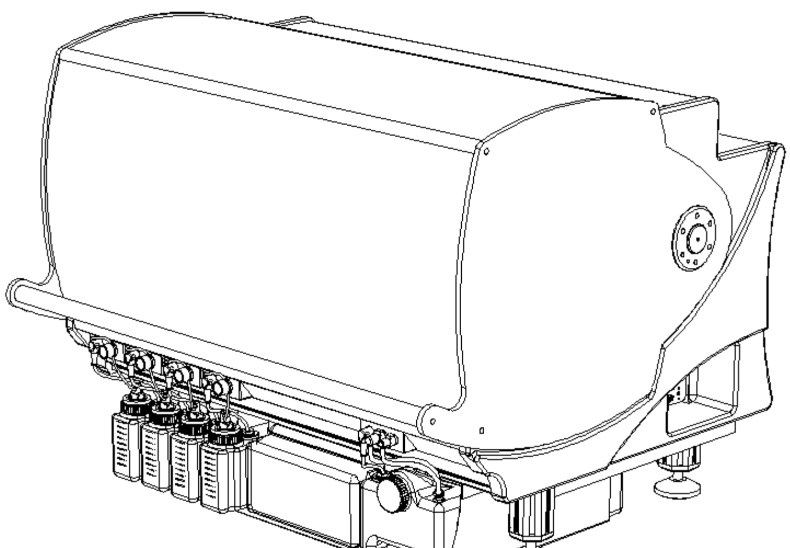
DSX™ Automated ELISA System

Service Manual



IMPORTANT: Please read this manual carefully before servicing or adjusting the system.

Revision History

Revision Date:
July 2004
April 2005

Notice: The *DSX™ Automated ELISA System* is covered by a warranty (a copy of which is enclosed in this manual). The customer is required to perform routine maintenance as described in the user's manual on a periodic basis to keep the warranty in effect.

DYNEX Technologies reserves the right to make technical improvements to this equipment and documentation without notice as part of a continuous program of product development. This manual supersedes all previous editions.

The material included in this manual is provided to assist service engineers in the maintenance and repair of the *DSX™ Automated ELISA System*. It is assumed that the individual using this manual has sufficient training in the service of analytical instrumentation and is aware of the potential hazards including (but not limited to) electrical hazards, chemical hazards and mechanical hazards.

If this manual is provided to an end user, it is with the understanding that the material included herein is proprietary to DYNEX Technologies, Inc. The user may not provide this material to a third party without the written permission of DYNEX Technologies.

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Part No. 91000090, Revision D

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Preface

The purpose of this manual is to enable a qualified field service engineer to carry out routine maintenance and minor repairs on the DYNEX Technologies *DSX*™ *Automated ELISA System*. In general, the service engineer is expected to make repairs, replace modules and replace electromechanical subassemblies. Printed circuit boards and a few other components are typically replaced as major subassemblies.

This manual is provided to complement the *DSX*™ *Automated ELISA System Operator's Manual* (Part No. 91000060). In some instances, references will be made to the *Operator's Manual*.

In most instances, the supplier of the reagent kit will install the unit. Detailed installation information is provided in Chapter 2 of the *Operator's Manual*.

Defective subassemblies may be returned to DYNEX Technologies or your DYNEX Technologies distributor, where comprehensive repair facilities are available.

The service engineer should contact the local DYNEX Technologies service office for additional information.

Warnings and Safety Precautions

The DYNEX Technologies *DSX™ Automated ELISA System* is designed to meet all relevant safety codes. The service engineer should note the following points:

1 If any fluid contains an organic solvent, make sure that the laboratory is well ventilated, so that a build-up of solvent cannot occur. In addition, avoid open flames and sparks.

2 The system should be plugged into a power line that is connected to a true ground. Make certain that all internal grounding cables are connected.

3 The reagents, wash solution etc., may contain compounds that may be hazardous. Always wear safety glasses and protective clothing when working with the washing solution or when the washer is operating (when testing the system, it is recommended that deionized water be used).

4 The microplates and the waste solution may contain materials that present a toxicological, radioactive or biological hazard. If the system is returned to a DYNEX Technologies service facility, make certain that a "Certification of Decontamination" is submitted before working on the unit.

5 Line voltage is present in the Power Supply printed circuit board and lower voltages are present in other components. If the power must be on during testing, take care to avoid contacting exposed components.

6 The cover interlock is provided as a safety feature so that the unit will not function when the cover is in the upright (open position). If the interlock is disabled, there is the possibility for bodily injury from rapid movements by the X, Y, and Z assemblies. Care should be taken when operating the unit in this state.

Table of Contents

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Chapter 1 Introduction to the DSX™ Automated ELISA System

1.1 Overview

The *DSX™ Automated ELISA System* (Figure 1-1) is a computer-controlled microplate analysis system that performs ELISA assays using protocols that are established via an application program and a personal computer. It is intended for use in clinical, research and industrial laboratories and is especially useful for laboratories with medium throughput, multiple assay workloads.

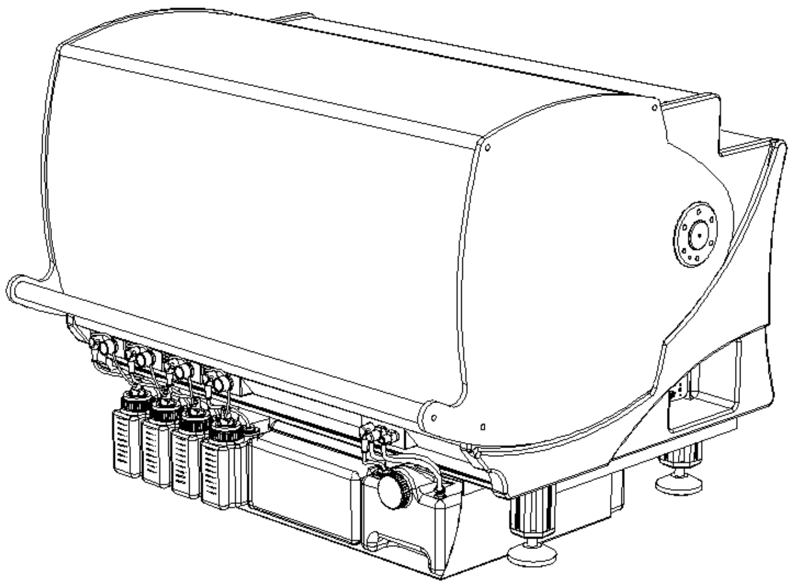

Figure 1-1 DSX™ Automated ELISA System

This chapter is designed to provide a broad overview to the system and includes:

- Functional Description and Features of *DSX™ Automated ELISA System*.
- Steps in an Analysis.
- Major Components of the System, *DSX™ Automated ELISA System*
- Introduction to Application Software.
- Contents of this Manual.

1.2 Functional Description and Features

The *DSX™ Automated ELISA System* is designed to automate each of the steps in an ELISA assay, including sampling, distribution, dilution, addition of reagents, incubation, washing, detection and data processing. All operations are performed via an assay protocol established by the application program; typically the analyst will be provided with appropriate assay protocols from the supplier of the reagents. An assay protocol can be established so that all samples on a given plate should use the same protocol (i.e. all wells are to be analyzed for the same compound) or so that different assays are performed on various wells on the plate.

The *DSX™ Automated ELISA System* has a number of performance and convenience features, including:

- ESP™ (Electronic Signature Pipetting) for liquid level and clot detection
- Endpoint data analysis to perform qualitative and quantitative data reduction
- Less than 10 second reading time (using single wavelength)
- On-board self-diagnostics
- Selection of up to six filters
- Single, dual and multiple wavelength reading modes
- Easily removable incubator, wash, and absorbance modules for servicing
- Small footprint
- A variety of wash protocols can be programmed
- A variety of plate types can be programmed
- Liquid level sensing on waste container and wash buffer containers
- Quick dispense
- Aspirating/pipetting speed can be changed for viscous liquids

1.3 Steps in an Analysis

In a typical assay, the operations shown in Figure 1-2 are performed under computer control. In some cases, two (or more) additional, incubation or wash cycles may be required for an analytical procedure.

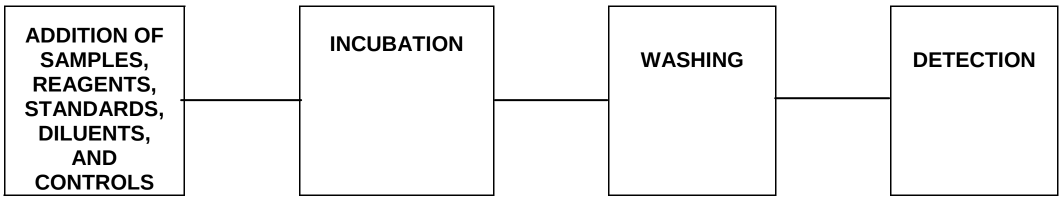

Figure 1-2 Operation Steps of the DSX™ Automated ELISA System

1 Addition of Samples, Reagents, Standards, Diluents and Controls to the Plates

The automated pipette is used to withdraw the appropriate amount of sample, reagent, standard, diluent or control from tubes (bottles) that are located in the workspace and add the liquid to the appropriate wells. Pipetting is performed by custom designed disposable pipette tips to assure pipetting precision and eliminate the possibility of cross contamination.

All movement of the pipette tip, as well as replacement of pipette tips is performed under computer control.

2 Incubation

Once the sample, reagents, diluents and standards have been added to each well, the microplate is placed in an incubator module that is set to a specific temperature (from 7 °C above ambient to 50 °C) for the appropriate period of time. If desired, the microplate can be shaken during the incubation

3 Washing

After the incubation is complete, the microplate is moved to the wash module and is washed. Eight wells of a microplate can be washed simultaneously, and different wash cycles can be used on different columns on a microplate.

