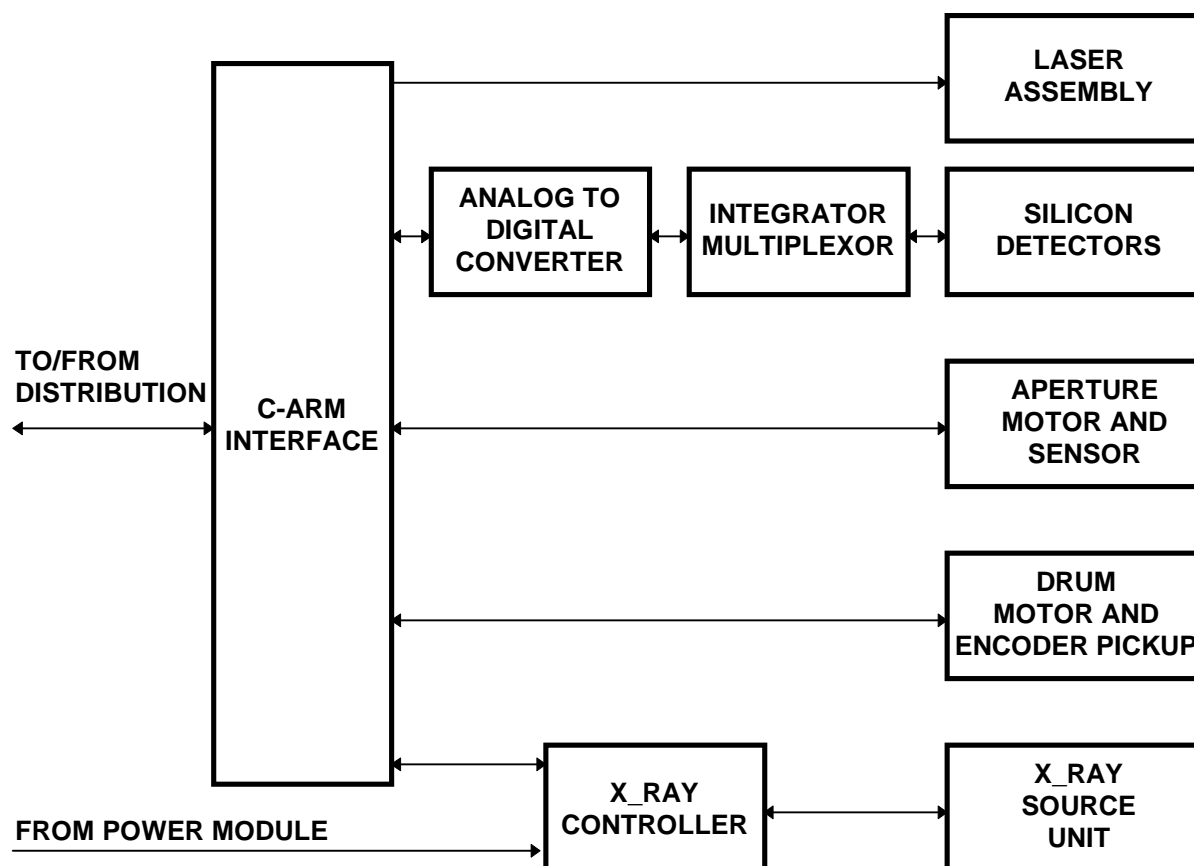


Figure 1-5. QDR 4500 Block Diagram (C-Arm Subsystem)

Block	Description
Computer	Controls and commands all QDR 4500 hardware modules.
Communications Controller	Controls the flow of commands to and from the Scanner modules via the communications bus.
Distribution Board	Provides the interconnections between the QDR 4500 Operator's Console and the Scanner.
Control Panel Controller	Interfaces the Scanner's Control Panel to the Operator's Console computer software.
Control Panel	Provides switches (with visual indicators) for moving the Scanner's C-Arm and Patient Table. Also provides an Emergency Stop switch.
TZ Drive Motor Controller	Controls the motion of the Patient's Table left and right pedestal motors based on commands from the computer software.

Section 1 - Introduction

Table Up/Down Motor and Position Encoder	Raises or lowers the Patient Table and provides position monitoring.
TX Stepper Motor Driver	Controls the motion of the Patient's Table in and out motor based on commands from the computer software.
Table In/Out Motor and Position Encoder	Moves the Patient Table in and out and provides position monitoring.
TY Stepper Motor Driver	Controls the motion of the Patient's Table left and right motor based on commands from the computer software.
Table Left/Right Motor and Position Encoder	Moves the Patient Table left and right and provides position monitoring.
AR Stepper Motor Driver	Controls the motion of the C-Arm rotation motor based on commands from the computer software.
C-Arm Rotation Motor and Position Encoder	Rotates the C-Arm and provides position monitoring.
AY Stepper Motor Driver	Controls the motion of the C-Arm left and right motor based on commands from the computer software.
C-Arm AY Motor and Position Encoder	Moves the C-Arm left and right and provides position monitoring.
C-Arm Interface	Controls the Aperture and Filter Drum motors, generates timing signals for the X-Ray Controller and the Data Acquisition System, and provides power to the Positioning Laser.
X-Ray Controller	Controls the operation of the X-ray source.
X-Ray Source Unit	Generates the X-ray beam.
Solid State Detectors	Converts the X-rays into electrical signals.
Integrator/Multiplexor	Integrates the signals from the Solid State Detectors and applies them to the Analog to Digital Converter.
Analog to Digital Converter	Converts the analog signals from the Integrator/Multiplexor to a digital format.
Positioning Laser	Provides a laser beam to assist in positioning the patient on the Patient Table.

PRODUCT SPECIFICATIONS

SPECIFICATION	MODEL	DEFINITION				
Scanning Method:	A,SL	Multidetector array, Indexing table, and motorized C-arm				
	W,C	Multidetector array, Indexing table, and Arm				
X-ray System:	All	Switched Pulse Dual-Energy X-ray tube, operating at 100 and 140kV, 5mA avg. at 50% duty cycle, 2.5mA avg. at 25% duty cycle, 30s maximum, Tungsten target				
Detector System:	A	216 multichannel detector consisting of CdWO ₄ scintillators coupled to Silicon diodes				
	SL	128 multichannel detector consisting of CdWO ₄ scintillators coupled to Silicon diodes				
	C,W	64 multichannel detector consisting of CdWO ₄ scintillators coupled to Silicon diodes				
Scanning Sites:	A	Lumbar spine (in AP and lateral projections), proximal femur (hip), and whole body				
	SL	Lumbar spine (in AP and lateral projections), proximal femur (hip)				
	W	Lumbar spine, proximal femur (hip), and whole body				
	C	Lumbar spine, proximal femur (hip)				
Scan Region:	A,W	195cm (76.77") x 65cm (25.59")				
	SL	96cm (38") x 65cm (25.59")				
	C	96cm (38") x 51cm (20")				
Scatter Radiation:	All	Less than 10µGy/h (1mrad/h) at 2m (79 in.) from the center of the X-ray beam for all scans except images, which is less than 10µGy/h (1mrad/h) at 3.5m (138 in.) from the center of the X-ray beam.				
Leakage Radiation:	All	The QDR-4500 meets the requirements of 21 CFR 1020.30(k) for leakage from the X-ray source				
External Shielding Requirement:	All	Contact state regulatory agency.				
Calibration:	All	Self Calibrating using HOLOGIC Automatic Internal Reference System. Operator calibration NOT required.				
System Weight:		Scanner		Console		
(installed)	A	365kg	800lb	68kg	150lb	
	SL	365kg	800lb			
	W	310kg	680lb			
	C	295kg	650lb			
(shipping)		System				
	A	660kg	1450lb			
	SL	660kg	1450lb			
	W	622kg	1370lb			
	C	610kg	1340lb			

Section 1 - Introduction

SPECIFICATION	MODEL	DEFINITION					
Operating Temperature:	All	15° - 32° C (60° - 90° F)					
Humidity:	All	20 - 80% relative Humidity, non-condensing					
Footprint:		Length		Width		Height	
		m	inches	m	inches	m	inches
C-arm not rotated, table not extended	A	2.02	79.5	1.40	55	1.42	56
C-arm rotated, table extended	A	3.02	119	1.50	59	1.42	56
C-arm not rotated	SL	2.02	79.5	1.40	55	1.42	56
C-arm rotated	SL	2.02	79.5	1.50	59	1.42	56
table extended	W	3.02	119	1.50	59	1.42	56
table not extended	W	2.02	79.5	1.22	48	1.42	56
	C	2.02	79.5	1.40	55	1.42	56
Average Heat Load:	ALL	1000w (3400 BTU/hr)					
Patient Table Height:	A,SL	Adjustable, 71cm (28") from floor when scanning in AP mode					
	W,C	71cm (28")					
Positioning Laser:	All	Laser Diode (<1mW) cross hair, with emergency mechanical shutter					
X-ray Collimation:	A,SL	Selectable by scan type					
	W,C	1.0mm slit					
Lateral Tracking:	A,SL	Exam table is capable of moving +/-2.54cm (1.0") in the x-axis from center location with scan arm in lateral position.					
	C,W	N/A					
Leakage Current:	All	Normal <75μA		Single Fault <400μA			
Resolution:	A/SL	1 line pair/mm		(approximately 0.5mm)			
	C/W	0.5 line pair/mm		(approximately 1.0mm)			

BMD Precision:

EXAM	MODEL	SCAN TIME (seconds)	in vivo PRECISION	DOSE	
				mGy	mrads
AP Spine Array	All	60	1.0%	0.20	20.0
AP Spine Fast	All	30	1.5%	0.10	10.0
AP Spine High Definition	A,SL	120	1.0%	0.20	20.0
AP Spine Turbo	A,SL	10	2.0%	0.07	7.0
	W,C	15	2.0%	0.05	5.0
Forearm	A,SL	30	1.0%	0.05	5.0
	W,C	30	1.0%	0.10	10.0
Hip Array	All	60	1.0%	0.20	20.0
Hip Fast	All	30	1.5%	0.10	10.0
Hip High Definition	A,SL	120	1.0%	0.20	20.0
Hip Turbo	A,SL	10	2.0%	0.07	7.0
	W,C	15	2.0%	0.05	5.0
Lateral Spine Array	A,SL	240	1.0%	0.70	70.0
Lateral Spine Fast	A,SL	120	1.0%	0.35	35.0
Lateral Spine High Def.	A,SL	240	1.0%	0.70	70.0
Whole Body	A	180	1.0%	0.01	1.0
	W	407	1.0%	0.015	1.5

Duty Cycle:

A	50% for all scan modes except Whole Body 100% for Whole Body scans
SL,W,C	50% for all Scan Modes

Leakage Technique Factors

The leakage technique factors for all models of QDR 4500's are the same. It is the maximum continuous current at the maximum peak potential. This is X-ray mode #3. Peak potential 140/100kVp. (dual energy), current 10mA peak 25% duty cycle or 2.5mA average.

Minimum Beam Filtration

The minimum filtration permanently in the beam is 3.7mm Al equivalent @80kV.

Measured Half Value Layer (HVL) At Different Operating Potentials

Measured operating potential	Measured Half Value Layer
QDR4500A/SL	
80kV	3.7mm Al equivalent
100kV	4.7mm Al equivalent
140kV	7.2mm Al equivalent
QDR4500C/W	
80kV	3.7mm Al equivalent
100kV	5.0mm Al equivalent
140kV	6.5mm Al equivalent

Line Voltage and Maximum Line Current

Power Requirements:	All	100VAC 16A 50/60Hz, Max apparent resistance = 0.32 ohm 120VAC 14A 50/60Hz, Max apparent resistance = 0.32 ohm 230VAC 8A 50/60Hz, Max apparent resistance = 1.28 ohm
---------------------	-----	---

Technique Factors for Maximum Line Current

Peak Potential 140kVp

Tube Current 10mA peak, 50% duty factor or 5mA average.

Maximum Deviation

The maximum deviation from the preindication given by labeled technique factor control settings or indicators are as follows:

Peak Potential:	+/- 15%
Current:	+/- 40%
Time :	+/- 10%

Measurement Criteria for Technique Factors

The measurement criteria of the technique factors is as follows:

Peak Potential:	The voltage peak is measured with an oscilloscope. Voltage is a square pulse. Peak is defined as the peak voltage of the 4 millisecond pulse shape, not counting any initial overshoot.
Current:	Current is measured with an oscilloscope on the last millisecond of the 4 millisecond pulse.
Time:	Time of each pulse is measured with an oscilloscope and defined as the time between 50% rise and fall times of the peak potential pulse. Time of the scan is measured by counting the number of AC line pulses from the start to the end. X-ray pulses are synchronous with the AC line.

SECTION 2

FUNCTIONAL DESCRIPTION

This section provides a detailed functional description along with interconnection diagrams and descriptions of the Hologic QDR 4500. Refer to Section 1 for a block diagram and a brief functional description of each block.

COMPUTER

The QDR 4500 Scanner interfaces to an ISA Bus computer to control table and C-arm movement and X-ray generation, perform all necessary calculations, and manage patient and QC database information.

The computer is a Pentium-based (or higher) PC compatible that comes equipped with 3.5-inch floppy disk and hard disk drives, keyboard, color monitor, and an optional Iomega 1GB JAZ drive. For details pertaining to the computer and its associated components, please refer to the documentation shipped with each unit.

COMMUNICATIONS CONTROLLER BOARD

The Communications Controller board handles all the communications between the Computer and the Scanner's C-Arm and Table assemblies. The board resides in one of the computer internal slots and interfaces with the computer via the computer's I/O bus. It connects to the Scanner's Distribution board through a 50 conductor ribbon cable. This cable contains two independent communications links (one asynchronous and one synchronous) and additional system control signals. Each signal requires a pair of conductors for differential (RS422) noise immunity.

The asynchronous communications link communicates with the Motor Controller boards (TX, TY, AY and AR), the TZ Drive board, the C-Arm Interface board, and the Control Panel Controller board. The synchronous communications link communicates with the Data Acquisition System (DAS).

Interface Connections

Table 2-1 describes the interconnections between the Communications Controller board and the Distribution board. The table also identifies the interconnection connector and pin assignments.

Figure 2-1 shows the interconnections between the Communications Controller board and the Distribution board.

Table 2-1. Communications Controller Board/Distribution Board Interconnection Descriptions

Signal Pair	Description	¹ CC Pin	² Dist Pin
ATD+ ATD-	Asynchronous data to the Scanner.	JP1-2 JP1-27	JP10-3 JP10-4
STD+ STD-	Synchronous data to the Scanner.	JP1-28 JP1-4	JP10-6 JP10-7
STCLK+ STCLK-	Synchronous data clock from Communications Controller board to Distribution board. Synchronizes data to the Scanner.	JP1-5 JP1-30	JP10-9 JP10-10
STFRM+ STFRM-	Synchronous data frame from Communications Controller board to Distribution board.	JP1-31 JP1-7	JP10-12 JP10-13
ARD+ ARD-	Asynchronous Data from the Scanner.	JP1-8 JJP1-33	JP10-15 JP10-16
SRD+ SRD-	Synchronous Data from the Scanner.	JP1-34 JP1-10	JP10-18 JP10-19
SRCLK+ SRCLK-	Synchronous data clock from Communications Controller board to Distribution board. Synchronizes data from the Scanner.	JP1-11 JP1-36	JP10-21 JP10-22
SRFRM+ SRFRM-	Synchronous data frame from Distribution board to Communications Controller board.	JP1-37 JP1-13	JP10-24 JP10-25
EMERGENCY_IN+ EMERGENCY_IN-	Signals an emergency condition. Generated by the C-Arm Interface board.	JP1-14 JP1-39	JP10-27 JP10-28
ZEROX+ ZEROX-	AC line zero-crossing signal used for system wide synchronization. Generated by the C-Arm Interface board.	JP1-40 JP1-16	JP10-30 JP10-31
INTEGRATE+ INTERGATE-	Synchronous signal for Detector Integrate period. Generated by the C-Arm Interface board.	JP1-17 JP1-42	JP10-33 JP10-34
SYSRESET+ SYSRESET-	Resets the Scanner controllers.	JP1-20 JP1-45	JP10-39 JP10-40
EMERGENCY+ EMERGENCY-	Removes power from the Scanner's motor drivers and the X-ray system	JP1-49 JP1-25	JP10-48 JP10-49

Note: 1. CC = Communications Controller board.
2. Dist = Distribution board.

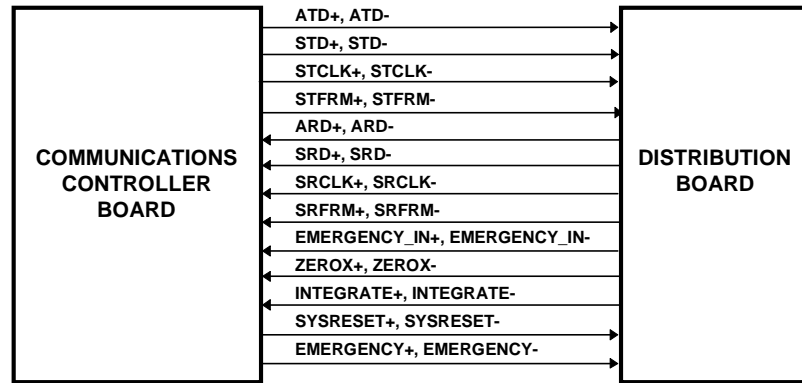


Figure 2-1. Communications Controller Board/Distribution Board Interconnection Diagram

DISTRIBUTION BOARD

The Distribution board provides interconnections between the QDR 4500 Operator's Console and the Scanner. It passes several signal and power lines from the Operator's Console directly to the C-Arm Interface module. It also provides buffering and individual drivers and receivers for various signal lines to and from individual Scanner modules and the Communications Controller. The Distribution board is located in the Electronics Tray in the base of the Scanner.

Three cables connect the Operator's Console to the Distribution board. One cable connects the communications buss to the Communications Controller located in the Operator's Console computer. Two cables connect to the Operator's Console Power Module. These two cables connect power to the Distribution board and connect the X-Ray On and Emergency signal lines to the Power Module.

Eight cables connect the Distribution board to the various Scanner boards. Four cables connect to the four Motor Controller boards (Table X, Table Y, Arm R, and Arm Y). Two (one signal and one power) connect to the C-Arm Interface board. One connects to the TZ Drive board. And, one connects to the Scanner's Control Panel Controller board.

The Distribution board has provision for three jumpers that can be installed to override the EMERGENCY signal lines when trouble-shooting.

Power

The Distribution board receives +28, +24 and +/-15VDC from the Operator's Console Power Module. The +28VDC is applied through four individual circuit breakers to the Table X, Table Y, Arm R, and Arm Y Motor Controller boards. The +24 and +/-15VDC are passed to the C-Arm Interface board. +24VDC is also applied through a circuit breaker to the Table Z Drive board. It is also reduced to +7 and +5VDC by regulators to power op-amplifiers and analog switches located on this board. The +7VDC is passed to the Table Z Drive and Control Panel Controller boards. The +5VDC powers the digital section of the Distribution board. The +28 and +24VDC power supplies are not closely regulated and their outputs may range from +24V to +35V under normal conditions.

Note: +7VDC may measure anywhere from +6.25VDC to +7.25VDC. This is true everywhere +7VDC is shown in this manual.

Six green LEDs indicate the status of the +28, +24, +15, -15, +7 and +5VDC (ON indicates the respective voltage is present). Five red LEDs indicate the status of the five circuit breakers applying voltage to the motor drivers/controller. ON indicates the circuit breaker has detected an over-current condition.

Interface Connections

Figure 2-2 shows boards that connect to the Distribution board.

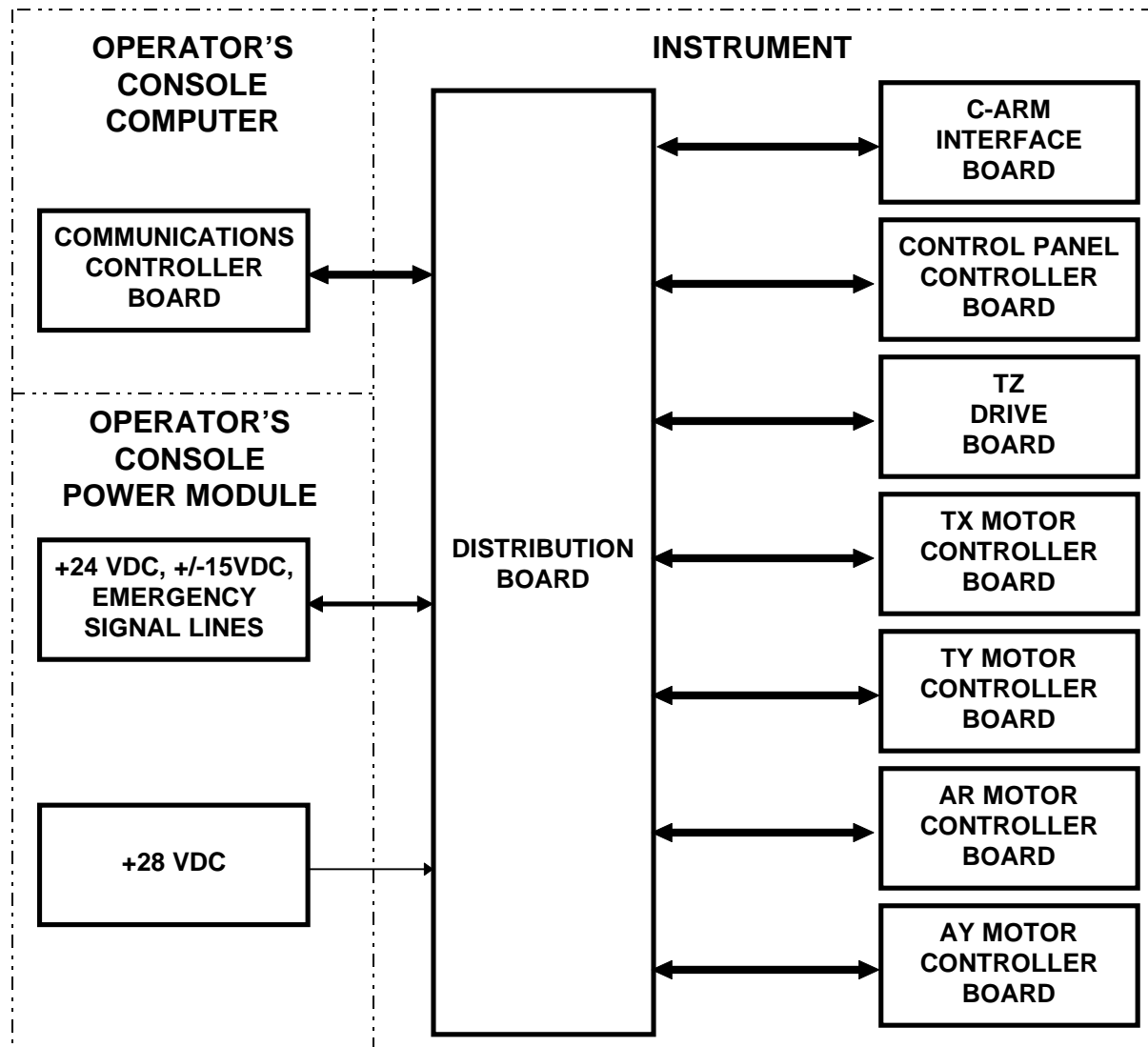


Figure 2-2. Distribution Board High Level Interconnection Diagram

MOTOR CONTROLLER BOARD

The Motor Controller board is a microprocessor controlled power driver circuit for use with a two coil bipolar stepper motor. It receives high level commands through the Distribution Board from the host computer, and applies 28 volt pulses to the stepper motor windings. The QDR 4500 uses four identical Motor Controller boards to control and drive the Table X (Table In/Out), Table Y (Table Left/Right), C-Arm Rotate, and C-Arm Y (C-Arm Left/Right) stepper motors. The motor windings are driven by two integrated H-bridges. These integrated circuits provide internal level conversion and power limiting. Their logic level control inputs are driven from a stepper motor control microcircuit that receives commands from the microprocessor. The control circuit senses the current in the motor windings and adjusts the duty cycle of the applied voltage in such a way as to limit the maximum motor current. The maximum value is determined by an 8-bit control word at a Digital to Analog Converter.

Each Motor Controller board monitors the position of its respective mechanism using a signal received from an associated Position Encoder connected to the mechanism. The Position Encoder is a precision potentiometer that divides a $\pm 3V$ reference source into a sense amplifier in proportion to the position of the mechanism driven by the motor. The sense amplifier output is converted to digital code that provides position feedback to the microprocessor.

The Motor Controller boards receive movement commands from the QDR 4500 computer via the communications bus. Each Motor Controller board contains an ID switch and four status indicators (LEDs). The ID switch is a 16-position rotary encoded switch (SW1) that is read during system initialization to determine the Motor Controller board's address for communicating with the QDR 4500 computer. ID switch settings for the four Motor Controller boards are as follows:

Table X drive	4
Table Y drive	5
C-Arm Rotate drive	6
C-Arm Y drive	7

The four red status LEDs provide visual indications of motor drive power on, Stepper CPU active, motor drive direction, and motor step pulses.

The Motor Controller board also has provision (JP2) for connecting limit switches to inhibit motor operation when the mechanism goes beyond established mechanical limits. This feature is not used in the QDR 4500 and therefore no cable is connected to JP2.

Power

Power input to the Motor Controller board is +28VDC. This voltage provides the motor drive power and is converted down to +5VDC for use by logic circuits on the board. The +5VDC is also converted to -5VDC. Two green LEDs provide visual indication of the power present on the Motor Controller board.

Interface Connections

Figure 2-3 shows the interconnections between the Distribution board, the Motor Controller boards, the Stepper Motors, and the Position Encoders. Table 2-1 describes the interconnections between the Distribution board and the Motor Controller. Table 2-3 describes the interconnections between each Motor Controller and its respective stepper motor and position encoder. The tables also identify the interconnection connector and pin assignments.

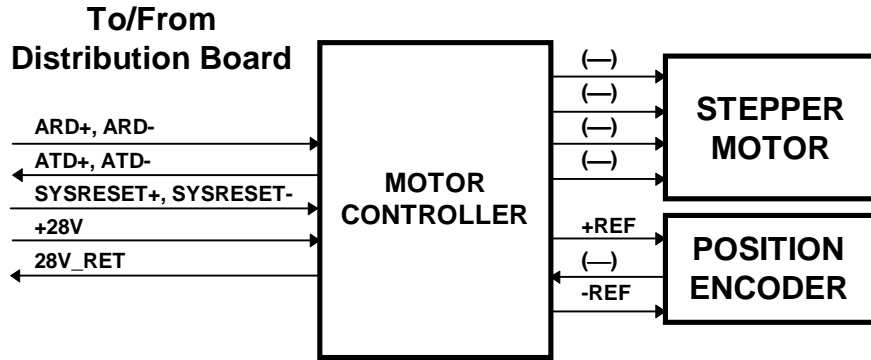


Figure 2-3. Distribution Board/Motor Controller Board Interconnection Diagram

Table 2-2. Distribution Board/Motor Controller Board Interconnection Descriptions

Signal	Description	Table X	Table Y	C-Arm Rotate	C-Arm Y	Pin(s)
ARD+ ARD-	Asynchronous Receive Data.	JP7	JP5	JP8	JP11	11 12
ATD+ ATD-	Asynchronous Transmit Data.	JP7	JP5	JP8	JP11	14 15
SYSRST+ SYSRST-	System Reset. Resets the Motor Controller board.	JP7	JP5	JP8	JP11	17 18
28V 28V_RET	DC power for the Motor Controller board.	JP7	JP5	JP8	JP11	2,3,4,5 1,6,7,8

Table 2-3. Motor Controller Board/Stepper Motor and Position Encoder Interconnection Descriptions

Signal	Description	Pin
(No label)	Motor drive signals (4).	JP5-1 - JP5-4
+REF	Precision positive voltage to position potentiometer.	JP3-1
(No label)	Position encoder wiper return voltage.	JP3-3
-REF	Precision negative voltage to position potentiometer.	JP3-5

TZ DRIVE BOARD

The TZ Drive Board is a microprocessor controlled power driver circuit for the two pedestal motors which raise and lower the patient table in the QDR 4500A and SL. This board is located in the electronics tray in the bottom of the Scanner base assembly.

The TZ Drive board communicates with the communications controller, via the Distribution board, to drive the pedestal motors under computer control. Manual raising of the pedestal may be required in case of an emergency. In this case, manual control is provided through the Table switch of the Scanner's Operator Control Panel.

The TZ Drive board monitors the position of each pedestal using signals received from an associated Position Encoder connected to the respective pedestal.

Service Switches

The TZ Drive board contains four service switches used during replacement of a defective pedestal or Position Encoder. Table 2-4 describes these switches and their respective functions.

CAUTION: The TZ drive motors are designed to run at a 5% duty cycle. If the motors overheat, the built-in thermal cutouts may trip and cause the motors to stop functioning. If this happens, you must wait about 20 minutes before functionality is restored. See the heading *Unable to position device within specified tolerance...* on page 6-45.

Table 2-4. TZ Drive Service Switches

Switch	Function
Mode (Normal/Service)	Determines whether the TZ Drive is in Normal or Service operation.
Direction (Up/Down)	When the TZ drive is in Service mode, determines the direction of pedestal movement (not active in normal mode).
Left	When the TZ drive is in Service mode, moves the left pedestal in the direction specified by the Direction switch (not active in normal mode).

Right	When the TZ drive is in Service mode, moves the right pedestal in the direction specified by the Direction switch (not active in normal mode).
Reset	Resets the board after manual operation. The TZ Drive board must be reset after any manual operation.

Power

Power input to the TZ Drive board is +24VDC from the Distribution board and 240VAC from the Operator's Console Power Module. +24VDC powers circuitry located on this board and is reduced to +5VDC. +5VDC is converted to -5VDC and +/-3VDC. The +5 and -5VDC powers logic circuitry on this board, while the +/- 3VDC provides the reference voltage for the position sensors. Two green LEDs provide visual indication of the +24 and +5VDC status (ON indicates the respective voltage is present).

The 240VAC power is connected through control relays to the pedestal motors.

Interface Connections

Figure 2-4 shows the interconnections between the Distribution board, the TZ Drive Board, the Pedestal Motors, and the Pedestal Position Encoders. Table 2-5 describes the interconnections between the Distribution board and the TZ Drive Board. Table 2-6 describes the line voltage (240VAC, line to line) between the Operator's Console Power Module and the TZ Drive Board. Table 2-7 describes the interconnections between the TZ Drive Board and the two pedestal motors and their respective position encoders. The tables also identify the interconnection connector and pin assignments.

To/From Distribution Board

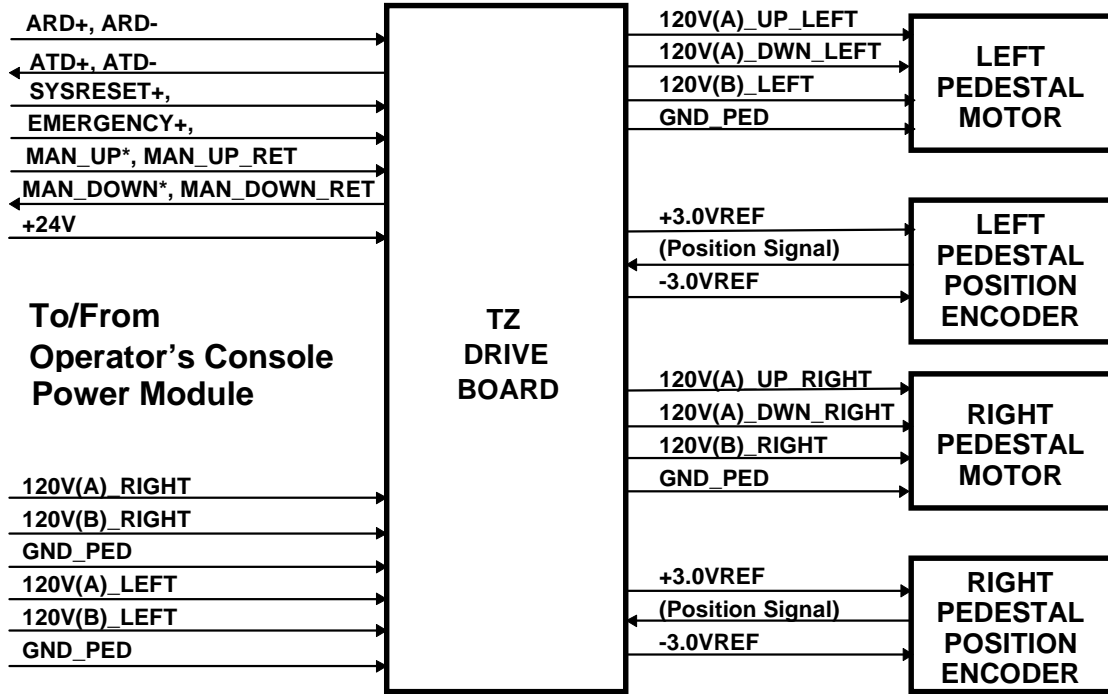


Figure 2-4. Distribution Board/TZ Drive Board Interconnection Diagram

Figure 2-4 shows the interconnections between the Distribution board, the TZ Drive Board, the Pedestal Motors, and the Pedestal Position Encoders. Table 2-5 describes the interconnections between the Distribution board and the TZ Drive Board. Table 2-6 describes the line voltage (240VAC line to line) between the Operator's Console Power Module and the TZ Drive Board. Table 2-7 describes the interconnections between the TZ Drive Board and the two pedestal motors and their respective position encoders. The tables also identify the interconnection connector and pin assignments.

Table 2-5. Distribution Board/TZ Drive Board Interconnection Descriptions

Signal	Description	Pin(s)
ARD+ ARD-	Asynchronous Receive Data.	JP1-11 JP1-12
ATD+ ATD-	Asynchronous Transmit Data.	JP1-14 JP1-15
SYSRST+ SYSRST-	System Reset. Resets the TZ Drive board.	JP1-17 JP1-18
EMERGENCY+ EMERGENCY-	Enables manual operation of the pedestals in the case of an emergency (under control of the Control Panel Table switch on the Patient Table).	JP1-20 JP1-21
MAN_UP* MAN_UP_RET	Raises the Patient Table in the case of an emergency.	JP1-23 JP1-24
MAN_DWN* MAN_DWN_RET	Lowers the Patient Table in the case of an emergency.	JP1-26 JP1-27
+24V	DC power for the Motor Controller board.	JP1-5, JP1-6
+6.5V	Not used.	JP1-2, JP1-3

Table 2-6. Operator's Console Power Module/TZ Drive Board Interface Descriptions

Signal	Description	Pin
120V(A)_LEFT	AC voltage (120) to drive the Left Pedestal motor.	JP6-4
120V(B)_LEFT	AC voltage (120) to drive the Left Pedestal motor.	JP6-5
120V(A)_RIGHT	AC voltage (120) to drive the Right Pedestal motor.	JP6-1
120V(B)_RIGHT	AC voltage (120) to drive the Right Pedestal motor.	JP6-2
GND_PED	Ground line to the Left/Right Pedestal motor.	JP6-3/JP6-6

Table 2-7. TZ Drive Board/Pedestal Motors and Position Encoders Interconnection Descriptions

Signal	Description	Pin
120V(A)_UP_LEFT	AC voltage to the Left Pedestal motor to move the left end of the Patient Table up.	JP5-1
120V(A)_DWN_LEFT	AC voltage to the Left Pedestal motor to move the left end of the Patient Table down.	JP5-2
120V(B)_LEFT	AC line to the Left Pedestal motor.	JP5-3
GND_PED	Ground line to the Left Pedestal motor.	JP5-4
120V(A)_UP_RIGHT	AC voltage to the Right Pedestal motor to move the right end of the Patient Table up.	JP4-1
120V(A)_DWN_RIGHT	AC voltage to the Right Pedestal motor to move the right end of the Patient Table down.	JP4-2
120V(B)_RIGHT	AC line to the Right Pedestal motor.	JP4-3
GND_PED	Ground line to the Right Pedestal motor.	JP4-4
+3.0VREF	Precision positive voltage to Left/Right Pedestal position encoder potentiometer.	JP3-1/JP2-1
(Position Signal)	Left/Right pedestal position encoder wiper return voltage.	JP3-3/JP2-3
-3.0VREF	Precision negative voltage to Left/Right Pedestal position encoder potentiometer.	JP3-4/JP2-4

CONTROL PANEL CONTROLLER BOARD

The Control Panel Controller board interfaces the Scanner's Operator Control Panel to the computer software allowing the software to determine the state of the Operator Control Panel switches and to define the state of the various Operator Control Panel LEDs. The board is located under the right side of the Patient Table assembly near the Operator Control Panel.

The Control Panel Controller communicates with the Operator's Console computer using the asynchronous communications signals, ARD and ATD, of the communications bus, and the system control signals SYSRESET, XRAY_LIGHT, and EMERGENCY. It also communicates the state of the manual Table Up switch to the TZ board and it monitors the state of the C-Arm's Tilt switch.

Power

The Control Panel Controller board receives +7VDC from the Distribution board. The +7 is reduced to +5VDC to power the circuitry on this board and is applied to the Operator Control Panel to power its LEDs. A green LED, on this board, provides visual indication of the +5VDC power (ON indicates the voltage is present).

Interface Connections

Figure 2-5 shows the interconnections between the Distribution board, Control Panel Controller board and the Operator Control Panel. Table 2-8 describes the interconnections between the Distribution board and the Control Panel Controller. Table 2-9 describes the interconnections between the Control Panel Controller and the Operator Control Panel. The tables also identify the interconnection connector and pin assignments.

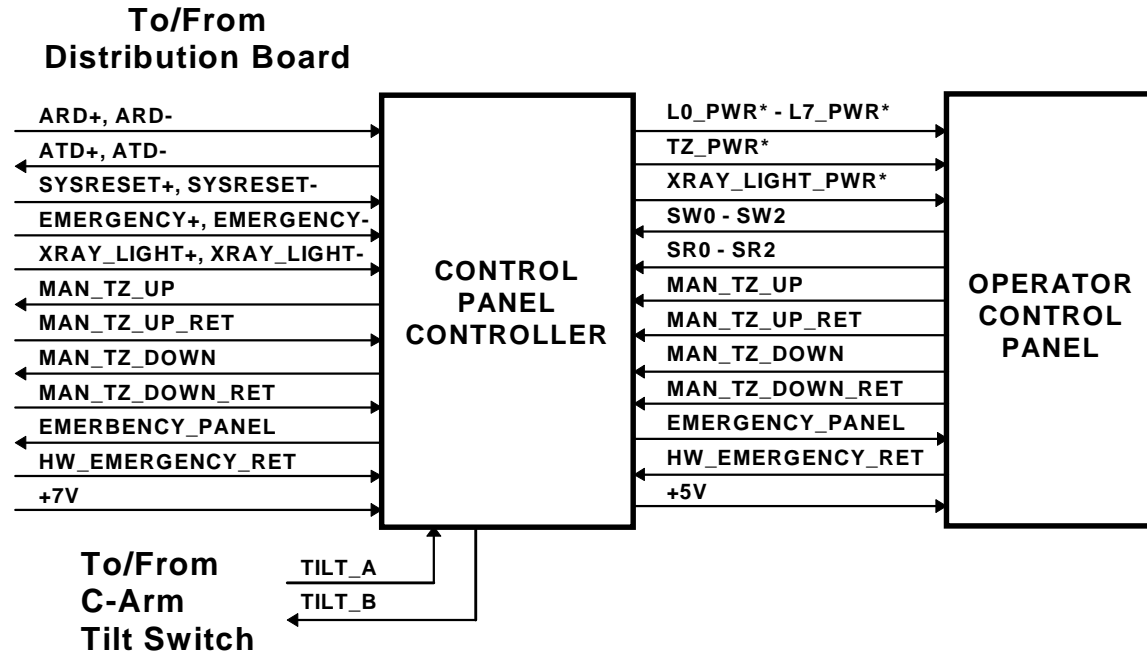


Figure 2-5. Control Panel Controller Interconnection Diagram

Table 2-8. Distribution Board/Control Panel Controller Interconnection Descriptions

Signal	Description	Pin
ARD+ ARD-	Asynchronous Receive Data from the Communications Controller via the Distribution board.	JP2-4 JP2-5
ATD+ ATD-	Asynchronous Transmit Data to the Communications Controller via the Distribution board	JP2-7 JP2-8
SYSRESET+ SYSRESET-	System Reset from the Communications Controller via the Distribution board. Resets the Control Panel Controller.	JP2-10 JP2-11
EMERGENCY+ EMERGENCY-	Emergency TZ drive indicator from the Communications Controller via the Distribution board.	JP2-13 JP2-14
XRAY_LIGHT+ XRAY_LIGHT-	X-Ray Light from the X-Ray Controller via the C-Arm Interface and Distribution boards.	JP2-16 JP2-17
EMERGENCY_CPanel HW_EMERGENCY_RET	State of the STOP switch and of the collision sensor. (Part of the safety daisy chain.)	JP2-19 JP2-20
MAN_TZ_UP MAN_TZ_UP_RET	State of the TABLE switch UP position.	JP2-21 JP2-22
MAN_TZ_DOWN MAN_TZ_DOWN_RET	State of the TABLE switch DOWN position.	JP2-23 JP2-24
TILT_A TILT_B	State of the C-Arm Tilt switch (C-Arm tilted or level) from the C-Arm Interface via the Distribution board.	JP2-26 JP2-25
+7V	DC power for the Control Panel Controller board.	JP2-2

Table 2-9. Control Panel Controller/Control Panel Interconnection Descriptions

Signal	Description	CPC ¹ Pin	CP ² Pin
L0_PWR*	Turns on the ENABLE switch LED.	JP6-11	JP1-11
L1_PWR*	Turns on the HOME switch LED.	JP6-12	JP1-12
L2_PWR*	Turns on the LOAD switch LED.	JP6-13	JP1-13
L3_PWR*	Turns on the TABLE switch IN/OUT LED.	JP6-14	JP1-14
L4_PWR*	Not used.	JP6-15	JP1-15
L5_PWR*	Turns on the C-ARM switch RIGHT/LEFT LED.	JP6-16	JP1-16
L6_PWR*	Not used.	JP6-17	JP1-17
L7_PWR*	Turns on the Laser LED.	JP6-18	JP1-18
TZ_PWR*	Turns on the TABLE UP LED.	JP6-20	JP1-20
XRAY_LIGHT_PWR*	Turns on the X_RAY LED	JP6-19	JP1-19
SW0	Control signal to determine the state of the C-ARM and LASER switches.	JP6-4	JP1-4
SW1	Control signal to determine the state of the TABLE IN/OUT switches.	JP6-5	JP1-5
SW2	Control signal to determine the state of the LOAD, HOME and ENABLE switches.	JP6-6	JP1-6
SR0	Returns the state of the C-ARM switch LEFT position when SW0 is active. Signals the state of the TABLE switch IN position when SW1 is active. Signals the state of the LOAD switch when SW2 is active.	JP6-1	JP1-1
SR1	Returns the state of the C-ARM switch RIGHT position when SW0 is active. Signals the state of the TABLE switch OUT position when SW1 is active. Signals the state of the HOME switch when SW2 is active.	JP6-2	JP1-2
SR2	Returns the state of the LASER and ENABLE switches when SW2 is active.	JP6-3	JP1-3
MAN_TZ_UP MAN_TZ_UP_RET	Returns the state of the TABLE switch UP position.	JP6-7 JP6-8	JP1-7 JP1-8
MAN_TZ_DOWN MAN_TZ_DOWN_RET	Not Used.	JP6-9 JP6-10	JP1-9 JP1-10
EMERGENCY_C_PANEL HW_EMERGENCY_RET	Returns the state of the STOP switch. (Part of the safety daisy chain.)	JP6-23 JP6-24	JP1-23 JP1-24
+5V	Provides power for the Control Panel LEDs.	JP6-21 JP6-22	JP1-21 JP1-22

Notes: 1. CPC = Control Panel Controller
2. CP = Control Panel

C-ARM INTERFACE BOARD

The C-Arm Interface board distributes DC power and signals to the Data Acquisition System (DAS) and provides control electronics for the devices located in the C-Arm assembly. It passes several signal and power lines from the Distribution board directly to the DAS. It also provides buffering for various signal lines. The C-Arm Interface board is located near the rear of the C-Arm's horizontal shelf.

Note: The Data Acquisition System (DAS) consists of the Analog to Digital Converter, Integrator/Multiplexor, and Solid State Detector boards.

The C-Arm Interface provides circuitry to:

- Control and monitor operation of the X-ray Controller board. Four LEDs (two red, one green, and one yellow), on this board, provide visual indication of the status of the X-Ray Controller and the X-ray control circuitry of this board.

- Generate timing references to the DAS and Communications Controller.

- Control power to the Positioning laser.

- Actuate the Aperture stepper motor and monitor its mechanically linked position sensing device.

- Actuate the stepper motor of the Reference Drum device and monitor the encoded signals returned from each drum of the device. Two green LEDs, on this board, provide visual indication of the Reference Drum operation.

- Generate +7VDC for the DAS system.

Continuity Daisy Chain

The C-Arm Interface board is part of two linked chains of boards. Removing any of these boards conveys an alarm message to the host computer indicating that the electrical integrity of the system is compromised. The message can be decoded by the host computer to detect the extent of the damage.

Power

The C-Arm Interface board receives +28, +24 and +/- 15VDC from the Distribution board. The + 28VDC powers the Aperture and Reference Drum stepper motor driver circuitry. The +/-15V is passed through this board to the DAS. The +24VDC is reduced to +5 and +7VDC. The +5VDC powers the digital section of this board and the laser while the +7VDC is applied to the DAS.

Three green LEDs, on this board, provide visual indication of the +28, +24 and +5VDC power (ON indicates the respective voltage is present).

Interface Connections

Figure 2-6 shows the interconnections between the Distribution board and the C-Arm Interface board. Table 2-10 describes the interface signals and identifies the interconnection connector and pin assignments.

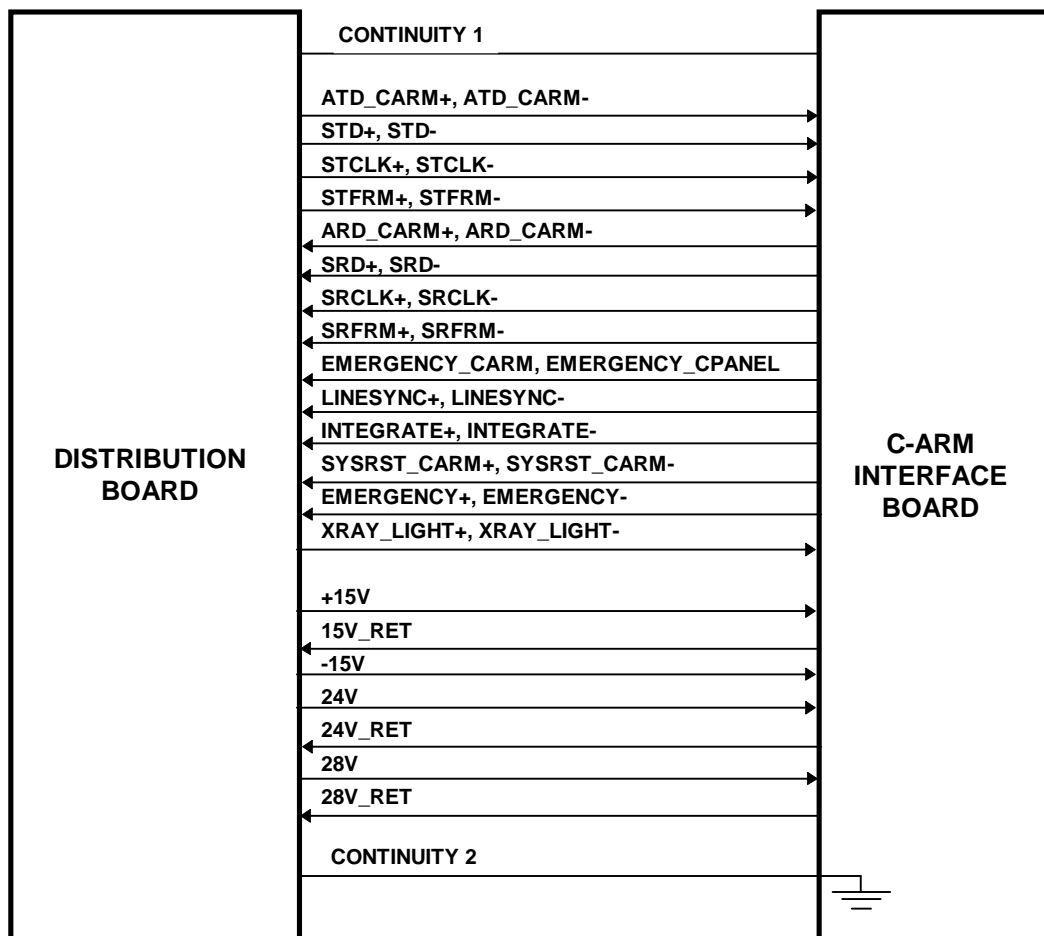


Figure 2-6. Distribution Board/C-Arm Interface Board Interconnection Diagram

Table 2-10. Distribution Board/C-Arm Interface Board Interconnection Descriptions

Signal	Description	Dist ¹ Pin	C-ARM ² Pin
ARD_CARM+ ARD_CARM-	Asynchronous data to the C-Arm Interface board.	JP1-3 JP1-4	JP1-3 JP1-4
STD+ STD-	Synchronous data through the C-Arm Interface board to the DAS.	JP1-6 JP1-7	JP1-6 JP1-7

Section 2 - Functional Description

Signal	Description	Dist¹ Pin	C-ARM² Pin
STCLK+ STCLK-	Synchronizes data through the C-Arm Interface board to the DAS.	JP1-9 JP1-10	JP1-9 JP1-10
STFRM+ STFRM-	Synchronous channel data frame from Communications Controller through the Distribution board to the DAS.	JP1-12 JP1-13	JP1-12 JP1-13
ATD_CARM+ ATD_CARM-	Asynchronous Data from the from the C-Arm Interface board.	JP1-15 JP1-16	JP1-15 JP1-16
SRD+ SRD-	Synchronous Data through the C-Arm Interface board from the DAS.	JP1-18 JP1-19	JP1-18 JP1-19
SRCLK+ SRCLK-	Synchronizes data through the C-Arm Interface board from the DAS.	JP1-21 JP1-22	JP1-21 JP1-22
SRFRM+ SRFRM-	Synchronous channel data frame through Distribution board to Communications Controller from the DAS.	JP1-24 JP1-25	JP1-24 JP1-25
XR_ZEROX_CC+ XR_ZEROX_CC-	AC line zero-crossing signal used for system wide synchronization. Generated by the C-Arm Interface board.	JP1-30 JP1-31	JP1-30 JP1-31
INTEGR_CC+ INTERG_CC-	Synchronous signal for Detector Integrate period. Generated by the C-Arm Interface board.	JP1-33 JP1-34	JP1-33 JP1-34
SYSRST_CARM+ SYSRST_CARM-	Resets the C-Arm Interface board.	JP1-39 JP1-40	JP1-39 JP1-40
EMERGENCY_CARM+ HW_EMGNCY_RET-	Removes power from the Scanner's motor drivers and the X-ray system	JP1-42 JP1-43	JP1-42 JP1-43
XRAY_LIGHT+ XRAR_LIGHT-	Applies power to the AUX X-RAY light outlet on the Power Console.	JP1-48 JP1-49	JP1-48 JP1-49
CONTINUITY 1 CONTINUITY 2	Emergency shutdown daisy chain.	JP1-1 JP1-5	JP1-1 JP1-5
+15V -15V 15V_RET	Powers the Data Acquisition System.	JP4-1 JP4-3 JP4-2	JP9-1 JP9-3 JP9-2
24V 24V_RET	Generates +5VDC to power the digital section of the C-Arm Interface board, and +7VDC for power to the Data Acquisition System.	JP4-4 JP4-5	JP9-4 JP9-5
28V 28V_RET	Powers the stepper motors and fan.	JP4-6 JP4-7	JP9-6 JP9-7

Notes: 1. Dist = Distribution board.

2. C-Arm = C-Arm Interface board

Figure 2-7 shows the boards and assemblies that connect to the C-Arm Interface board.

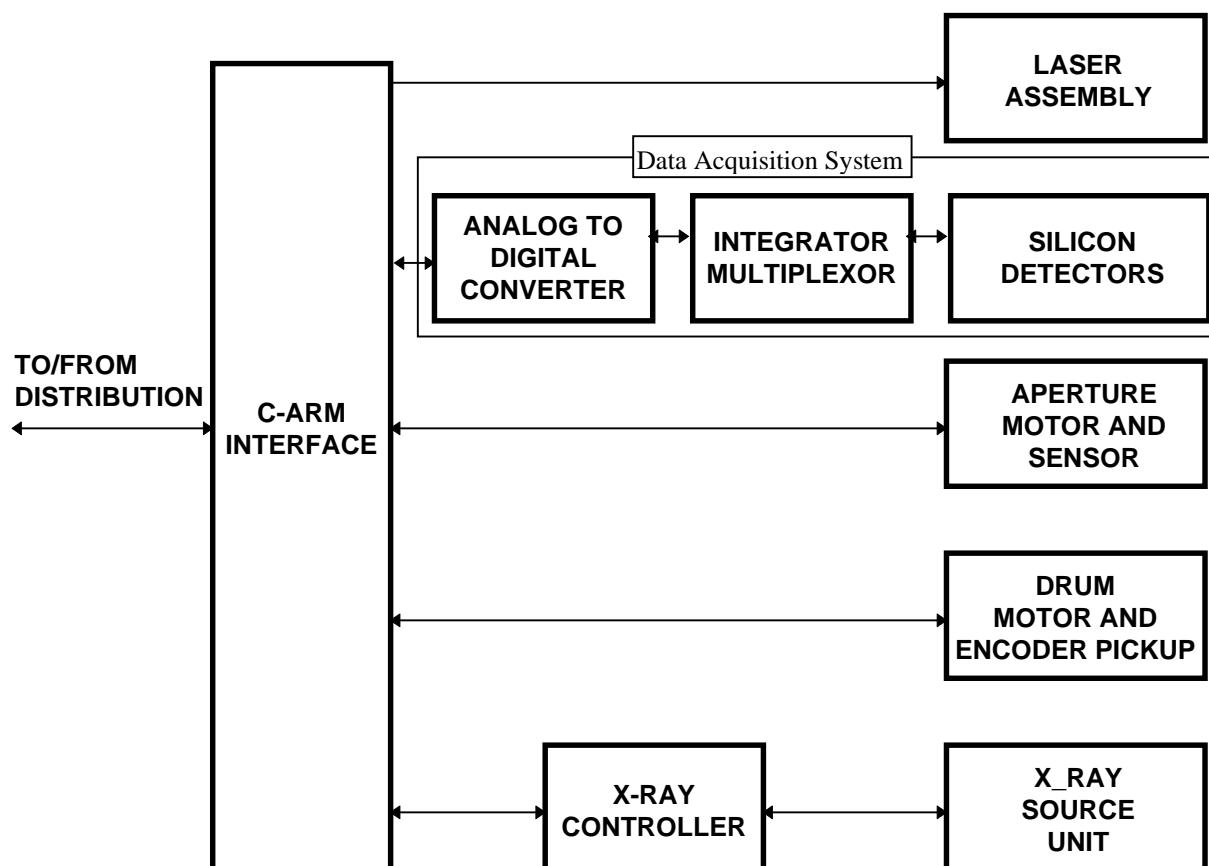


Figure 2-7. C-Arm Interface Board High Level Interconnection Diagram

X-RAY CONTROLLER ASSEMBLY

The X-Ray Controller (XRC) assembly provides pulsed power to the primary winding of the high voltage transformer in the X-Ray Source Unit and AC power to the primary winding of the filament transformer. It consists of five printed circuit boards and several large components contained in a chassis mounted at the front of the lower C-arm just in front of the Tank Assembly. The five boards are the I/O and Logic, Low Voltage Power Supply, H-Bridge, Power Factor Regulator (PFR) Substitution, and Duty Cycle Driver.

The XRC receives split 240VAC power from the Operator's Console Power Distribution Module. It also receives command and timing data from the C-Arm Controller board and it provides a line frequency timing signal and housekeeping and diagnostic data to the C-Arm Interface board.

Interface

Figure 2-8 shows the interface connections between the C-Arm Interface board and the X-Ray Controller Assembly. Table 2-11 describes the interface signals and identifies the

Section 2 - Functional Description

interconnection connector and pin assignments. Note that the AC input power comes directly from the Operator's Console Power module and connects to the Low Voltage Power Supply board of the X-Ray Controller Assembly. All others connect to the I/O and Logic board of the assembly.

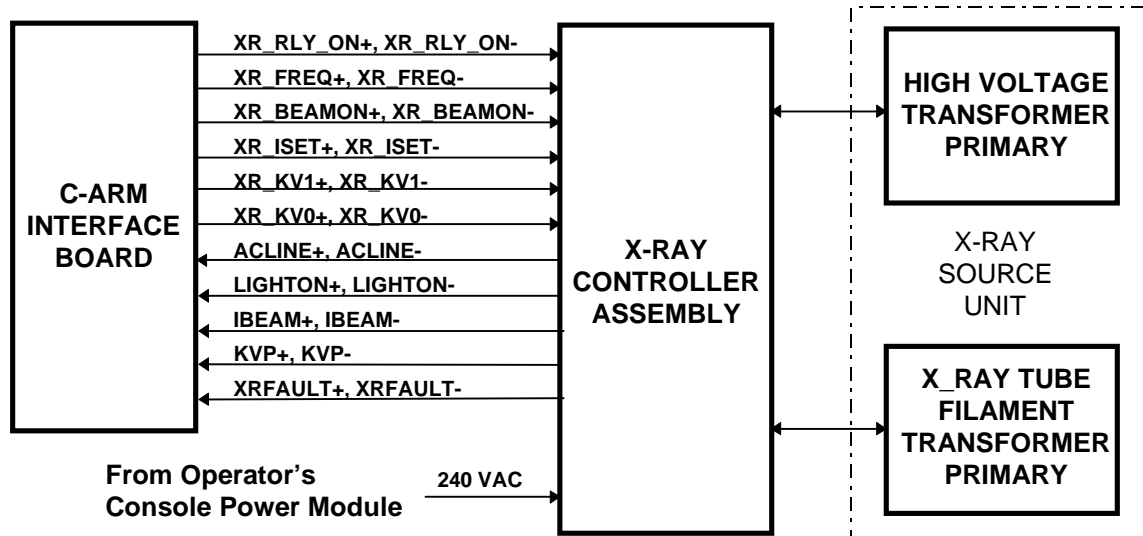


Figure 2-8.

