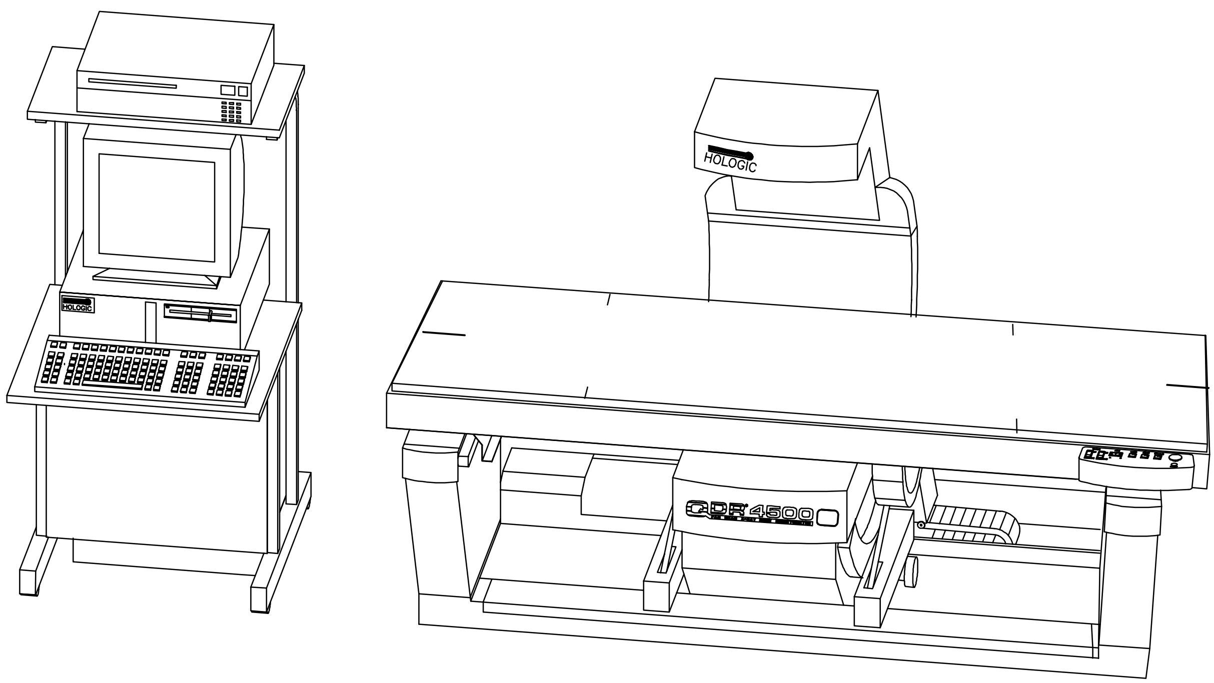
HOLOGIC®

MODEL QDR® 4500
QDR FOR WINDOWS®

FAN BEAM X-RAY BONE DENSITOMETER

TECHNICAL MANUAL



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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 QDR for Windows 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/cm^2 of the same compound.

Note: In most cases, no additional shielding is necessary for patient, operator or room, and the QDR 4500 QDR for Windows 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 QDR for Windows 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 QDR for Windows, 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.

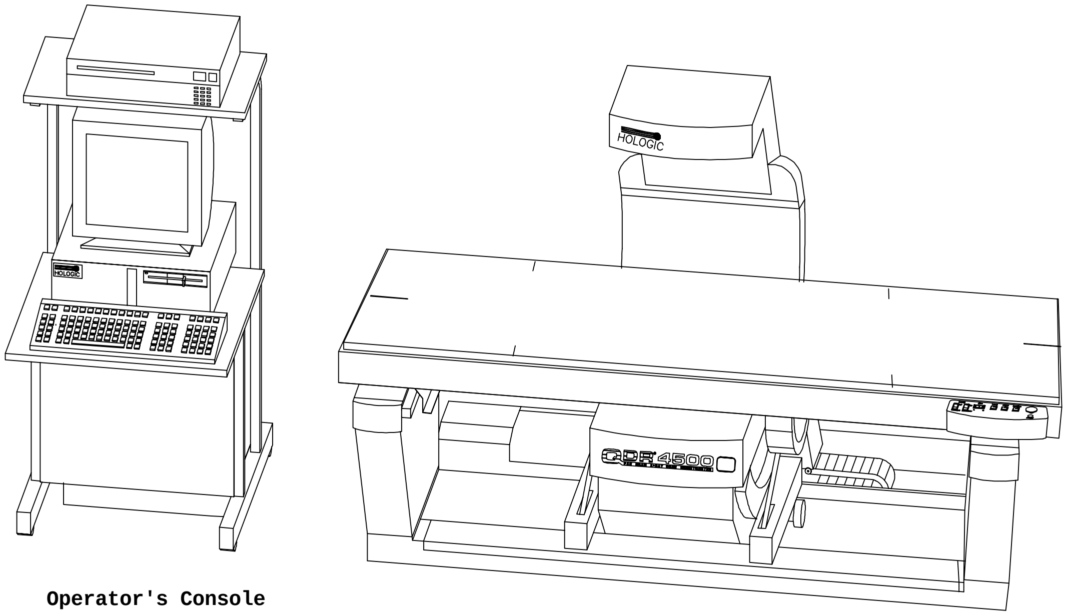


Figure 1-1. QDR® 4500

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.

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:

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

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).

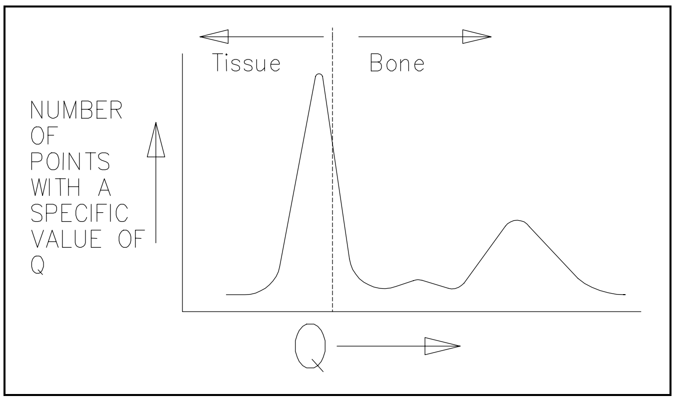


Figure 1-2. Q Scan Plot

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.

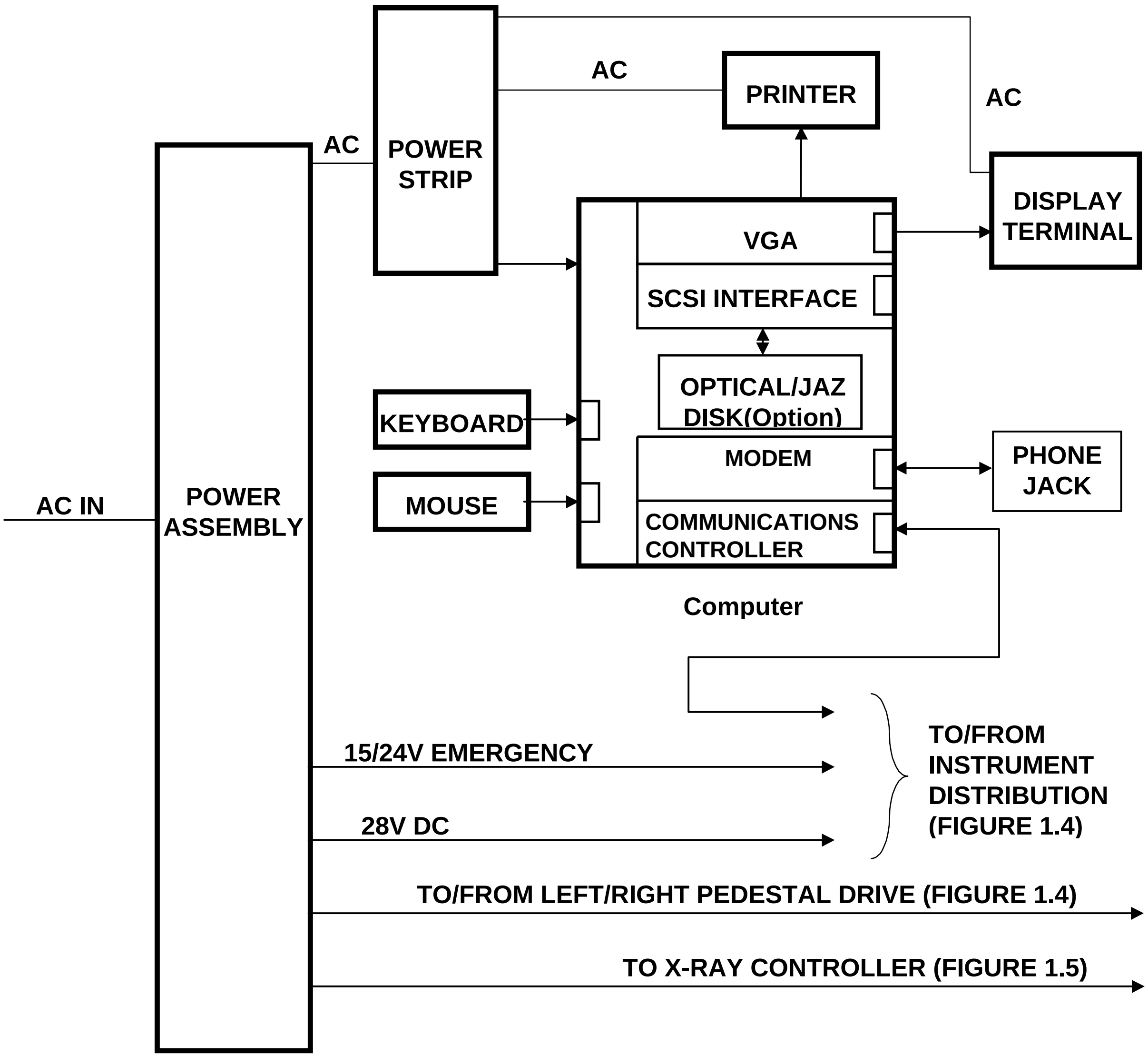


Figure 1-3. QDR 4500 Block Diagram (Operator's Console)

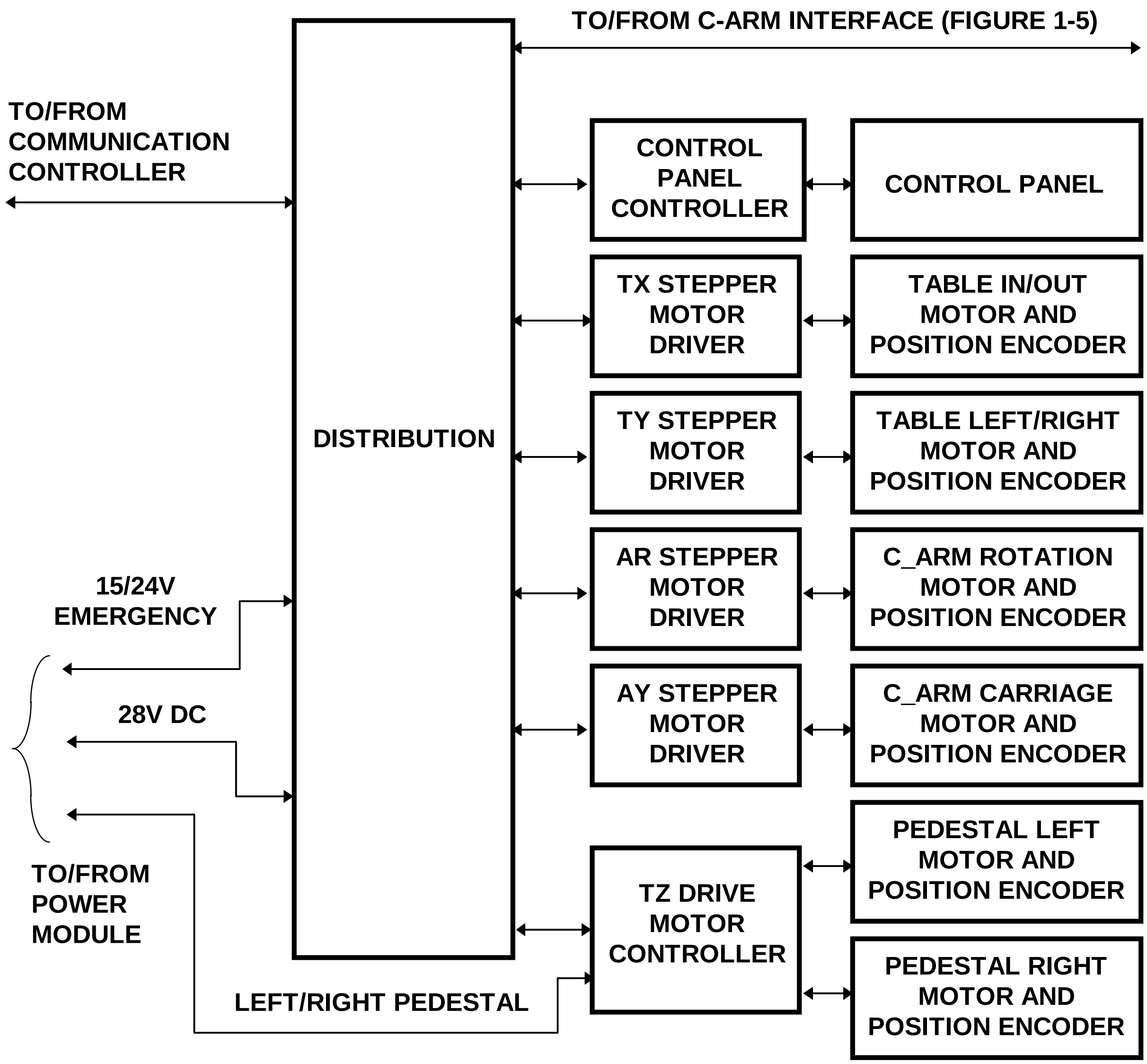


Figure 1-4. QDR 4500 Block Diagram (Scanner Unit)

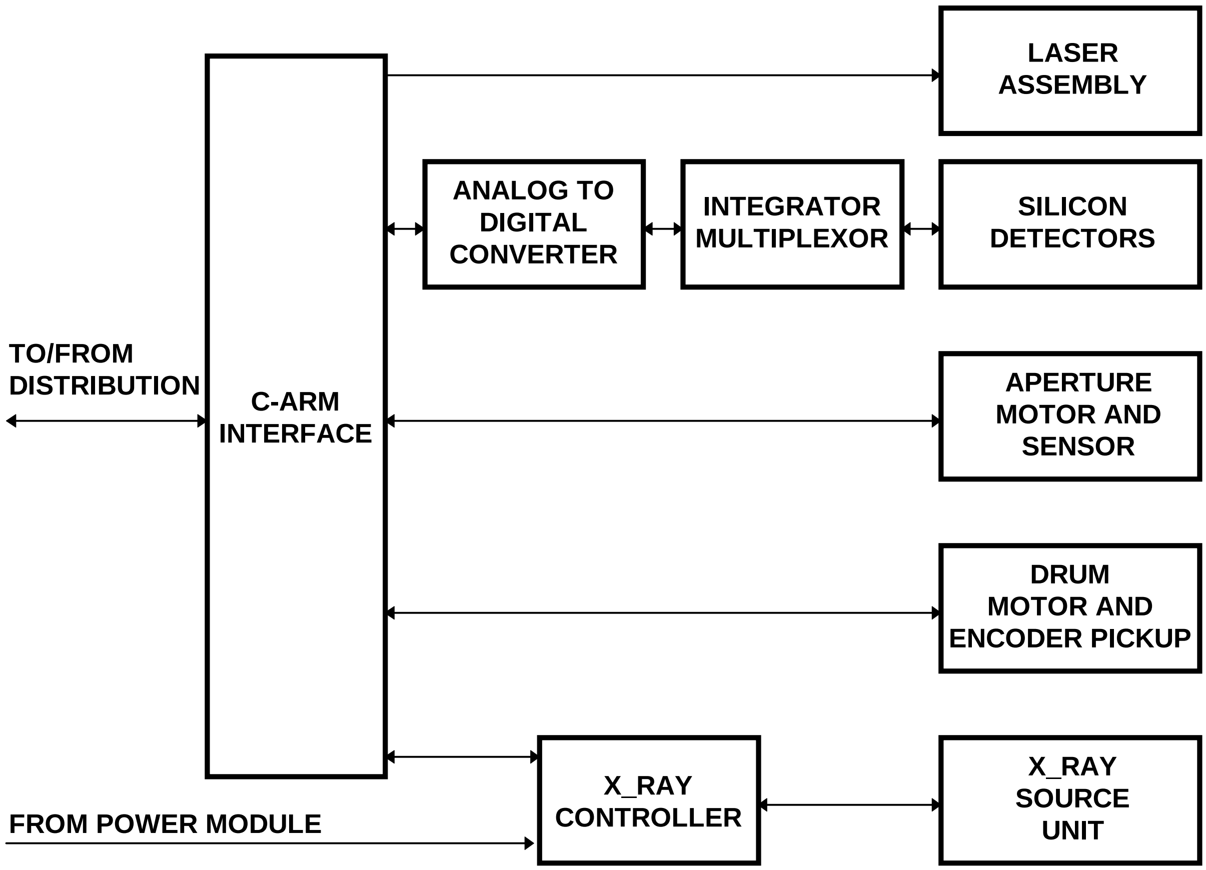


Figure 1-5. QDR 4500 Block Diagram (C-Arm Subsystem)

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.

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

<table>
<tr><th>SPECIFICATION</th><th>MODEL</th><th colspan="4">DEFINITION</th></tr>
<tr><td rowspan="2">Scanning Method:</td><td>A,SL</td><td colspan="4">Multidetector array, Indexing table, and motorized C-arm</td></tr>
<tr><td>W,C</td><td colspan="4">Multidetector array, Indexing table, and Arm</td></tr>
<tr><td>X-ray System:</td><td>All</td><td colspan="4">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</td></tr>
<tr><td rowspan="3">Detector System:</td><td>A</td><td colspan="4">216 multichannel detector consisting of $CdWO_4$ scintillators coupled to Silicon diodes</td></tr>
<tr><td>SL</td><td colspan="4">128 multichannel detector consisting of $CdWO_4$ scintillators coupled to Silicon diodes</td></tr>
<tr><td>C,W</td><td colspan="4">64 multichannel detector consisting of $CdWO_4$ scintillators coupled to Silicon diodes</td></tr>
<tr><td rowspan="4">Scanning Sites:</td><td>A</td><td colspan="4">Lumbar spine (in AP and lateral projections), proximal femur (hip), and whole body</td></tr>
<tr><td>SL</td><td colspan="4">Lumbar spine (in AP and lateral projections), proximal femur (hip)</td></tr>
<tr><td>W</td><td colspan="4">Lumbar spine, proximal femur (hip), and whole body</td></tr>
<tr><td>C</td><td colspan="4">Lumbar spine, proximal femur (hip)</td></tr>
<tr><td rowspan="3">Scan Region:</td><td>A,W</td><td colspan="4">195cm (76.77") x 65cm (25.59")</td></tr>
<tr><td>SL</td><td colspan="4">96cm (38") x 65cm (25.59")</td></tr>
<tr><td>C</td><td colspan="4">96cm (38") x 51cm (20")</td></tr>
<tr><td>Scatter Radiation:</td><td>All</td><td colspan="4">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.</td></tr>
<tr><td>Leakage Radiation:</td><td>All</td><td colspan="4">The QDR-4500 meets the requirements of 21 CFR 1020.30(k) for leakage from the X-ray source</td></tr>
<tr><td>External Shielding Requirement:</td><td>All</td><td colspan="4">Contact state regulatory agency.</td></tr>
<tr><td>Calibration:</td><td>All</td><td colspan="4">Self Calibrating using HOLOGIC Automatic Internal Reference System. Operator calibration NOT required.</td></tr>
<tr><td>System Weight:</td><td></td><td colspan="2">Scanner</td><td colspan="2">Console</td></tr>
<tr><td rowspan="4">(installed)</td><td>A</td><td>365kg</td><td>800lb</td><td rowspan="4">68kg</td><td rowspan="4">150lb</td></tr>
<tr><td>SL</td><td>365kg</td><td>800lb</td></tr>
<tr><td>W</td><td>310kg</td><td>680lb</td></tr>
<tr><td>C</td><td>295kg</td><td>650lb</td></tr>
<tr><td rowspan="5">(shipping)</td><td></td><td colspan="2">System</td><td colspan="2"></td></tr>
<tr><td>A</td><td>660kg</td><td>1450lb</td><td colspan="2"></td></tr>
<tr><td>SL</td><td>660kg</td><td>1450lb</td><td colspan="2"></td></tr>
<tr><td>W</td><td>622kg</td><td>1370lb</td><td colspan="2"></td></tr>
<tr><td>C</td><td>610kg</td><td>1340lb</td><td colspan="2"></td></tr>
</table>

SPECIFICATION	MODEL	DEFINITION					
Operating Temperature:	All	15^o - 32^o C (60^o - 90^o 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	DOSE mrad
AP Spine Array	All	60	1.0%	0.20	20.0
AP Spine Fast	All	30	1.0%	0.10	10.0
AP Spine High Definition	A,SL	120	1.0%	0.20	20.0
AP Spine Turbo	A,SL	10	1.5%	0.07	7.0
	W,C	15	1.5%	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	1.0%	0.10	10.0
Hip High Definition	A,SL	120	1.0%	0.20	20.0
Hip Turbo	A,SL	10	1.5%	0.07	7.0
	W,C	15	1.5%	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 pre-indication 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	CC[1] Pin	Dist[2] 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.

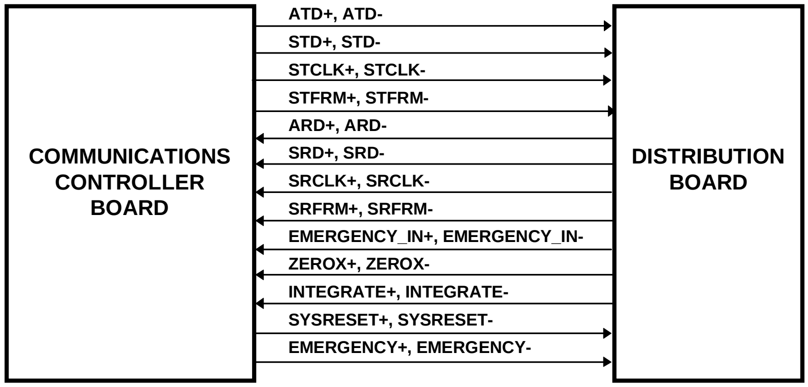


Figure 2-1. Communications Controller Board/Distribution Board Interconnection Diagram

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. In addition, 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.

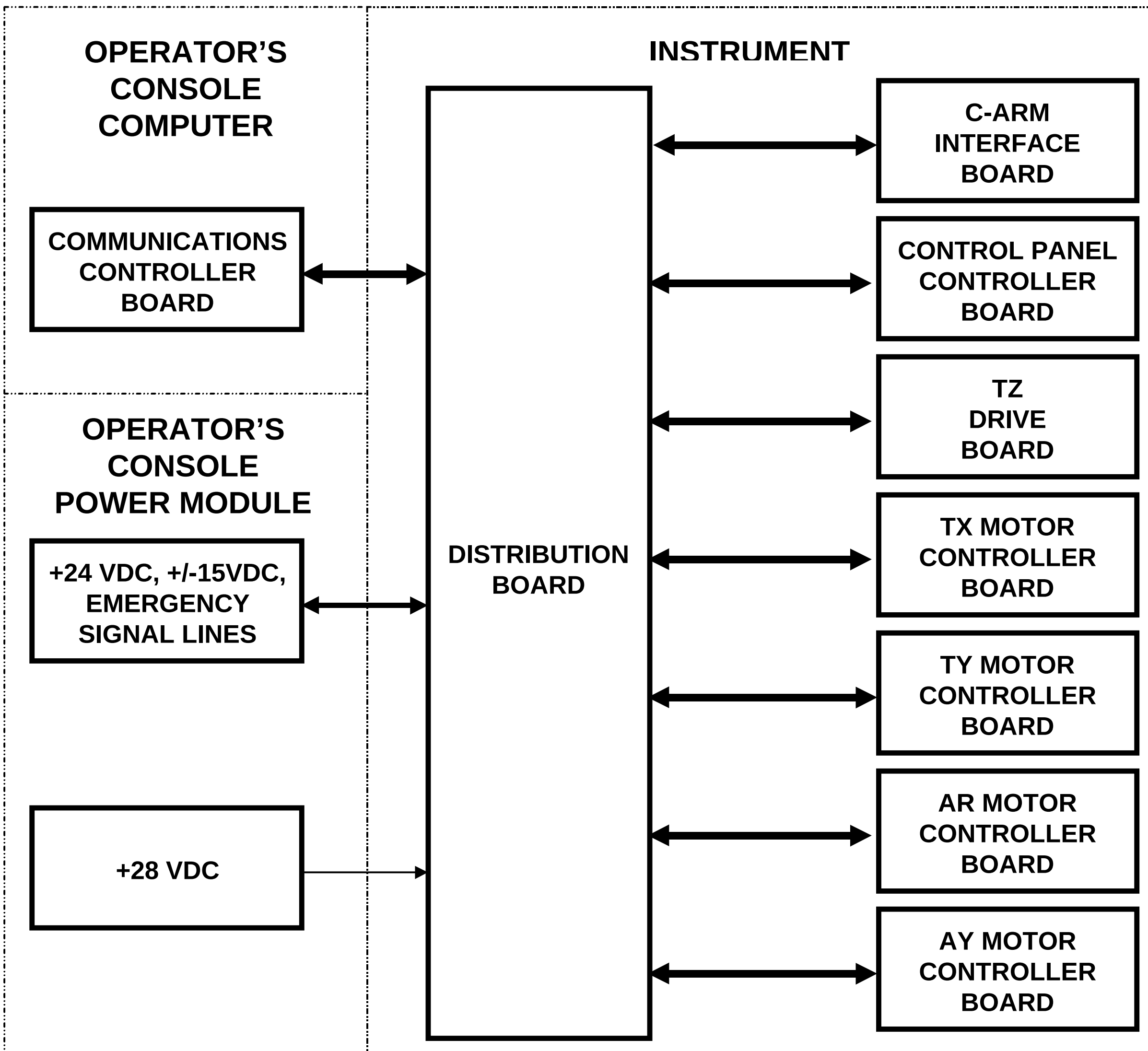


Figure 2-2. Distribution Board High Level Interconnection Diagram

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 +/-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 drives	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.

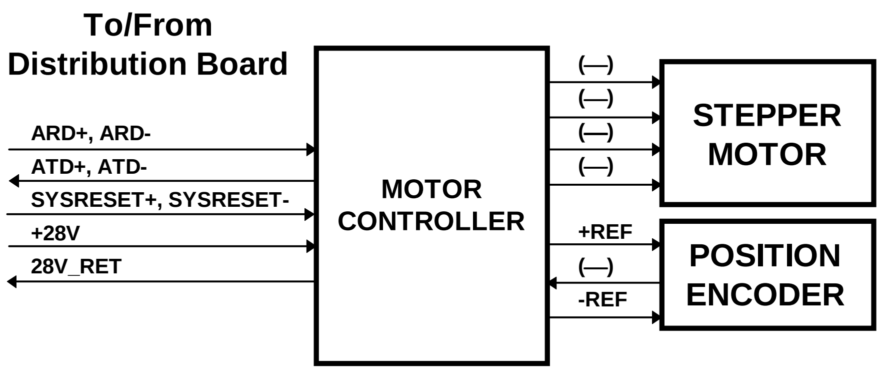


Figure 2-3. Distribution Board/Motor Controller Board Interconnection Diagram

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.