4 Detection and Calculation

The absorbance module measures the optical density of each sample, which is used to calculate the concentration of the compound of interest in each sample on the microplate. In addition, QC operations on raw data as well as curve fitting can be performed to provide the desired results.

1.4 Major Components of the System

> ***Note**: This section is provided to present an overview of the major components of the system. A detailed discussion of each component is presented in Chapters 5-17.*

The *DSX™ Automated ELISA System* is an integrated system that consists of a number of modular systems that are controlled via the application software. This section describes each major component. The locations of the principal hardware components of the *DSX™ Automated ELISA System* are shown in Figure 1-3.

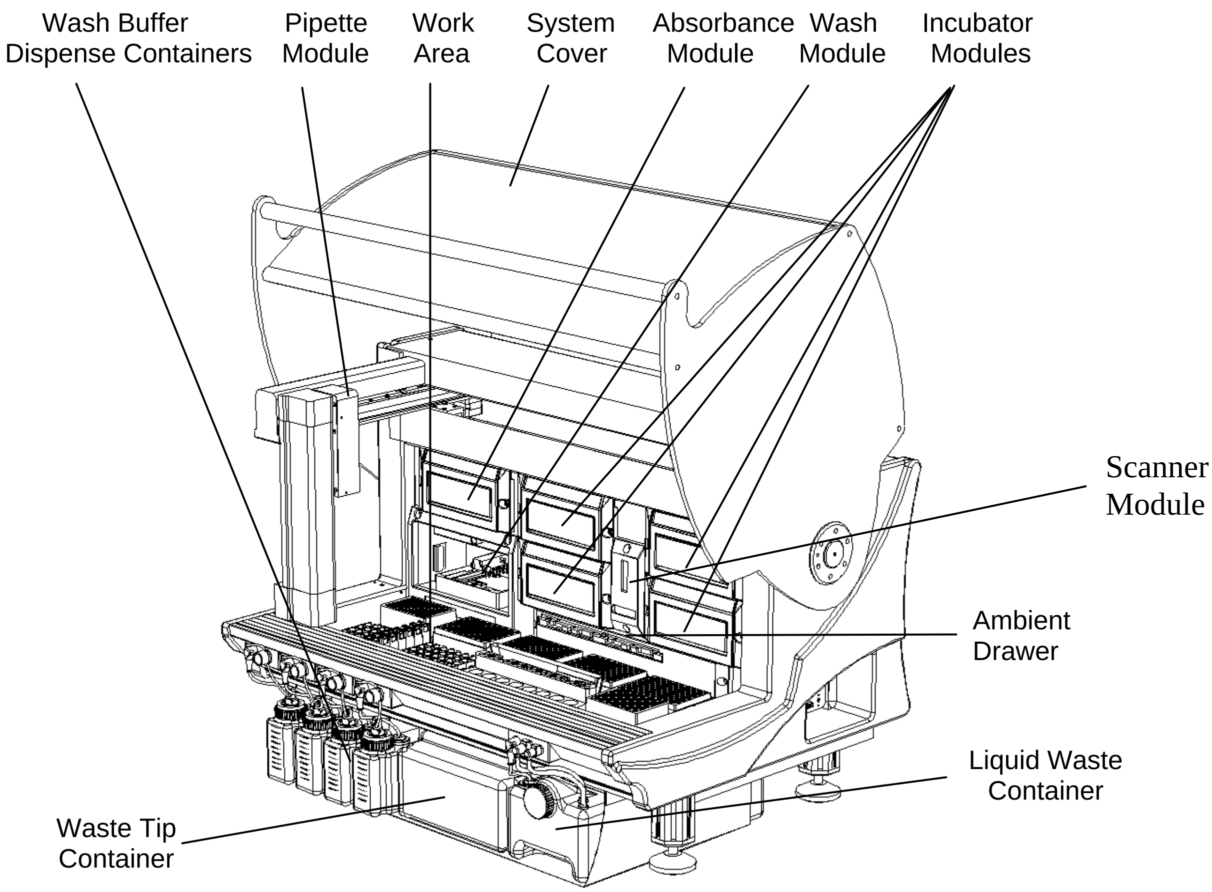

Figure 1-3 Location of Principal Hardware Components

1.4.1 Work Area

The *Work Area* is a platform on which the Sample Caddy (which contains seven Sample racks), the Dilution Plate(s), the Reagent Rack with Reagent Tip holder, the Sample Tip Racks and the Control Rack are placed.

The pipette arm will be driven to the appropriate position to perform each task. After a given process is completed (for example, adding a reagent to each well), the pipette arm is moved to the Tip Waste Chute and the pipette tip is discarded.

1.4.2 Ambient Drawer and Plate Holders

The Ambient Drawer (Figure 1-4) is used to store microplates when room temperature incubation in the dark is required. The ambient drawer extends into the work area during pipetting. The ambient drawer includes four regions where a plate holder (Figure 1-5) can be placed. The gripping slot is used to pick up a plate holder for transport and the positioning spring clips are used to ensure that the microplate is properly seated in the plate holder.

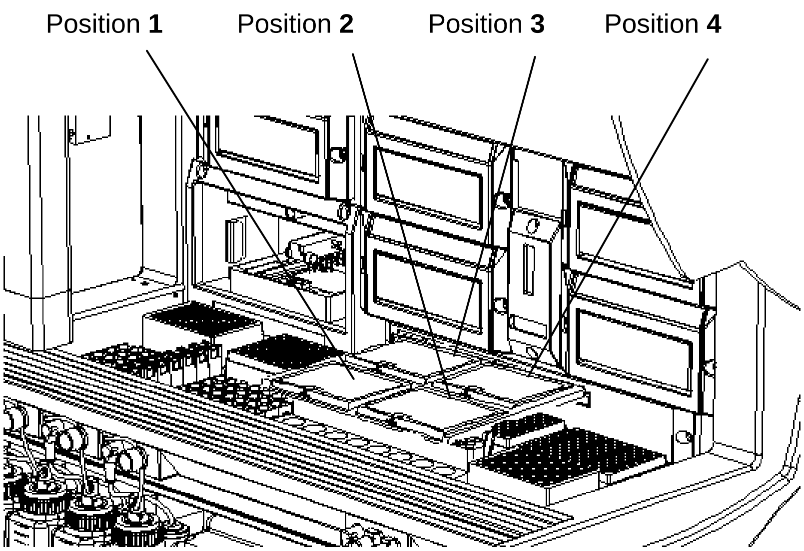

Figure 1-4 Ambient Drawer

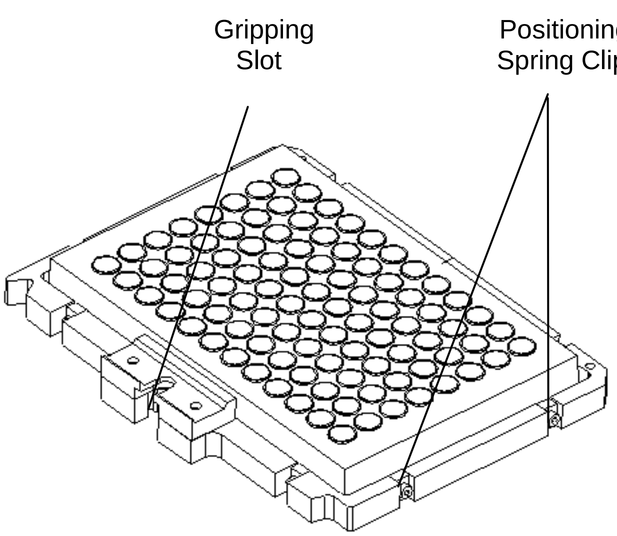

Figure 1-5 Plate Holder

1.4.3 Pipette Module

The Pipette Module (Figure 1-6) provides the following functions:

Function	Purpose
Microplate Handling	Transfers microplate between the ambient drawer, incubator module, wash module and absorbance module by gripping the holder, moving it to a new location and releasing it.
Pipetting (automatic liquid level sensor)	Delivers user-selected volume of sample, standard, reagent or control using disposable pipette tips. Each tip is automatically discarded into the waste bin after use and new tip is obtained from a sample or the reagent tip rack when it is needed.
Tip Ejection Detection	Verifies that a used tip was ejected before obtaining a new tip.
Tip Present Detection	Verifies that a tip is on the pipette.
Liquid Level Sensing	Ensures that the proper level of fluid is present.
Electronic Signature Pipetting	Automatic detection of clots, foam or bubbles when pipetting samples.

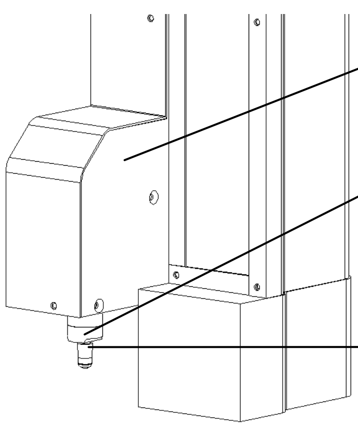

Figure 1-6 Pipette Module

The pipetting system of the *DSX™ Automated ELISA System* includes ESP™ (Electronic Signature Pipetting) software for automatic detection of clots, foam, or bubbles when pipetting samples. The pipetting signature observed when pipetting each sample is compared to nominal pipetting signatures of particular sample types (for example, serum or plasma) obtained during system configuration. If the pipetting signature does not fall within the normal range of pipetting profiles for that sample type, the system records an error.