C-Arm Interface Board/X-Ray Controller Assembly Interconnection Diagram

Table 2-11. C-Arm Interface Board/X-Ray Controller Assembly Interconnection Description

Signal	Description	C-Arm Pins	I/O Logic Pins	XRC Pins
XR_RLY_ON+ XR_RLY_ON-	Allows the energy storage capacitor to be “trickle charged” before applying full power to avoid large turn-on current surges that could cause the circuit breaker to trip.	JP12-1 JP12-2	JP7-1 JP7-2	JP3-1 JP3-20
XR_FREQ+ XR_FREQ-	States whether the line frequency is 50 or 60Hz.	JP12-3 JP12-4	JP7-3 JP7-4	JP3-2 JP3-21
XR_BEAMON+ XR_BEAMON-	Controls the ON/OFF status of the X-Ray beam.	JP12-5 JP12-6	JP7-5 JP7-6	JP3-3 JP3-22
XR_ISET+ XR_ISET-	Selects the X-Ray beam current (3 or 10mA).	JP12-7 JP12-8	JP7-7 JP7-8	JP3-4 JP3-23
XR_kV1+ XR_kV1- XR_kV0+ XR_kV0-	Selects the X-Ray beam energy (80, 100, 120 or 140kVp).	JP12-9 JP12-10 JP12-11 JP12-12	JP7-9 JP7-10 JP7-11 JP7-12	JP3-5 JP3-24 JP3-6 JP3-25
ACLINE+ ACLINE-	States the phase of the power frequency.	JP12-19 JP12-20	JP7-19 JP7-20	JP3-10 JP3-29

Signal	Description	C-Arm Pins	I/O Logic Pins	XRC Pins
LIGHTON+ LIGHTON-	States whether the X-Ray beam is ON/OFF. This signal controls the X-Ray ON lights of the C-Arm Control Panel, the table Control Panel, and the Operator's Console Power Module. It also controls a remote X-ray ON light through the Power Module when one is connected.	JP12-21 JP12-22	JP7-21 JP7-22	JP3-11 JP3-30
IBEAM+ IBEAM-	Value of current pulses at the X-ray source. This is a frequency modulated diagnostic signal whose frequency is proportional to the quantity being monitored.	JP12-23 JP12-24	JP7-23 JP7-24	JP3-12 JP3-31
kVp+ kVp-	Value of voltage pulses at the X-ray source. This is a frequency modulated diagnostic signal whose frequency is proportional to the quantity being monitored.	JP12-25 JP12-26	JP7-25 JP7-26	JP3-13 JP3-32
XRFAULT+ XRFAULT-	States whether or not any fault condition exists in the X-Ray Controller Assembly.	JP12-27 JP12-28	JP7-27 JP7-28	JP3-14 JP3-33

X-Ray Controller Assembly Boards

The following sub-sections describe the five individual boards that make up the X-Ray Controller Assembly and illustrates and describes their interconnection signals.

I/O and Logic Board

The I/O & Logic Board receives control signals from the C-Arm Controller and provides timing and reference signals for the operation of the XRC. It also regulates AC power to the X-ray tube filament so as to generate the desired beam current. A power frequency timing reference signal (AC_LINE) is returned to the C-arm controller for synchronizing the operation of the detectors to the X-ray source.

Low Voltage Power Supply

The Low Voltage Power Supply generates the DC voltages used in the X-Ray Assembly. It generates regulated +5, +15 and -15V used on the I/O and Logic board. It also generates unregulated +20 and -20V that are applied to the Duty Cycle Driver board to generate the regulated voltages used by the Duty Cycle Driver board.

In addition, the Low Voltage Power Supply applies switched 240VAC to the PFR Substitution board and unswitched 120VAC to the I/O and Logic board. The unswitched 120VAC is used to provide AC power for the X-Ray tube filament transformer while the switched 240VAC is used to generate the anode potential.

Power Factor Regulator (PFR) Substitution Board

The PFR Substitution Board is an interface adapter that rectifies the 240VAC power voltage from the Low Voltage Power Supply and applies it to an energy storage capacitor. This board may be replaced in future XRC designs by an active filter (Power Factor Regulator) designed to control the crest factor and wave shape of the current drawn by the XRC from the power source.

Duty Cycle Regulator

The Duty Cycle Regulator generates power pulses of controlled amplitude for application, through the H-Bridge, to the high voltage transformer in the X-ray source unit. These power pulses are generated by a switching regulator transferring charge from the energy storage capacitor to the load through a transfer inductor. The pulse amplitude determines the peak energy of the X-rays generated by the X-ray Source Unit.

H-Bridge Board

The H-Bridge alternately connects the output pulses from the Duty Cycle Regulator to the high voltage transformer in the X-Ray source unit with forward and reverse polarity.

Interface Connections

Figure 2-9 shows the high-level interconnections of the five X-Ray Controller Assembly boards. Figure 2-10 through Figure 2-14 show the interface connections between the five boards. Table 2-11 through Table 2-19 describe the interface signals and identify the interconnection connector and pin assignments among the five boards.

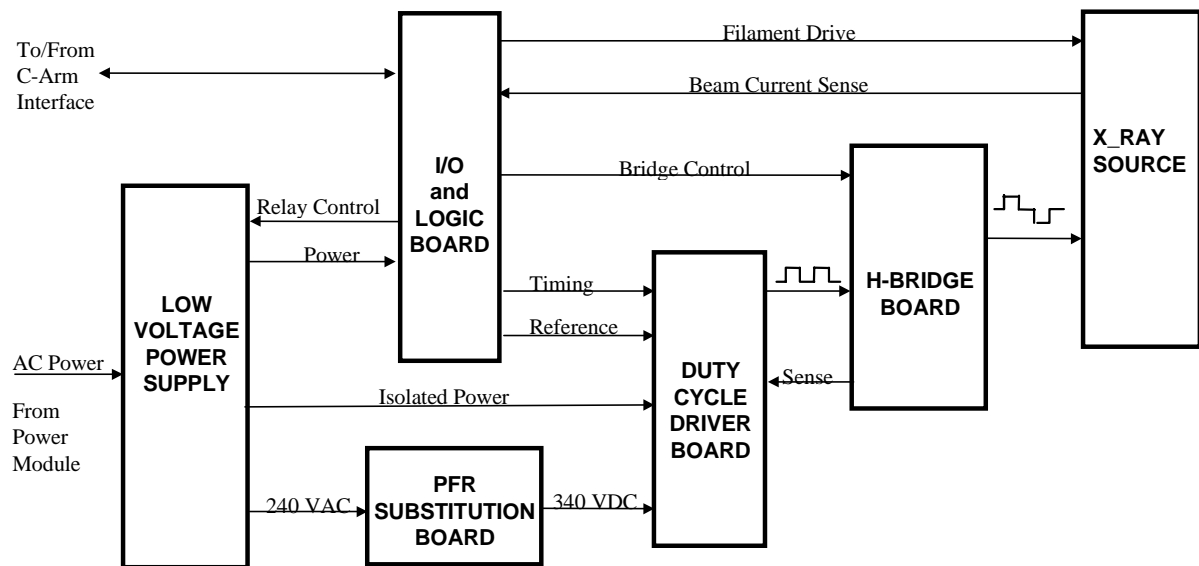


Figure 2-9. X-Ray Controller Assembly High-Level Interconnection Diagram

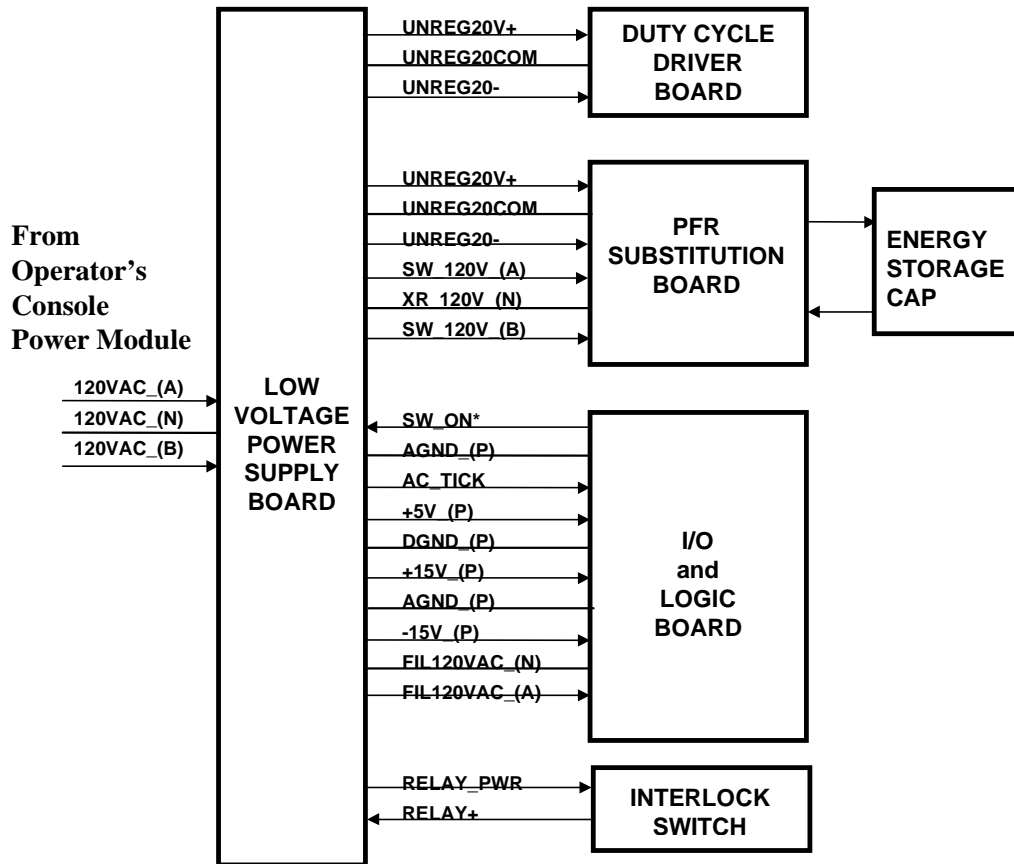


Figure 2-10. Low Voltage Power Supply Board Interconnections

The interlock switch, shown in the above figure, has two sets of contacts, one for relay power (shown), and one for discharging the Energy Storage Capacitor (not shown).

Table 2-12. Low Voltage Power Supply Board/Duty Cycle Driver Board Interconnection Description

Signal	Description	LVPS Pins	DCD Pins
UNREG20V+ UNREG20COM UNREG20-	Generates the regulated voltages used on the Duty Cycle Driver board.	JP2-1 JP2-2 JP2-3	JP3-1 JP3-2 JP3-3

Table 2-13. Low Voltage Power Supply Board/PFR Substitution Board Interconnection Descriptions

Signal	Description	LVPS Pins	PFR Pins
UNREG20V+ UNREG20COM UNREG20-	Not Used.	JP1-1 JP1-2 JP1-3	JP3-1 JP3-2 JP3-3
SW_120V_(A) SW_120V_(N) SW_120V_(B)	Generates energy storage capacitor voltage.	JP4-1 JP4-2 JP4-3	JP1-1 JP1-2 JP1-3

Table 2-14. Low Voltage Power Supply Board/I/O and Logic Board Interconnection Descriptions

Signal	Description	LVPS Pins	IOL Pins
SW_ON*	Turns on the main power relay on the Low Voltage Power Supply board	JP7-6	JP2-1
AC_TICK	Used for generating the line frequency clock signal.	JP7-1	JP2-6
+5V_(P) DGRND_(P) -15V_(P) AGND_(P) +15V_(P)	Provides power for the I/O and Logic and Duty Cycle Driver boards.	JP5-8 JP5-7 JP5-6 JP5-5 JP5-4	JP1-8 JP1-7 JP1-6 JP1-5 JP1-4
FIL120VAC_(N) FIL120VAC_(A)	Provides the AC power for the primary winding of the X-Ray tube filament transformer.	JP5-2 JP5-1	JP1-2 JP1-1

Table 2-15. Low Voltage Power Supply Board/Interlock Switch Interconnection Descriptions

Signal	Description	LVPS Pins
RELAY_PWR RELAY+	Provides the DC voltage to operate the main power relay on the Low Voltage Power Supply board	JP6-2 JP6-1

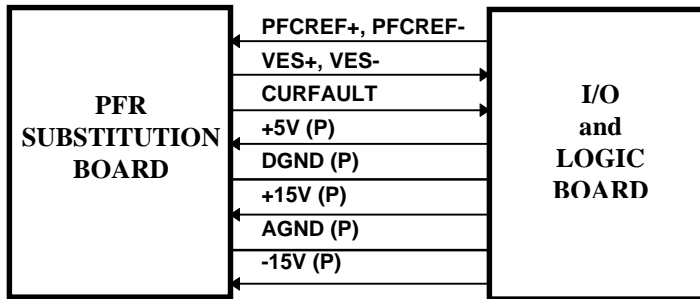


Figure 2-11. PFR Substitution Board/I/O and Logic Board Interconnection Diagram

Table 2-16. PFR Substitution Board/I/O and Logic Board Interconnection Descriptions

Signal	Description	PFR Pins	IOL Pins
PFRREF+ PFRREF-	Not used.	JP5-2 JP5-3	JP3-2 JP3-3
VES+ VES-	Energy storage sense signal.	JP5-5 JP5-6	JP3-5 JP3-6
CURFAULT	Fault indicator (not used)	JP5-8	JP3-8
+5V_(P) DGRND_(P) +15V_(P) AGND_(P) -15V_(P)	Provides power for the PFR Substitution board (not used).	JP5-7 JP5-9 JP5-10, JP5-11 JP5-12, JP5-13 JP5-14, JP5-15	JP3-7 JP3-9 JP3-10, JP3-11 JP3-12, JP3-13 JP3-14, JP3-15

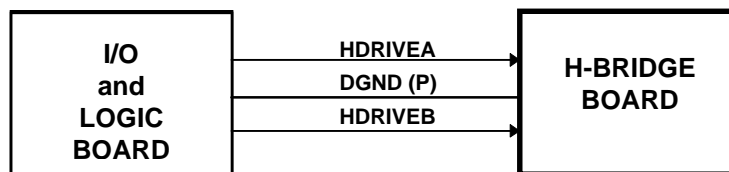


Figure 2-12. I/O and Logic Board/H-Bridge Board Interconnection Diagram

Table 2-17. I/O and Logic Board/H-Bridge Board Interconnection Descriptions

Signal	Description	IOL Pins	H-B Pins
HDRIVEA	Drive for H-Bridge transistors Q1 and Q2.	JP5-1	JP2-1
DGND (P)	Ground	JP5-2 JP5-4	JP2-2 JP2-4
HDRIVEB	Drive for H-Bridge transistors Q3 and Q4.	JP5-5	JP2-5

Section 2 - Functional Description

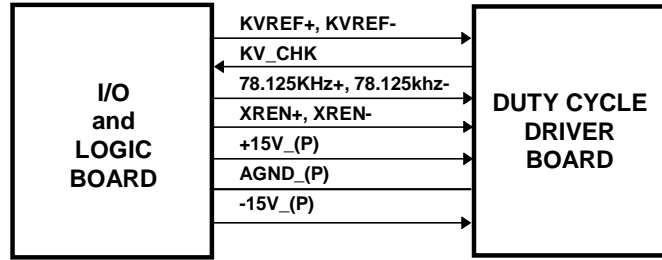


Figure 2-13. I/O and Logic Board/Duty Cycle Driver Board Interconnection Diagram

Table 2-18. I/O and Logic Board/Duty Cycle Driver Board Interconnection Descriptions

Signal	Description	IOL Pins	DCD Pins
kVREF+ kVREF-	Pulse Amplitude reference	JP4-2 JP4-3	JP1-2 JP1-3
kVCHK	Sense amplifier output signal.	JP4-4	JP1-4
78.125KHZ+ 78.125KHz-	Duty cycle Driver clock.	JP4-5 JP4-6	JP1-5 JP1-6
XREN+ XREN-	X-Ray enabling gate.	JP4-7 JP4-8	JP1-7 JP1-8
+15V_(P) AGND_(P) -15V_(P)	Provides power for the Duty Cycle Driver board.	JP4-10, JP4-11 JP4-12, JP4-13 JP4-14, JP4-15	JP1-10, JP1-11 JP1-12, JP1-13 JP1-14, JP1-15

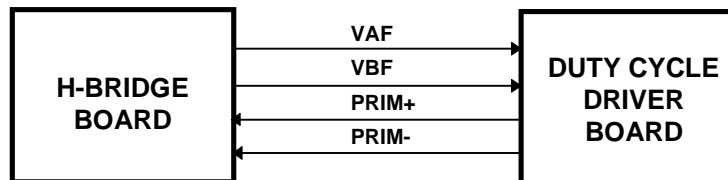


Figure 2-14. H-Bridge Board/Duty Cycle Driver Board Interconnection Diagram

Table 2-19. H-Bridge Board/Duty Cycle Driver Board Interconnection Descriptions

Signal	Description	H-B Pins	DCD Pins
VAF VBF	Pulse amplitude feedback pulse.	JP3-1 JP3-3	JP2-1 JP2-3
PRIM+ PRIM-	High Voltage Transformer drive pulse.	WP1, WP2 WP3, WP4	JP4-1, JP4-2 JP4-3, JP4-4

X-RAY SOURCE UNIT

The X-Ray Source (commonly referred to as the Tank assembly) consists of the X-Ray tube, the X-Ray tube filament transformer, the high voltage transformer, the high voltage rectifier circuit, and the sensing circuits that monitor the high voltage applied to the X-ray tube and the beam current.

Table 2-20 describes the interconnections between the X-Ray Controller Assembly and the X-Ray Source unit. The table also identifies the X-Ray Controller Assembly board, connector and pin assignments for each interconnection signal.

Table 2-20. X-Ray Controller Assembly/X-Ray Source Unit Interface

Signal	Description	XRC Board	Controller Pin	Tank Terminal
HV_XFMR_PRI+ HV_XFMR_PRI-	High Voltage Transformer Primary	H-Bridge (JP1)	JP1-1, JP1-2 JP1-3, JP1-4	TB1-3 TB1-4
FIL_XFMR_A FIL_XFMR_B	Filament Transformer Primary	I/O & Logic (JP6)	JP2-7 JP2-8	TB1-6* TB1-9
IF+	Beam Current Sense "+"	I/O & Logic (JP6)	JP2-4	TB1-10
IF-	Beam Current Sense "-" (Chassis)	I/O & Logic (JP6)	JP2-5	TB1-7
TP1	Anode pulse monitor	I/O & Logic (JP6)	JP2-2	TB1-12
TP2	Cathode pulse monitor	I/O & Logic (JP6)	JP2-1	TB1-11

* A thermal overload protector is installed in series with the filament transformer primary winding, between TB1-6 and TB1-8.

DATA ACQUISITION SYSTEM

The QDR 4500 Data Acquisition System (DAS) consists of three Solid State Detector printed circuit boards, an Integrator/Multiplexor board, and an Analog To Digital Converter (ADC) board. The Solid State Detector boards and the Integrator/Multiplexor board are physically located within the upper end of the C-arm. The detector boards mount under the Integrator/Multiplexor board and connect to the Integrator/Multiplexor board. The Integrator/Multiplexor board is contained in an electrically shielded enclosure. There is also a lead radiation shield between the detector and the integrator/multiplexor boards to stop any X-rays that might get through the detectors. The ADC board is located within the rear downward slope of the C-arm.

Solid State Detector

The Solid State Detector boards convert X-rays into signals that are applied to the Integrator/Multiplexor board. X-rays striking detector crystals are converted into visible light. Solid State photo diodes sense this light and convert the light into current which is amplified in a current to voltage converter. Output from the amplifier is applied to the Integrator through analog switches. The analog switches all operate in parallel and are turned on during the X-ray pulse. These switches are turned off during the integrator hold time to prevent integrating noise into the data. The turning on and off of these switches is controlled by the INTEGRATE signal supplied from the Integrator/Multiplexor board. Each solid state detector board has a capacity of either 36 low resolution detectors, or 72 high resolution detectors. Depending on the model, detector boards may be either fully or partially populated by low resolution or high resolution detectors, and amplifiers.

The detector assembly is available in two resolutions and two lengths. Detectors may be 2mm or 4mm at the detector. This is equal to slightly less than 1mm or 2mm resolution in an AP spine. Detector arrays may contain 64 4mm detectors, or 128 (or 216) 2mm detectors. Most scans can be done with the shorter arrays. The longer arrays are only necessary for three pass whole body scans.

Power

The Solid State Detector board receives +/-15V from the Integrator/Multiplexor board. Voltage regulators, located on this board, convert this voltage to +/-12V to power the amplifiers and switches.

Interface Connections

Figure 2-15 shows the interconnections between the Integrator/Multiplexor board and the Solid State Detector boards. Table 2-21 describes the interface signals and identifies the interconnection connector and pin assignments.

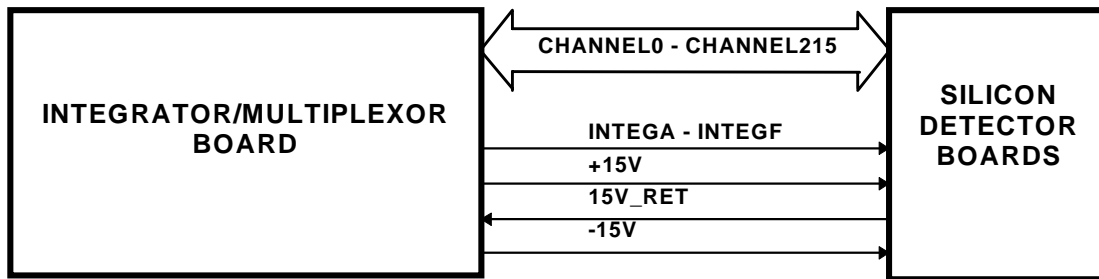


Figure 2-15. Integrator/Multiplexor Board/Solid State Detector Boards Interconnection Diagram

Table 2-21. Integrator/Multiplexor Board/Solid State Detector Boards Interconnection Descriptions

Signal	Description	I/M Pins	SD PINS
CHANNEL0 - CHANNEL215		See Note 1	See Note 2
INTEGA INTEGB INTEGC INTEGD INTEGE INTEGF		JP2-6, JP2-44 JP1-6, JP1-44 JP4-6, JP4-44 JP3-6, JP3-44 JP6-6, JP6-44 JP5-6, JP5-44	JP1-44, 6 JP2-44, 6
+15V 15V_RET -15V	Powers the amplifiers and switches of the Solid State Detector boards.	JP1-JP6-47, JP1-JP6-48 JP1-JP6-3, JP1-JP6-4, JP1-JP6-5, JP1-JP6-43, JP1-JP6-45, JP1-JP6-46, JP1-JP6-49, JP1-JP6-50 JP1-JP6-1, JP1-JP6-2	JP1/2-47, JP1/2-48 JP1/2-3, JP1/2-4, JP1/2-5, JP1/2-43, JP1/2-45, P1/2-46, JP1/2-49, JP1/2-50 JP1/2-1, JP1/2-2

- Notes: 1. Refer to schematic drawing I40-0048-SD for connector and pin assignments (cannot scope these signals).
2. Refer to schematic drawing I40-0050-SD for connector and pin assignments (cannot scope these signals).
3. Note that the CHANNEL hardware numbers are reversed from the software numbers. e.g. Hardware CHANNEL0 = software CHANNEL215.

INTEGRATOR/MULTIPLEXOR BOARD

The Integrator/Multiplexor receives up to 216 signals in parallel from the Solid State Detector boards. The board integrates and stores those signals, and then applies the stored signals in four groups of up to 64 signals in parallel to the Analog To Digital board.

Switched signals from the Solid State Detector board charge integrating capacitors on this board during a given charging time. After the charging time, the switched signals are turned off and the charges are held on the capacitors. Each integrator will be sampled by the multiplexor and sent to the Analog To Digital board.. At the end of sampling, all the integrating capacitors will be discharged in parallel by shorting them out with analog switches.

Each integrator has an additional input into which a test signal (TESTLVL) can be applied when there are no X-rays present. This test signal is used to verify the operation of the integrators and multiplexors.

Power

The Integrator/Multiplexor board receives +/-15V and +5V from the Analog To Digital board. The +/-15V is passed through this board to the Solid State Detector boards. Voltage regulators, located on this board, convert this voltage to +/-12V to power circuitry contained on this board. Analog and digital returns are kept separate.

Interface Connections

Figure 2-16 shows the interconnections between the Analog/Digital Converter board and the Integrator/Multiplexor board. Table 2-22 describes the interface signals and identifies the interconnection connector and pin assignments.

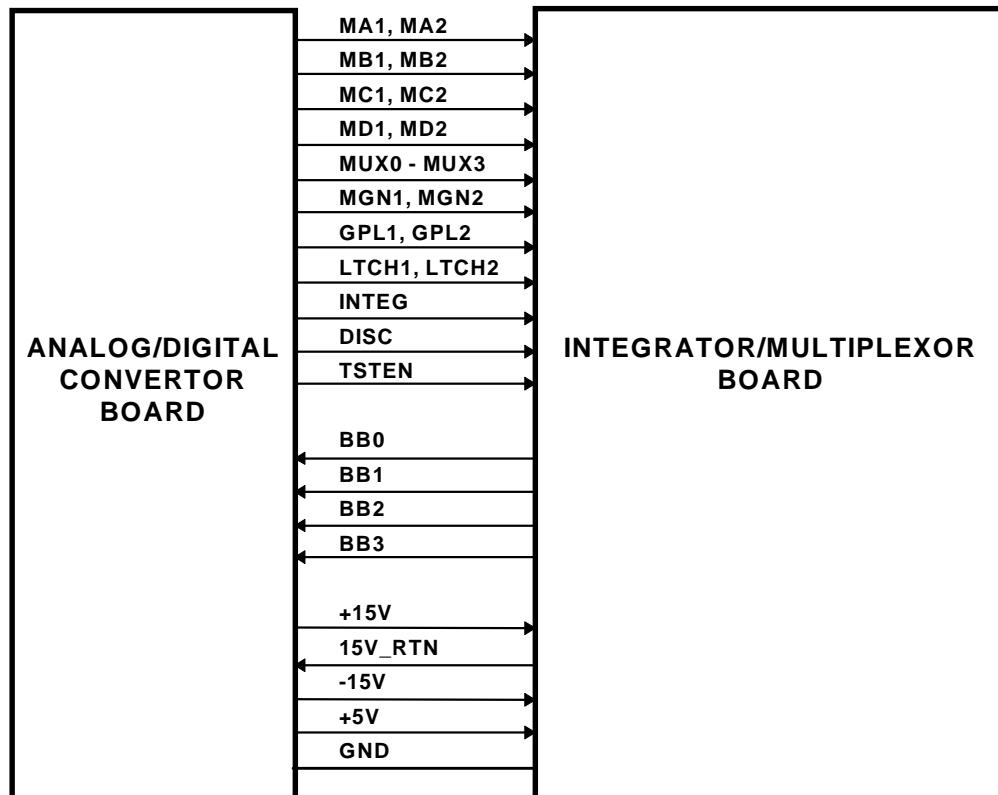


Figure 2-16. Analog Digital Converter Board/Integrator Multiplexor Board Interconnection Diagram

Table 2-22. Analog Digital Converter Board/Integrator Multiplexor Board Interconnection Descriptions

Signal	Signal (see Note 1)	Description	ADC Pins	I/M PINS
MA1, MA2 MB1, MB2 MC1, MC2 MD1, MD2	IN0, IN1 IN6, IN7 IN2, IN3 IN4, IN5	Selects integrator channels to be returned to the Analog/Digital Converter.	JP4-1, JP4-3 JP4-13, JP4-15 JP4-5, JP4-7 JP4-9, JP4-11	JP7-1, JP7-3 JP7-13, JP7-15 JP7-5, JP7-7 JP7-9, JP7-11
MUX0- MUX3	IN8 IN9 IN10, IN11		JP4-17, JP4-19, JP4-21, JP4-23	JP7-17, JP7-19, JP7-21, JP7-23
GPL1, GPL2	IN14, IN15		JP4-29, JP4-31	JP7-29, JP7-31
MGN1, MGN2	IN12, IN13	Controls integrator/multiplexor gains.	JP4-25, JP4-27	JP7-25, JP7-27
LTCH1, LTCH2	IN16	Latches control signals on Integrator/ Multiplexor.	JP4-33 JP4-37	JP7-33 JP7-37
INTEG	IN18	Controls signal integration.	JP4-35	JP7-35
DISC	IN19	Discharges the integrating capacitors.	JP4-39	JP7-39
TSTEN	IN20	Test signal used to verify the operation of the integrators and multiplexor when no X-rays are present.	JP4-41	JP7-41
BB0 BB1 BB2 BB3		Integrator signals to the Analog/Digital Converter.	JP2-2 JP2-6 JP2-10 JP2-14	JP11-2 JP11-6 JP11-10 JP11-14
+15V 15V_RET -15V		Powers the amplifiers and switches of the Integrator/Multiplexor board and powers the Solid State Detector boards.	JP1-5 JP1-4 JP1-3	JP10-5 JP10-4 JP10-3
+5V		Powers the digital circuitry of the Integrator/Multiplexor board.	JP1-2	JP10-2
GND			JP1-1	JP10-1

Note 1. Some signal names are labeled differently on different schematic drawings.

Analog To Digital Board

The Analog To Digital (ADC) board converts analog signals received from the Integrator/Multiplexor board to a digital format.

Analog signals from the Integrator/Multiplexor board are applied to differential amplifiers on the ADC board in four groups of up to 64 channels. Outputs from the differential amplifiers are combined in a final multiplexor consisting of four analog switches. The multiplexed signals pass through a programmable gain amplifier and summing amplifier before being applied to an A/D converter. A one volt fixed DC offset is inserted at the summing amplifier to insure that no

Section 2 - Functional Description

channels ever go negative. The A/D converter converts the analog signal into 16 bit parallel data for processing by a Digital Signal Processor.

The ADC board uses a Motorola 56000 Digital Signal processor to generate all the control signals necessary for the detector array assembly. This processor is used to generate pseudo channels when a low resolution (4mm) array is used. A pseudo channel is generated between every low resolution channel before the data is sent to the computer. This makes the low resolution array data the same as the high resolution array data. The same software can now be used with all systems. This processor also provides a high speed serial data link to the computer.

Note: Jumper JP5, on the ADC board, is used to select between high and low resolution. When the jumper is *in* the board is configured for *high resolution*, when the jumper is *out* the board is configured for *low resolution*.

Power

The ADC board receives +/-15V and +7V from the C-arm Interface board. The +/-15V is passed through this board to the Integrator/multiplexor board. It is also reduced to +/-12V by series regulators to power op-amplifiers and analog switches located on this board. The +/-15V also generate +/-5V to power the analog-to-digital converter circuit. The +7V is reduced to +5V to power the digital section of this board. The +5V is also passed on to the Integrator/Multiplexor board.

Interface Connections

Figure 2-17 shows the interconnections between the Analog/Digital Converter board and the Integrator/Multiplexor board. Table 2-23 describes the interface signals and identifies the interconnection connector and pin assignments.

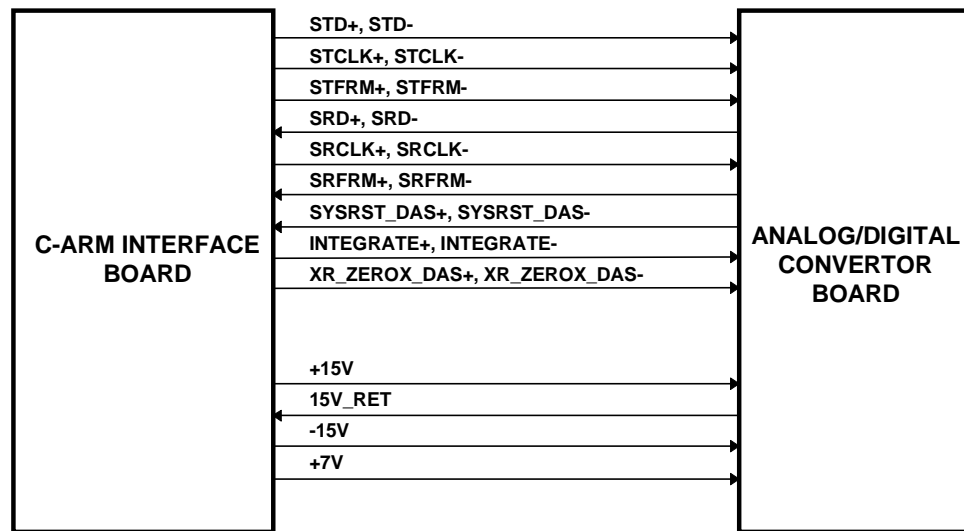


Figure 2-17. C-Arm Interface Board/Analog/Digital Converter Board Interconnection Diagram

Table 2-23. C-Arm Interface Board/Analog/Digital Converter Board Interconnection Descriptions

Signal	Description	C-Arm1 Pin	ADC2 Pin
STD+ STD-	Synchronous data to the Analog/Digital Converter board.	JP10-3 JP10-4	P1-12 P1-13
STCLK+ STCLK-	Synchronizes data to the Analog/Digital Converter board.	JP10-6 JP10-7	P1-15 P1-16
STFRM+ STFRM-	Synchronizes DSP Communications.	JP10-9 JP10-10	P1-18 P1-19
SRD+ SRD-	Synchronous Data from the Analog/Digital board.	JP10-12 JP10-13	P1-3 P1-4
SRCLK+ SRCLK-	Synchronizes data from the Analog/Digital Converter board.	JP10-15 JP10-16	P1-6 P1-7
SRFRM+ SRFRM-	Synchronizes DSP Communications.	JP10-18 JP10-19	P1-9 P1-10
SYSRST_DAS+ SYSRST_DAS-	Resets the Analog/Digital Converter board.	JP10-21 JP10-22	P1-21 P1-22
INTEGRATE+ INTEGRATE-	Data integration signal. Generated by the C-Arm Interface board.	JP10-24 JP10-25	P1-24 P1-25
XR_ZEROX_DAS+ XR_ZEROX_DAS-	AC line zero-crossing signal used for system wide synchronization. Generated by the C-Arm Interface board.	JP10-27 JP10-28	P1-27 P1-28
+15V -15V 15V_RET +7V	Powers the Data Acquisition System.	JP10-32 JP10-33 JP10-36 JP10-37 JP10-30 JP10-31 JP10-34 JP10-35 JP10-38 JP10-39	P1-32 P1-33 P1-36 P1-37 P1-30 P1-31 P1-34 P1-35 P1-38 P1-39
CONTINUITY	Emergency shutdown daisy chain (grounded on ADC board)	JP10-1	P1-1

Notes: 1. C-Arm = C-Arm Interface board
2. ADC = Analog/Digital Converter board.

POWER MODULE

The Power Module provides the AC and DC voltages required by the QDR 4500 Operator's Console computer system and Scanner. It is located in an enclosure in the bottom of the

Section 2 - Functional Description

Operator's Console and consists of a Main Power circuit breaker, a Power On indicator, an AC line input isolation transformer, a Power Control Panel, a Power board, a +/-15VDC power supply board, a 24VDC power supply board, and a computer power outlet.

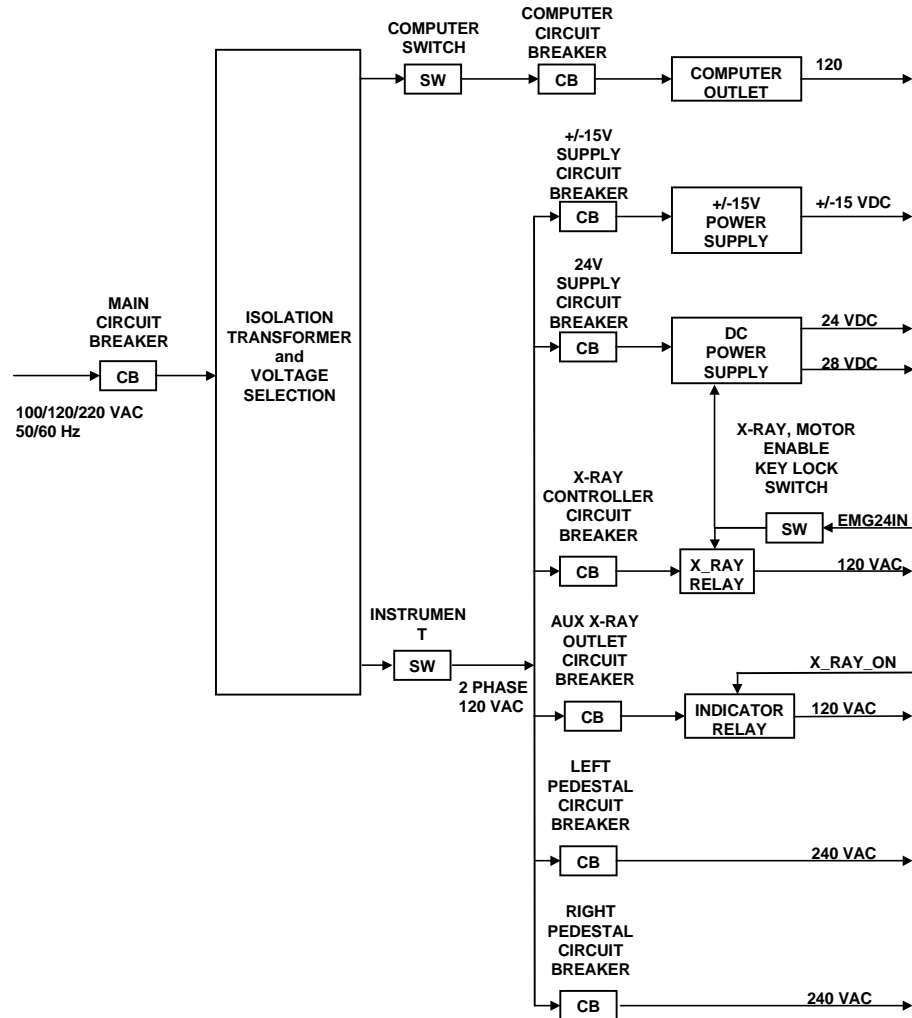


Figure 2-18. Power Module Block Diagram

The Main Power circuit breaker, Power On indicator, and computer power outlet are located on the back of the Power Module near the bottom. The isolation transformer, Power Board, and +/-15VDC and 24VDC power supply boards are located within the Power Module enclosure.

The Power Control Panel is the Power Module's right side panel and it contains several circuit breakers, switches, and indicators. It also contains a power outlet for connecting an external X-Ray On light. Separate power switches are provided for the computer and the Scanner allowing the computer to be operated separately. A key lock switch is used to switch power on/off to the Scanner's X-Ray unit, and to the stepper motors. The Power Module provides over current

protection for each power line using resettable circuit breakers with visual fault indication located on the Power Control Panel.

The Power Board contains the connectors to all power supplies, circuit breakers, and key lock switch. It also contains two relays that switch power to the Scanner's X-Ray unit and to an external X-Ray On light. Indicators on the Power board, provide visual indication of the status of the +15, -15, and 24VDC voltages and of the X-Ray enable signal.

Figure 2-18 provides a block diagram of the Power Module. Table 2-24 identifies the Power Module connectors.

Table 2-24. Power Control Board Connectors

Connection	Connector
AC power in from transformer	P17
AC power to Computer circuit breaker	P15
AC power to Power Strip (Computer, Monitor, Printer power)	P16
AC power to 15V power supply circuit breaker	P5
AC power to 15V power supply	P4
+/-15VDC from 15V power supply	S2
AC power to DC power supply circuit breaker	P7
AC power to DC power supply	P6
Enable signal to DC power supply and +24VDC from DC power supply	S1
X-Ray Enable Key switch	S4
AC power to X-Ray Controller circuit breaker	P11
AC power to X-Ray Controller	P12
AC power to Aux X-Ray Lamp Outlet circuit breaker	P13
AC power to Aux X-Ray lamp outlet	P14
AC power to Left Pedestal circuit breaker	P8
AC power to Right Pedestal circuit breaker	P10
AC power to TZ Drive Controller (Left/Right Pedestal)	P9
DC voltages to Scanner and Emergency signal from Scanner	S3

SECTION 3

INSTALLATION

REQUIRED TOOLS

When installing the QDR 4500, a tool kit that includes the following items is required:

- Assortment of both flat-blade and Phillips screwdrivers
- Assortment of needle-nose and diagonal cutting pliers
- Socket drivers (full set including 1/4", 3/8", 7/16", 1/2" and 3/4")
- Open-end wrenches (full set including 3/8", 7/16", 1/2", 9/16", 5/8" and 3/4") and an adjustable wrench
- Hex driver (Allen wrench) set including sizes 1/16", 5/64", 3/32", 7/64", 1/8", 9/64", 5/32", 3/16", 7/32" and 1/4"
- Digital level, precise to ± 0.1 degree
- Oscilloscope and digital multimeter
- Survey meter (Victoreen model 450P or equivalent)
- X-ray leakage test tool, #099-0566
- Measuring tape, approx. 3.7 meters (12 feet)
- Beam alignment tool (010-0923)

REQUIRED DOCUMENTATION

The following documents are required:

- *QDR 4500 User's Guide*
- Computer manual
- Printer manual
- DOS Operating System manual (for DOS systems)
- *Introducing Microsoft Windows® 95* (for Windows 95 systems)
- Optical Disk Drive manual (when installed)
- *The Radiation Measurement Report* (CSD-0026-01)

ROOM AND DOORWAY SIZE

Use the following table to prepare for the move. Also see Figure 3-1 through Figure 3-4 for more details.

Model	Minimum Room Size	Minimum Doorway Width
SL, C	2.44m (8.0ft) x 2.44m(8.0ft)	0.77m (30.0in)
A, W	2.44m (8.0ft) x 3.05m (10.0ft)	0.77m (30.0in)

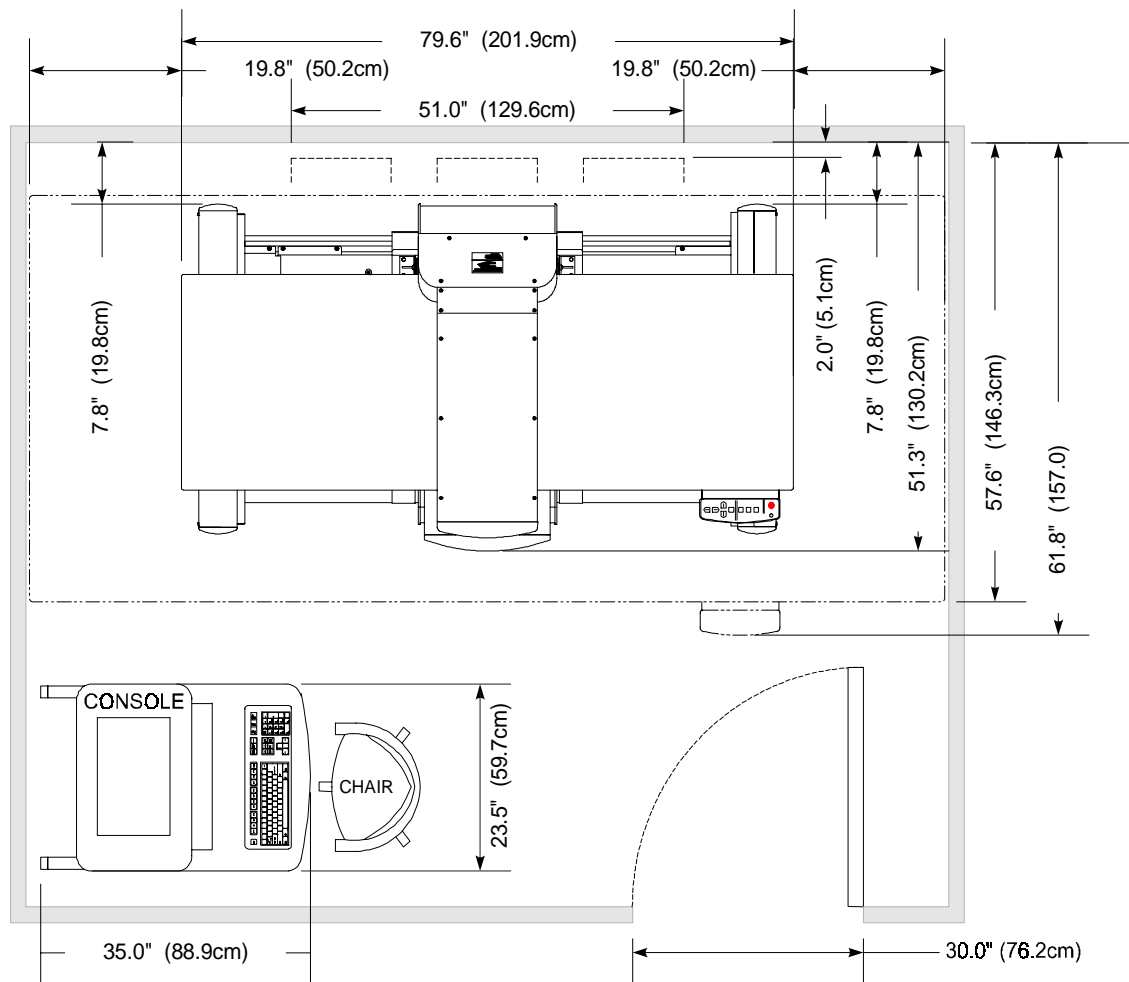


Figure 3-1. Room Layout (4500A)

Section 3 - Installation

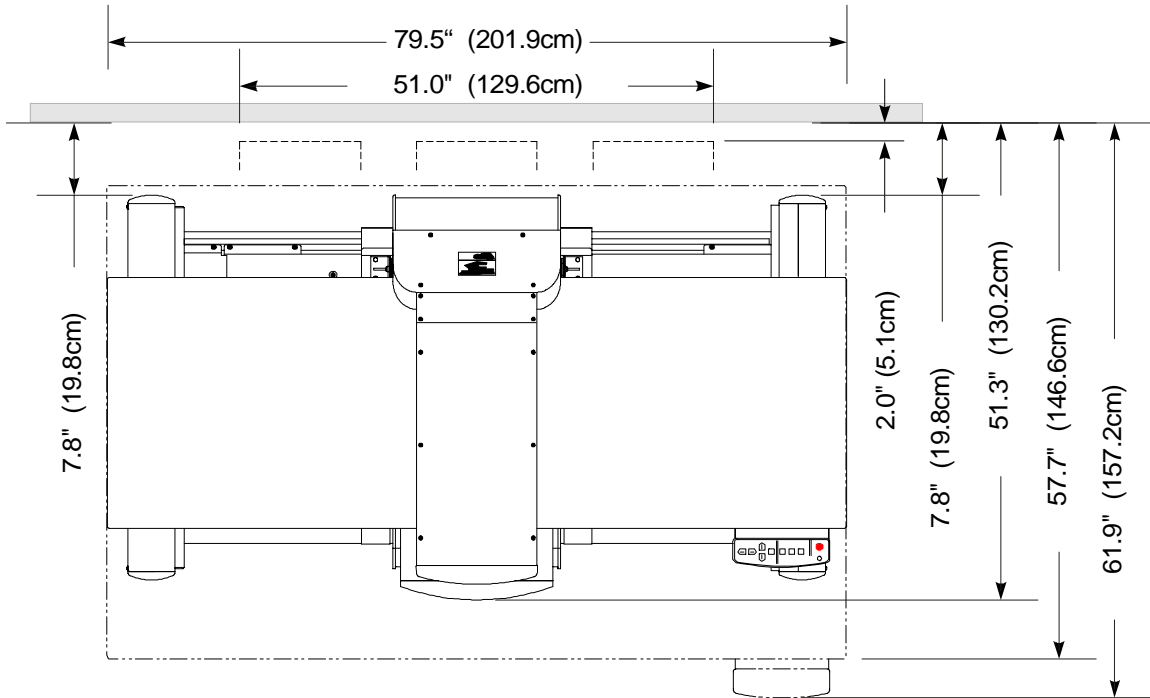


Figure 3-2. System Dimensions (4500SL)

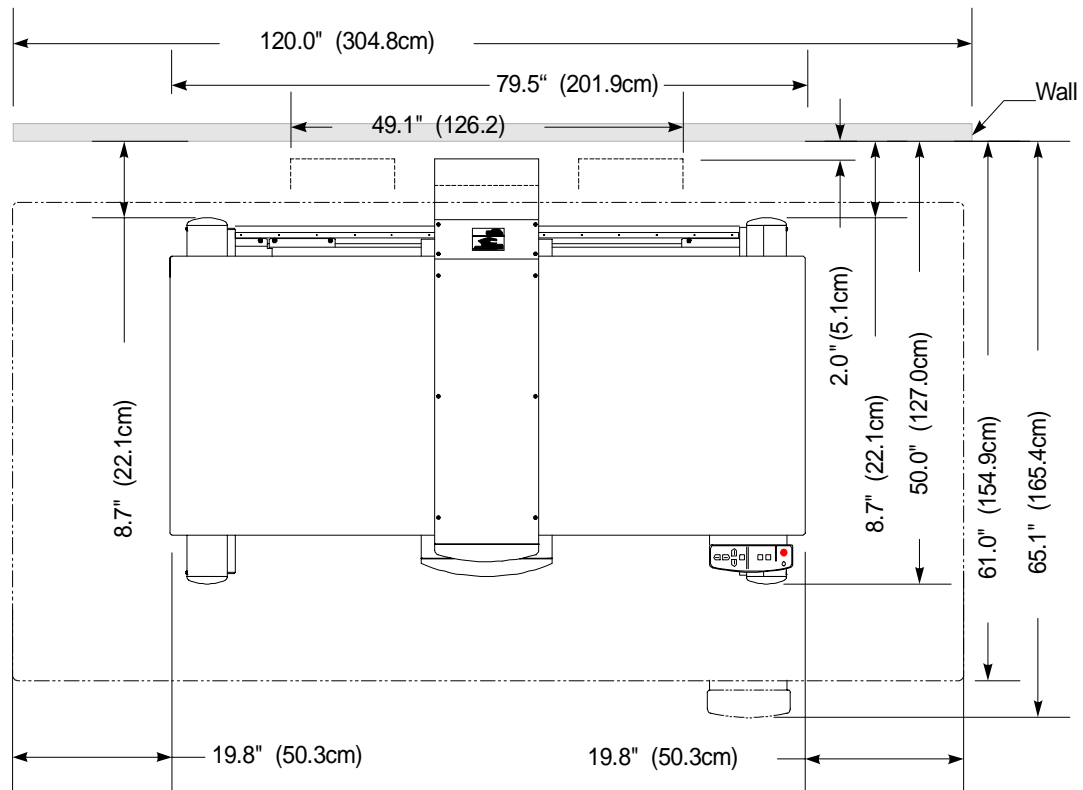


Figure 3-3. System Dimensions (4500W)

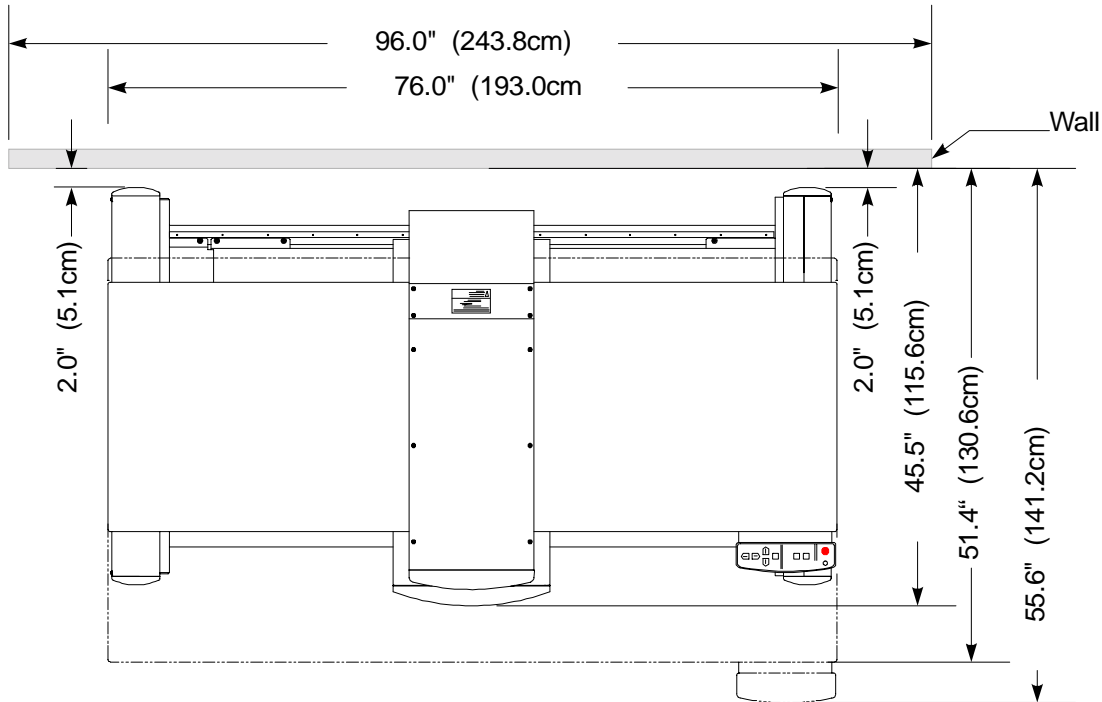


Figure 3-4. System Dimensions (4500C)

The Operator's Console may be up to 50ft (15.24m) away from the Scanner, but since leakage and scatter radiation levels are extremely low, it can be safely located in the same room with the QDR 4500 itself.

ARRANGE FOR HELP

Moving the unit to its final location requires at least two able-bodied people to direct the machine, hold doors and lift heavy parts. The following table gives some representative weights.

	QDR 4500 Model				Computer, Printer, Monitor	Power Console
	A	SL	W	C		
Weight (lb)	800	700	700	660	100	100
(kg)	365	320	320	300	45	45

INSPECT FOR VISIBLE SHIPPING DAMAGE

Inspect the exteriors of all crates and boxes for shipping damage, and bring any damage discovered to the attention of the customer's Shipping/Receiving department before proceeding.

Section 3 - Installation

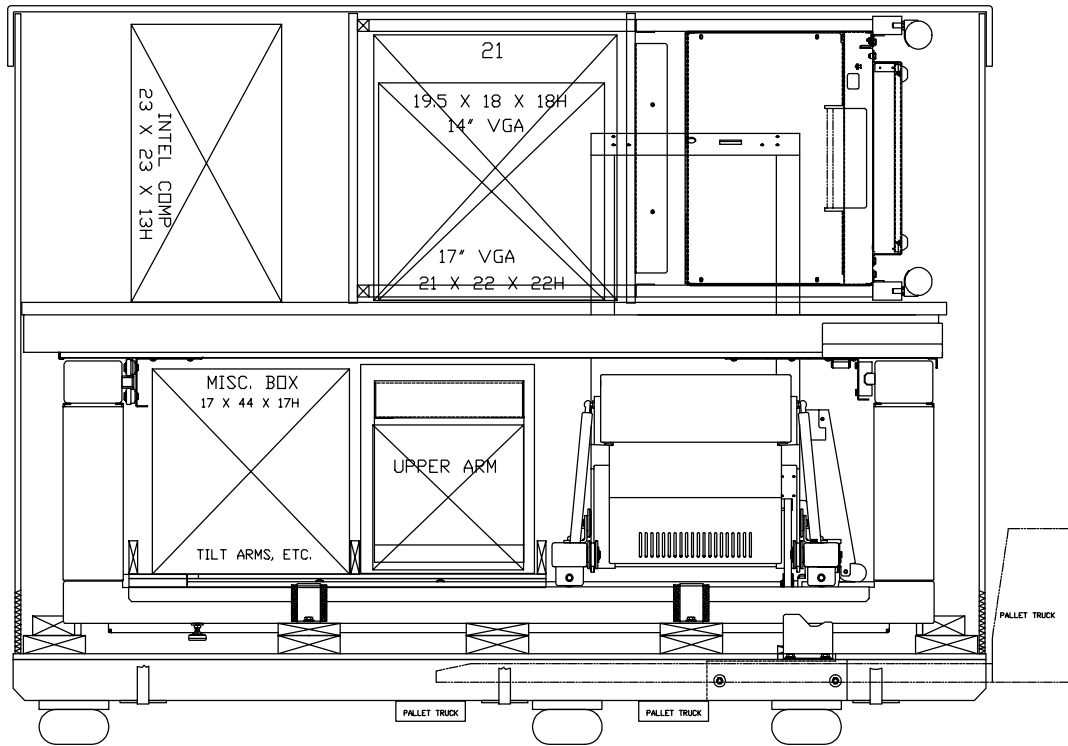


Figure 3-5. Crated Unit (QDR 4500A and QDR 4500SL)

UNCRATE UNIT

Remove the unit from the crate as described below:

1. Cut the strapping that holds the packaging together.
2. Remove the cardboard cap by lifting it up and off.
3. Remove the cardboard sleeve by lifting it straight up and off. Be careful not to scratch the unit.
4. Remove the wooden table shelf and the boxes packed with the unit.

Note: There is a metal cross brace attached to the wooden table shelf. Remove and save this cross brace as it is used later in the installation.

5. Verify that the serial numbers on the crate, computer pallet, scanner and console all match.

INSPECT FOR HIDDEN SHIPPING DAMAGE

Open all crates and boxes, and check for signs of hidden damage. Bring any damage discovered to the attention of the customer's Shipping/Receiving department.

TAKE INVENTORY

Using the following check list, take inventory of the contents of all crates and boxes, and confirm that all of the expected items have been received. Report any discrepancies to Hologic.

Installation Inventory Check List

(Quantities are one (1) each unless otherwise specified)

- | | |
|---|---|
| <input type="checkbox"/> Main QDR 4500 Assembly | <input type="checkbox"/> Upper C-Arm Assembly |
| <input type="checkbox"/> Computer and Keyboard | <input type="checkbox"/> VGA Monitor |
| <input type="checkbox"/> Black & White or Color Printer | <input type="checkbox"/> Knee (Block) Elevation Pad |
| <input type="checkbox"/> QDR Spine Phantom | <input type="checkbox"/> Foot Restraint |
| <input type="checkbox"/> Tabletop Pad | <input type="checkbox"/> QDR 4500 User's Guide |
| <input type="checkbox"/> Printer Manual | <input type="checkbox"/> Printer Paper (B & W or Color) |
| <input type="checkbox"/> 3.5" Floppy Disks (2 boxes) | <input type="checkbox"/> System Power Cable |
| <input type="checkbox"/> Key (for enabling X-rays) | <input type="checkbox"/> Miscellaneous Hardware Box |
| <input type="checkbox"/> Miscellaneous Cables Box | |

MEASURE PATH TO FINAL DESTINATION

Contact the department receiving the unit, and request that a representative show you the room where the unit is to be installed. As you make your way from the loading dock to the room, measure all doorways and openings including any elevator on which you must travel. Look for other obstacles (thresholds, steps, sharp corners, etc.) which could cause a problem during transport.

A QDR 4500A, or QDR 4500SL, fits through any doorway at least 30 inches (76.2cm) wide and 81 inches (206cm) high, and hallways 45 inches (114cm) wide. All measurements are inside dimensions.

A QDR 4500W, or QDR 4500C, fits through any doorway or hallway at least 30" (76.2cm) wide, and 81" (206cm) high. All measurements are inside dimensions.

Short Doorway

If a QDR 4500 (any model) must be moved through a doorway that is not at least 81" (206cm) high, the table top can be removed. This allows the unit to fit through a doorway 79" (201cm) high (inside dimension). See the instructions for removing the table top below.

Narrow Hallway

If a QDR 4500A, or QDR 4500SL, unit must be moved through a hallway that is not at least 45" (114cm) wide, the C-arm can be removed. This allows the unit to fit through a hallway 29" (74cm) wide (inside dimension). See the instructions for removing the C-arm below.