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 +5and -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.

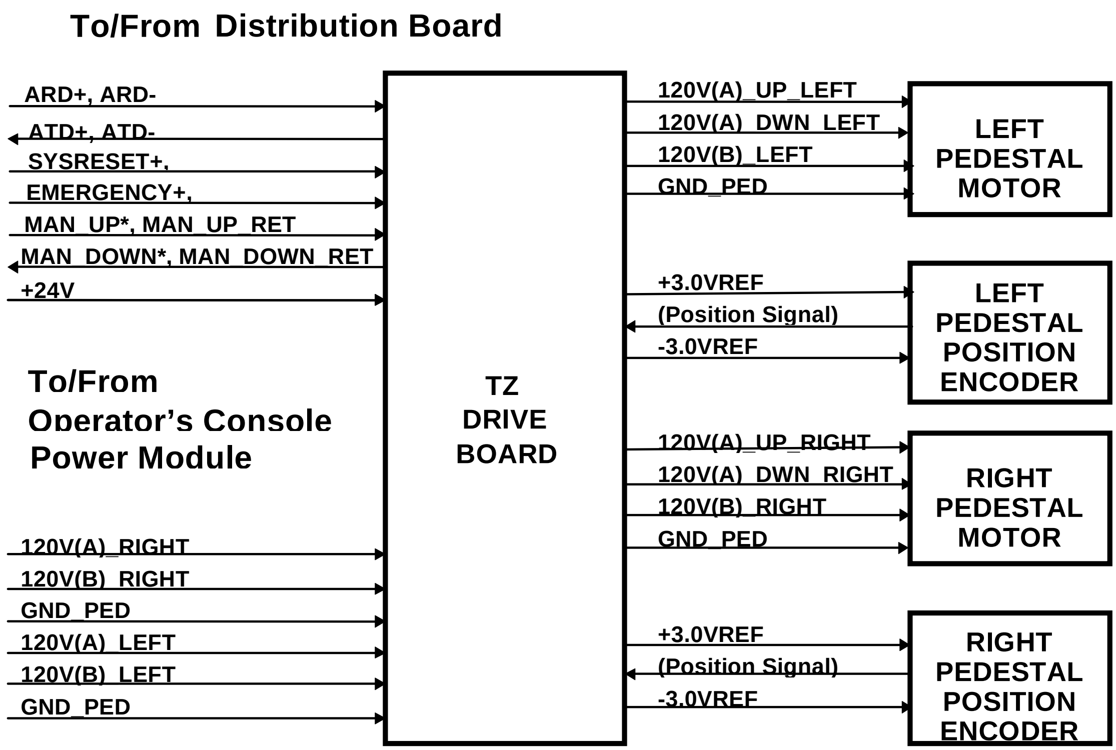


Figure 2-4. Distribution Board/TZ Drive Board Interconnection Diagram

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.

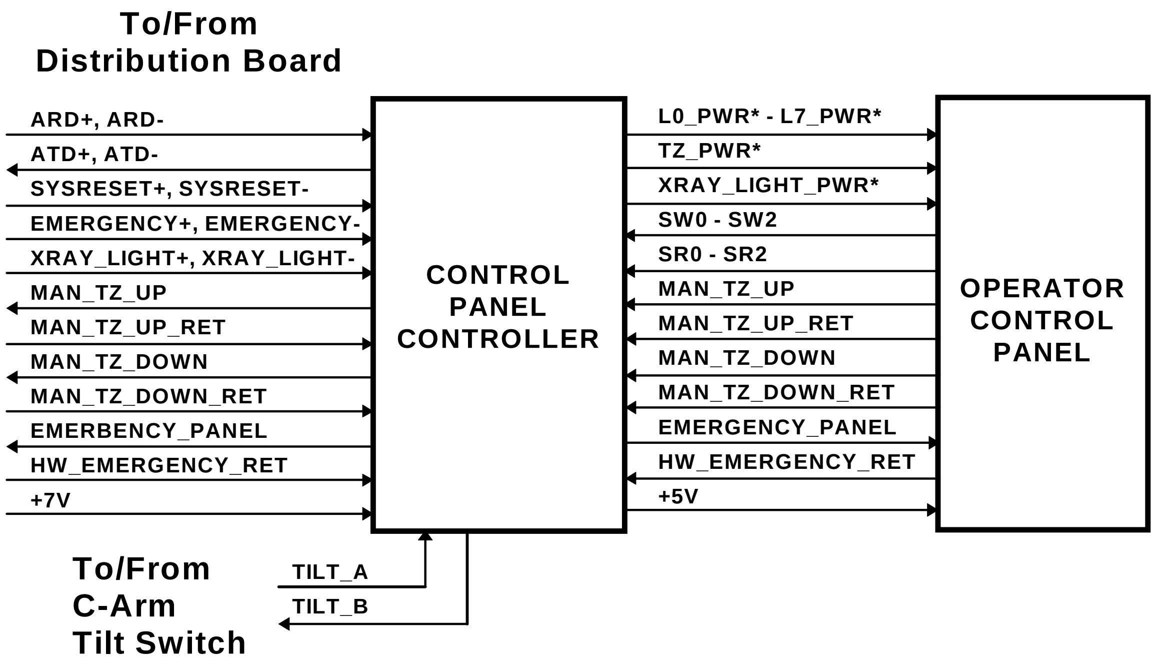


Figure 2-5. Control Panel Controller Interconnection Diagram

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_CPANEL 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.

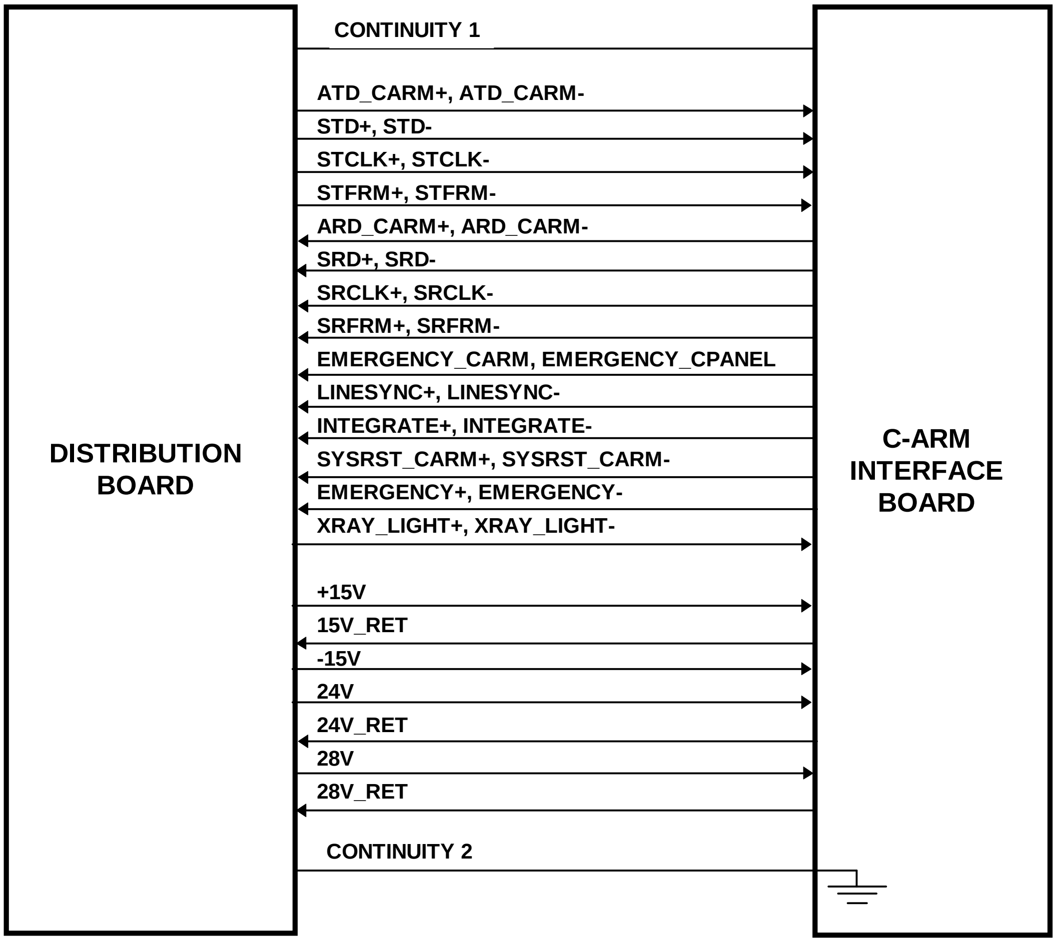


Figure 2-6. Distribution Board/C-Arm Interface Board Interconnection Diagram

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

Signal	Description	Dist[1] Pin	C-ARM[2] 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.

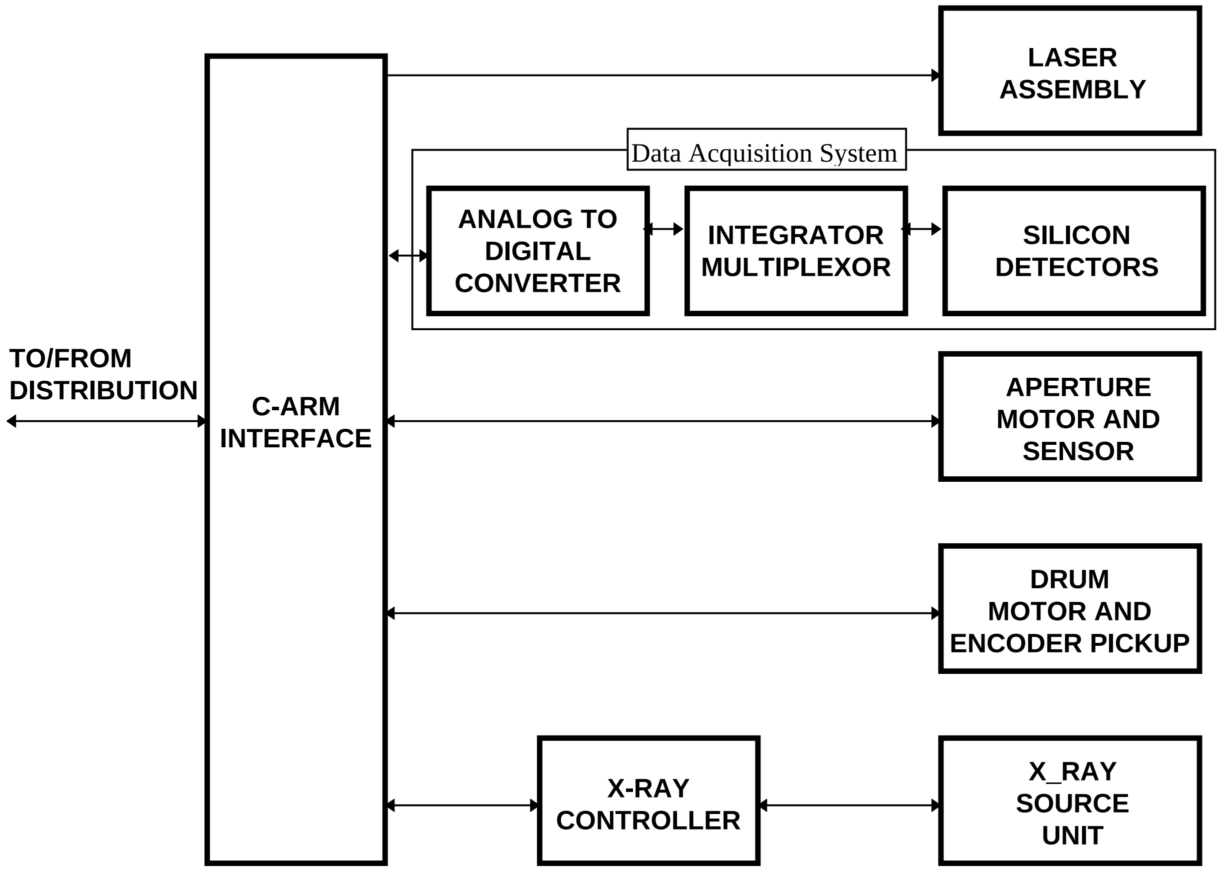


Figure 2-7. C-Arm Interface Board High Level Interconnection Diagram

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 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.

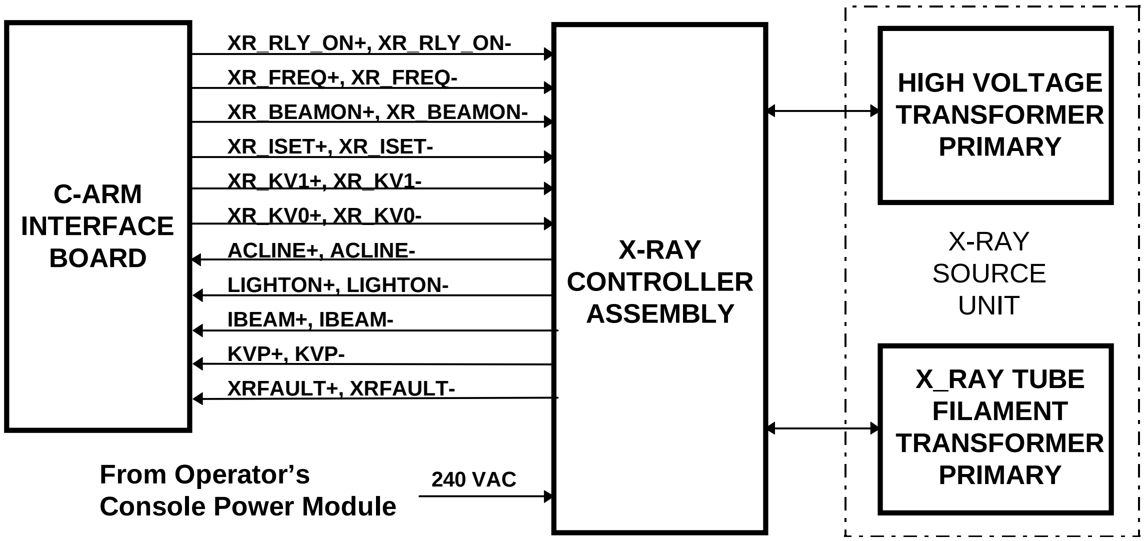


Figure 2-8.
C-Arm Interface Board/X-Ray Controller Assembly Interconnection Diagram

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 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.

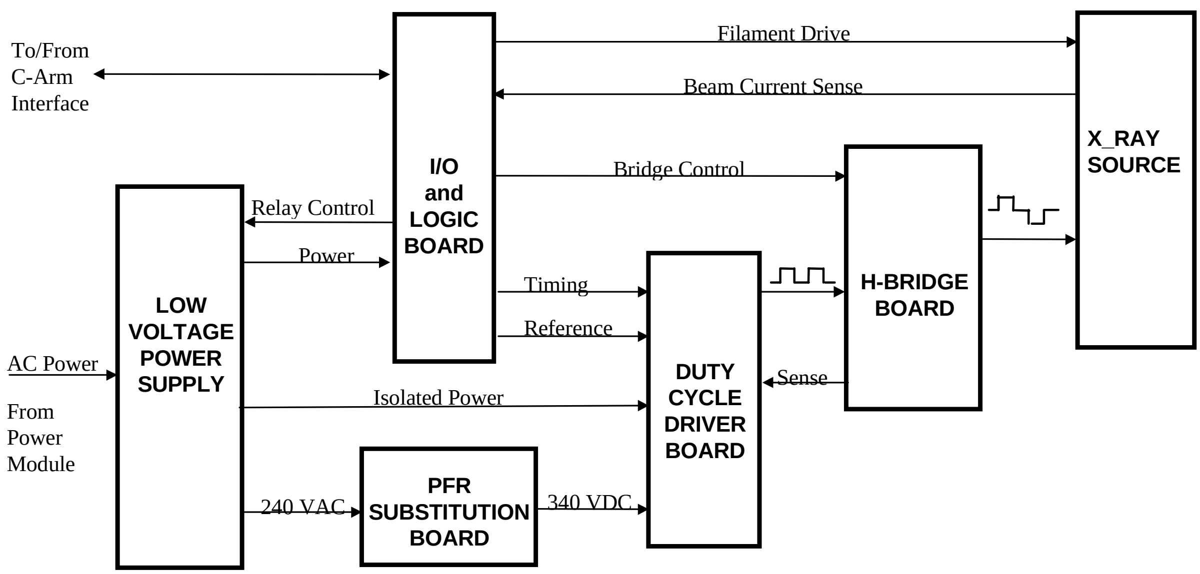


Figure 2-9. X-Ray Controller Assembly High-Level Interconnection Diagram

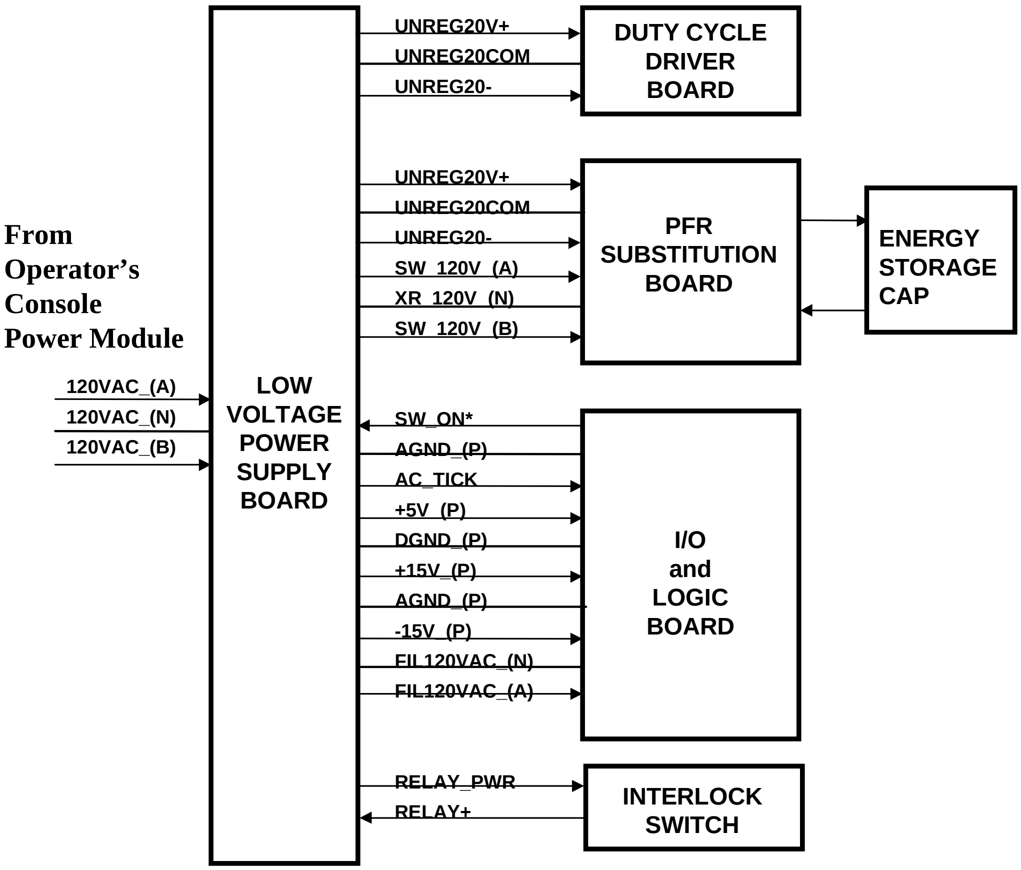


Figure 2-10. Low Voltage Power Supply Board Interconnections

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

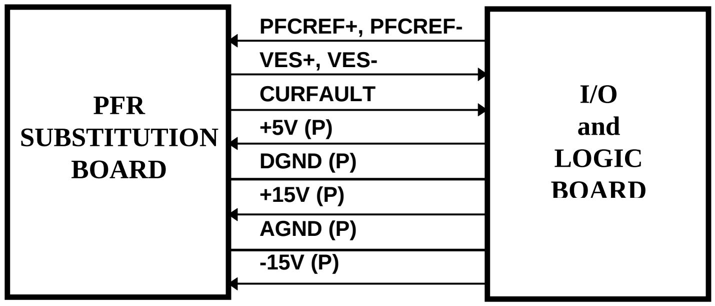


Figure 2-11. PFR Substitution Board/I/O and Logic Board Interconnection Diagram

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

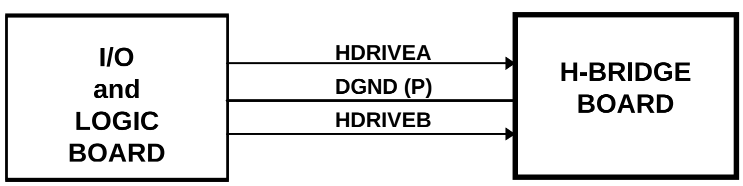


Figure 2-12. I/O and Logic Board/H-Bridge Board Interconnection Diagram

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

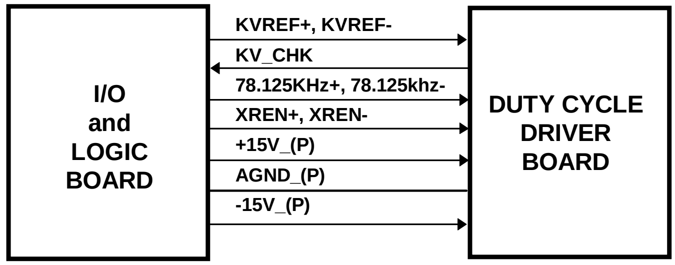


Figure 2-13. I/O and Logic Board/Duty Cycle Driver Board Interconnection Diagram

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

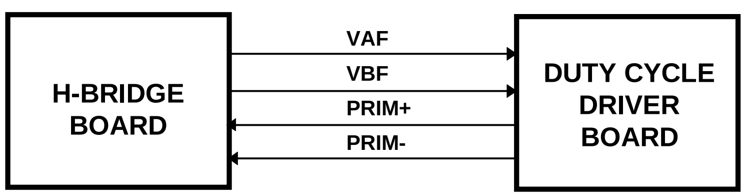


Figure 2-14. H-Bridge Board/Duty Cycle Driver Board Interconnection Diagram

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.

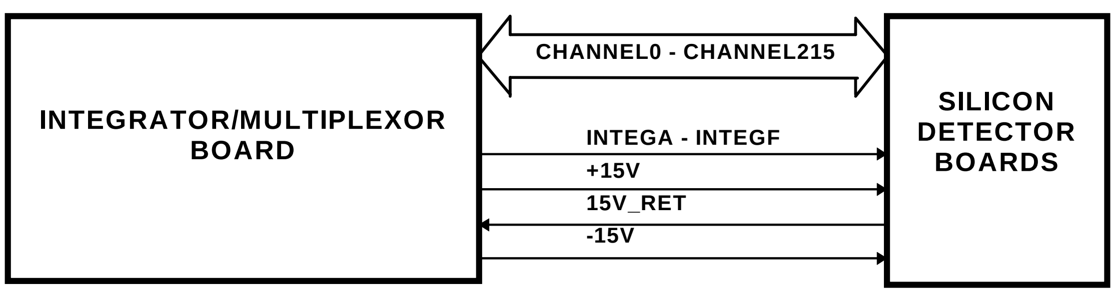


Figure 2-15. Integrator/Multiplexor Board/Solid State Detector Boards Interconnection Diagram

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 140-0048-SD for connector and pin assignments (cannot scope these signals).
2. Refer to schematic drawing 140-0050-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.

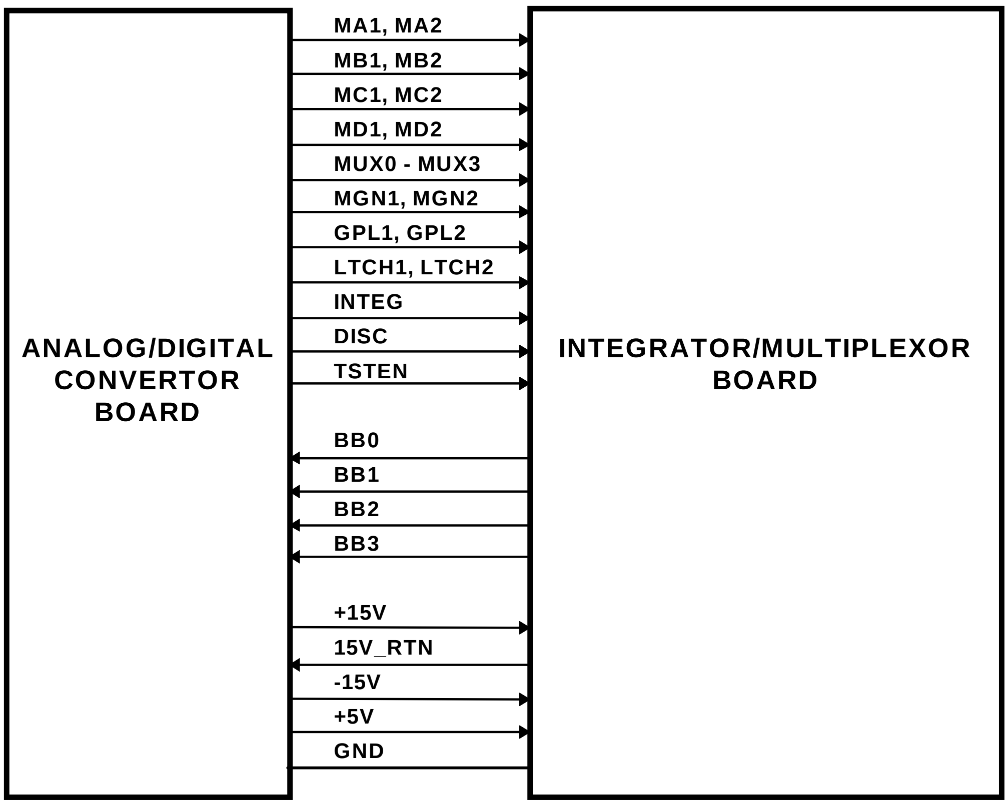


Figure 2-16. Analog Digital Converter Board/Integrator Multiplexor Board Interconnection Diagram

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 MUX0- MUX3 GPL1, GPL2	IN0, IN1 IN6, IN7 IN2, IN3 IN4, IN5 IN8 IN9 IN10, IN11 IN14, IN15	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 JP4-17, JP4-19, JP4-21, JP4-23 JP4-29, JP4-31	JP7-1, JP7-3 JP7-13, JP7-15 JP7-5, JP7-7 JP7-9, JP7-11 JP7-17, JP7-19, JP7-21, JP7-23 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 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 generates +/-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.