1.4.4 Incubator Modules

Microplates are incubated and shaken in Incubator Modules (Figure 1-7). Up to four incubator modules may be present in a system, so that different microplates can be incubated at different temperatures. If desired, the microplate can be shaken during incubation. The appropriate temperature and shake duration are specified during definition of an assay.

The particular incubator modules that are used during a work list and the temperature and shaking of each incubator are automatically set by the system when the work list is created. Processing of the work list will not commence until the temperature of each required incubator module is at the correct value.

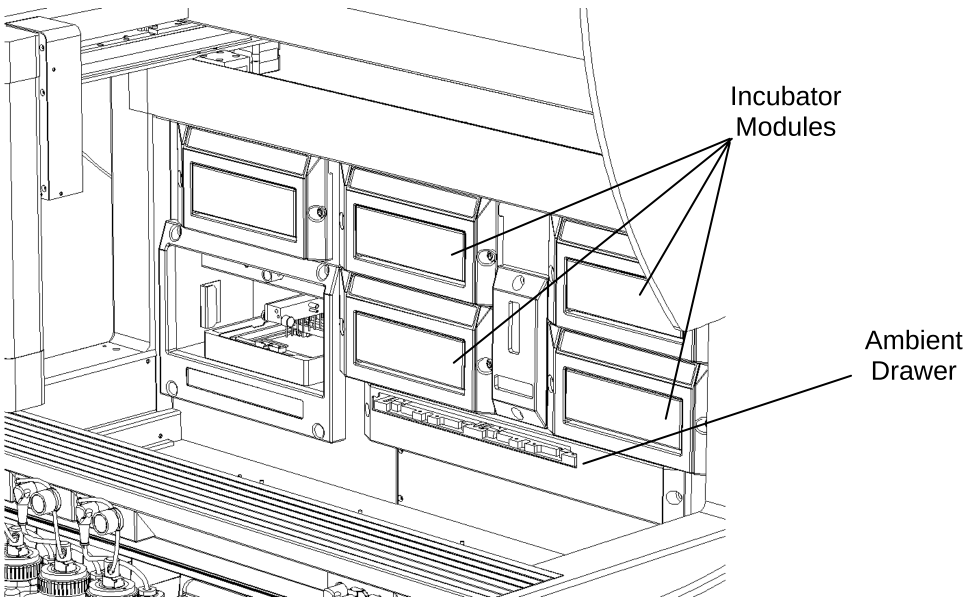

Figure 1-7 Incubator Modules

1.4.5 Wash Module

The well contents of a microplate are washed in the Wash Module (Figure 1-8). The wash module is designed to wash all 8 wells in one column of an 8 x 12 microplate simultaneously. The washing protocol can be defined to wash partially filled plates containing complete columns.

Different user-defined wash protocols can be contained on the system. In addition, the system can be configured with different plate types so that the wash head positions for each plate type can be specified. The system can accommodate flat-bottom, C-bottom, U-bottom and V-bottom types of microplates.

1.4.5.1. Wash Head

The Wash Head contains two sets of wash pins that are fixed to the wash head. The shorter pins (the dispense pins) dispense fluid and the longer pins (the aspirate pins) aspirate fluid. The aspirate pins and the dispense pins are closely spaced so that fluid can be aspirated from and dispensed into wells at the same time. During operation, the wash head assembly is lowered to insert the wash pins into the wells or raised to remove the wash pins from the wells. Lowering the wash head assembly allows the well contents to be aspirated or a bottom wash to be performed. Raising the wash head assembly allows the wash head to be moved so another column can be washed or so the wells can be filled.

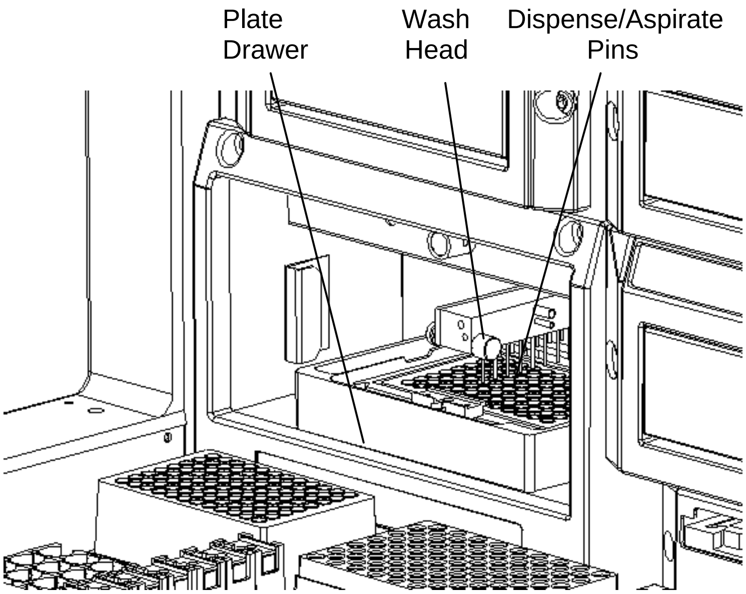

Figure 1-8 Wash Module

1.4.6 Wash Buffer Containers

Up to four different washing and/or dispensing reagents are contained on the system in Wash Buffer Containers that are located at the front of the instrument (Figure 1-9).

Each container contains up to two liters of wash buffer. Dispensing of wash buffer from a container is controlled by a submersible pump in the wash container, a dispense valve above the wash bottle, and a dispense valve located near the wash head. The specified wash buffer is dispensed into wells whenever a Dispense or Fill operation is specified in the wash protocol. A quick connect fitting and a level sensor/pump connector allow easy removal of a wash buffer container from the system.

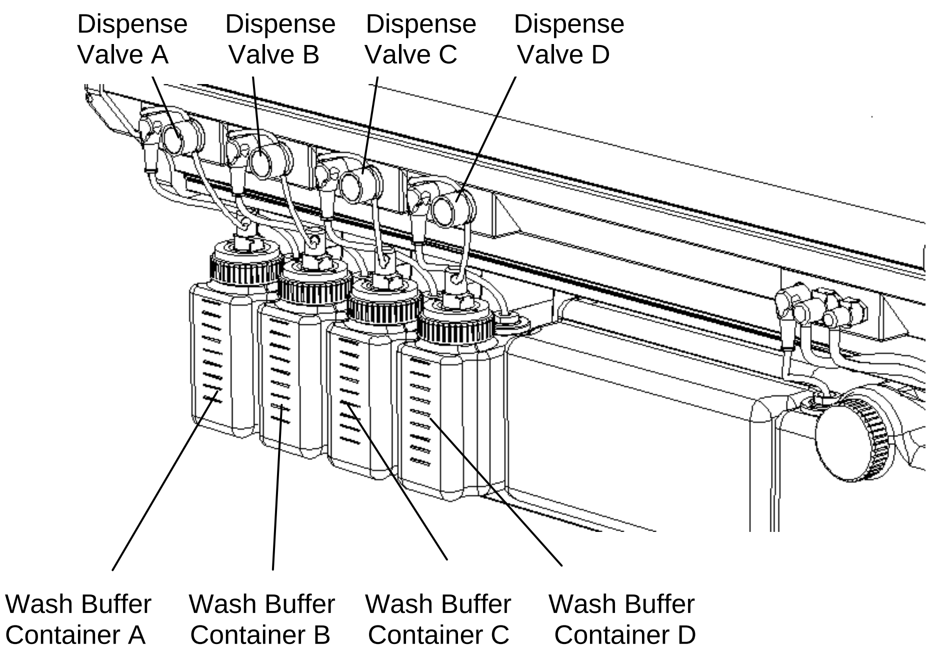

Figure 1-9 Wash Buffer Containers and Wash Buffer Dispense Valves

1.4.7 Waste Containers

Fluid that is removed during purging and washing is collected in the Liquid Waste Container. Used sample and reagent pipette tips are disposed into the Tip Waste Container. Both containers are located at the front of the instrument (Figure 1-10).

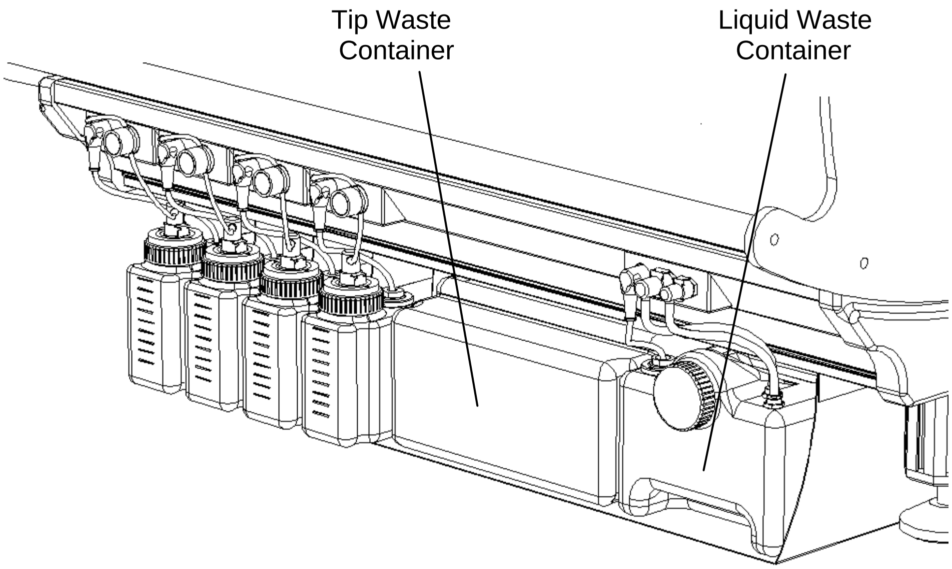

Figure 1-10 Waste Containers

1.4.8 Absorbance Module

The Absorbance Module measures the optical density (OD) of the final reaction mixture in each microplate well. The wavelength that is used and the wavelength(s) at which the optical density is measured are specified during assay definition.