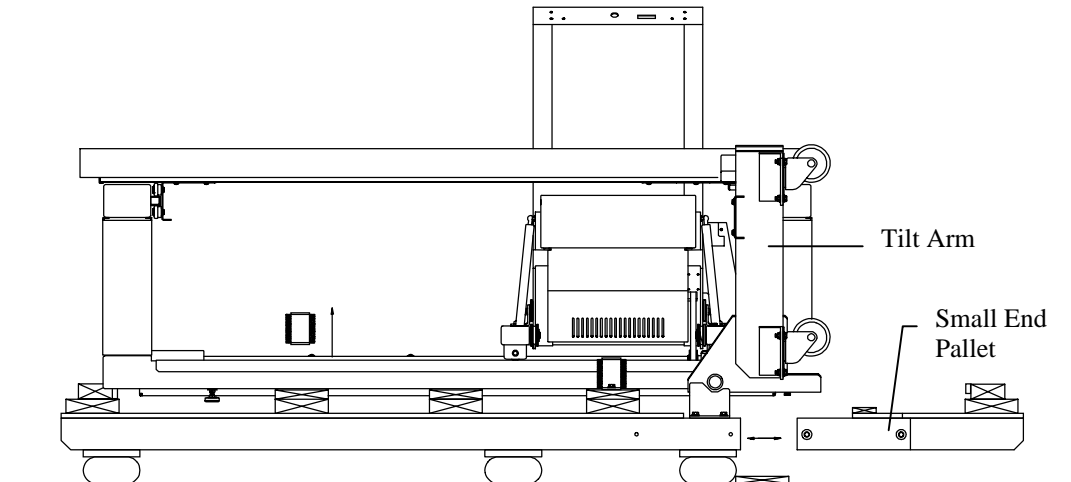


Figure 3-6. Uncrated Unit (QDR 4500A and QDR 4500 SL)

REMOVE TABLE TOP (IF NECESSARY)

Note: It is not necessary to remove the table top if the doorway(s) the unit must go through is at least 81" (206cm) high (top to bottom inside dimension). Removing the table top allows the unit to fit through a doorway 79" (201cm) high.

The table top can be removed before taking the unit off the pallet. Follow the procedure below to remove the table top:

1. Remove the table pad, and remove the right table rail end cover (2 Phillips screws located on the right end). This cover slides straight out the end.
2. Remove the two screws (Phillips) that secure the table top in place (located on top of the table near the rear center), and slide the table to the left far enough to access the Table X bearing blocks.
3. Referring to Figure 3-7, remove the right side front endcap (3 Phillips screws).
4. Remove the back Phillips screw from the right side cover (of the table X drive assembly) and slide the cover out from the front.
5. Unplug the cable to the Motor Controller board.
6. Refer to Figure 3-7. Disconnect the stainless steel cable guard (2 screws), and remove the Table X drive attachment bracket (4 bolts and 2 nuts).
7. Remove the left rail stop (1 counter sunk screw, located next to the left side front endcap) to allow the table top to be rolled off from the front.
8. Remove the 8 Allen screws (6mm) holding the table X drive bearing blocks.

9. Remove the table top by carefully sliding it off the front (requires two people). **Be careful not to slide the bearing blocks off the rail.**
10. Refer to Figure 3-7. Install the right angle bracket (found in the miscellaneous hardware kit) to hold the bearing blocks and X drive bracket, in place while the scanner is moved. If this bracket is not available, tape the bearing blocks, and X drive bracket, in place.

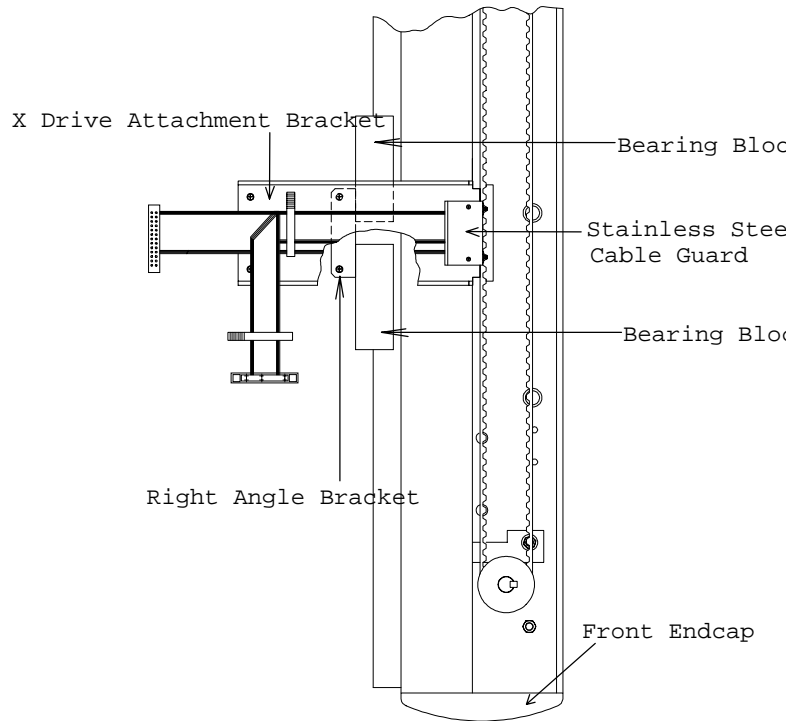


Figure 3-7. Table X Drive

REMOVE QDR 4500A, OR SL, C-ARM (IF NECESSARY)

Note: It is not necessary to remove the C-arm if the hallway(s) that the unit must go through is at least 45" (114cm) wide (side to side inside dimension). Removing the C-arm allows the unit to fit through a hallway 29" (74cm) wide.

The C-arm Carriage Assembly can be removed before taking the unit off the pallet. Follow the procedure below to remove the C-arm:

1. Remove the 2 carriage-to-base shipping brackets (see Figure 3-12).
2. Remove the table locking "L" bracket located on the left side of the scanner (see Figure 3-12).
3. Move the table forward, remove the C-Arm Interface board cover, and remove the tank cover. Then move the table back.
4. Remove the X-Ray Controller Assembly (4 Phillips screws). See the *Remove and Replace Procedures* section, of this manual, for detailed removal information.

Section 3 - Installation

5. Remove the Tank Assembly (leave Filter Drum Assembly attached). See the *Remove and Replace Procedures* section, of this manual, for detailed removal information.
6. Disconnect the cables and Nylatrac mounting hardware, and tape Nylatrac and cables in the bottom of the scanner so that they are secure.
7. Disconnect the ribbon cable from the Arm R Motor Controller board.
8. Remove the Arm Y bearing blocks at the rear of the arm.
9. Remove the bracket that connects the C-arm to the Arm Y belt.

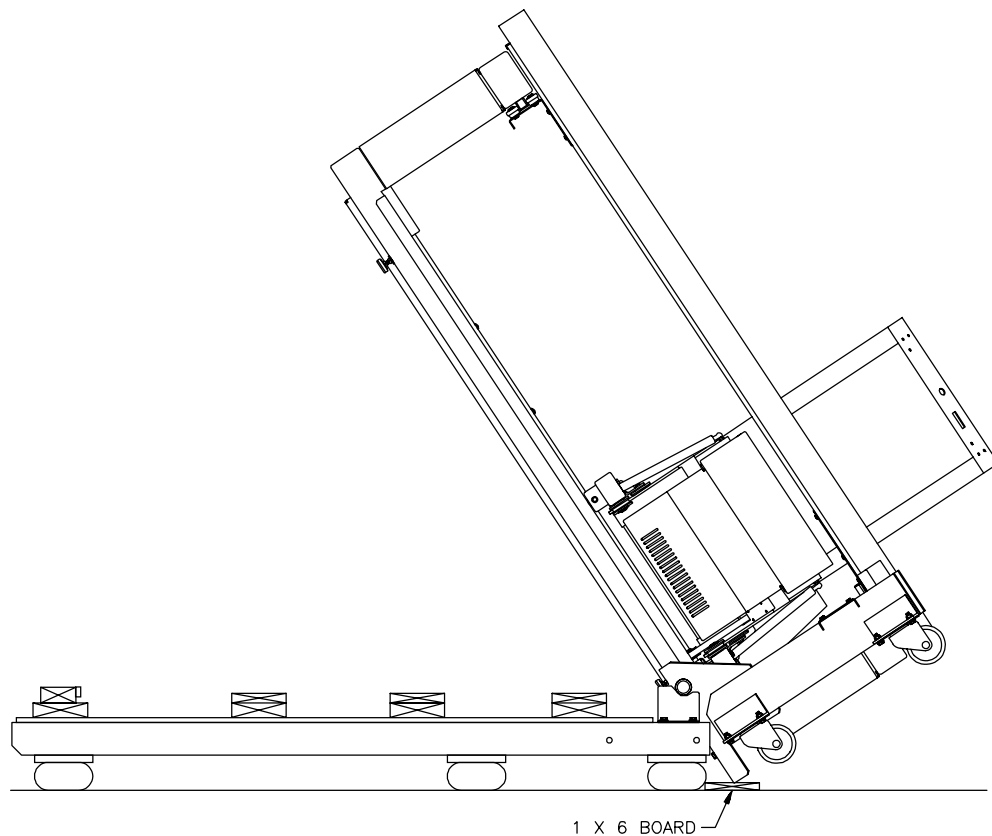


Figure 3-8. Tipping Unit

10. Lift the C-arm carriage up and out of the scanner unit.
11. Tape, or tie wrap, the bearing blocks to prevent them from sliding off the end of the rail.

PREPARING THE TABLE TOP FOR MOVING (SL only)

WARNING: Do not tilt the unit to the vertical position until the Table End Bracket is properly installed (step 4 below).

Before the SL model can be tilted to vertical, you must slide the table to the left and clamp it so it clears the floor when the unit is tilted to vertical. Do the following:

1. Remove the table top pad.
2. Remove the three Phillips screws holding the table top. There are two at the left corners and one at the right back corner, looking down from the top.
3. Slide the table top to the left until it clears the control panel.
4. Referring to Figure 3-12, adjust the Table End Stop as pictured.

MOVE UNIT TO DESTINATION (VERTICAL POSITION)

Follow the procedure below to move the unit:

1. Remove the small end pallet.
2. Loosen the end brackets (this is necessary in order to mount the tilt arms).
3. Locate the tilt arms packed with the unit (see Figure 3-6), and mount the arms on the end of the unit using the jam nuts on the leveling feet and end bolts. Tighten the end brackets.
4. Install the cross brace (shipped screwed to the wooden table shelf) being careful not to scratch the paint.
5. Remove the four hold-down brackets (see Figure 3-12).
6. Remove the remaining corner brace.
7. Lock the casters.
8. Tip the unit on end as shown in Figure 3-9 (a 1 x 6 board, or equivalent, can be used to protect the floor).
9. Move the unit, and everything that shipped with it, to the destination room.

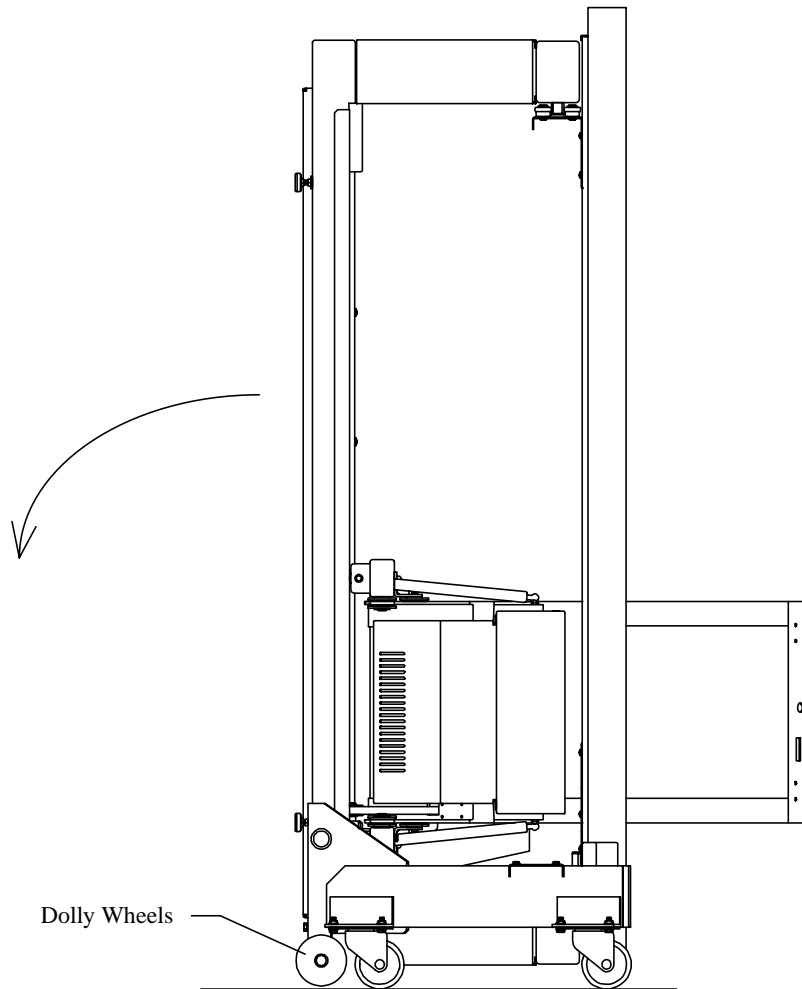


Figure 3-9. Moving and Tilting the Unit Down

MOVE UNIT TO DESTINATION (HORIZONTAL POSITION)

You may have to lower the unit to a horizontal position to move it to its destination if the ground clearance is not sufficient. To do this, use the auxiliary caster assemblies and mounting hardware shipped with the unit and follow these steps:

1. Follow the procedure in the previous section for moving the unit in the vertical position (steps 1-8).
2. Using the hardware shipped with the unit, reference Figure 3-10 to install the auxiliary casters to the bottom of the unit.
3. Carefully tilt the unit down.

WARNING: You should not do this alone. This requires two people.

4. Move the unit to its destination.

Note: Temporarily remove the tilt arm assembly if the unit is too wide.

5. Carefully tilt the unit back to its vertical position (two people required). If the room is small, the dolly wheels may have to be installed (see Figure 3-9) to tilt the unit down and move sideways simultaneously.
6. Remove the auxiliary casters from the bottom of the unit and set aside.
7. Reinstall the hex bolts and flat washers into the rivet nuts.

Note: Ship all tilt arm assemblies and caster bar assemblies back to Hologic in the box provided. Discard the tilt arm cross brace.

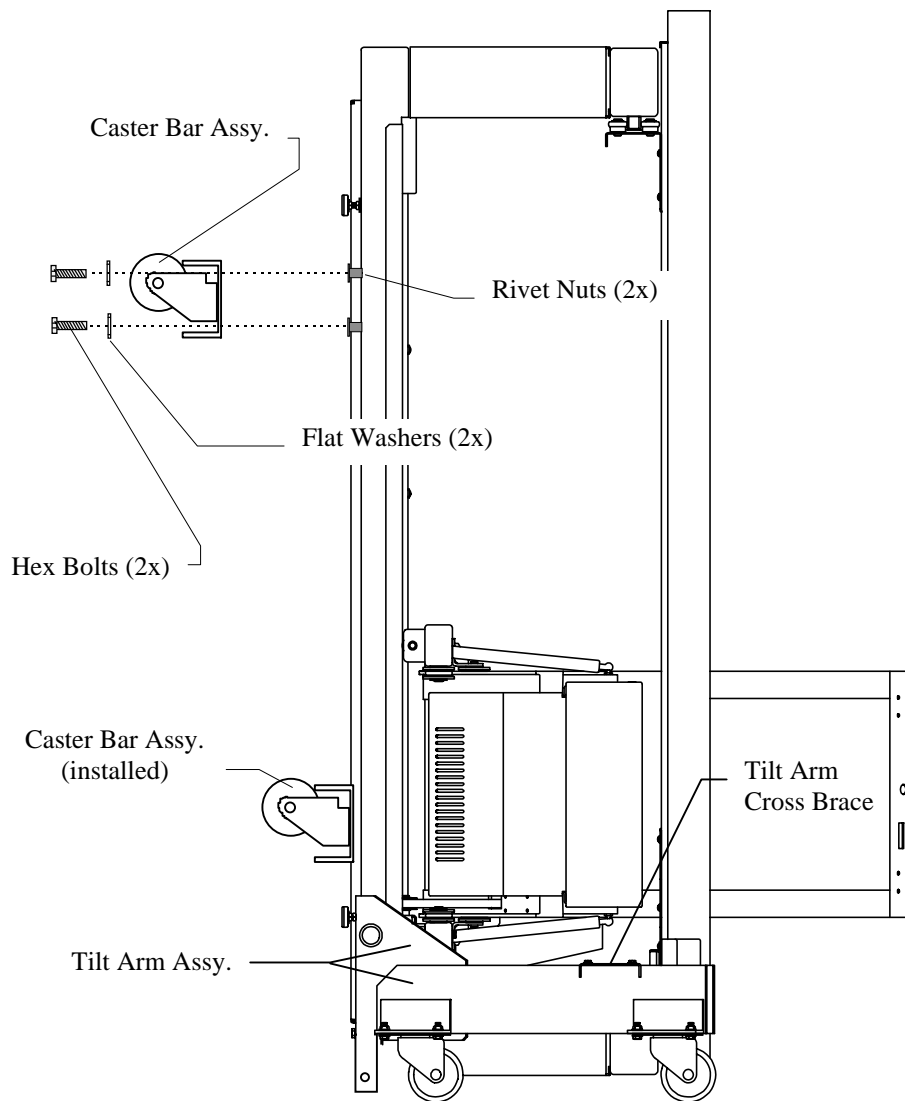


Figure 3-10. Auxiliary Horizontal Caster Installation

SET UP UNIT

Follow the procedure below to set up the unit:

1. Carefully tilt the unit down (if the room is tight, install the dolly wheels supplied to tilt the unit down and move sideways simultaneously).

WARNING: The unit will feel heavier when putting it down than it felt when tipping it up. This is because the pivot point is different.

2. Remove the tilt arms and position the unit in its final location in the room.
3. Level the unit.
4. Remove the 2 carriage-to-base shipping brackets. Refer to Figure 3-13.
5. Remove the table end stop. Refer to Figure 3-12.

Note: This step applies only to QDR 4500A and QDR 4500W.

6. Remove the table locking "L" bracket located on the left side of the scanner (see Figure 3-11).

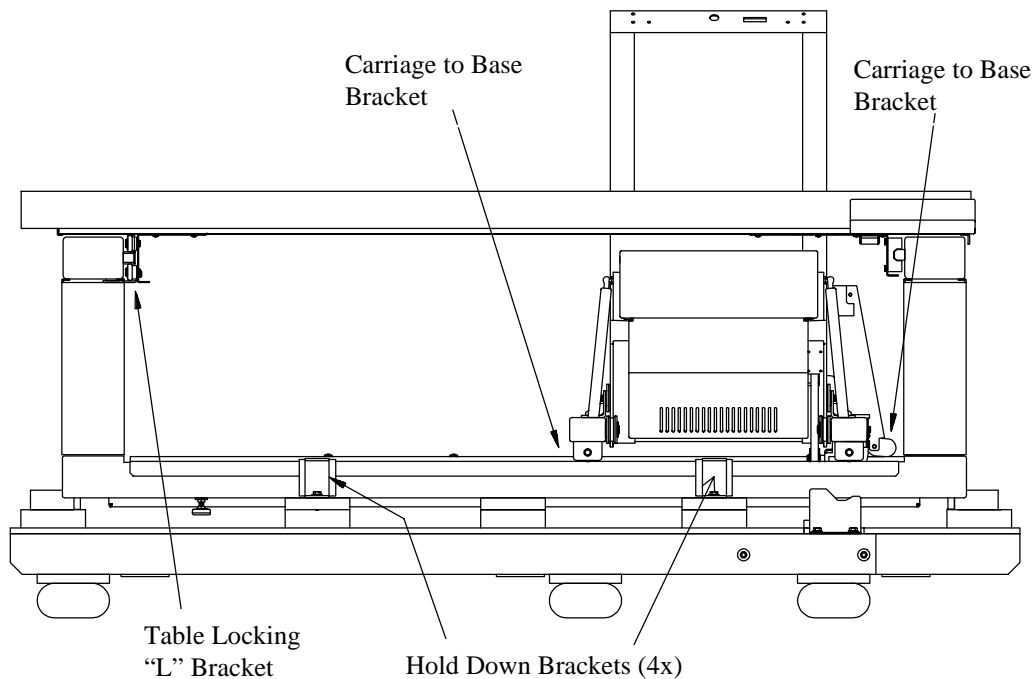


Figure 3-11. Shipping Bracket Locations (QDR 4500A and SL)

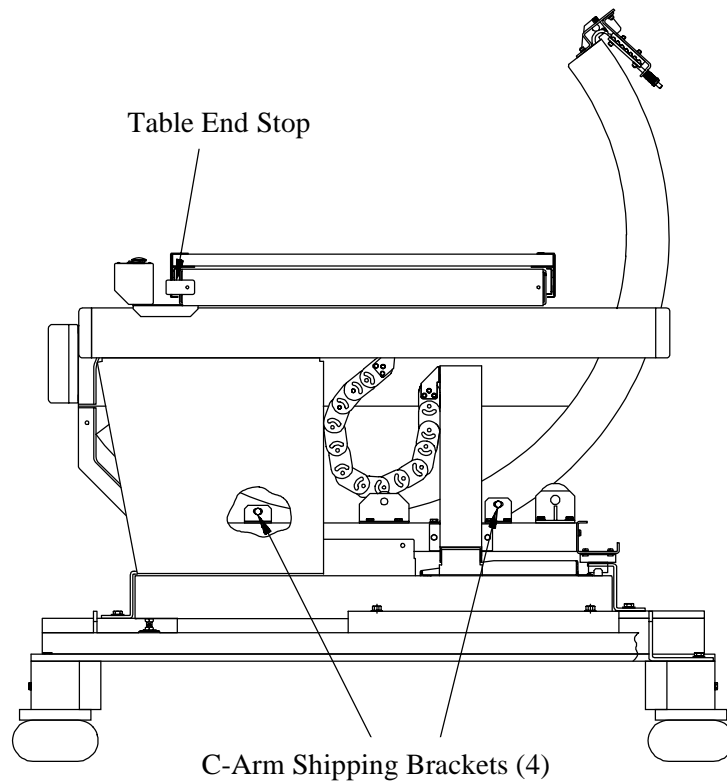


Figure 3-12. Shipping Bracket Locations (QDR 4500A and SL)

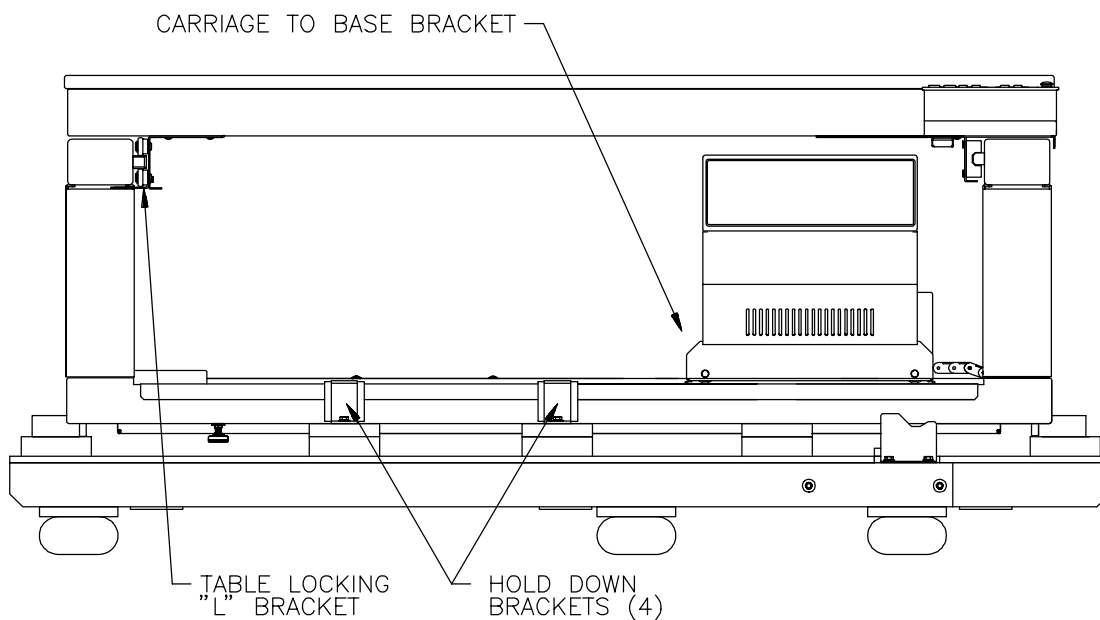


Figure 3-13. Shipping Bracket Locations (QDR 4500W and C)

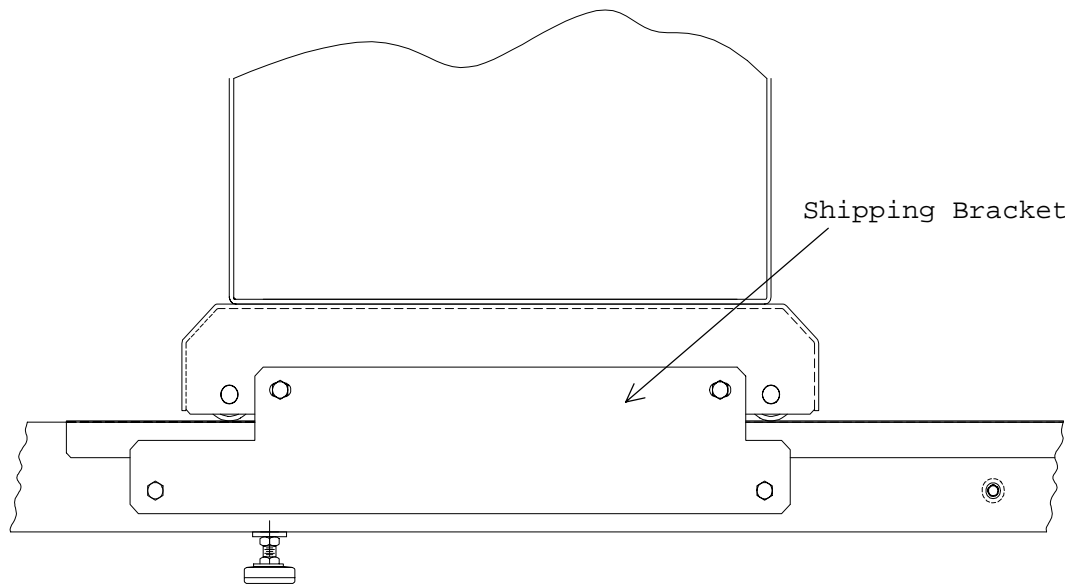


Figure 3-14. Shipping Bracket Location (QDR 4500W and C)

INSTALL QDR 4500A, OR QDR 4500SL, UPPER C-ARM

Follow the procedure below to install a QDR 4500A, or QDR 4500SL, upper C-arm assembly:

WARNING: Do not remove C-arm shipping brackets (Figure 3-12) until done.

1. Refer to Figure 3-15. Reposition the belt tensioning mechanism. The belt tensioning mechanism is turned around to facilitate shipping and moving the assembly (the shipping bracket is not used after the mechanism is repositioned).
2. Remove the back C-arm cover (2 Phillips screws).
3. Remove the two 1/2" bolts that lock the upper C-arm in place (left in place during shipment).
4. Remove the screws for the C-arm shoulder cover (left in place during shipment).
5. Remove the two C-arm retaining brackets (to allow upper C-arm to be set in place).
6. Remove the cover from the upper C-arm.
7. Install the upper C-arm onto the lower C-arm (tilt the front of the upper C-arm up to slide it in place).
8. Install the retaining brackets.

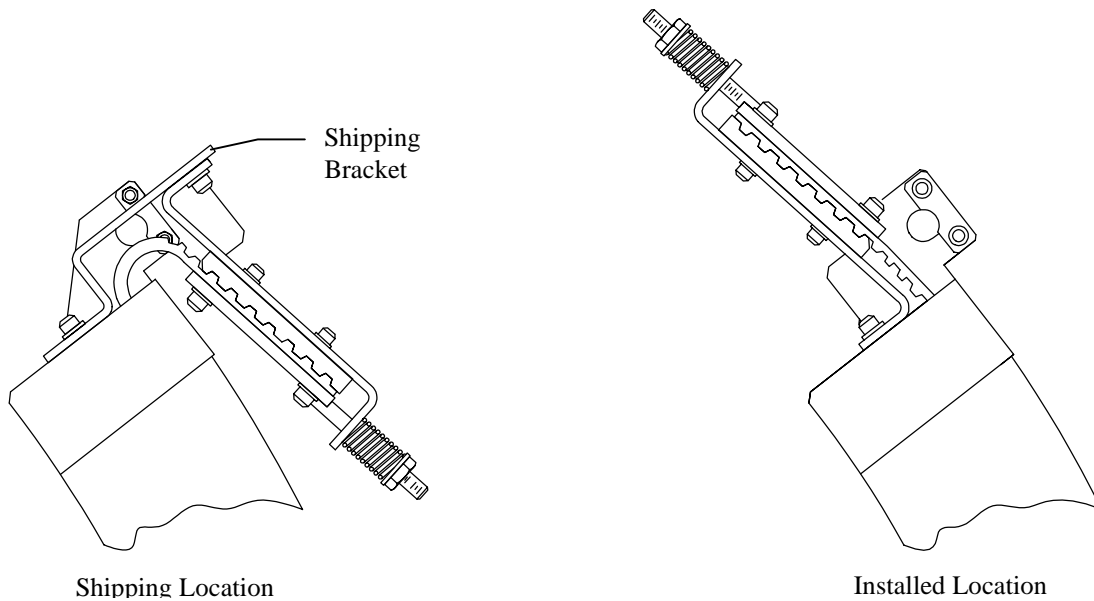


Figure 3-15. Repositioning the Belt Tensioning Mechanism

9. Install the two 1/2" bolts.
10. Remove the C-arm top cover.
11. Install the counter-weights.
12. Connect the two cables from the upper C-arm to the lower C-arm.
13. Install the 1/2" x 13" trim plate that mounts (on the front) between the upper and lower C-arm (make sure trim plate is aligned to front of C-Arm).
14. Replace the back C-arm cover.
15. Remove the four C-arm shipping brackets (see Figure 3-12). Save these brackets, they are needed if the tank is ever removed.
16. Measure from the bottom of the C-arm to the top of the tank cover in all four corners. All measurements should be within 1/8". If not, perform the *C-Arm Parallelism Adjustment* on page 4-3.
17. Ensure that the scanner is level.

INSTALL QDR 4500W, OR QDR 4500C, C-ARM

Follow the procedure below to install a QDR 4500W, or QDR 4500C, C-arm assembly:

1. Carefully place the C-arm on the bottom bolts. Tilt the arm back slightly and slip the two cables through the openings, then tilt the arm forward until the front bolts are in place.
2. Put 7/16" nuts and washers on all 4 bolts and tighten.
3. Install both cables.

Section 3 - Installation

4. Install the Control Panel and T-beam end caps (QDR 4500W only).
5. Insure that the scanner is level.

INSTALL COMPUTER

Follow the procedure below to install the computer:

1. Set up the computer cart and place the computer, keyboard, monitor and printer in place.
2. Install computer system cables.

INSTALL CABLES

Follow the procedure below to cable the system:

1. Locate the box of cables shipped with the system.
2. Remove two covers on the electronics tray (on the left side facing the machine).
3. Install the cables from the Scanner to the power console and computer.

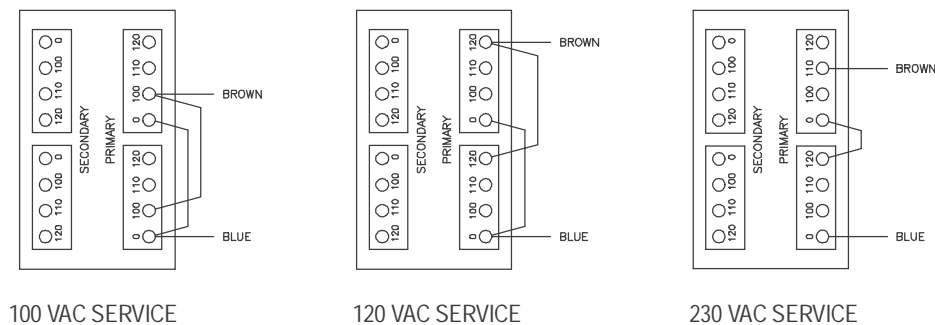


Figure 3-16. Isolation Transformer Taps

SAFETY PRECAUTIONS

There are a number of safety precautions that **MUST** be observed when servicing the QDR 4500 systems.

HIGH VOLTAGE: Voltage levels that can be injurious or fatal are present through the QDR 4500 systems. The line voltage (100, 120, 230 volts) is supplied to the power console. The X-ray source unit contains 140kV as well as other AC and DC voltages. The pedestal motors use 230 volts regardless of the line voltage. Use caution when checking, calibrating and troubleshooting. Always trip the main breaker when replacing components.

X-RADIATION: Service personnel are required to wear a dosimeter. Do not leave the system unattended in SUSQ (SURVEY mode).

ESD PRECAUTIONS: To prevent damage due to ESD (Electrostatic Discharge), you must take precautions when handling components. Remove any charge from your body by wearing an approved and properly grounded wrist strap. Keep PCBs in their ESD protective bag until you are ready to install them. Treat defective PCBs as new to prevent any additional damage.

CHECK POWER LINE VOLTAGE

Hologic strongly recommends that the QDR 4500 be powered from a dedicated power line. See the product specifications in Section 1 for power requirements.

Measure Line Voltage

With an AC voltmeter, before plugging in the QDR 4500, measure the voltage at the outlet the unit will be plugged into. The measured voltage must be within $\pm 10\%$ of the voltage shown on the power label (located where the power cord attaches to the unit). The QDR 4500 has a built-in step up/down isolation transformer which can be re-strapped to accommodate other voltages if necessary. See Figure 3-16 for the most common configurations of the isolation transformer.

There are two standards for conductor color coding. The North American standard specifies the BLACK conductor as LINE and the WHITE as NEUTRAL, while the International standard defines the BROWN conductor as LINE and the BLUE as NEUTRAL. On newer units, the primary side of the isolation transformer is on the left and the secondary is on the right.

Note: Be sure to change the label if you restrap the transformer.

Note: Enter this information into *The Radiation Measurement Report* (see page 3-28).

Measure Isolation Transformer Secondary Voltage

After plugging in the instrument and switching on the main breaker, measure the voltage at the accessory outlet located at the bottom rear corner of the power console with an AC voltmeter.

Note: Do not try to measure the voltage at the "AUXILIARY X-RAY ON" outlet, as this outlet is only energized when X-rays are on. The voltage should be between 110 VAC and 130

VAC. If the voltage is out of this range, recheck the voltage at the wall outlet, and the strapping of the isolation transformer as shown Figure 3-16.

CHECK TUBE KV PEAK POTENTIAL

Proper operation of the QDR 4500 requires that the X-ray tube generate X-ray pulses of 80kVp, 100kVp and 140kVp, all $\pm 10\%$. The peak potential check must be performed at installation time and whenever the X-ray source or X-ray controller is repaired or replaced. Because it would be very dangerous to directly monitor the kVp potentials, a 10,000 to 1 voltage divider circuit is utilized inside the High Voltage Power Supply/Source (HVPS/S). By monitoring this divided voltage, one can determine the peak potentials being impressed on the X-ray tube. The monitoring can be done on the barrier strip on top of the X-ray source.

WARNING: Even though the test voltage is low, there are elevated voltages near and around the test points.

1. Remove the tank cover (2 Phillips screws). For QDR 4500A and QDR 4500SL systems, raise the table to its upper limit for better access to the tank.
Set up the scope as follows:
Channel 1: 2V/div (0.2V/div if using x10 probes)
Channel 2: 2V/div (0.2V/div if using x10 probes)
Time base: 5.0ms/div
Trigger on line (positive slope)
Set vertical mode to add and invert channel 2.
Connect Channel 1 to TB1-PIN 12 (on the tank)
Connect Channel 2 to TB1-PIN 11 (on the tank)
2. Ground both channels and move the trace to the bottom of the screen. Remove the grounds and go to DC coupling.
3. Instrument power, computer power and the X-ray enable key should all be on.
4. From the main menu, press <Alt> <F1> to exit to DOS and type **SUSQ** <Enter> to run the survey program.
5. Change the X-ray Mode to 4 and Aperture to 3.
6. Press <F1> to turn on the X-rays.
7. Observe the oscilloscope. You should see a trace similar to Figure 3-17, approximately 4ms pulses with a peak amplitude of 8V (ignore the overshoot, measure after it settles out). This corresponds to 80kVp inside the tank.
8. Press <F2> to turn off X-rays.
9. Change the X-ray Mode to 3.

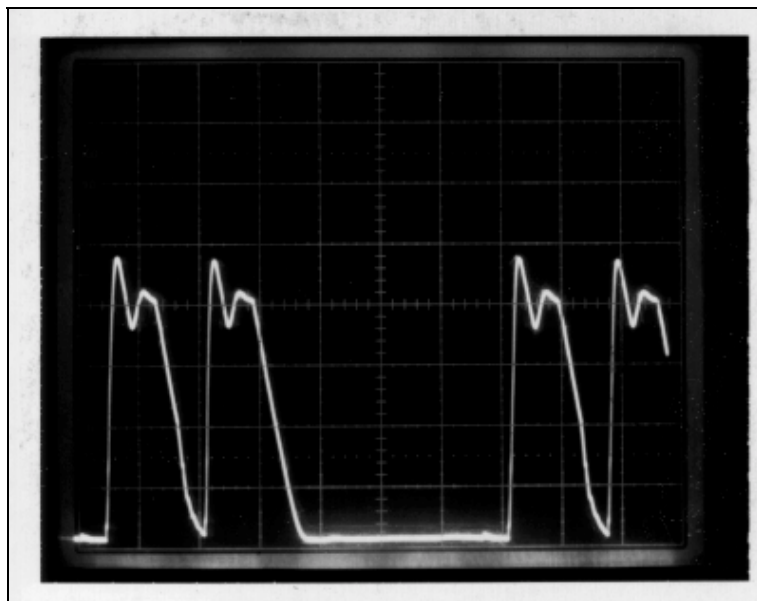


Figure 3-17. Peak Potential Mode 4

10. Press <F1> to turn on the X-rays.
11. Observe the oscilloscope. You should see a trace similar to Figure 3-18, alternating pulses, approximately 4ms in duration, with a peak amplitude of 14v and 10v respectively (corresponding to 140kVp and 100kVp inside the tank).

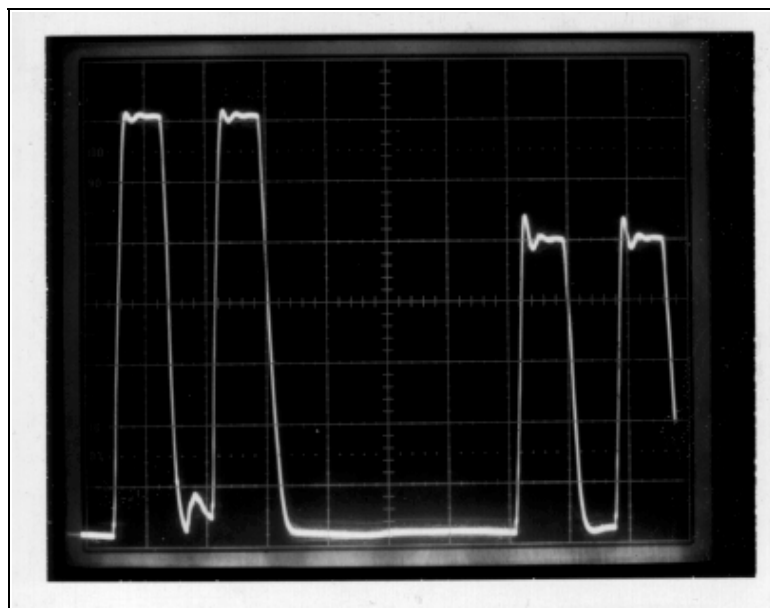


Figure 3-18. Peak Potential Mode 3

If the scope trace seen in either Figure 3-17 or Figure 3-18 is not as shown, the system may have a faulty X-ray Controller or tank.

Note: Enter this information into *The Radiation Measurement Report* (see page 3-28).

CHECK TUBE CURRENT

Follow the procedure below to check X-ray tube current. Monitoring tube current is done on the barrier strip on top of the X-ray source.

WARNING: Even though the test voltage is low, there are elevated voltages near and around the test points.

1. If the tank cover is not off, remove it (2 Phillips screws). For QDR 4500A and QDR 4500SL systems, raise the table to its upper limit for better access to the tank.
2. Set up the scope as follows:
 - Channel 1: 2V/div (0.2V/div if using x10 probes)
 - Channel 2: 2V/div (0.2V/div if using x10 probes)
 - Time base: 5.0ms/div
 - Trigger on line (positive slope)
 - Set vertical mode to add and invert channel 2.
 - Connect Channel 1 to TB1-PIN 10 (on the tank)
 - Connect Channel 2 to TB1-PIN 7 (on the tank)
3. Ground both channels and move the trace to the bottom of the screen. Remove the grounds and go to DC coupling.
4. Instrument power, computer power and the X-ray enable key should all be on.
5. From the main menu, press <Alt> <F1> to exit to DOS and type **SUSQ** <Enter> to run the survey program.
6. Change the X-ray Mode to 1 and Aperture to 3.
7. Press <F1> to turn on the X-rays.
8. Observe the oscilloscope. You should see a trace similar to Figure 3-19, approximately 4ms pulses with a peak amplitude of 3v (ignore the overshoot and measure current on the back, after it settles out). This corresponds to 3ma \pm 35% tube current.
9. Press <F2> to turn off X-rays.

Note: Enter this information into *The Radiation Measurement Report* (see page 3-28).

10. Change the X-ray Mode to 3.

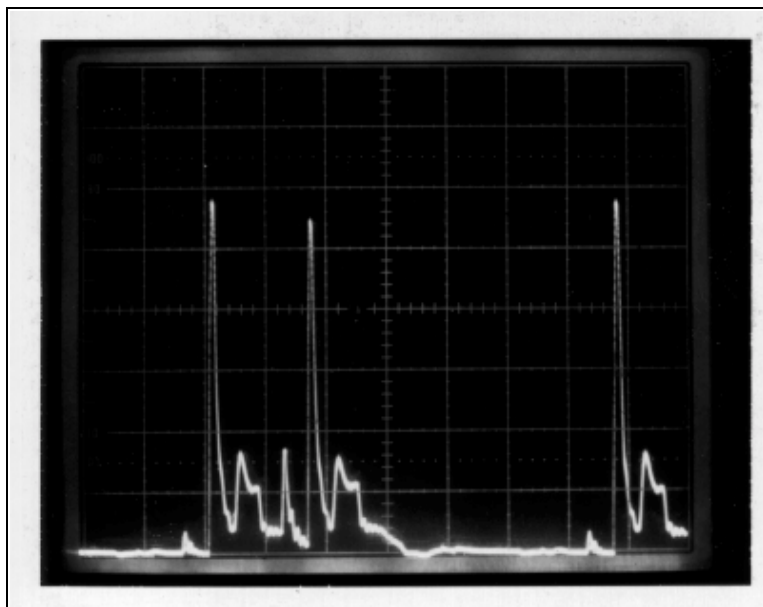


Figure 3-19. Tube Current Mode 1

11. Press <F1> to turn on the X-rays.
12. Observe the oscilloscope. You should see a trace similar to Figure 3-20, approximately 4ms pulses with a peak amplitude of 10v (ignore the overshoot and measure current on the back, after it settles out). This corresponds to 10mA \pm 35% tube current.

If the scope trace seen in either Figure 3-19 or Figure 3-20 is not as shown, the system may have a faulty X-ray Controller or tank.

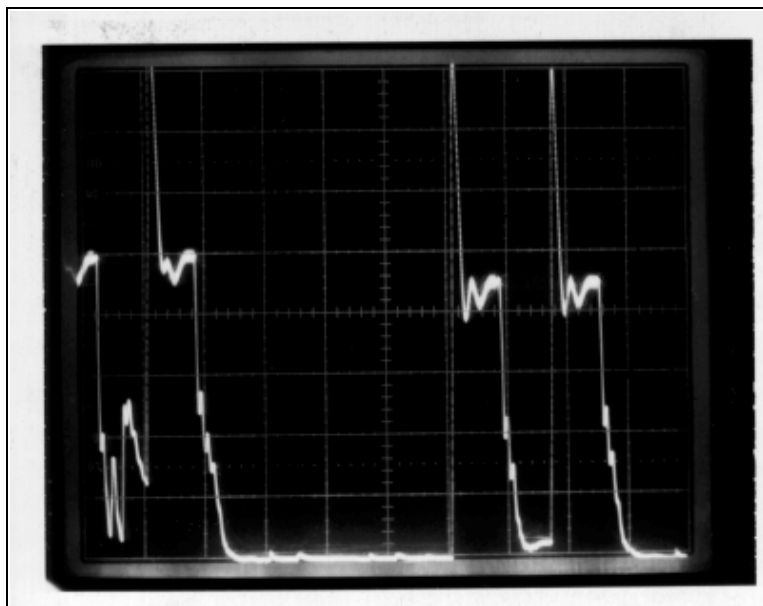


Figure 3-20. Tube Current Mode 3

Note: Enter this information into *The Radiation Measurement Report* (see page 3-28).

CHECK BELT TENSION

Check for proper tension on each of the motor drive belts. If any belt is loose, perform the tension adjustment for that belt in *Section 5, Remove and Replace Procedure* of this manual.

ADJUST C-ARM Y BELT

The C-Arm Y belt should always be adjusted during installation. To do this, perform the following:

1. Move the C-Arm to the center of the table.

CAUTION: Do not move the C-arm or the table more than 1"/second with the power off.
--

2. Turn off the QDR 4500 instrument power, computer power, and main circuit breaker.
3. Loosen the two mounting bolts holding the tension block.
4. Adjust the tension nut so that the spring is compressed to 7/8 inch.
5. Tighten the two mounting bolts holding the tension block.

CALIBRATE MOTORS

The SQDRIVER program provides a CALIBRATE command for each of the motors (TZ, AY, TY, TX and AR) to calibrate the encoder read back and determine the limits of motion.

Perform the *Motor Calibration* procedure in the *ALIGNMENT AND CALIBRATION* section of this manual.

Note: During Installation, the MOTOR\$AY, MOTOR\$TY, MOTOR\$TX and MOTOR\$AR procedures may be performed without unclasp the drive shaft tubing (this allows the procedure to be completed quicker). This applies *only* during installation.

CHECK X-RAY BEAM ALIGNMENT

It is crucial that the X-ray beam be precisely aligned with the detector, as improper alignment directly affects the repeatability (coefficient of variability, or CV) of the QDR 4500.

To check beam alignment, perform the *X-Ray Beam Alignment* procedure in the *ALIGNMENT AND CALIBRATION* section of this manual.

CALIBRATE APERTURE (QDR 4500A AND SL)

Note: If the table cannot be moved from the Control Panel it may be necessary to exit to DOS and type: TOAP <Enter>. This sets the arm and table to the AP position.

This procedure identifies the exact positions of each aperture (slit) in the encoder unit.

1. Center and lower the table.

2. Run SQDRIVER.
3. At the CARM\$\$\$\$> prompt type CALIBRATE (be patient, this procedure takes several minutes).

CHECK LASER POSITIONING OFFSET

Center the table and arm using Center Table, or utility A/P position feature. Turn on the laser and set it on the point of a sharp object. At the DOS prompt type SCANSQ -PNOFLAT and begin a scan. Using the F3 function, realign the arm to the proper position and exit before the scan begins. Turn on the laser and physically adjust back to the point of the object as follows:

1. Locate the 3 laser adjustment screws (small Phillips) under the C-arm. Adjust these screws until the laser cross-hair is on the pointed object.
2. Run another scan to check your adjustments.

ADJUST A/D GAIN CONTROL

In order that all QDR 4500 machines have the same input to the A/D converter, regardless of slight variation in X-ray flux detected, a potentiometer has been installed on the unit's A/D converter board. Perform the *A/D Gain Control Adjustment* procedure in the *ALIGNMENT AND CALIBRATION* section of this manual.

PERFORM BEAM FLATTENING

This procedure flattens the X-ray beam for each scan mode. Perform the *Beam Flattening* procedure in the *ALIGNMENT AND CALIBRATION* section of this manual.

Note: All covers, table mat, etc., in the X-ray path, must be on the Scanner before running beam flattening.

PERFORM LATERAL ALIGNMENT TEST

This procedure verifies lateral alignment. Perform the *Lateral Alignment Test* procedure in the *ALIGNMENT AND CALIBRATION* section of this manual.

MEASURE X-RAY DOSE TO PATIENT

A radiation dose measurement must be performed at installation time, and should be done routinely whenever the machine is worked on. This test requires the use of a Victoreen Model 450P or equivalent.

Note: The dose measurements must be done with the machine fully assembled and the table mat in place. The typical dose measurements are as follows for listed scan modes:

1. Place the meter in the center of the table and position the laser about 1/4 inch to the left of the meter.

Section 3 - Installation

2. Select Array spine scan and set scan length for 9.5 inches.
3. Scan the meter.
4. Observe the scan to verify that the entire chamber of the meter is included in the scan.
5. Record the result.

Note: Array spine scan dose should be less than 200 μ Gy (20mrad).

6. Record the highest reading in the service report.

Note: Enter this information into *The Radiation Measurement Report* (see page 3-28).

CHECK HVPS/S (TANK) FOR RADIATION LEAKAGE

For regulatory and safety reasons, the High Voltage Power Supply/Source (HVPS/S) must be checked for radiation leakage at installation time or whenever the HVPS/S is replaced.

Theory

Radiation leakage from the HVPS/S results from a defect in the lead liner of the tank or its cover. If there is a hole in the lead liner, the resulting leakage produce pencil beam. If there is a crack in the lead liner, the resulting leakage produce a fan beam.

In either case, the initial survey must be taken close to and almost touching the tank with the survey meter probe. If a leak is found, the meter indicates a spike in the reading. If this occurs, you must then move the probe one meter (approx. 40") along the beam from that spot to determine if the leakage is within acceptable levels.

The Victoreen 450P has a response time of:

Range	Time
0-4mR/h	3.3 seconds
0-40mR/h	4.5 seconds

Performing The Procedure

1. Remove the tank cover and set the X-ray leakage test shield (099-0566) over the aperture slot.

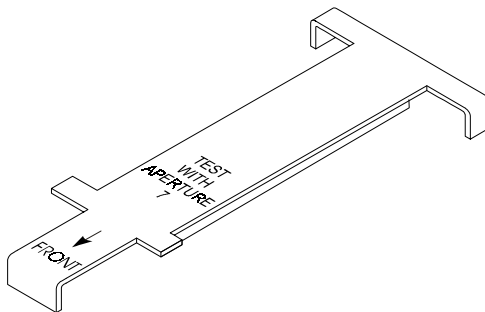


Figure 3-21. Leakage Test Shield (099-0566)

2. Go to the SUSQ program in the MENU directory; set X-ray mode to 3, and aperture to 7.

Initial Leakage Survey

3. Turn on X-rays.
4. Slowly move the meter probe (Victoreen Model 450P or equivalent) about all accessible surfaces. (See table above for meter response times) to detect any leaks.
5. If a leak is detected (a spike in the reading) measure the that point at a one meter (approx. 40") distance from the leak and assure that the reading is 10 μ Gy/h (1.0mrad/h) or less.

Final Leakage Survey

6. Position the survey meter one meter (approx. 40") from the tank and move it all around the outside.
7. The reading must be 10 μ Gy/h (1.0mrad/h) or less. Record the highest reading in the service report.
8. Turn off X-rays, remove the tool and replace the tank cover.

Note: Enter this information into *The Radiation Measurement Report* (see page 3-28).

CALIBRATE FOR AREA, BMD AND BMC

The final calibration procedure is to calibrate for Area, BMD and BMC. Perform the *Area, BMD and BMC Calibration* procedure in the *ALIGNMENT AND CALIBRATION* section of this manual.

TEST SCAN MODES

Perform at least one scan in each of the scan modes to verify that machine is fully functional in all modes of operation. Verify that there are no electrical or mechanical problems during each scan mode.

1. Perform a fast AP, turbo AP and a high definition AP scan.
2. Perform an array left hip, and an array right hip scan.
3. Perform a high definition lateral spine scan.
4. Perform a whole body scan.
5. Perform an array forearm scan (if option loaded).

FINISH ASSEMBLING UNIT

Dress all cables at the rear of the console with nylon tie wraps. At this point, take the time to replace any covers or enclosures that may not have been reassembled previously. Check that all of the machine's safety features (ground wires, limit switches, emergency stop, etc.) are in place

and working properly. Finally, clean up the machine and remove any unwanted packing materials from the room.

MEASURE X-RAY SCATTER FROM PHANTOM

A radiation scatter measurement must be performed at installation time. You must use a survey type radiation meter (Victoreen 450P or equivalent).

Do the following:

1. Center the table and C-arm.
2. Place the spine phantom in the center of the table and align using the laser.
3. Start a normal AP scan.
4. Stop the scan (<Esc>) when it is between the two middle vertebrae.
5. Turn on the X-rays using SUSQ.
6. Using the survey meter, measure the scatter radiation at a distance of 2 meters from the phantom on a horizontal plane all around the unit. Move the meter slowly (refer to the Victoreen response table on page 3-25).

Note: If you can not measure the scatter radiation at a distance of 2 meters because of space restrictions, you can measure at 1 meter and divide the result by 4.

This reading must be less than 10 μ Gy/h (1.0mrad/h) at 2 meters (approx. 80 in.) in array AP scan mode.

7. Record the highest reading in the service report.

Note: Enter this information into *The Radiation Measurement Report* (see page 3-28).

PERFORM QC

Once the machine has been fully assembled and calibrated, at least one QC scan should be performed.

- Perform the daily QC procedure and enter the scan into the QC database.

RUN REPRODUCIBILITY TEST

Reproducibility is the ability of the scanner unit to perform consecutive scans while keeping the amount of radiation for each scan consistent. Reproducibility is checked by scanning the spine phantom shipped with the unit 10 consecutive times. You must then plot the results of the High Air and Low Air measurements for these scans and assure that coefficient of variation for absolute radiation is less than 4%.

The plot screen does not readily display the coefficient of variation for absolute radiation. You must use the formula:

coefficient of variation for absolute radiation = standard deviation (SD) x .0028.

So:

If...	Then...
the Standard Deviation (SD) for both High Air (HiA) and Low Air (LoA) is less than or equal to 14,	the coefficient of variation for absolute radiation is less than 4%.


To do this:

1. Perform 10 spine scans using AUTOSCAN (if not already done so).
2. Analyze the 10 scans (using AUTOCOMP).
3. Put the results in the QC database (if you have not already done so).
4. At the Hologic Main Menu, select “QC”.
5. Select “Database”.
6. Press <Alt><F1>.
7. At the displayed dialog box, select all parameters (type Y<Enter>).
8. Select “Plot”.
9. Select “HiA”.
10. Plot the data for the 10 scans in step 1.
11. Assure that the SD is 14 or less.
12. Repeat for “LoA” by repeating steps 9-11. This result must also be 14 or less.

Note: Enter this information into *The Radiation Measurement Report* (see page 3-28).

THE RADIATION MEASUREMENT REPORT

After installation, the field engineer must fill out the Radiation Measurement Report and keep this information on file. A sample of this report follows:



QDR 4500 Radiation Measurement Report

Customer Name _____

Customer Address _____

Customer Contact _____

Hologic Model Number _____

Serial Number _____

Date Measurement Taken _____

Voltage and Current Tests

<p>Line Voltage: (choose one)</p> <p>(100V) _____ ($\geq 90V, \leq 110V$)</p> <p>(120V) _____ ($\geq 108V, \leq 132V$)</p> <p>(230V) _____ ($\geq 207V, \leq 253V$)</p>	<p>Tube Peak Potential:</p> <p>(80 kVp) _____ ($\geq 72 \text{ kVp}, \leq 88 \text{ kVp}$)</p> <p>(100 kVp) _____ ($\geq 90 \text{ kVp}, \leq 110 \text{ kVp}$)</p> <p>(140 kVp) _____ ($\geq 126 \text{ kVp}, \leq 154 \text{ kVp}$)</p>
<p>Reproducibility Test:</p> <p>SD Hi Air _____ (≤ 14)</p> <p>SD LoAir _____ (≤ 14)</p>	<p>Tube Current:</p> <p>Mode 1 (3 mA) _____ ($\geq 2.0 \text{ mA}, \leq 4.0 \text{ mA}$)</p> <p>Mode 3 (10 mA) _____ ($\geq 6.5 \text{ mA}, \leq 13.5 \text{ mA}$)</p>

Radiation Tests

Leakage Test using Victoreen Model #450P (or equivalent) S/N _____

Array Beam _____ mR/h

Dosage Test using Victoreen Model #450P (or equivalent) S/N _____

Array Beam _____ mR

Scatter Test using Victoreen Model #450P (or equivalent) S/N _____

Array Beam _____ mR/h

F/E Signature _____

Date _____

CSD-0026-01 Rev B

SECTION 4

ALIGNMENT AND CALIBRATION

TABLE ALIGNMENT

Checking Table Alignment

To check the table alignment, perform the following procedure:

1. Using a measuring tape, and referring to Figure 4-1, check the following:
 - Distance from the edge of the table to the back of both T-rails (measurement “A”).
 - Distance between the T-rails (front and rear).
 - Gap from the edge of the table bracket (left side) to the rail.
2. Record all the measurements.
3. Facing the front of the QDR 4500, gently push the foot end (left side) of the table. The table should move away from, then back to its original position.
4. Check measurement “A” and the bracket to guide rail gap again, and compare them to their original values.
5. If all the measurements are within specs, the table is properly aligned. If the measurements are not within specs, go to the Aligning Table section.