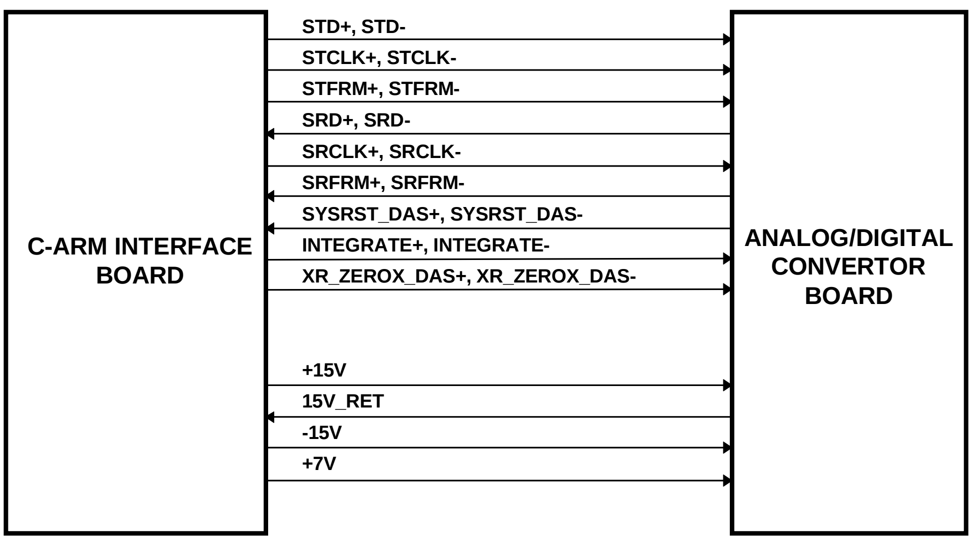


Figure 2-17. C-Arm Interface Board/Analog/Digital Converter Board Interconnection Diagram

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	Powers the Data Acquisition System.	JP10-32 JP10-33	P1-32 P1-33
-15V		JP10-36 JP10-37	P1-36 P1-37
15V_RET		JP10-30 JP10-31 JP10-34 JP10-35	P1-30 P1-31 P1-34 P1-35
+7V		JP10-38 JP10-39	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

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.

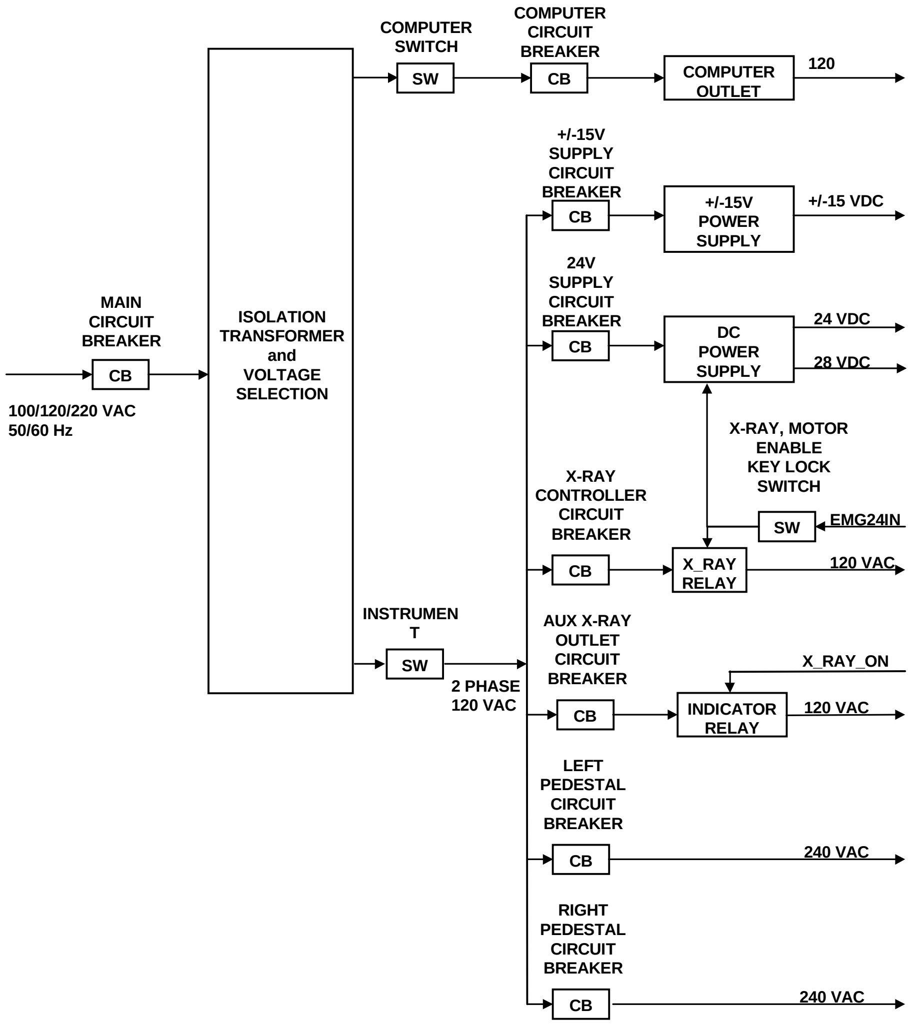


Figure 2-18. Power Module Block Diagram

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 Elite Windows® Version User's Guide*
- Computer manual
- Printer manual
- *Introducing Microsoft Windows® 98*
- 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)

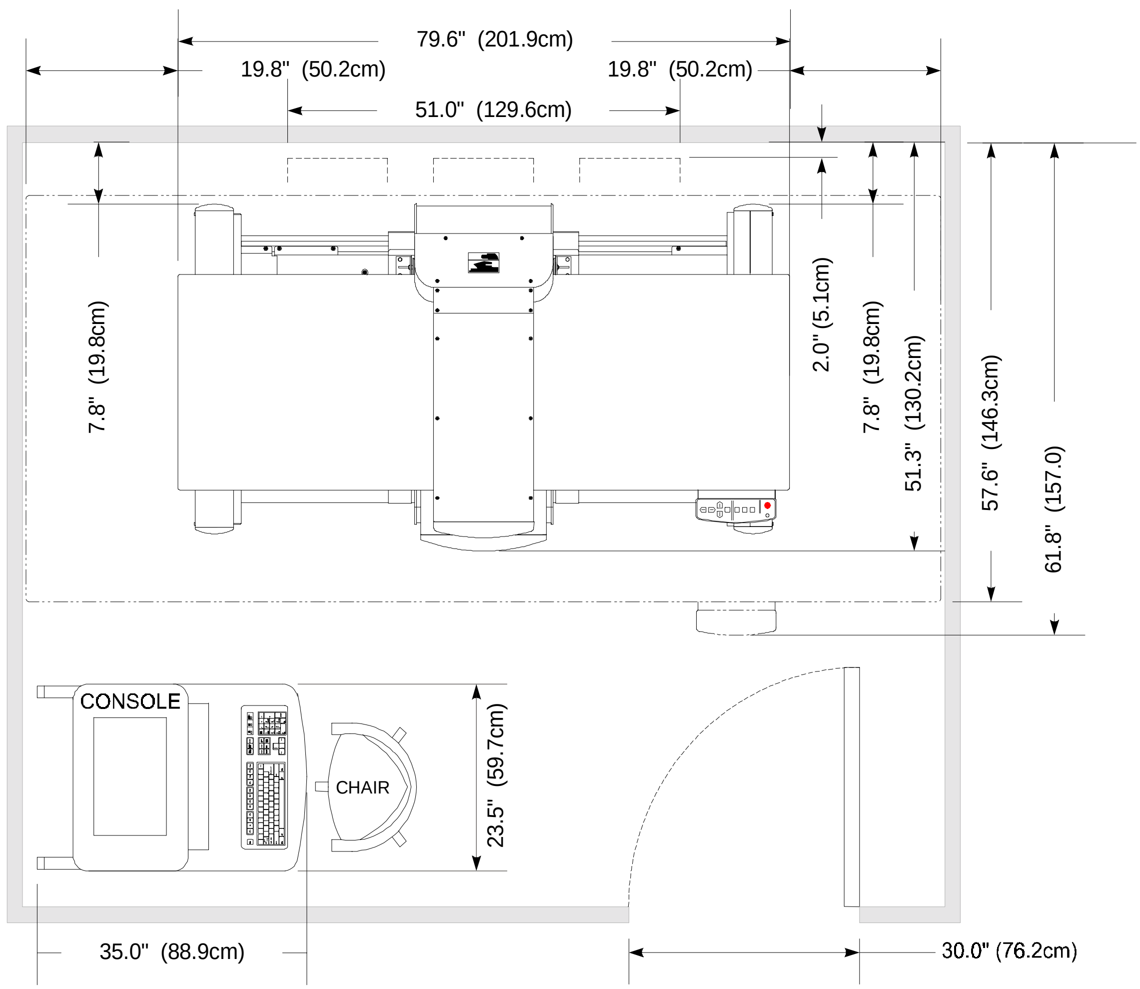


Figure 3-1. Room Layout (4500A)

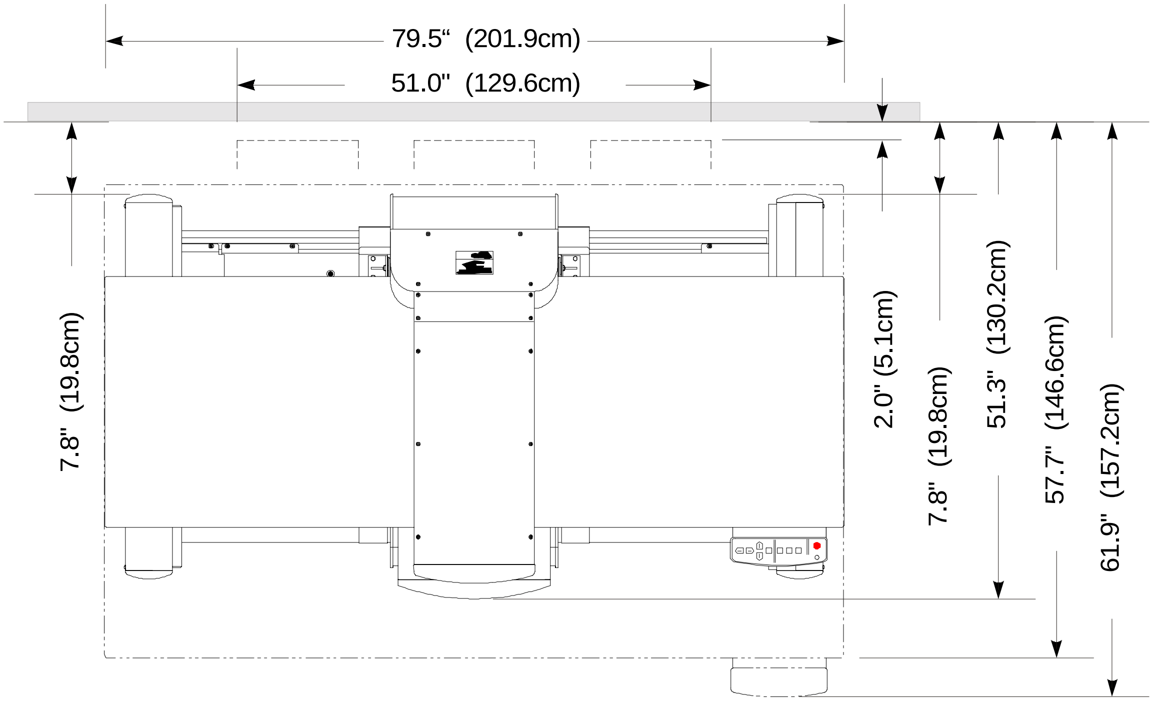


Figure 3-2. System Dimensions (4500SL)

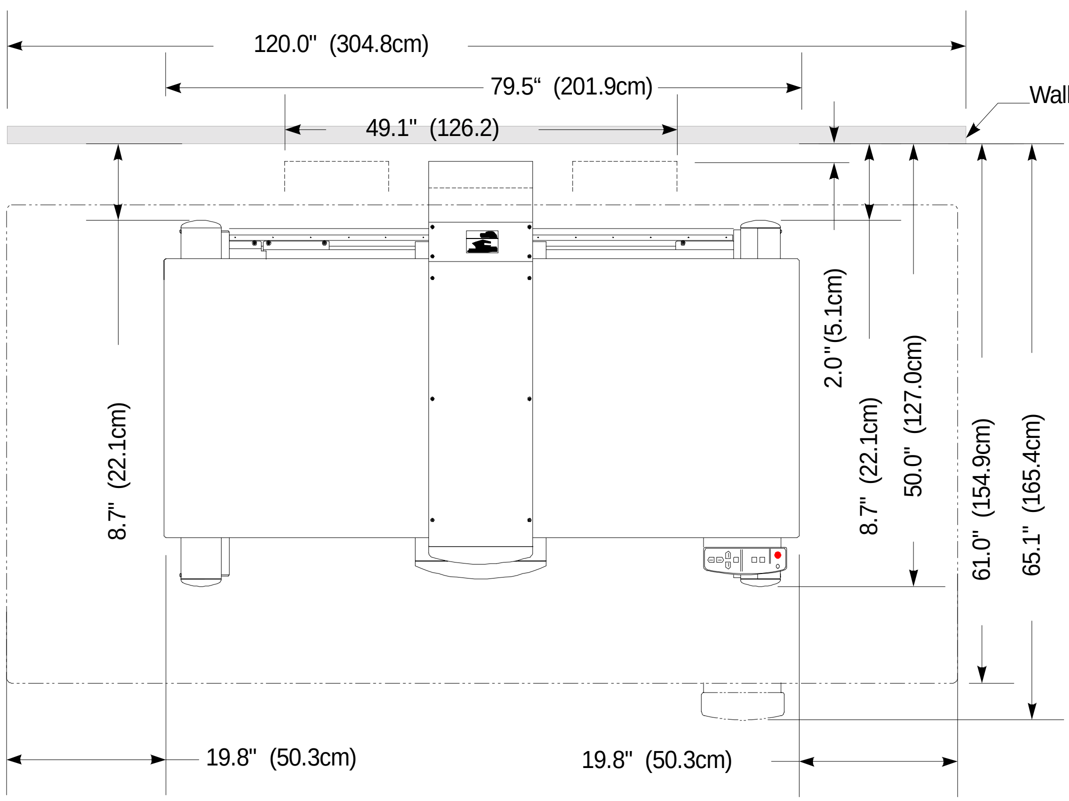


Figure 3-3. System Dimensions (4500W)

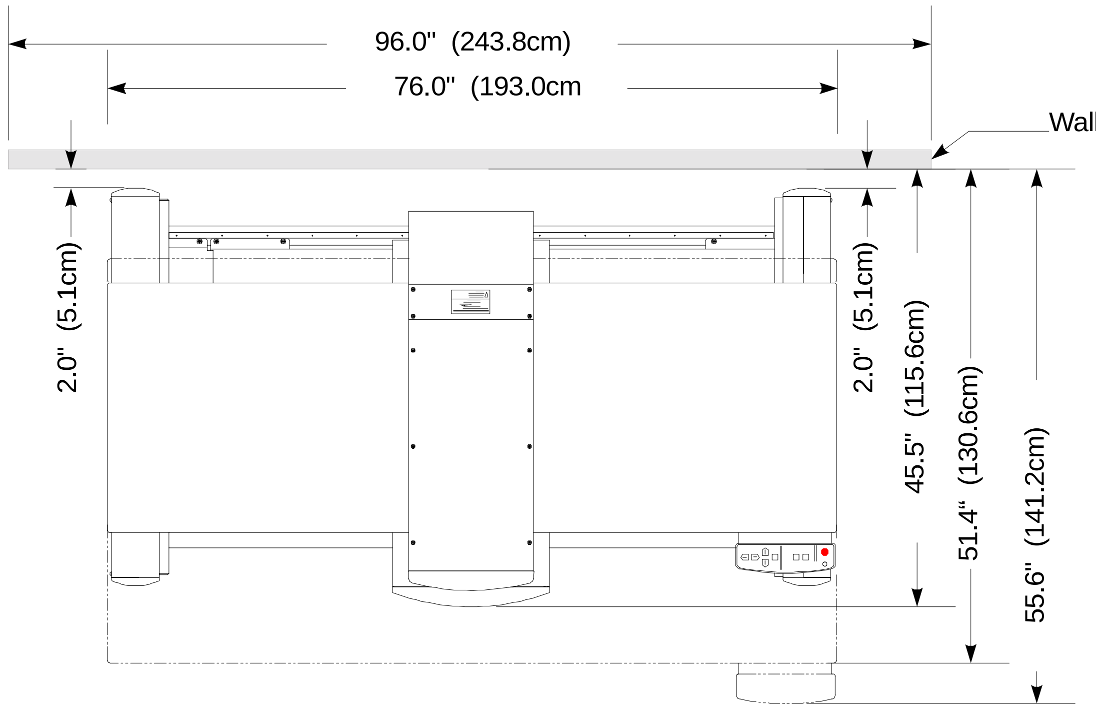


Figure 3-4. System Dimensions (4500C)

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 A	SL	W	C	Computer, Printer, Monitor	Power Console
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.

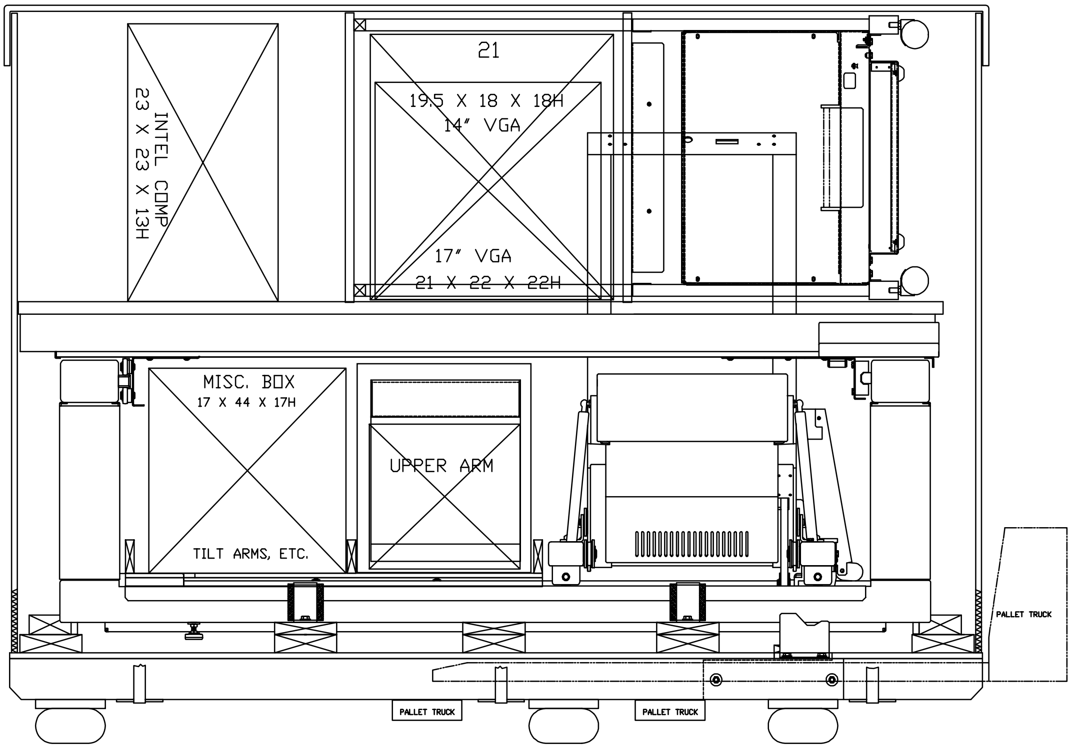


Figure 3-5. Crated Unit (QDR 4500A and QDR 4500SL)

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 checklist, 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)

- [ ] Main QDR 4500 Assembly
- [ ] Computer and Keyboard
- [ ] Black & White or Color Printer
- [ ] QDR Spine Phantom
- [ ] Table top Pad
- [ ] Printer Manual
- [ ] 3.5" Floppy Disks (2 boxes)
- [ ] Key (for enabling X-rays)
- [ ] Miscellaneous Cables Box
- [ ] Upper C-Arm Assembly
- [ ] VGA Monitor
- [ ] Knee (Block) Elevation Pad
- [ ] Foot Restraint
- [ ] QDR 4500 User's Guide
- [ ] Printer Paper (B & W or Color)
- [ ] System Power Cable
- [ ] Miscellaneous Hardware 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 81inches (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.

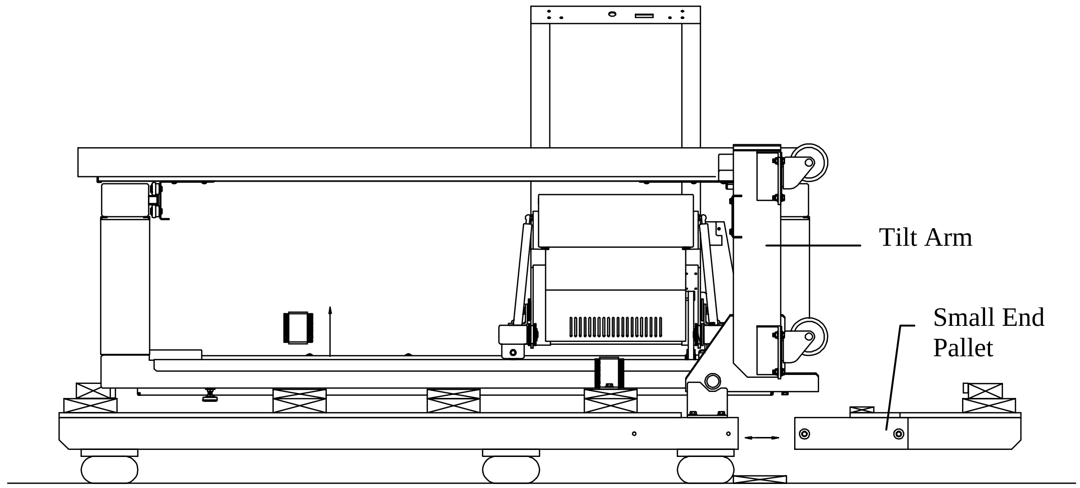


Figure 3-6. Uncrated Unit (QDR 4500A and QDR 4500 SL)

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.

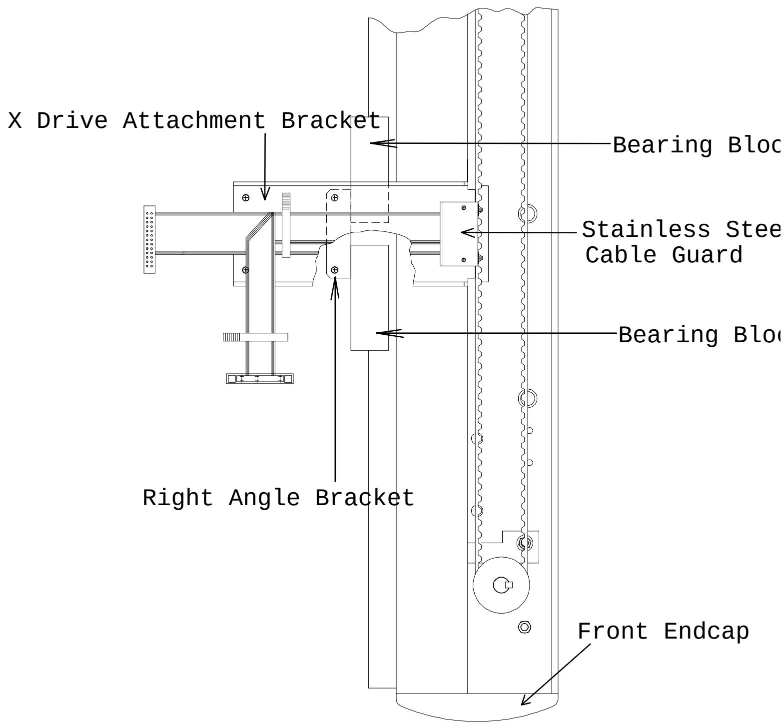


Figure 3-7. Table X Drive

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.

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.

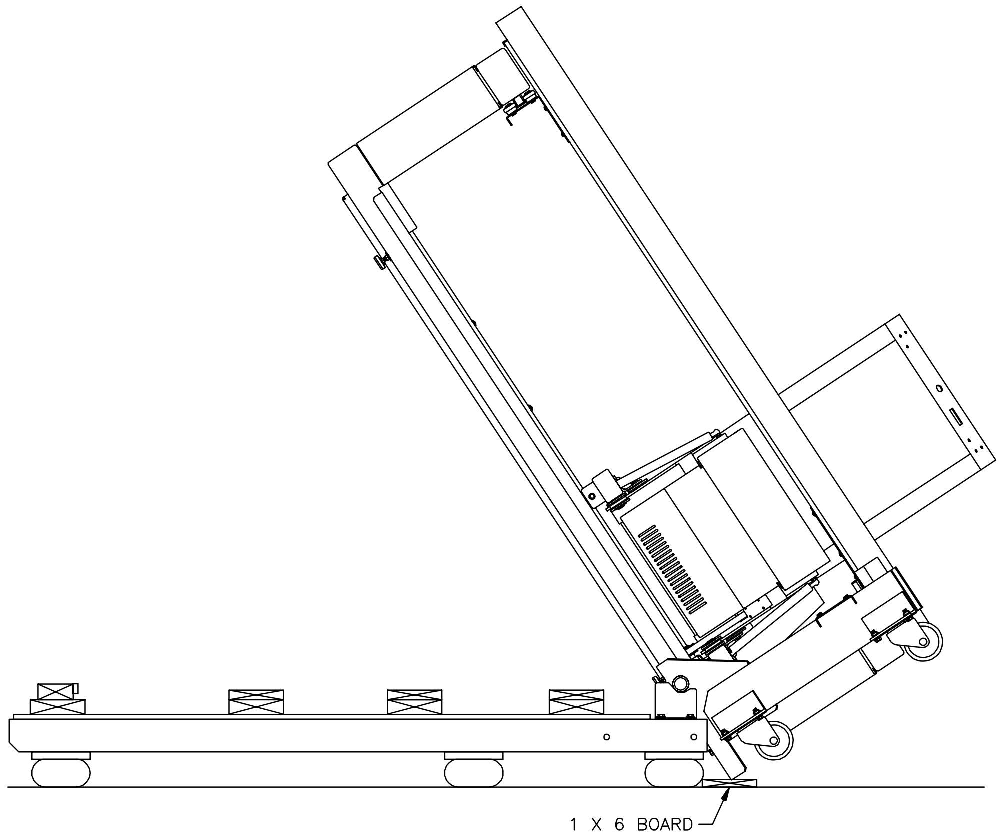


Figure 3-8. Tipping Unit

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.

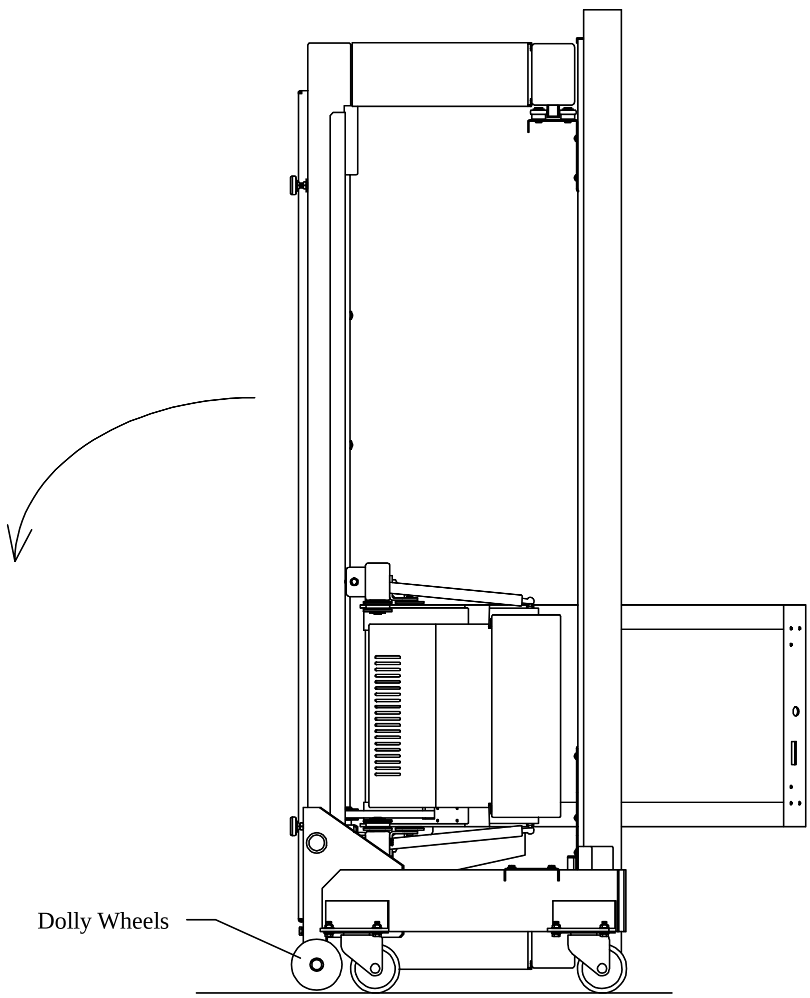


Figure 3-9. Moving and Tilting the Unit Down

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.