During operation, each microplate is automatically transferred to the absorbance module at the appropriate time. The optical densities of the wells specified during assay definition are read, the various calculations (for example, Blanking, QC Raw Data, Threshold or Curve Fitting) are applied, and the calculated results for the microplate are reported.

The location of the absorbance module is shown in Figure 1-11.

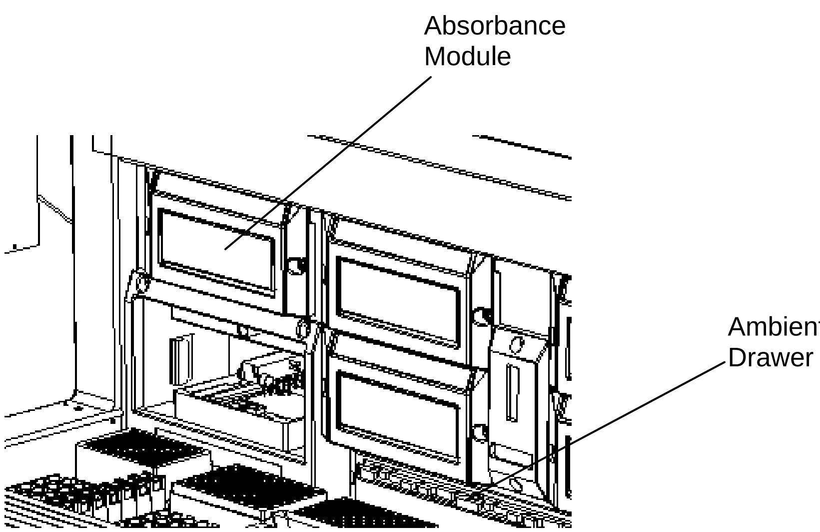

Figure 1-11 Absorbance Module

1.4.9 System Cover

The System Cover (Figure 1-12) encloses the workspace and pipette module. The cover must be closed during operation to prevent the pipette module from accidentally contacting an operator or bystander. An electrical interlock prevents operation of the pipette module when the system cover is open. To close the cover, push down on the handle until the cover is fully closed and locked. The system cover rests on the front extrusion when it is fully closed.

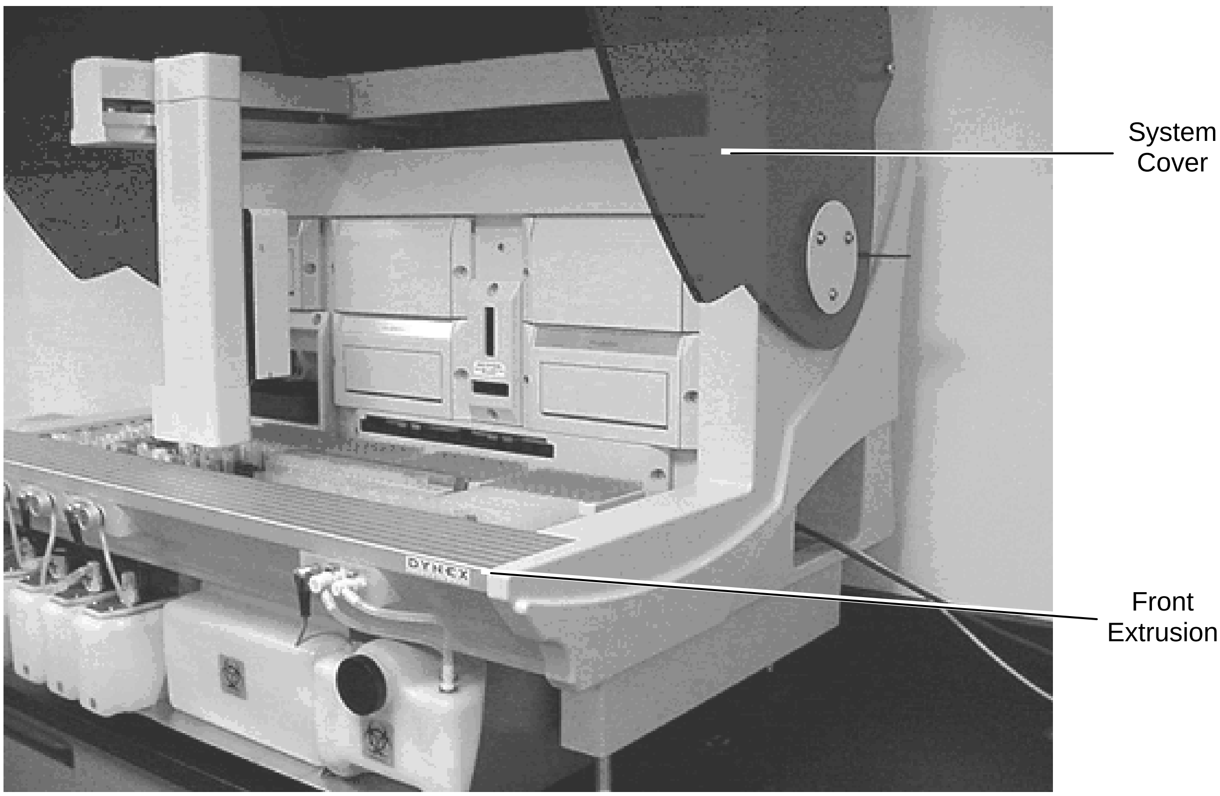

Figure 1-12 System Cover

1.5 Application Software

The *DSX Automated ELISA System* is controlled by a personal computer and application software which automates the sample distribution, incubation, reagent addition, washing and detection phases of microplate assays. It also provides the user interface for configuration of the instrument and management of consumables (Figure 1-13).

The software includes an extensive menu of assay definition options that allow you to customize the readings, calculations, QC checks and results format for an assay.

Additional information about the software can be found in the *DSX* Online Operator's Manual, accessed by selecting the **Help** menu.

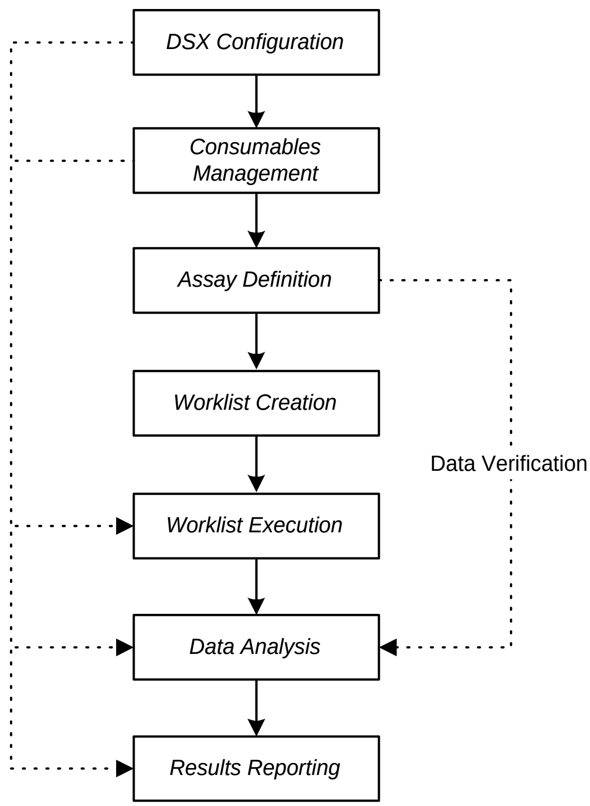

Figure 1-13 Application Software Overview

1.6 Contents of this Manual

This manual contains the following information:

Section A: General Service Information

- **Chapter 2: Installation** - describes how the *DSX Automated ELISA System* is installed in the customer's facility.
- **Chapter 3: Maintenance and Introduction to Service** - Outlines a series of activities that should be performed on a routine basis and describes the general approach to servicing the system.
- **Chapter 4: Troubleshooting, Self-Test Information and Error Codes** - describes how the service engineer can determine the cause of the immediate problem. In addition, this chapter describes general calibration of the system.
- **Chapter 5: Manual Operation of the System -** describes a series of operations that can be performed by the service engineer to manually control various components of the system. These functions can be used to independently test the modules in the system.
- **Chapter 6: The Pipette Module/XYZ Drive** - includes detailed technical information about the Pipette Module and the XYZ Drive.
- **Chapter 7: Servicing the Pipette Module and XYZ Drive** - describes how various components in the Pipette Module/XYZ Drive are serviced/replaced.
- **Chapter 8: The Incubator Module** - includes detailed technical information about the Incubator Module.
- **Chapter 9: Servicing the Incubator Module** - describes how various components in the Incubator Module are serviced/replaced.
- **Chapter 10: The Reader Module** - includes detailed technical information about the Reader Module
- **Chapter 11: Servicing the Reader Module** - describes how various components in the Reader Module are serviced/replaced.
- **Chapter 12: The Washer Module -** includes detailed technical information about the Washer Module. In addition, this chapter describes the supply of wash fluid to the washer module and the flow of fluids to the waste container.
- **Chapter 13: Replacing Washer Module Components -** describes how various components in the Reader Module are serviced/replaced.
- **Chapter 14: The Ambient Drawer** - includes detailed technical information about the Ambient Drawer.
- **Chapter 15: Servicing the Ambient Drawer** - describes how various components in the Ambient Drawer are serviced/replaced.