Aligning Table

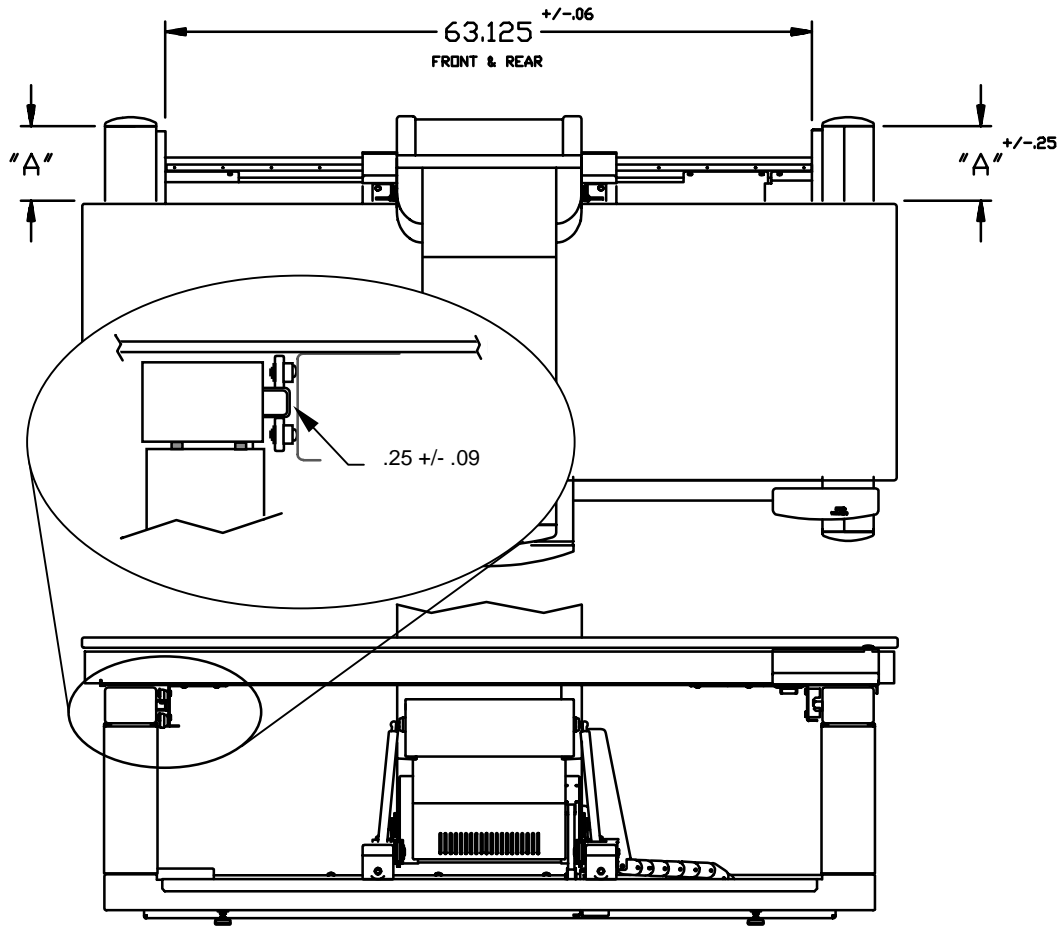
After you have taken the measurements in the Checking Table Alignment section, use the procedures below to align the table. Note that if both measurement “A” and the bracket to guide rail gap are out of specification, you should recheck the measurements after performing the first adjustment.

Table Edge to T-Rail (“A” Dimension) Adjustment

To change the “A” dimension, do the following:

1. Remove the upper and lower covers from the right pedestal.
2. Loosen the four bolts fastening the top of the pedestal and the four bolts fastening the bottom of the pedestal (see Figure 4-2).
3. Adjust the table so the “A” measurements are within specifications.
4. Tighten the bolts and check the table alignment again.

If the alignment is within specifications, replace the pedestal covers. If you still note a change in the “A” measurement, continue with the following steps.



Measurements are in inches.

Figure 4-1. Table Alignment

5. Make sure the upper and lower brackets are securely fastened to the upper and lower frames.

Note: Even if the brackets are secured to the frames, they may not be securely fastened to the pedestal. If not, remove the table to access the screws that secure the brackets to the pedestal. Refer to Section 3, Installation, for table removal procedures.

If the screws are loose, apply a small amount of Loctite and tighten them.

Section 4 - Alignment & Calibration

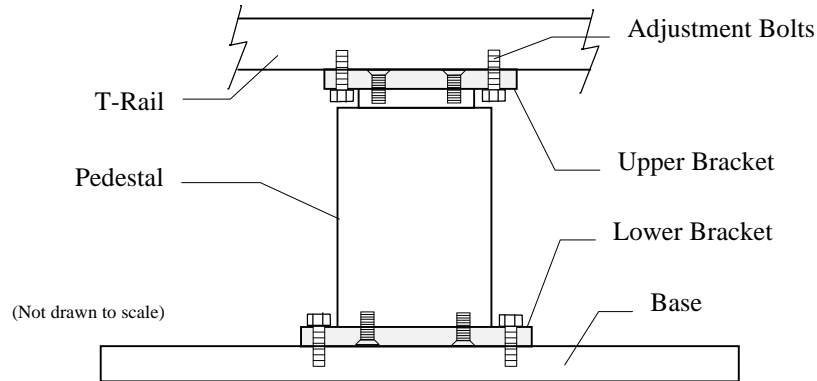


Figure 4-2. Pedestal (covers removed)

The upper and lower brackets are attached to the pedestal with four 6mm flat-head Allen screws. While the table is off, it is a good idea to remove the pedestal and make sure these screws are tight.

6. Mount the pedestal to the lower frame. Do not tighten the bolts until the alignment is done.
7. Install the table and check its alignment. Make the necessary adjustments, then tighten the upper and lower bolts.
8. Install the pedestal covers that were removed in Step 1.

Front to Back T-Rail and Table Edge/Rail Gap Adjustment

To adjust the front-to-back T-Rail dimensions and table edge/rail gap, do the following:

1. Remove the upper and lower covers from the left pedestal.
2. Loosen the four bolts fastening the top of the pedestal and the four bolts fastening the bottom of the pedestal.

Note: Before adjusting the distance between the rails, make sure the upper and lower brackets are securely fastened to the pedestal. Refer to Steps 3 -5 of the previous (Aligning Table) section and then go to the next step.

3. Adjust the distance between the T-rails and the table edge/rail gap and tighten the bolts.
4. Install the pedestal covers that were removed in Step 1.

C-ARM PARALLELISM ADJUSTMENT (A and SL only)

1. Measure from the bottom of the C-arm to the top of the tank cover in all four corners. If the measurements vary more than 1/8", do the following.
2. Remove the C-arm shoulder cover.
3. Loosen eight 1/4" bolts (4 on each side).
4. Move the C-arm until it is parallel to the tank cover.

5. Tighten the bolts and repeat step 1.
6. Replace the cover.

X-RAY BEAM ALIGNMENT (A and SL only)

It is crucial that the X-ray beam be precisely aligned with the detector, because improper alignment will directly affect the repeatability (coefficient of variability, or CV) of the QDR 4500. Therefore this alignment must be verified at the time of installation or whenever any work is performed that may affect it.

To check beam alignment:

WARNING: X-rays are being generated during this procedure. Keep hands, head and other body parts out of beam.

Insert the alignment fixture (see the following three figures) into the detector opening.

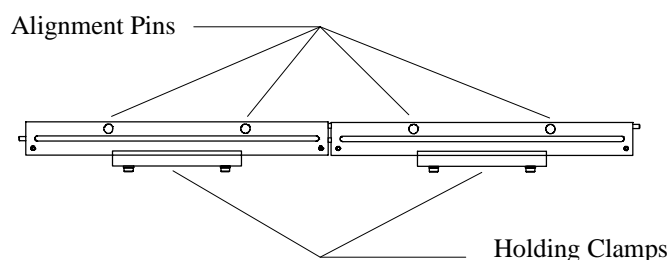


Figure 4-3. X-Ray Alignment Fixture (010-0923)

1. Go to aperture #10 (use gain of “2” for high and “1” for low; use X-ray mode “3”).
2. Turn the X-rays on (using SUSQ).
3. Look at the monitor screen.

The correct display should be flat and have an amplitude of about six (6) volts. If the X-Ray beam alignment is not correct, perform the following procedure.

1. Remove the C-arm cover.
2. Ensure that the upper C-Arm is parallel to the table (see *C-Arm Parallelism Adjustment* in this section).
3. At the DOS prompt, type SQDRIVER. The SQDRIVER prompt is CARM\$\$\$>.
4. At the SQDRIVER prompt, CARM\$\$\$>, type MOVE_APER_REL. Place the pin through the alignment hole in the aperture. Move the aperture approximately 100 steps at a time (If the tank cover is on, remove it).
5. Move the aperture approximately 100 steps at a time (+100 moves right, -100 moves left) until the pin drops easily into place through the alignment hole in the base plate. Move the aperture until the pin is visually perpendicular to the base plate.

Section 4 - Alignment & Calibration

(Place the block on the base plate next to the pin, and compare the pin to the vertical surface of the block to better visualize whether the pin is perpendicular).

6. Raise the pin from the base plate, but not out of the aperture plate. Insert the alignment block and insert the pin through the block and back into the base plate alignment hole. Move the aperture until the base of the block sits flat on the base plate.

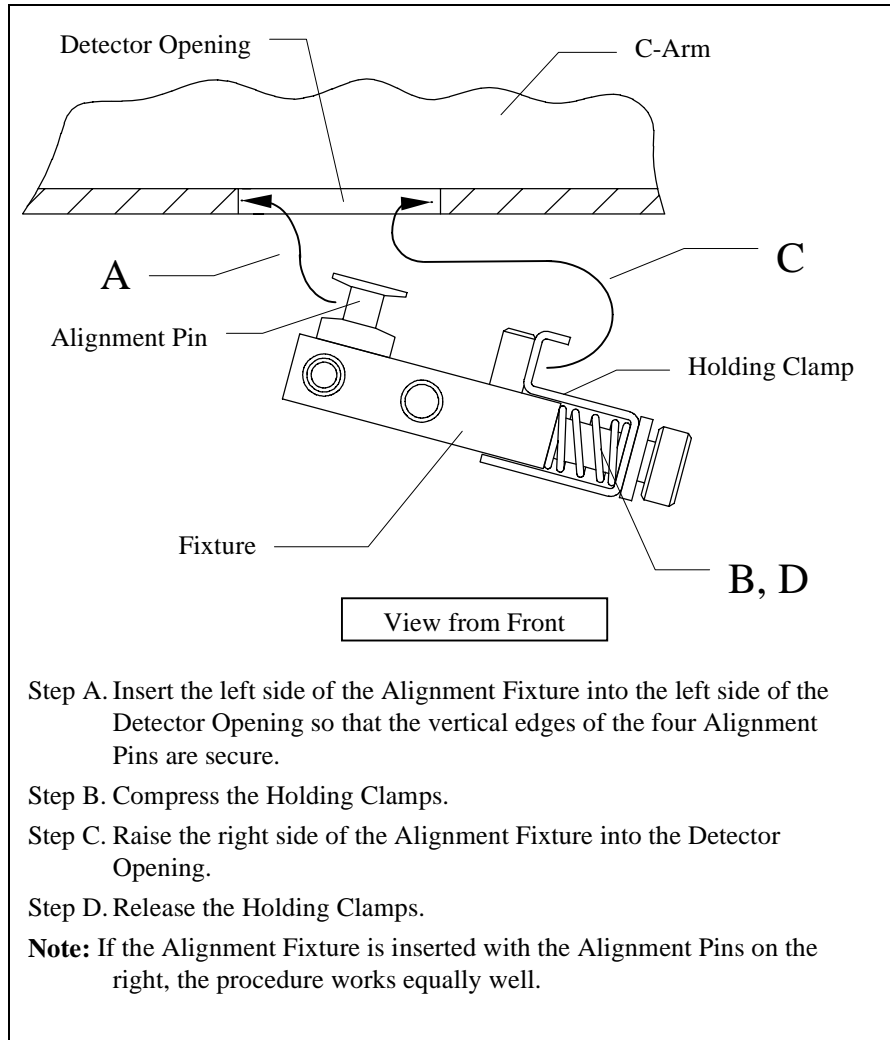


Figure 4-4. Inserting The X-Ray Alignment Fixture

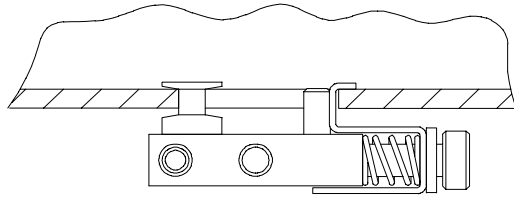


Figure 4-5. The Alignment Fixture Properly Installed

7. Exit SQDRIVER.
8. Set the machine in the Center Table position, then raise the table all the way up.

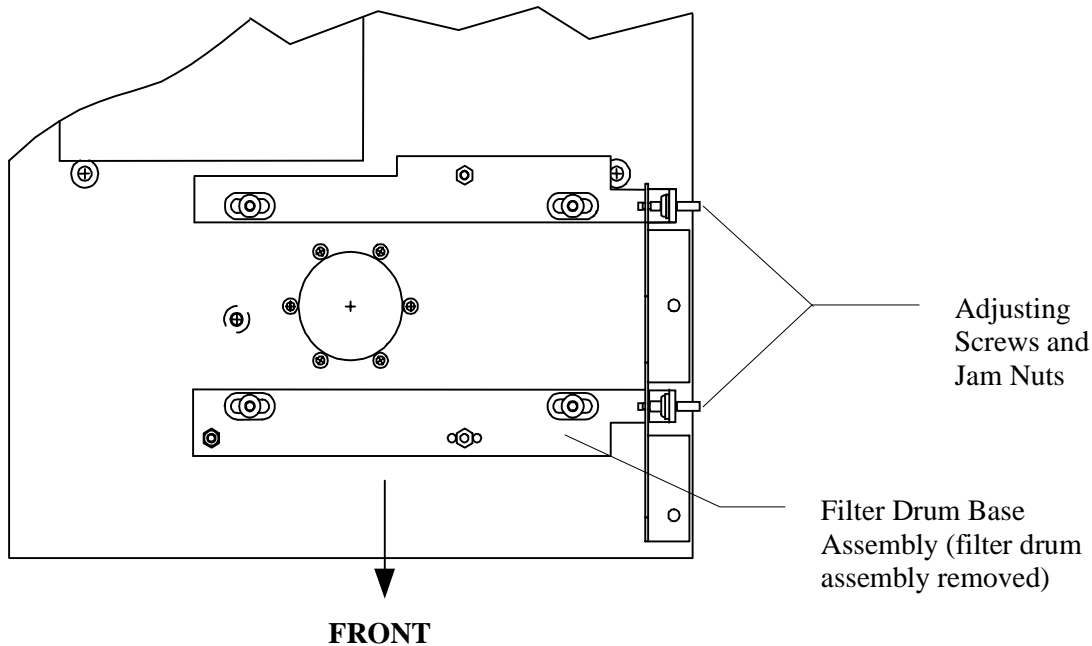


Figure 4-6. Filter Drum Adjustments - Top View

9. At the Filter Drum assembly, loosen the jam nuts, and insert Allen wrenches (3/32"), in both Filter Drum Allen alignment screws. (Figure 4-6 above shows location of alignment screws and jam nuts.) Ensure that the Filter Drum is running.
10. Type SUSQ <Enter>, set high gain = 2, low gain = 1. Set X-ray mode to 3.
11. Press <Ctrl> <Pg Dn> to get the bar graph.
12. Verify that the screen shows Pulse 1 (high air). If it doesn't, press <Alt><P> until it does.
13. Set X-ray mode to 3, press <Ctrl><PageDown> and make sure the screen still shows pulse 1.
14. Press F1 to turn on X-rays. View the X-ray plot.

Section 4 - Alignment & Calibration

The next 5 steps adjust the beam side to side.

WARNING: The X-rays are on. Keep body parts out of the beam.

1. Move the **front** Filter Drum Allen alignment screw until the X-ray signal peaks.

Note: The last direction turned should be clockwise to eliminate backlash when the jam nuts are tightened. The plot should show peak amplitude.

2. Move the **back** Filter Drum Allen alignment screw until the X-ray signal peaks.

Note: The last direction turned should be clockwise to eliminate backlash when the jam nuts are tightened. The plot should show peak amplitude.

3. Tighten the jam nuts on both Filter Drum Allen alignment screws.

Note: The X-rays should still show peak amplitude.

4. Turn off the X-rays.
5. Remove the alignment test fixture.

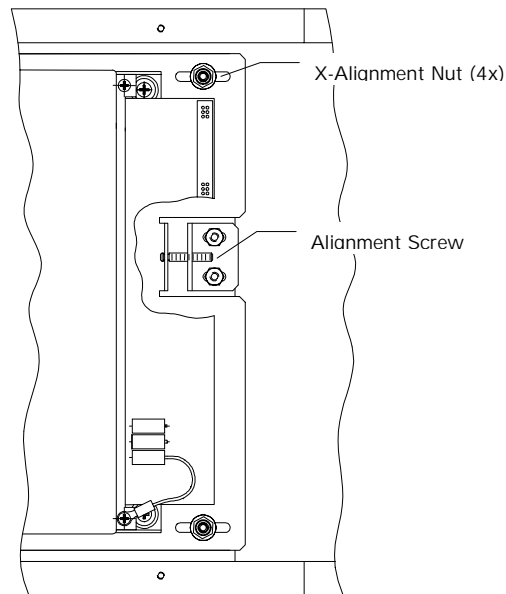


Figure 4-7. Array Assembly - Top View, Partial

The next 6 steps adjust the beam front to back.

1. At the Array assembly, loosen the four X-alignment nuts (see Figure 4-7 above).
2. Turn on the X-rays. Adjust the array X-alignment screw in one direction until the trace drops off (the signal on the end detectors of the array will drop off). Then, count the turns while moving it in the other direction until the trace falls off on the detector on the other end of the array. Set the adjustment in the middle by turning the screw back half the number of turns counted.
3. Tighten the four array X-alignment nuts.

4. Turn off X-rays.
5. Remove the block and pin.
6. Turn off SUSQ.

X-RAY BEAM ALIGNMENT (C and W only)

It is crucial that the X-ray beam be precisely aligned with the detector, because improper alignment will directly affect the repeatability (coefficient of variation, or CV) of the QDR 4500. Therefore this alignment must be verified at the time of installation or whenever any work is performed that may affect it.

To check the beam alignment:

1. Insert the alignment test fixture into the detector opening.
2. Turn on X-rays (using SUSQ)

WARNING: X-rays are being generated during this procedure. Keep hands, head and other body parts out of beam.

- a) use gain of "2" for high and "1" for low
- b) use X-ray mode "3"
3. Look at the monitor screen. The display should be flat and have an amplitude of about six (6) volts.
4. If the X-ray beam alignment is not correct, continue this procedure.
5. If the tank cover is on, remove it.
6. Remove the C-arm cover.
7. Set the machine in the Center Table position.
8. At the Filter Drum assembly, loosen the jam nuts, and insert Allen wrenches (3/32"), in both Filter Drum Allen alignment screws (Figure 4-7 shows location of front alignment screw and jam nuts). Ensure that the Filter Drum is running.
9. Type SUSQ <Enter>, set high gain = 2, low gain = 1. Set X-ray mode to 3.
10. Press <Ctrl> <Page Down> to get the bar graph.
11. Verify that the screen shows Pulse 1 (high air). If it doesn't, press <Alt><P> until it does.
12. Set X-ray mode to 3, and make sure the screen still shows pulse 1. Press <Ctrl><Page Down>.
13. Press F1 to turn on X-rays.

The next 3 steps adjust the beam side to side.

1. Move the **front** Filter Drum Allen alignment screw until the X-ray signal peaks.

Section 4 - Alignment & Calibration

Note: The last direction turned should be clockwise to eliminate backlash when the jam nuts are tightened.

2. Move the **back** Filter Drum Allen alignment screw until the X-ray signal peaks.

Note: The last direction turned should be clockwise to eliminate backlash when the jam nuts are tightened.

3. Tighten the jam nuts on both Filter Drum Allen alignment screws. (The X-rays should still show peak amplitude.)

The next 7 steps adjust the beam front to back.

1. Turn off X-rays and remove the alignment test fixture.
2. At the Array assembly, loosen the four X-alignment nuts (see Figure 4-7).
3. Turn on X-rays.
4. Adjust the array X-alignment screw in one direction until the trace drops off (the signal on the end detectors of the array will drop off). Then, count the turns while moving it in the other direction until the trace falls off on the detector on the other end of the array. Set the adjustment in the middle by turning the screw back half the number of turns counted.
5. Tighten the four array X-alignment nuts.
6. Turn off X-rays.
7. Turn off SUSQ.

APERTURE CALIBRATION (A and SL only)

This procedure identifies the exact positions of each aperture (slit) in the encoder unit.

1. Center and lower the table.
2. Run SQDRIVER, press <Enter>.
3. At the CARM\$\$\$> prompt type CALIBRATE (be patient, this procedure takes several minutes).

MOTOR CALIBRATION

The SQDRIVER program provides a CALIBRATE command for each of the motors (TZ, AY, TY, TX and AR) to calibrate the encoder read back and determine the limits of motion.

Use the following table to determine which calibration procedures you need to perform on a given QDR 4500 model.

Perform the calibration procedures if indicated (*) from left to right order.					
Model	TZ	AY	TY	TX	AR
A	*	*	*	*	*
SL	*	*	-	*	*
W	-	*	*	*	-
C	-	*	-	*	-

Except for the TZ motor, each motor requires the corresponding protocol calibration file in the PROTOCOL sub-directory (e.g., for MOTOR\$AY, the calibration protocol is MOTOR_AY.PRO).

To begin the calibration procedure, at the Hologic main menu, type:

1. <Alt><F1>
2. At the C:\MENU> prompt, type SQDRIVER<Enter>
3. At the CARM\$\$\$\$> prompt, type MOTOR\$XX<Enter>, where XX equals TZ, AY, TY, TX, or AR, depending on which motor you are calibrating.

MOTOR\$TZ (QDR 4500A and SL)

1. Select the TZ motor device driver by typing:

MOTOR\$TZ<Enter>

2. At the MOTOR\$TZ> prompt, type:

CALIBRATE<Enter>

The program sends the calibration command to the TZ microprocessor and waits twenty seconds for table motion to complete. During this time, the TZ microprocessor moves the table pedestals to the top mechanical limit and then back down to the bottom mechanical limit. You are then asked the following:

Mark the current height of the table and press the <Enter> key to move the table to the topmost position. Then measure the distance that the table moved in centimeters.

3. Measure the distance moved using the bottom edge of the top pedestal cover and the floor. The system displays:

Total Distance Moved By Pedestal [20.0 cm] ?

4. Type xx.x<Enter> where xx.x = the distance you measured. It should be around 20.0 cm.
5. Press <Enter>. The system then displays the following:

Are Sure Total Distance Moved By Pedestal Is xx.x cm. [Y/N] ?

Section 4 - Alignment & Calibration

The xx.x equals the measurement you typed in above. If you type N, the system redisplay the second message and you should retype the distance you measured. If you type Y, the system displays the following:

Update Driver INI-File [Y/N] ?

6. Type Y<Enter>.

The SQDRIVER program then reads the calibration parameters from the TZ microprocessor and prompts

```
set_table_calibration=499,3490,500,3494
calibrate_position=10,1000,1000,819,50000,500,500,3494
pos_limit_position=182784
neg_limit_position=0
```

Update Driver INI-File [Y/N] ?

The four values for **set_table_calibration** are, respectively, the left pedestal lower and upper encoder limits and the right pedestal lower and upper encoder limits. The two lower limits should be *close* to each other, as should the two upper limits. The eight **calibrate_position** fields are:

- 1) **10** (Tolerance). The \pm position tolerance, in encoder ticks, for absolute moves. Although the TZ microprocessor does its own absolute moves, not the AT device driver, this field is used by state machine programs to determine whether the TZ position is within tolerance and should be ten (10).
- 2,3) **1000,1000** (NumberOfSteps,StepDistance). The number of motors steps corresponding to the step distance in microns. These two fields are only used for stepping motors, not for the DC table motors, and should always be 1000,1000.
- 4,5) **819,50000** (NumberOfTicks,TickDistance). The number of encoder ticks corresponding to the tick distance in microns. The table encoder calibration is fixed and should always be 819 encoder counts per 50,000 microns.
- 6) **500** (EncoderOffset). The value subtracted from the encoder readback to set the origin of motion. The origin of TZ motion is the lower right pedestal, so this field should be the same as the third field in the **set_table_calibration** line (above).
- 7,8) **500,3494** (NegLimit,PosLimit). The encoder readings for the negative (downward) and positive (upward) mechanical stops. In normal operation, the TZ microprocessor uses the right pedestal readings for closed loop control so these two fields should be the same as the last two fields in the **set_table_calibration** line (above).

The **pos_limit_position** and the **neg_limit_position** are the limits of motion, in microns, in the positive and negative direction

Note: The *PosLimitOffset* and *NegLimitOffset* entries in the *[TzMotor]* section of the *hardware.ini* file determine the motion limits relative to the mechanical stops. If these entries are not present, or are zero, the motion limits are set to the mechanical limits, as in the above example.

7. Type Y<Enter> to accept the calibration values.

MOTOR\$AY (all QDR 4500 models)

Before beginning this procedure, make sure that the AY motor encoder *is not* clamped to the drive shaft tubing.

1. Select the AY motor device driver by typing:

MOTOR\$AY<Enter>

2. At the MOTOR\$AY> prompt in SQDRIVER.EXE, type:

CALIBRATE<Enter>

The program prompts:

Press <Enter> when the AY motor reaches the LEFT mechanical limit.
Press <ESC> to stop calibration.

The program moves the TZ motor to its topmost position and then starts AY moving to the left. When AY hits the left mechanical stop the first time:

3. Press <ESC>.

The program returns to the MOTOR\$AY menu page (below).

In the right hand column of the display, eight lines from the bottom (and highlighted in the figure below), is the raw a/d readback of the motor encoder (in the example below, it is 2048). Manually rotate the encoder until the readback is 3750 ± 50 (i.e., in the range 3700-3800) and then clamp the encoder to the drive shaft, making sure not to over stress the clamp.

4. Repeat the calibration procedure above but now, when AY hits the left mechanical stop, press **<Enter>**.

The program then starts AY moving to the right and prompts:

Press <Enter> when the AY motor reaches the RIGHT mechanical limit.
Press <ESC> to stop calibration.

5. When AY hits the right mechanical stop, press <Enter>.

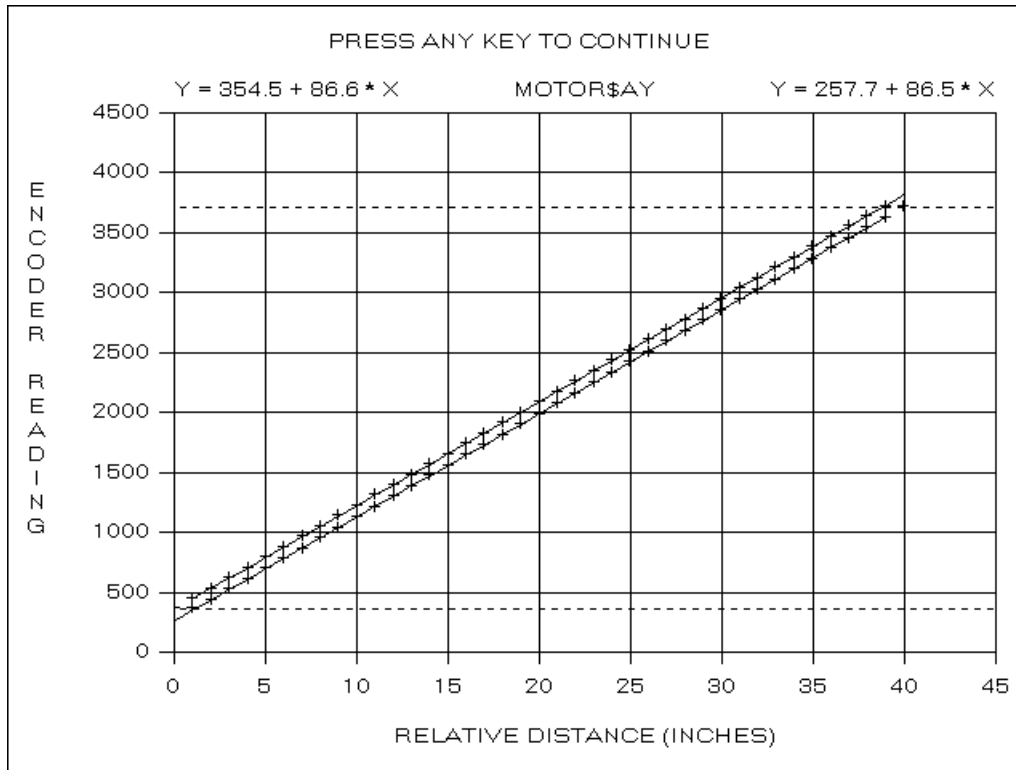
The program then switches to graphics mode and draws the Encoder Vs Distance calibration grid. It steps the AY motor to the left in one inch increments until the motor hits the left mechanical stop, and then steps the AY motor to the right in one inch increments until the motor hits the right mechanical stop. The program plots the encoder data during the scan (in raw encoder units, 0-4095).

Section 4 - Alignment & Calibration

6. Press <ESC> anytime during the scan to terminate the calibration procedure.

MotionState	NONE	OnLine	1
DeviceState	E_OK	EmergencyStop	0
MotionError	E_OK	InterlockInhibit	0
PosMotionSwitch	0	CollisionImminent	0
NegMotionSwitch	0	LocalMotionEnable	0
PosLimitSwitch	NONE	C/C Version	0.00
NegLimitSwitch	NONE	# C/C Interrupts	5678(18)
Position	363812	# DOS Interrupts	878
MoveState	DONE	StepStatus	0
FirstRate	4000	AccelType	1
FinalRate	30000	Direction	1
HoldPower	LOW	HoldPower	1
StepPower	MEDIUM	StepPower	2
AccelDistance	3006	InputSwitches	3
AccelType	1	Position	2048
MinMotion	0	NegLimitPosition	900
MotionDetect	0	PosLimitPosition	3992
PosLimitPosition	936949	FirstRate	222
NegLimitPosition	25355	FinalRate	1667
PositionAverage	1	AccelSteps	167
DriverVersion	3.41	NumberOfSteps	50000
DeviceVersion	2.03	RateScaleFactor	1
G-11110		G	
MOTOR\$AY>			

When the calibration scan completes, the program computes the linear fits to the positive and negative motion. The linear fit parameters are displayed at the top left and top right of the plot in the form $Y = \text{Intercept} + \text{Slope} * X$. The two slopes (e.g., 86.6 and 86.5) should be within 0.3 of each other.



The program displays the positive and negative limits as horizontal dashed lines.

Note: The *PosLimitOffset* and *NegLimitOffset* entries in the [AyMotor] section of the *hardware.ini* file determine the motion limits relative to the mechanical stops. If these entries are not present, or are zero, the motion limits are set to the mechanical limits).

The program then changes the plot title to **PRESS ANY KEY TO CONTINUE**. Press the <Enter> key and the program prompts

```
motor_direction=1
calibrate_position=1,2288,41187,209,61339,363,363,3719
pos_limit_position=984946
neg_limit_position=0
```

Update Driver INI-File [Y/N] ?

The **motor_direction** field determines whether the positive step direction is the *reverse* of the direction of increasing encoder values ('0' if the direction is *not* reversed, '1' if it is). This value is set from the corresponding parameter in the MOTOR_AY.PRO file and is a constant for each motor (i.e., the direction of increasing encoder values must agree with the system coordinates and the positive step direction is set by the wiring harness for the stepper motor).

The eight **calibrate_position** fields are:

Section 4 - Alignment & Calibration

- 1) **1** (Tolerance). The \pm position tolerance, in encoder ticks, for absolute moves. The calibration program sets this field to the value found in the corresponding **calibrate_position** field in the MOTOR_AY.PRO file.
- 2,3) **2288,41187** (NumberOfSteps,StepDistance). The number of motors steps corresponding to the step distance in microns. The ratio of these two numbers determines the step size ($41187/2288 \cong 18$ microns). The calibration program sets these fields to the values found in the corresponding **calibrate_position** fields in the MOTOR_AY.PRO file. Since these values are a property of the mechanical design of the system, they should never change.
- 4,5) **209,61339** (NumberOfTicks,TickDistance). The number of encoder ticks corresponding to the tick distance in microns. Again, it is the ratio of these two numbers ($61339/209 \cong 293$ microns) that determines the encoder calibration. These numbers will generally change from calibration to calibration (although the ratio should remain approximately the same).
- 6) **363** (EncoderOffset). The value subtracted from the encoder readback to set the origin of motion. The origin of AY motion is the extreme right mechanical stop, so this value should be the same as the first field below.
- 7,8) **363,3719** (NegLimit,PosLimit). The encoder readings for the negative (right) and positive (left) mechanical stops.

The **pos_limit_position** and the **neg_limit_position** are the limits of motion, in microns, in the positive and negative direction.

Note: The *PosLimitOffset* and *NegLimitOffset* entries in the [AyMotor] section of the *hardware.ini* file determine the motion limits relative to the mechanical stops. If these entries are not present, or are zero, the motion limits are set to the mechanical limits, as in the above example).

Type **Y<Enter>** to accept the calibration values or **N<Enter>** to reject them.

Note: The last calibration scan data is saved in the file **MOTOR_AY.DAT**. You can reanalyze the data—e.g., after editing *hardware.ini*—by typing the command **CALIBRATE @MOTOR_AY.DAT** at the MOTOR\$AY> prompt in SQDRIVER.EXE.

MOTOR\$TY (QDR 4500A and W)

Before beginning this procedure, make sure that the TY motor encoder *is not* clamped to the drive shaft tubing.

1. Select the TY motor device driver by typing

MOTOR\$TY<Enter>

2. At the MOTOR\$TY> prompt in SQDRIVER.EXE, type

CALIBRATE<Enter>

The program starts TY moving to the left and prompts

Press <Enter> when the TY motor reaches the LEFT mechanical limit.

Press <ESC> to stop calibration.

The program moves the TZ motor to its topmost position and then starts TY moving to the left.

3. When TY hits the left mechanical stop the first time, press <ESC>.

The program returns to the MOTOR\$TY menu page (below).

In the right hand column of the display, eight lines from the bottom (and highlighted in the figure below), is the raw a/d readback of the motor encoder (in the example below, it is 2048). Manually rotate the encoder until the readback is 3750 ± 50 (i.e., in the range 3700-3800) and then clamp the encoder to the drive shaft, making sure not to over stress the clamp.

Section 4 - Alignment & Calibration

MotionState	NONE	OnLine	1
DeviceState	E_OK	EmergencyStop	0
MotionError	E_OK	InterlockInhibit	0
PosMotionSwitch	0	CollisionImminent	0
NegMotionSwitch	0	LocalMotionEnable	0
PosLimitSwitch	NONE	C/C Version	0.00
NegLimitSwitch	NONE	# C/C Interrupts	2088(1)
Position	462579	# DOS Interrupts	336
MoveState	DONE	StepStatus	0
FirstRate	4000	AccelType	1
FinalRate	40000	Direction	1
HoldPower	LOW	HoldPower	1
StepPower	MEDIUM	StepPower	2
AccelDistance	3996	InputSwitches	3
AccelType	1	Position	2048
MinMotion	0	NegLimitPosition	585
MotionDetect	0	PosLimitPosition	3415
PosLimitPosition	871071	FirstRate	333
NegLimitPosition	25400	FinalRate	3333
PositionAverage	1	AccelSteps	333
DriverVersion	3.41	NumberOfSteps	50000
DeviceVersion	2.03	RateScaleFactor	1
T1	T		
MOTOR\$TY>			

4. Repeat the calibration procedure above but now, when TY hits the left mechanical stop, press **<Enter>**.

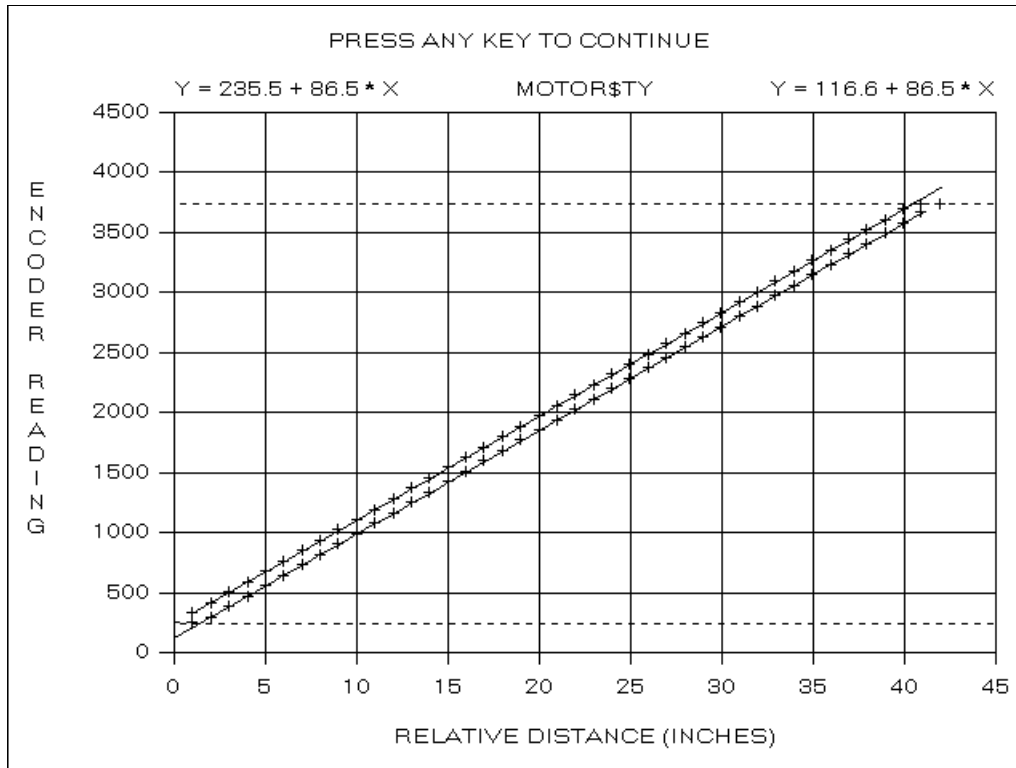
The program then starts TY moving to the right and prompts

Press <Enter> when the TY motor reaches the RIGHT mechanical limit.

Press <ESC> to stop calibration.

When TY hits the right mechanical stop, press **<Enter>**. The program then switches to graphics mode and draws the Encoder Vs Distance calibration grid. It steps the TY motor to the left in one inch increments until the motor hits the left mechanical stop, and then steps the TY motor to the right in one inch increments until the motor hits the right mechanical stop. The program plots the encoder data during the scan (in raw encoder units, 0-4095).

5. Press **<ESC>** anytime during the scan to terminate the calibration procedure.



When the calibration scan completes, the program computes the linear fits to the positive and negative motion. The linear fit parameters are displayed at the top left and top right of the plot in the form $Y = \text{Intercept} + \text{Slope} * X$. The two slopes (e.g., 86.5 and 86.5) should be within 0.3 of each other.

The program displays the positive and negative limits as horizontal dashed lines

Note: The *PosLimitOffset* and *NegLimitOffset* entries in the *[TyMotor]* section of the *hardware.ini* file determine the motion limits relative to the mechanical stops. If these entries are not present, or are zero, the motion limits are set to the mechanical limits.

The program then changes the plot title to **PRESS ANY KEY TO CONTINUE**.

6. Press the <Enter> key and the program prompts

```
motor_direction=0
calibrate_position=1,2287,27446,154,45219,238,238,3742
pos_limit_position=1028879
neg_limit_position=0

Update Driver INI-File [Y/N] ?
```

The **motor_direction**, **calibrate_position**, **pos_limit_position** and **neg_limit_position** fields have the same interpretation as discussed under MOTOR\$AY.

Section 4 - Alignment & Calibration

7. Type **Y<Enter>** to accept the calibration values or **N<Enter>** to reject them.

Note: The last calibration scan data is saved in the file **MOTOR_TY.DAT**. You can reanalyze the data—e.g., after editing *hardware.ini*—by typing the command **CALIBRATE @MOTOR_TY.DAT** at the **MOTOR\$TY>** prompt in **SQDRIVER.EXE**.

MOTOR\$TX (all QDR 4500 models)

Before beginning this procedure, make sure that the TX motor encoder *is not* secured to the drive shaft and that the tank assembly is not under the operator console.

1. Select the TX motor device driver by typing

MOTOR\$TX<Enter>

2. Then, at the **MOTOR\$TX>** prompt in **SQDRIVER.EXE**, type:

CALIBRATE<Enter>

The program prompts

Press <ESC> to stop calibration.

The program moves the TY and AY motors to their center positions, then moves the TZ motor to its topmost position and prompts:

Use the Table IN / OUT switch to move the C-Arm to 0 degrees.
--

Press <Enter> when the C-Arm is positioned.
--

Press <ESC> to stop calibration.

The above message is always displayed when calibrating **MOTOR\$TX**. This is normal. For QDR 4500W and QDR 4500C systems, press **<Enter>** to continue.

For QDR 4500A and QDR 4500SL systems, place the digital level on top of the C-arm and use the Table IN/OUT switch on the operator panel to move the C-arm until it is level ($\pm 0.1^\circ$). It is not necessary for this procedure that the C-arm be *exactly* level, only that it is sufficiently close that subsequent relative rotations do not hit the table).

3. Remove the level and then press **<Enter>**. The program prompts:

Press <Enter> when the TX motor reaches the OUTER mechanical limit.
--

Press <ESC> to stop calibration.

When TX hits the outer mechanical stop the first time,

4. Press **<ESC>**.

The program returns to the **MOTOR\$TX** menu page (below). In the right hand column of the display, eight lines from the bottom (and highlighted in the figure below), is the raw a/d

readback of the motor encoder (in the example below, it is 2048). Manually rotate the encoder until the readback is 1000 ± 100 (i.e., in the range 900-1100) and then secure the encoder to the drive shaft.

Repeat the calibration procedure above but now, when TX hits the outer mechanical stop,

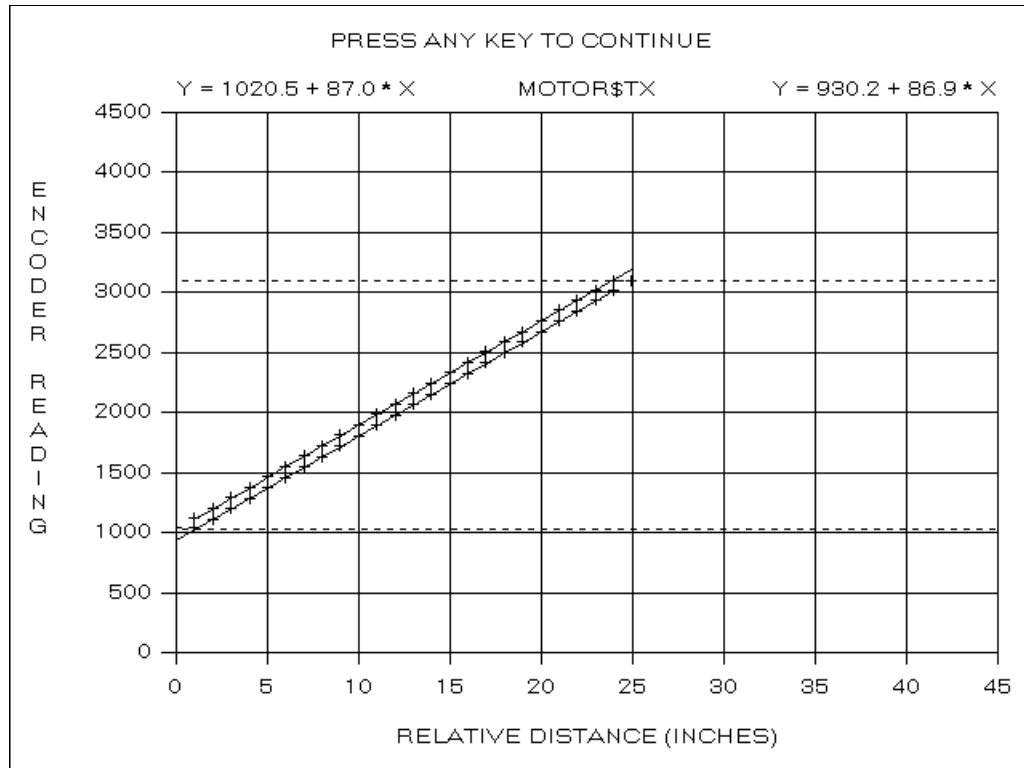
5. Press **<Enter>**.

The program switches to graphics mode and draws the Encoder Vs Distance calibration grid. It moves the TZ motor to its topmost position and then steps the TX motor in by 1" increments until the inner mechanical stop is hit (while simultaneously rotating the C-arm to keep the table and C-arm from hitting). The program plots the encoder data during the scan (in raw encoder units, 0-4095).

6. Press **<ESC>** at anytime during the scan to terminate the calibration procedure.

MotionState	NONE	OnLine	1
DeviceState	E_OK	EmergencyStop	0
MotionError	E_OK	InterlockInhibit	0
PosMotionSwitch	0	CollisionImminent	0
NegMotionSwitch	0	LocalMotionEnable	0
PosLimitSwitch	NONE	C/C Version	0.00
NegLimitSwitch	NONE	# C/C Interrupts	1133(0)
Position	298545	# DOS Interrupts	191
MoveState	DONE	StepStatus	0
FirstRate	3600	AccelType	1
FinalRate	36003	Direction	1
HoldPower	LOW	HoldPower	1
StepPower	MEDIUM	StepPower	2
AccelDistance	2004	InputSwitches	3
AccelType	1	Position	2048
MinMotion	0	NegLimitPosition	1026
MotionDetect	0	PosLimitPosition	3096
PosLimitPosition	604684	FirstRate	300
NegLimitPosition	0	FinalRate	3000
PositionAverage	1	AccelSteps	167
DriverVersion	3.41	NumberOfSteps	50000
DeviceVersion	2.03	RateScaleFactor	1
T1	T		
MOTOR\$TX>			

Section 4 - Alignment & Calibration



When the calibration scan completes, the program computes the linear fits to the positive and negative motion. The linear fit parameters are displayed at the top left and top right of the plot in the form $Y = \text{Intercept} + \text{Slope} * X$. The two slopes (87.0 and 86.9 in the example below) should be within 0.3 of each other.

The program displays the positive and negative limits as horizontal dashed lines (

Note: The *PosLimitOffset* and *NegLimitOffset* entries in the *[TxMotor]* section of the *hardware.ini* file determine the motion limits relative to the mechanical stops. If these entries are not present, or are zero, the motion limits are set to the mechanical limits.

The program then changes the plot title to **PRESS ANY KEY TO CONTINUE**. Press the **<Enter>** key and the program prompts

```
motor_direction=1
calibrate_position=1,2287,27446,43,12563,1026,1026,3096
pos_limit_position=604777
neg_limit_position=0

Update Driver INI-File [Y/N] ?
```

The **motor_direction**, **calibrate_position**, **pos_limit_position** and **neg_limit_position** fields have the same interpretation as discussed under MOTOR\$AY.

Type **Y<Enter>** to accept the calibration values or **N<Enter>** to reject them.

Note: The last calibration scan data is saved in the file **MOTOR_TX.DAT**. You can reanalyze the data—e.g., after editing *hardware.ini*—by typing the command **CALIBRATE @MOTOR_TX.DAT** at the **MOTOR\$TX>** prompt in **SQDRIVER.EXE**.

MOTOR\$AR (QDR 4500A and SL)

Before beginning this procedure, make sure that the AR motor encoder *is not* clamped to the drive shaft tubing.

1. Select the AR motor device driver by typing **MOTOR\$AR<Enter>**
2. Then, at the **MOTOR\$AR>** prompt in **SQDRIVER.EXE**, type **CALIBRATE<Enter>**

The program prompts:

Press <ESC> to stop calibration.

The program moves the TY and AY motors to their center positions, then moves the TZ motor to its topmost position and prompts:

Use the Table IN / OUT switch to move the C-Arm to 0 degrees.
--

Press <Enter> when the C-Arm is positioned.
--

Press <ESC> to stop calibration.

3. Remove the bottom C-arm cover.
4. Place the digital level on the bottom of the C-arm tank assembly (*not on the top of the C-arm*) and use the Table IN/OUT switch on the operator panel to move the C-arm until it is level $\pm 0.1^\circ$.
5. Remove the level
6. Press **<Enter>**.

The program prompts

Press <ESC> to stop calibration.

The program moves the TZ table to its top most position and moves the TX table inwards until it almost touches the C-arm. It rotates the C-arm by 2 degrees to obtain an initial estimate of the encoder calibration and then prompts

Press <Enter> when the AR motor reaches the AP mechanical limit.

Press <ESC> to stop calibration.

Section 4 - Alignment & Calibration

The program rotates the C-arm counter clockwise (i.e., the tank assembly moves away from the front of the machine). When the C-arm hits the AP mechanical limit the first time,

7. Press <ESC>.

In the right hand column of the display, eight lines from the bottom (and highlighted in the figure below), is the raw a/d readback of the motor encoder (in the example below, it is 2048). Manually rotate the encoder until the readback is 250 ± 50 (i.e., in the range 200-300) and then clamp the encoder to the drive shaft, making sure not to over stress the clamp. Before repeating the calibration procedure, rotate the C-arm back to approximately 0° by

8. Typing the command `MOVE_REL 1470`

MotionState	NONE	OnLine	1
DeviceState	E_OK	EmergencyStop	0
MotionError	E_OK	InterlockInhibit	0
PosMotionSwitch	0	CollisionImminent	0
NegMotionSwitch	0	LocalMotionEnable	0
PosLimitSwitch	NONE	C/C Version	0.00
NegLimitSwitch	NONE	# C/C Interrupts	1619(0)
Position	1836	# DOS Interrupts	265
MoveState	DONE	StepStatus	0
FirstRate	33	AccelType	0
FinalRate	331	Direction	1
HoldPower	OFF	HoldPower	0
StepPower	MEDIUM	StepPower	2
AccelDistance	0	InputSwitches	3
AccelType	0	Position	2048
MinMotion	0	NegLimitPosition	250
MotionDetect	0	PosLimitPosition	3831
PosLimitPosition	5063	FirstRate	300
NegLimitPosition	-1420	FinalRate	3000
PositionAverage	1	AccelSteps	0
DriverVersion	3.41	NumberOfSteps	50000
DeviceVersion	2.03	RateScaleFactor	1
MOTOR\$AR>		E_OK	

Wait until the rotation completes and then repeat the calibration procedure above but now, when the C-arm hits the AP mechanical stop,

9. Press <Enter>.

The program prompts

Press <ESC> to stop calibration.

and moves the C-arm back to the approximate 0° position. The program then prompts

Use the Table IN / OUT switch to move the C-Arm to 0 degrees.

Press <Enter> when the C-Arm is positioned.

Press <ESC> to stop calibration.

Place a level on top of the X-ray tank assembly (*not* the top of the C-arm) and use the Table IN/OUT switch on the operator panel to move the C-arm until it is level $\pm 0.1^\circ$. Remove the level and then

10. Press <Enter>.

The program prompts:

Press <ESC> to stop calibration.

and moves the C-arm and the X-table together until the C-arm is at approximately 83°. It then changes the prompt to:

Press <Enter> when the AR motor reaches the LATERAL mechanical limit.

Press <ESC> to stop calibration.

and begins rotating the C-arm clockwise (i.e., the tank assembly moves toward the front of the machine). When the C-arm hits the LATERAL mechanical limit,

11. Press <Enter>.

The program prompts

Press <ESC> to stop calibration.

and moves the C-arm back to the approximate 83° position. The program then prompts:

Use the Table IN / OUT switch to move the C-Arm to 83 degrees.

Press <Enter> when the C-Arm is positioned.

Press <ESC> to stop calibration.

12. Place the digital level on top of the X-ray tank assembly and use the Table IN/OUT switch on the operator panel to move the C-arm until it is at $83^\circ \pm 0.1^\circ$ (do *not* make this measurement with the cosmetic covering on the tank assembly).

13. Remove the level and then press <Enter>.

The program prompts:

Section 4 - Alignment & Calibration

Press <ESC> to stop calibration.

and moves the C-arm and the X-table back to their initial 0° positions.

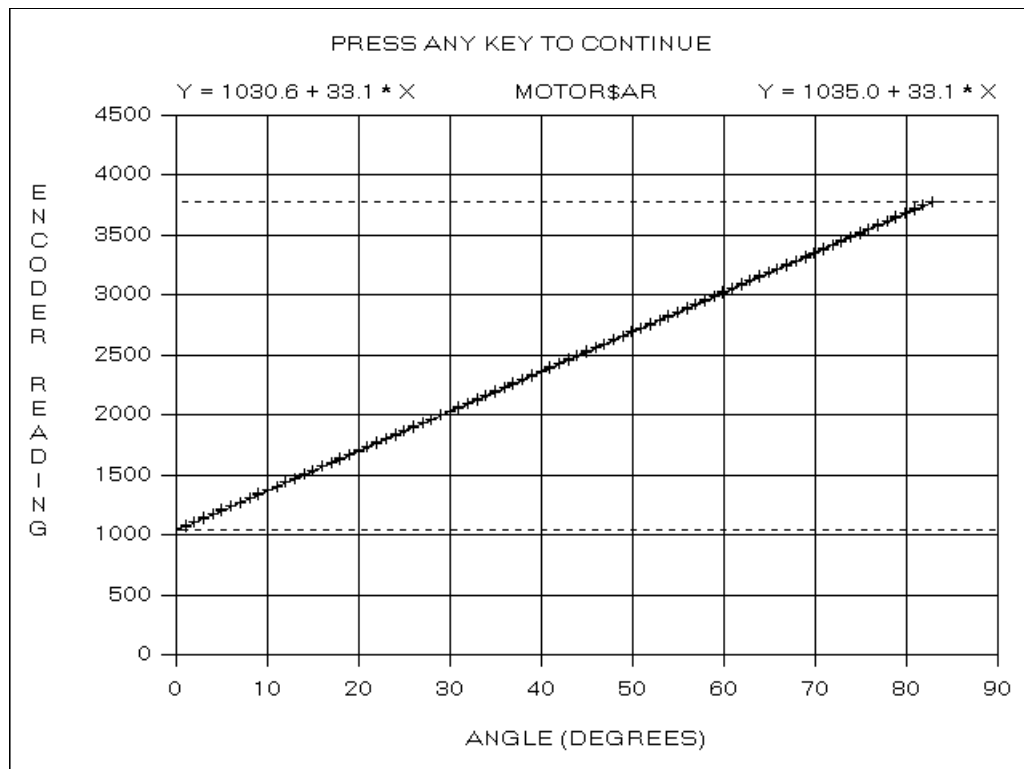
The program then switches to graphics mode and draws the Encoder Vs Angle calibration grid. It steps the AR motor clockwise in 1° increments until the motor reaches the 83° position and then steps the AR motor counter clockwise in 1° increments until the motor return to approximately 0°. The program plots the encoder data during the scan (in raw encoder units, 0-4095).

Note: Press <ESC> anytime during the scan to terminate the calibration procedure.

When the calibration scan completes, the program computes the linear fits to the positive and negative rotation. The linear fit parameters are displayed at the top left and top right of the plot in the form $Y = \text{Intercept} + \text{Slope} * X$. The two slopes should be within 1% of each other.

The program displays the positive and negative limits as horizontal dashed lines

Note: The *PosLimitOffset* and *NegLimitOffset* entries in the *[ArMotor]* section of the *hardware.ini* file determine the motion limits relative to the mechanical stops. If these entries are not present, or are zero, the motion limits are set to the mechanical limits.



The program then changes the plot title to

PRESS ANY KEY TO CONTINUE

14. Press the <Enter> key and the program prompts:

<pre> motor_direction=0 calibrate_position=1,50771,5601,2747,4980,1035,265,3831 pos_limit_position=5069 neg_limit_position=-1395 Update Driver INI-File [Y/N] ? </pre>

The **motor_direction** field determines whether the positive step direction is the *reverse* of the direction of increasing encoder values ('0' if the direction is *not* reversed, '1' if it is). This value is set from the corresponding parameter in the MOTOR_AR.PRO file and is a constant for each motor (i.e., the direction of increasing encoder values must agree with the system coordinates and the positive step direction is set by the wiring harness for the stepper motor).

The eight **calibrate_position** fields are:

- 1) **1** (Tolerance). The \pm position tolerance, in encoder ticks, for absolute moves. The calibration program sets this field to the value found in the corresponding **calibrate_position** field in the MOTOR_AR.PRO file.
- 2,3) **50771,5601** (NumberOfSteps,StepDistance). The number of motors steps corresponding to the step distance in minutes of rotation. The ratio of these two numbers determines the step size. The calibration program calculates these fields based on the measurements of the 0° and 83° positions.
- 4,5) **2747,4980** (NumberOfTicks,TickDistance). The number of encoder ticks corresponding to the tick distance in minutes of rotation. Again, it is the ratio of these two numbers that determines the encoder calibration. These numbers will generally change from calibration to calibration (although the ratio should remain approximately the same).
- 6) **1035** (EncoderOffset). The value subtracted from the encoder readback to set the origin of motion. The origin of AR motion is the 0° position, so this value is the encoder reading at 0°.
- 7,8) **265,3831** (NegLimit,PosLimit). The encoder readings for the negative (counter clockwise, or AP) and positive (clockwise, or LATERAL) mechanical stops.

The **pos_limit_position** and the **neg_limit_position** are the limits of motion, in minutes of rotation, in the clockwise and the counter clockwise direction

Note: The *PosLimitOffset* and *NegLimitOffset* entries in the [ArMotor] section of the *hardware.ini* file determine the motion limits relative to the mechanical stops. If these

Section 4 - Alignment & Calibration

entries are not present, or are zero, the motion limits are set to the mechanical limits, as in the above example.

Type **Y<Enter>** to accept the calibration values or **N<Enter>** to reject them.

Note: The last calibration scan data is saved in the file **MOTOR_AR.DAT**. You can re analyze the data—e.g., after editing *hardware.ini*—by typing the command **CALIBRATE @MOTOR_AR.DAT** at the **MOTOR\$AR>** prompt in **SQDRIVER.EXE**.

LASER POSITIONING OFFSET ADJUSTMENT

Center the table and arm using Center Table, or utility A/P position feature. Turn on the laser and set it on the point of a sharp object. At the DOS prompt type **SCANSQ -PNOFLAT** and begin a scan. Using the F3 function, realign the arm to the proper position and exit before the scan begins. Turn on the laser and physically adjust back to the point of the object as follows:

1. Locate the 3 laser adjustment screws (small Phillips) under the C-arm. Adjust these screws until the laser cross-hair is on the pointed object.
2. Run another scan to check your adjustments.

A/D GAIN CONTROL ADJUSTMENT

Before performing the A/D Gain Control Adjustment, check the Hi/Lo Resolution jumper in the upper left corner of the ADC board (the jumper is in for high resolution).

In order that all QDR 4500 machines have the same input to the A/D converter, regardless of slight variation in X-ray flux detected, a potentiometer has been installed on the unit's ADC board. ***All covers, that are normally in the X-ray beam, must be on.*** This potentiometer is set as follows:

1. With the table all the way down, go to survey program **SUSQ** located in the **MENU** directory.
2. Set Pulse to 1. ALT-p
3. Set High gains to 1 for QDR 4500A and SL. Set High gains to 2 for QDR 4500W and C.
4. Set Low gains to 0 for QDR 4500A and SL. Set Low gains to 1 for QDR 4500W and C.
5. Set X-ray Mode to 3.
6. Set Aperture to 11 (this step for QDR 4500A and SL only).
7. Bring up graphic display. CTRL PGDN
8. Set to observe Hi Air.
9. Turn on X-rays and observe the screen. Check that the X-ray level on the display is between 4.5V and 8.5V. The graph should be approximately even from front to back. If it is not, it indicates that the source and detector may require alignment. If any part of the graph is below 4.5V or above 8.5V, it may indicate either bad detector(s), or an adjustment is required. Note that a "spike" or "absence" may indicate a bad detector.

DO NOT ADJUST THE A/D GAIN UNLESS ABSOLUTELY NECESSARY. Any adjustment of this potentiometer affects the QC highs and lows.