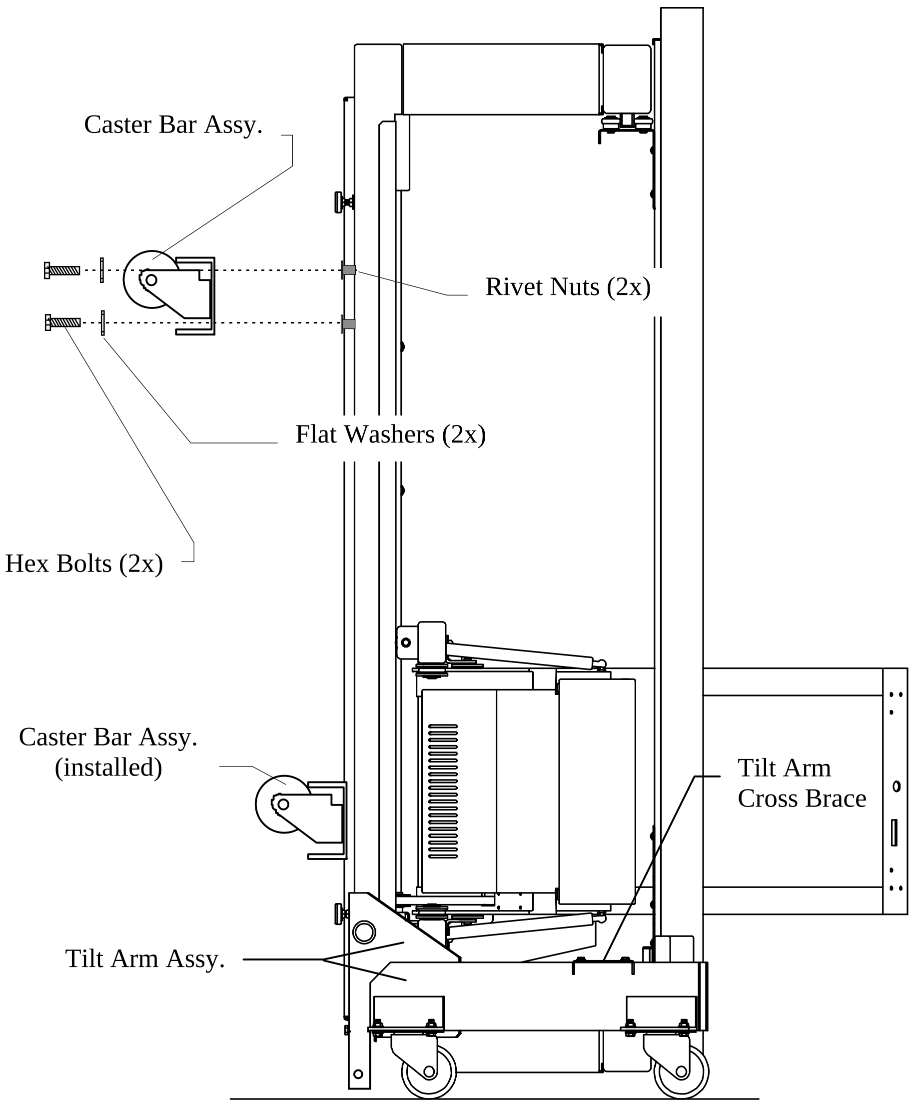


Figure 3-10. Auxiliary Horizontal Caster Installation

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).

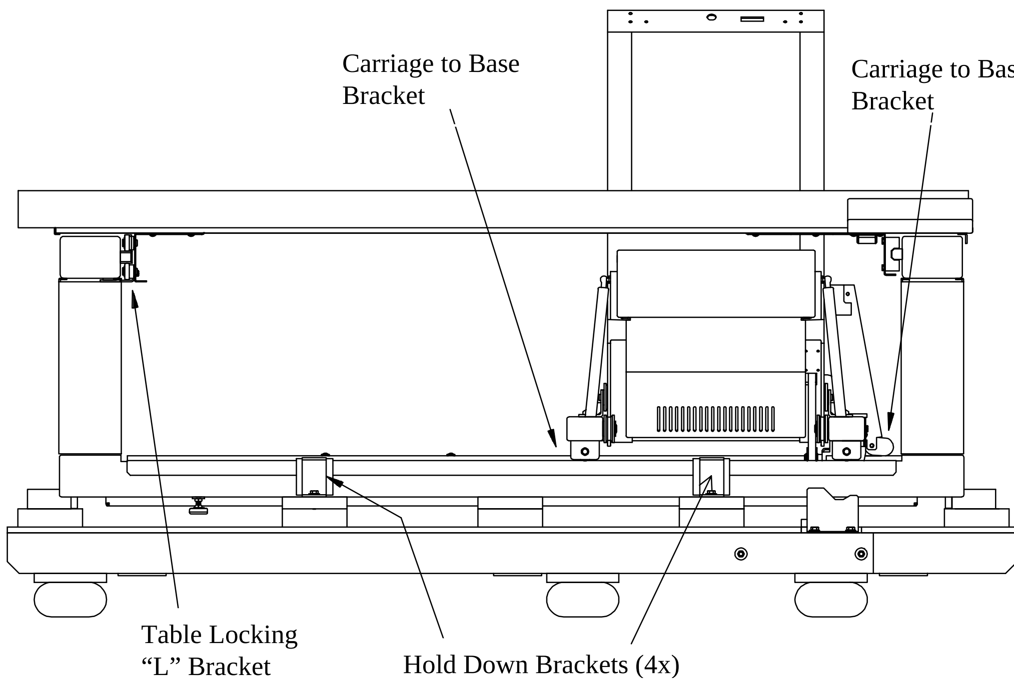


Figure 3-11. Shipping Bracket Locations (QDR 4500A and SL)

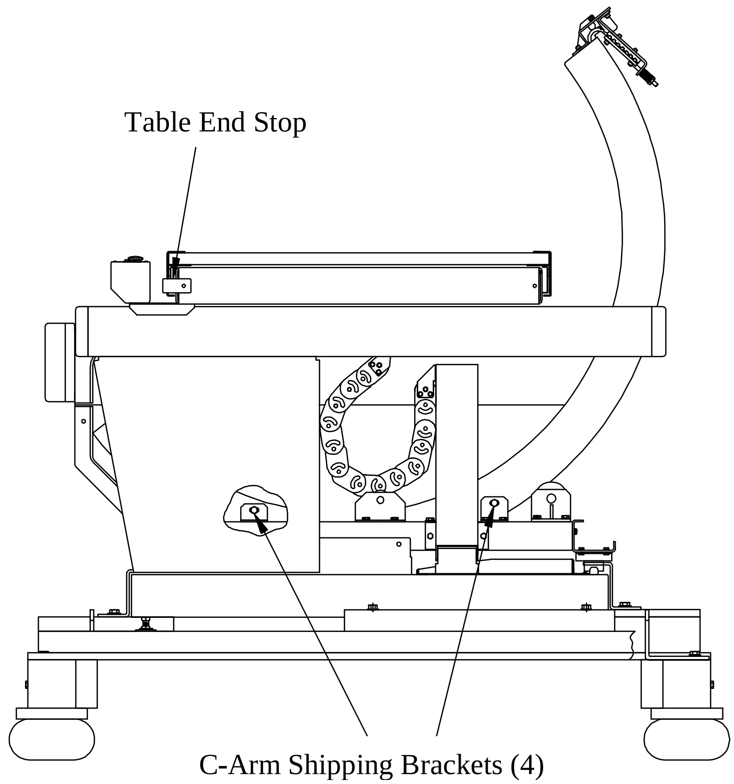


Figure 3-12. Shipping Bracket Locations (QDR 4500A and SL)

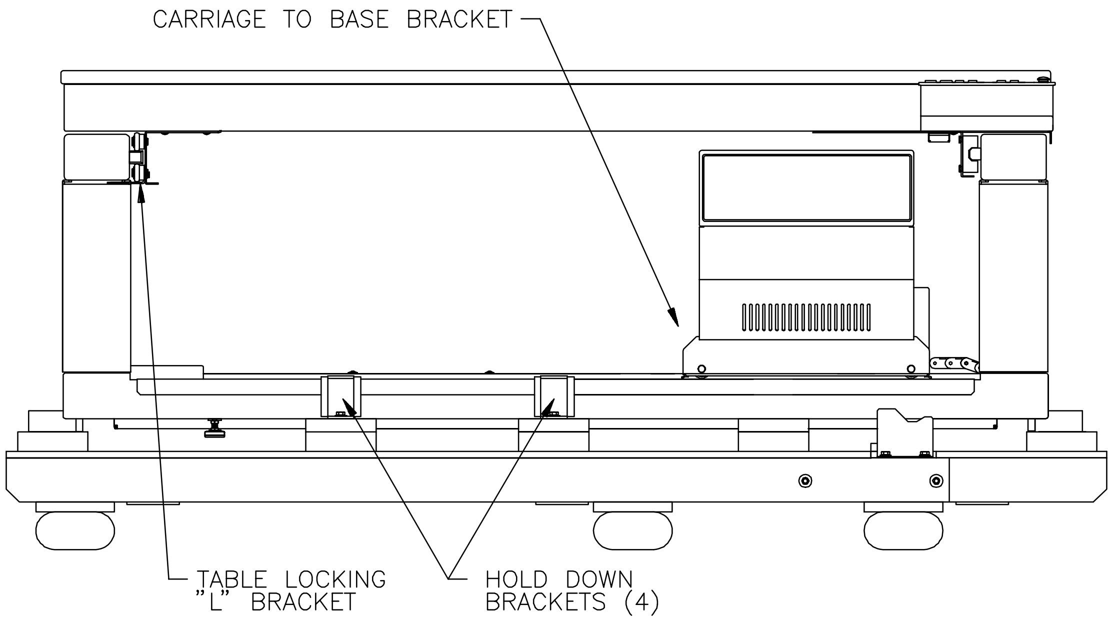


Figure 3-13. Shipping Bracket Locations (QDR 4500W and C)

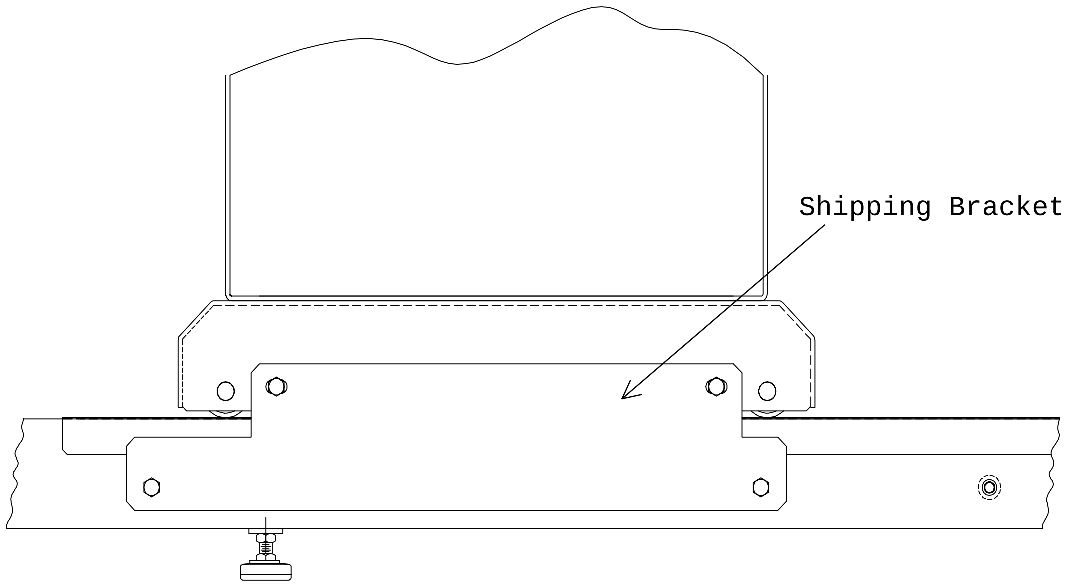


Figure 3-14. Shipping Bracket Location (QDR 4500W and C)

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.

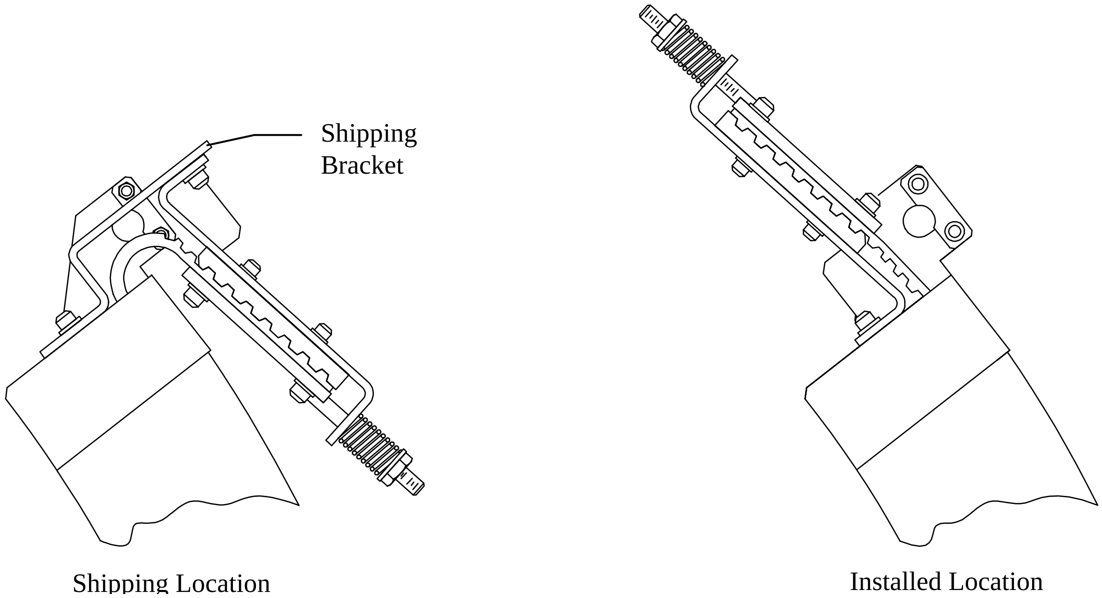


Figure 3-15. Repositioning the Belt Tensioning Mechanism

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.

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

INSTALL COMPUTER

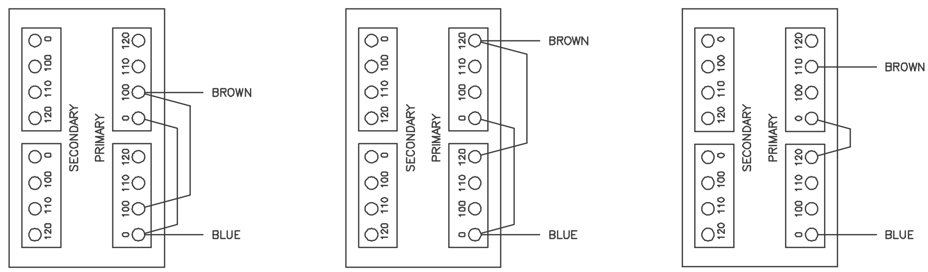
Follow the procedure below to install the computer:

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.



100 VAC SERVICE   120 VAC SERVICE   230 VAC SERVICE

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 X-RAY SURVEY (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 ± 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 re-strap the transformer.

Note: Enter this information into *The Radiation Measurement Report* (see page 3-30).

Measure Isolation Transformer Secondary Voltage

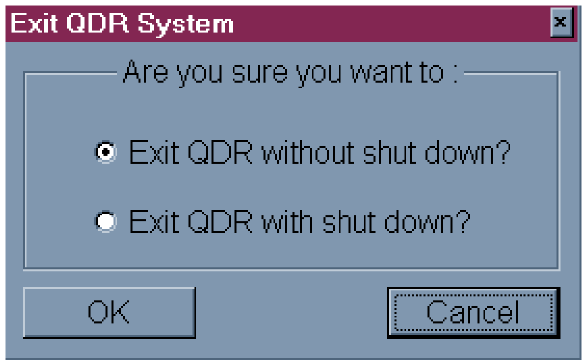
After plugging in the instrument and switching on the main breaker, measure the voltage at the accessory outlet located at the bottom rear corner of the power console with an AC voltmeter.

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

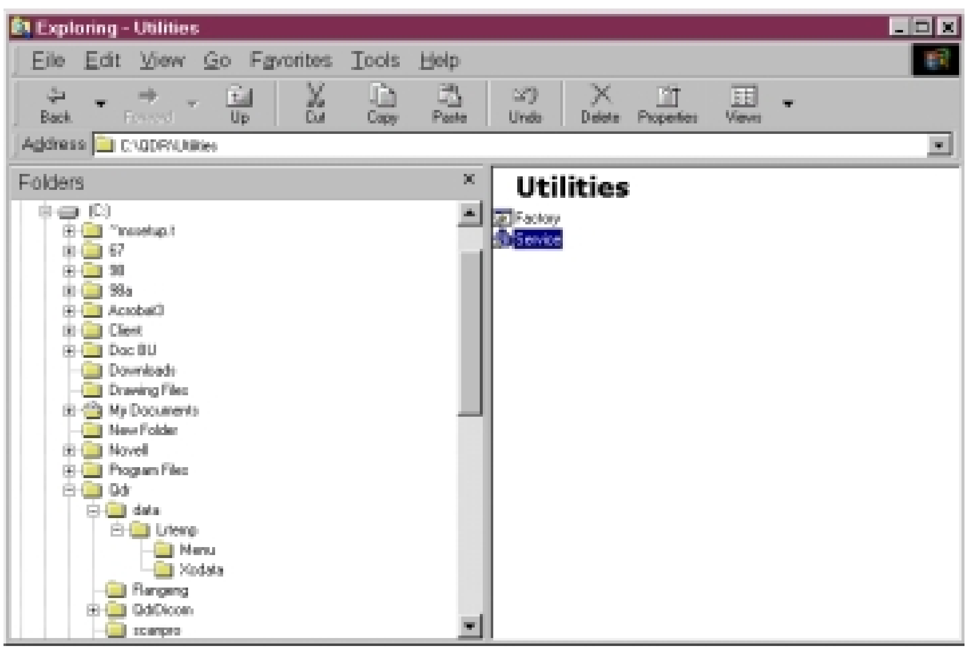
VAC. If the voltage is out of this range, recheck the voltage at the wall outlet, and the strapping of the isolation transformer as shown Figure 3-16.

STARTING QDR SOFTWARE IN SERVICE MODE

1. Exit the QDR software and select "Exit QDR without shutdown."



2. On the Windows 98 desktop, select Start, Programs, Windows explorer.
3. Execute Service.pif in the QDR/Utilities directory.



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 ±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:	Although 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 QDR main window, select Utilities, Service, X-ray survey.
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.

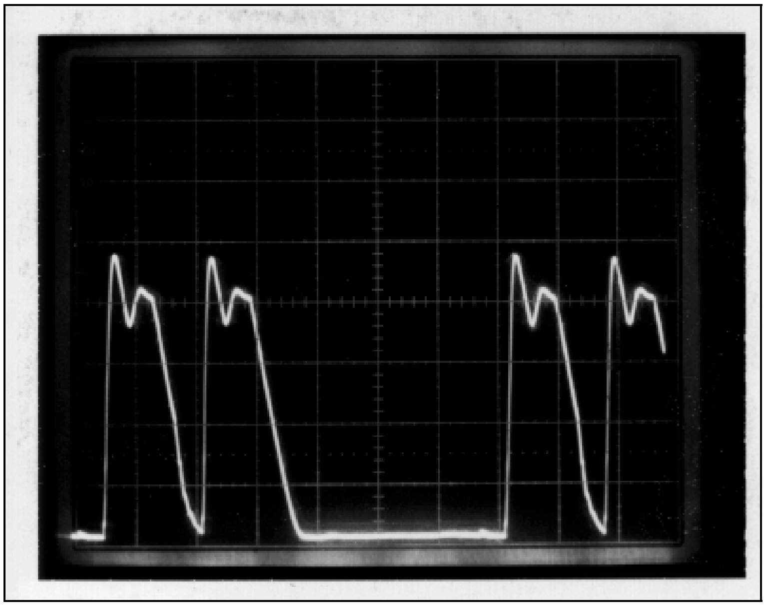


Figure 3-17. Peak Potential Mode 4

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).

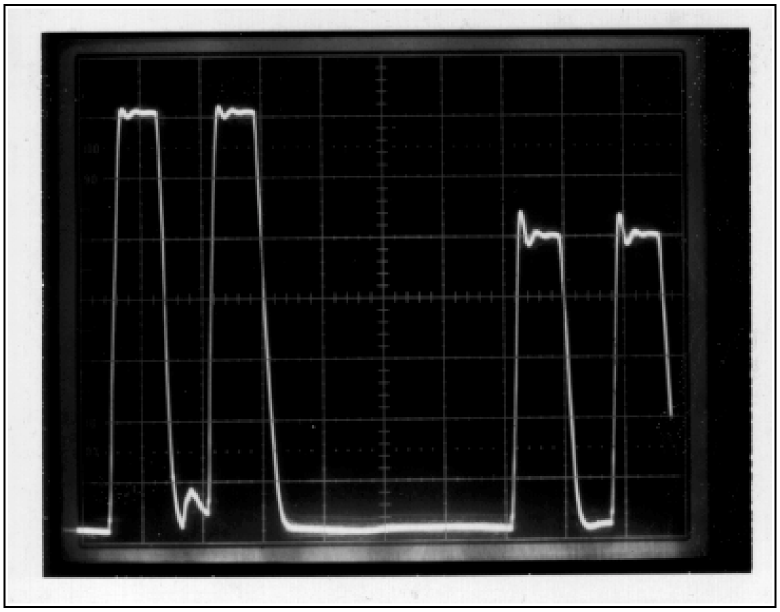


Figure 3-18. Peak Potential Mode 3

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 3-30).

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:	Although 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 QDR main window, select Utilities, Service, X-ray survey.
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 ±35% tube current.
9. Press <F2> to turn off X-rays.

Note: Enter this information into *The Radiation Measurement Report* (see page 3-30).

10. Change the X-ray Mode to 3.

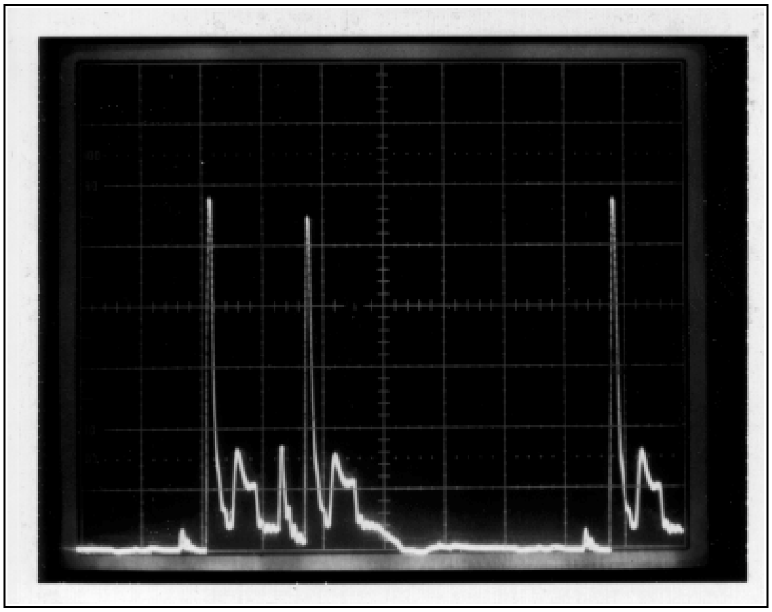


Figure 3-19. Tube Current Mode 1

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 ±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.

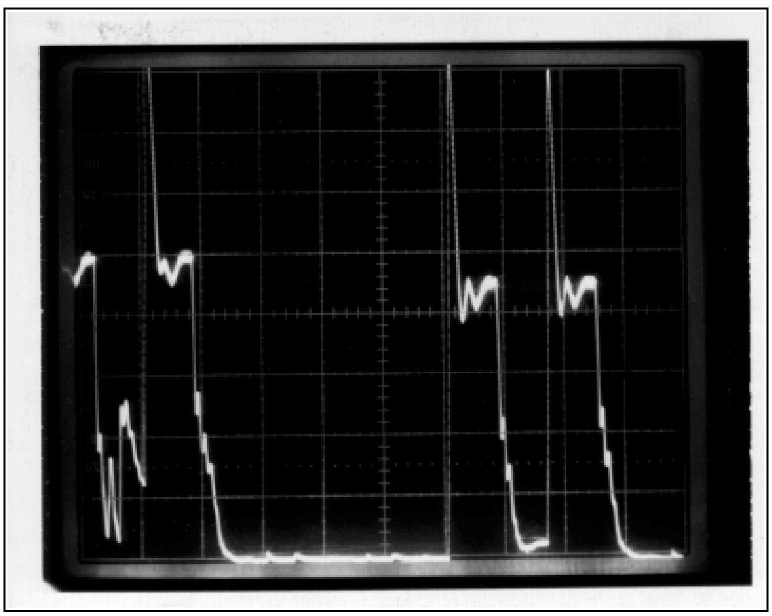


Figure 3-20. Tube Current Mode 3

Note: Enter this information into *The Radiation Measurement Report* (see page 3-30).

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 unclasping 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 go to the Service menu and select AP reposition.

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 QDR for Windows main screen, Select Perform Exam, select Spine Phantom, AP Lumbar. Start the scan. After scan starts, click reposition scan. Let arm reposition and cancel scan. Turn on the laser.

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 DETECTOR FLATTENING

This procedure flattens the X-ray beam for each scan mode. Perform the *Detector 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 detector 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 <u>*and the table mat in place*</u>. 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.
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 200μGy (20mrad).

6. Record the highest reading in the service report.

Note: Enter this information into *The Radiation Measurement Report* (see page 3-30).

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 will produce a pencil beam. If there is a crack in the lead liner, the resulting leakage will 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.