- **Chapter 16: Mechanical System Components** - includes detailed technical information and service information about a variety of mechanical components that are attached directly to the system frame and not part of a specific module (for example, the gas mounting springs and the cover).
- **Chapter 17: Electrical System Components** - includes detailed technical information and service information about a variety of electrical components that are not part of a specific module (for example, the EPOD and the back plane board).

In addition, a series of appendices are included: a list of tools required to service the system, a copy of the user warranty, specifications, and definitions of warning labels that are on the system.

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Chapter 2 Installation

2.1 Overview

The DYNEX Technologies *DSX™ Automated ELISA System* is normally installed and set up by a DYNEX Technologies representative or a representative of the organization that is supplying the reagent kits. Typically, the manufacturer of the reagent kits provides the required assays for the desired kits, so that they are loaded with the application software.

2.2 Receipt of the System

The *DSX™ Automated ELISA System* is normally shipped in a single crate and the PC that is to be used with the system is shipped in cartons (normally 3). Upon arrival of the system, the customer should inspect the shipment and ensure that all components have arrived in good shape. If damage is observed, either upon arrival of the system or upon unpacking, the customer should immediately make a written claim to the transport company and the organization that shipped the unit.

A packing list of all components shipped with the system is provided. If any items are missing upon unpacking, the customer should immediately make a written claim to the transport company and the organization that shipped the unit.

2.3 Power Requirement

The system requires 800 VA and should be installed on a common power line along with the personal computer and printer. It is recommended that a dedicated power line be used for the system. We recommend that the DSX and computer system be plugged into an Uninterruptible Power Supply of 1000VA/800W output power capacity and 120V nominal output voltage and 10-30 minutes backup time.

2.4 Locating the System in the Laboratory

The system should be installed on a lab bench that is capable of supporting 135 kg (300lb.). When the system is installed on the bench, at least 4 people should be used to position it.

Make sure that the system is away from air conditioning vents, heat vents, windows and any other device that can lead to significant temperature change. If organic solvents are used, make sure that there are no open flames or devices that can create sparks in the laboratory.

Connect the RS232 Cable to the bottom communication port on the *DSX™ Automated ELISA System* (lower rear of the right panel) and to a Communications port on the personal computer. Connect the personal computer and the system to the mains.

2.5 Loading the Application

The *DSX™ Automated ELISA System* can be used with the following operating systems (this information can change with the release of any new version of software so it is best to review the software notes or any bulletins regarding current specifications):

- Windows 2000
- Windows NT 4.0 (Service Pack 6)

The personal computer should have the following minimum configuration:

- 2.4 GHz processor
- 256 MB RAM
- 15" SVGA Monitor with a minimum screen display of 800 x 600 pixels
- 256-color video
- 10 GB hard disk
- CD-ROM Drive with CD burner
- 3.5” 1.44 MB floppy disk drive
- Mouse and Keyboard
- 9 pin Serial Port

Optional equipment:

- Sound card and speakers (recommended)
- Printer (B/W or Color)
- A local or network printer can be used
- Uninterruptible Power Supply

> ***Note**: Running the application software on a laptop computer may result in the incorrect display of processed results. The results and printout of the results are unaffected.*

The application software is supplied on a CD-ROM disk.

- If the operating system is configured with the Autoload feature, the Welcome screen is automatically presented.
- If the operating system is not configured with the Autoload feature, select **Run** on the **Start** menu to present the Run dialog box. Press the **Browse** button, locate Setup on the CD and press **Run** to access the *Welcome* screen of the application.

The installation program is self-explanatory. It is suggested that you keep the default *Destination Folder* on the Choose Destination Location dialog box, the default *Program Folder* on the Select Program Folder dialog box and the *Typical* selection on the Choose Type dialog box. On the Choose type dialog box, *Custom* is selected if you want to select only certain components, and *Compact* is selected if you want to install the default configuration with the Help files.

After you have loaded the program, view the *Readme* file for any information that has been generated since the preparation of the service manual.

In addition, the *Internal Technical Documents* file (InternalTechNotes.txt) file should be reviewed for assistance.

It is suggested that you place an icon on the desktop for the program. This can be done by using the *Search* command to find Revelation.exe, right clicking on it and then selecting *Create a Shortcut*. A dialog box will be presented asking if you want to place a shortcut on the desktop.

2.6 Initializing Communication

Click on the *DSX* icon to present the Password dialog box and enter the appropriate password. The system will present the *Revelation* welcome screen (Figure 2-1).

Figure 2-1 First Screen

Select the **Connect to DSX** (on Port1) radio button and press the **Do It** button to present the Reader Type dialog box (Figure 2-2).

> ***Note****: The DSX™ Automated ELISA System should normally be connected to Communication Port 1. If for some reason it is necessary to connect the system to some other communication port, it will be necessary to change this by selecting the Configure hardware radio button to access the Configure Hardware dialog box, then select the appropriate radio button and press* ***Do It*** *to present the Reader type dialog box.*

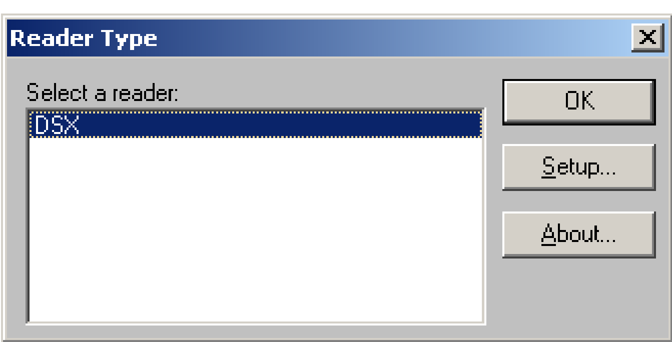

Figure 2-2 Reader Type Dialog Box

Select *DSX* and press Setup to present the Setup *DSX* dialog box (Figure 2-3).

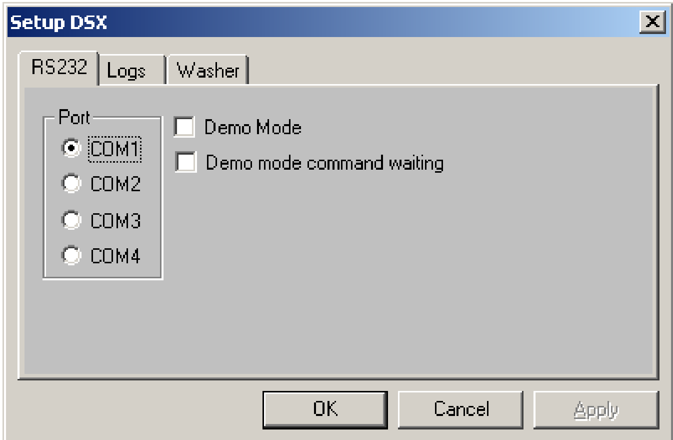

Figure 2-3 Setup DSX *Dialog Box*

Click **OK**. If the appropriate communication port has been selected and communication between the computer and the *DSX* has been established, the *DSX* will go through a self-test and generate a report. A typical self-test report is shown in Figure 2-4.

Date: 19/01/01
Time: 11:22

Comms

Serial No. 1EPA1050
Version No. CM 1.01

ALL TESTS PASSED

AM Reader

Serial No. 1AXA1066
Version No. AM v1.2

ALL TESTS PASSED

AM Reader settings:
Filter 1: 405
Filter 2: 450
Filter 3: 490
Filter 4: 630
Filter 5: Not fitted
Filter 6: Not fitted

Drawer

Serial No. 1ADA1046
Version No. DM v2.00

ALL TESTS PASSED

Drawer settings:
Out to eject offset: 7.00 mm
Ramp profile: Initial: 246, Final: 3500, Acceleration: 25

Washer

Serial No. 1WMA1044
Version No. WM1.11

ALL TESTS PASSED

Washer settings:
Number of wash head rows: 8
Number of wash head columns: 1
Number of dispense pumps: 4

Incubator 1

Serial No. 1IMA1213
Version No. IM v2.0

ALL TESTS PASSED

Incubator 2

Serial No. 1IMA1205
Version No. IM v2.0

ALL TESTS PASSED

Incubator 3

Serial No. 1IMA1191
Version No. IM v2.0

ALL TESTS PASSED

Incubator 4

Serial No. 1IMA1204
Version No. IM v2.0

ALL TESTS PASSED

Pipette

Serial No. 1PMA1068
Version No. PM 1.00

ALL TESTS PASSED

Pipette settings:
Z Ramp home profile: Initial: 400, Final: 800, Acceleration: 15
Z Ramp slow profile: Initial: 400, Final: 3000, Acceleration: 30
Z Ramp fast profile: Initial: 400, Final: 7000, Acceleration: 65
E Home Ramp profile: Initial: 100, Final: 300, Acceleration: 6
E Ramp profile: Initial: 246, Final: 2000, Acceleration: 30
P Home Ramp profile: Initial: 200, Final: 2500, Acceleration: 30
P Micro litres per P Step: 0.319186
Fluid level detection gain pressure sensor setting: 300
Fluid level detection; Sample tip adjust offset: -2, Reagent tip adjust offset: -8
Fluid level detection profile: Initial: 500, Final: 3000, Acceleration: 80
Maximum P steps: 4499
Low volume air gap steps: 30, High volume air gap steps: 150
Low volume air gap limit: 150 ul
Home offsets, Z: 229, P: 30, E: 30
Backlash steps: 5, Blow out steps: 100
Maximum aspirate volume: 1305.7 ul
Single shot sample tip volume calibration readings = 11
Single shot reagent tip volume calibration readings = 7
Multiple shot sample tip volume calibration readings = 5
Multiple shot reagent tip volume calibration readings = 9
Calibration date: 18 December 2000

XY Module

Serial No. 1DXA0052
Version No. XY 1.01

ALL TESTS PASSED

XY Module settings:
X Ramp home profile; Initial: 100, Final: 1000, Steps: 60
X Ramp slow profile; Initial: 100, Final: 5000, Steps: 450
X Ramp fast profile; Initial: 150, Final: 8500, Steps: 450
Y Ramp home profile; Initial: 100, Final: 1000, Steps: 60
Y Ramp slow profile; Initial: 100, Final: 3500, Steps: 350
Y Ramp fast profile; Initial: 100, Final: 6500, Steps: 350
Home Offsets; X: 273, Y: 85

Figure 2-4 Typical Self-Test Report

> ***Note**: This report is printed out in a continuous fashion by the system. It is presented above in a two-column format so it can be shown on one page.*

If the personal computer cannot establish communication with the system, the *DSX* Communication Module Error dialog box is presented (Figure 2-5).