If an adjustment is required, proceed as follows:

The object is to have all the detectors fall within the 4.5V and 8.5V range, so first adjust the average signal level to approximately 6.25V, then check to see if all the detectors are now within the 4.5V and 8.5V range. If they are, the adjustment is complete. If they are not, adjust the gain (in the required direction) until all the detectors are within the 4.5V and 8.5V range.

BEAM FLATTENING

WARNING: X-rays are being generated during this procedure. Keep hands, head and other body parts out of beam.

This procedure flattens the X-ray beam for each scan mode.

Note: All covers, table mat, etc., normally in the X-ray path, must be on the Scanner before running beam flattening.

1. From DOS type BIGFLAT. This move the table and arm to the correct position and turns on the laser.
2. Place the phantom on end (vertical) with the laser 1.5" in from the left end and centered (some phantoms will have a target hole, if not, use a ruler).
3. Press <Esc> <Esc>.
4. Go to survey program SUSQ located in the MENU directory.
5. Set Pulse 1.
6. Set Gains 2, 1.
7. Set Mode 3.
8. Set Aperture to 7 (this step for QDR 4500A and SL only).
9. Bring up graphic display. CTRL PGDN
10. Turn on X-rays and observe the screen.
11. Check that phantom covers the whole beam. This is critical. If phantom does not cover the whole beam, move it until it does. Keep the phantom as straight as possible.
12. Turn off X-rays. Exit to the DOS prompt.
13. From the DOS prompt type BIGFLAT. A scan that moves the beam off the phantom then onto the "tissue" part of the phantom, is performed for each mode. This takes about 30 minutes.
14. When flattening is complete, run a QC scan and ignore it.
15. Using the phantom, run an AP/Lateral pair.

Section 4 - Alignment & Calibration

16. Go to the Utility Menu, choose Service, then choose Plot. Using diags and windowing check for flatness.

X-RAY BEAM ALIGNMENT "AIRSCAN" TEST

This procedure verifies proper X-ray beam alignment (for 4500A and W only):

1. Type WBAIRQC in the Patient Biography. Enter the serial number of the unit in the Patient ID field.
2. Perform one Whole Body *air* scan (a scan with nothing on the table) from the Hologic main menu.

Make sure that only the pad is on the table. Clear the table of anything else. From the main menu, select scan, then whole body, then press <F10>.

Note: Do NOT interrupt the scan for any reason.

3. Exit to DOS. Insert the AIRSCAN.EXE test tool (part #099-0628) into the floppy drive.
4. At the DOS prompt, type GETSCAN<Enter>.
5. Select the Whole Body scan.
6. From the C:\MENU> prompt, type A:\AIRSCAN<Enter>.

The monitor displays a screen similar to the following:

```

C:\MENU>airscan
Selected scan = \xcddata\PO98C09A.P00
Total points per phase in row: 109
Total lines in column: 150
lowair lines with a standard deviation greater than 2.0
phase   line   mean   stdev   min   max
1        0    584.16  2.06    581    598
1        1    584.17  2.08    581    599
Global Stats:
1          584.51  1.52    580    599
lowair columns with a standard deviation greater than 2.0
phase   line   mean   stdev   min   max
1        0    584.73  3.54    580    599
1       108    583.74  2.38    581    593
\ MENU\

```

The example screen (above) shows that there were 2 lines (1) and 2 columns (3) with a standard deviation (S.D.) of greater than 2.0 and that the global S.D. is 1.52 Keith units (Kth).

If the Global S.D. (2) is less than 2.0, the instrument is properly aligned.

Section 4 - Alignment & Calibration

If the global S.D. is greater or equal to 2.0, then the machine is not aligned properly. Check the following:

- If the image appears "streaky" or "banded", check for loose wires or other debris between the table and the tank.
- Check the C-arm parallelism (page 4-3).
- Check the aperture alignment (page 4-9).
- Check beam flattening (page 4-28).
- Re-run daily QC (see the *QDR 4500 User's Guide*).

After realignment, repeat the AIRSCAN test. If the global S.D. is less than 2.0, you are done. If the global S.D. is equal or greater than 2.0, the non-uniformity may be attributed to the table itself. If so, continue with this procedure.

Check to see if the machine has body composition loaded. Then follow the appropriate procedure below.

Machines using Body Composition Analysis (BCA)

Machines performing BCA must be held to having a global S.D. of less than 2.0. If the realignment and recalibration above has been performed, then the table top needs to be replaced.

Note: Archive the airscans you have acquired and either e-mail or Fed. Ex. them to a Hardware Support Specialist for final evaluation.

Machines using BMD Whole Body Analysis

Machines using only BMD Whole Body measurements can tolerate a larger S.D. If the global S.D. is less than 3.0, then you are done. If the S.D. is equal or greater than 3.0, then the table top needs to be replaced.

Note: Archive the airscans you have acquired and either e-mail or Fed. Ex. them to a Hardware Support Specialist for final evaluation.

If the customer upgrades to the Body Composition Analysis option, you must re-evaluate the table global S.D. to less than 2.0.

LATERAL ALIGNMENT TEST (QDR 4500A AND SL)

This procedure verifies lateral alignment.

1. Press Center Table on the control panel to move the table and C-Arm to the center position.
2. Press Laser on the control panel to turn the laser light on.
3. Place the spine phantom on the table top so the laser is on the laser target and the vertebrae are to the right of the laser (use the same target used for normal QC scans).

4. From the main menu, press <P> for biograPhy, <Insert> to add, and choose spine phantom biography.
5. From the main menu, press <S> to Scan, <L> for AP/Lateral, then <1> for AP setup. The laser will turn on and a message will appear on the monitor to check the laser targeting. Re-check the laser targeting and move the phantom if necessary (do not move the arm or table).
6. Press any key to continue.
7. Press <2> for AP Scan.
8. Press <A> for Array.
9. Type "6" followed by <F10> to run a six inch scan.
10. Upon completion, press <A> to Analyze.
11. Press <End> three times to begin analysis.
12. At the "Insert or delete points..." prompt, press <End>.
13. A dashed line will appear (centerline) and an angle will be displayed just below the scan. The angle must be between -2 and +2 degrees.
14. Press <End> twice to complete the analysis.
15. Press <Esc> to return to the Lateral Scan menu.
16. Press <3> to perform a Lateral Setup.
17. A message will appear asking you to hold the Enable Motion switch (on the control panel) while the arm moves to the Lateral position.
18. Hold down the Enable Motion switch until the arm and table are in the lateral position. When the motion is complete, the Lateral Scan menu will appear on the screen.
19. Press <4> for Lateral scan.
20. Press <F> for Fast Array scan.
21. Press <F10> to begin scanning.
22. Upon completion, press <5> to return to the AP position. A message will appear to hold down the Enable Motion switch while the system moves into position.
23. Hold down the Enable Motion switch until the arm and table return to the AP position. When the motion is complete, the Lateral Scan menu will appear on the screen.
24. Press <6> to analyze the Lateral Scan.
25. Press <A> to analyze.
26. Press <Enter> and use the arrow keys to change the level and width (contrast) until the posterior elements of the spine are visible. Press <Enter>.
27. Press and use the arrow keys to make the ROI vertical. Press <Insert> and use the left and right arrow keys to align the left edge of the ROI with the edge of the posterior elements of the spine.

Section 4 - Alignment & Calibration

28. Press <PrintScreen> to make a hard copy of the scan.

The following conditions must be met:

- The posterior elements of the spine must be clearly and completely visible on the left side of the scan.
- If there is a black stripe on the extreme left edge of the scan, the collimation and/or flattening is incorrect; notify Hologic Customer Service.
- Refer to the printout. Below the scan, the ROI location is indicated as "##x##" at [nn, ##]" where nn is the distance from the left side of the scan to the ROI. There should be 7 channels, or less, distance between the left edge of the scan and the edges of the posterior elements of the spine. The "nn" is the number of channels from the left edge of the scan, and should be less than, or equal to, 7.

AREA, BMD AND BMC CALIBRATION

Calibration for Area, BMD and BMC is accomplished in 3 stages:

- a) Array Scan Thickness Measurement & Calibration
- b) Calibration of Area and BMC, for Array Scan Modes
- c) Adding Array AP and Fast lateral scans to the QC database

Follow the procedure, in order, and exactly as shown, for each stage of the calibration.

Note: If the QDR 4500 being installed is to replace an existing QDR (model 2000*plus*, 2000, 1500, 1000*plus*, 1000 or 1000/W) then a cross-calibration must first be performed to ensure that any longitudinal studies begun on the QDR being removed can safely be continued on the new QDR 4500. *Perform the cross-calibration before de-installing the existing QDR.*

Note: To ensure stability, the machine must be completely powered up for a minimum of 30 *minutes* prior to running any of the following tests. Also, because the table top pad will have a slight affect on the test results, all scans *must* be performed with it in place.

WARNING: X-rays are produced during most of these tests. Keep hands, head and other body parts out of the X-ray beam path. The tester should also be wearing an approved radiation dosimetry badge.

Scan Thickness Measurement & Calibration (QDR 4500A and SL)

1. From the QDR patient menu, select the spine phantom to be used for checking the array scan modes. This should be the one shipped with the machine.

Note: Be sure the spine phantom has been entered in the patient database in the form of "Spine Phantom #*nnn*" (where *nnn* is the number of the phantom) so that the QC plot program can identify it properly.

2. Place the phantom on the table and set it up using the AP/Lateral setup as follows: press S for Scan, then L for AP/Lateral, then choose 1 for (1) *AP SETUP*.
3. Press and hold Enable until the arm and table move into position.

Note: Do not move the arm or table, otherwise the test will have to be started over.

4. When the laser comes on, place the phantom so that the laser dot is on the centerline of the phantom, 1/2" from the left end, shining on the phantom target. The sides of the phantom should be aligned parallel to the table, using a ruler if necessary.
5. The AP/Lateral menu should now appear on the screen.
6. Choose 2 for (2) *AP SCAN*, then A for array spine.
7. Change the scan length to 6 inches (15.25cm for metric units), and Press <F10> to begin the scan.
8. When the scan has finished, analyze it following the standard AP scan analysis routine (i.e., analyze L1 through L4).
9. At the conclusion of the regular analysis, the scan will reappear on the screen along with two red lines and a dashed centerline. The vertebrae **must** be centered and completely contained between the two red lines. The angle (shown in degrees) directly below the scan indicates the misalignment of the spine phantom and it **must** be between ± 2 degrees. If the angle is greater than this, start the test over (from Step 4), using a ruler if necessary to correctly align the phantom.
10. If the angle of the phantom is less than ± 2 degrees, press <End>. A blue arrow will now appear near the bottom of the screen, indicating where the lateral scan is to begin.
11. Press <End>. The final AP analysis report will now appear on the screen.
12. Press <Esc>. The AP/Lateral menu will now appear on the screen.
13. Choose 3 for (3) *LAT SETUP*.
14. Press and hold Enable until the arm and table move into position.
15. Choose 4 for (4) *LAT SCAN*, then press <F> for fast array, and then press <F10> to start.
16. Choose 5 (Return to AP), and press enable.
17. Choose 6 (Analyze Lateral Scan).

Note: Only L2 through L4 will be analyzed in lateral scans.

18. Set the Global Region of Interest (ROI):

The scan will appear with a global ROI determined by the ROI used in the AP scan analysis. Press "T" (to select the top of the ROI) and using the ← and → keys, make the sides of the ROI box vertical.

19. Press <Insert> (to select entire ROI box) and use the ← and → keys to position the box so that the middle line (the "bisecting" line) is 2 lines to the left of the edges of the vertebral bodies, separating them from the posterior elements of the spine phantom.

Section 4 - Alignment & Calibration

Press <PgDn> (to select the bottom right side of the ROI box) and using the ← and → keys, set the right edge of the ROI roughly 1/2 of a vertebral body width away from the right hand edges of the vertebrae.

Press <PgUp> (to select the top left side of the ROI box) and using the ← and → keys, set the left edge of the ROI, 5 lines to the right of the leftmost edges of the posterior elements of the spine.

19. When completed press <End>.
20. Verify the Intervertebral Markers. These markers are set automatically and should not be adjusted, Press <End>.
21. Labeling the Vertebrae is also automatic, Press <End>.
22. To set the Sub-Region: Use the ← and → keys to set the right edge of the (dashed) sub-region 4 lines to the right of the right edges of the vertebral bodies, then Press <End> (to end Sub-Region positioning).
23. The program will begin the analysis, and in about 10 seconds, Press <End> again (to finish the analysis).
24. The lateral analysis report will appear. Press <Esc> (to return to the main menu).
25. Start the Field Service Calibration program by exiting to DOS (<Alt> <F1>) and, at the DOS prompt, typing FSCAL <Enter>.
26. The following FSCAL opening menu appears:

```

.
*****
*
*               FIELD SERVICE MENU
*               *****
*      RECALIBRATION OF CAL PARAMETERS
*      *****
*
*      n :  update ARRAY PHANTOM No. and HEIGHT
*
*      s :  His\Los for ARRAY SPINE phantom
*      l :  His\Los for ARRAY LATERAL phantom
*      e :  write temporary results
*
*      a :  for ARRAY SPINE ACF/BCF
*      w :  final write to ARRC.TXT file
*
*
*      x :  to EXIT
*
* YOUR CHOICE IS:

```

27. Press "S" <Enter> to select the "s: His\Los for ARRAY SPINE phantom" option and to calculate the new thickness indicators for array spine mode (HIA_N, LOA_N, HIT_N, and LOT_N).
28. Press "+" to select the **AP spine scan**, performed at Step 6 above, using the array scan mode. The program will then calculate new HIA_N, LOA_N, HIT_N, and LOT_N values and present them on the screen.

WARNING: Do not modify any values.

29. Press <F10> (to display the second screen).
30. Press <F10> again (to accept the values). The program will now verify that these values are within specification, display those which are out of range, and return to the FSCAL opening menu.
31. Press "L" <Enter> to select the "l: His\Los for ARRAY LATERAL phantom" option and to calculate the thickness indicators for fast lateral spine mode (HIA_NL, LOA_NL, HIT_NL, and LOT_NL).
32. Press "+" to select the **fast lateral spine scan** performed at Step 15 above. The program will then calculate new HIA_NL, LOA_NL, HIT_NL, and LOT_NL values and present them on the screen.

WARNING: Do not modify any values.

33. Press <F10> (to display the second screen).
34. Press <F10> again (to accept the values). The program will now verify that these values are within specification, display those which are out of range, and return to the FSCAL opening menu.
35. Press "E" <Enter> to select the "e: write temporary results" option, which will write the calculated values into the ARRC.TXT file and then return to the FSCAL opening menu.
36. Press "X" <Enter> to EXIT the FSCAL program.

Scan Thickness Measurement & Calibration (QDR 4500W and C)

1. From the QDR patient menu, select the spine phantom to be used for checking the array scan modes. This should be the one shipped with the machine.

Note: Be sure the spine phantom has been entered in the patient database in the form of "Spine Phantom #nnn" (where nnn is the number of the phantom) so that the QC plot program can identify it properly.

2. Press Center Table.
3. Turn on the laser.
4. With the laser on, place the phantom so that the laser dot is on the centerline of the phantom, 1/2" from the left end, shining on the phantom target. The sides of the phantom should be aligned parallel to the table, using a ruler if necessary.

Section 4 - Alignment & Calibration

5. From the main menu select **Scan**, then **Spine**, then **Array**.
6. Change the scan length to 6 inches (15.25cm for metric units), and Press <F10> to begin the scan.
7. When the scan has finished, analyze it following the standard AP scan analysis routine (i.e., analyze L1 through L4).
8. Press <End>. The final AP analysis report will now appear on the screen.
9. Start the Field Service Calibration program by exiting to DOS (<Alt> <F1>) and, at the DOS prompt, typing FSCAL <Enter>.
10. The FSCAL opening menu appears (above).
11. Press "S" <Enter> to select the "s: His\Los for ARRAY SPINE phantom" option and to calculate the new thickness indicators for array spine mode (HIA_N, LOA_N, HIT_N, and LOT_N).

```
*****
*                                     *
*               FIELD SERVICE MENU   *
*               *****             *
*          RECALIBRATION OF CAL PARAMETERS
*          *****
*
*      n :  update ARRAY PHANTOM No. and HEIGHT
*
*      s :  His\Los for ARRAY SPINE phantom
*      l :  His\Los for ARRAY LATERAL phantom
*      e :  write temporary results
*
*      a :  for ARRAY SPINE ACF/BCF
*      w :  final write to ARRC.TXT file
*
*
*      x :  to EXIT
*
* YOUR CHOICE IS:
```

12. Press "+" to select the **AP spine scan**, performed at Step 6 above, using the array scan mode. The program will then calculate new HIA_N, LOA_N, HIT_N, and LOT_N values and present them on the screen.

WARNING: Do not modify any values.

13. Press <F10> (to display the second screen).
14. Press <F10> again (to accept the values). The program will now verify that these values are within specification, display those which are out of range, and return to the FSCAL opening menu.
15. Press "E" <Enter> to select the "e: write temporary results" option, which will write the calculated values into the ARRC.TXT file and then return to the FSCAL opening menu.

16. Press "X" <Enter> to EXIT the FSCAL program.

Calibration of Area and BMC, for Array Scan Modes

After the machine has been calibrated for thickness measurement in the array mode, it must be calibrated for the array AREA and BMC measurements.

1. Run 20 (medium) array scans by typing SCANSQ -PAP7SP60 -N20 -L6 (this will take approximately 20 minutes, slightly longer on 50Hz machines).
2. When the scans have finished, return to the QDR software menu (type MAINMENU <Enter>) and analyze the first scan using the default ROI. Compare each succeeding scan to the first scan, using *compare*.
3. Once all of the scans have been analyzed, return to DOS (simultaneously press <Alt> <F1>) and at the DOS prompt type FSCAL <Enter>.
4. Press "A" <Enter> to select the "a: for ARRAY SPINE ACF/BCF" option and to calculate new ACF and BCF correction factors for the spine phantom used in the array scan mode. The program will then display the **Array** spine phantom's serial number and its appropriate Area and BMC values. *Do **not** change these values unless directed to do so by an Hologic representative.*
5. Press <Y> to verify the correct phantom serial number, area and BMC.
6. Press "+" to select the **20 (medium) array spine scans** from Step 1 above.

The program will then calculate new Array ACF and BCF values, and display them on the screen along with the averages from the 20 scans, their upper and lower limits, and their CV's.

Answer [Y]es/[N]o <Enter> to the query if you want to proceed/not proceed to update the existing ACF and BCF values in the ARRC.TXT file with the new calculated values. A screen with all the values will then be presented.

7. Make a note of the ACF and BCF values, then verify that ACFL is equal to ACF and BCFL is equal to BCF. If they are not equal, edit the ACFL and BCFL fields to make ACFL=ACF and BCFL=BCF.
8. Press <F10> (to have the second screen displayed). Verify that the ACFT is also equal to ACF and the BCFT is equal to BCF. Again, if necessary, edit the ACFT and BCFT fields to make ACFT=ACF and BCFT=BCF.
9. Press <F10> (to accept the values). The program will now verify that these values are within specified limits and display those that are out of range. You will then be returned to the FSCAL opening menu.
10. Press "W" <Enter> to select the "w: final write to ARRC.TXT file" option. The program will then update the ARRC.TXT file and return to the FSCAL opening menu.

The following messages appear:

Modified ARRC.TXT

Section 4 - Alignment & Calibration

Modified ENVIRON.BAT

Press CTRL - ALT - DEL

11. Press CTRL - ALT - DEL to re-boot the computer.
12. After re-boot, print the ARRC.TXT file by typing COPY \XCADATA\ARRC.TXT LPT1:
13. Verify that $ACF = ACFL = ACFT$, and $BCF = BCFL = BCFT$.
14. Print ENVIRON.BAT and verify that ACF and BCF are the same as in ARRC.TXT.

Adding Array AP Scans to the QC Database

Once the unit has been calibrated, AP scans must be re-analyzed and added to the QC database.

1. Perform the following procedure on the AP Array scans acquired in Step 1 of the *Calibration of Area and BMC, for Array Scan Modes* section above.
2. Exit to the DOS prompt, System disk, Menu directory.
3. Type RECALYZE. At the message type any key.
4. At the scan selection menu, select the scans to be re-analyzed (i.e. scans acquired in Step 1 of the *Calibration of Area and BMC, for Array Scan Modes* section above) and type <Enter>. The re-calibration analysis is complete when the system returns the prompt.
5. Once all the scans have been analyzed, add them to the QC database. Beginning from the main QDR menu, press "Q" for *QC*, then press "A" for *Add*, and then select the 20 (medium) array AP scans to be added to the QC database.
6. Select the PLOT option (also under the QC menu) to plot a AREA, BMC and BMD plot for each array mode.
7. Ensure that all scans fall between the two dotted white limit lines.
8. Print the BMD, BMC and Area QC plots. Include them with the other paperwork being returned to Hologic.

Note: For more details on performing the QC setup and producing QC plots, refer to the QDR 4500 User's Guide.

Sample ENVIRON.BAT (Environment/Calibration) File

ENVIRON.BAT Variables	Set by...	Descriptions
SET MODEL=QDR 4500 S/N 45006	Factory	QDR model and serial number.
SET INSTITUTION=Hologic	Fact. or F.S.	Name of institution where unit is to be installed.
SET ACF=1.021550	Fact. or F.S.	Area Correction Factor for Whole Body and Forearm scans
SET BCF=1.005450	Fact. or F.S.	Bone Correction Factor for Whole Body and Forearm scans
SET Q1=0.618,0.617	Factory	Thin,
SET Q2=1.029,0.980	Factory	Medium, and
SET Q3=1.623,1.445	Factory	Thick pencil beam calibration constants used to compensate for non-linear X-ray hardening effects of bone. The first set of numbers are the true densities of three (thin, medium, and thick) bone equivalent blocks, while the second set of numbers are the measured densities.
QDRPARM	-	Allocates 1K of memory to be used as a holding place for information which all Hologic programs can share.
\FLANGENG\SETQPRM	-	Initializes the memory set aside by QDRPARM with the appropriate language values specified by the directory name \FLANG???. The current options are "ENG" for English, "FRN" for French, and "DEU" for German.
COMMAND /C PATINIT /E:512	-	Checks for the presence of a <u>patient</u> database and asks if one should be initialized if none is found.
COMMAND /C QCINIT /E:512	-	Checks for the presence of a <u>QC</u> database and asks if one should be initialized if none is found.
MAINMENU	-	Executes the QDR main software menu program.

Sample ARRC.TXT (Array Calibration) File

ARRC.TXT Variables	Set by...	Descriptions
USE = 0	Factory	A variable used by the software to determine what parameters to use for scatter correction. It can be set to one of four possible values (0, 1, 2, or 3) but should <u>always</u> be set to 0 .
Q4 = 0.651 1.013 1.461	Factory	These numbers are similar to the Q1, Q2, and Q3 numbers in ENVIRON.BAT, except these are used for all array modes. The numbers are determined by measuring a three-step (thin, medium, and thick) block phantom at the factory.
Q4_HAT = 0.617 0.980 1.445	Factory	Similar to Q4, only the measurements are taken on the block phantom with extra absorber material placed on top of it.
T4 = 2.628	Factory	Thickness (height in inches) of the block phantom.
T4_HAT = 7.00	Factory	Thickness (height in inches) of the block phantom with extra absorber.
DELTA0 = 0.493	Factory	Thickness of tissue segment in the filter wheel.
T0_N = 6.85	Fact. or F.S.	Overall height of the phantom (in inches) shipped with the QDR 4500. (Varies with each phantom.)
HIA_N = 1305.39	Automatic	Hi Air,
LOA_N = 1622.56	Automatic	Low Air,
HIT_N = 1389.09	Automatic	Hi Tissue, and
LOT_N = 1718.52	Automatic	Low Tissue attenuations values in "raw A/D" numbers. These values are used to determine the thickness of a patient being scanned in an AP array scan mode. They are updated whenever a spine array scan is added to the QC database (i.e. the daily array QC scan) or in FSCAL.
ACF = 1.021550	Fact. or F.S.	Area Correction Factor for AP Spine and Hip scans
BCF = 1.005450	Fact. or F.S.	Bone Correction Factor for AP Spine and Hip scans
SFF = 1.083600 1.095000	Factory	Spine Fan Factors
LFF = 0.943000 0.954000	Factory	Lateral Fan Factors
HFF = 1.077300 1.120000 1.077300 1.120000 1.077300 1.120000 1.077300 1.120000	Factory	Hip Fan Factors Multiplication factors for BCF & ACF array scans. These values are the same on all QDR 4500s.

ARRC.TXT Variables	Set by...	Descriptions
T0_NL = 6.00	Factory	Width of the phantom shipped with the QDR 4500. This value is the same for all phantoms.
HIA_NL = 1149.08	Automatic	Hi Air,
LOA_NL = 1187.00	Automatic	Low Air,
HIT_NL = 1231.63	Automatic	Hi Tissue, and
LOT_NL = 1282.07	Automatic	Low Tissue attenuations values in "raw A/D" numbers. These values are used to determine the thickness of a patient being scanned in the lateral scan mode. They are updated whenever a lateral scan is added to the QC database or in FSCAL.
ACFL = 1.021550	Fact. or F.S.	Area Correction Factor for Lateral scans.
BCFL = 1.005450	Fact. or F.S.	Bone Correction Factor for Lateral scans.
HIA_NF = 1319.16	Factory	Hi Air,
LOA_NF = 1634.86	Factory	Low Air,
HIT_NF = 1402.73	Factory	Hi Tissue, and
LOT_NF = 1730.71	Factory	Low Tissue attenuations values in "raw A/D" numbers. Factory values for AP array scans. Used as reference for the software to determine if the Hi/Low values are out of factory range.
HIA_NLF = 1149.08	Factory	Hi Air,
LOA_NLF = 1187.00	Factory	Low Air,
HIT_NLF = 1231.63	Factory	Hi Tissue, and
LOT_NLF = 1282.07	Factory	Low Tissue attenuations values in "raw A/D" numbers. Factory values for lateral scans. Used as reference for the software to determine if the Hi/Low values are out of factory range.
QC_HILO_MIN = 50.0	Factory	Day-to-day drift check warning message limit.
QC_HILO_MAX = 100.0	Factory	Day-to-day drift check error message limit.
QC_HILO_FACT_MAX = 200.0	Factory	Long-term drift check warning message limit.
QC_HILO_FACT_MIN = 100.0	Factory	Long-term drift check error message limit.
UPDATED = 06/20/94 12:00:00	Automatic	Date and time the ARRC.TXT file was last updated.
UPDATED_N = 11/09/94 QC Version 8.03	Automatic	Date and version of QC program which updated the Hi/Low values for a daily QC AP array scan.
UPDATED_NL =	Automatic	Date and version of QC program which updated the Hi/Low values

Section 4 - Alignment & Calibration

ARRC.TXT Variables	Set by...	Descriptions
QDR_SERIAL_NB = 4506	Factory	Serial number of the QDR 4500.
ARRAY_PHANTOM_NM = 1922	Fact. or F.S.	Serial number of the <u>array</u> (or shipped) phantom.
ARRC_SEQUENCE_NB = 000	Automatic	Sequential number of the last ARRC.TXT file.
ACFT = 1.021550	Fact. or F.S.	Area Correction Factor for Turbo scans.
BCFT = 1.005450	Fact. or F.S.	Bone Correction Factor for Turbo scans.
SFFT = 1.083600 1.095000	Factory	Spine Fan Factors Turbo mode.
HFFT = 1.077300 1.120000 1.077300 1.120000 1.077300 1.120000 1.077300 1.120000	Factory	Hip Fan Factors Turbo mode. Multiplication factors for BCF & ACF in turbo scan modes. These values are the same on all QDR 4500s.
VERSION_NB = 003 6/20/94		Fan Factor Version # (same for all)
WBINTACF = 1.000		Whole Body Fan Factor Area
WBINTBCF = 1.131		Whole Body Fan Factor BMC
AWBAREA = 0.975		Whole Body Fan Factor Area
AWBBMC = 1.020		Whole Body Fan Factor BMC
AWBLEAN = 0.962		Body Composition Fan Factor lean
AWBWT = 1.01		Body Composition Total Mass
FOREAREA = 1.0		Forearm Fan Factor Area
FOREBMC = 1.0		Forearm Fan Factor BMC
HWVERSION = 8		System Hardware Descriptor

SECTION 5

REMOVE AND REPLACE PROCEDURES

This section describes how to remove and replace the Field Replaceable Units (FRUs) in the QDR 4500. To safely perform a FRU removal or replacement, take care to follow the procedure precisely as written.

Note: Whenever a component is replaced, you must rerun QC and recalibrate.

RECOMMENDED TOOLS

Tool	Size/Type
Hex driver	3/32"
Hex driver or wrench	5/32"
Nut driver	1/4"
Nut driver	3/8"
Nut driver	5/16"
Nut driver	7/16"
Screwdriver	Narrow slotted
Screwdriver	Phillips head
Screwdriver	Slotted
Wrench	3/8"

ELECTRONICS TRAY FRUS

This section describes how to remove and replace the FRUs in the Electronics Tray/Carriage Drive area of the QDR 4500 (see Figure 5-1).

To remove any of the FRUs in the Electronics Tray assembly remove the 5 Phillips screws that hold the tray cover and remove the cover.

Electronics Tray Printed Circuit Boards

To remove and replace the Distribution Board, Motor Controller Board, or TZ Drive Board refer to Figure 5-1 and follow the procedure below:

1. Move the C-arm all the way to the right.
2. Turn off the QDR 4500 instrument power, computer power, and main circuit breaker.
3. Remove the cable covers and unplug the cables on the board to be replaced.
4. To remove the board, unscrew the Phillips screws holding the board

Note: Some boards have standoffs and/or plastic hold-down snaps.

5. To replace the board reverse the steps.

6. Restore the motor cable shield.

Note: When replacing the AY Motor Controller board make sure that you set the ID switch to 7. When replacing the TZ Drive board, make sure that you set the Normal/Service switch to Normal.

C-Arm Y Belt

To remove and replace the C-arm Y Belt refer to Figure 5-1 and follow the procedure below:

1. Move the C-arm to the center of the table.
2. Turn off the QDR 4500 instrument power, computer power, and main circuit breaker.
3. At the encoder end of the belt, loosen the 2 bolts holding the tension block, remove the tensioning nut, and remove and replace the belt.
4. Install the tension spring and tensioning nut.
5. Tighten the tension nut so that the spring compresses to 7/8 inch. The bracket cutout can be used as a measuring guide (the inside of the washer should be flush with the bracket cut).
6. Tighten the two mounting bolts holding the tension block.
7. Perform the MOTOR\$AY calibration procedure.

Section 5 - Remove & Replace

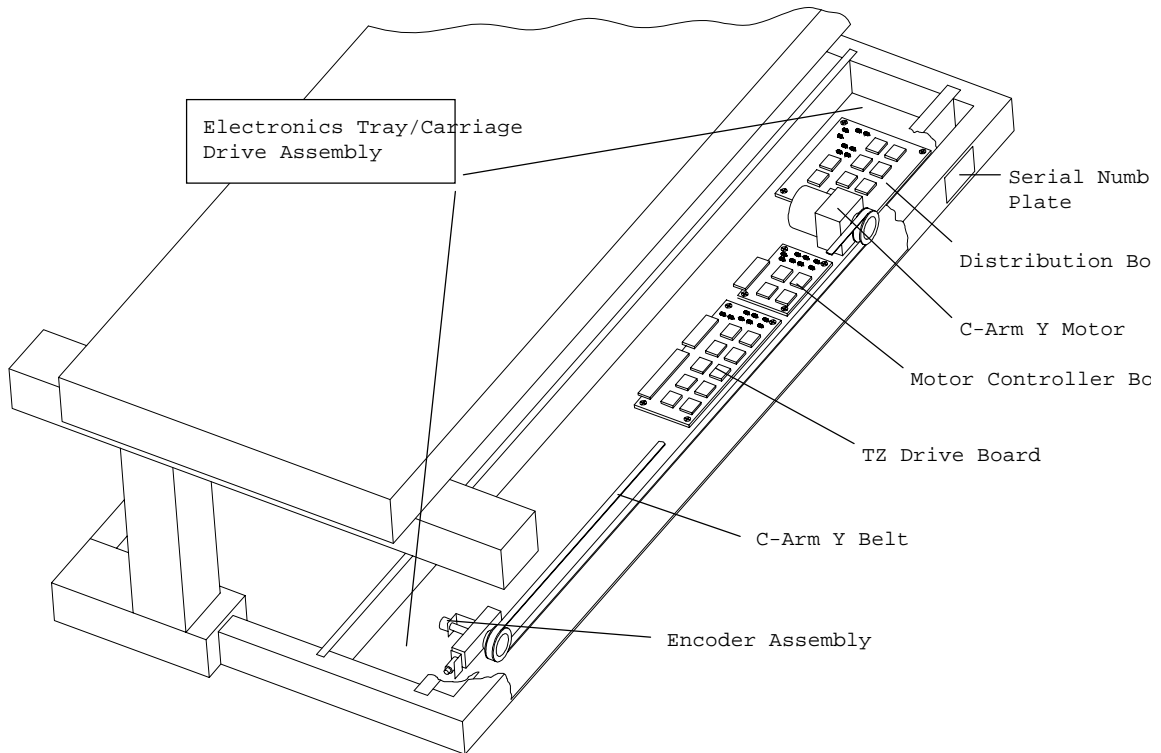


Figure 5-1. Electronics Tray FRUs

C-Arm Y Motor or Gearcase

To remove and replace the C-arm Y Motor or Gearcase refer to Figure 5-1, and follow the procedure below:

1. Move the C-arm to the center of the table.
2. Turn off the QDR 4500 instrument power, computer power, and main circuit breaker.
3. At the encoder end of the belt, loosen the 2 bolts holding the tension block, remove the tensioning nut and remove the belt.
4. At the motor end of the belt, remove the cable cover and unplug the motor cable from the Motor Controller Board.
5. Remove the four Allen bolts, and nuts, holding the motor and gearcase

Note: The two bottom nuts are accessible with a ratchet wrench and extension.

6. Remove the motor first, then the gearcase.
7. If replacing the gearcase, install the pulley from the old gearcase on the new gearcase.
8. Replace the motor and gear case assembly making sure to align the gasket correctly. Snug the Allen bolts but do not over tighten.

9. Install the belt on both pulleys.
10. At the encoder end of the belt, install the tension spring and tensioning nut.
11. Tighten the tension nut so that the spring compresses to 7/8 inch. The bracket cutout can be used as a measuring guide (the inside of the washer should be flush with the bracket cut).
12. Tighten the two mounting bolts holding the tension block.
13. Restore the cable shield and ground strap terminations.
14. Perform the MOTOR\$AY calibration procedure.

C-Arm Y Encoder

To remove and replace the Encoder refer to Figure 5-1 and follow the procedure below:

1. Before removing power from the QDR 4500, remove both cable covers, unhook the center cable hold-down clip and free the encoder cable as much as possible without unplugging it.
2. Move the C-arm towards the center of the Scanner (so the encoder is accessible).
3. Turn off the QDR 4500 instrument power, computer power, and main circuit breaker.
4. Unplug the encoder from the Motor Controller Board and pull out the cable.
5. Remove the hose clamp fastener holding the encoder to the belt drive.
6. Remove the encoder from the bracket assembly.
7. Replace the encoder on the bracket, install the tubing but do not attach the clamp.
8. Perform the MOTOR\$AY calibration procedure.

Note: When starting this procedure, make sure the encoder **is not** clamped to the drive shaft tubing.

CONTROL PANEL AND TABLE Y FRUS

Note: Table Y operations apply to models A and W only.

This section describes how to remove and replace the FRUs associated with the Control Panel and Table Y motion of the QDR 4500 (see Figure 5-1 and Figure 5-3).

1. Before removing power from the QDR 4500, move the table to the far left using the Motor Control Pad. The Motor Control Pad can be accessed from the Main Menu by choosing **Utility**, followed by **emergency Motion**.
2. Turn off the QDR 4500.
3. Remove 2 screws from the right table rail end cover, and slide the cover off from the end.

Section 5 - Remove & Replace

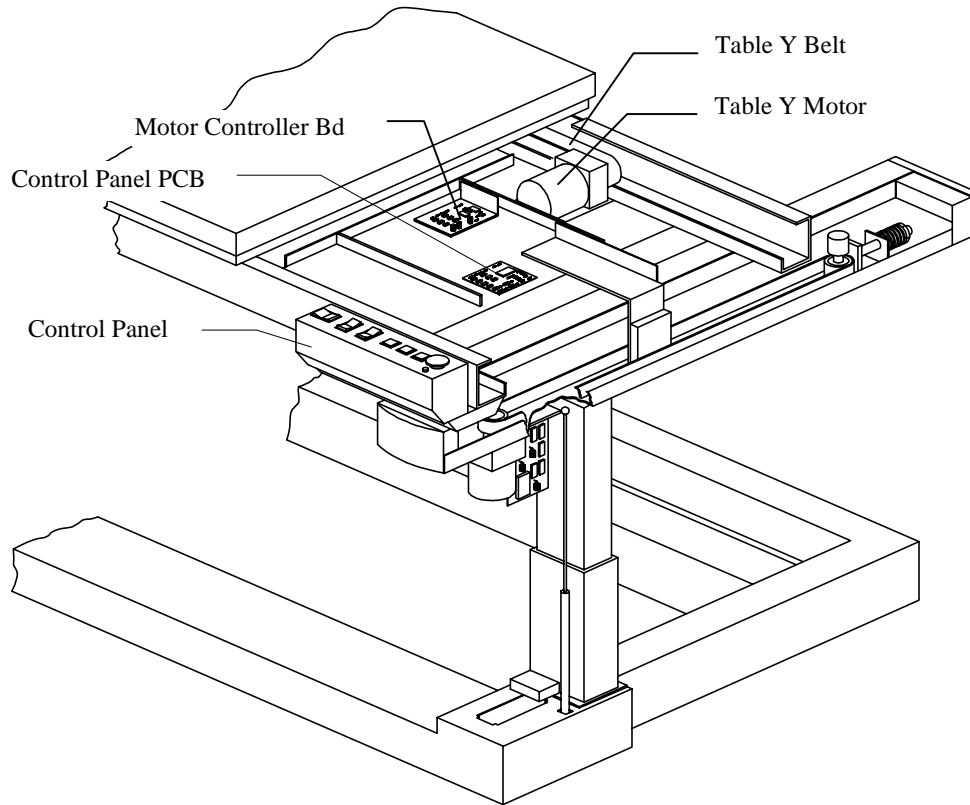


Figure 5-2. Control Panel and Table Y FRUs

Control Panel

To remove and replace the Control Panel refer to Figure 5-2 and follow the procedure below:

1. Turn off the QDR 4500 instrument power, computer power, and main circuit breaker.
2. Remove 3 screws located under the Control Panel box.
3. Unplug the cable (from the Control Panel to the Control Panel board) on the Control Panel board and remove the panel.
4. To replace the Control Panel reverse the steps.

PCBs Under Right-Side of the Table

To remove and replace the boards under the table (Motor Controller Board or Control Panel Board) refer to Figure 5-2 and follow the procedure below:

1. Unplug the cables on the board to be replaced.
2. To remove the board, unscrew the Phillips screws holding the board

Note: Some boards have standoffs and/or plastic hold-down snaps.

3. To replace the board reverse the steps.

Note: When replacing the TY Motor Controller board ensure that the ID switch is set to 5.

Table Y Belt

To remove and replace the Table Y Belt refer to Figure 5-2, and Figure 5-3, and follow the procedure below:

1. Center the table and remove the two screws that secure the table top in place.
2. Turn off the QDR 4500 instrument power, computer power, and main circuit breaker.
3. Pull the table top to the left far enough to remove the right table rail end cover, and remove the cover. Mark this as the right cover so that it is not confused later with the left cover (they are not interchangeable).
4. Pull the table top to the right far enough to remove the left table rail end cover, and remove the cover. Mark this as the left cover so that it is not confused later with the right cover (they are not interchangeable).
5. At the encoder end of the belt, loosen the 2 bolts holding the tension block, remove the tensioning nut, and remove and replace the belt.
6. Install the tension spring and tensioning nut.
7. Tighten the tension nut so that the spring is compressed to 7/8". The bracket cutout can be used as a measuring guide (the inside of the washer should be flush with the bracket cut).
8. Tighten the two mounting bolts holding the tension block.
9. Perform the MOTOR\$TY calibration procedure.

Note: When starting this procedure, make sure the encoder **is not** clamped to the drive shaft tubing.

Table Y Motor or Gearcase

To remove and replace the Table Y Motor or Gearcase refer to Figure 5-2, and Figure 5-3, perform the steps for removing the belt described above, and continue with this procedure. perform the following:

1. Remove the Table Y Belt as described above.
2. Unplug the motor cable from the Motor Controller Board.
3. Remove the four Allen bolts, and nuts, holding the motor and gearcase.
4. Remove the motor and the gearcase.
5. If replacing the gearcase, install the pulley from the old gearcase on the new gearcase.
6. Replace the motor and gear case assembly making sure to align the gasket correctly. Snug the Allen bolts but don't over tighten.
7. Install the belt on both pulleys.

Section 5 - Remove & Replace

8. At the encoder end of the belt, install the tension spring and tensioning nut.
9. Tighten the tension nut so that the spring is compressed to 7/8". The bracket cutout can be used as a measuring guide (the inside of the washer should be flush with the bracket cut).
10. Tighten the two mounting bolts holding the tension block.
11. Perform the MOTOR\$TY calibration procedure.

Note: When starting this procedure, make sure the encoder **is not** clamped to the drive shaft tubing.

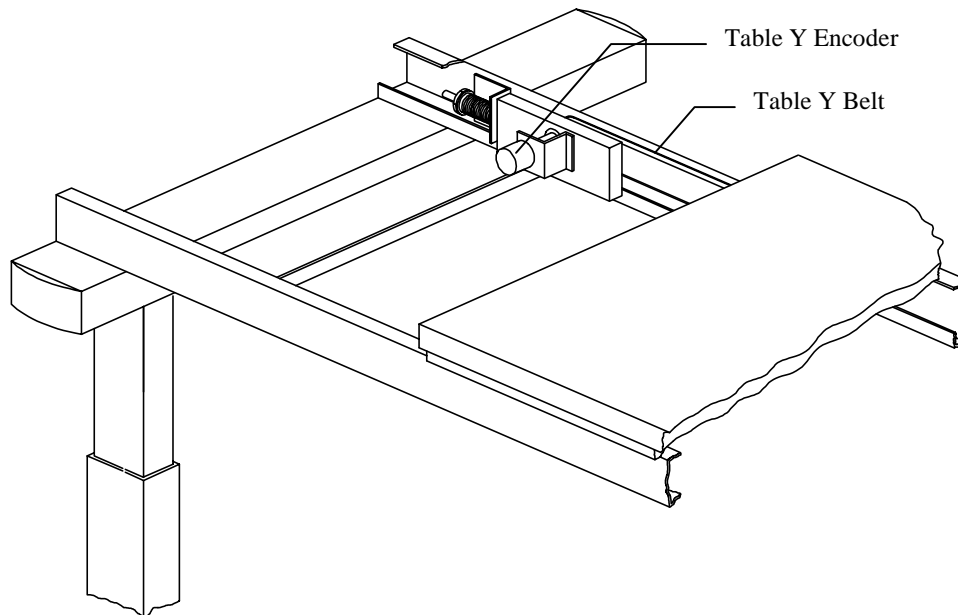


Figure 5-3. Left Side Table Y FRUs

Table Y Encoder

To remove and replace the Table Y Encoder refer to Figure 5-2, and Figure 5-3, and follow the procedure below:

1. Center the table and remove the two screws that secure the table top in place.
2. Turn off the QDR 4500 instrument power, computer power, and main circuit breaker.
3. Pull the table top to the left far enough to remove the right table rail end cover, and remove the cover. Mark this as the right cover so that it is not confused later with the left cover (they are not interchangeable).
4. Pull the table top to the right far enough to remove the left table rail end cover, and remove the cover. Mark this as the left cover so that it is not confused later with the right cover (they are not interchangeable).

5. Unplug the encoder from the Motor Controller Board and pull out the cable.
6. Remove the hose clamp fastener holding the encoder to the belt drive.
7. Remove the encoder from the bracket assembly.
8. Replace the encoder on the bracket, install the tubing but do not attach the clamp.
9. Perform the MOTOR\$TY calibration procedure.

Note: When starting this procedure, make sure the encoder **is not** clamped to the drive shaft tubing.

TABLE X FRUS

This section describes how to remove and replace the FRUs associated with Table X motion of the QDR 4500 (see Figure 5-4).

Table X Motor Controller PCB

To remove and replace the TX Motor Controller board refer to Figure 5-4 and follow the procedure below:

1. Before removing power from the QDR 4500, move the table up as far as it will go.
2. Remove 6 flat head Phillips screws from the upper pedestal cover and remove the cover.
3. Turn off the QDR 4500 instrument power, computer power, and main circuit breaker.
4. Unplug the cables on the TX Motor Controller board.
5. To remove the board, unscrew the Phillips screws holding the board.
6. To replace the board reverse the steps.
7. Restore the motor cable shield.

Note: When replacing the TX Motor Controller board ensure that the ID switch is set to 4.

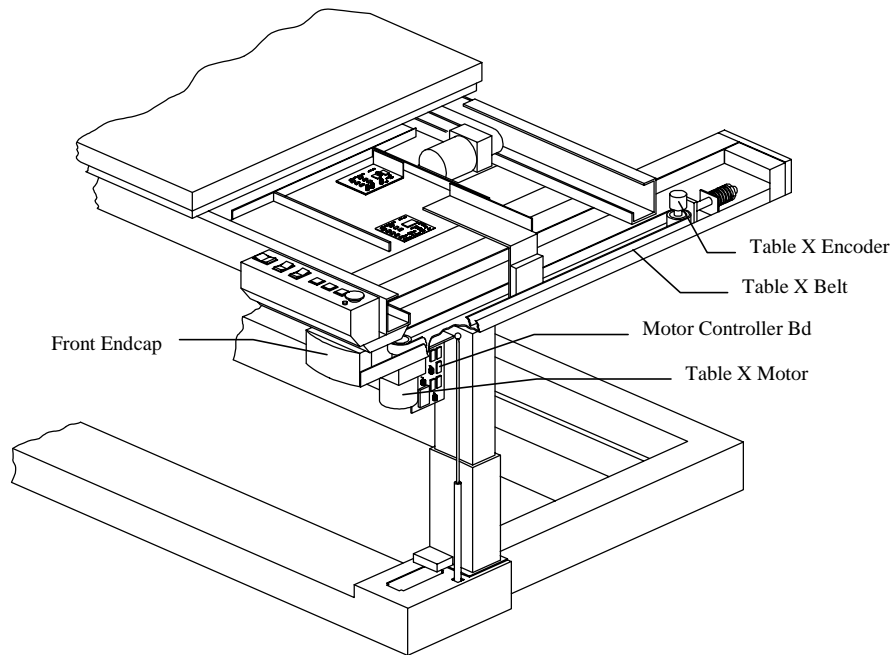


Figure 5-4. Table X FRUs

Table X Belt

To remove and replace the Table X Belt located within the X Table Drive Assembly, refer to Figure 5-4 and follow the procedure below:

1. Before removing power from the QDR 4500, move the table to the far left using the Motor Control Pad. The Motor Control Pad can be accessed from the Main Menu by choosing **Utility**, followed by **emergency Motion**.
2. Turn off the QDR 4500 instrument power, computer power, and main circuit breaker.
3. Remove 2 screws from the right table rail end cover, and slide the cover off from the end.
4. Remove the front endcap from the table X drive assembly (3 Phillips screws).
5. Remove the back Phillips screw from the right side cover (of the table X drive assembly) and slide the cover out from the front. This provides access to the belt.
6. At the encoder end of the belt, loosen the 2 bolts holding the tension block, remove the tensioning nut, and remove and replace the belt.
7. Install the tension spring and tensioning nut.
8. Tighten the tension nut so that the spring is compressed to 7/8". The bracket cutout can be used as a measuring guide (the inside of the washer should be flush with the bracket cut).
9. Tighten the two mounting bolts holding the tension block.

10. Perform the MOTOR\$TX calibration procedure.

Note: When starting the MOTOR\$TX calibration procedure, make sure the encoder **is not** clamped to the drive shaft tubing.

Table X Motor or Gearcase

To remove and replace the Table X Motor or Gearcase refer to Figure 5-4 and follow the procedure below:

1. Remove the Table X Belt as described above.
2. Remove 5 flat head Phillips screws from the upper pedestal cover and remove the cover.
3. Unplug the motor cable from the Motor Controller Board.
4. Remove the four Allen bolts, and nuts, holding the motor and gearcase.
5. Remove the motor and the gearcase.
6. If replacing the gearcase, install the pulley from the old gearcase on the new gearcase.
7. Replace the motor and gear case assembly making sure to align the gasket correctly. Snug the Allen bolts but don't over tighten.
8. Install the belt on both pulleys.
9. At the encoder end of the belt, install the tension spring and tensioning nut.
10. Tighten the tension nut so that the spring is compressed to 7/8". The bracket cutout can be used as a measuring guide (the inside of the washer should be flush with the bracket cut).
11. Tighten the two mounting bolts holding the tension block.
12. Restore the cable shield and ground strap terminations.
13. Perform the MOTOR\$TX calibration procedure.

Note: When starting the MOTOR\$TX calibration procedure, make sure the encoder **is not** clamped to the drive shaft tubing

Table X Encoder

To remove and replace the Table X Encoder located within the X Table Drive Assembly, refer to Figure 5-4 and follow the procedure below:

1. Before removing power from the QDR 4500, move the table to the far left using the Motor Control Pad. The Motor Control Pad can be accessed from the Main Menu by choosing **Utility**, followed by **emergency Motion**.
2. Turn off the QDR 4500 instrument power, computer power, and main circuit breaker.
3. Remove 2 screws from the right table rail end cover, and slide the cover off from the end.

Section 5 - Remove & Replace

4. Remove the front endcap from the X table drive assembly. The cover is held on with 2 hex screws.
5. Remove 6 Phillips screws from the right side cover (of the X table drive assembly) and slide the cover out from the front. This provides access to the encoder and belt.
6. Remove 5 flat head Phillips screws from the upper pedestal cover and remove the cover. This provides access to the Motor Controller Board.
7. Unplug the encoder from the Motor Controller Board and pull out the cable.
8. Remove the hose clamp fastener holding the encoder to the belt drive.
9. Remove the encoder from the bracket assembly.
10. Replace the encoder on the bracket, install the tubing but do not attach the clamp.
11. Perform the MOTOR\$TX calibration procedure.

Note: When starting the MOTOR\$TX calibration procedure, make sure the encoder **is not** clamped to the drive shaft tubing

TABLE Z FRUS (A and SL only)

This section describes how to remove and replace the FRUs associated with Table Z (up and down) motion of the QDR 4500 (see Figure 5-5).

Pedestal

To remove and replace either pedestal, refer to Figure 5-6 and follow the procedure below. The procedure requires two pieces of 2 x 4 lumber, approximately 2.5 to 3 foot long, and two pieces of foam padding.

1. Remove the electronics tray covers.
2. Remove 6 flat head Phillips screws from the upper pedestal cover and remove the cover.
3. Remove 5 flat head Phillips screws from the lower pedestal cover and remove the cover.
4. Move the C-arm towards the pedestal to be replaced, but ensure that the service switches on the TZ Motor Controller board are accessible.
5. Place two 2 x 4s on end, on top of the tank. The 2 x 4s should be oriented front to back, on the tank, to support the table. Place foam padding between the 2 x 4s and the table to protect the tape safety switch.

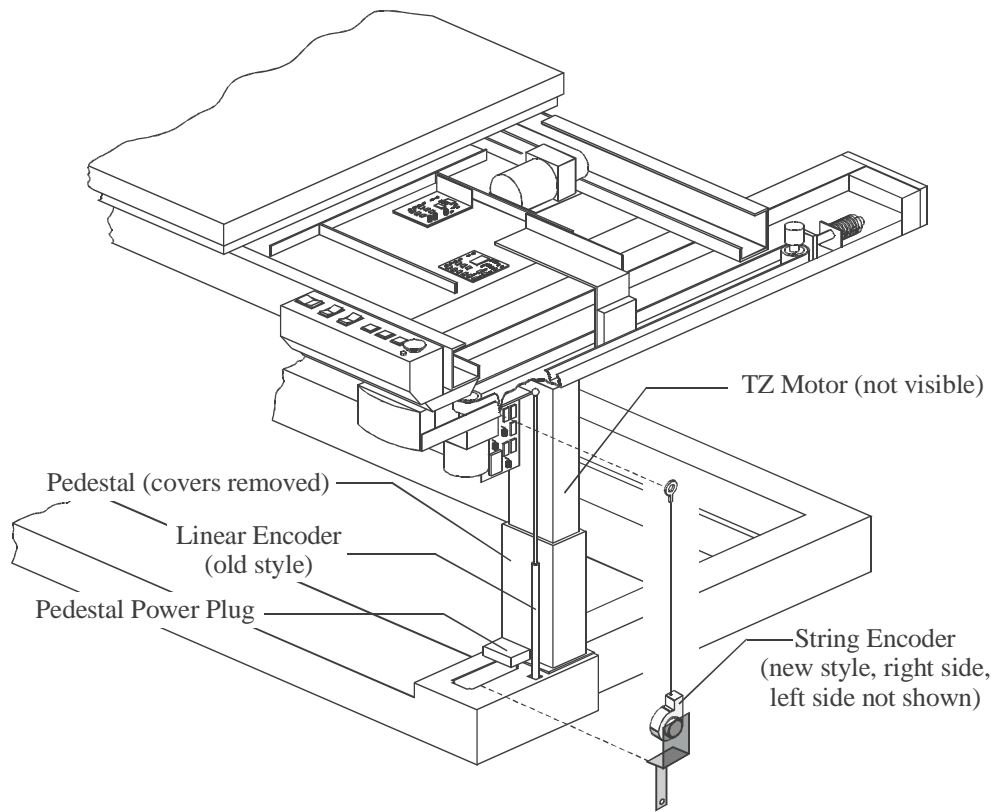


Figure 5-5. Table Z FRUs

6. Push in the Emergency Stop switch.
7. On the TZ Motor Controller board, set the Normal/Service switch to Service, and set the Direction switch to Down.
8. Press the left and right switches together, until the table just rests on the 2 x 4s.
9. Remove the top bolts on the pedestal (9/16"). The cosmetic bracket will come off.

Note: If removing the left pedestal, the left T-rail will become loose. Be careful not to drop this T-rail.

10. Press the appropriate pedestal switch, on the TZ Motor Controller board, to lower the pedestal completely.
11. Remove the pedestal power plug, the lower four pedestal bolts, and remove the pedestal.
12. Remove the end plates from the old pedestal and install on the new pedestal being careful to maintain their orientation (6mm Allen screws). Apply a small amount of Loctite when installing the screws.
13. Replace the pedestal and install the pedestal lower bolts but leave them loose for now.
14. Replace the power plug.
15. On the TZ Motor Controller board, set the Direction switch to Up.

Section 5 - Remove & Replace

16. Press the appropriate pedestal switch, on the TZ Motor Controller board, to raise the pedestal carefully, until it just touches the T-rail.
17. Install the cosmetic bracket and upper pedestal bolts, leaving the bolts loose for now.
18. Using the switches on the TZ Motor Controller board, raise both pedestals and remove the 2 x 4s and foam.
19. Measure from the inside of one T-rail to the inside of the other. It must be 65 inches at both the front and back. If it is not, move the pedestal until the measurements are correct.
20. Tighten the lower and upper pedestal bolts.
21. On the TZ Motor Controller board, set the Direction switch to Down.
22. Using the switches on the TZ Motor Controller board, lower both pedestals all the way down.
23. On the TZ Motor Controller board, set the Service switch to Normal, and press Reset (large black button).
24. Run SQDRIVER, type MOTOR\$TZ <Enter>, then type CALIBRATE.
25. Replace all covers.

Linear Potentiometer (Encoder- Obsolete)

To remove the linear encoder and replace with a rotary string encoder, refer to Figure 5-5 and Figure 5-6 and follow the procedure below:

The Linear Rotary String (Encoder)

Installation

When replacing one of these encoders, make certain you have the correct part. The linear string encoder kit is made up of two parts.

CAUTION: When one encoder fails (either linear or string) you must replace both using the kit listed below:

Description	Part Number	Contains	Part Number
Linear Encoder Kit	010-1020	Right Encoder	030-2417
		Left Encoder	030-2418

Refer to Figure 5-5 and Figure 5-6 and follow the procedure below:

1. Remove the electronics tray covers.
2. Move the table all the way up.

WARNING: Turn off the QDR 4500 instrument power using the switch on the right side of the power console.

3. Remove 6 flat head Phillips screws from the upper pedestal cover and remove the cover.
4. Remove 5 flat head Phillips screws from the lower pedestal cover and remove the cover.
5. Remove the linear encoder top screw (Phillips).
6. Remove the linear encoder bottom screw (access to the bottom Phillips screw is through the frame hole).
7. Unplug the linear encoder cable from the TZ Drive board and snake the cable out.

Note: Older versions have a tubular type encoder. The new encoders are mounted on a mounting bracket and have left and right versions.

CAUTION: Do not allow the string to snap back into the encoder after being extended. This can permanently damage the unit.

8. Route the new encoder cable through the path of the old encoder, and plug it into the TZ Drive board.
9. Install the rotary encoder at the bottom using the screw and two washers provided.
The bracket must sit on the top surface of the base frame before tightening.
10. Replace the linear encoder top screw by extending the string and fastening to the top using screw and washers provided.
11. Turn the instrument power on.

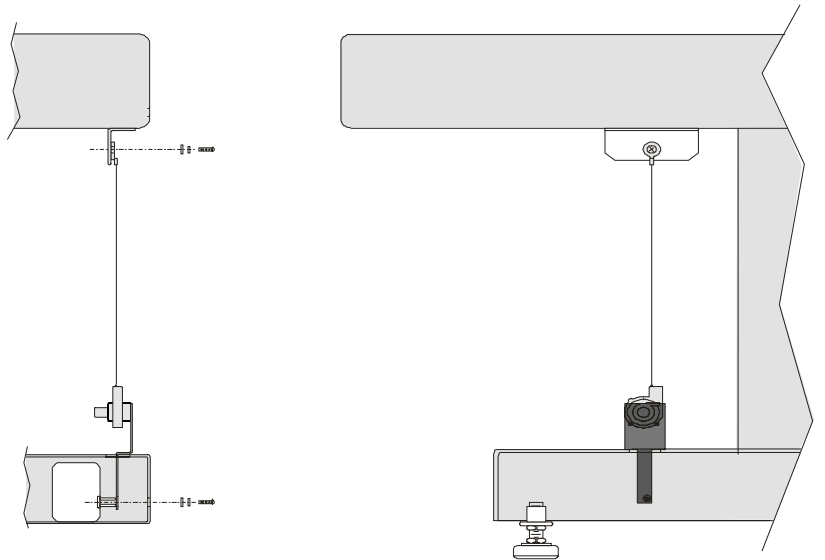


Figure 5-6. Installing the Rotary String Encoder

12. Run QC and recalibrate.

ARM R FRUS

This section describes how to remove and replace the Arm R (Rotate) FRUs located on the right side of the lower C-arm (see Figure 5-7 and Figure 5-8).