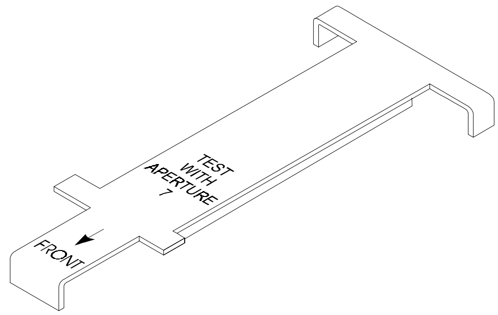


Figure 3-21. Leakage Test Shield (099-0566)

2. Be sure to start QDR for Windows software in service mode. From the QDR main window, select Utilities, Service, X-ray survey. Set X-ray mode to 3, and aperture to 7.

Initial Leakage Survey

3. Turn on X-rays by pressing the F1 key.
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 10μGy/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 10μGy/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 3-30).

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.
7. Perform an array forearm scan (if option loaded).
8. Configure and test any Dicom or networking options.

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. Restart QDR for Windows software in service mode. From the QDR Main window, select Utilities, Service Utilities, X-RAY survey. Turn on the X-rays by typing F1.
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 3-26).

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 10μGy/h (1.0mrad/h) at 2 meters (approx. 80 in.) in array AP scan mode.

9. Record the highest reading in the service report.

Note: Enter this information into *The Radiation Measurement Report* (see page 3-30).

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 Auto Scan if not already done so).
2. Analyze the 10 scans (using Auto Analyze in the Service Utilities menu).
3. Put the results in the QC database (if you have not already done so).
4. Restart in service mode, (if not already there) Go to QDR Main Window, select QC, QC Data Management, Plot. Use a start and end date that will only select the scans that you have just completed.
5. Select QC Parameter to Plot, HiA, and Plot.
6. Plot the data for the 10 scans in step 1.
7. Assure that the SD is 14 or less.
8. Repeat for "LoA" by repeating steps 4-7. This result must also be 14 or less.

Note: Enter this information into *The Radiation Measurement Report* (see page 3-30).

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:

HOLOGIC®

QDR 4500 Radiation Measurement Report

Customer Name ______________________

Customer Address ______________________

Customer Contact ______________________

Hologic Model Number ______________________

Serial Number ______________________

Date Measurement Taken ______________________

Voltage and Current Tests

Line Voltage: (choose one)

(100V) ____________ (≥90V, ≤110V)

(120V) ____________ (≥108V, ≤132V)

(230V) ____________ (≥207V, ≤253V)

Tube Peak Potential:

(80 kVp) ____________ (≥72 kVp, ≤88kVp)

(100 kVp) ____________ (≥90kVp, ≤110kVp)

(140 kVp) ____________ (≥126kVp, ≤154kVp)

Reproducibility Test:

SD Hi Air____________(≤14)

SD LoAir ____________(≤14)

Tube Current:

Mode 1 (3 mA) _________ (≥2.0mA, ≤4.0mA)

Mode 3 (10 mA) _________ (≥6.5mA, ≤13.5mA)

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

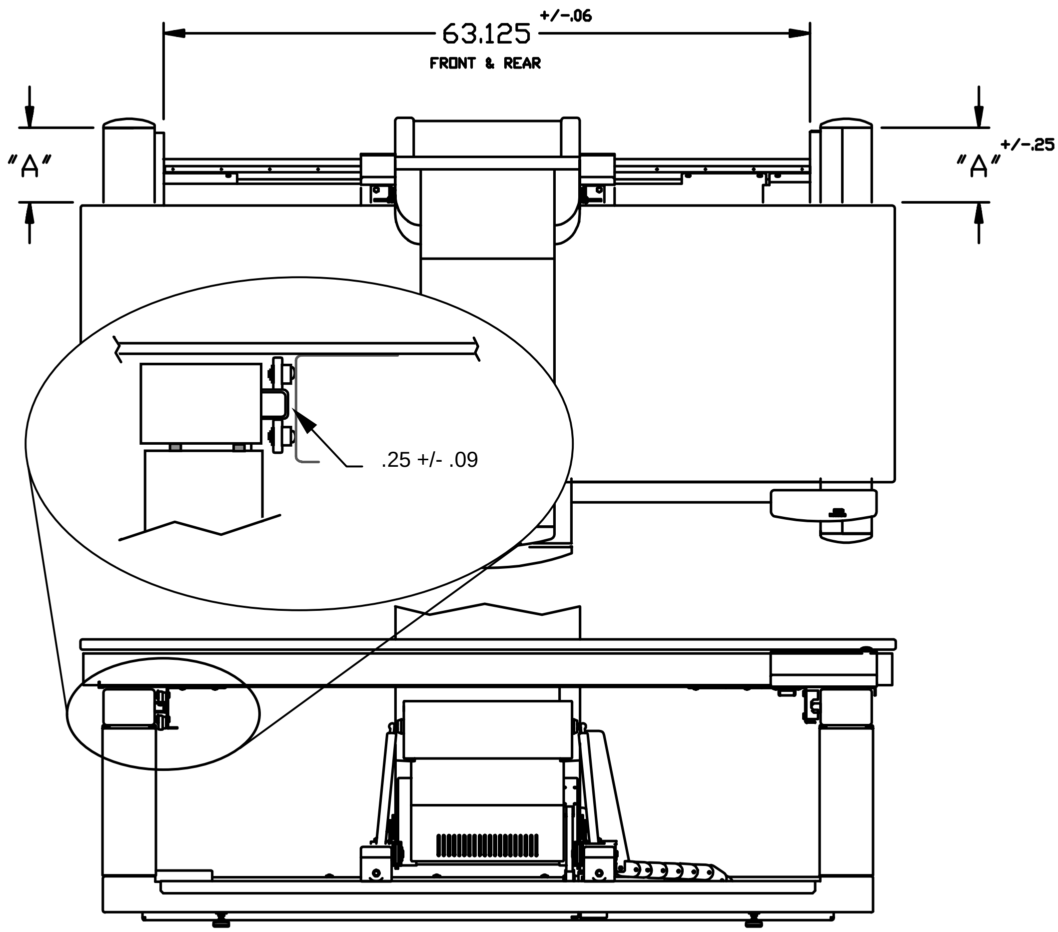
After you have taken the measurements in the Checking Table Alignment section, use the procedures below to align the table. Note that if both measurement “A” and the bracket to guide rail gap are out of specification, you should recheck the measurements after performing the first adjustment.

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.

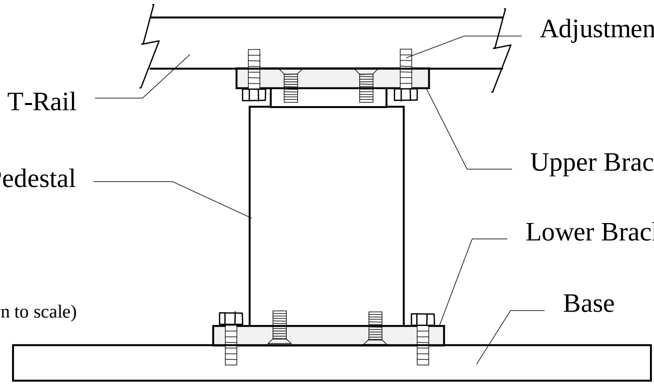


Figure 4-2. Pedestal (covers removed)

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.

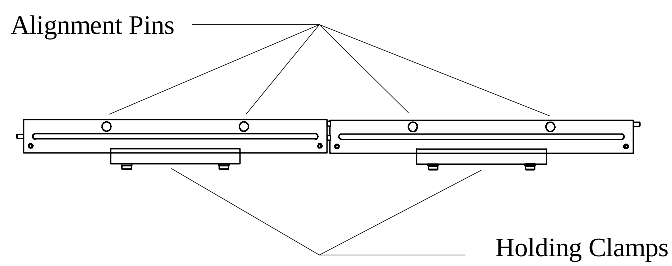


Figure 4-3. X-Ray Alignment Fixture (010-0923)

1. Go to aperture #10 (use gain of “2” for high and “1” for low; use X-ray mode “3”).
2. Restart QDR for Windows software in service mode (if not already). From the QDR Main window, select Utilities, Service Utilities, X-RAY survey. Turn on the X-rays by typing F1.
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.

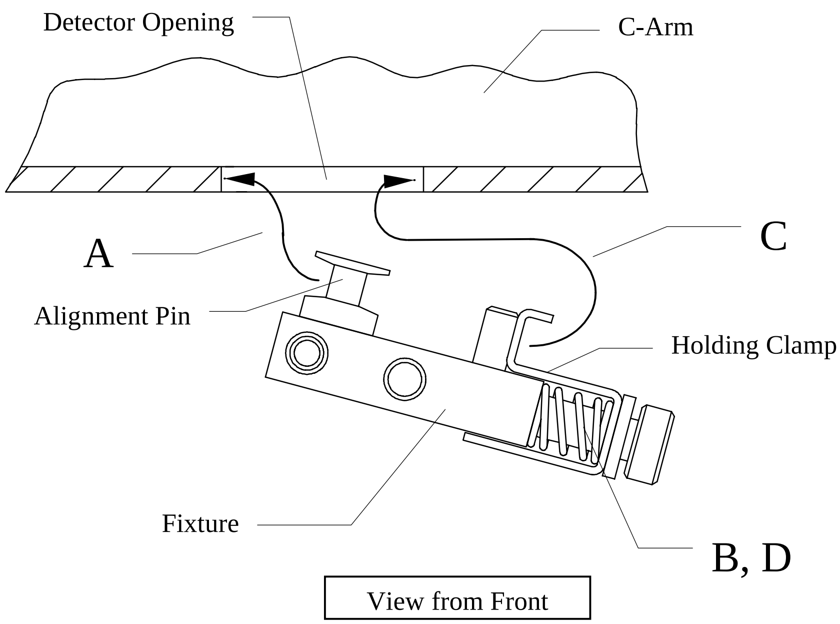
1. Remove the C-arm cover.
2. Ensure that the upper C-Arm is parallel to the table (see *C-Arm Parallelism Adjustment* in this section).
3. Restart QDR for Windows software in service mode (if not already). From the QDR Main window, select Utilities, Service Utilities, SQDRIVER. The SQDRIVER prompt is 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

   (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.



Step A. Insert the left side of the Alignment Fixture into the left side of the Detector Opening so that the vertical edges of the four Alignment Pins are secure.

Step B. Compress the Holding Clamps.

Step C. Raise the right side of the Alignment Fixture into the Detector Opening.

Step D. Release the Holding Clamps.

Note: If the Alignment Fixture is inserted with the Alignment Pins on the right, the procedure works equally well.

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

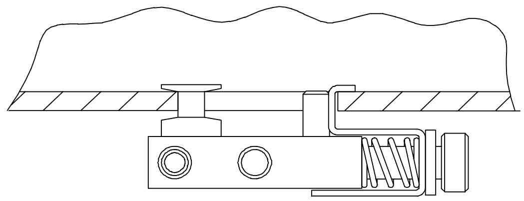


Figure 4-5. The Alignment Fixture Properly Installed

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

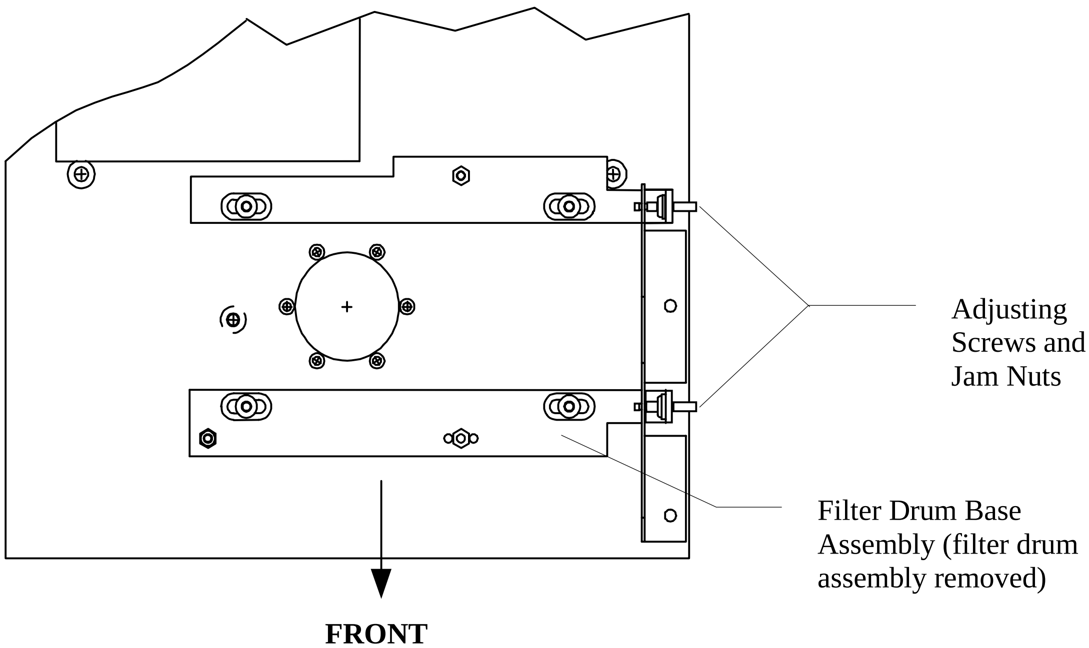


Figure 4-6. Filter Drum Adjustments - Top View

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. Restart QDR for Windows software in service mode (if not already). From the QDR Main window, select Utilities, Service Utilities,X-ray Survey. 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.

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.

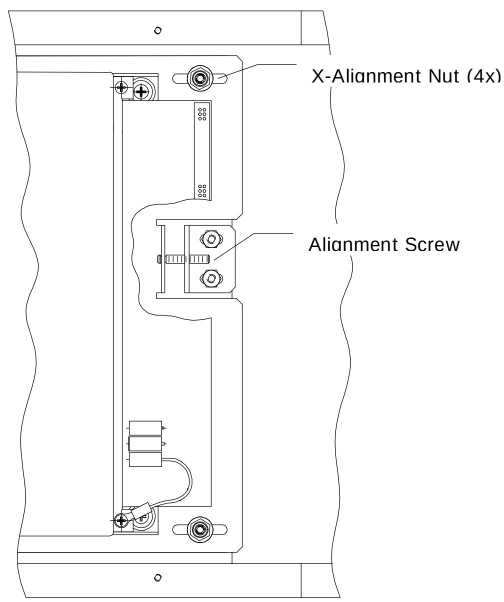


Figure 4-7. Array Assembly - Top View, Partial

The next six 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. Press ESC to exit Survey and return to QDR for Windows.

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. Restart QDR for Windows software in service mode (if not already). From the QDR Main window, select Utilities, Service Utilities, X-Ray Survey.

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. If not running, return to X-Ray Survey, <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 three steps adjust the beam side to side.

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.

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 seven 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. Press the Esc key to exit from X-Ray Survey.

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. From the QDR Main window, select Utilities, Service Utilities, SQDRIVER.
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.

1. From the QDR Main window, select Utilities, Service Utilities, SQDRIVER (must be in service mode).
2. 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] ?

The xx.x equals the measurement you typed in above. If you type N, the system redisplays 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 ± 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, 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.

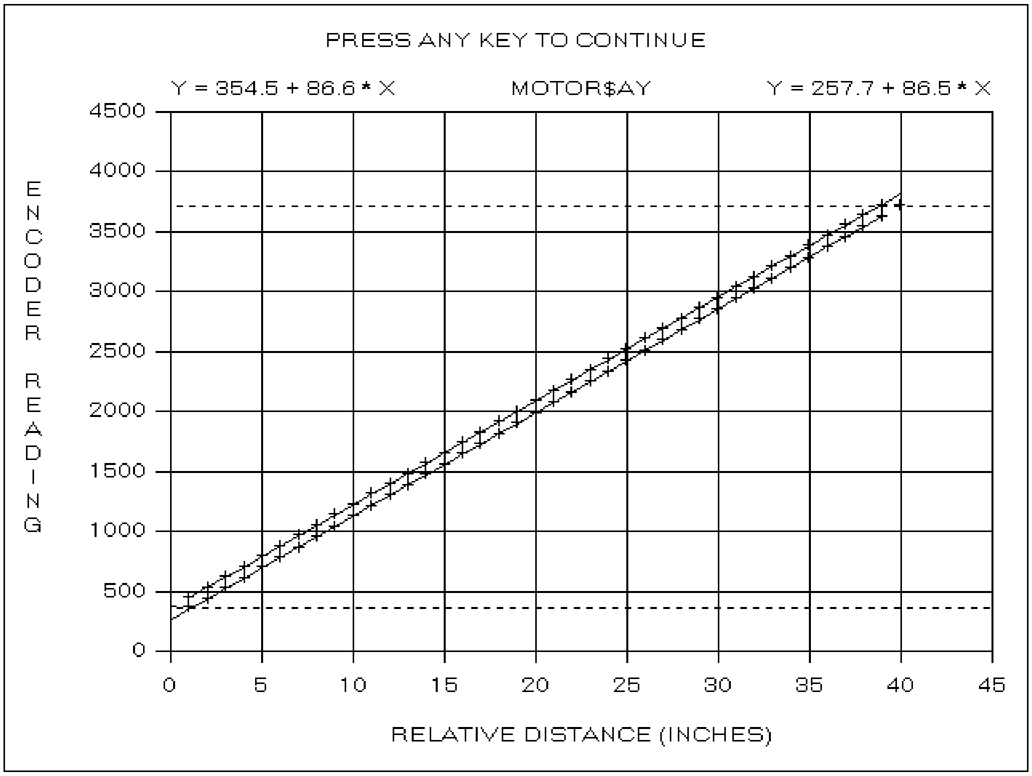
5. When AY hits the right mechanical stop, press <Enter>.

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).

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 = Intercept + 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:

1) **1** (Tolerance). The ± 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 ≅ 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 ≅ 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.

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, 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.

```
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>**.

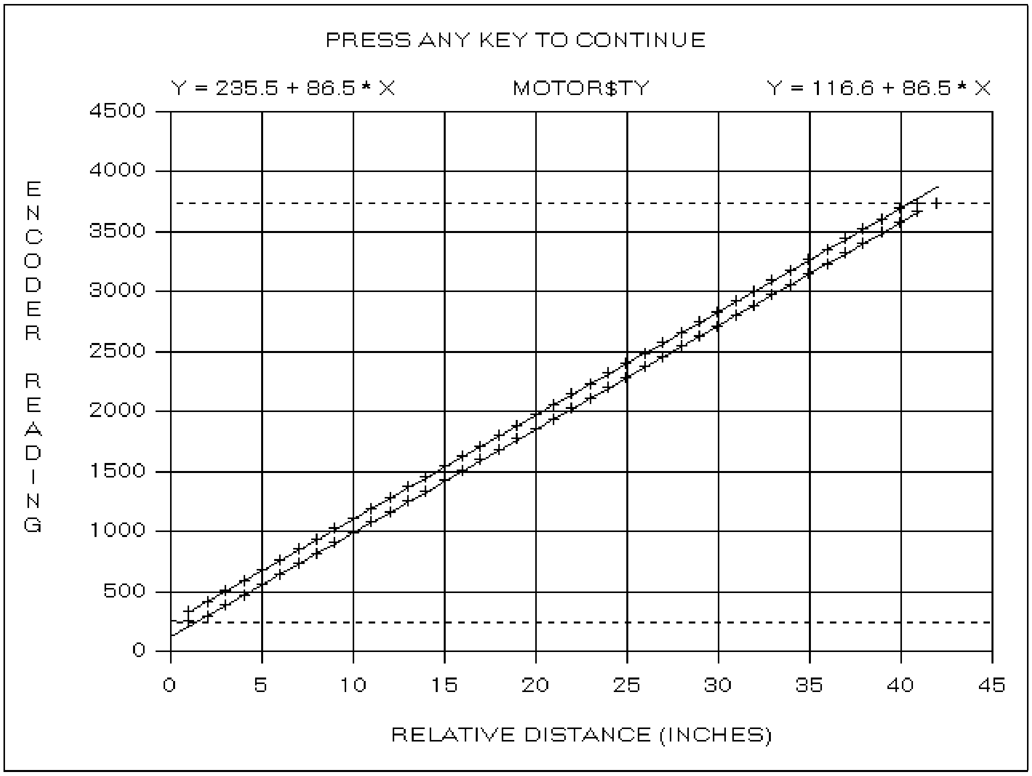
The program then starts TY moving to the right and prompts

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 = Intercept + 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.

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.

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 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 (±0.1°). 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.

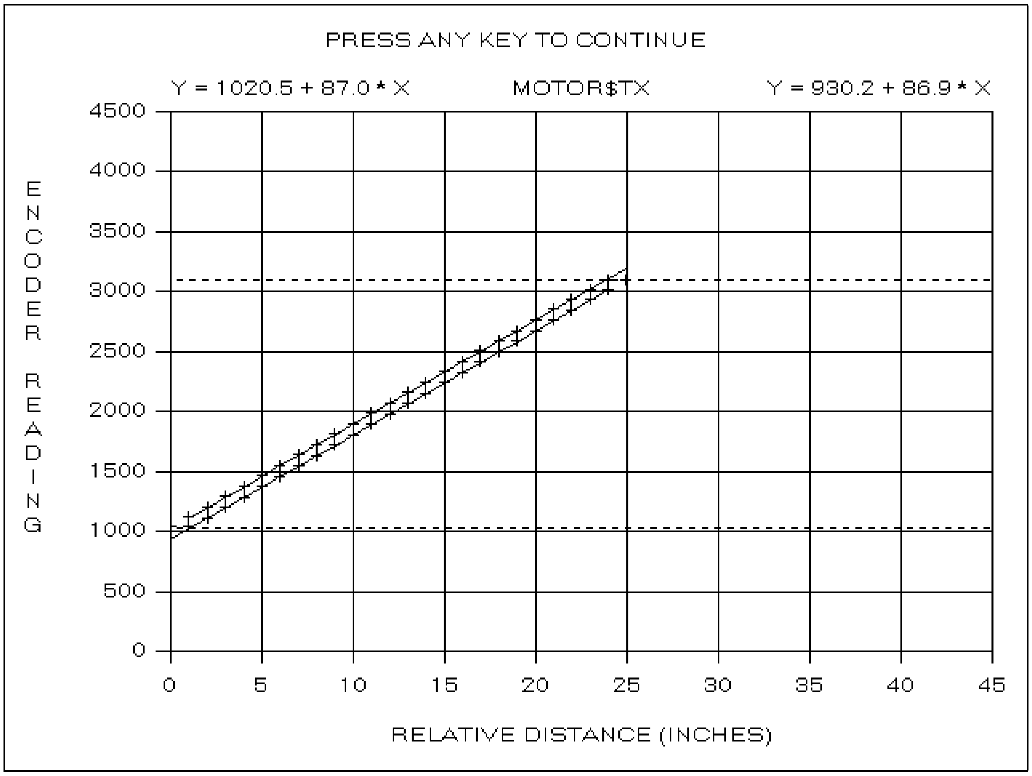
Repeat the calibration procedure above but now, when TX hits the outer mechanical stop,

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>
```



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 = Intercept + 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.

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, 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 ±0.1°.

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.

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 0º 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 ±0.1º. 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°±0.1º (do ***not*** make this measurement with the cosmetic covering on the tank assembly).

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

The program prompts:

Press <ESC> to stop calibration.

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

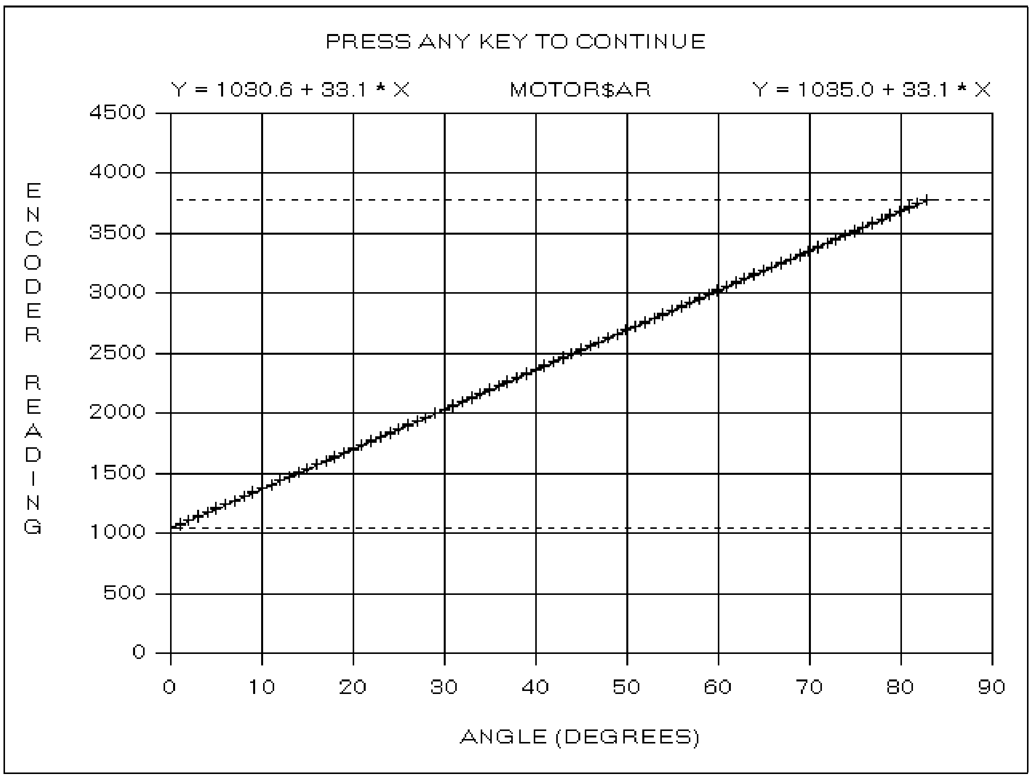
The program then switches to graphics mode and draws the Encoder Vs Angle calibration grid. It steps the AR motor clockwise in 1° increments until the motor reaches the 83° position and then steps the AR motor counter clockwise in 1° increments until the motor return to approximately 0°. The program 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 = Intercept + 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:

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] ?

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 ± 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 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.

Exit SQDRIVER by typing exit and hitting return.

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.

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 QDR for Windows main screen, Select Perform Exam, select Spine Phantom, AP Lumbar. Start the scan. After scan starts, click reposition scan. Let arm reposition and cancel scan. Turn on the laser.

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, Restart QDR for Windows software in service mode (if not already). From the QDR Main window, select Utilities, Service Utilities, X-Ray Survey.
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. (Alt-S)
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.

DETECTOR 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. Restart QDR for Windows software in service mode (if not already). Press center table button and turn 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. Select Utilities, Service Utilities, X-Ray Survey.
4. Set Pulse 1.
5. Set Gains 2, 1.
6. Set Mode 3.
7. Set Aperture to 7 (this step for QDR 4500A and SL only).
8. Bring up graphic display. CTRL PGDN
9. Turn on X-rays and observe the screen.
10. 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.
11. Turn off X-rays. Press ESC to return to QDR Main Screen.
12. Select Utilities, Service Utilities, Detector Flattening. Select Continue. This procedure can takes about 30 minutes, depending on system model.
13. When flattening is complete, run a QC scan and cancel adding it to the QC plot.

14. Select Perform Exam, selct the phantom, and run an AP/Lateral pair. Use a scan lenght of six inches.
15. Select each analyzed scan, and check each for flattness using the image display tools.

TABLE TOP RADIOGRAPHIC UNIFORMITY

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). Select Exit Exam when complete.

   Make sure that only the pad is on the table. Clear the table of anything else.

Note: Do NOT interrupt the scan for any reason.