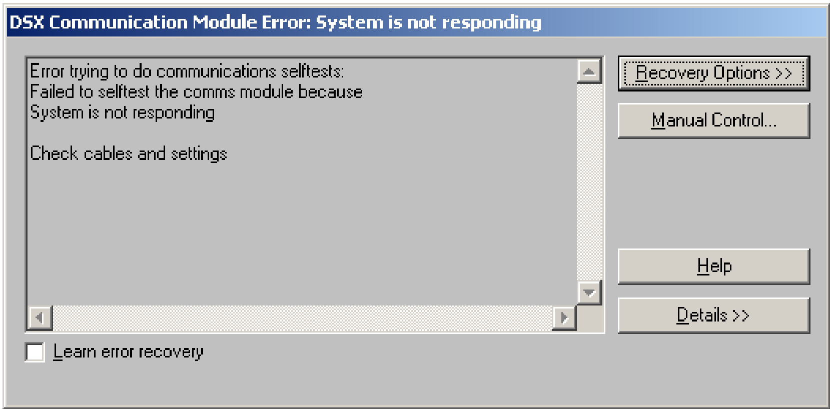

Figure 2-5 DSX *Communication Module Error Dialog Box*

Press the **Recovery Options** button to present the options at this point (Figure 2-6). The Manual Control selection lets you manually operate various components of the system and is not used at this point.

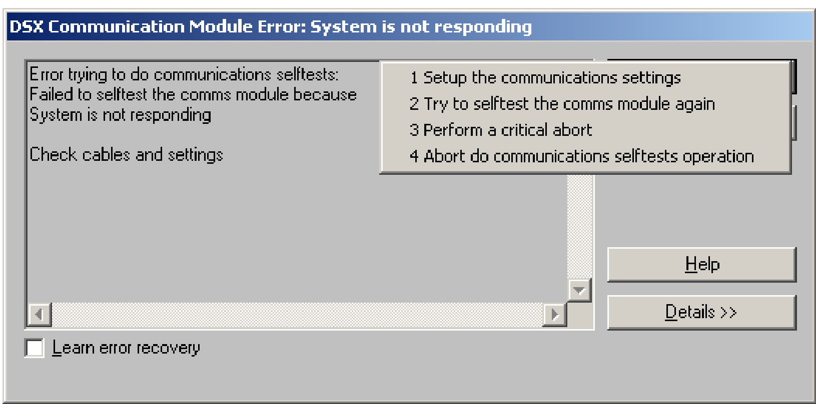

Figure 2-6 Recovery Options Dialog Box

In most cases, the problem is that you have not connected the *DSX™ Automated ELISA System* to the indicated communications port on the personal computer. If this is the case, select Setup the communications settings option to present the Setup *DSX* dialog box (Figure 2-7) and select the correct port (at this point, do not worry about the rest of the tabs).

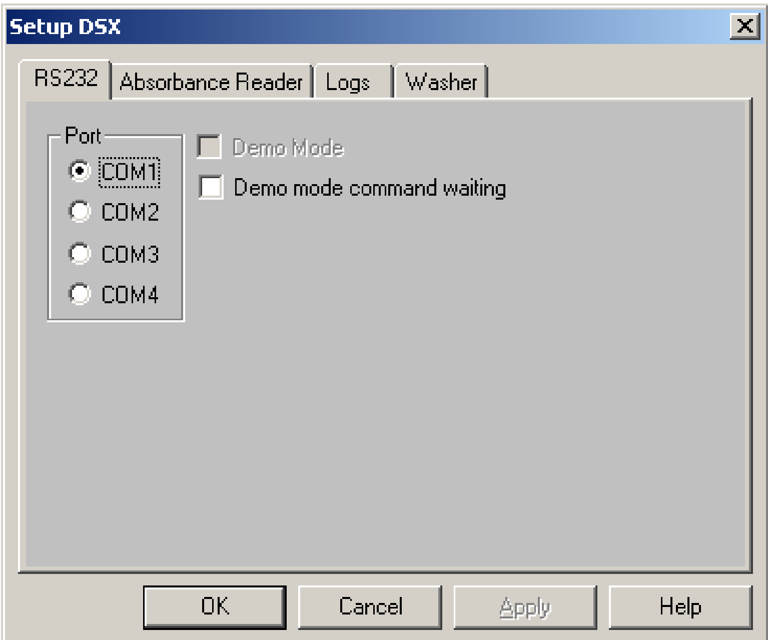

Figure 2-7 COMPORT Selection Dialog Box

2.7 Loading the Desired Assay

While the application program allows the user to prepare assay and workspace protocols, in almost all cases the system will be used with a program that is prepared by the supplied by the manufacturer of the assay kits.

To load the desired assay, get the diskette that includes the assay(s), place it into the disk drive and open the assay, then save it in the \applicationsoftware\assays folder.

Chapter 3 Maintenance and Introduction to Service

3.1 Overview

This chapter describes:

- User Maintenance – Routine maintenance, cleaning and decontamination activities that should be performed by the user. While this material is included in the user's manual, it is included here as the service engineer may be required to perform these activities from time to time.
- Cleaning and Decontamination – General comments about servicing the unit.

A detailed discussion about troubleshooting is presented in Chapter 4 (*Troubleshooting*).

WARNING

WARNING: THE SAMPLES, REAGENTS, WASH SOLUTION AND/OR THE ASPIRATED WASH SOLUTION MAY CONTAIN TOXIC MATERIALS OR BIOHAZARDS. THE SERVICE ENGINEER MUST ASSUME THAT THESE LIQUIDS AND ANY COMPONENTS THAT COME IN CONTACT WITH THEM ARE HAZARDOUS.

ENSURE THAT THE SYSTEM HAS BEEN DECONTAMINATED OR TAKE SUITABLE PRECAUTIONS (e.g., WEAR RUBBER GLOVES AND SUITABLE EYE PROTECTION).

IF THE SYSTEM IS SENT BACK TO A DYNEX TECHNOLOGIES FACILITY, THE USER MUST CERTIFY THAT THE UNIT HAS BEEN DECONTAMINATED.

3.2 User Maintenance

3.2.1 Maintenance Schedule

The user is expected to perform a number of tasks on a periodic basis.

On a Daily Basis:

1 Verify that the self-test passes. The tests are automatically carried out when the system is started. The test results can be printed using the Print command on the **File** menu. It is recommended that the daily test reports are printed or stored on a daily basis for review at a later date (i.e., to assist in troubleshooting).

2 Empty and clean the Waste Tip Container.

> ***Note**: If desired, the Waste Tip Container and the Liquid Waste Container can be disinfected with a 10% (v/v) solution of household bleach in water or 70% ethanol. If bleach is used, the containers must be thoroughly rinsed with deionized water before replacing them in the system as residual bleach fumes may affect the results of ELISA assays.*

3 Empty and clean the Liquid Waste Container

4 Clean any plate drawers and external surfaces using a moist towel dampened with 70% alcohol.

5 Purge the washer with 50 mL of deionized water.

6 The Pipette Spigot tip should be cleaned with alcohol at the end of each day.

> ***Note**: The deionized water used for purging should be placed in Wash Buffer Container D.*

On a Weekly Basis:

1. Empty Wash Buffer Containers and clean with several volumes of deionized water.
2. Remove and Clean the Waste Tip Chute.

> ***Note**: If desired, the waste tip chute can disinfected with 70% ethanol. Bleach should not be used since it will corrode the metal. Bleach will not affect the newer plastic waste tip chute.*

3. Inspect tubing for leaks, cracks and signs of degradation.
4. The tubing should be replaced if it has cracks, cloudy, compressed or is otherwise defective. If tubing is replaced, the dispense bottles need to be recalibrated and verified.

On a Six-Month Basis:

1. Replace the aspiration tubing.
2. Replace the dispense tubing.
3. Recalibrate Dispense Pumps.

> ***Note**: The tubing should be replaced if it has cracks, is cloudy or is otherwise defective.*
>
> *The tubing may have to be replaced more frequently that every six months, depending on the frequency of use, the severity of the operating conditions, and the nature of the wash solution.*

4. Replace the In-Line Vacuum Filter in the vacuum line.
5. Readjust the Vacuum Sensor.
6. Check belt tension on the X-Drive, Y-Drive, and Z-Drive and adjust as required.
7. Reseat all modules. Check Carrier Plate clips and replace as necessary.
8. Check Workspace and coordinate calibrations (refer to the section entitled Post-Service Checkout Protocol on page 3-6).
9. Perform verification of the reader using the appropriate verification plate and perform the Tip Alignment test.
10. Perform temperature verification on the incubators using the proper verification plate.