Before removing power from the QDR 4500, move the C-arm towards the middle-left side of the table to allow working room. Use the Motor Control Pad. The Motor Control Pad can be accessed from the Main Menu by choosing **Utility**, followed by **emergency Motion**.

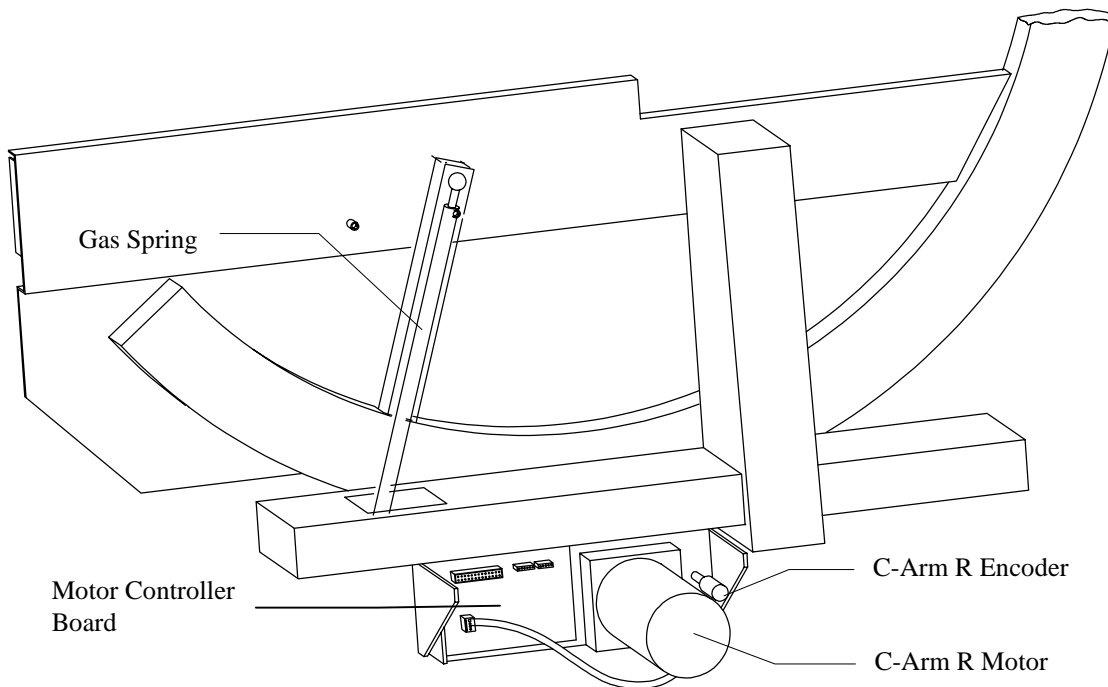


Figure 5-7 C-Arm R FRUs (Outside View)

Motor Controller Board

To remove and replace the Motor Controller Board refer to Figure 5-7 and follow the procedure below:

1. Remove the motor cover plate by removing 2 (Phillips) screws.
2. Turn off the QDR 4500 instrument power, computer power, and main circuit breaker.
3. Unplug the cables and unscrew the Phillips screws holding the board.
4. To replace the board reverse the steps.

Note: When replacing the AR Motor Controller board ensure that the ID switch is set to 6.

Arm R Belt

To remove and replace the Arm R Belt refer to Figure 5-7 and Figure 5-8 , and follow the procedure below:

1. Remove the tank covers.
2. Remove the X-ray controller assembly (to gain access to the front belt clamp).
3. Remove the rear C-arm shoulder cover.

Note: Take care not to move the C-arm during the remainder of this procedure.

4. Remove the belt tension nut, and remove the rear belt clamp (four 5/16" bolts).
5. Remove the belt from the motor pulleys. Access the pulleys from the left side of the Scanner looking under the C-arm (see Figure 5-8).
6. Remove the belt from the front belt clamp (four Phillips screws).
7. Install the new belt in reverse order, front belt clamp first, then over the pulleys, then rear belt clamp.
8. Tighten both belt clamps.
9. Loosen the belt tension block (two 1/4" bolts).
10. Install the tension nut and adjust to 7/8" from the inside of one washer to the inside of the other washer.
11. Tighten the tension block bolts.
12. Perform the MOTOR\$AR calibration procedure.

Arm R Motor, Gearcase, Encoder or Encoder Belt

To remove and replace the Arm R Motor refer to Figure 5-7 and Figure 5-8, and follow the procedure below:

1. Remove the rear C-arm shoulder cover and the arm R motor cover plate.
2. At the rear of the C-arm, remove the belt bracket (2 bolts) while leaving the belt attached. This provides enough slack to remove the belt from the motor pulleys.

Section 5 - Remove & Replace

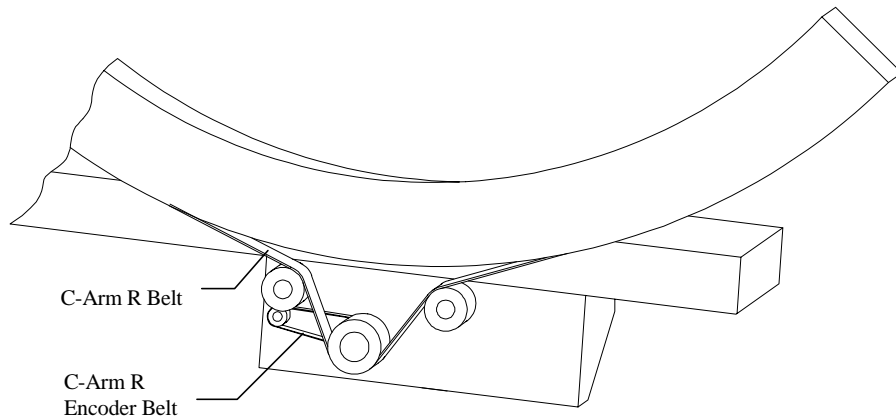


Figure 5-8. C-Arm R FRUs (Inside View)

3. Remove the belt from the motor pulleys. Access the pulleys from the left side of the Scanner looking under the C-arm (see Figure 5-8).
4. Remove the arm R encoder cable.
5. Remove the Motor Controller board ribbon cable and snake the cable through the access hole.
6. Remove the entire arm R motor assembly bracket with motor, board and encoder (four 7/16" bolts).
7. Remove the encoder and pulley assembly (2 Phillips screws), and the encoder belt.
8. If replacing the motor or gearcase, remove the four Allen bolts, and nuts, holding them. If replacing the gearcase, install the pulley from the old gearcase on the new gearcase. Then, replace the motor and gear case assembly making sure to align the gasket correctly. Snug the Allen bolts but don't over tighten.
9. If replacing the encoder, remove the hose clamp fastener holding the encoder to the belt drive and remove the encoder from the bracket assembly. Then, replace the encoder on the bracket, install the tubing but do not attach the clamp.
10. Replace the arm R motor assembly bracket with motor, board and encoder (four 7/16" bolts).
11. Replace the cables, and replace the belt on the motor pulleys. Be sure to restore the cable shield and ground strap terminations.
12. Replace the belt bracket, and loosen the belt tension block (two 1/4" bolts).
13. Adjust the tension nut so that the spring is compressed to 7/8" from the inside of one washer to the inside of the other washer.
14. Tighten the tension block bolts.
15. Perform the MOTOR\$AR calibration procedure.

Note: When starting the MOTOR\$AR calibration procedure, make sure the encoder **is not** clamped to the drive shaft tubing.

Gas Spring

It is not necessary to remove any covers to remove and replace either Gas Spring. Refer to Figure 5-7 (right Gas Spring), or Figure 5-9 (left Gas Spring), and follow the procedure below:

From DOS type TOLAT, then press the Enable Motion switch, on the Control Panel, to get to the lateral position.

1. Remove the retaining clip from the top of the gas spring, and remove the spring from the stud.
2. Remove the nut that holds the lower stud in place and take the stud and spring out together.
3. Prior to installing the new spring, lubricate the ball studs at both ends with white lithium grease.
4. Put the lower stud on the new spring and attach.
5. Install the top of the spring to the top stud, and replace the retaining clip.

LOWER C-ARM FRUS

This section describes how to remove and replace the C-arm Interface Board, X-Ray Controller (XRC), Tank and Filter Drum Assemblies located on the lower C-arm (see Figure 5-9).

C-Arm Interface Board

To remove and replace the C-Arm Interface Board refer to Figure 5-9 and follow the procedure below:

1. With the C-arm in the AP position, use the Motor Control Pad to move the table out as far as it will go, for easier access.
2. Turn off the QDR 4500 computer and instrument power switches, and main power circuit breaker.
3. Remove the rear tank cover (covers the C-arm Interface board).
4. Unplug all cables to the C-Arm Interface Board.
5. Remove 4 Phillips screws and remove the board.
6. To replace the C-Arm Interface Board reverse the steps.
7. Perform the Test Scan Modes procedure in the *Installation* section of this manual.

X-Ray Controller Assembly

To remove and replace the X-Ray Controller (XRC) refer to Figure 5-9 and follow the procedure below:

Section 5 - Remove & Replace

1. Using the Motor Control Pad, move the table in, for easier access to the XRC.
2. Turn off the QDR 4500 computer and instrument power switches, and main power circuit breaker.
3. Remove the lower C-arm cover by removing 2 Phillips screws and sliding it out from the front. Also remove the bottom cover.
4. Remove the 4 Phillips screws holding the XRC (see Figure 5-9).
5. Pull the XRC forward far enough to access the cables.
6. Unplug the cables and remove the XRC.
7. To replace the XRC reverse the steps.
8. Perform the Area, BMD and BMC Calibration procedure in the *Alignment and Calibration* section of this manual.
9. Perform the Test Scan Modes procedure in the *Installation* section of this manual.

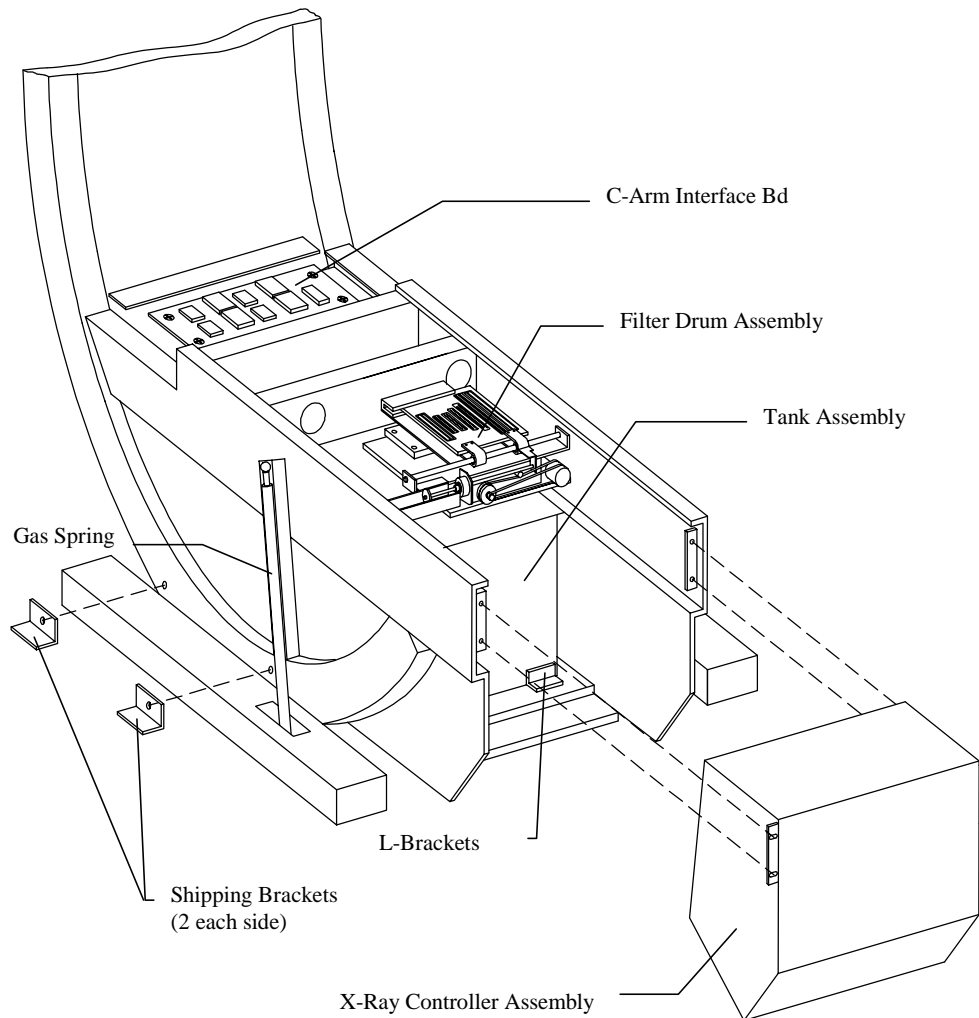


Figure 5-9. Lower C-Arm FRUs

Filter Drum Assembly

To remove and replace the Filter Drum (FD) Assembly refer to Figure 5-9 and follow the procedure below:

1. Using the Motor Control Pad, move the table up and in as far as it will go, and center the C-arm, for easier access to the FD.
2. Using SURVEY, move the FD aperture to 7.
3. Turn off the QDR 4500 computer and instrument power switches, and main power circuit breaker.
4. Remove the lower C-arm cover by removing 2 Phillips screws and sliding it out from the front. Also remove the bottom cover.
5. Remove the 4 Phillips screws holding the XRC (see Figure 5-9).

Section 5 - Remove & Replace

6. Pull the XRC forward far enough for access to the FD (it is not necessary to remove the XRC cables).
7. Remove the rear tank cover (covers the C-arm Interface board).
8. Unplug the 2 FD cables from the C-arm Interface board.
9. Remove 3 hex head screws (3/32" Allen screws).
10. Remove the FD by lifting it up (while tilting it slightly forward) and out.

Note: Early QDR 4500s have spacers on the standoffs that support the FD. If present, ensure these are in place when re-installing the FD.

11. Replace the 3 hex head screws. Ensure that the curved spring washers are placed (curved downward) so that the washer compresses when the screw is tightened.
12. Replace the cables.
13. Replace the screws in the XRC assembly.
14. Perform the X-Ray Beam Alignment procedure in the *Alignment and Calibration* section of this manual.
15. Perform the Aperture Calibration procedure in the *Alignment and Calibration* section of this manual.
16. Perform the A/D Gain Control Adjustment in the *Alignment and Calibration* section of this manual.
17. Perform Beam Flattening in the *Alignment and Calibration* section of this manual.

Tank Assembly

To remove and replace the Tank Assembly refer to Figure 5-9, and Figure 5-10, and follow the procedure below:

<p>WARNING: Because of the weight of the tank (about 200lb), it requires 2 people to safely remove and replace it.</p>

1. Using the Motor Control Pad, move the table up and in as far as it will go, for easier access.
2. Using SURVEY, move the Filter Drum (FD) aperture to 7.
3. Turn off the QDR 4500 computer and instrument power switches, and main power circuit breaker.
4. Remove the lower C-arm cover by removing 2 Phillips screws and sliding it out from the front. Also remove the bottom cover.
5. Remove the XRC (see procedure above).
6. Remove the FD (see procedure above).

<p>WARNING: Before proceeding with this procedure, the C-arm must be locked in place (see next step) or it will rotate when the L-brackets are removed.</p>
--

7. Lock the C-arm in place by securing the shipping brackets on each side of the arm.
8. Remove two L-brackets from the front of the tank that holds the tank to the C-arm (7/16").
9. Carefully slide the tank out of the C-arm onto a pallet (requires 2 people).
10. Remove the old tank from the tank tray, and install the new tank on the tray.

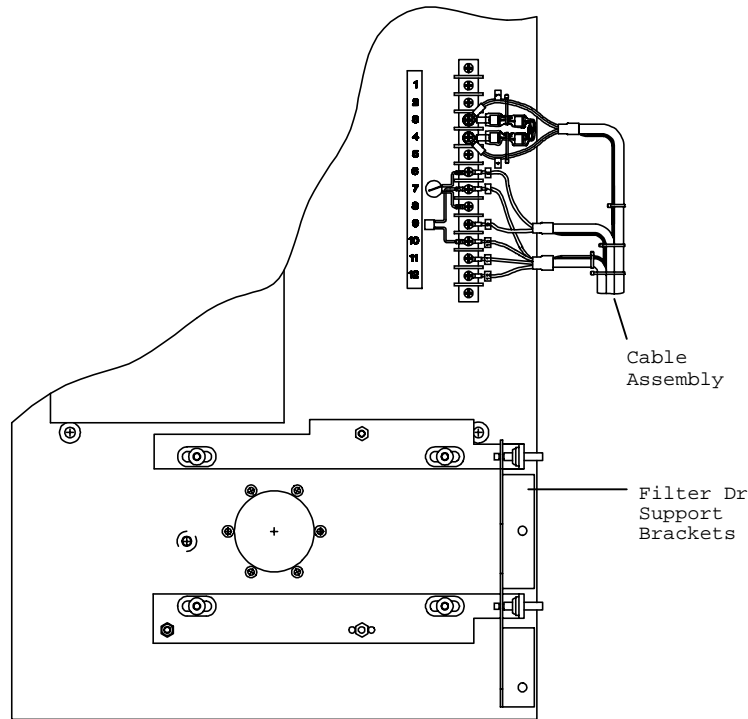


Figure 5-10. Top View of Tank

11. Remove the cable assembly from the old tank, and install it on the new tank (see Figure 5-10).
12. Remove the Filter Drum support brackets from the old tank, and install on the new tank (see Figure 5-10).
13. Slide the tank tray, with tank installed, back in place in the C-arm, and replace the L-brackets.
14. Remove the 2 shipping brackets on each side of the C-arm.
15. Replace the Filter Drum assembly.
16. Replace the X-ray Controller assembly.
17. Be sure to restore the cable shield and ground strap terminations.
18. Before turning on the Scanner, check the tank cable connections to ensure that they are correct.

Section 5 - Remove & Replace

19. Starting with the Check Tube kV Peak Potential procedure in the *Installation* section of this manual, perform all the procedure in that section in order, with the exception of the Calibrate Motors and Check Laser Positioning Offset procedures.

UPPER C-ARM FRUS

This section describes how to remove and replace the Integrator/Multiplexor Board, Detector Boards and Laser Assembly located on the upper C-arm (Figure 5-11).

Integrator/Multiplexor Board

To remove and replace the Integrator/Multiplexor (Mux) Board refer to Figure 5-11 and follow the procedure below:

1. Turn off the QDR 4500 computer and instrument power switches, and main power circuit breaker.
2. Remove the top C-arm cover.
3. Remove the three cables at the Mux board.
4. Remove the two screws holding down the back of the detector assembly, and also remove the ground wire.
5. Remove the detector assembly cover.
6. Remove the 6 Phillips screws holding the detector assembly to the box, and remove the entire detector assembly from the box.

Note: Place the assembly on something soft (such as the table pad) so as not to damage the detectors.

7. With the Mux board facing up, remove the 12 Phillips screws holding the Mux board to the center metal plate.
8. Gently remove the Mux board from the center metal plate (can be done by prying gently and evenly around all sides with a large flat blade screwdriver).
9. To replace the Integrator/Multiplexor Board reverse the steps.
10. Perform the A/D Gain Control Adjustment in the *Alignment and Calibration* section of this manual.
11. Perform Beam Flattening in the *Alignment and Calibration* section of this manual.

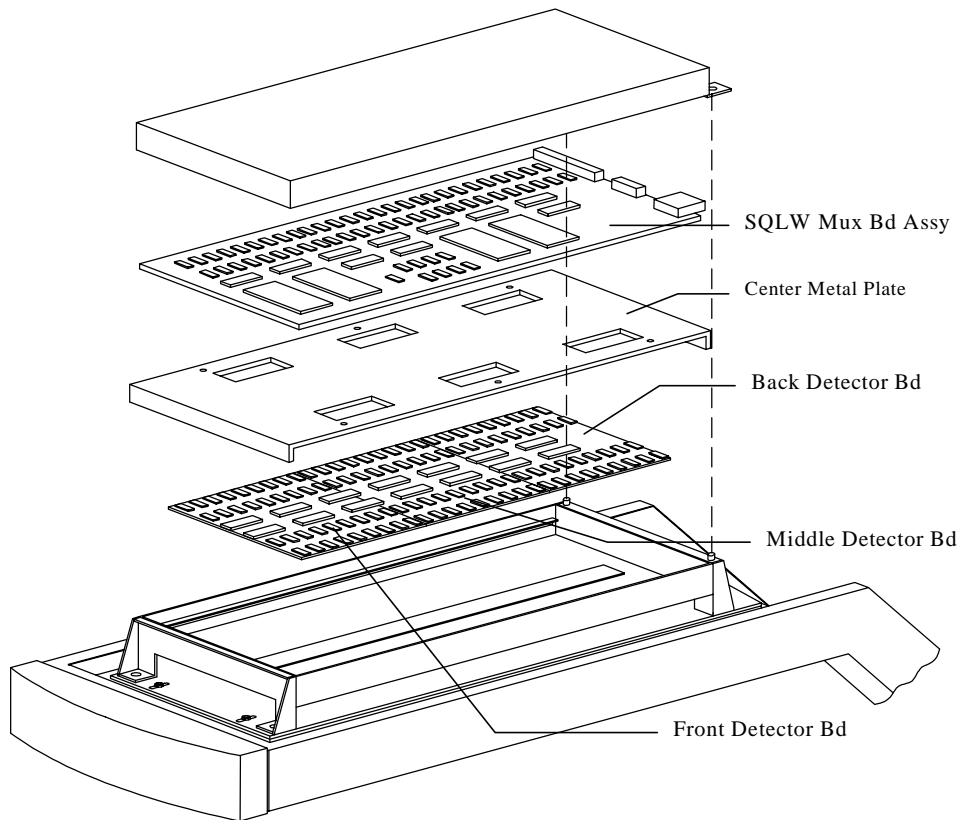


Figure 5-11. Upper C-Arm FRUs

Detector Boards

To remove and replace the Detector Boards refer to Figure 5-11 and follow the procedure below:

1. Turn off the QDR 4500 computer and instrument power switches, and main power circuit breaker.
2. Remove the Integrator/Multiplexor Board (see procedure above).

CAUTION: Do not attempt to remove detectors without first removing the Mux board, as the detectors may be damaged.

3. After the Mux board has been removed, loosen (do not remove) the screws on all three detector boards (4 on each board).
4. Remove the screws on the detector board being replaced, and remove the detector board.
5. Replace the detector board (reverse the steps) and the Mux board (see above procedure).
6. Perform the A/D Gain Control Adjustment in the *Alignment and Calibration* section of this manual.
7. Perform Beam Flattening in the *Alignment and Calibration* section of this manual.

Section 5 - Remove & Replace

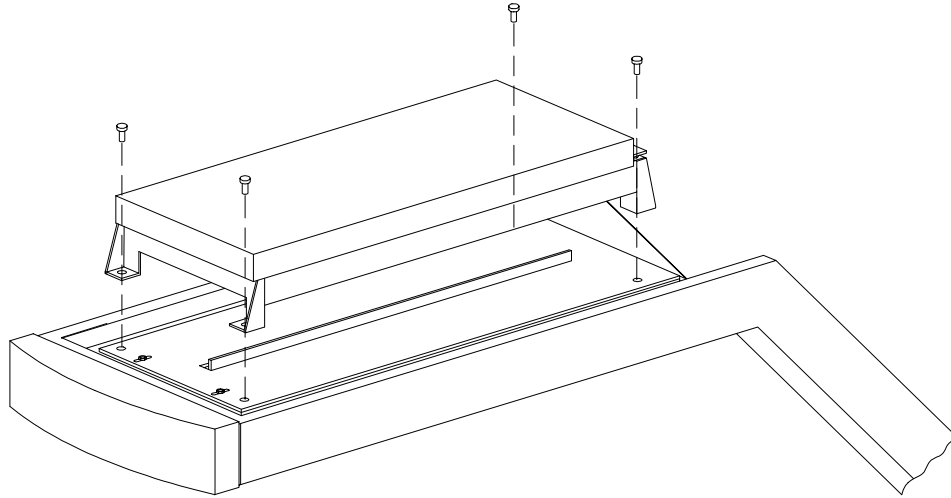


Figure 5-12. Detector Assembly Mounting

Laser Assembly

To remove and replace the Laser, or Laser Assembly, refer to Figure 5-12 and Figure 5-13 and follow the procedure below:

1. Turn off the QDR 4500 computer and instrument power switches, and main power circuit breaker.
2. Remove the top C-arm cover.
3. Remove the three cables at the Mux board.
4. Remove the 4 bolts holding the detector assembly (on rubber grommets) to the C-arm (see Figure 5-12).
5. Remove the detector assembly.

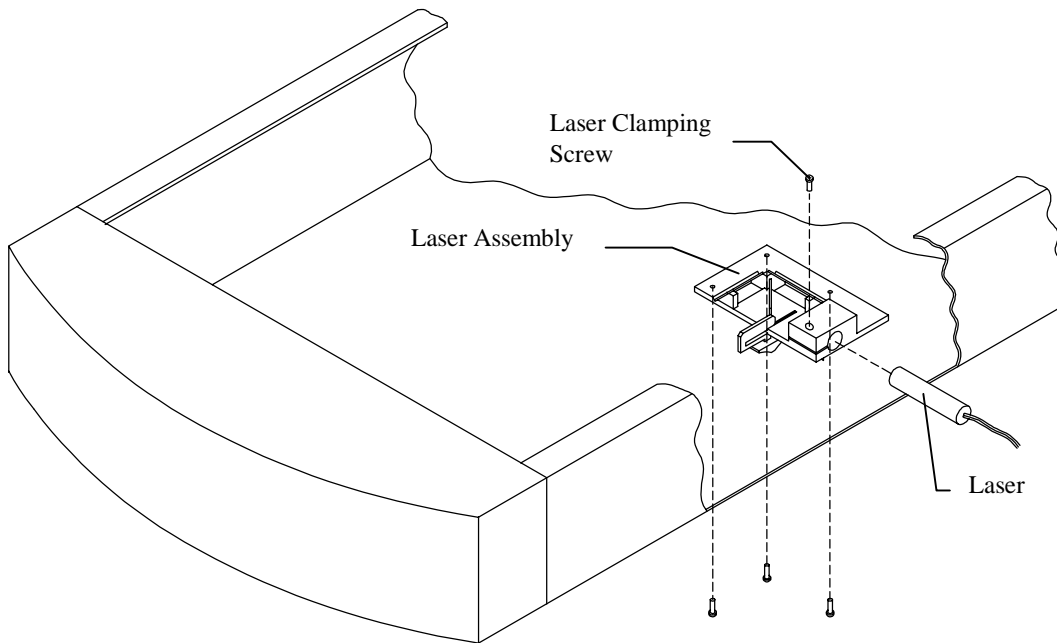


Figure 5-13. Laser Assembly

6. To replace the laser only, loosen the laser clamping screw. To replace the laser assembly remove the three mounting screws.
7. To adjust the laser, loosen the laser clamping screw, turn the laser on and rotate it until the correct alignment is seen.

REAR C-ARM FRUS

This section describes how to remove and replace the Analog to Digital Converter (ADC) Board located on the rear C-arm (see Figure 5-14).

Analog to Digital Converter Board

To remove and replace the Analog to Digital Converter (ADC) Board refer to Figure 5-14 and follow the procedure below:

1. The C-arm should be in the AP position.
2. Turn off the QDR 4500 computer and instrument power switches, and main power circuit breaker.
3. Remove the rear C-arm shoulder cover by removing 4 Phillips screws.
4. Unplug the cables on the ADC board.
5. Remove 4 Phillips screws, and remove the ADC board.

Section 5 - Remove & Replace

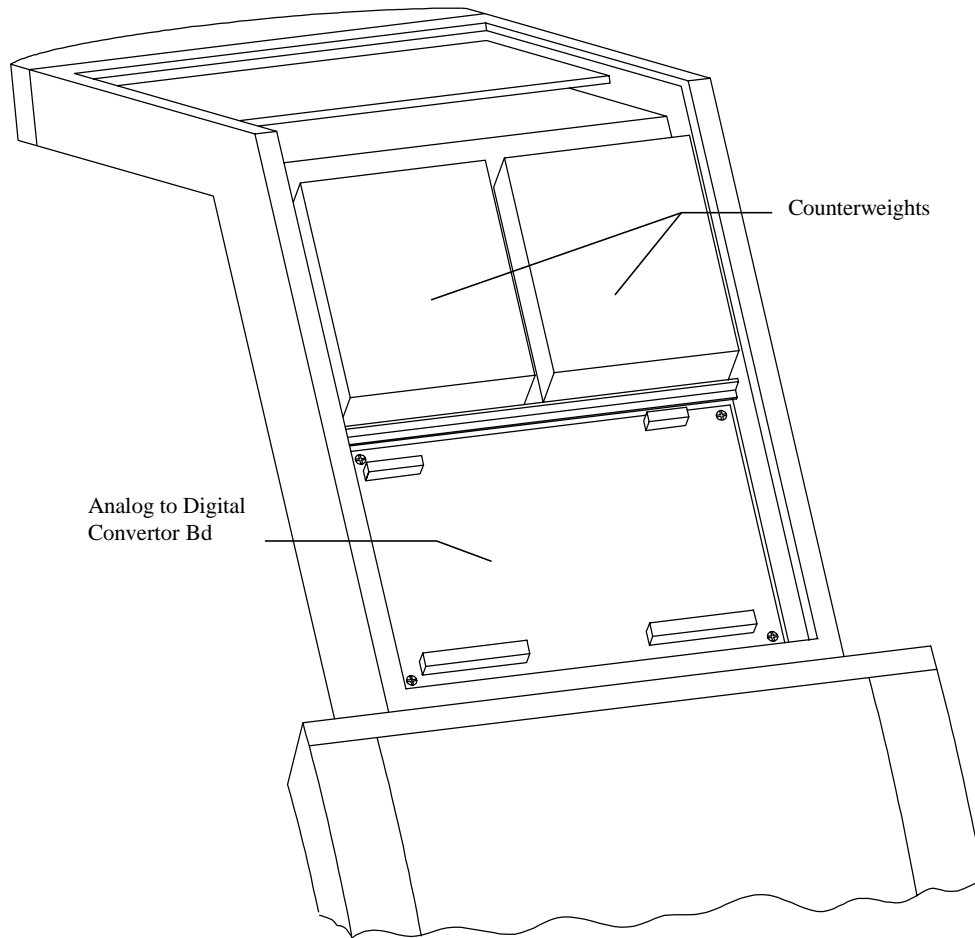


Figure 5-14. Rear C-Arm FRUs

6. To replace the ADC board reverse the steps.
7. Perform the A/D Gain Control Adjustment in the *Alignment and Calibration* section of this manual.
8. Perform Beam Flattening in the *Alignment and Calibration* section of this manual.

POWER MODULE FRUS

This section describes how to remove and replace the FRUs in the power module. The power module is located at the bottom of the computer stand. Figure 5-15 shows a rear view of the power module with the side panel removed.

28 Volt Power Supply

To remove and replace the 28V Power Supply refer to Figure 5-15 and follow the procedure below:

1. Turn off the QDR 4500 computer and instrument power switches, and main power circuit breaker. Unplug the power cord.
2. Remove the power module rear cover (4 Phillips screws).
3. Locate the 28V Power Supply and unplug all cables (3 connectors).
4. Remove the 4 nuts holding the 28V Power Supply and remove the supply.
5. Reverse the steps to install the new 28V Power Supply.

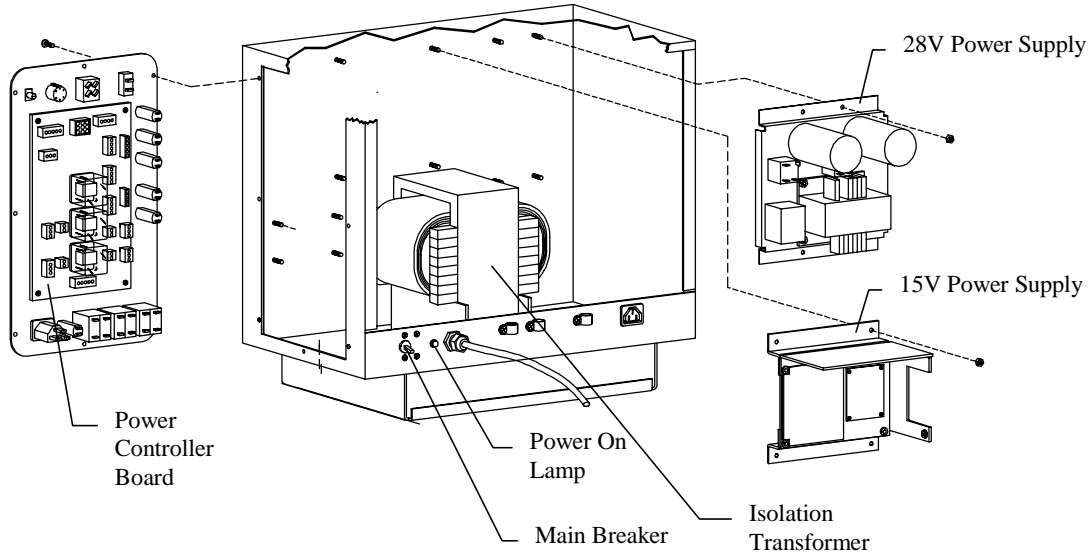


Figure 5-15. Power Module FRUs

Note: On newer units there are two line filters.

±15 Volt Power Supply

To remove and replace the 15V Power Supply refer to Figure 5-15 and follow the procedure below:

1. Turn off the QDR 4500 computer and instrument power switches, and main power circuit breaker. Unplug the power cord.
2. Remove the power module rear cover (4 Phillips screws).
3. Locate the 15V Power Supply and unplug all cables (2 connectors).
4. Remove the 4 nuts holding the 15V Power Supply and remove the supply.
5. Reverse the steps to install the new 15V Power Supply.

Section 5 - Remove & Replace

Line Filter

To remove and replace either Line Filter, refer to Figure 5-15 and follow the procedure below:

1. Turn off the QDR 4500 computer and instrument power switches, and main power circuit breaker. Unplug the power cord.
2. Remove the power module rear cover (4 Phillips screws).
3. Locate the Line Filter and remove 5 push-on spade connectors.
4. Remove the 4 nuts holding the Line Filter and remove it.
5. Reverse the steps to install the new Line Filter.

Isolation Transformer

To remove and replace the Isolation Transformer refer to Figure 5-15 and follow the procedure below:

1. Turn off the QDR 4500 computer and instrument power switches, and main power circuit breaker. Unplug the power cord.
2. Remove the power module rear cover (4 Phillips screws).
3. Locate the Isolation Transformer and unplug all cables.
4. Remove the 4 nuts holding the Isolation Transformer and remove the transformer.
5. Reverse the steps to install the new Isolation Transformer.

Power Controller Board

To remove and replace the Power Controller Board refer to Figure 5-16 and follow the procedure below:

1. Turn off the QDR 4500 computer and instrument power switches, and main power circuit breaker. Unplug the power cord.
2. Remove the power module rear cover (4 Phillips screws).
3. Remove the side control panel (8 Phillips screws).
4. Remove all connectors from the Power Controller Board.



The Operator's Console FRUs, computer, keyboard, n

Section 5 - Remove & Replace

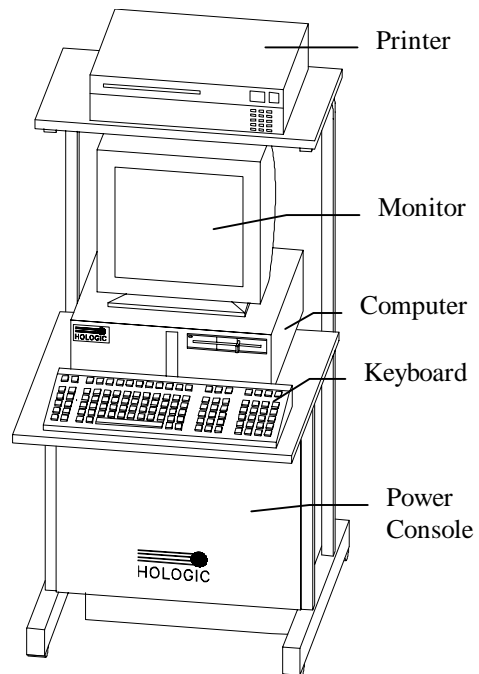


Figure 5-17. Operator's Console Assemblies

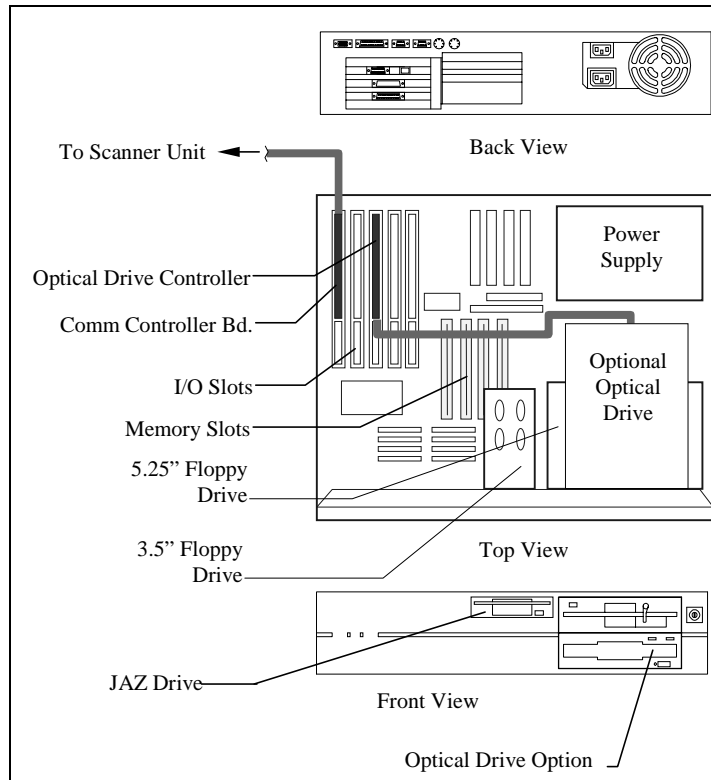


Figure 5-18. Computer Assemblies

APERTURE ASSEMBLY FRUS

This section describes how to remove and replace the FRUs on the Aperture Assembly.

Aperture Stepper Motor

To remove and replace the Aperture Stepper Motor (320-0041) refer to Figure 5-19 and follow the procedure below:

1. Unplug the motor cable.
2. Remove the 2 Phillips screws from the motor shaft bracket.
3. Remove the motor mount (2 Phillips screws) and remove the motor assembly.
4. Remove the motor from the motor mount, and remove the end lock nut and flat washer. Transfer the dampening pad to the new motor.
5. Reverse the steps above to install the new motor.

Section 5 - Remove & Replace

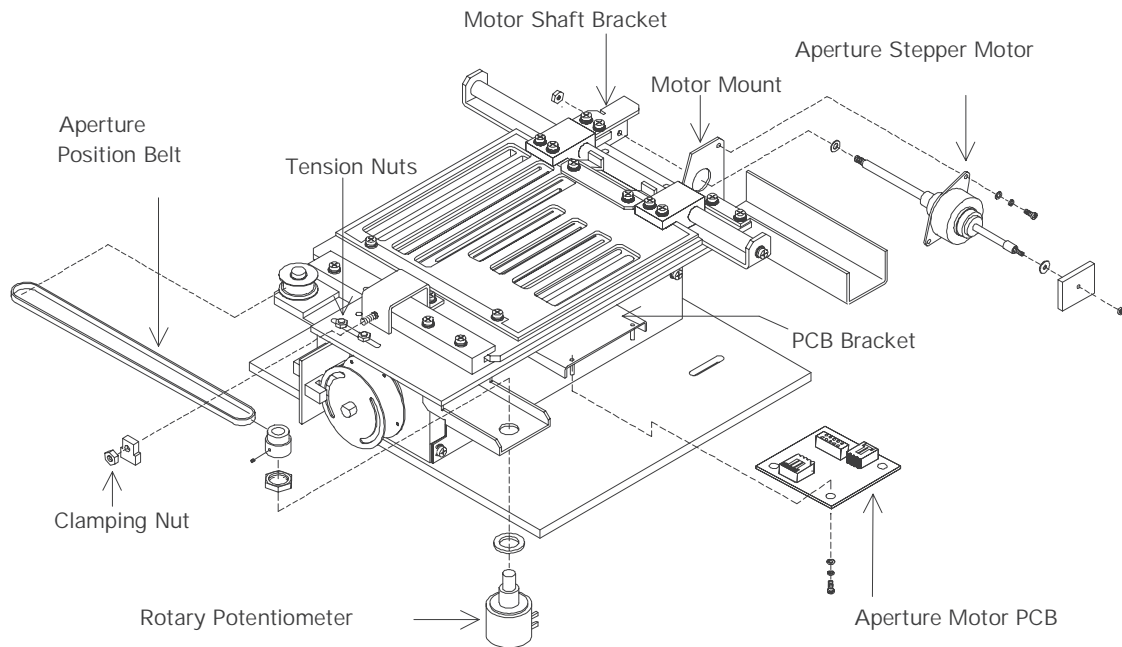


Figure 5-19. Aperture Assembly FRUs (QDR 4500A and SL)

Aperture Motor PCB

To remove and replace the Aperture Motor PCB (140-0068) refer to Figure 5-19 and follow the procedure below:

1. Remove the 2 Phillips screws from the motor shaft bracket.
2. Move the aperture back far enough to expose the screws that hold the PCB bracket.
3. Remove the 2 PCB bracket screws.
4. Unplug the cables and install the new PCB on the bracket.
5. Reverse the steps above to complete the installation of the new Aperture Motor PCB assembly.

Aperture Position Belt

To remove and replace the Aperture Position Belt (255-0032) refer to Figure 5-19 below:

1. Loosen the 2 belt tension nuts and the belt clamping nut.
2. Remove and replace the belt (ensure the belt is under the pem stud).
3. Tension the belt moderately tight (remove slack), and tighten the belt tension nuts.
4. Remove the 2 Phillips screws from the motor shaft bracket.
5. Rotate the belt pulley fully clockwise, then turn the pulley back 3/4 turn counter clockwise (3/4 turn of the potentiometer pulley, not the idler pulley).

6. Move the aperture towards the potentiometer until it stops.
7. Tighten the belt clamping nut (do not over tighten).
8. Move the aperture back until the motor shaft bracket screw holes line up.
9. Install the 2 Phillips screws holding the motor shaft bracket.

Rotary Potentiometer

To remove and replace the Rotary Potentiometer (180-0267) refer to Figure 5-19 and follow the procedure below:

1. Remove the Aperture Position Belt (refer to the procedure above).
2. Remove the potentiometer pulley.
3. Remove and replace the potentiometer (face wires towards the Aperture Motor PCB).
4. Replace the potentiometer pulley (pulley goes all the way down on the shaft).
5. Refer to the Aperture Position Belt procedure and replace the belt.

DRUM ASSEMBLY FRUS

This section describes how to remove and replace the FRUs on the Drum Assembly.

Drum Encoder PCB

To remove and replace the Drum Encoder PCB (140-0065/0089) refer to Figure 5-19, and Figure 5-21, and follow the procedure below:

1. Remove the Aperture Assembly by removing 4 Phillips screws that secure the assembly, and 2 Phillips screws that secure the aperture motor mount, to the drum end plates.
2. Unplug the PCB cable.
3. Remove and replace the PCB (ensure that the encoder wheels are not touching the sensors).
4. Replace the Aperture Assembly.

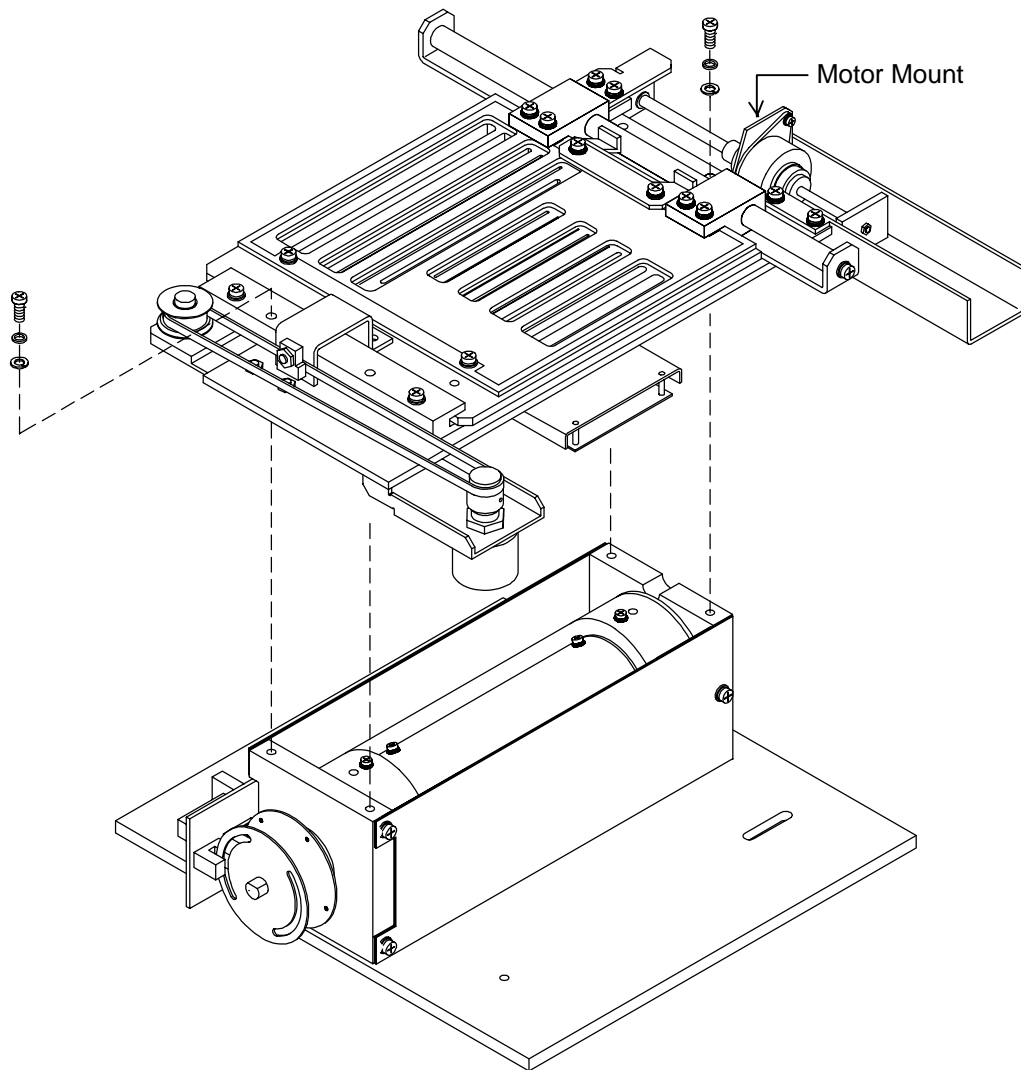


Figure 5-20. Aperture Assembly Removal (QDR 4500A and SL)

Drum Belts

To remove and replace either Drum Belt (130 teeth or 150 teeth) refer to Figure 5-21 and follow the procedure below:

1. Remove the Aperture Assembly by removing 4 Phillips screws that secure the assembly, and 2 Phillips screws that secure the aperture motor mount, to the drum end plates (refer to Figure 5-19).
2. Loosen the 2 drum motor mount screws, the idler screw and the outer pulley set screw. Remove the belts.

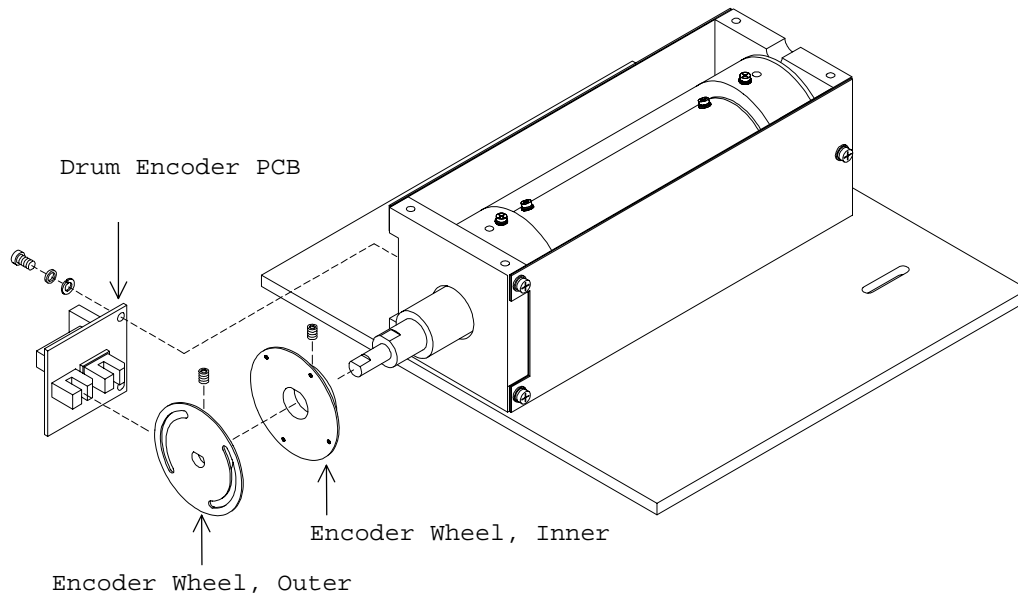


Figure 5-21. Rear Drum Assembly FRUs

3. Install the Filter Drum Alignment Pin (099-0110), small end first, through the slotted holes and into the small hole at the base plate. If the pin is installed properly, the drum will not rotate.
4. Install the 150 tooth belt on the back pulley (ensure the belt is positioned under the idler).
5. Install the 130 tooth belt on the front pulley.
6. Tighten the 2 drum motor mount screws (the motor mount is spring loaded to seek proper tension).
7. Tighten the idler screw (the idler is spring loaded to seek proper tension).
8. Tighten the outer pulley set screw.
9. Remove the Filter Drum Alignment Pin.

Stepper Motor Assembly

To remove and replace the Stepper Motor Assembly refer to Figure 5-21 and follow the procedure below:

1. Remove the Aperture Assembly.
2. Remove the drum belts (see procedure above).
3. Remove the stepper motor pulley.
4. Remove and replace the motor (4 flathead Phillips screws).
5. Replace the pulley, use Loctite 222 (540-0100) on the set screw.

Section 5 - Remove & Replace

6. Refer to the Drum Belts procedure above and replace the belts.

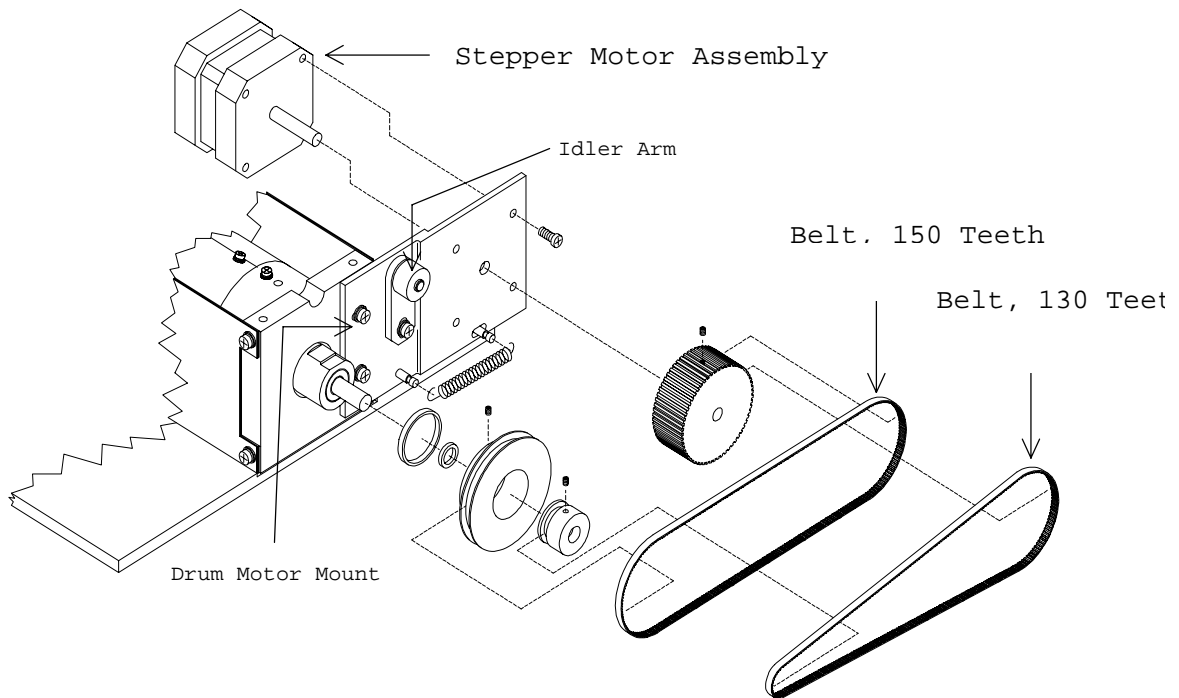


Figure 5-22. Front Drum Assembly FRUs

Drum Bearings

To remove and replace the drum bearings refer to Figure 5-22, and Figure 5-23, and follow the procedure below:

1. Remove the aperture assembly and drum belts (see procedures above).
2. Remove the 2 drum motor mount screws (see Figure 5-21).
3. Remove 6 screws from underneath the drum assembly base plate (4 screws hold the end plates and 2 screws hold the motor mount spring tensioner block).
4. Remove the side plates and lead shields (3 Phillips screws on each side).
5. Remove the drum encoder PCB and both encoder wheels.
6. Remove both drum belt pulleys.
7. Remove the drum. from the endplates.
8. Remove one drum endcap (4 Phillips screws) and remove the inner drum.
9. Replace the bearings.
10. Reassemble the drum and replace (and tighten) the screws in the endcap.

Note: When replacing the end cap ensure that the flats on each side of the drum shaft are facing the same way (this happens where the two side-by-side holes line up).

11. Replace the 2 endplates. The endplate with the cutout (for the PCB) goes on the drum end *away* from the alignment hole (see Figure 5-22).
12. Replace the lead shields and side plates (6 screws).

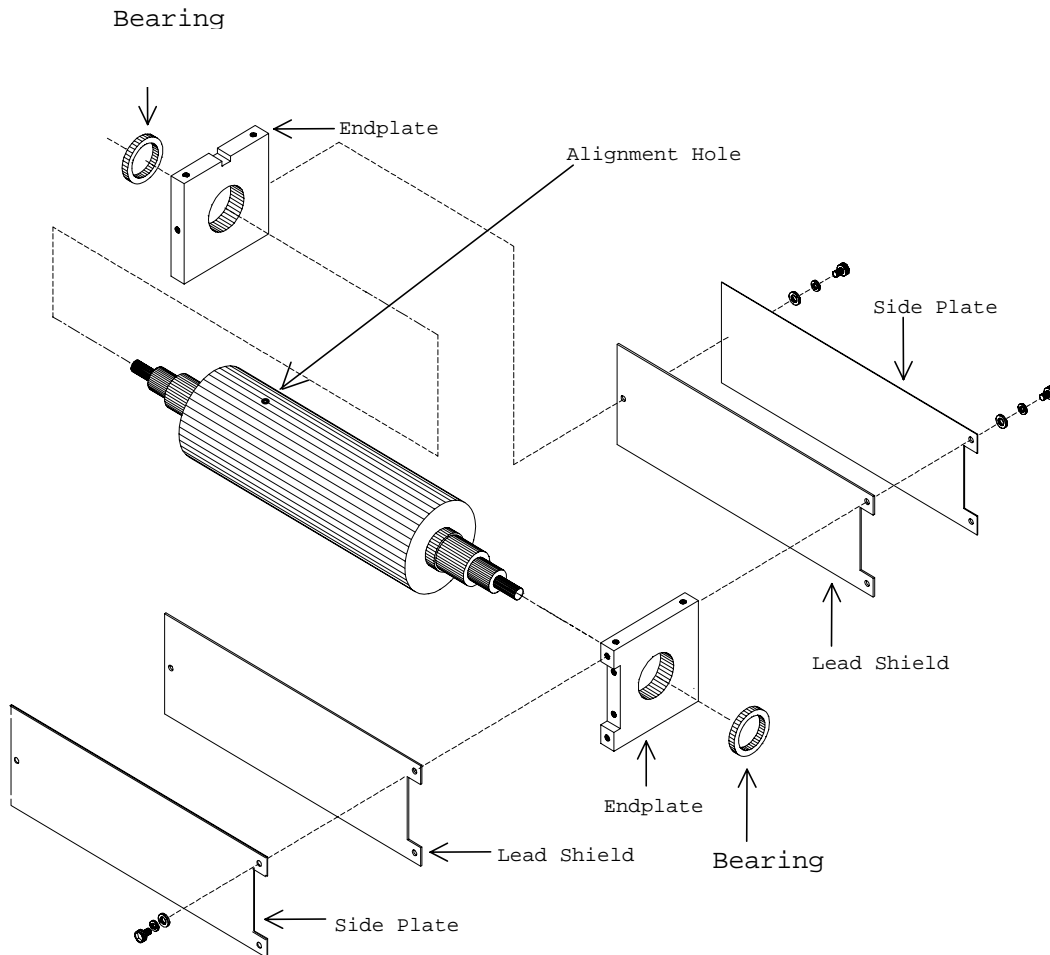


Figure 5-23. Drum Outer Bearings

13. Align the 2 endplates onto the holes on the recessed area on the base plate. Orient the front endplate towards the 2 slotted holes. Orient the rear endplate on the opposite set of holes and position so that the endplate side with cutout (for PCB) is facing the "C" cutout of the base plate. Replace the 4 flat washers, split locks, and 4-40 x 3/8 screws that secure the endplates.
14. Insert the Drum Spacing Fixture (099-0296) between the endcap and the front endplate. Push the filter drum against the fixture to center it between the two blocks. Do not remove the fixture at this time.

Section 5 - Remove & Replace

15. Install the spacers and pulleys at the front endplate (see Figure 5-21). Ensure that the pulley set screws line up with the flat, and use Loctite 222 on set screws. Press the filter drum against the fixture, and the pulley against the endplate, while tightening the set screw.

Note: Leave the outer pulley set screw loose until belts are installed.

16. Remove the Drum Spacing Fixture.
17. Replace the inner encoder wheel (see Figure 5-20). Press (squeeze together) the drum and encoder wheel against the endplate and tighten the set screw (use Loctite 222).
18. Replace the outer encoder wheel.
19. Replace the drum encoder PCB. Ensure that the encoder wheels do not contact the sensors.
20. Replace the stepper motor assembly (2 screws on the motor mount, and 2 screws on the base plate). Leave the motor mount screws loose for now.
21. Replace the drum belts (see the Drum Belts procedure).
22. Tighten outer pulley set screw after belts are installed.
23. Refer to the Aperture Assembly procedure and install the aperture assembly.