3. Restart QDR for Windows software in service mode (if not already). From the QDR Main window, select Utilities, Service Utilities, Table Top Radiographic Uniformity.
4. Select the Whole Body scan, and click next.
5. Table Top Radiographic Uniformity results tabs are now displayed. Select the Low Air Tab.
6. Print the results and include with paperwork.

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

If the Global StatsS.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 Detector Flattening (page4-28).
- Re-run daily QC (see the *QDR 4500 User's Guide).*

After realignment, repeat the Table Top Radiographic Uniformity test. If the global S.D. is less than 2.0, you are done. If the global S.D. if 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. In the S.D. is equal or greater then 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.

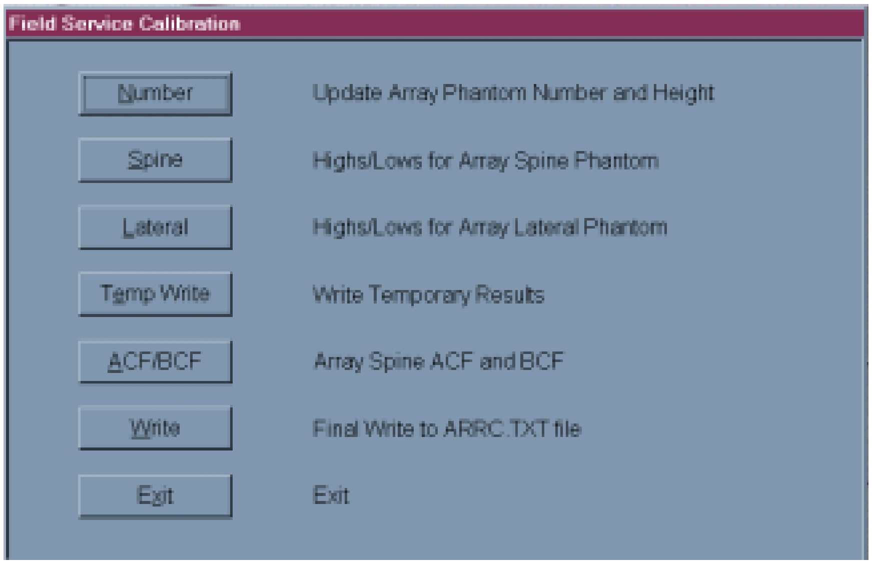
LATERAL ALIGNMENT TEST (QDR 4500A AND SL)

This procedure verifies lateral alignment.

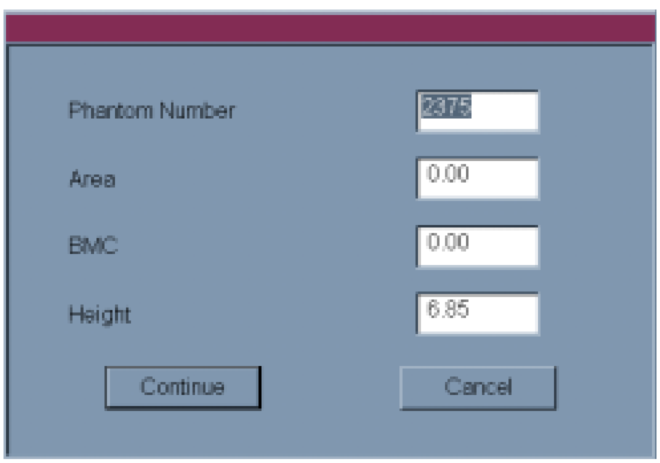
1. Press Center Table on the control panel to move the table and C-Arm to the center position.
2. Press Laser on the control panel to turn the laser light on.
3. Place the spine phantom on the table top so the laser is on the laser target and the vertebrae are to the right of the laser (use the same target used for normal QC scans).
4. Select Perform Exam.
5. Select Spine Phantom.
6. Select OK at patient Confirmation Screen..
7. Select AP/Lateral Pair. Uncheck Use Default Scan Mode.
8. Select Array and click next.
9. Select Array at the Select Lateral Scan Mode for AP/Lateral Exam screen
10. Continuously press The Enable Swicth to move the system into position.
11. Verify Laser alignment and click continue.
12. Change Scan Length to six inches and click start scan.
13. When scan has finished, select Lumbar spine with centerline as the analyis method, and click next.
14. Analyze the scan, and click start position. Check at bottom of screen that the centerline angle is + or – 2 Degrees.
15. Click close, and then hold the enable button to lateral position.
16. Click Start Scan to perform exam.
17. Press and hold the Enable switch to return to AP position.
18. Analyze scan (refer to user guide for Lateral analysis) and close the screen.
    - At the Exit Analysis screen, select Report. Print a report of the Lateral scan just performed.

CHECK PHANTOM VALUES

1. Start Field Service Calibration in the service utilities menu.
2. Select Number.



3. Compare values displayed with actual values printed on the phantom. If there is a discrepancy, check to make sure you have the proper phantom that shipped with the unit.



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 For Windows perform exam button, 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. Center the table, place the phantom on the table and set up a exam using the AP/Lateral setup, uncheck the use default scanmode box,click next, select Array scan mode for the AP component and Fast Array for the Lateral component. The sides of the phantom should be aligned parallel to the table, using a ruler if necessary.
3. Press and hold Enable until the arm and table move into position. Recheck phantom alignment with laser, and click continue.

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

4. Change the scan lenght to 6 inches, and click start scan to begin the AP component.
5. When scan has finished, select Lumbar spine with centerline as the analyis method, and click next.
6. Analyze the scan, and click start position. Check at bottom of screen that the centerline angle is + or - 2 Degrees.
7. Click close, and then hold the enable button to lateral position..
8. Click Start Scan to perform Lateral component.
9. Press and hold the Enable switch to return to AP position.
10. Analyze scan (refer to user guide for Lateral analysis) and close the screen..
11. Click exit to close the Exit Analysis screen.

12. Restart QDR for Windows software in service mode (if not already). From the QDR Main window, select Utilities, Service Utilities, Field Service Calibration.
13. Select Highs/Lows for Array Spine Phantom
14. Select the AP scan just performed and click next
15. Click continue on the Caculated highs and lows page.
16. Select Highs/Lows for Array Lateral Phantom.
17. Click continue on the Caculated highs and lows page.
18. Click Temp Write to write temporary results and click continue to exit the write dialog box.

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

1. Press Center Table.
2. Turn on the laser.
3. 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.

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.

4. From the QDR for Widows main menu select Perform Exam, Select the Spine Phantom, click OK at patient information dialog box, .
5. Select AP Lumbar Spine, Uncheck default scan and click next.
6. Select Array and click next, set scan lenght to 6 inches and start the scan.
7. Analyze the scan. Exit Analysis.
8. Start the Field Service Calibration program by selecting Utilities, service utilities, Field service calibration.
9. Select Spine Highs/Lows for Array Spine phantom option and to calculate the new thickness indicators for array spine mode.

12. Select the Spine Phantom scanned in step 6 from the list of Analyzed Scans and click Next. Click Continue on the Successfully Calculated message box.
13. Click on Temp Write and click Continue on the Successfully Wrote message box. Exit FSCAL.

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. Restart Eagle software in service mode (if not already). Center table. From the QDR Main window, select Utilities, Service Utilities, AP reposition. Return to the service utilities menu and selct Auto Scan.
2. Select Spine Phantom.
3. Click OK at Patient Confirmation dialog box.
4. Select AP Lumbar Scan Type, input 20 for number of scans, uncheck Use Default, and click next.
5. Select Array and click next.
6. Analyze the first scan. Note the scan #. Click close then exit analysis.
7. From the QDR Main window, select Utilities, Service Utilities, Auto Analyze.
8. Click on unanalyzed Scans and select the 19 scans, click on compare and then next.
9. Now select the analyzed scan from step 6, then click next.
10. The 19 scans will now be compared with the analyzed scan.
11. From the QDR Main window, select Utilities, Service Utilities, Field Service Calibration.
12. Select ACF/BCF. Select the 20 scans and click next, and then continue at the Successfully calculated dialog box.
13. At the FSCAL dialog box, click "Write" to write the values to Arrc.txt. Click contine to return to the QDR main screen.
14. Print Arrc.txt by using these steps:
    - Press CTRL and ESC.
    - Select Find
    - Select Files or Folders
    - Type Arcc.txt in Named
    - Click Find Now or Hit enter
    - Right Click on the first Arrc.txt and select print. (QDR\DATA dir NOT QDR\DATA\LRTEMP)
15. Verify ACF=ACFL=ACFT and BCF=BCFL=BCFT in ARRC.TXT.

RECALYZE and Add 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. From the QDR Main window, select Utilities, Service Utilities, Auto Analyze.
2. Select Analzyed scans, click RECALYZE and select the 20 scans just acquired and click next.
3. The scans will now be recalibrated.
4. From the QDR main screen, select QC, QC Data Management, Select Scans.
5. Highlight the scans from the Excluded list and click Include Scans, and then Finish. (Selection is easier if you click Scan Date to order the scans by date and time).
6. Select the PLOT option (also under the QC, QC Dtat Management 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 Elite Windows Version 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 patient database and asks if one should be initialized if none is found.
COMMAND /C QCINIT /E:512	-	Checks for the presence of a QC 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 **always** 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

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 **array** (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.

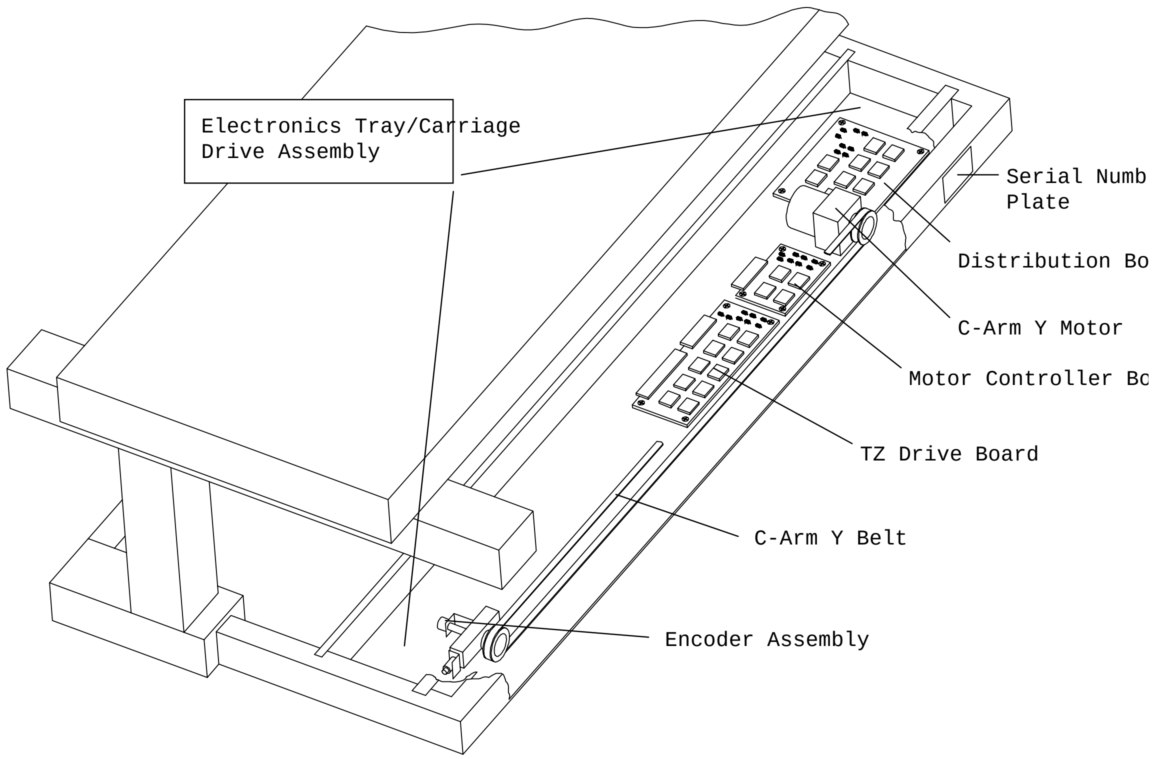


Figure 5-1. Electronics Tray FRUs

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 QDR for Windows main screen 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.

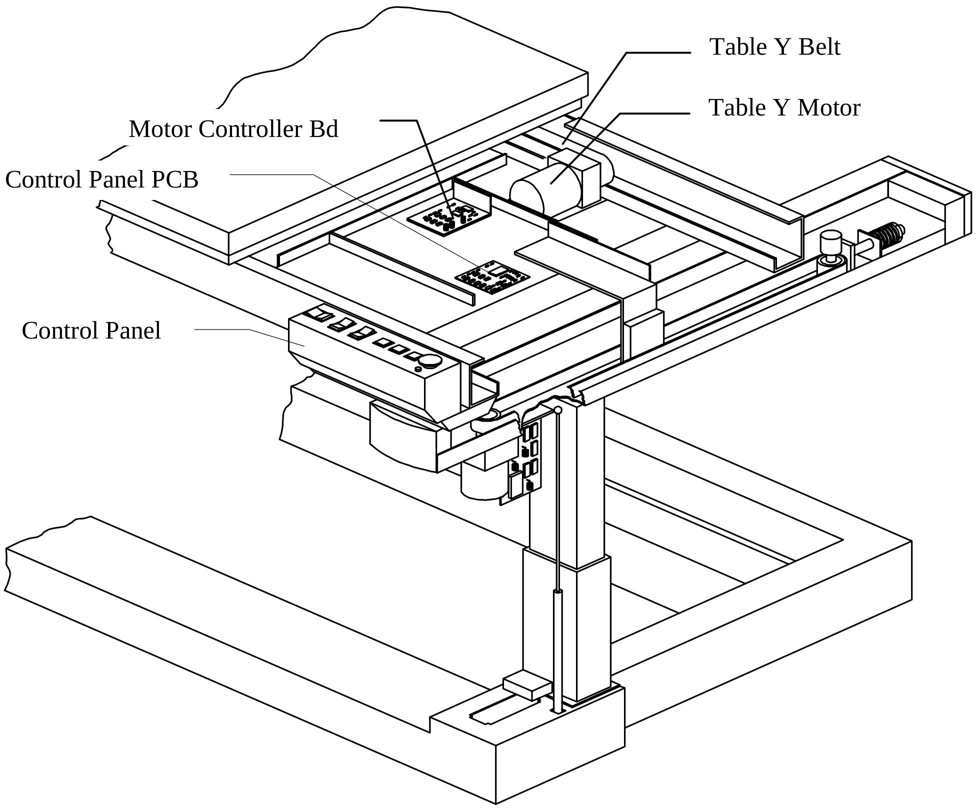


Figure 5-2. Control Panel and Table Y FRUs

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.

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.

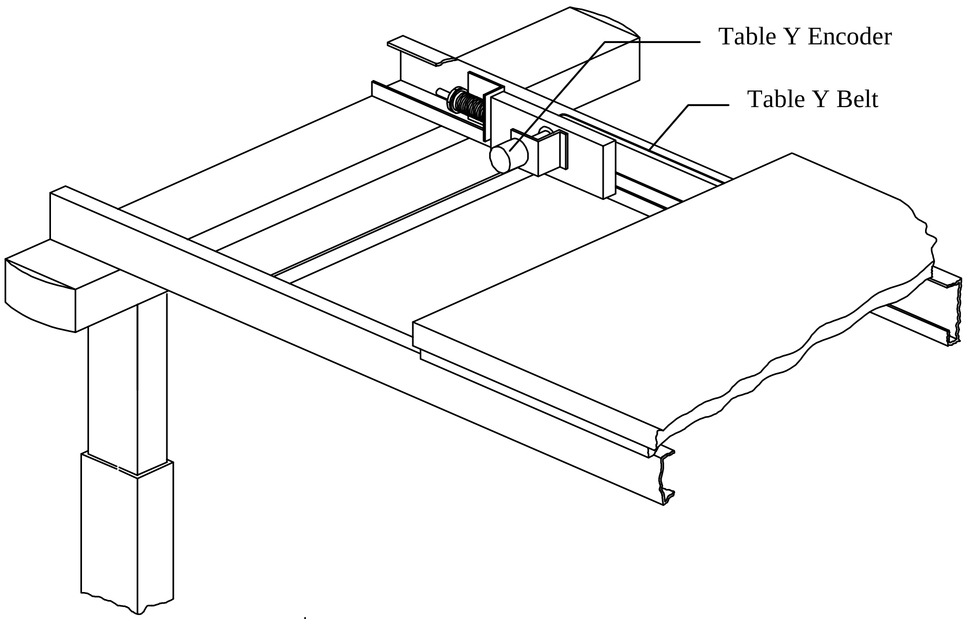


Figure 5-3. Left Side Table Y FRUs

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.

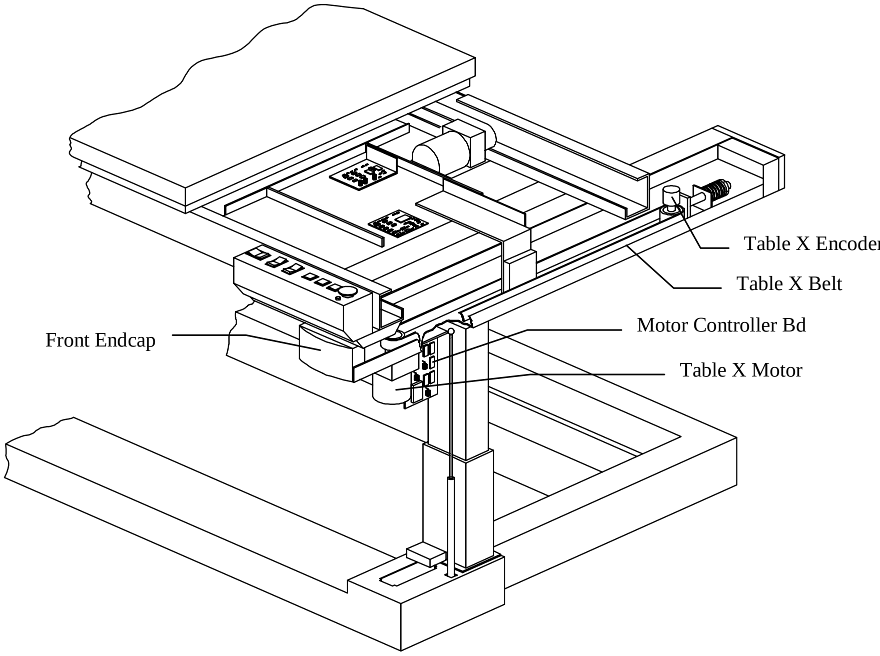


Figure 5-4. Table X FRUs

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 QDR for Windows main screen 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 QDR for Windows main screen 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 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.

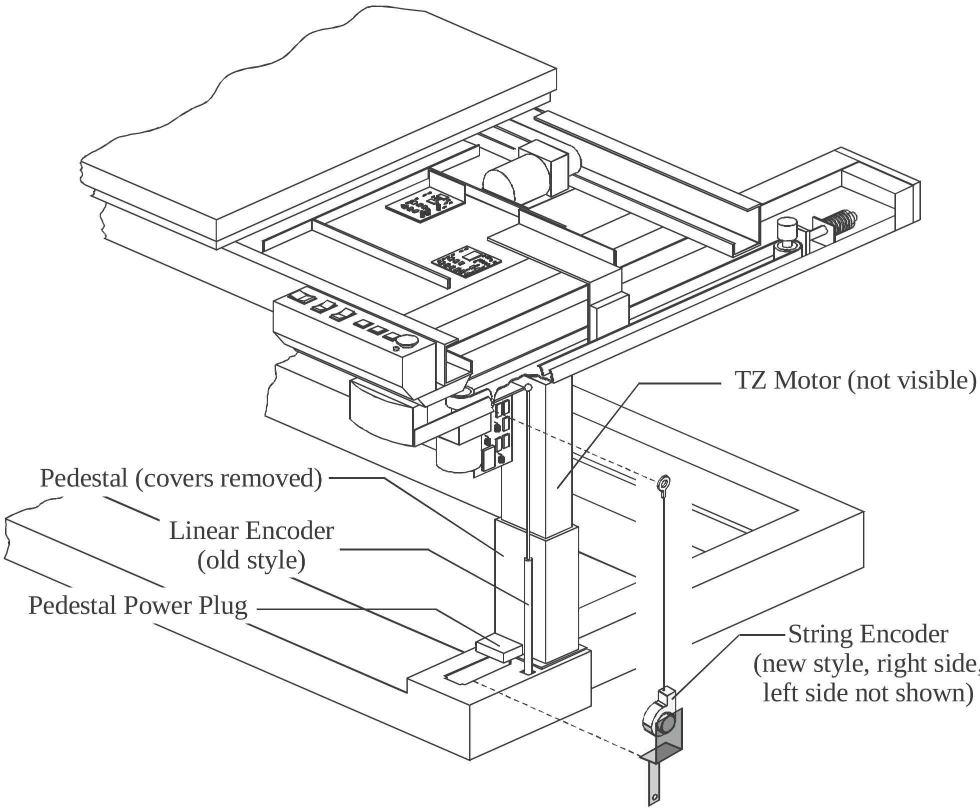


Figure 5-5. Table Z FRUs

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.

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. From the Service Utilities menu, select 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.

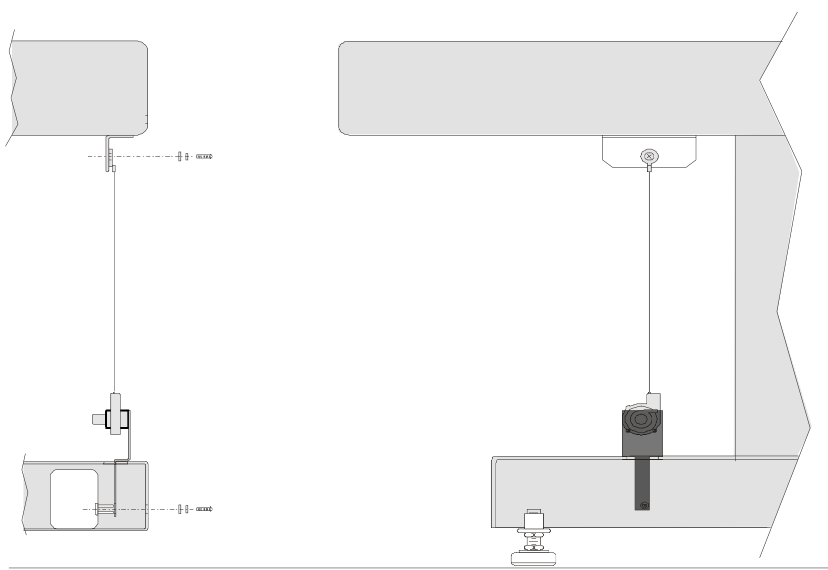


Figure 5-6. Installing the Rotary String Encoder

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 QDR for Windows main screen by choosing **Utility**, followed by **emergency Motion**.

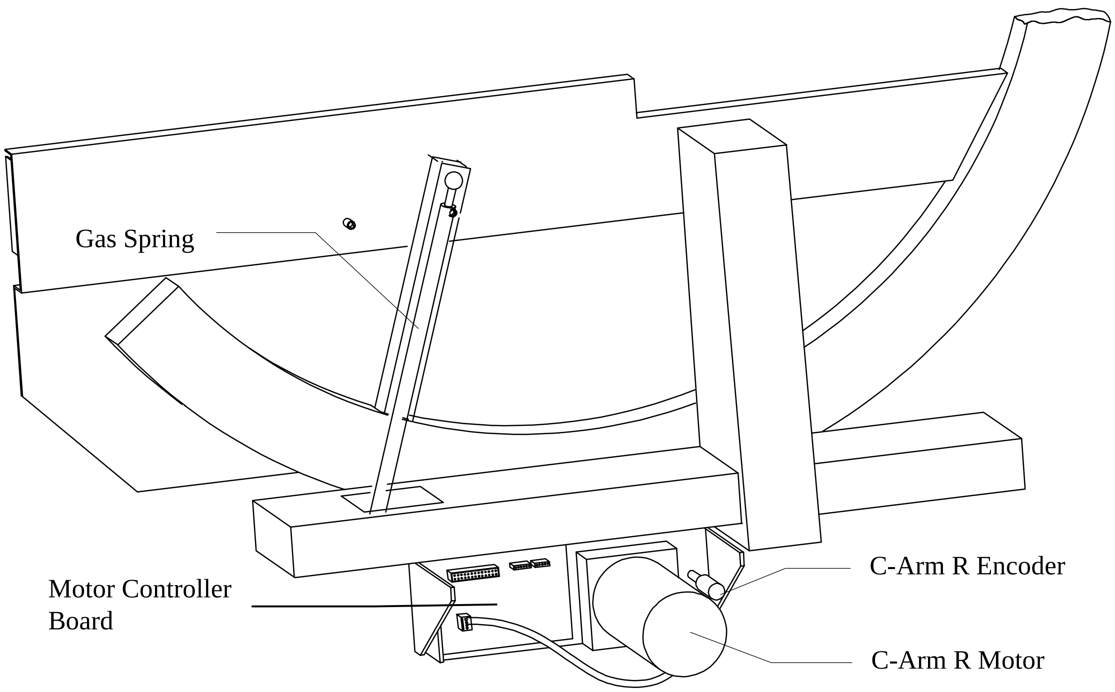


Figure 5-7 C-Arm R FRUs (Outside View)

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.

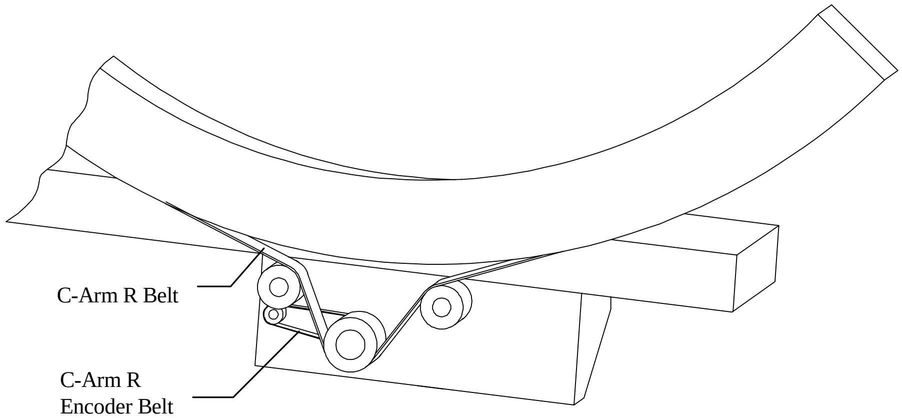


Figure 5-8. C-Arm R FRUs (Inside View)

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:

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.