3.3 Cleaning and Decontamination

3.3.1 Cleaning the System

The DYNEX Technologies *DSX Automated ELISA System* is constructed from materials that are resistant to chemical attack.

Spills should be cleaned up as soon as possible. The service engineer should clean and decontaminate the system before servicing it.

WARNING*:* **MAKE CERTAIN THAT THE POWER CABLE IS DISCONNECTED BEFORE CLEANING THE INSTRUMENT.**

To Clean the System:

Clean all external surfaces with a cloth moistened with a mild laboratory detergent. If necessary dilute the detergent according to the manufacturer's instructions before using.

Note*: If particulate matter is observed in the Wash Bottle, the wash solution should be discarded at once.*

To Decontaminate the System:

Wipe all surfaces with a cloth moistened with a cleaner such as iDecon Detergent disinfectant or a 70 % (by volume) solution of alcohol.

Note*: If bleach is used, remove residual bleach from surfaces with a cloth moistened with deionized water. Residual bleach fumes may affect the results of ELISA assays.*

If the system will not be used for a period of time, the system should be flushed with de-ionized water so that buffers and/or reagents are not deposited on the wash head or other components of the system. The dispense tubing should be removed from the pinch valves to prevent permanent compression of the tubing.

If dispense or aspiration tips become clogged, use the wires supplied with the system to remove any particulate matter from them.

If a system is returned to a DYNEX Technologies facility, the customer must decontaminate the system before shipment and a decontamination certificate must be submitted with the unit (see Cleaning and Decontamination on page 3-4).

3.4 Servicing the *DSX Automated ELISA System*

3.4.1 Servicing Modules

The incubator modules, the detector module, the ambient drawer and the washer module are readily removed from the DYNEX Technologies *DSX Automated ELISA System*. When a problem is identified in one of these modules, the normal service operation is to replace the entire module and return the defective one to a service center.

Typically, the replacement module will be sent via express and the user can install the replacement module.

The service engineer is expected to perform the following activities on-site for the incubator modules, the detector module, the ambient drawer and the washer module:

- Replacement of consumable items, such as the lamp in the detector module or tubing in the wash module.
- Changing components to meet the need of a different assay (for example, changing a filter).
- Simple repairs that can be readily performed in a short period of time.

3.4.2 Servicing Non-Modular Components

Other components of the system, such as the XYZ pipetting arm or the power distribution are not modular. For these items, the service engineer is expected to determine the problem and perform the necessary service on-site.

3.5 Post-Service Checkout Protocol

3.5.1 Role of the Post Service Checkout Protocol

After any service activity, the checkout protocol described below should be performed to ensure that all components of the system are function properly and all components are properly aligned.

3.5.2 Power Down the System

Power down the system and the computer and power them up again in the normal manner. The Self-Test report should indicate that all tests have passed (refer to Initializing Communication on page 2-4).

3.5.3 Workspace Calibration

Perform the Tip Alignment Test to ensure that the coordinates of the workspace are properly defined. If the Tip Alignment Test fails you will need to perform The Workspace Calibration.

To Perform the Workspace Calibration:

1. Remove all components and racks from the workspace area and place the Calibration Jig (Part No. WAFIX-003) onto the workspace at the left-hand end. Make sure that the holes and pins align. The pillars on the plate should be in the back-left and front-left corners of the workspace area on the *DSX*, as shown in Figure 3-1.

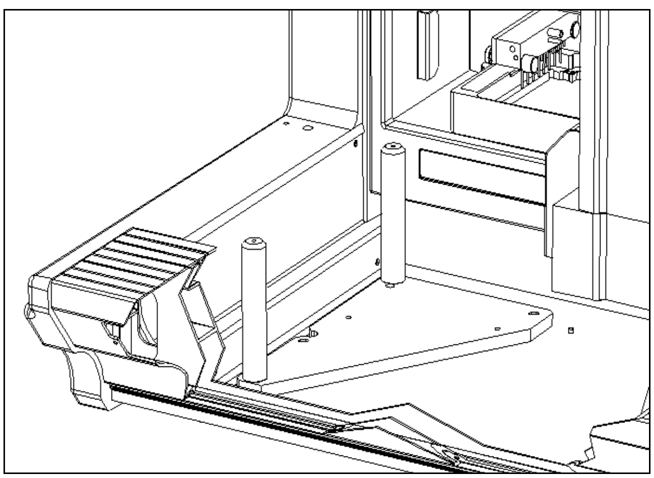

Figure 3-1 Positioning the Workspace Fixture - Left Side of DSX *Workspace*

2 Start Revelation, select “Tools” and then select “Configure System”. Select the Coordinate Calibration tab of the Setup *DSX* dialog box (Figure 3-2).

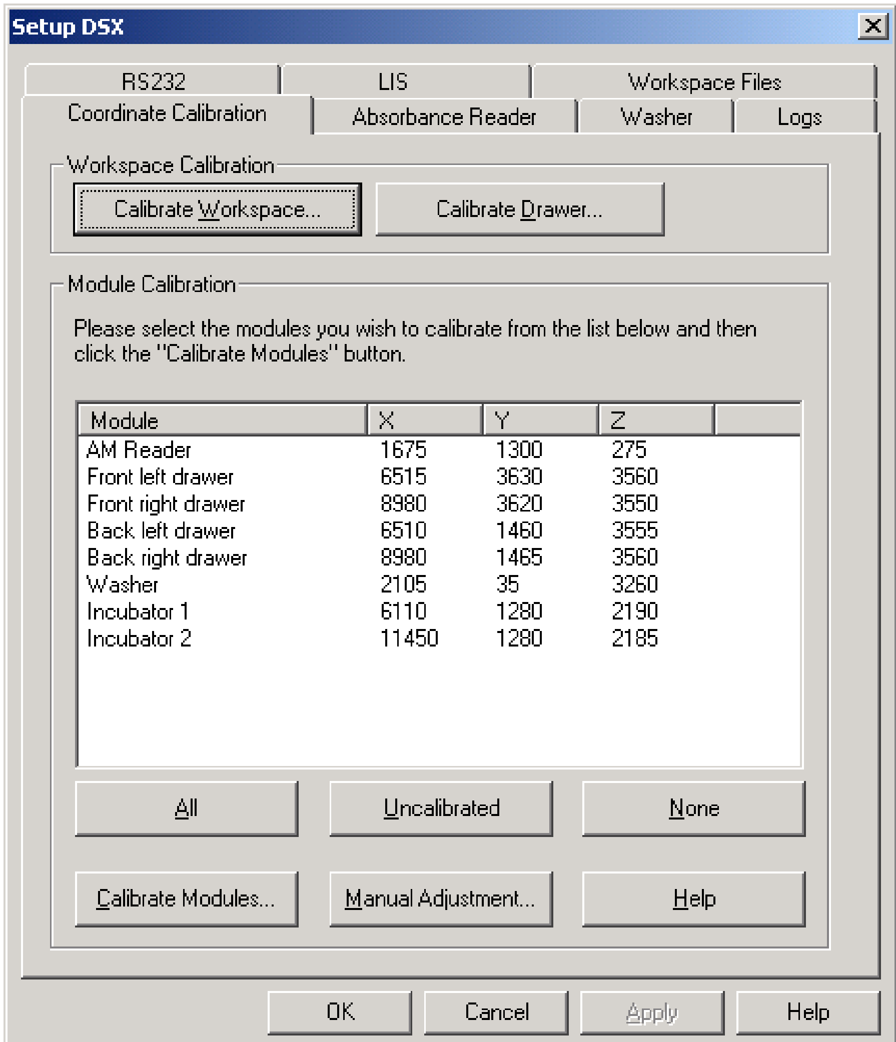

Figure 3-2 Setup DSX *Dialog Box - Coordinate Calibration Tab*

3 Press the **Calibrate Workspace** button to start the Workspace Calibration procedure. Follow the on-screen instructions to calibrate the workspace.

4 Manually move the Pipette assembly to the rear pillar and insert the spigot of the pipette into the alignment hole on the post (Figure 3-3).

> ***Note***: *The pipette spigot must enter the alignment hole vertically (directly overhead) without any left-to-right or front-to-back side movement. Move the x-arm or y-arm assemblies if necessary and push on the pipette only from the top. Check for correct alignment several times and hold the pipette spigot in the alignment hole (without compressing the spigot spring) while pressing "OK".*

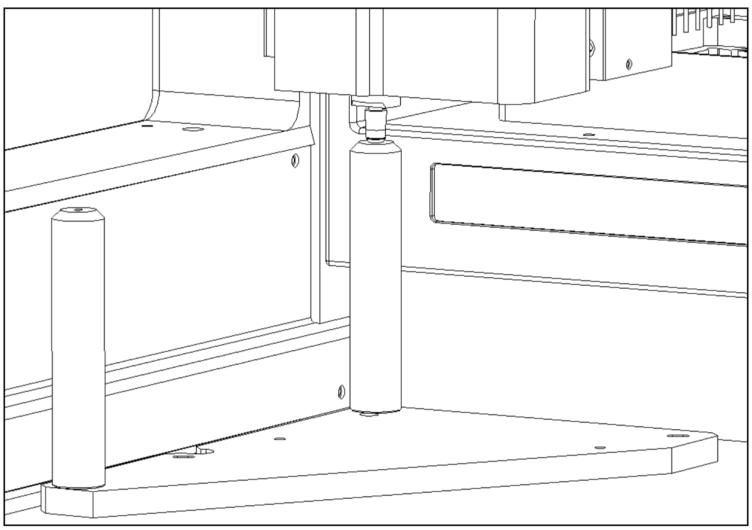

Figure 3-3 Positioning of the Pipette Spigot in the Rear Pillar

> CAUTION
>
> **CAUTION: WHEN YOU MOVE THE ARM IN A GIVEN DIRECTION (e.g. IN THE Y DIRECTION), BE SURE TO MOVE IT BY HOLDING IT NEAR WHERE IT IS ATTACHED TO THE REST OF THE SYSTEM RATHER THAN AT THE END OF THE ARM.**

5 Press **OK**

> CAUTION
>
> **CAUTION: THE SYSTEM WILL MOVE THE PIPETTE TIP AUTOMATICALLY. TAKE CARE THAT YOUR HANDS, FACE, ETC., ARE NOT IN THE WORKSPACE AREA DURING THIS OPERATION.**

6 The program will alert you to move the pipette tip to the front and repeat steps **4** and **5**.

7 Revelation will move the XYZ arm over to the right-hand end of the *DSX* to record the position of the right-back pillar. Remove the Calibration Jig and place it as shown in Figure 3-4.