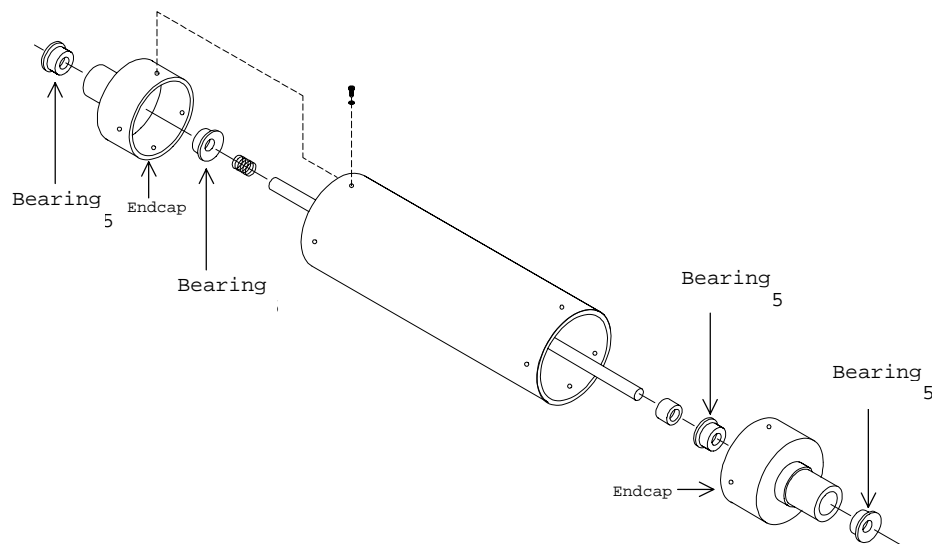


Figure 5-24. Drum Inner Bearings

REPLACING EMI CABLES

EMI cables are ribbon cables modified with braided shielding and ground lugs. When replacing, be sure each ground lug is fastened to a ground connection, usually to the ground plane of the PCB at that end. Use a star washer between the ground lug and the ground plane. Be sure the ground lug does not short out any component on the PCB.

When dressing the cables, be sure the braided shield does not come in contact with any electrical component or voltage source.

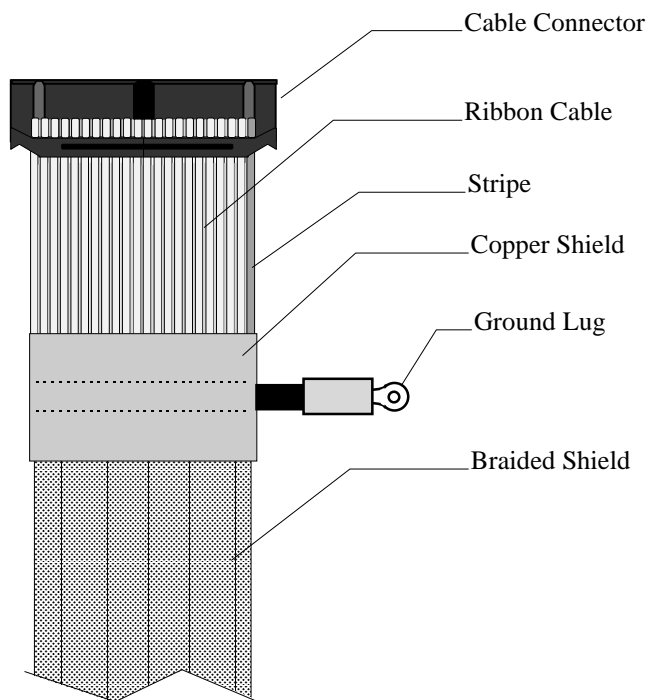


Figure 5-25. The EMI Compliance Cable

FRU LISTS

The following tables provide the information necessary to identify and order the correct FRU.

Please note:

1. The tables are listed by Figure, and then by Cable, Miscellaneous, Mobile, and then Special Tools.
2. If the "Used On" column is blank, this means that the part is used on all models.

Figure 5-1. Electronics Tray FRUs

Part Number	Description	Used On
010-0792	X, Y, R Drive Motor (new, replaces 010-0617)	C,W
140-0049	TZ Drive Board	A,SL
140-0085	Motor Control Board (EMI, replaces 140-0055)	
140-0086	Distribution Board (EMI, replaces 140-0047)	
180-239	Cable, AY Encoder	
255-0026	C-Arm Y drive belt	
285-0004	Encoder, Rotary Potentiometer	
325-0004	Table Y, Arm Y and Arm R Gearcase	

Figure 5-2. Control Panel and Table Y FRUs

Part Number	Description	Used On
010-0675	Control Panel Assembly	C,W
010-0676	Control Panel Assembly	A,SL
140-0053	Control Panel Board	
140-0085	Motor Control Board (EMI, replaces 140-0055)	
255-0033	Table Y drive belt	A,SL
325-0004	Table Y, Arm Y and Arm R Gearcase	

Figure 5-3. Left Side Table Y FRUs

Part Number	Description	Used On
180-0241	Cable, TY Encoder	
255-0033	Table Y drive belt	A,SL
285-0004	Encoder, Rotary Potentiometer	

Figure 5-4. Table X FRUs

Part Number	Description	Used On
010-0792	X, Y, R Drive Motor (new, replaces 010-0617)	C,W
140-0085	Motor Control Board (EMI, replaces 140-0055)	
180-0240	Cable, TX Encoder	
255-0021	Table X-drive belt	
285-0004	Encoder, Rotary Potentiometer	
325-0005	Table X Gearcase	

Figure 5-5. Table Z FRUs

Part Number	Description	Used On
010-1020	Rotary Linear Part FRU Kit	A,SL
010-1023	Pedestal Assy. (replaces 321-0034)	A,SL
320-0042	Pedestal	A,SL

Figure 5-6. Installing the Rotary String Encoder

Part Number	Description	Used On
010-1020	Rotary Linear Part FRU Kit	A,SL

Figure 5-7 C-Arm R FRUs (Outside View)

Part Number	Description	Used On
010-0792	X, Y, R Drive Motor (new, replaces 010-0617)	C,W
010-0802	Gas Spring Repair Kit	A,SL
140-0085	Motor Control Board (EMI, replaces 140-0055)	
180-0238	Cable, AR Encoder	
285-0004	Encoder, Rotary Potentiometer	
295-0308	Arm Gas Spring	
325-0004	Table Y, Arm Y and Arm R Gearcase	

Figure 5-8. C-Arm R FRUs (Inside View)

Part Number	Description	Used On
255-0022	Arm Rotation belt	
255-0023	Arm Rotation Encoder belt	

Figure 5-9. Lower C-Arm FRUs

Part Number	Description	Used On
010-0575	X-ray Tank	
010-0651	Fixed Aperture Filter Drum Assembly	C,W
010-0667	Aperture & Filter Drum Assembly	A,SL
010-0987	XRC Assy. (replaces 010-0606)	
030-1665	Tension Pulley Spacer	
030-1666	Tension Pulley	
229-0021	Tension Pulley Clip	
140-0090	C-arm Interface Board (EMI, replaces 140-0051)	
295-0308	Arm Gas Spring	A,SL
330-0010	Fan (back of C-arm)	

Figure 5-11. Upper C-Arm FRUs

Part Number	Description	Used On
140-0048	SQLW Mux Board, High Res	
140-0063	Detector Front and Back High Res Board	SL
140-0064	Detector Middle High Res Board	A,SL
140-0067	SQ Mux Board, Low Res	

Figure 5-12. Detector Assembly Mounting

Part Number	Description	Used On
010-0578	Detector 128 Channel	SL
010-0604	Detector 216 Channel	A
010-0771	Low Res Detector Assy	C,W

Figure 5-13. Laser Assembly

Part Number	Description	Used On
010-0682	Laser Assembly	

Figure 5-14. Rear C-Arm FRUs

Part Number	Description	Used On
140-0087	Analog to Digtl Convtrtr Board (ADC, EMI, replaces 140-0054)	

Figure 5-15. Power Module FRUs

Part Number	Description	Used On
101-0032	15V Power Supply (VDE version)	
101-0033	28V Power Supply (VDE version)	
140-0056	Power Controller Board	
160-0001	Line Filter, 20A	
310-0018	Circuit Breaker, 20 Amp 2 Pol	
370-0047	Isolation Transformer (VDE version)	
485-0011	Power On Lamp, Neon Green	

Figure 5-16. Power Control Panel FRUs

Part Number	Description	Used On
140-0056	Power Controller Board	
310-0029	Ckt Breaker, 2 Pole, 220v 6amp	
310-0030	Ckt Breaker, 2 Pole, 240v 3amp	
310-0032	Circuit Breaker, 120vac, 1amp	
310-0033	Circuit Breaker, 120vac, 3amp	
310-0035	Circuit Breaker, 120vac, 10amp	
310-0039	Circuit Breaker, 120 Vac 4 Amp	
465-0031	Switch, SPDT Power, Rocker	
485-0043	X-Ray On LED, Green, 24V	

Figure 5-17. Operator's Console Assemblies

Part Number	Description	Used On
010-0576	Power Console Assy.	
120-0049	Monitor, 17" SVGA	
120-0055	Mouse	
120-0072	Monitor, 14" SVGA	
120-0104	Printer, Color	
120-0122	Monitor, 15 in.	
120-0124	PRINTER,HP,LASERJET,6P	
120-0125	PENTIUM 133MHZ W/WINDOWS 95	
120-0127	MONITOR,14" COLOR,HI-RES.	
120-0131	PENTIUM, 200MHZ MMX	
120-0132	PENTIUM 200MHZ ELITE	
120-0139	Computer Keyboard	
120-0142	PENTIUM,300 MHZ	
120-0153	PENTIUM, 400MHZ	
120-0156	HP DJ 660C	
120-0157	HP DJ 870C	
180-0179	Keyboard Adapter	
180-0182	Keyboard Adapter	
COMPUTER-400	Computer Assy.	C
COMPUTER-410	Computer Assy.	W
COMPUTER-420	Computer Assy.	SL
COMPUTER-430	Computer Assy.	A
KEYBOARD-400	Kit,Keyboard Replacement, 4500	

Figure 5-18. Computer Assemblies

Part Number	Description	Used On
120-0017	Floppy Drive, 1.44MB 3.5"	
120-0081	Optical Disk Drive, Internal Half Height	
120-0083	SCSI Interface Board	
120-0116	Hard Drive, 1GB minimum	
120-0120	JAZ Drive, 1GB	
120-0145	CD-ROM, 12X MINIMUM	
120-0148	VIDEO ACCELERATOR, 4 MB PCI	
120-0154	Network Card	
120-0160	HARD DRIVE 2 GB JAZ REMOVABLE	
130-0009	Floppy Drive, 1.2MB 5.25"	
140-0042	Communications Controller PCB	
180-0136	Optical Disk Cable, Internal	
JAZ-ISA-DOSV9-110	Kit Jaz Drive Isa Dosv9 Option	
JAZ-PCI-WIN-110	Kit Jaz Drive Pci Win Option	

Figure 5-19. Aperture Assembly FRUs (QDR 4500A and SL)

Part Number	Description	Used On
140-0068	Aperture Motor PCB	
180-0267	Cable, Aperture Motor Signal	
255-0032	Aperture Position Belt	
320-0041	Aperture Stepper Motor	

Figure 5-22. Front Drum Assembly FRUs

Part Number	Description	Used On
010-0627	Filter Drum Stepper Motor Assembly	
255-0030	Drum Wheel Belt 150 Teeth	
255-0031	Drum Wheel Belt 130 Teeth	

Figure 5-23. Drum Outer Bearings

Part Number	Description	Used On
250-0046	Drum Outer Bearing	

Figure 5-24. Drum Inner Bearings

Part Number	Description	Used On
250-0045	Drum Inner Bearing	

Cables

Part Number	Description	Used On
180-0185	Cable, A/D Analog Data	
180-0189	Cable, A/D Digital Data	
180-0190	Cable, Power Multiplex	
180-0191	Cable, DAS Communication	
180-0194	Cable, Arm Faceplate	
180-0195	Cable, Safety Switch	
180-0213	Cable, Fan, X-Ray Controller	
180-0328	Cable, X-Ray Signal (EMI, replaces 180-0193)	
180-0332	Cable, C-Arm Signal (EMI, replaces 180-0186)	
180-0334	Cable, AR Drive (EMI)	
180-0335	Cable, C-Arm Power (EMI)	
180-0336	Cable, TX Drive (EMI)	
180-0337	Cable, TY Drive (EMI)	

Miscellaneous

Part Number	Description	Used On
010-0926	Cable Kit	
010-1026	A/SL Enhancement Kit	A,SL
UPS-100-0033	UPS, 60Hz	
UPS-100-0034	UPS, 50Hz	

Mobile

Part Number	Description	Used On
010-0980	ASSY, L'KG PIN Y CARR, MOBILE	A,SL
010-0981	ASSY, L'KG PIN C-ARM MOBILE	A,SL
010-0993	ASSY,CARR L'KG PIN,MOBILE	C,W

Special Tools

Part Number	Description	Used On
010-0923	X-Ray Beam Alignment Fixture (2 needed)	A,SL
099-0110	Filter Drum Alignment Pin	A,SL
099-0111	Aperture Alignment Pin	C,W
099-0145	Filter Drum Alignment Block	
099-0258	Field Service Tools Disk	
099-0264	Comm Controller Board Loopback Plug	
099-0269	Digital Level	
099-0283	24" Case, Digital Level	
099-0296	Drum Spacing Fixture	

SECTION 6

FAULT ISOLATION

This section provides information to help identify the source of a problem in the QDR 4500 system. The four general categories are:

Problem...	Refer to the section titled...	On page...
Dead system, or power problem	<i>Power Problems</i>	6-1
Scanner motion problem	<i>Motion Problems</i>	6-2
Computer display problem	<i>Display Problems</i>	6-5
Error message displayed or logged	<i>Messages</i>	6-16

BEFORE STARTING

Before starting, make sure the software configuration is compatible with the scanner.

SOFTWARE CONFIGURATION

Check the release number at the top of the Hologic main menu to be sure that it is valid for the scanner model.

HARDWARE CONFIGURATION

When troubleshooting, it is sometimes helpful to observe all the indicators available on the PCBs and other FRUs. Many components of the system have LEDs indicating the presence of necessary voltages and the state of some signals. Section 8 is helpful in locating these LEDs and observing the state of the system.

POWER PROBLEMS

Table 6-1. Power Component Locations

Component...	Figure...
Main circuit breaker	5-14
Power switches	5-15
Circuit breaker on power module	5-15
LEDs for DC voltages	5-1, 5-16 (power console), most driver and control PCBs
Tape switches and connectors	
Emergency stop switches and circuits	
Computer power and operation	5-16

QDR® 4500 Technical Manual

The following suggestions apply to a QDR 4500 system exhibiting a power problem:

If...	Check...	Refer to...
System "dead"	Main breaker Power switches	<i>Check Power Line Voltage</i> heading, Section 3
Main power suspect	Circuit breakers on power module Power cables to the power module	<i>Power Module</i> heading, Section 2
Suspected Power Module problem		<i>Power Module FRU s</i> heading, Section 5
Suspected DC power supply problem	LEDs for all DC voltages (lit if present)	
28V LED not lit	All tape switches and connectors (tape sw. reads 120• when open) Emergency stop switch and associated circuitry Computer is on Hologic software running (check error log)	Distribution board, Figure 5-1
System does not start up	System properly configured (see BEFORE STARTING) Before starting, make sure the software configuration is compatible with the scanner. Software Configuration above) Emergency stop switch in "Off" (Up) position X-ray enable key switch locked in the horizontal position	
Power console does not power up	Incoming A/C line voltage Main circuit breaker	Figure 5-14

Also...

Problem...	Possible cause...	Corrective action...
Laser does not turn on	Safety feature if system thinks C-arm is at head of table	<ol style="list-style-type: none"> 1. Exit to DOS 2. Run SQDRIVER 3. At CARM\$\$\$\$> prompt, type <u>LASER SAFTY 0</u> <Enter> 4. Exit from SQDRIVER 5. Reboot the computer

MOTION PROBLEMS

Motion problems are failures related to movement of the table and/or C-arm. In most (but not all) cases, an error message accompanies QDR 4500 motion problems. Therefore, it is good troubleshooting practice to check the error log (C:\ERRLOG.DAT file) for occurrences of

Section 6 - Fault Isolation

motion related problems. The following suggestions apply to a QDR 4500 system that exhibits a motion problem.

Start by identifying the bad axis (if it is not obvious). Ask the operator for symptoms and check the error log. See Figure 6-1 for possible motion directions.

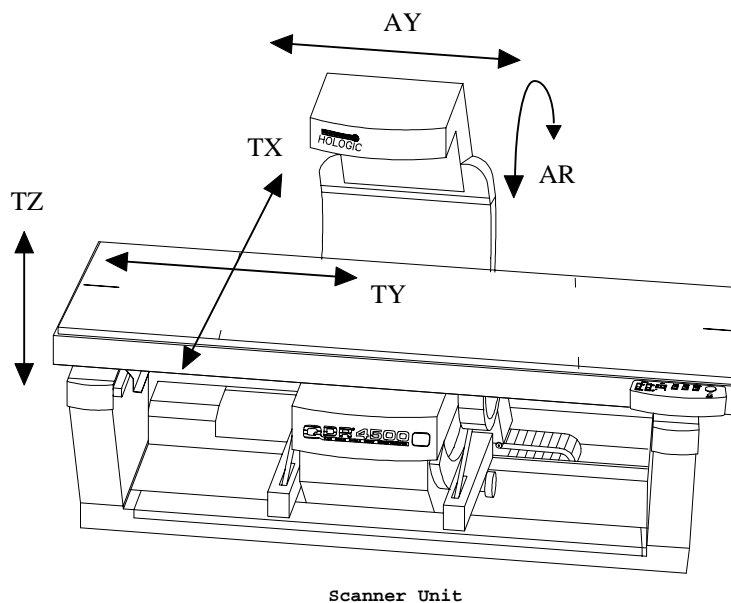


Figure 6-1. Scanner Motion Directions

	Refer to the Figure Below				
	ARM-Y	ARM-R	TX	TY	TZ
Drive Belt	5-1	5-7	5-4	5-2,5-3	
Drive Motor	5-1	5-6	5-4	5-2	5-5
Driver Board	5-1				
Encoder	5-1	5-6	5-4	5-3	5-5
Encoder Belt		5-7			
Motor Controller Board	5-1	5-6	5-4	5-2	
Distribution Board	5-1				
Oper Cntrl Panel	5-2				
Control Panel PCB	5-2				
Computer	5-16				
Communications Controller	5-17				

Table 6-2. Motion Component Locations

TX, TY, AR, AY

Check...	Refer to...
Belt	<i>Motor Controller Board</i> heading,
Encoder coupling hose	Section 2
Encoder coupling clamp	Figure 5-1, 5-2, 5-3, 5-4, 5-6, 5-7
Motor controller board	Section 8
Motor/gear case for the motor subsystem in question	
TY (on A and W models only)	
Left and right end panels on table for proper installation. This may cause problems if reversed. (Left 030-1376, right 030-1838).	

TZ

To...	Refer to...
Operate pedestal motors by service switches located on the TZ Drive board	<i>TZ Drive Board</i> heading, Section 2 Block diagram and interconnection chart for the TZ motor subsystem
Troubleshoot TZ drive problems Note: The pedestal drive test cable (180-0320) is used to isolate pedestal problems from driver problems.	Section 8

Do not run the TZ motors for more than 30 seconds continuously. These pedestal motors are rated at a 10% duty cycle. Exceeding the rating causes an overheat condition and shuts down the motor. After shut down, the motors must cool for at least 5 minutes before running.

CAUTION: Running any motor subsystem to its limit (in either direction) does not damage the motor. However, if the motor encoder is not properly calibrated it may be damaged.

TX, TY, TZ, AR, AY

To...	Run...	Refer to...
Perform simple table and C-arm movements	Motor Control Pad (computer motion control)	The Hologic Main Menu, select: 1. Utility 2. Emergency motion
Perform precise table and C-arm movements	SQDRIVER	<i>Motor Calibration</i> heading, and <i>Motor\$XX</i> (for the specific motor), Section 4
Monitor all motion parameters		
Troubleshoot problems encountered initiating motion from the Operator's Control Panel		<i>Control Panel Controller Board</i> heading, Section 2
	Hardware checker	SQCHECK, 080-0476

CONTROL PANEL PROBLEMS

If a Control Panel problem is suspected, or if control panel functions are not responding, use the PANEL command under SQDRIVER to help isolate the problem. From DOS, type:

1. sqdriver<Enter>, then
2. panel\$\$\$ <Enter>.

The program displays the state of all switches and lamps on the control panel (0 = off, 1 = on). The display is dynamic, allowing control panel functions to be tested.

DISPLAY PROBLEMS

Display problems can be grouped into four general categories: vertical stripe, horizontal stripe, noise (dots, speckles, etc.), and no display.

Table 6-3. Display Component Locations

Component	See Figure...
Detector Boards	5-10
Integrator/Multiplexor Board	5-10
A/D Converter Boards	5-13
Aperture Assembly	5-18,5-19
C-Arm Interface Board	5-8
Filter Drum Assembly	5-8
Filter Drum Assembly (X-Ray Beam Alignment)	4-1
Array Assembly (X-Ray Beam Alignment)	4-2
Printer (if quality is bad on printout and not display).	5-16
X-ray tank	5-8, 5-19
Collimator	5-8, 5-19

Vertical Stripe

This type of display problem is most likely related to the detector subsystem. The following suggestions apply to a QDR 4500 system that exhibits a vertical stripe in the display:

Check...	Refer to...
Detectors	SUSQ in graphic mode to check for signal strength and noise (Section 9)
Narrow vertical stripe - bad detector	<i>Data Acquisition System</i> heading, Section 2, for block diagrams and interconnection charts
Wide vertical stripe - bad Integrator/ Multiplexor or ADC board	for the Detector, Integrator/Multiplexor and Analog/Digital Converter boards
Foreign matter (especially metallic) anywhere in the X-ray beam path in the aperture slit, collimator cup, etc.	Figure 5-8, 5-19
Also...	
Run the hardware checker	SQCHECK, 080-0476, F/S Tools disk

Horizontal Stripe

This type of display problem is most likely related to the line voltage or X-ray subsystem. The following suggestions apply to a QDR 4500 system that exhibits a horizontal stripe in the display:

Check...	Refer to...
Line voltage	<i>Check Power Line Voltage</i> heading, Section 3
Tube kV Peak Potential	<i>Check Tube kV Peak Potential</i> heading, Section 3
Tube Current	<i>Tube Current</i> heading, Section 3
Filter drum turning	Figures 5-8, 5-18 through 5-23
Filter drum belt	Figures 5-18, 5-21
Green LEDs on C-Arm Interface	Figure 5-8, Appendix A
Banding—variations in horizontal stripe intensity, usually spread across display.	X-ray controller, figure 5-8
Also...	
Run the hardware checker	SQCHECK, 080-0476, F/S Tools disk

Noise

The term "noise" is used here to describe any flaw, or irregularity in the display (dots, specks, uneven lines, etc.) or similar problem. The following suggestions apply to a QDR 4500 system that exhibits noise in the display:

Section 6 - Fault Isolation

Check...	Refer to...
Tube kV peak potential	<i>Check Tube kV Peak Potential</i> heading, Section 3
Tube current	<i>Tube Current</i> heading, Section 3
X-ray beam alignment	<i>X-Ray Beam Alignment (A/SL, C/W)</i> heading, Section 4
Signal strength and noise	SUSQ diagnostic in graphic mode
Aperture position and aperture belt	<i>Aperture Calibration</i> heading, Section 4
Filter Drum is turning	Figures 5-8, 5-18 through 5-23
Filter Drum belt	Figures 5-18, 5-21
Green LEDs on C-Arm Interface board	Figure 5-8, Section 8
Aperture plate assembly, first precollimator, second precollimator and collimator for specs of lead and other deformities.	Figures 5-9, 5-19, 5-20
Also...	
Run the hardware checker	SQCHECK, 080-0476

No Display

The term "no display" is used here to describe:

- no scan display
- completely white screen
- completely dark screen
- other similar problems

This type of display problem may be related to the detector subsystem, or the X-ray subsystem.

The following suggestions apply to a QDR 4500 system that exhibits no display:

Check...	Refer to...
Tube kV peak potential	Check Tube kV Peak Potential heading, Section 3
Tube current	Check Tube Current heading, Section 3
X-ray production	Field Service Preventive Maintenance heading, Section 7
Signal strength and noise	SUSQ in graphic mode,
Filter Drum is turning	Figures 5-8, 5-18 through 5-23
Filter Drum belt	Figures 5-18, 5-21
Green LEDs on C-Arm Interface board	Figure 5-8, Section 8
No display may indicate a bad Integrator/Multiplexor or Analog to Digital Converter board	Refer to the Data Acquisition System heading, in Section 2 of this manual, for block diagrams and interconnection charts for the Integrator/Multiplexor and Analog/Digital Converter boards
Check aperture position and aperture belt	<i>Aperture Calibration</i> heading, Section 4
Also...	
Run the hardware checker	SQCHECK, 080-0476, F/S Tools disk

TARGETING/LASER PROBLEMS

If...	Check...	Refer to...
Object being scanned appears to the left or right of the scan window	Detector array. It may be too far forward or back inside the upper arm assembly.	Figure 5-10
	Laser alignment	Page 4-22
	Run... BIGFLAT	

DATA COMMUNICATIONS PROBLEMS

Data communications problems occur between the computer and the scanner. Refer to the following table:

Error messages usually include the keywords:	Check the:
Message Packet Sent	Digital Signal Processor PCB. If IC is not seated properly, replace the board.
• Received	Data, power, and ribbon cables for proper seating.
	• Device states in the SQDRIVER for errors. If a device is stated as "E_TIMEOUT", it is suspect.

AREA /BMD/BMC/CV SPECIFICATION PROBLEMS

If...	Possible cause		Refer to...
X-ray beam misaligned	X-ray beam alignment on aperture 11. Signal output level should not rise or fall by a significant margin.		Page 4-1
X-ray beam quality problems	Measure X-ray peak potential and tube current waveforms. Make sure they are both stable and within specs. Check SUSQ bar graph for shifting or “dancing” X-rays. If so, test X-Ray Controller. Check A/C line for stability (voltage and frequency).		Page 3-17, 3-19 Page 4-4
Mechanical frame problems	Check motor drive belts for excessive play. Ensure all hardware on the arm, frame, and drives are secure and clear of moving assemblies (C-arm, etc.)		Page 7-1
Mechanical motor drive problems	Check for loose assemblies:	Detector array X-ray tank X-ray controller Aperture assembly	Figure 5-10 Figure 5-8 Figure 5-18 Figure 5-18
	The bone and/or tissue segments in the filter drum may be defective or out of spec. If so, replace and restart system testing.		Figure 5-18 through 5-23

X-RAY PROBLEMS

The following lists some common X-ray problems and some suggested solutions. Refer to Section Two *Functional Description* for more information on the X-Ray subsystem.

No X-Rays

If...	Check...	Refer to...
X-Ray (28VDC LED) on distribution board is not lit	X-ray enable LED on console and Signal Distribution board should be out	
“NO A/C Line Interrupts” message at start-up	Interlock inhibit 28VDC cable to power console, power distribution X-ray controller interlock switch Computer problems Jumper (240VAC) on the isolation transformer secondary (brown: 0 to 120) Fast-on connections to the XRC power line filters under the signal distribution PCB for secure fit	Figure 5-1, 5-2, 5-14, 5-16

X-Ray Alignment Problems

X-Ray beam does not align properly

If the X-ray beam does not align properly per the procedure, follow these suggestions.

1. Try to align the X-ray beam to the drop-off points per the alignment procedure. Recheck the position of aperture 10 with the alignment block and pin. If the block and pin line up, the alignment brackets need to be repositioned. (Check captive screws and jam nuts.)
2. If you align the X-ray beam to both drop-off points but the range is narrow, (on aperture 10 you should have 3-8 turns of the hex driver), the collimator cup and/or the pre-collimator disk on the X-ray tank may be misaligned.

Using glow paper, assure that the X-ray beam is hitting the front and back on the detector array equally. If not, this may indicate that the X-ray tube has shifted within the letharge. Perform further verification before replacing the X-ray tank.

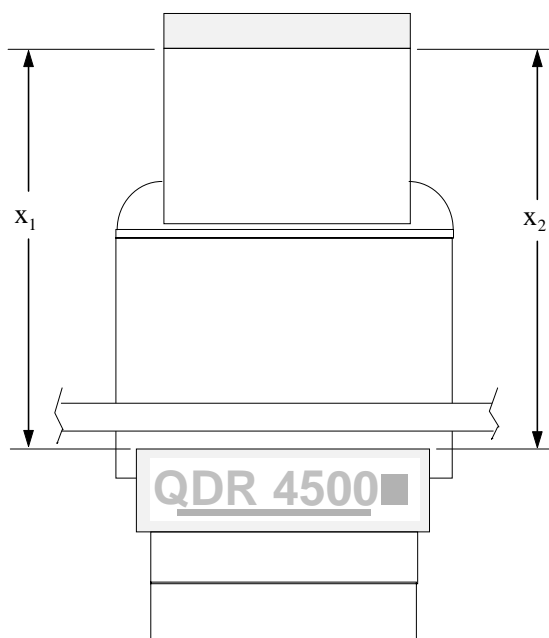


Figure 6-2. Checking C-Arm Parallelism

3. If the aperture and detector array window are aligned, remove the aperture assembly and inspect the cup and disk. Look for any debris or lead fragments. When replacing the cup and disk, align the apertures as closely as possible to the detector array window.
4. Inspect the upper and lower arm assemblies and make sure they are not misaligned. This is done by aligning the #10 aperture. If the alignment process involves moving the aperture so far over that aperture 10 moves out of alignment with the X-ray beam origination from the collimator cup and pre-collimator disk, then there is an alignment problem. You may need to reposition the tank or the upper arm assembly.

Section 6 - Fault Isolation

Verify upper arm parallelism with respect to lower arm assembly. Referring to Figure 6-2, assure dimension x_1 is equal to x_2 .

System Fails X-Ray Beam Alignment Verification

Align the X-ray beam and recalibrate the aperture. If this fails, inspect the aperture assembly for any loose hardware or excessive play in the aperture plate. Check the aperture assembly encoder's belt tension. If the belt is too tight, it may cause encoder readback errors and cause the calibration program to fail.

Beam Flattening Problems

System Consistently Fails the Beam Flattening Procedure

1. Check for loose, misaligned, or defective aperture assembly, collimator cup, or pre-collimator disk. (Refer to X-ray Alignment Problems, above.)
2. If the X-rays are unstable or "dancing", monitor the X-rays on the SUSQ bar graph screen for any amplitude shifting of the defective signal display.
3. If shifting is taking place, check/replace the X-ray controller assembly and X-ray tank connections. Check the X-ray peak potential and tube current waveforms and monitor for waveform distortion. This may indicate a defective interconnection cable, X-ray tank, or power supply.
4. Check output signal level. You may have to reset the ADC gain level.
5. Check for bad detectors in the detector array assembly. Load the Field Service Tools disk and run SQCHECK.
6. Check the filter drum to see that it is installed correctly. Check the segment readback values in SUSQ with X-rays ON.
7. Check for lead fragments in the X-ray beam. Inspect the collimator cup, disk, and aperture assembly.
8. If a failure occurs during a whole body or lateral flattening, recheck the AR and TX motor cal files. The X-rays may be hitting the table edge. Make sure the drives are operating normally. Examine the beam flattening scans for any unusual indications. If an error message is displayed, go to the *Error Message List* heading on page 6-19.

LASER PROBLEMS

WARNING: The laser beam can cause serious retina damage if focused directly into the eye. Be sure to turn the laser OFF when visually inspecting the shutter and aperture.

When troubleshooting the laser, refer to the following:

Make sure...	Refer to...
Shutter is open and not obstructing the beam	Page 4-21, Figure 5-12
Motor drives have been calibrated	Pages 4-6 to 4-17

If...	Suggestions
Laser does not turn on	<p>(Software is inhibiting laser when table head is near the laser) Move the C-arm to the center of the table and retry. Do the following:</p> <ol style="list-style-type: none"> 1. Check black and yellow wires from the C-arm interface PCB to the underside of the Detector Array Assembly 2. Shut off instrument power (switch on console). 3. Disconnect Molex laser power connector. 4. Connect a DVM to the plug coming from the C-arm PCB. 5. Turn laser power on. 6. Check connector for +5VDC. If not, check using SQKEYPAD. <p>Check C-arm Interface PCB, Signal Distribution PCB, all cables. Check computer. At installation only, type "laser_safey=0" in SQDRIVER and reboot. Check AY motor calibration file. If data is corrupt or uncalibrated, laser may not turn on, despite position of C-arm.</p>
Laser crosshair beam is defective	<p>Check laser block assembly mirrors for breaks, cracks, or misalignment Check shutter is open Check aperture is unobstructed Loosen the laser securing screw to adjust the laser to perpendicularity (see Figure 5-12)</p>
Laser does not turn off	<p>Check laser button on control panel Check control panel laser switch at PANEL\$\$\$> prompt in SQDRIVER Check for bad:</p> <ul style="list-style-type: none"> C-arm assembly Signal Distribution PCB Interconnect cable Computer assembly

OIL LEAKAGE

If the tank assembly is leaking oil, you may have to tighten the screws on the tank cover. It is important that you tighten the screws using the proper torque specifications and the proper sequence.

The Torque Specifications

The torque settings are listed in the following table:

Location	Torque Specifications	Set wrench to...
Lexan Cup	10-12 in-lb	11 in-lb
Bladder Gasket	10-12 in-lb	11 in-lb
Transformer Seal	70 in-lb	70 in-lb
Tank Cover Gasket	36-40 in-lb	38 in-lb

Tank Top Cover Components and Screw Location

The following figure shows the Tank Top Cover and the locations of the seals:

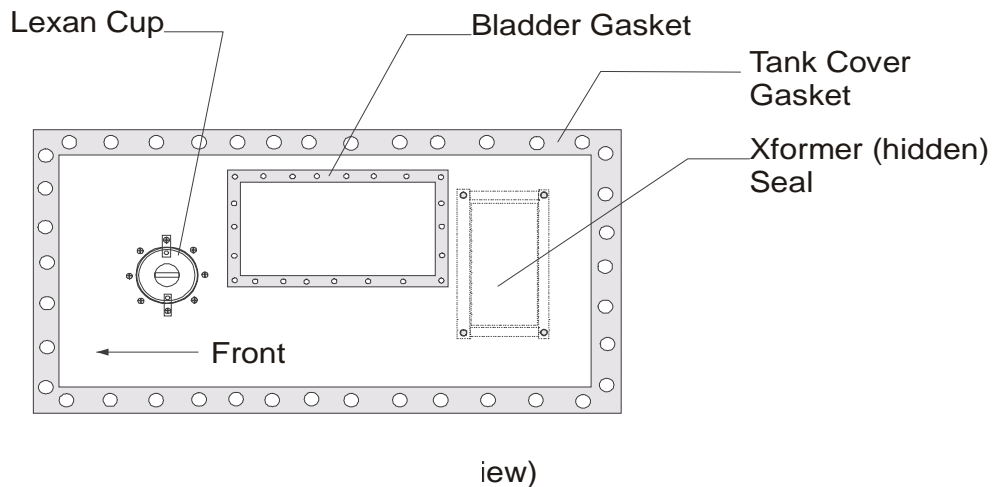


Figure 6-3 Tank Assembly Top view

Tightening the Lexan Cup Screws

Tighten the Lexan Cup seals in the following order using the torque settings in the above table:

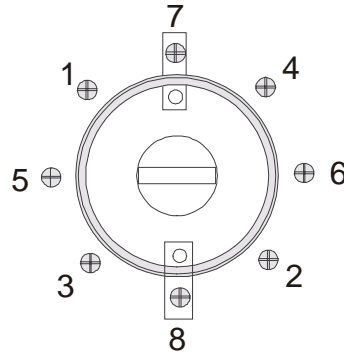


Figure 6-4 Lexan Cup Screw Tightening Order

Tightening the Bladder Gasket Screws

Using the torque settings in the table above and referring to the figure below, tighten the Bladder Gasket screws as follows:

1. Tighten screw #1, then #2, then #3, and then #4.
2. After screw #4, continue around the edge of the gasket in a clockwise direction, tightening alternate screws, until returning to #4.
3. Continue around the edge of the gasket in a clockwise direction, tightening all the remaining screws.

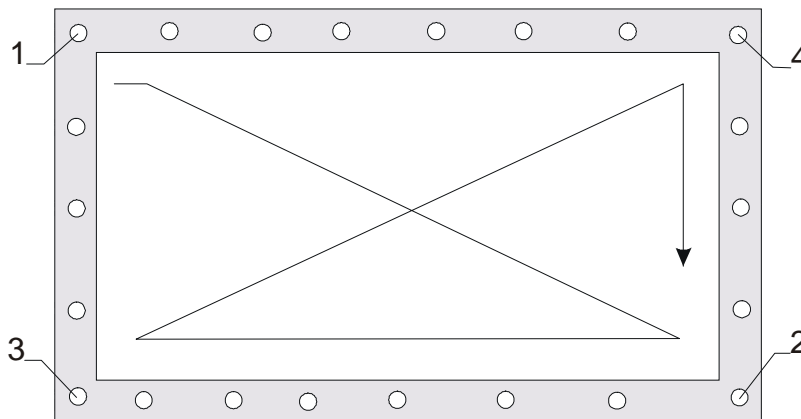


Figure 6-5. Bladder Gasket Screws

Tightening the Transformer Seal Screws

Tighten the Transformer Seal screws using the torque settings in the table above and the sequence in the figure below.

Section 6 - Fault Isolation

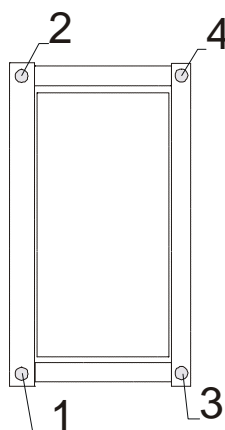


Figure 6-6. Transformer Screws

Tightening the Tank Cover Gasket Screws

Refer to the figure below and the torque settings in the table above and tighten the Tank Cover Gasket screws as follows:

1. Tighten screws #1 through #6 in the sequence as indicated.
2. Starting at the screw next to screw #6, move in a clockwise direction and tighten alternate screws.
3. Repeat this pattern in a clockwise direction and tighten all remaining screws.

Note: The three Tank Cover Gasket screws at the rear of the tank and shown below are the most critical locations for oil leaks. Always check these screws if a leak is suspected.

4. **Important: Do not remove screws located on the tank.** There are no field replaceable units or required adjustments inside the tank, so there is no reason to loosen or remove any screws on the tank.

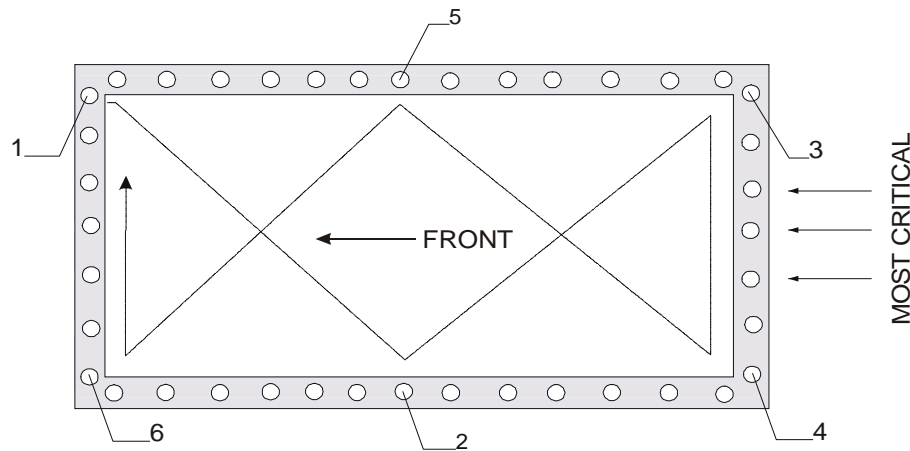


Figure 6-7. Tank Cover Gasket

MISCELLANEOUS PROBLEMS

Problem...	Symptom...	Solution...
Detector	SUSQ bar graph is ramped, or it appears as 3 or 4 separate ramped sections.	Analog/Digital Converter PCB
X-ray lamp	Turns on with X-rays off	Replace the Signal Distribution PCB
System	Fails HI-Pot test	Check all ground connections Make sure ground wire terminals are secure Check crimped terminals
Hi voltage transformer	Buzzing sound from X-ray tank assembly	Check torque on transformer bolts
System	No power	Check main circuit breaker Check main power cord Check power module circuits breakers

MESSAGES

The QDR 4500 system software displays three types of messages to the operator:

- informational messages
- warnings
- error messages.

Informational messages

Section 6 - Fault Isolation

Displayed in green, they provide information to the user about the operation being performed (see example below). After the message is displayed, normal operation can be resumed, usually by pressing any key.

MESSAGE

There are no analyzed scans to select for this patient.
Press any key to continue

Warning messages

Displayed in purple, these indicate that an operational problem is about to occur. The warning message describes the problem and indicates what should be done (see example below). After the message is displayed, operation can be resumed, usually by pressing any key.

WARNING

The center line extends outside of the acceptable range.
Reposition the patient and repeat this scan.
Press any key to continue

Error messages

Displayed in red, these indicate that a system (hardware or software) error has occurred (see example below). After an error occurs, system operation can be resumed only after the system is re-booted.

ERROR

DBARCHIV Version 8.00 Locus: NONE E_MSG_NO_FORM_O
Boundaryline Internal Software Error

NO A/C LINE INTERRUPTS

Also, The X-Ray Controller Is Not Generating A/C Line Interrupts, X-Ray Controller Is Not Generating System Timing Interrupts

The above messages can appear when booting. The Distribution Board (see Figure 5-1) has 3 jumpers enabling you to disable one of three sections of the scanner. If jumpering a section allows you to boot without these error messages, continue troubleshooting in that part of the scanner. If not, move jumper to another section. The following table gives more details on these jumpers:

Jumper Label	Possible problem	Refer to...
	Tape switches	SECTION 7
Panel	Control Panel	Table 2-9, Figure 5-2, SECTION 8
	Controller Panel Controller	
	C-Arm Interface Board	Table 2-10, Figure 2-7, Figure 2-8, Figure 5-8
C-Arm	Components connected to the C-Arm Interface Board	SECTION 8
	Motor Controller PCBs	Figure 2-2, Figure 2-3, Figure 2-4, Figure 5-1, Figure 5-2, Figure 5-4, Figure 5-5, Figure 5-6, SECTION 8
Distribution	Cabling	SECTION 2
	X-Ray Controller	Figure 2-7, Figure 2-8, Figure 2-9, SECTION 8
All jumpers out	No instrument power	<i>Check Power Line Voltage</i> heading, Page 3-18
	Emergency stop switch on	See Figure 5-2 (Control Panel)

ERROR MESSAGE LIST

For any system error there may be one, or more, messages. The initial message is displayed when the error occurs. **To display an additional message(s) press <Shift><F9>, and continue to press <Shift><F9> until all messages, for that error, are seen.** Messages shown in the *Error Message List* section below may be the first message, or a subsequent message.

Note: All messages, for each system error, are saved in the ERRLOG file.

The top line in the message box, is the message title line. The message title line shows the following:

- Program, and version of that program, in which the error occurred. In the above example the program, and version, is DBARCHIV Version 8.00.
- LOCUS field - this field is often used to identify the device that has the problem. In the above example, LOCUS is NONE (i.e. no LOCUS field).
- Message identifier - the message identifier is the name Hologic Software Engineering uses to identify the message. In the above example, the message identifier is E_MSG_NO_FORM_O.

The main body of information in the message box, is the message text (in the above example, the message text is Boundaryline Internal Software Error). In the *Error Message List* section below, error messages are in alphabetical order (by first line of their message text). In some cases a message identifier is also provided [in brackets].

The error messages covered in this section may indicate a hardware, or software, error. For hardware errors a suggested action is provided.

In most cases, software errors are "sanity checks" that are used during the software development process. During normal operation, these messages should never appear. If they do, and a suggested action is not provided, call Hologic Technical Support. Include as much information as possible about what was being done at the time the error occurred (including all messages for that error, LOCUS field, message identifier, etc.).

Error Message List

Address in the response message did not match the address in the sent message. [E_ADDRESS_MISMATCH_I]

Action: This message should be reported to Hologic Technical Support. Include as much information as possible about the scan.

Analysis aborted. d0= ____ below acceptable limit.

Hardware or Software Error: d0 is found to be below zero, which is not possible if there are X-rays reaching the detector.

Action: This message should be reported to Hologic Technical Support. Include as much information as possible about the scan.

Arm and table are in danger of colliding! [E_COLLISION_IMMINENT_I]

Comment: The C/C has calculated that the C-arm and table are within 1/4".

Action: If the C-arm and table are really within this distance, the problem is with the application (or operator) that moved them so close. If they are not, then either the calibration information for the system is wrong or the mechanical stops for the table and C-arm have moved. One or more of the motors may have stopped short of the actual mechanical stop during calibration. Verify that the positive limit positions for each motor correspond to the published specs for the model. To recover from this, select the **Utility** option from the main menu and then select the **emergency Motion** option from the sub-menu. By holding down the **Enable** button on the operator control panel, you can use the keypad to move the table and C-arm away from each other.

Bad checksum in message. [E_BAD_BLOCK_I]

Comment: The checksum calculated by the C/C for a message did not match the one in the message packet.

Action: Either the driver is incorrectly configured, one or more devices are jumpered to the debug mode, there is a hardware problem on the communication link (cable or connectors) or one of more of the DSP chips in the C/C or DAS board is not properly seated. Verify that the DEVICE=C:\MENU\MAPIDEV.SYS line in CONFIG.SYS has the options /OVERLAP=0 and /HANDSHAKE=1. Check each stepper motor board and verify that its address is correctly set. Verify that the TZ motor board **does not** have the debug jumper installed. Verify that the communications cable is installed and properly secured on the back of the C/C board. If the problem persists, it may be because one (or both) of the DSP chips on the

Section 6 - Fault Isolation

C/C or DAS board is not properly seated in the PGA socket. Try "massaging" the DSP chip on the C/C board **and** the one on the DAS board. If the problem changes (gets worse or better) when you do so, replace the appropriate board. If the problem persists, place all devices in emulation mode (e.g., by turning off instrument power and booting in the workstation mode). Disconnect all devices except the C-arm from the communications link. Turn off C-arm emulation. If there are no problems, proceed to re-connect each device and take it out of emulation until the offending device is found. Replace the appropriate board.

BoundaryLine Internal Software Error

Software Error: This message should be reported to Hologic Technical Support. Include as much information as possible about what you were doing at the time.

Cannot generate bad detector map, too many bad detectors

Action: One or more detectors is bad. See instructions for running hardware checking program.

Cannot obtain results of scan _____ of _____

Software Error: For some reason, the system was unable to obtain the results of a scan that was selected for normals plotting. This message should be reported to Hologic Technical Support.

Can't open a window

Software Error: Ensure that **only** Hologic software is installed on the computer. If so, report this message to Hologic Technical Support. Include as much information as possible about what you were doing at the time.

Carm Unable to position device within specified tolerance

Hardware Error: There is a problem with the aperture mechanism.

Action: Check the aperture assembly. Test the aperture positioning with the SUSQ program.

Corrupted Scan Data Detected

Software Error: This message should be reported to Hologic Technical Support. Include as much information as possible about what you were doing at the time.

Could not find file extension in

Software Error: This message should be reported to Hologic Technical Support. Include as much information as possible about what you were doing at the time.

Couldn't write the new record

Hardware or
Software Error: The system was unable to write a reference curve that was entered or edited.

Action: Check that the hard drive is not full. That is, check the message "Room for ___ scans" in the status window and ensure that it does not say zero. If it is full, then archive and delete one or more scans and try again.

If the hard drive is not full, then you have either a hard drive failure or a corrupt reference curve database.

db_File error __

or

db_VISTA error __

Software Error: Any message that begins this way should be reported to Hologic Technical Support. Include as much information as possible about what you were doing at the time.

Device already in use by foreground task [E_LOCKOUT_I]

LOCUS: MAPI The MAPI driver was already opened by another application when the driver attempted to go ON_LINE (i.e., the driver requires exclusive access to the MAPI driver).

Action: Report this error to Hologic Technical Support.

LOCUS: STATE An application attempted to load or execute a state machine when one was already running, or an application attempted to execute a state machine while one or more devices were still executing a command, or an attempt to abort the currently executing state machine failed.

Action: Report this error to Hologic Technical Support.

LOCUS: Motor_xx An application attempted to modify stepper motor parameters while the motor was moving (acceleration distance/type, first/final rates, position average, etc.), or an application issued a MOVE_ABS while a MOVE_REL was in progress (or vice versa).

Section 6 - Fault Isolation

Action:	Report this error to Hologic Technical Support.
LOCUS: C-Arm	An application attempted to control the laser positioning light when it was under local control or an application attempted to turn on the laser while the C-arm and table were within the laser safety distance of each other.
Action:	Be sure the table and C-arm are properly positioned before starting a scan. If the problem persists, report this error to Hologic Technical Support.
LOCUS: C-Arm	An application attempted to issue another move command to the aperture shuttle while it was still moving.
Action:	The aperture may not be calibrated and an application attempted to move it to a calibrated position. The aperture shuttle on the C-arm may be jammed and the driver is still attempting to position it in response to a previous MOVE_ABS command. Visually inspect the aperture shuttle and use the MOVE_REL command to verify that the shuttle is moving. If it is not, fix the mechanical or electrical problem with the aperture shuttle and then recalibrate the aperture.
LOCUS: Motor_TZ	The TZ system is in service mode; the pedestals are moving and an application attempts to move them in the opposite direction; or the TZ system is performing a calibration.
Action:	Verify that the TZ board service mode switch is in the off position
Note:	If you change the service mode switch position on the TZ board, you must reset the TZ microprocessor before the new switch position takes affect. Otherwise, report this error to Hologic Technical Support.
LOCUS: STATE	Whenever an application issues a device command and the state machine is executing a state machine protocol.
Action:	Report this error to Hologic Technical Support.

Device has not been configured [E_NOT_CONFIGURED_I]

Comment:	Invalid motor calibration data has been sent to the driver (e.g., one or more of the motor calibration parameters—number of steps, step distance, number of ticks or tick distance—is less than or zero).
Action:	Verify that the system has been properly calibrated and the normal Hologic system startup procedure has been followed (i.e., reboot the machine and if the problem persists, recalibrate the motor).

Device is in emulation mode [E_EMULATE_I]

Comment:	The device is in emulation mode. This is not an error but a report of the device driver internal state. Some QDR 4500 models normally run with
----------	--

QDR® 4500 Technical Manual

emulation enabled for the devices that are not installed (e.g., the 4500W does not support the AR device).

Action: None.

Device not ready to perform requested action [E_NOT_READY_I]

LOCUS: STATE An application attempted to execute a state machine but the state machine is not ready to execute because one or more of the necessary data structures has not been downloaded (program or task table).

Action: Report this error to Hologic Technical Support.

LOCUS: C-Arm Attempt to turn on X-rays when either the filter drum is not yet locked (if it is on) or the initial 30-second X-ray delay after startup has not elapsed. Reported as the device state if the C-arm is reset. Reported as command error for any IS_xxx command executed from an application (as opposed to executing from a state machine).

Action: Wait until the filter drum synchronizes to the A/C line and until the high voltage relay in the X-ray controller is turned on (30 seconds after the system starts).

LOCUS: Motor_xx Reported as command error for any IS_xxx command executed from an application (as opposed to executing from a state machine). Reported as device state if the motor is reset.

Action: Determine why the motor was reset (e.g., power line brown out).

LOCUS: Motor_TZ Reported as command error for any move command until valid calibration information has been downloaded. Reported as command error for any IS_xxx command executed from an application (as opposed to executing from a state machine).

Action: Verify that the TZ driver has been calibrated and that the correct Hologic system startup procedure has been followed (i.e., reboot the system and if the problem persists, recalibrate the TZ motor).

Device time-out waiting for requested action [E_TIME_OUT_I]

Comment: For everything except the state machine, indicates that a message was sent to the device and a response was not received within 150ms.

Action: Follow the procedure under "BAD CHECKSUM IN MESSAGE." for isolating the failed device and replace or repair it.

Section 6 - Fault Isolation

Comment: For the state machine, indicates that one of the self-limiting commands has timed out or that the state machine continued executing into the next cycle.

Action: Report this error to Hologic Technical Support.

Driver is not installed [E_NOT_INSTALLED_I]

Comment: Returned in response to the ON_LINE command to indicate that the MAPI driver is not installed in the system.

Action: Verify that the line DEVICE=C:\MENU\MAPIDEV.SYS is in the system CONFIG.SYS file, that the correct interrupt level (IRQ) and I/O base address are specified and that the file C:\MENU\MAPIDEV.SYS is installed on the system.

Driver is off line [E_OFF_LINE_I]

Comment: Returned by any driver whenever a command is written to the driver and the system is OFF_LINE.

Action: Put the driver back on line.

Driver missed a hardware interrupt [E_MISSED_INTERRUPT_I]

Comment: The filter drum or the X-ray hi/lo monitor is enabled in the C-arm driver and the driver detected a dropped message from the C-arm microprocessor (indicated by a mismatch in the message sequence field).

Action: Verify that no other software, TSR or operating system is running while you do a scan (e.g., do not run a scan with while connected to a network or attempt to run a scan under Windows). This may also be due to a communications error between the AT and the C-arm. Follow the procedure under "BAD CHECKSUM IN MESSAGE." to diagnose I/O errors.

Emergency stop active [E_EMERGENCY_STOP_I]

Comment: The system emergency stop is active, either because the operator has pressed the emergency stop button, one of the emergency stop strips has been touched, or because the C/C has calculated that the C-arm and the table are within 1/10" of each other.

Action: If the emergency stop button on the operator panel is down (on), pull it up. Verify that nothing is touching the emergency stop strips on the table. If the C-arm and table are within 1/10", the problem is with the application (or operator) that moved them so close. If they are not, see the discussion about E_COLLISION_IMMINENT_I. If both E_COLLISION_IMMINENT_I and E_EMERGENCY_STOP_I are active, the only way to recover is to

QDR® 4500 Technical Manual

manually push the table and C-arm away from each other and then follow the recovery procedure under E_COLLISION_IMMINENT_I.

End of file

Action: This could occur at the start of a lateral scan if the currently selected scan is not an analyzed companion AP scan.

Error closing optical file _____

or

Error flushing optical file _____

or

Error writing optical record _____

Hardware error: There is a problem writing an optical file. Either the medium is full, or there is a hardware malfunction.

Action: Check for disk full. Go to DOS, type DIR D: and check for free space.

If the disk is not full, call Hologic Technical Support.

Error copying file _____

Hardware Error: There was an error copying the named file.

Action: Verify that there was space on the target drive. Check the "Room for .." message in the status window. Run appropriate diagnostics.

Error creating file _____

Hardware or Software Error: There is a problem creating a new file (which may be on your hard drive, your diskette, or your optical). Either the medium is full, or there is a hardware error.

Action: First determine which disk drive is involved. The filename should start with a drive letter, followed by a colon. Drive A: is diskette, C: is hard drive, and D: is the optical.

Check for disk full. For diskette, simply try a different diskette and see if the problem goes away. For hard drive, check the "Room for ____" message in the status window. For optical, type DIR D:.

If the disk is not full, run appropriate diagnostics.

Section 6 - Fault Isolation

Error initializing graphics module.

Action: This can be caused by not enough available memory or an incorrect graphics adapter. Verify that **only** Hologic software is installed on the system and that the graphics adapter has not been modified.

Error in region of interest structure

Software Error: This message should be reported to Hologic Technical Support. Include as much information as possible about what you were doing at the time.

Error opening the flattening input file

Action: Disk error or missing software. Check operation of hard disk, and check consistency of system software with CHEKPART.

Error reading flattening configuration record

Action: Disk error or missing software. Check operation of hard disk, and check consistency of system software with CHEKPART.

Error reading flattening factor record

Action: Most likely cause is no flattening done for given scan mode. Re-run BIGFLAT.

Error reading flattening records

Action: Disk error or missing software. Check operation of hard disk, and check consistency of system software with CHEKPART.

Error reading Optical drive: _____

Error reading file _____ : _____

Hardware Error: There was a disk problem while reading a file.

Action: Run appropriate diagnostics.

Error reading reference attenuation record

Action: Flattening may not have been done for this scan mode. Re-run BIGFLAT.

QDR® 4500 Technical Manual

Failure at file _____ line _____

Software Error: This message should be reported to Hologic Technical Support. Include as much information as possible about what you were doing at the time.

file extension doesn't start with 'P' in ...

Software Error: This message should be reported to Hologic Technical Support. Include as much information as possible about what you were doing at the time.

flattening records are not initialized

Action: Disk error or missing software. Check operation of hard disk, and check consistency of system software with CHEKPART.

Garbled Optical File

Software Error: The optical file that you are attempting to restore scans from seems to be clobbered.

Action: Run diagnostics on the optical drive. If this error recurs, report it to Hologic Technical Support.

GetDKernel Internal Software Error

or

GetKernel Internal Software Error

Software Error: These messages should be reported to Hologic Technical Support. Include as much information as possible about what you were doing at the time.

Section 6 - Fault Isolation

Histogram Overflow in datahist

or

Histogram Smoothing Error

or

Illegal Context Record Type

or

Illegal high value in qgen

or

Inconsistent d0 limits in rsattencalc

or

Indeterminate or bad data for attenuation curves

or

Indeterminate Data For k Calculation

or

Insufficient Data To Determine k/delta0

Software Error: These messages should be reported to Hologic Technical Support. Include as much information as possible about what you were doing at the time.

Internal Buffer Size Exceeded

Software Error: This message should be reported to Hologic Technical Support. Include as much information as possible about what you were doing at the time.

Internal device request queue full [E_QUEUE_FULL_I]

Comment: The common buffer area for storing system sounds is full.

Action: Run CHEKPART to verify system software is correctly installed. Reduce the size of one or more of the tunes or tune files you used to specify the system sounds.

Internal driver error [E_INTERNAL_ERROR_I]

- Comment: If returned in response to an ON_LINE command, indicates that the MAPI device driver is not properly installed in the system.
- Action: Verify that the line DEVICE=C:\MENU\MAPIDEV.SYS is in the system CONFIG.SYS file, that the interrupt level (IRQ) and I/O base address are correctly set and that the file C:\MENU\MAPIDEV.SYS is installed on the system.
- Comment: If returned in response to a XRAY_ON_PHASE, XRAY_SEQUENCE, or PULSE_PER_SEG command to the C-arm device, indicates that the currently selected X-ray mode is invalid.
- Action: Report this to Hologic Technical Support.
- Comment: If reported as the device status for the C-arm, it indicates an unrecognized response from the C-arm micro.
- Action: This may be due to a communications error between the AT and the C-arm. Follow the procedure under "BAD CHECKSUM IN MESSAGE." to diagnose I/O errors.
- Comment: If reported as the abort code for the state machine, it indicates that the internal driver event queue was full when the state machine attempted to issue the system-wide abort code for state machine termination.
- Action: Report this error to Hologic Technical Support.