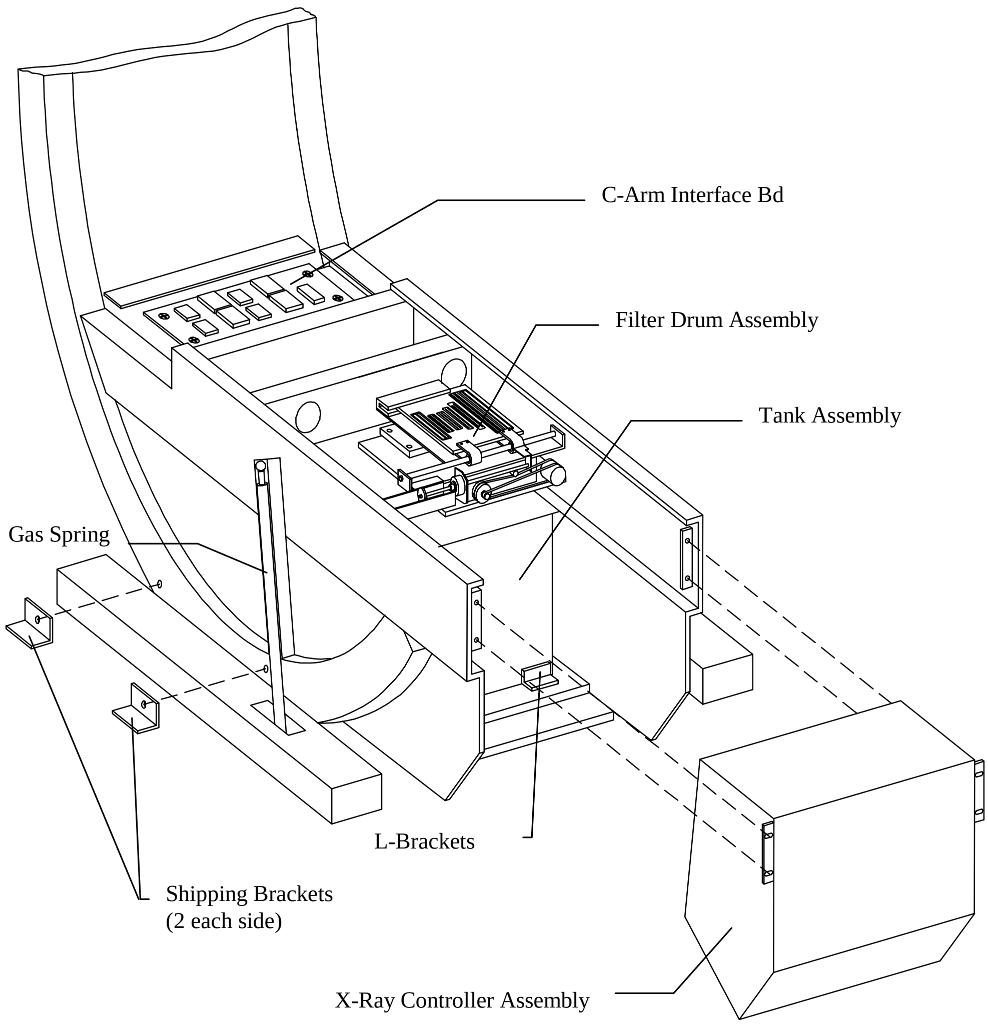


Figure 5-9. Lower C-Arm FRUs

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 X-Ray 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).

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 Detector 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:

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

1. Using the Motor Control Pad, move the table up and in as far as it will go, for easier access.
2. Using X-Ray 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).

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.

7. Lock the C-arm in place be 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.

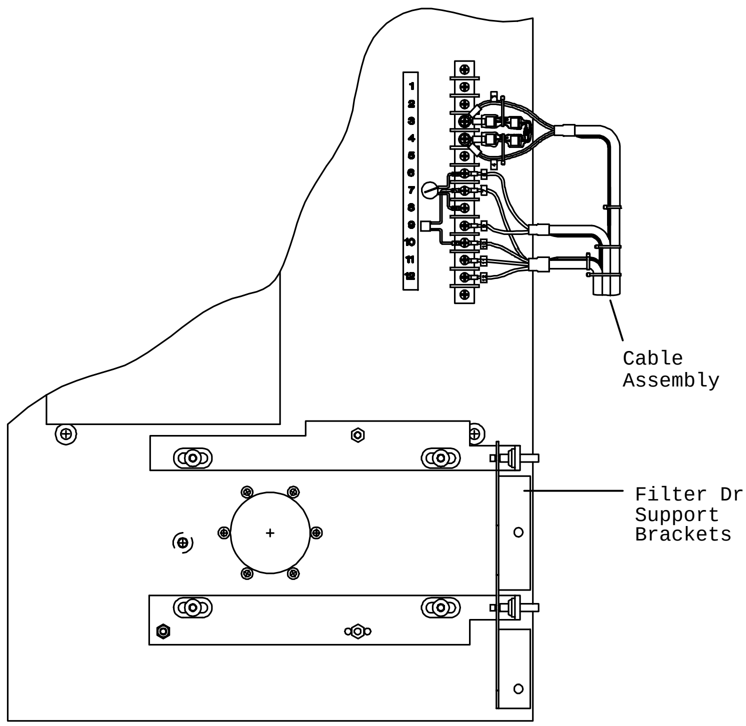


Figure 5-10. Top View of Tank

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.

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 Detector Flattening in the *Alignment and Calibration* section of this manual.

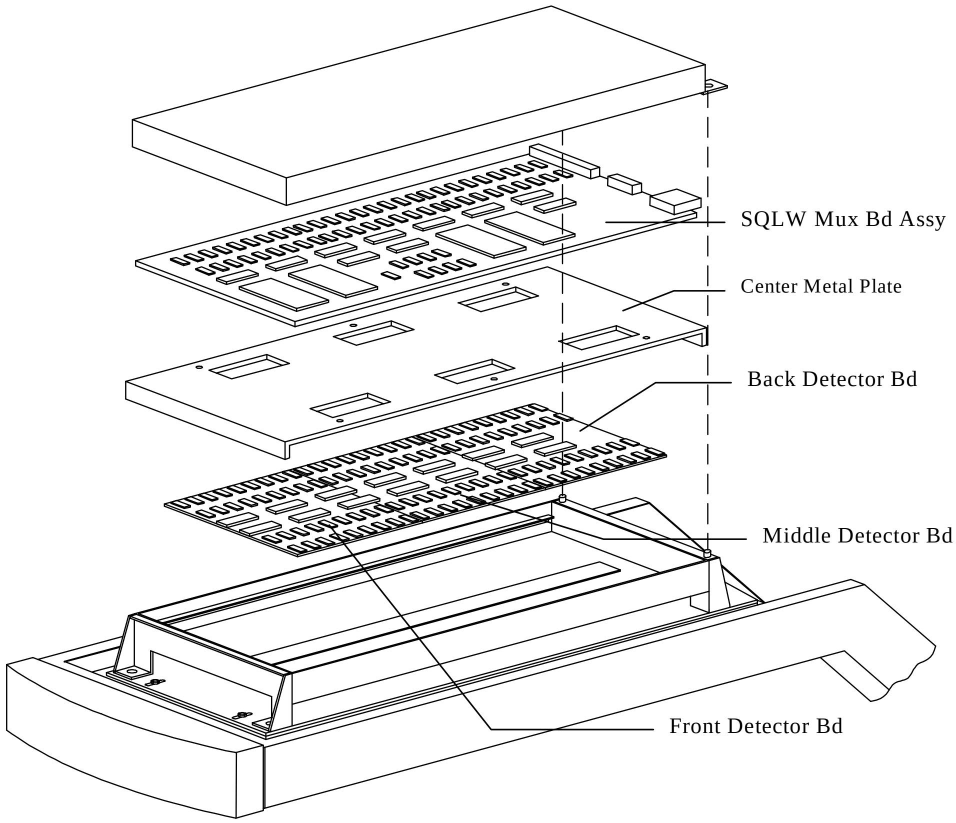


Figure 5-11. Upper C-Arm FRUs

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 Detector Flattening in the *Alignment and Calibration* section of this manual.

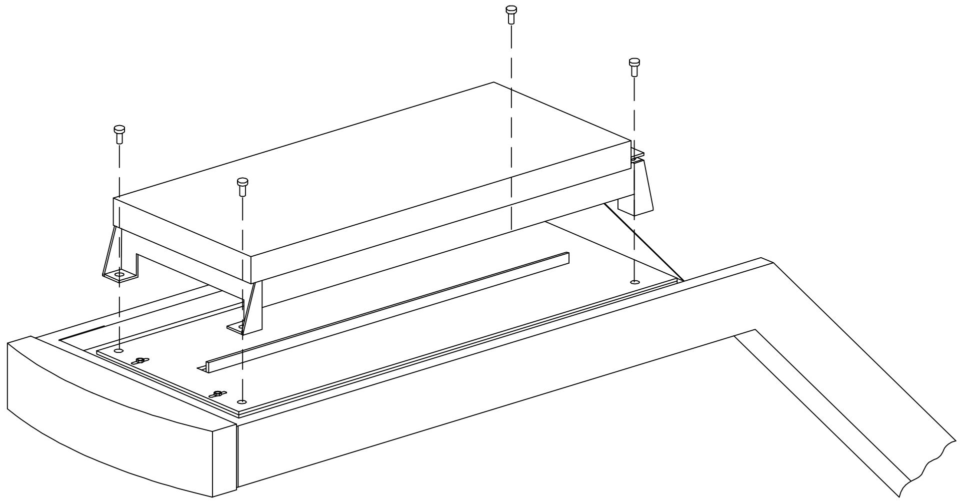


Figure 5-12. Detector Assembly Mounting

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.

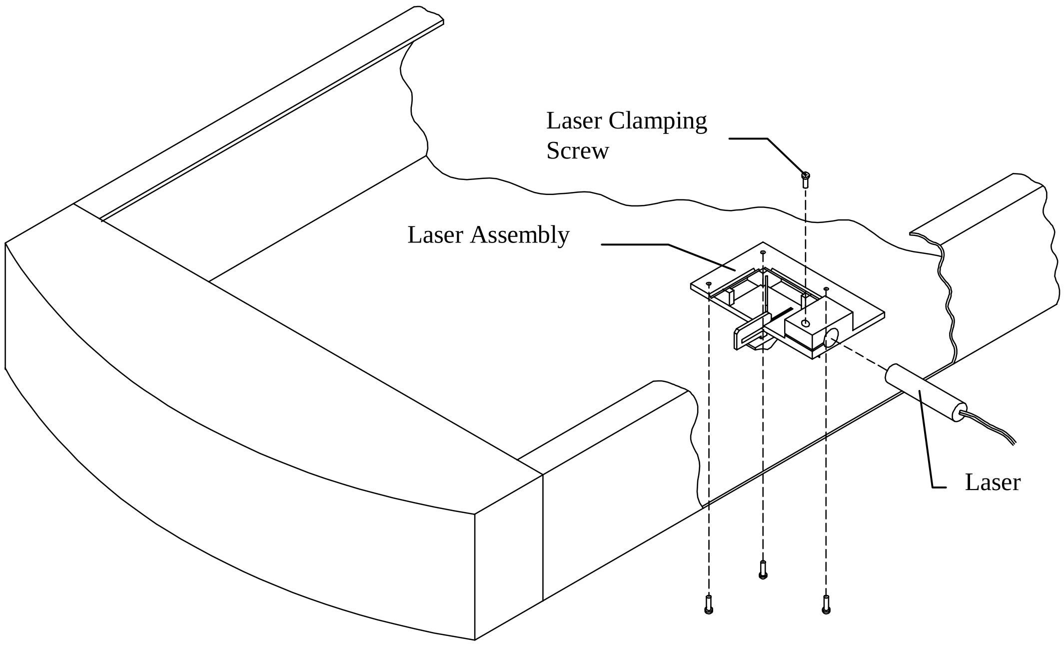


Figure 5-13. Laser Assembly

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.

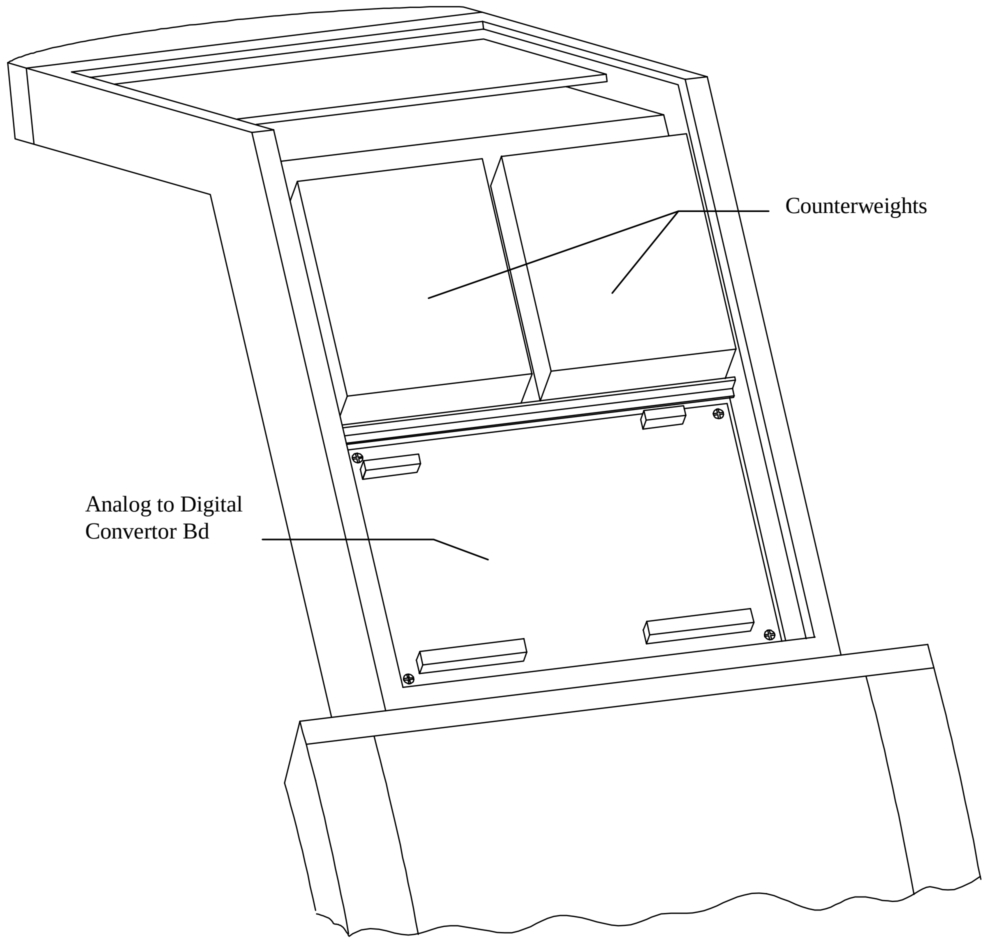


Figure 5-14. Rear C-Arm FRUs

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 Detector 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.

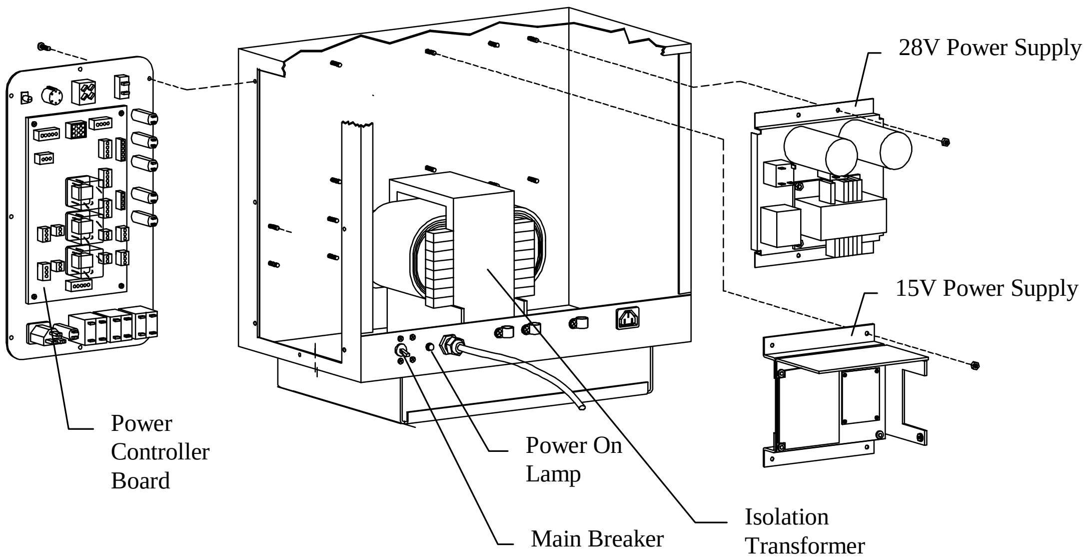


Figure 5-15. Power Module FRUs

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.

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.

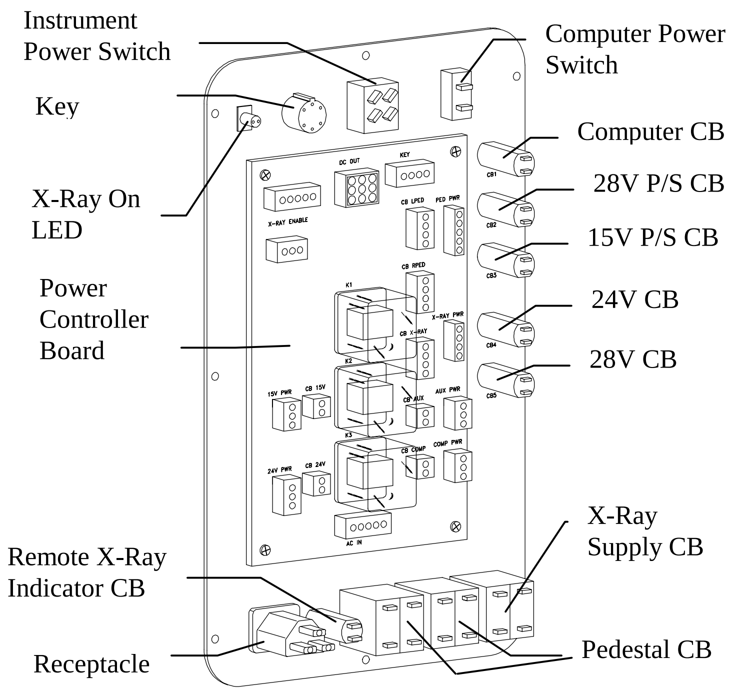


Figure 5-16. Power Control Panel FRUs

5. Remove 4 Phillips screws and slide the board out.
6. Reverse the steps to install the new Power Controller Board.

OPERATOR'S CONSOLE FRUS

The Operator's Console FRUs, computer, keyboard, monitor and printer, are located on the computer stand (see Figure 5-17). If replacement is necessary, the keyboard, monitor or printer are replaced as an entire unit. Refer to the computer service manual for computer servicing information.

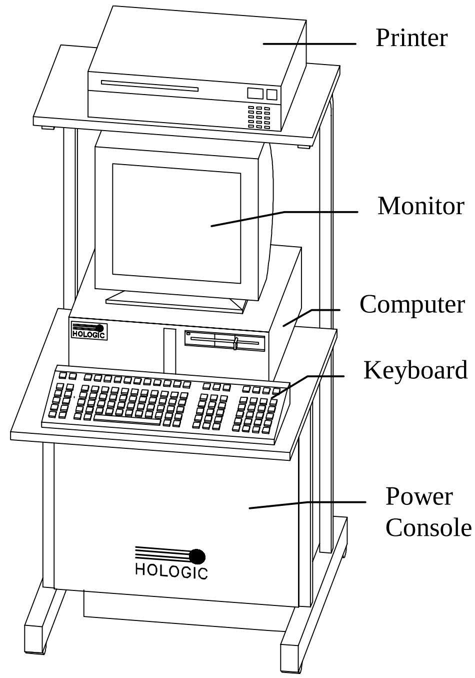


Figure 5-17. Operator's Console Assemblies

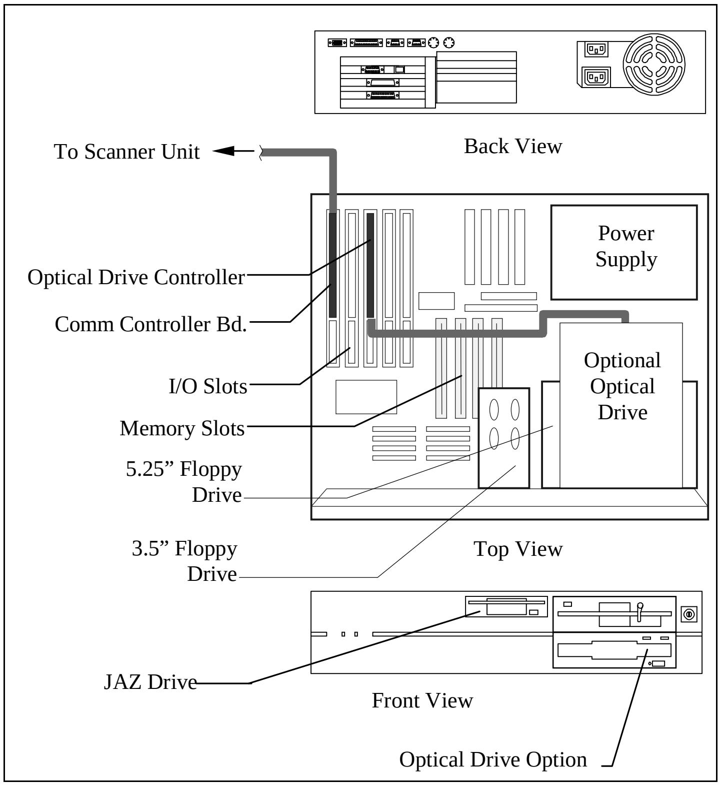


Figure 5-18. Computer Assemblies

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.

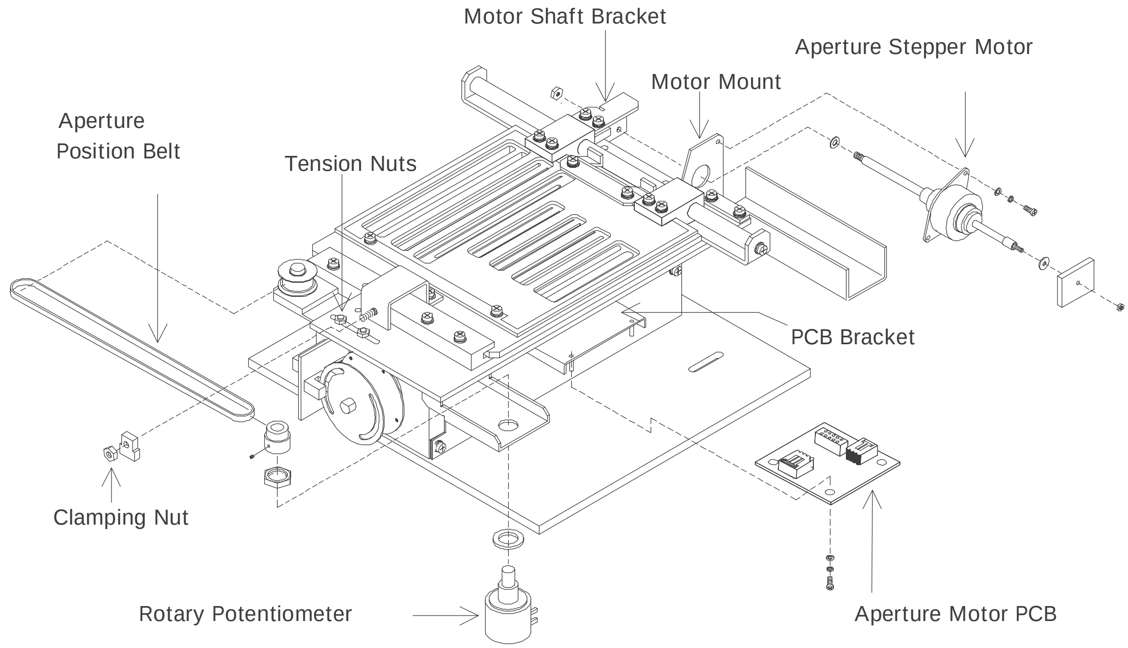


Figure 5-19. Aperture Assembly FRUs (QDR 4500A and SL)

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.

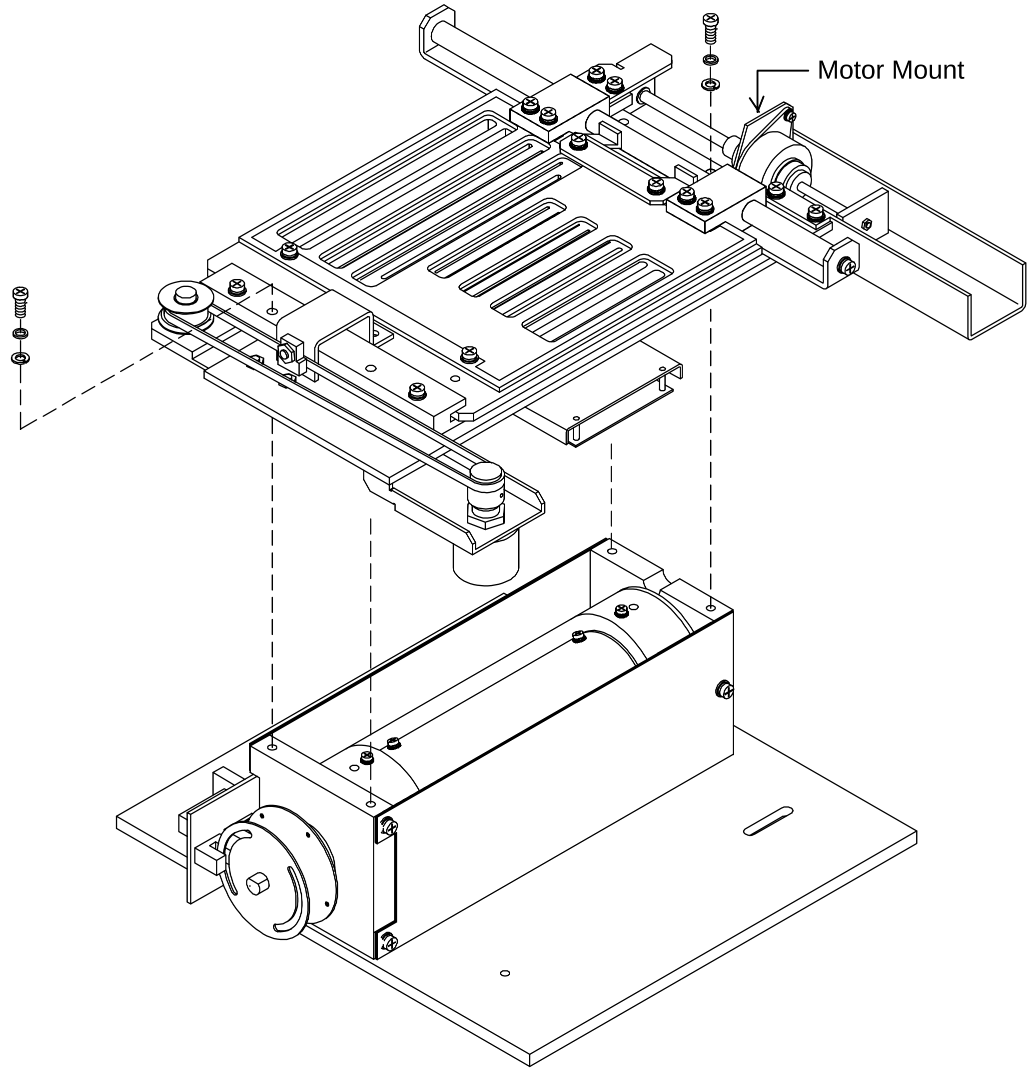


Figure 5-20. Aperture Assembly Removal (QDR 4500A and SL)

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.

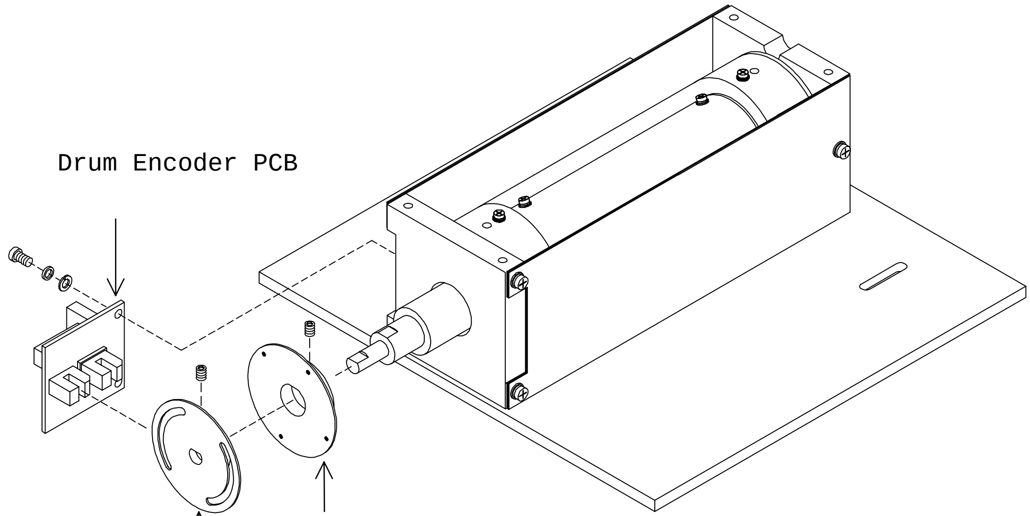


Figure 5-21. Rear Drum Assembly FRUs

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.

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

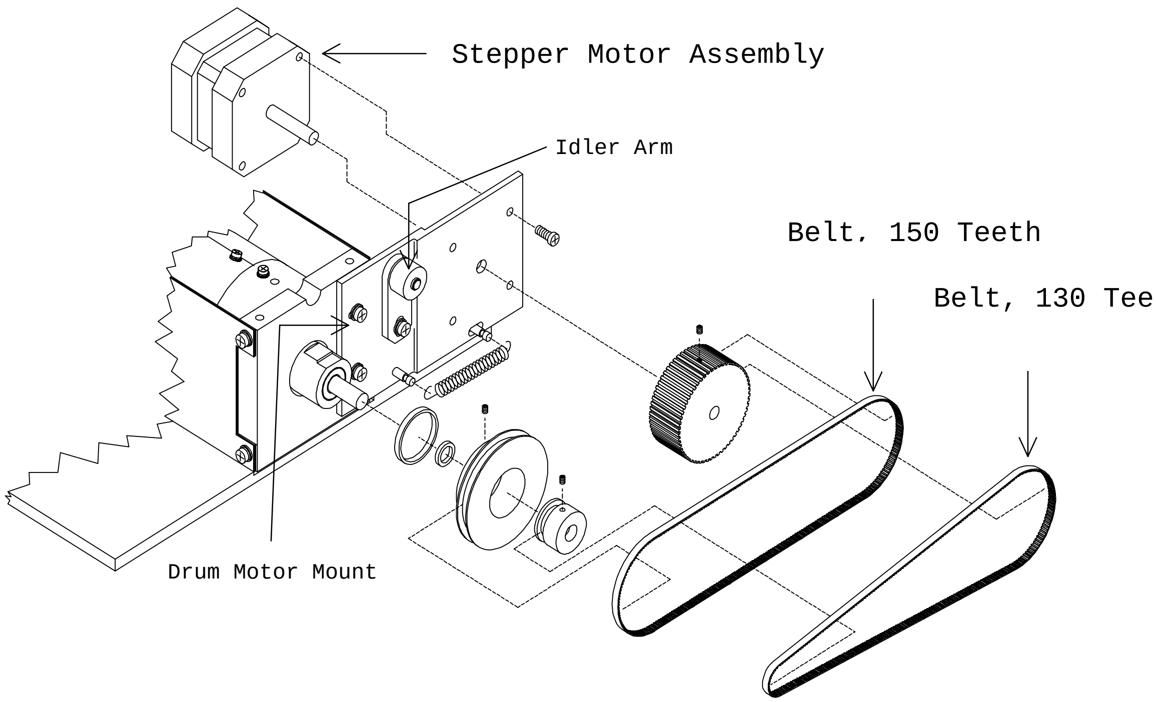


Figure 5-22. Front Drum Assembly FRUs

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).

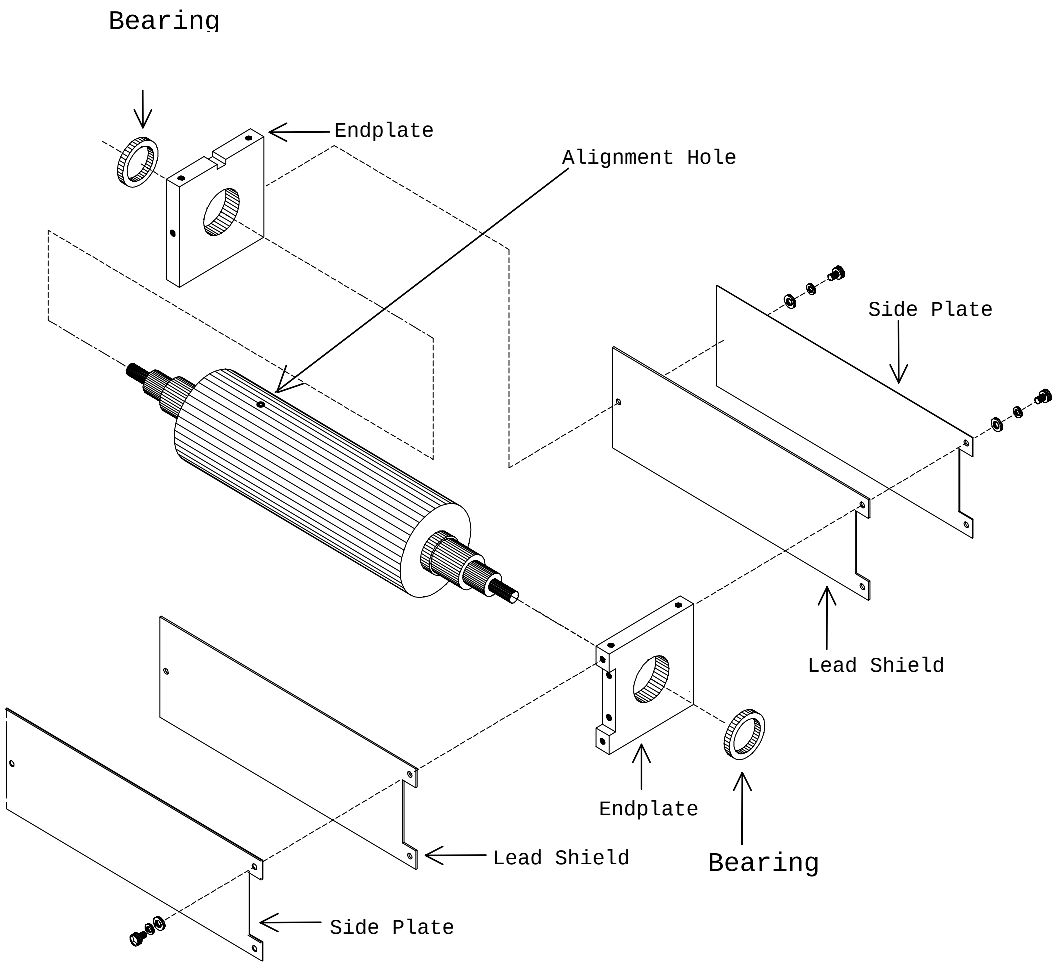


Figure 5-23. Drum Outer Bearings

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.

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.

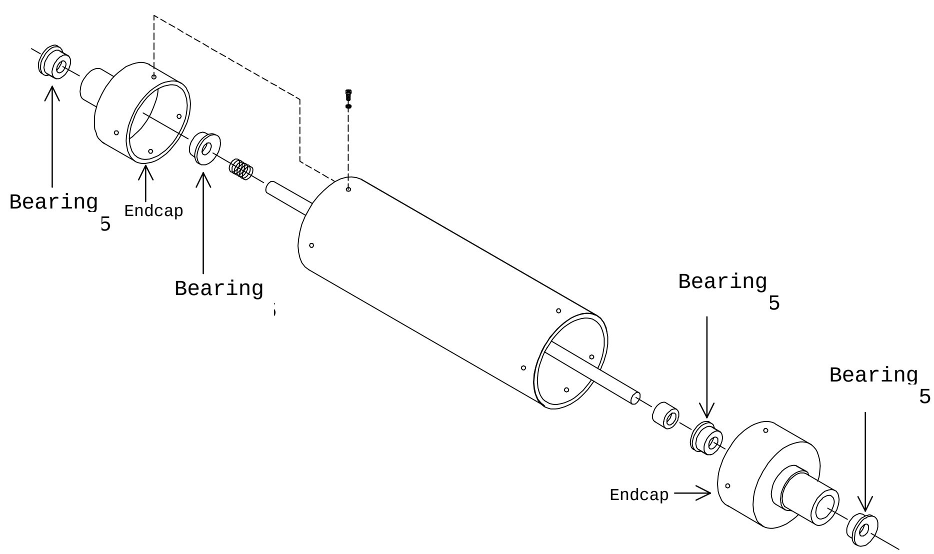


Figure 5-24. Drum Inner Bearings

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.

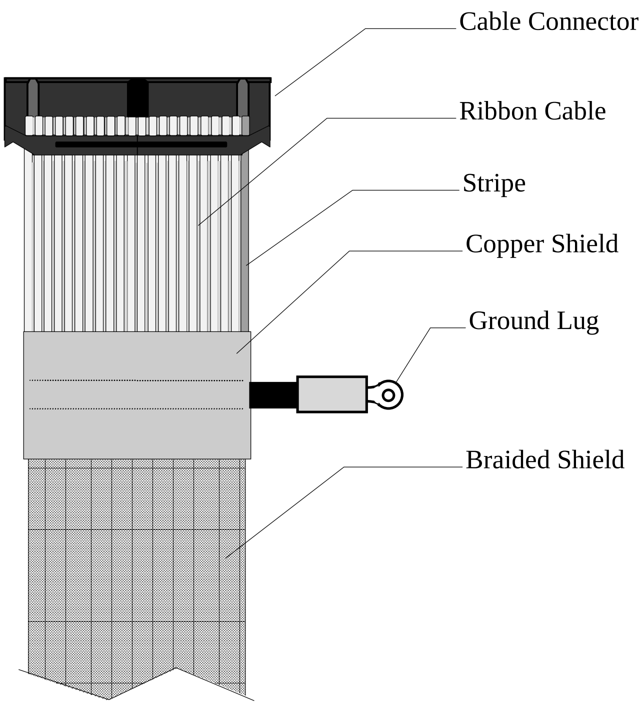


Figure 5-25. The EMI Compliance Cable

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 Convrtr 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	*Power Problems*	6-1
Scanner motion problem	*Motion Problems*	6-2
Computer display problem	*Display Problems*	6-5

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

The following suggestions apply to a QDR 4500 system exhibiting a power problem:

If...	**Check...**	**Refer to...**
System "dead"	Main breaker Power switches	*Check Power Line Voltage* heading, Section 3
Main power suspect	Circuit breakers on power module Power cables to the power module	*Power Module* heading, Section 2
Suspected Power Module problem		*Power Module FRU s* 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	1. Restart in Service mode 2. From Service utils, 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 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.

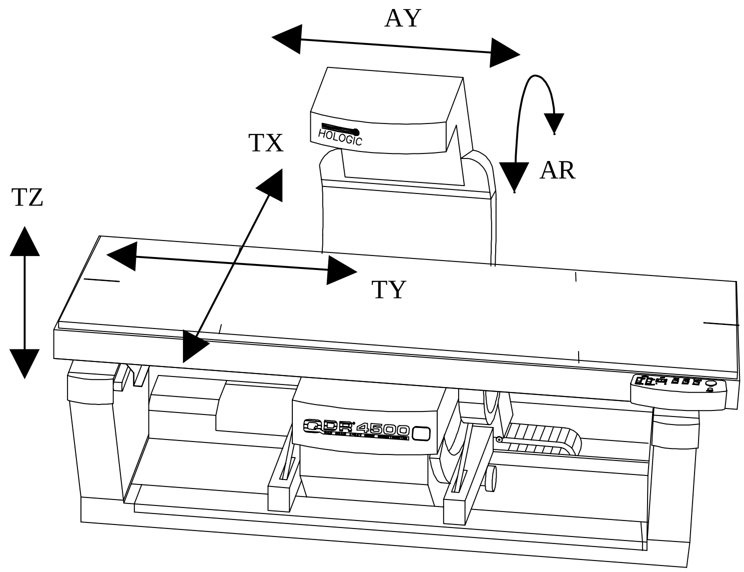


Figure 6-1. Scanner Motion Directions

	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	*Motor Controller Board* 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	*TZ Drive Board* 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 QDR Main Window, select: 1. Utility 2. Emergency motion
Perform precise table and C-arm movements	SQDRIVER	*Motor Calibration* heading, and *Motor$XX* (for the specific motor), Section 4
Monitor all motion parameters		
Troubleshoot problems encountered initiating motion from the Operator's Control Panel		*Control Panel Controller Board* heading, Section 2
Run the hardware checker	Hardware checker	SQVERIFY

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 QDR main window, select utilities, service utilities, sqdriver. Type panel$$$ and press 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	X-Ray Survey in graphic mode to check for signal strength and noise (Section 9)
Narrow vertical stripe - bad detector	*Data Acquisition System* 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	SQVERIFY

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	*Check Power Line Voltage* heading, Section 3
Tube kV Peak Potential	*Check Tube kV Peak Potential* heading, Section 3
Tube Current	*Tube Current* 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	SQVERIFY

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:

Check...	**Refer to...**
Tube kV peak potential	*Check Tube kV Peak Potential* heading, Section 3
Tube current	*Tube Current heading*, Section 3
X-ray beam alignment	*X-Ray Beam Alignment (A/SL, C/W)* heading, Section 4
Signal strength and noise	X-Ray Survey in graphic mode
Aperture position and aperture belt	*Aperture Calibration* 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	SQVERIFY

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	X-Ray Survey 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	*Aperture Calibration* heading, Section 4
Also...	
Run the hardware checker	SQVERIFY

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 5-12
	Laser alignment	Page 4-27
	Run... detector flattening	Page 4-28

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 • Received	Digital Signal Processor PCB. If IC is not seated properly, replace the board. 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 X-Ray Survey 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.

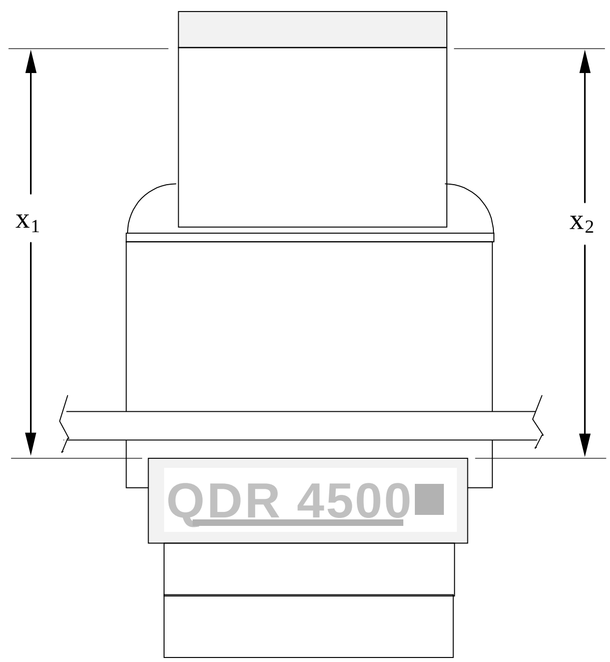


Figure 6-2. Checking C-Arm Parallelism

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.

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.

Detector Flattening Problems

System Consistently Fails the Detector 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 X-RAY SURVEY 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. Run SQVERIFY.
6. Check the filter drum to see that it is installed correctly. Check the segment readback values in X-Ray Survey 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 Detector Flattening scans for any unusual indications. If an error message is displayed, go to the Detector Flattening heading on page 4-28.

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	(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: 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. 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.
Laser crosshair beam is defective	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)
Laser does not turn off	Check laser button on control panel Check control panel laser switch at PANEL$$$> prompt in SQDRIVER Check for bad: 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:

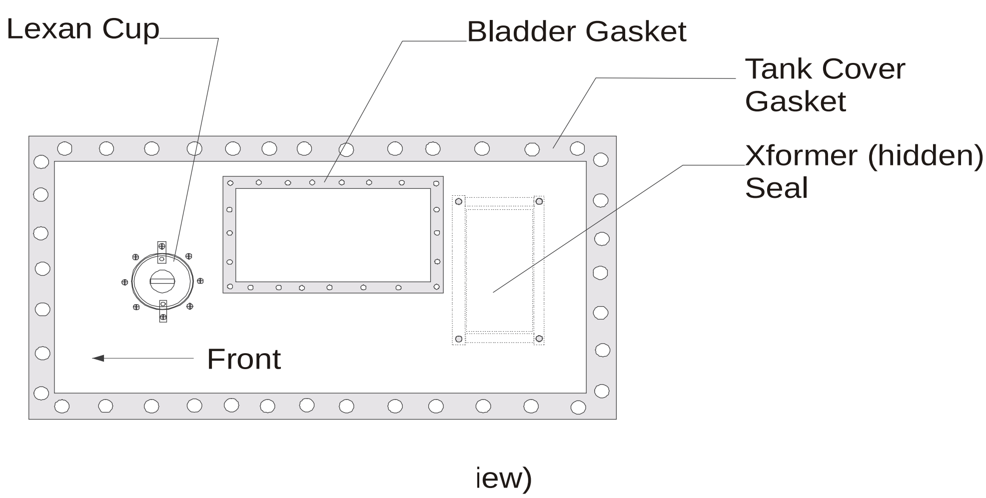


Figure 6-3 Tank Assembly Top view

Tightening the Lexan Cup Screws

Tighten the Lexan Cup seals in the following order using the torque settings in the above table:

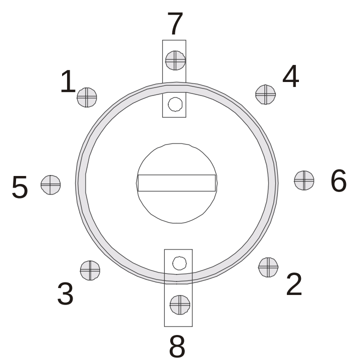


Figure 6-4 Lexan Cup Screw Tightening Order

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.

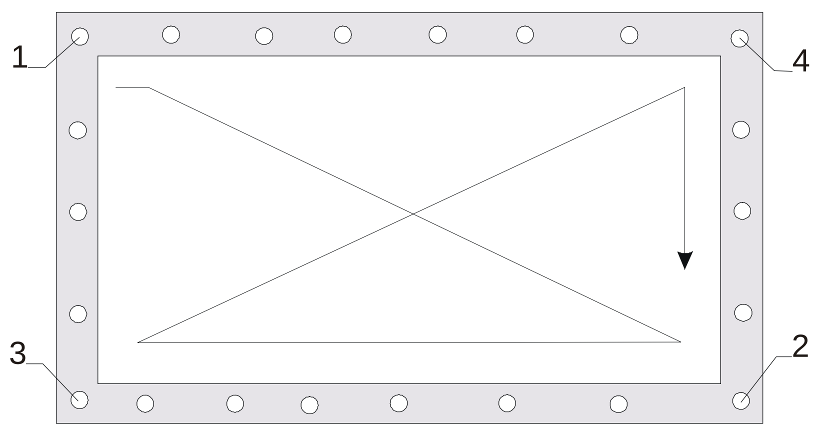


Figure 6-5. Bladder Gasket Screws

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.

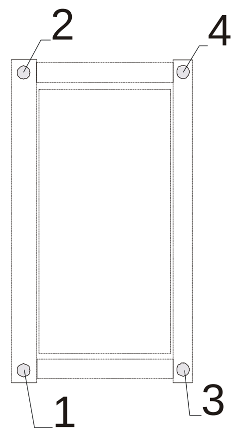


Figure 6-6. Transformer Screws

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.

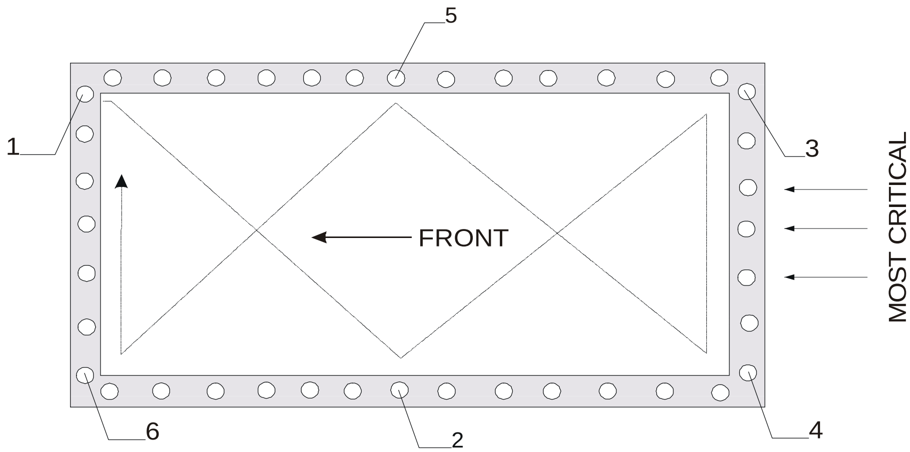


Figure 6-7. Tank Cover Gasket

MISCELLANEOUS PROBLEMS

Problem...	**Symptom...**	**Solution...**
Detector	X-Ray Survey 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

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 System Backup.

[ ] 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 Table top Radiographic Uniformity 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 scan averaging 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. This is located in the start, program files, accessories, system tools, menu.

[ ] If necessary, run Disk defragmenter to unfragment and condense the files on the computer's hard disk. This is located in the start, program files, accessories, system tools, menu.

[ ] 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).

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.

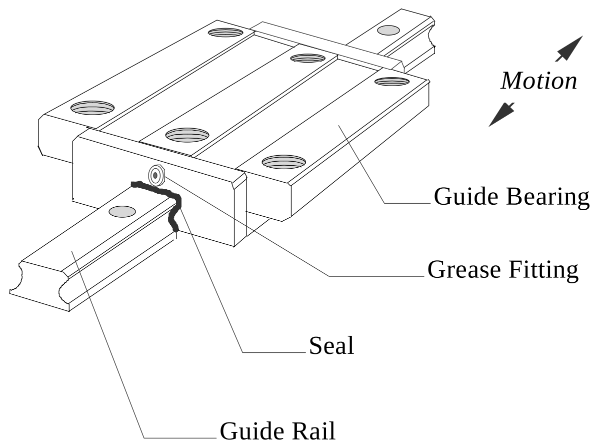


Figure 7-1. Guide Bearing and Rail

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
D2	On	XRAY ENABLE	-	-	W/C	JP9 not used	5-14, 5-15
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	

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					Set to...	
		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.	

C-Arm Interface

LEDs		Signal	Voltage Source		Jumpers			Refer to...
D1	On	+28VDC	Ext	Signal Dist.	JP7	DRUM	Out	
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		Figure 5-8
D7	On	**LOCKED**						
D8	Flashing	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 QDR for Windows system software includes software tools to troubleshoot the system. They are:

- X-Ray Survey
- SQKEYPAD

X-Ray Survey

For a more detailed description of the X-RAY SURVEY utility, refer to the X-RAY SURVEY Diagnostic Program reference guide.

Starting X-Ray Survey

At the QDR for Windows Main screen, select Utilities, Service utilities, X-Ray Survey:

The X-Ray Survey Service Screens

<table>
<tr><th>Screen</th><th>Description</th><th colspan="2">Notes</th></tr>
<tr><td>Main Screen</td><td>Appears when entering the X-Ray Survey program</td><td>Note: If the filter drum stops rotating after 30 minutes (sleep mode), press <F5> to restart it and <Home> to reset sampling.</td><td rowspan="3"><Ctrl><PageUp>, <Ctrl><PageDown> to toggle from screen to screen</td></tr>
<tr><td>Channel Data</td><td>Contains Detector Array channel data only</td><td><PageUp> <PageDown> to view all data channels</td></tr>
<tr><td>Bar Graph</td><td>Visual indication of Xray/detector activity</td><td></td></tr>
</table>

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

Figure 9-1. X-RAY SURVEY 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

Figure 9-2. X-RAY SURVEY Screen–X-Rays ON

Note: <Home> resets status bits to RED (no change)–GREEN (changed at least once).

Testing the QDR 4500 System in SURVEY (X-RAY SURVEY)

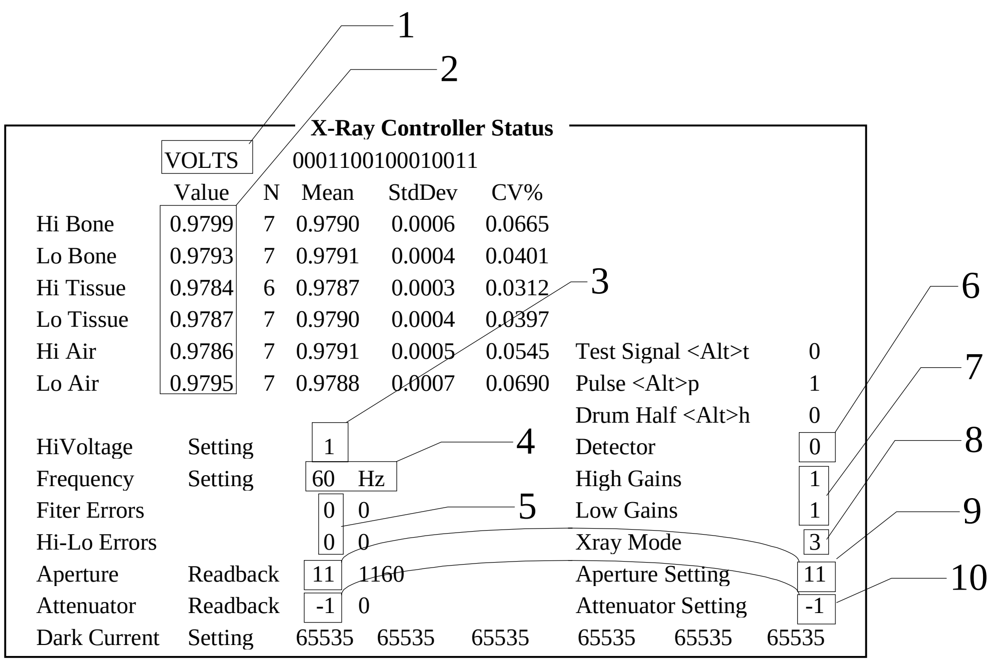


Figure 9-3. X-RAY SURVEY Screen Settings

Use the UP/DOWN arrows to change settings (see Figure 9-3).

1. Toggle <F10> to change this entry to VOLTS.
   a) When X-rays are OFF, all voltages should be approximately 1V.
   b) When X-rays are turned ON, Hi Bone should be the lowest reading and Lo Air should be the highest at approximately 8V (see Figure 9-2).
2. Should read “1”.
3. Should read “60Hz”.
4. Should read “0”.
5. Indicates the channel being monitored.
6. Set to 1.
7. Set to 3.
8. Set the Aperture to a 11. The Aperture Readback should then read 11.
9. Not used.