Internal Error:.....

or

Internal Software Error:

- Software Error: Any message that begins this way should be reported to Hologic Technical Support. Include as much information as possible about what you were doing at the time.

Internal stack error [E_STACK_ERROR_I]

- Comment: Returned by the state machine driver to indicate that the local stack for a task has overflowed or underflowed.
- Action: Report this problem to Hologic.

Section 6 - Fault Isolation

Invalid ...

Software Error: In general, any message that begins with the word "Invalid" should be reported to Hologic Technical Support. Include as much information as possible about what you were doing at the time. See the following "Invalid..." errors for more information.

Invalid address for message packet [E_INVALID_ADDR_I]

Comment: The address of a message packet was invalid. The MAPI driver keeps an address table that maps each byte address to its respective communications link (SSI, SCI or C/C). The selected address was not assigned to any link and therefore was not recognized by the MAPI driver.

Action: Report this error to Hologic Technical Support.

Invalid flattening data [E_INVALID_FLAT_DATA_S]

Comment: The most likely cause is that the signal for one or more of the detectors is higher than allowed.

Action: One or more detectors is bad. See instructions for running hardware checking program.

Invalid identification file.

Action: QDR 4500 ID file C:\SQUID.DAT is not valid. Call Hologic Technical Support.

Invalid machine type in ARRC.TXT.

Action: This is not an error if the machine is not yet calibrated.

Invalid mode for device driver [E_INVALID_MODE_I]

LOCUS: C-Arm Returned by the C-arm if an application attempts to change the X-ray mode when X-rays are already on.

Action: Report this error to Hologic Technical Support.

LOCUS: STATE Returned as the device state if the C-arm microprocessor returned an unrecognized response to the fast query.

Action: This may be due to a communications error between the AT and the C-arm. Follow the procedure under "BAD CHECKSUM IN MESSAGE." to diagnose I/O errors. Otherwise, report this error to Hologic Technical Support.

QDR[®] 4500 Technical Manual

LOCUS: Motor_xx For a stepper motor, the application attempted to move a motor in the opposite direction in which it is currently moving (i.e., a motor's motion can be extended in the same direction as the current motion but it cannot reverse motion).

Action: Report this error to Hologic Technical Support.

LOCUS: STATE For the state machine driver, this error indicates that either the protocol attempted to execute a command that is not supported; that an instruction that requires a register reference did not provide one; or, more commonly, an attempt was made to access the external data buffers and they were either not available or were still being using by the application.

Action: If you are running any program other than standard Hologic software, remove it and retry the scan (e.g., do not run a scan while connected to a network or attempt to run a scan under Windows). Otherwise, report this error to Hologic Technical Support.

Invalid parameter(s) [E_INVALID_PARAM_I]

Comment: The value of the parameter associated with a device command was out of range.

Action: Report the application in error to Hologic Technical Support.

Invalid serial number in ARRC.TXT.

Action: This is not an error if the machine is not yet calibrated.

Invalid serial number in environ.bat file.

Action: Machine serial number is not valid. Call Hologic Technical Support.

Invalid values in bad detector map

Action: See instructions for running hardware checking program.

I/O Error

Hardware or There was an error reading or writing a disk drive. The message should identify the
Software Error: drive and say something about the nature of the error.

Section 6 - Fault Isolation

Action: If this is an "out of space" error, verify that there is room on the target drive. Check the "Room for ..." message in the status window. Otherwise, run appropriate diagnostics on the disk and controller; if the problem involves diskette (Drive A:), try a different diskette.

Limit Exceeded:

Software Error: Any message that begins this way should be reported to Hologic Technical Support. Include as much information as possible about what you were doing at the time.

Local motion active [E_LOCAL_MOTION_I]

Comment: An application has attempted to enable or disable local motion when one or more motors were still moving. This is also the abort code reported by the state machine when a protocol is aborted to start the local motion state machine.

Action: When moving the system using the operator control panel, wait until all motion stops before starting an application that requires motor movement (e.g., the scan program).

Machine serial number is not valid.

Action: QDR 4500 ID file C:\SQUID.DAT is not valid. Call Hologic Technical Support.

Machine type in configuration files is inconsistent.

Action: QDR 4500 ID file C:\SQUID.DAT is not valid. Call Hologic Technical Support.

Machine type is not valid.

Action: QDR 4500 ID file C:\SQUID.DAT is not valid. Call Hologic Technical Support.

Memory allocation error.

Action: Verify that **only** Hologic software is installed on the system.

Message packet canceled [E_CANCELED_I]

Comment: The message packet was canceled before the response was received. This is not an error but merely records the current state of a message packet. The driver normally cancels all outstanding message packets when it goes off line.

Action: None.

Message packet not sent yet to the C/C [E_WAITING_I]

Comment: Indicates that the message has been queued up in the MAPI's buffers for transmission but has not yet been sent. Reported as the C-arm device status if the fast query message was not sent before the beginning of the next A/C line cycle.

Action: Because the driver must communicate with the C-arm every A/C line cycle, and because all other devices share the communications link, any device that causes an I/O error (e.g., a timeout) generally causes this error in the C-arm. The first thing to do is to determine if the problem is really with the C-arm or with another device in the system. Place all devices in emulation mode (e.g., by turning off instrument power and booting up in the workstation mode). Then, first take the C-arm out of emulation. If it reports no errors, then proceed to take each one of the other devices out of emulation mode until the one in error is found. Also see the discussion under "BAD CHECKSUM IN MESSAGE." for diagnosing I/O errors.

Message packet sent and waiting for response [E_SENT_I]

Comment: The message has been sent but the response has not yet been received. Reported as the C-arm device status if the fast query response for a cycle is not received before the next cycle.

Action: See the discussion of the associated error E_WAITING_I.

Missing ARRC.TXT file.

Action: Check that ARRC.TXT exists in C:\XCDATA. If it does, re-boot to ensure that the system is correctly initialized. If not, restore ARRC.TXT from a dbarchive backup.

Missing tissue bar initialization file

Software Error: The file that contains the calibration information for the tissue bar is missing or has not been installed.

Action: Install the tissue bar initialization software that comes with the tissue bar.

Section 6 - Fault Isolation

Motor direction has reversed during stepping [E_MOTION_REVERSED_I]

Comment: Whenever a motor is moving, the driver checks its position every three seconds. If the motor direction at each of these check intervals is not in the correct direction, the driver stops motion and returns this error.

Motion reversal is primarily due to the stepper motor cutting out because of a thermal overload and usually occurs on the AY motor. In most cases, a mechanical problem (loose belt, loose encoder coupling, etc.) causes this problem. In some cases, a bad encoder and in fewer cases, a bad drive board causes this problem.

Action: Wait a few minutes for the motor to cool down and re-try the scan.

Check the drive belt tension. Check the encoder coupling (hose clamps). If the problem is not corrected, replace the drive board. If these steps fail, replace the encoder motor. The procedure for these operations can be found in the *Remove and Replace* section of this manual. If the problem persists, contact Hologic Technical Support.⁴

Motor is at a limit [E_LIMIT_POSITION_I]

Comment: An application tried to move the motor beyond the limit position (i.e., the motor need not necessarily be **at** a limit).

Action: Be sure that the table and C-arm are at the correct starting position before starting a scan. Verify that the range of motion (positive limit position) of the motors (AR, AY, TX, TY and TZ) are correct for the QDR model. Also see the discussion under E_COLLISION_IMMINENT_I.

Motor power has been turned off because the arm and table have collided! [E_COLLISION_STOP_I]

Action: To proceed, select emergency Motion on the Utility menu. Then push the table away from the arm. To restart the system, select retry by pressing the <ENTER> key.

No A/C line interrupts! [E_WORKSTATION_BOOT_I]

Action: Check that instrument power is on. When the problem is corrected, press <Enter> to continue. If you want to leave instrument power off, press <ESC> to boot in the workstation mode. In this mode, you can not do any scans even if you turn instrument power back on. This message can occur if the Emergency Stop switch is pushed in.

Refer to the No A/C Line Interrupts header, page 6-17 in this section.

QDR® 4500 Technical Manual

No motion detected while motor stepping [E_NO_MOTION_I]

Hardware Error:	The QDR is equipped with motion detectors which detect actual motion in the X, Y and C-arm rotation motors. This message occurs when one of these motors was commanded to move and no motion was detected.
Action:	Check for loose belt couplers, tighten set screws A/R. Check for coupler hitting bearing block, move coupler A/R. Check motion encoder, replace if defective. Check Motor & Drive board, replace if defective. Check stepper translator, replace if defective.
MOTOR\$xx:	Whenever a motor is moving, the driver checks its position every three seconds and stops stepping if the incremental positions at these check intervals do not match the motion parameters (final rate) to within approximately 50%.
Action:	Determine why the motor is not moving (check motor coupling, drive belt, and encoder shaft coupling).
MOTOR\$TZ:	The device state reported whenever the TZ firmware reports a pedestal timeout during a move command.
Action:	See the discussion of the TZ drive's E_TOLERANCE_I error.

No data for attenuation curves

Software Error:	This message should be reported to Hologic Technical Support. Include as much information as possible about what you were doing at the time.
-----------------	--

Not enough memory

Software Error:	Ensure that only Hologic software is installed on the computer. If so, this message should be reported to Hologic Technical Support. Include as much information as possible about what you were doing at the time.
-----------------	--

Old Whole Body Context Type

Software Error:	This message should be reported to Hologic Technical Support. Include as much information as possible about what you were doing at the time.
-----------------	--

Operator terminated action [E_OPERATOR_I]

Action:	None.
---------	-------

Section 6 - Fault Isolation

Out of memory

Software Error: Ensure that **only** Hologic software is installed on the computer. If so, this message should be reported to Hologic Technical Support. Include as much information as possible about what you were doing at the time.

Overflow calculating flattening or daily factors

Action: Most likely cause is saturation of one or more detectors during the flattening procedure.

Parameter size is invalid [E_INVALID_SIZE_I]

Comment: The device state reported by the C-arm if the response to a fast query is not a minimum length to encompass all necessary information.

Action: This may be due to a communications error between the AT and the C-arm. Follow the procedure under "BAD CHECKSUM IN MESSAGE." to diagnose I/O errors.

Parameter size is too large for driver [E_TOO_LONG_I]

Comment: For the state machine, indicates that a reference was made beyond the machine limits (e.g., a register reference that exceeded the number of registers; a jump to a location beyond the end of the state machine; etc.). For all other devices, indicates that the message response from the remote micro overflowed the internal buffers and was partially lost.

Action: For the state machine, report this error to Hologic Technical Support. For other devices, this error may indicate a problem on the communications bus. Follow the procedure under "BAD CHECKSUM IN MESSAGE." for isolating I/O errors.

Patient File Record __ Too Small

or

Patient File Record __ Too Large

Hardware or These messages indicate problems performing I/O operations (usually to the hard drive, Software Error: but possibly to diskette or optical).

Action: Ensure that there is adequate space on the hard drive (Check the "Room for ..." message in the status window. You should always leave room for 1 or 2 scans). There may be a disk problem; appropriate diagnostics should be run. If you are unable to find a hardware problem, the message should be

QDR® 4500 Technical Manual

reported to Hologic Technical Support. Include as much information as possible about what you were doing at the time.

PGLINE: ...

Software Error: Any message that begins this way should be reported to Hologic Technical Support. Include as much information as possible about what you were doing at the time.

Remote device did not echo command [E_NAK_I]

Comment: Whenever the first byte in a message response does not match the command character.

Action: This is probably a communications error between the AT and the microprocessor. Follow the procedure under "BAD CHECKSUM IN MESSAGE." to diagnose I/O errors.

ROI Limit Error

Software Error: This message should be reported to Hologic Technical Support. Include as much information as possible about what you were doing at the time.

Scan File Record __ Too Small (__)

or

Scan File Record __ Too Large (__)

or

Scan has 0 points or lines

Hardware or Software Error: These messages indicate problems performing I/O operations (usually to the hard drive, but possibly to diskette or optical).

Section 6 - Fault Isolation

Action: Ensure that there is adequate space on the hard drive (Check the "Room for ..." message in the status window. You should always leave room for 1 or 2 scans). There may be a disk problem; appropriate diagnostics should be run. If you are unable to find a hardware problem, the message should be reported to Hologic Technical Support. Include as much information as possible about what you were doing at the time.

Software Error

Software Error: Any message that begins this way should be reported to Hologic Technical Support. Include as much information as possible about what you were doing at the time.

Starting phase Out of Range

Software Error: This message should be reported to Hologic Technical Support. Include as much information as possible about what you were doing at the time.

Test failed - absolute max or min limit exceeded

Action: One or more detectors is bad. See instructions for running hardware checking program.

Test failed - maximum SD exceeded

Action: Detectors are not seeing a uniform beam. Check all hardware having to do with X-ray generation or detection.

Test failed - mean exceeds limits

Action: X-ray beam at edges is not consistent with beam at center. Check X-ray beam alignment.

The analyze data file either did not exist or did not contain any valid entries

Software Error: The software was not correctly installed (No ANALYZE.DAT file). This might also be due to a hardware problem with the hard disk drive.

Action: Notify Hologic Technical Support.

There are no files available to restore (*Optical restore*)

User or When restoring files from optical ("Optical" on main menu), you selected an archive
Software Error: that contains no scans.

Action: Report this problem to Hologic Technical Support.

There are no records in the Normals Curve database.

Software Error: The reference curve database appears to be totally empty. This condition should never occur in normal operations.

Action: The Hologic software may not have been installed correctly.

**The X-ray controller is not generating A/C line interrupts
[E_NO_TIMER_INTERRUPT_I]**

Hardware Error: The X-ray Controller assembly generates an interrupt every 1/120 of a second (60HZ line) or every 1/100 of a second (50Hz line). The PC clock generates 18 interrupts a second (regardless of line frequency). If two clock ticks occur with NO Motor & Drive board interrupts between them, then this message is produced.

Action: Report this error to Hologic Technical Support. Include as much information as possible about what you were doing at the time.

Refer to the *No A/C Line Interrupts* header, page 6-17 in this section.

Section 6 - Fault Isolation

Truncated Patient Record ...

Hardware or Software Error: This messages indicate problems performing I/O operations (usually to the hard drive, but possibly to diskette or optical).

Action: Ensure that there is adequate space on the hard drive (Check the "Room for ..." message in the status window. You should always leave room for 1 or 2 scans). There may be a disk problem; appropriate diagnostics should be run. If you are unable to find a hardware problem, the message should be reported to Hologic Technical Support. Include as much information as possible about what you were doing at the time.

device: Unable To Allocate Resources

Software Error: This message should be reported to Hologic Technical Support. Include as much information as possible about what you were doing at the time.

Unable to Allocate Space for Environment

or

Unable to Restore Environment

or

Unable to Calculate Line-By-Line d0's

Software Error: These messages should be reported to Hologic Technical Support. Include as much information as possible about what you were doing at the time.

Unable to determine power line frequency

Hardware Error: The C-Arm was unable to measure line frequency interval.

Action: Check function of the C-Arm.
Check stability of A/C line frequency.

Unable to format diskette

User or

Software Error: This usually means that you attempted to format a diskette that was defective.

Action: Try a different diskette. If this message occurs repeatedly, and with more than one diskette, it may mean a hardware problem with a diskette drive or the controller board. (In some computers, the controller circuitry is on the motherboard; if this circuitry is defective, the entire computer must be replaced.)

Unable to normalize line sums

Software Error: This message should be reported to Hologic Technical Support. Include as much information as possible about what you were doing at the time.

Section 6 - Fault Isolation

Unable to find file

or

Unable to Find Line by Line d0's

or

Unable to Find Previous Analysis Results

or

Unable to Open Tissue Calibration File _____

or

Unable to open temporary file _____

or

Unable to open temporary Q-File

or

Unable to Position File to HALO Record

or

Unable to Position Data File

or

Unable to Position File: _____

or

Unable to Position Patient File

or

Unable to Position Patient File Past Record ____

or

Unable to Position Patient File To End

or

Unable to Position Scan File Past Record ____ (____)

or

Unable to Position Q-Data File

or

Unable to Read Data File

or

Unable to Read File: _____

or

Unable to Read Line by Line d0's

or

Unable to Read Previous Analysis Results

or

Unable to Rewind Q-File

or

Unable to Rewind File: _____

or

Unable to Read BMD Image Frame

or

Unable to Read HALO Frame Header

or

Unable to Read Q-Data File

or

Unable to Write to Q-Image File

Hardware or	These messages indicate problems performing I/O operations (usually to the hard drive,
Software Error:	but possibly to diskette or optical).

Action:	Ensure that there is adequate space on the hard drive (Check the "Room for ..." message in the status window. You should always leave room for 1 or 2 scans). There may be a disk problem; appropriate diagnostics should be run. If you are unable to find a hardware problem, the message should be reported to Hologic Technical Support. Include as much information as possible about what you were doing at the time.
---------	---

Section 6 - Fault Isolation

Unable to position device within specified tolerance [E_TOLERANCE_I]

- Comment: For the stepping motors, the aperture shuttle or the TZ drive, indicates that the requested position could not be obtained within the specified device tolerance.
- Action: For the TZ drive (table pedestals), check the firmware version. If it is not 2.30 or higher, replace the TZ EPROM with the latest version. If the problem persists (or if the firmware version was already 2.30 or higher), it may be caused by a thermal overload in the DC motors. Our experience has been that they cannot run at much more than a 5% duty cycle. You can check whether it is a firmware or hardware problem by engaging the emergency stop button on the operator's panel. Then use the table up switch to move the table. If it does not move, wait at least twenty (20) minutes and try again. If it moves after 20 minutes, it was a thermal overload. If it does not move, call Hologic Field Service.
- Action: For one of the stepping motors (AR, AY, TX or TY), either the motor has not been properly calibrated, the motor is binding, or the drive belt is too loose.
- Action: For the aperture shuttle (LOCUS CARM), either the apertures have not been calibrated or the mechanism is binding. Visually inspect the aperture shuttle and use the MOVE_REL command to verify that the shuttle is moving without binding. If it does not move or binds, fix the electrical or mechanical problem with the shuttle. If it does move, recalibrate the shuttle.

Unable to open a window

- Software Error: Ensure that **only** Hologic software is installed on the computer. If so, this message should be reported to Hologic Technical Support. Include as much information as possible about what you were doing at the time.

Unable to restore scan. If the System Disk is full Delete Archived scans and try again.

- User or
Software Error: The system was unable to restore one or more scans.
- Action: This usually means that the hard drive is full. Check the "Room for ..." message in the status window. If the disk is **not** full, then this indicates a hard drive problem.

Unexpected message from remote device [E_UNEXPECTED_RESPONSE_I]

- Comment: The first character in a fast query response was not the fast query command ("?").
- Action: Follow the procedure under "BAD CHECKSUM IN MESSAGE." for isolating communications bus I/O errors.

Unknown ROI type in DrawROI

Software Error: These messages should be reported to Hologic Technical Support. Include as much information as possible about what you were doing at the time.

device: Unrecognized Command Code

Software Error: This message should be reported to Hologic Technical Support. Include as much information as possible about what you were doing at the time.

Unrecognized device command [E_UNKNOWN_COMMAND_I]

Comment: Returned by all devices in response to an unrecognized command.

Action: Report this error to Hologic Technical Support. Include as much information as possible about what you were doing at the time.

Unsolicited message from C/C [E_UNSOLICITED_MESSAGE_I]

Action: Report this error to Hologic Technical Support. Include as much information as possible about what you were doing at the time.

**X-ray controller is not generating A/C line interrupts
[E_NO_TIMER_INTERRUPT_I]**

LOCUS: DAS A request was made to read the a/d's and there was no system line frequency interrupts (required to synchronize DAS with C-arm).

LOCUS: Global The system was on-line and another on-line command was issued but there were still no timer interrupts.

Action: Check that the Instrument Power switch and the X-Ray Enable key are on. Also, see the discussion of E_INTERLOCK_INHIBIT_I, E_EMERGENCY_STOP_I and E_COLLISION_IMMINENT_I.

Refer to the *No A/C Line Interrupts* header, page 6-17 in this section.

Section 6 - Fault Isolation

X-ray controller is not generating system timing interrupts [E_INTERLOCK_INHIBIT_I]

Comment: There have been at least two consecutive system clock ticks (approximately 1/10 second) without any A/C line frequency interrupts from the X-ray controller.

Action: Verify that the X-ray controller current fuse on the operator console is not "popped". If it is, push it in. If it continues to pop, repair or replace the X-ray tank. The E_EMERGENCY_STOP_I error also turns off power to the X-ray controller and thus disables the A/C line interrupts. Follow the procedure under E_EMERGENCY_STOP_I to clear this condition first.

Refer to the *No A/C Line Interrupts* header, page 6-17 in this section.

X-ray firing order is out of sequence [E_XRAY_SEQUENCE_I]

Comment: The X-ray pulse level reading from the C-arm did not match the expected level (i.e., the C-arm driver has a "template" for each X-ray pulsing mode and if the actual pulse level does not match the template for the given X-ray mode, it generates this error).

Action: If the filter drum and X-ray generator are out of sync, it is often difficult to determine which is at fault. Verify that the filter drum is synchronized with the A/C line and that the X-ray modes are correctly defined in SQDRIVER.INI. The set screw and/or the belts on the filter drum assembly may need adjustment (in addition to the two drum pickoff segments). To aid in diagnosing the problem, disable the filter drum and X-ray hi/lo monitors in SQDRIVER.EXE (remember to re-enable them before you leave the program). Another problem that may occur is that the X-ray filament thermal overload has tripped. To check this, turn on X-rays in SQDRIVER.EXE and verify that the **XraySignalLevel** readback is changing (and does not read zero). If it reads as zero, wait 2-3 minutes for the thermal overload condition to clear itself and then try again. To see if the X-rays are pulsing properly, turn off the filter drum and then turn on X-rays.

X-ray signal level (hi/lo) did not match the filter drum position [E_XRAY_PHASE_I]

Comment: If the filter drum monitor is enabled and the filter drum is on, this error indicates that the filter drum wheel readback did not match the expected value (i.e., there must be six segment readbacks, there must be eight pulses within each segment and the first four pulses in each segment are required to be brass and the second four are required to be air).

Action: See the discussion under E_XRAY_SEQUENCE_I.

SECTION 7

PREVENTIVE MAINTENANCE

This section lists the procedures that should be performed by trained service personnel at least once per year, and preferably at six-month intervals.

NOTICE

The QDR system meets applicable FDA radiation performance standards through its useful and expected life provided no components or parts are removed from the system and no unauthorized adjustment or unauthorized replacement of certified components is performed.

CUSTOMER PREVENTIVE MAINTENANCE

Hologic requires that the customer run a daily QC scan of the spine phantom supplied with the QDR 4500, and add that scan to the QC database. If the CV of the database exceeds 0.8% the customer is asked to apprise Hologic Field Service.

The customer is further advised to perform a weekly backup of the patient database (dbArchive) and a monthly backup of the QC database (QC archive).

No other regular maintenance activity is recommended or required of the customer.

FIELD SERVICE PREVENTIVE MAINTENANCE

Hologic recommends that the following procedures be performed by trained service personnel at least once per year, and preferably at six-month intervals:

- [] Perform dbArchive.
- [] Check the QC database for any problems (e.g. drift, etc.).
- [] Check Errorlog.
- [] Check X-ray tube voltage and current, as described in the *INSTALLATION* section of this manual.
- [] Measure scatter, leakage, and patient dose, as described in the *INSTALLATION* section of this manual.
- [] Check X-ray beam alignment, as described in the *ALIGNMENT AND CALIBRATION* section of this manual.
- [] Run the Beam Alignment "Airsan" Test, (Page 4-30), for whole body units (A and W).
- [] Run 10 spine scans and check calibration.
- [] Print copies of the baseline phantom scan, recent phantom scan, and the results of AVERSCAN for the 10 spine scans in the previous step. Compare these printouts with

those from the last PM for possible problems, and keep the printouts with the service records for this system.

- [] During a scan, verify that pressing the red emergency STOP switch, or turning the X-RAY ENABLE key-switch to OFF, *immediately* stops all carriage motion and X-ray production. X-ray production should be monitored by a Victoreen 450P or equivalent.
- [] Test all tape switches. The tape switches are located along the length of the front and back of the table, and mounted on the frame under the table. Verify that pressing a tape switch *immediately* stops all carriage motion and X-ray production. X-ray production should be monitored by a Victoreen 450P or equivalent.

Note: The front (table) tape switch is disabled when the C-arm is at 0°, so this switch should be checked with the C-arm at a position other than 0°.

- [] Adjust the motor drive belts as follows:

Note: Detailed instructions for all drive belt adjustments can be found in the *REMOVE AND REPLACE* section of this manual.

1. For each drive belt (C-Arm Y, Table Y, Table X, and C-Arm R), loosen the 2 mounting bolts holding the tension block.
2. Tighten the tension nut so that the spring is compressed to 7/8". For AY, TY and TX tension springs, the bracket cutout can be used as a measuring guide (the inside of the washer should be flush with the bracket cut). For the AR tension spring, adjust to 7/8" from the inside of one washer to the inside of the other.
3. Tighten the two mounting bolts holding each drive belt's tension block.
4. It is not necessary to perform the MOTOR calibration procedures after tensioning the motor drive belts.

- [] Ensure that all cable connections are tight.
- [] Run SCANDISK to test the computer's hard disk. (SCANDISK is a DOS command on DOS versions later than 5.0)
- [] If necessary, run DEFRAG to unfragment and condense the files on the computer's hard disk. (DEFRAG is a DOS command on DOS versions later than 5.0). It is not necessary to run DEFRAG if the program indicates that the disk is less than 5% fragmented.
- [] Run a computer virus checker (any major brand that is current for latest virus types).
- [] Clean the fan filters, paying special attention to the computer fan filter.
- [] Clean all exterior metal surfaces, and wipe off the rails.
- [] Clean the monitor screen, keyboard and printer.

Guide Rail and Bearing Maintenance

On all 4500 models, a guide rail and two guide bearings (AY) are located at the lower back of the C-arm. Another guide rail and two guide bearings (TX) are located on the right side running front to back just below the table. (See Figure 7-1).

Section 7 - Preventive Maintenance

1. Clean the AY and the TX guide rails using a dry, clean cloth.

Note: DO NOT use a solvent such as alcohol or WD-40. If a solvent is needed to remove dirt and/or gum buildup on the rail, be sure to thoroughly dry the rail before moving the bearings. The solvent may harm the bearing grease.

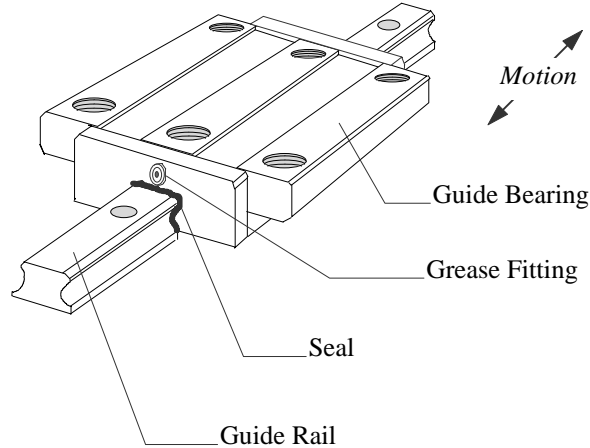


Figure 7-1. Guide Bearing and Rail

2. Grease the guide bearings.

Note: The bearings must be greased every 100km (62mi) of travel, depending on usage. This may range between one and two years. The following table lists more information about the grease to be used.

Generic	Brand Names	Manufacturer
EP-2 Lithium soap-based grease	Beacon 325	ESSO
	Alvania Grease RA	Shell
	Mobilux Grease No. 2	Mobil
	Isoflex Super LDS 18	Kluber

Consult Field Service Headquarters for more information on obtaining the proper tools, material, and procedure.

SECTION 8

PCB SUMMARY INFORMATION

Power Distribution								
LEDs		Signal	Voltage Source		Jacks		Refer to...	
D1	On	+24VDC	Ext	Power Console	A/SL	All used	Figure 5-14, 5-15	
D2	On	XRAY ENABLE	-	-	W/C	JP9 not used		
D3	On	+15VDC	Ext	Power Console				
D4	On	-15VDC	Ext	Power Console				
-	-	+28VDC	Ext	Power Console				

ADC								
LEDs		Voltage	Voltage Source		Jumpers		Refer to...	
D1	On	VCC	Int.	Voltage Reg.	JP3 (GROUND)	Out	Figure 5-13	
D2	On	+5VDC	Int.	Voltage Reg.	JP5 (HI/LO RES)			
D3	On	+12VDC	Int.	Voltage Reg.	A/SL	In		
D4	On	-12VDC	Int.	Voltage Reg.	C/W	Out		
D5	On	-5VDC	Int.	Voltage Reg.				
-	-	+7VDC	Ext	C-Arm Int. Bd.				
-	-	+/-15VDC	Ext	C-Arm Int. Bd.				
U14 (LED display) Flickers “1” on bootup, then lock on “2”.								
Potentiometer			P3 (A/D GAIN CNTRL) See procedure in Section 4.					Page 4-24

Signal Distribution

LEDs ¹		Signal	Voltage Source		Jumpers			Refer to...
D1	On	+7VDC	Int.	Voltage Reg.	JP1 (panel)		Out	Figure 5-1
D3 ²	Off	TZ drive	-	-	JP2 (dist)		Out	
D5	On	+5VDC	Int.	Voltage Reg.	JP3 (C-arm)		Out	
D7	On	+28VDC	Ext	Console Power	Circuit Breakers			
D9	On	+15VDC	Ext	Console Power	CB	Drive	Normally	
D10	On	-15VDC	Ext	Console Power	1	TZ	In	
-	-	+24VDC	Ext	Console Power	2	TY	In	
D11 ²	Off	TY DRIVE			3	TX	In	
D12 ²	Off	TX DRIVE			4	AR	In	
D13 ²	Off	AR DRIVE			5	AY	In	
D14 ²	Off	AY DRIVE						
Notes: 1. Voltage indicators = green; motor drive status = red 2. If red led is on, there is a failure in the PCB. The CB should be tripped.								

Communications Controller

Jumpers		Refer to...
JP1 (IRQ) at 10	In	Figure 5-17
JP2 (IRQ)	Out	
JP3 (IREQA)	Out	
JP4 (IREQB)	In	
JP5 (E-OUT) at C	In	

Section 8 - PCB Summary Information

Detector Array Assembly				
Voltage /Signal		Source		Refer To...
+15VDC	Ext.	ADC PCB	Figure 5-10	
-15VDC	Ext.	ADC PCB		
+5VDC	Ext.	ADC PCB		
+12VDC	Int.	Voltage Reg.		
-12VDC	Int.	Voltage Reg.		

TZ Drive								
LEDs		Voltage /Signal	Source		Jumpers		Refer To...	
D1	On	+5VDC	Int.	Voltage Reg.	JP7 (NORMAL)	In	Figure 5-1	
D2	On	+24VDC	Ext.	Signal Dist.	JP8 (TEST)	Out		
D8	Flash	STATUS (4 LED group)	-	-	NORMAL/ SERVICE	NORM		
-	-	-5VDC	Int.	Voltage Reg.	UP/DOWN SERVICE	N/A		
-	-	+3VDC	Int.	Voltage Reg.				
-	-	-3VDC	Int.	Voltage Reg.				
-	-	240VAC	Ext.	Power Cons.	JP6	Left Ped. (pin 4 to 5) Right Ped. (pin 1 to 2)		

Stepper Motor Controller

LEDs		Signal	Source		Jumpers and Switches		Refer to...
D3	On	+28VDC	Ext	Signal Dist.	W1 (SYSRESET)	In	
D6	On	+5VDC	Int.	Voltage Reg.			
-	-	-5VDC	Int.	Voltage Reg.			
D7 (4 LED pack)							
MEN	On	Note: All 4 LEDs are On solid when the selected motor drive is engaged.					
CPU	Flash						
DIR	Off						
STEP	Off						
		Stepper motor (AR)		SW1	6	Figure 5-6	
		Stepper motor (AY)		SW1	7	Figure 5-1	
		Stepper motor (TX)		SW1	4	Figure 5-4	
		Stepper motor (TY)		SW1	5	Figure 5-2	

Control Panel Controller

LEDs		Signal/Voltage	Voltage Source		Jumpers		Refer to...
D1	On	NLEVEL	-	-	JP3 (OPER)	In	Figure 5-2
D2	On	TAPE SWITCH	-	-	JP4 (TEST)	Out	
D3	On	+5VDC	Int.	Voltage Reg.	JP1- JP5 (A/SL)	JP1- JP5 (W/C)	
-	-	+7VDC	Ext	Signal Dist.	Connected to tape switches.	Tape switch eliminator.	
Note: D2 goes off when tape switch is depressed.					Control Panel Emergency SW.	Located on Operator's Console. Must be UP.	

Section 8 - PCB Summary Information

C-Arm Interace									
LEDs		Signal	Voltage Source		Jumpers			Refer to...	
D1	On	+28VDC	Ext	Signal Dist.	JP7	DRUM	Out	Figure 5-8	
D3	On	+24VDC	Ext	Signal Dist.	JP8	MAIN	Out		
D6	On	+5VDC	Int.	Voltage Reg.	W1, W2	NORMAL(1-2) TEST (2-3)	In		
-	-	+7VDC	Int.	Voltage Reg.	W3	SYS-RESET	In		
-	-	+15VDC	Ext	Signal Dist.	W4	TEST-MODE	Out		
-	-	-15VDC	Ext	Signal Dist.	W5	Safety switches	In		
Drum						JP15	Redundant for W5 may be Out if W5 is In		
D7	On	LOCKE D							
D8	Flash-ing	DRUM AT TOP							
X-Ray									
D9	Off	X-RAY CPU ERROR							
D10	Off	X-RAY ENABLE							
D11	On	X-RAY CPU OK							
D12	Off	X-RAY FAULT							

SECTION 9

SOFTWARE TOOLS

The Hologic system software includes software tools to troubleshoot the system. They are:

- SUSQ
- SQKEYPAD

SUSQ

For a more detailed description of the SUSQ utility, refer to the SUSQ Diagnostic Program reference guide.

Starting SUSQ

At the Hologic Main Menu:

1. Press <Alt><F1> together
2. At the DOS prompt, type SUSQ<Enter>

The SUSQ Service Screens

Screen	Description	Notes	
Main Screen	Appears when entering the SUSQ program	Note: If the filter drum stops rotating after 30 minutes (sleep mode), press <F5> to restart it and <Home> to reset sampling.	<Ctrl><PageUp>, <Ctrl><PageDown> to toggle from screen to screen
Channel Data	Contains Detector Array channel data only	<PageUp> <PageDown> to view all data channels	
Bar Graph	Visual indication of Xray/detector activity		

The Main Screen Control Keys

Key(s)	Description	Key(s)	Description
<F1>	X-Rays on	<Home>	Resets sampling data (under N column on upper left of main screen.
<F2>	X-Rays off	<Alt>T	Sends test signal to Detector Array assembly (visible on Bar Graph). (Set to 0 for normal operation, 1 for test)
<F5>	Filter drum on	<Alt>P	Pulse (normally reads 1)
<F6>	Filter drum off	<Alt>D	Dark current setting
<F10>	Toggles between VOLTS, RAW DATA, LOG DATA	<Alt>H	Drum half (normally reads 0)

X-Ray Controller Status								
VOLTS		0001100100010011						
	Value	N	Mean	StdDev	CV%			
Hi Bone	0.9799	7	0.9790	0.0006	0.0665			
Lo Bone	0.9793	7	0.9791	0.0004	0.0401			
Hi Tissue	0.9784	6	0.9787	0.0003	0.0312			
Lo Tissue	0.9787	7	0.9790	0.0004	0.0397			
Hi Air	0.9786	7	0.9791	0.0005	0.0545	Test Signal <Alt>t	0	
Lo Air	0.9795	7	0.9788	0.0007	0.0690	Pulse <Alt>p	1	
						Drum Half <Alt>h	0	
HiVoltage	Setting	1				Detector	0	
Frequency	Setting	60 Hz				High Gains	1	
Fiter Errors			0	0			Low Gains	1
Hi-Lo Errors			0	0			Xray Mode	3
Aperture	Readback	11	1160			Aperture Setting	11	
Attenuator	Readback	-1	0			Attenuator Setting	-1	
Dark Current	Setting	65535	65535	65535	65535	65535	65535	65535

Figure 9-1. SUSQ Screen–X-Rays OFF

X-Ray Controller Status								
VOLTS		1100111100101010						
	Value	N	Mean	StdDev	CV%			
Hi Bone	4.5217	80	1.4633	1.2334	84.287			
Lo Bone	4.6651	80	1.4897	1.2768	85.712			
Hi Tissue	5.1012	80	1.5412	1.4298	92.771			
Lo Tissue	6.3711	81	1.7820	1.9278	108.18			
Hi Air	6.1627	80	1.6885	1.8010	106.66	Test Signal <Alt>t	0	
Lo Air	8.0925	80	1.9613	2.4650	125.68	Pulse <Alt>p	1	
						Drum Half <Alt>h	0	
HiVoltage	Setting	1				Detector	140	
Frequency	Setting	60 Hz				High Gains	1	
Fiter Errors			0	0			Low Gains	1
Hi-Lo Errors			0	0			Xray Mode	3
Aperture	Readback	11	1158			Aperture Setting	11	
Attenuator	Readback	-1	0			Attenuator Setting	-1	
Dark Current	Setting	65535	65535	65535	65535	65535	65535	65535

Figure 9-2. SUSQ Screen–X-Rays ON

Note: <Home> resets status bits to RED (no change)–GREEN (changed at least once).

SQKEYPAD

The SQKEYPAD utility allows you to control motor functions and turn on the laser. If there is a problem with the Operator Control Panel, use this utility to isolate a panel or a motion problem.

Note: SQKEYPAD will not work for some motor drives until the motor drive calibrations are completed.

Running SQKEYPAD

At the MENU> prompt, type:

SQKEYPAD<Enter>

The screen that appears (seen at right) allows you to control various motion functions and toggle the laser on and off by using the numerical keypad on the right side of the computer keyboard.

Use this utility to determine whether the motor/x-ray system or the operator control panel is at fault.

7 ARM LATERAL	8 TABLE IN	9 TABLE UP
4 TABLE LEFT	5 LASER LIGHT On/Off	6 TABLE RIGHT
1 ARM AP	2 TABLE OUT	3 TABLE DOWN
0 ARM LEFT		. ARM RIGHT

The SQKEYPAD Screen

APPENDIX A

SOFTWARE

DEINSTALLATION/INSTALLATION

This appendix describes the steps used to deinstall and reinstall the Hologic operating system software versions V9.10 and V9.8.

Deinstalling Hologic V9.10/V9.8

Do the following:

1. Perform a dBArchive.
2. At the Windows Taskbar, select Start, then Programs, then the MS-DOS prompt.
3. At the C:\WINDOWS> prompt type CD\<Enter>.
4. At C:\> prompt type ATTRIB -R -H -S SQUID.DAT<Enter>
5. At C:\> prompt type DEL SQUID.DAT<Enter>
6. Delete folders by typing deltree and the appropriate folder.
Example: DELTREE MENU<Enter>. Answer 'Yes' when asked to delete the directory and all of the files.
The following folders need to be removed:
MENU, SCAN, UTIL, XCDATA, FLANGENG.
7. Delete the following files by typing DEL and the appropriate file name.
Example: DEL SYSTEM.PRX <Enter>.
The following files need to be deleted:
SYSTEM.PRX, STANDARD.TBL, SCONFIG.TXT, VALIDOPT.TXT, LINST *.* ,
AWKIE.EXE, AND WREBOOT.EXE.
8. Exit the MS-DOS window.
9. Reboot the computer.

Reinstalling Hologic V9.10/V9.8:

1. At the Windows Taskbar, select [Start], then [Programs], then [MS DOS prompt].
3. At the Windows Taskbar, select Start, then Programs, then the MS-DOS prompt.
4. At the C:\> prompt, type SET ASKMACHINE=1<Enter>.
5. Insert disk 1 of V9.10 into drive A: or B:.
6. At the C:\> prompt, type COPY A:*.EXE <Enter>
7. At the C:\> prompt type LINSTALL<Enter>

8. Follow the instructions on the screen to install system software. When prompted, indicate model type for this installation.
9. Reboot the computer when the software instructs you to do so.
10. Answer "Yes" to initialize patient and QC databases.
11. At Hologic main menu, go to Utility, then Upgrade.
12. Insert the first disk of the Elite System Upgrade (V9.8).
13. Follow the instructions on the screen and reboot the computer when prompted.
14. At the Hologic main menu, go to Utility, then Service, then dbManagement, then dbRecover.
15. Insert the last (or only) dBArchive disk into the drive and press Enter. Press Enter again to do a complete database recovery.
16. Install the remaining dBArchive disks, if applicable, as prompted by the recovery program.
17. Reinstall the Hologic V9.03 System Software after the dbRecover operation through Utility/Upgrade.
18. At the Hologic main menu, go to Utility, then Upgrade.
19. Insert the first disk of the Elite System Upgrade (V9.8).
20. Follow the instructions on the screen and reboot the computer when prompted.
21. If applicable, Install the Version 9 System Software Patch disk through Utility/Upgrade.
22. Install option disks (i.e. U.S.Reference Database/NHANES, Forearm, Low Density Spine) through Utility/Upgrade.
23. Install OnePage and background printing.
Verify that the port and spool settings in Windows printer properties are correct.
24. Perform five QC scans and inspect BMD, BMC, and Area plots.
25. Archive a phantom scan and restore the scan to the hard drive.
26. Perform dBArchive.

APPENDIX B

CROSS-CALIBRATION

Cross-Calibrating a QDR FAN-BEAM SYSTEM to another QDR FAN-BEAM SYSTEM

This procedure describes how to cross-calibrate a QDR fan-beam system to another QDR fan-beam system.

It is assumed that this procedure is used to cross-calibrate a new (just installed) QDR system to an existing QDR system. For clarity, the new (just installed) QDR system is referred to as "NEW QDR" and the existing QDR system is referred to as "ORIGINAL QDR".

The spine phantom shipped with the NEW QDR is referred to as the "NEW PHANTOM" and the phantom shipped with the ORIGINAL QDR is referred to as the "ORIGINAL PHANTOM."

The ORIGINAL PHANTOM is used for the cross-calibration procedure. The NEW QDR is calibrated to produce the same values as the ORIGINAL QDR on the ORIGINAL PHANTOM.

In cases where the customer intends to keep the ORIGINAL QDR system and operate it alongside the NEW QDR system, the ORIGINAL PHANTOM should be used for daily QC on both the ORIGINAL QDR and the NEW QDR. Using the same phantom on both machines simplifies the interpretation of the QC results from the two systems because you don't have to correct for differences between the two phantoms.

In some cases it is not practical to use the ORIGINAL PHANTOM for daily QC on both systems. For example, if the two systems are not in the same room, it may be necessary to use the phantom supplied with each QDR instrument for daily QC on that instrument. If the ORIGINAL PHANTOM cannot be used for daily QC on both machines, the NEW PHANTOM must be scanned on the QDR and relabeled after the NEW QDR has been cross-calibrated to the ORIGINAL QDR using the ORIGINAL PHANTOM (see Step 4 below).

If two or more spine phantoms are kept on site, the spine phantoms should never be switched between QDR instruments when performing daily QC measurements. Doing so defeats the purpose of the quality control program. The operator should be instructed to always use the same spine phantom for a given QDR system.

If the ORIGINAL QDR is being de-installed, the ORIGINAL PHANTOM should be kept on site and used to perform daily QC on the NEW QDR. The NEW PHANTOM should be shipped back to the factory along with the de-installed ORIGINAL QDR.

Definition Summary

FAN-BEAM SYSTEM	QDR 2000, 2000 <i>plus</i> , 4500.
NON-FAN-BEAM SYSTEM	QDR 1000, 1000 <i>plus</i> , 1000/W, 1500, 4000.
QDR	For this procedure only, a QDR means any Hologic fan-beam system.

NEW QDR	A Hologic fan-beam system just installed, typically a QDR 4500.
ORIGINAL QDR	An existing Hologic fan-beam system, typically a QDR 2000 or 2000 <i>plus</i> .
NEW PHANTOM	The phantom that came with the NEW QDR.
ORIGINAL PHANTOM	The phantom that came with the ORIGINAL QDR.

Six Steps to Cross-Calibration

In this procedure, you will perform the following six steps:

1. Check the ORIGINAL QDR's Calibration.
2. Archive the ORIGINAL QDR Patient Database and Transfer the ORIGINAL QDR Patient Database to the NEW QDR (skip this step if the ORIGINAL QDR is not being replaced)
3. Cross-calibrate the NEW QDR to the ORIGINAL QDR using the ORIGINAL PHANTOM
4. Update the QC Database on the NEW QDR
5. Archive the NEW QDR Database
6. Delete all Unnecessary Phantom Scans

It is very important that all steps be performed exactly in the order given.

WARNING: X-rays are produced during most of these tests. Keep hands, head and other body parts out of the X-ray beam. The tester should also wear an approved radiation dosimetry badge.

Step 1 - Check the ORIGINAL QDR's calibration and save its patient database.

If the ORIGINAL QDR is being deinstalled, verify its calibration and save the patient database so that can be transferred to the NEW QDR.

Proceed as follows on the ORIGINAL QDR:

- 1.1 Obtain the ORIGINAL QDR's current calibration readings for Area and BMC on the ORIGINAL PHANTOM by performing one of the following two steps (1.1a or 1.1b).

Note: Because of the possibility that the ORIGINAL QDR may have been miscalibrated, the current Area and BMC values (as measured by the ORIGINAL QDR and recorded in its QC database) could be different from those found on the phantom's label. Because the operating history of the ORIGINAL QDR is very important, the measured values produced by the ORIGINAL QDR during daily QC take precedence over the values printed on the phantom label.

- a. If the "Array Spine" QC plot shows that the ORIGINAL QDR has been stable during at least last four weeks preceding the upgrade, use the "from" choice of the "Plot"

Appendix B – Cross-Calibration

function in QC to get an average over at least one month of QC data. Use this option only if:

- 1) the QC data has been stable,
- 2) there has been no recent re-calibrations or field service, and
- 3) QC has been performed on a regular basis.

Print out the average results for Area and BMC over a recent period of stable data. These results represent the target calibration for the NEW QDR on the ORIGINAL PHANTOM. Write the phantom's number and "ORIGINAL QDR A/P Array Spine Area" and "ORIGINAL QDR A/P Array Spine BMC" on the respective Area and BMC printouts.

or

- b. If QC scans have not been performed regularly or if the QC data has not been stable for more than a month, then obtain the current ORIGINAL QDR calibration by performing 20 Array Spine scans on the ORIGINAL PHANTOM. Add the scans to the QC database by choosing "QC" from the main menu, then "Add" from the QC menu, and selecting the scans from the scan selection screen. Then use AVRSCAN or QC to obtain the current Area and BMC results from these 20 scans. Print out the results and write the phantom's number and "ORIGINAL QDR A/P Array Spine Area" and "ORIGINAL QDR A/P Array Spine BMC" on the respective Area and BMC printouts.

1.2 Archive the ORIGINAL QDR's Patient Database by proceeding as follows:

- a. Verify that all ORIGINAL QDR patient scans have been archived to a floppy or optical disk. If some patient scans have not been archived, ask the operator to archive the patient measurements. If the operator is unavailable, archive them yourself.
- b. Select "dBarchive" from the menu, then press <Enter> to begin the database archive. You will require 1, or possibly 2, blank diskettes for this procedure.
- c. Insert disk 1 and press <Enter>. If required, you will be asked to insert disk 2.
- d. At the completion of the database archiving, remove the diskette from the drive and label your diskette(s) "**DB-ARCHIVE ORIGINAL QDR**".
- e. Make sure the printer of the ORIGINAL QDR is turned on and properly connected. Exit to DOS and type:

PRINT \XCDATA\ARRC.TXT<Enter>

Look for the line in **arrc.txt** which reads:

TO_N = 6.xx

where 6.xx is the ORIGINAL PHANTOM height in inches. This line is usually the fifth line in the file. A common value is: TO_N = 6.78

Circle this line and write next to it "**original QDR array phantom height**".

for use in Step 3.6b of the cross-calibration of the NEW QDR.

STEP 1 - Check the ORIGINAL QDR's Calibration and Save its Patient Database

Step 2 - Transfer the ORIGINAL QDR's database to the NEW QDR.

Note: This step should only be performed if the ORIGINAL QDR is being removed from the site (deinstalled). If the ORIGINAL QDR will remain on site, skip this step and proceed to Step 3.

- 2.1 Place the first diskette from Step 1.3 (DB-ARCHIVE ORIGINAL QDR) into the floppy disk drive of the NEW QDR computer. Select "Utility" and then "Set Floppy" to enable the 5 1/4" disk drive (usually drive A:).

CAUTION: Any mistakes during the next steps will destroy the calibration of the NEW QDR. Follow the instructions exactly. Restore only the ORIGINAL QDR Patient Database. Do not restore calibration files, bat files, txt files, QC files, or any other files.

- 2.2 From the NEW QDR main menu select "Utility", then "Service", then "Dbmngmnt", and last "dbRecover".
- 2.3 Press 1 to recover: the Patient Database. Do not restore any other items on the monitor. Do not press any other key.
- 2.4 Press <Enter> to continue and clear the message "Old files will be lost."
- 2.5 When finished, press <Esc> to end exit from the Database Archive Recover.
- 2.6 Press <Enter> to build the PATSCAN4 key files.
- 2.7 Press <Enter> to continue after keybuild completed.
- 2.8 Press <Enter> to continue checking PATSCAN4.
- 2.9 Press <Enter> to continue after Database Passed.
- 2.10 Press <Enter> to Update PATSCAN4.
- 2.11 The ORIGINAL QDR Patient Database has been successfully recovered by the NEW QDR. If any errors occurred, re-archive the ORIGINAL QDR patient database and retry this procedure from Step 2.0.
- 2.12 Select "Utility" and then "Set Floppy" to enable the 3 1/2" disk drive (usually drive B:).

Step 3 - At this point the NEW QDR should have been installed according to the standard QDR installation procedure.

- 3.1 Before doing anything, perform a complete DBARCHIVE of the NEW QDR.
- 3.2 Verify that the NEW QDR is operating correctly by performing 10 scans as follows.
- a. Enter "Biography" from the NEW QDR main menu and select "Spine phantom # xxxx" where "xxxx" is the number of the QDR phantom.
 - b. Center the laser on the QDR spine phantom starting point and exit to DOS.
 - c. Perform a set of 10 A/P array spine scans by exiting to DOS and typing:

Appendix B – Cross-Calibration

SCANSQ -pap7sp60 -l6 -n10<Enter>

- d. Analyze the 10 scans manually with compare or use autocomp. To use autocomp, analyze the first scan, exit to DOS and type:

AUTOCOMP 10 <Enter>

- e. Verify that the BMD of the 10 scans is within +/- 2.0 % of the factory value written on the label and that the CV is less than 0.5%. If the BMD is not within 2% or if the CV exceeds 0.5%, recheck the installation process for possible errors or problems and repeat the above set of 10 scans until both conditions are satisfied.
- f. Make sure the printer of the NEW QDR is turned on and properly connected. Exit to DOS and type:

PRINT \XCDATA\ARRC.TXT

Look for the line in arrc.txt which reads:

TO_N = 6.xx

where 6.xx is the ORIGINAL PHANTOM height in inches. This line is usually the fifth line in the file. A common value is: TO_N = 6.78

Circle this line and write next to it “**QDR array phantom height**”, for use in Step x.xx of the cross-calibration of the NEW QDR.

- 3.3 Use the NEW QDR to perform 20 Array Spine scans of the ORIGINAL PHANTOM. First, select “Biography” from the NEW QDR main menu and create a new patient <Spine Phantom # xxxx> where xxxx is the ORIGINAL PHANTOM serial number. Press <F10> to save this patient biography. You may have to press <Esc> several times to create the new biography because it may be similar to other biographies which already exist on the NEW QDR.

- 3.4 Perform 20 A/P Array Spine Scans on the NEW QDR by exiting to DOS and typing:

SCANSQ -pap7sp60 -l6 -n20

- 3.5 Analyze the 20 scans from Step 3.3 manually using compare or with AUTOCOMP:

AUTOCOMP 20 <Enter>

- 3.6 Exit to DOS (<Alt> <F1>) and start the FSCAL program by typing “FSCAL” <Enter>

Note: FSCAL **will not** accept anything less than 20 scans.

- 3.7 Modify the “phantom.cal” file by as follows:

- a. Choose option “n” from the FSCAL menu. The program will display the array phantom number, the array Area, and the array BMC as obtained at the factory. The “Array Phantom Number” should be modified to reflect the ORIGINAL PHANTOM number. The “Array Area” should be modified to reflect the AREA value determined from Step 1.1 and the “Array BMC” should be modified to reflect the BMC value determined from Step 1.1. Press <F10> to accept the modified values. Answer “Y” to the query “Do you want to change PHANTOM.CAL[y/n] ?

- b. Enter the ORIGINAL PHANTOM height printed in Step 1.3f into the NEW QDR system and Press <F10>.

Enter the measured height for phantom # xxxx : 6.78
- c. Verify that the Array phantom information is correct and press “Y” to continue.
- d. Chose option “a” from FSCAL. Select the 20 A/P Array Spine scans of the ORIGINAL PHANTOM from Step 3.2 by using the <+> key. Press <Enter> after all 20 sans have been selected. The results of each scan will flash on the screen as it is read into the program.
- e. A green screen will appear when all of the scans have been processed. The Area, BMC, and BMD results and CV’s will be displayed. In addition, the screen will display a separate message for Area and BMC saying whether or not the system is out of calibration. Press <Print scrn> to obtain a copy of this screen. If either the Area or BMC is out of calibration, the following message will appear: "It is recommended that the recalculated ACF/BCF be used." Answer "Y" to the query "do you want to recalibrate?".
- f. Press <F10> twice.
- g. Choose option "w" from the FSCAL menu to write the new values to ARRC.TXT. Press <Enter> to clear the message “THE ARRC.TXT FILE HAS BEEN UPDATED” and press <ENTER> to clear the message “THE ENVIRON.BAT FILE HAS BEEN UPDATED”.
- h. Reset the NEW QDR by pressing <Ctrl><Alt>.
- i. Recalyze the 20 scans of the ORIGINAL PHANTOM from Step 3.2 by exiting to DOS and typing “RECALYZE” <Enter>. Select the 20 A/P Array Spine scans of the ORIGINAL PHANTOM using the <+> key and press <Enter>. The scans will be automatically reanalyzed.
- j. Add the 20 scans from 3.6i to the NEW QDR QC database. Setup the QC database to reflect the ORIGINAL PHANTOM number and the results of the 20 recalyzed scans of the ORIGINAL PHANTOM.

Note: Step 3.7j is unnecessary if the customer intends to use the QDR phantom to perform daily QC on the NEW QDR. If the customer intends to use the QDR phantom on the QDR, proceed to Step 4 and disregard the instructions in Step 3.6j and 3.6k.

Note: Step 4 may also be necessary if the ORIGINAL PHANTOM is an older design with large separations between vertebral bodies. These separations can cause poor precision on the QDR. If the BMD CV of the QDR is greater than 0.5% when the ORIGINAL PHANTOM is used, proceed with Step 4 to relabel the QDR phantom for daily QC on the QDR.

- k. (Skip this step if the customer intends to use the QDR phantom for daily QC on the NEW QDR). Enter QC from the main menu. Verify that the QC program asks for the ORIGINAL PHANTOM serial number. Perform a daily QC scan according to the instructions on the monitor. After the scan has been analyzed press <Enter> to add the scan to the QC database. Inspect the database to ensure that the scan is within the QC limits.

STEP 4 - Re-label the QDR PHANTOM

Note: This step is unnecessary if the customer intends to use the ORIGINAL PHANTOM to perform daily QC measurements on the NEW QDR. It is only required if the customer intends to use the NEW PHANTOM for daily QC on the NEW QDR system.

- 4.1 Enter “Biography” from the NEW QDR main menu and select “Spine phantom # xxxx” where “xxxx” is the number of the QDR phantom. (This Biography was created at the factory).
- 4.2 Center the laser on the starting point of the QDR phantom and perform 20 array spine scans of the QDR phantom using the NEW QDR:
SCANSQ -pap7sp60 -l6 -n20
- 4.3 Analyze these scans in the standard fashion as in Step 3.4.
- 4.4 Exit to DOS and type AVRSCAN <Enter> to obtain the average area, BMC, and BMD of the 20 A/P Array Spine measurements of the QDR phantom. Select all 20 scans with the <+> key and press <Enter>. Print the average values of the 20 scans.
- 4.5 Construct a label with the new area, BMC, and BMD values for the NEW PHANTOM determined from Step 4.4. Remove the factory label and Affix the new label to the NEW PHANTOM. This label should indicate that a “cross-calibration has occurred”.
- 4.6 From DOS type “FSCAL” <Enter> Choose option "n" from the FSCAL menu. The program will display the array phantom number, the array Area, and the array BMC as obtained at the factory. The “Array Phantom Number” should be modified to reflect the QDR phantom number. The “Array Area” should be modified to reflect the AREA value determined from Step 4.4 and the “Array BMC” should be modified to reflect the BMC value determined from Step 4.4. Press <F10> to accept the modified values. Answer “Y” to the query “Do you want to change PHANTOM.CAL[y/n] ?
- 4.7 Enter the height of the QDR phantom that was recorded earlier in Step 3.1f. Press <F10> after the correct height for the QDR phantom has been entered.
Enter the measured height for phantom # xxxx : 6.78
- 4.8 Verify that the Array phantom information is correct and press “Y” to continue.
- 4.9 Add the scans from Step 4.2 into the QC database. Setup the QC database using the new cross-calibrated results on the QDR phantom from the 20 scans performed in Step 4.2. QC Setup is necessary because the calibration of the QDR has been changed from the factory defaults due to the recalibration that occurred in Step 3.6f. Delete all the older factory QC scans and the scans of the ORIGINAL PHANTOM from the QC database. Plot and Print the A/P Array Spine Area, BMC, and BMD plots of the QDR phantom scans performed in Step 4.2.
- 4.10 From the main menu choose Delete and use the <+> key to select all ORIGINAL PHANTOM scans and QDR phantom scans except those just completed in Step 4.2. Press <Enter> to delete all older spine phantom scans from the hard disk.
- 4.11 Reset the computer by pressing <Ctrl><Alt>.

- 4.12 Enter QC from the main menu. Verify that the QC program asks for the QDR phantom serial number. Perform a daily QC scan according to the instructions on the monitor. After the scan has been analyzed press <Enter> to add the scan to the QC database. Inspect the database to ensure that the scan is within the QC limits setup in Step 4.9.

The NEW PHANTOM can now be used for daily QC on the NEW QDR.

STEP 5 - Archive the Database

Perform a complete database archive (dBarchive) of the NEW QDR's database. Leave these floppies at the site for future reference.

STEP 6 - Delete All Unnecessary Phantom Scans

Delete all phantom scans that were used during recalibration from the hard disk and from the QC database. Leave only the last 20 scans from Step 3.7i (if the ORIGINAL PHANTOM will be used for QC on the QDR) or the 20 scans from Step 4.2 (if the QDR phantom will be used for QC on the QDR).