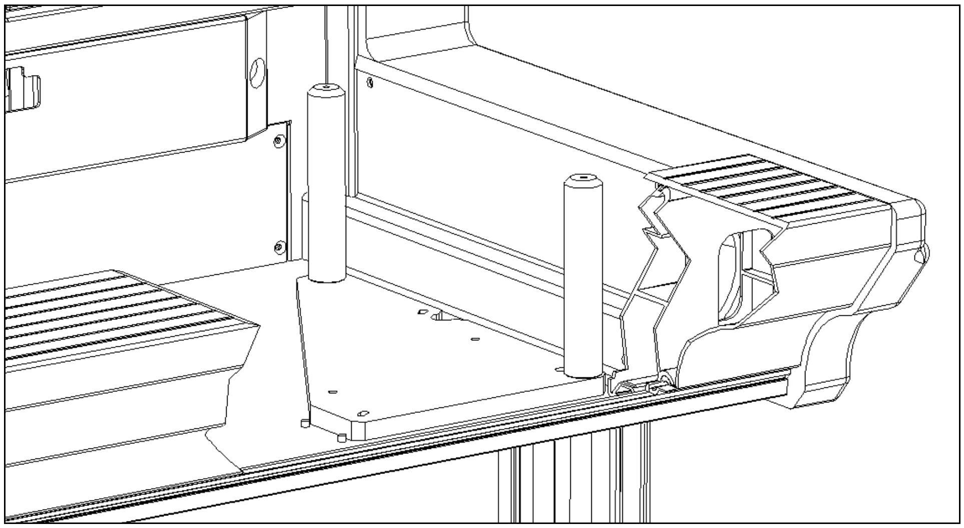

Figure 3-4 Positioning the Workspace Fixture - Right Side of DSX *Workspace*

8 The program will alert you to move the pipette tip to the rear pillar and repeat steps **4** and **5**.

9 When Revelation has the X, Y and Z coordinates for the three positions, it calculates the home-offsets for the three motors, and the amount of skew (in three dimensions) between the movement of the arm, workspace and modules.

10 Click **OK**. This will save the XYZ coordinates.

3.5.4 Module Calibration

Module calibration is performed to make sure that the coordinates for each module is properly defined so that the pipette arm can move the plates as appropriate. The present position of each module is indicated in the Module Calibration region of the Setup *DSX* dialog box - Coordinate Calibration Tab (Figure 3-2).

To Perform Module Calibration:

1. Start **Revelation**, select **Tools** and then select **Configure System**. Select the **Coordinate Calibration** tab of the Set-up *DSX* dialog box (Figure 3-2).

   Select the module to calibrate by left clicking on it, and then select **Calibrate Modules**. The program will prompt you to perform the next steps. The following is an example using the left front drawer, but all the modules are calibrated in the same manner.

2. Select **Front Left Drawer** and press **Calibrate Modules**. The drawer will eject and the Arm will position itself over the drawer. The program will prompt you to insert the *DSX* Coordinate calibration plate in the front left drawer.

3. Insert the calibration jig and click **OK**. The drawer will retract and eject again to ensure proper positioning. The program will prompt you to please move the arm to the front left drawer calibration hole and click **OK** when done.

4. Manually move the arm and pipette to the calibration fixture. When moving the arm you should always grasp the points at which the arm and pipette are secured to prevent bending/flexing of the arms. You should also be cautious not to bump or move the drawer out of its proper position. Carefully position the tip of the pipette spigot until it fits into the hole of the calibration jig. While holding the pipette in the calibration hole, press OK when complete. The program will prompt you to *please remove the DSX Coordinate Calibration plate from the Front left drawer*. Click **OK** when done. The drawer will move to the in position.

This process should be performed for every module as required.

> ***Note**: If it is necessary to change the X, Y, or Z coordinates; only a small change is normally required. An integer change is equivalent to a change in 0.1 mm.*

3.5.5 Drawer Calibration

The drawer calibration locates all of the XYZ positions of the wells of all four plate positions. It is performed if a new drawer module is installed, if the tip does not center correctly, or if the tip does not go to the proper dispense height above the wells.

To Perform the Drawer Calibration:

1. Start **Revelation**, select **Tools** and then select **Configure System**. Select the **Coordinate Calibration** tab of the Set-up *DSX* dialog box (Figure 3-2).
2. Select **Calibrate Drawer**. Follow the on-screen instructions to calibrate the drawer.
3. The pipette spigot must enter the alignment hole vertically (directly overhead) without any left-to-right or front-to-back side movement. Move the x-arm or y-arm assemblies (if necessary) and push on the pipette only from the top.
4. Check for correct alignment several times. Hold the pipette spigot in the alignment hole (without compressing the spigot spring) while selecting **OK**.

3.5.6 Manual Adjustment of the Module Calibration

Manual adjustment of a module may be required using a standard plate carrier if the unit does not put and get the plates properly. Prior to starting this, the user should put a standard carrier into the module that requires a manual adjustment.

1 Start **Revelation**, select **Tools** and then select **Configure System**. Select the **Coordinate Calibration** tab of the Set-up *DSX* dialog box (Figure 3-2).

2 Select the module to manually adjust by left clicking on it with the mouse and then select **Manual Adjustment**.

> ***Note****: The front left drawer is used as an example. The other modules are adjusted in the same manner.*

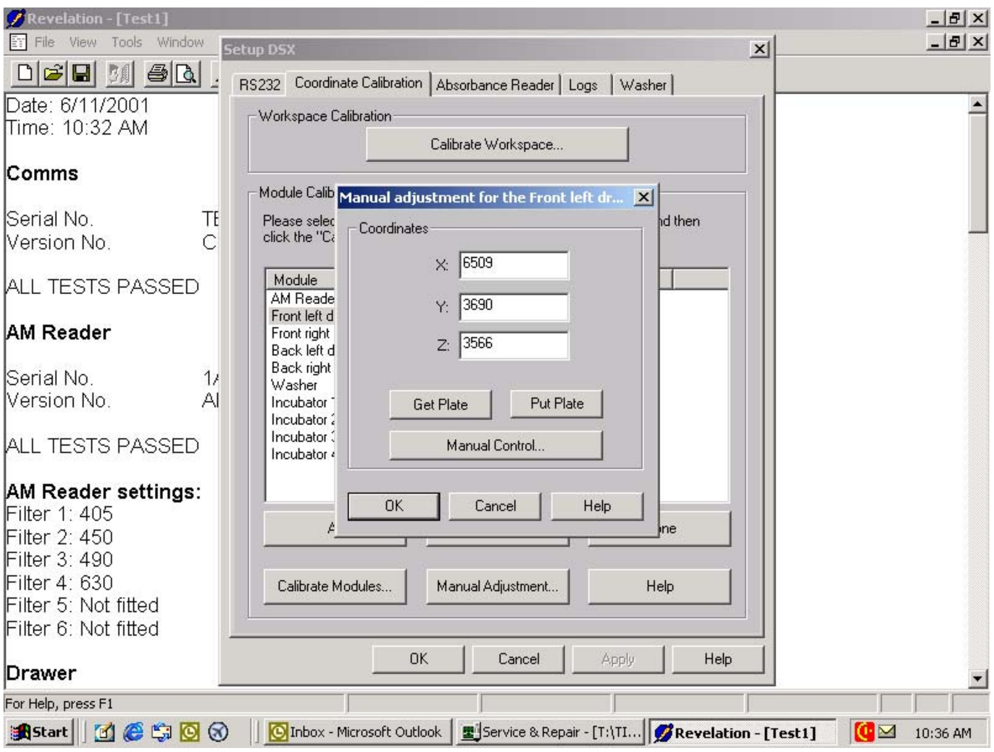

Figure 3-5 Front Left Drawer Manual Adjustment Dialog Box.

> ***Note****: The values in the Manual Adjustment Dialog Box for the three axes represent approximately 0.01mm in travel. For example, the value reported in Figure 3-5 for Z is equivalent to the step count (3566) multiplied by.0625 would provide the distance in millimeters from the Z home position. The Y & Z step count multiplication factor is .0625 and the X is .0600. The home position for the X is the farthest left position or 0, the Y is farthest inward position or zero and the Z is the up most position or zero.*

> ***Note** (continued): Depending on the particular situation, you can either increase or decrease the number to achieve the optimal position. Try small increases or decrease around 5 until you gain a thorough understanding.*
>
> *Therefore, if the arm position needs to be moved to the left, the X coordinate would be decreased. If the arm position needs to be moved up, the Z coordinate would be decreased. And finally, decreasing the Y coordinate would move the arm toward the back of the unit.*

3 Select **Get Plate** while observing the pipette spigot as it enters the plate holder assembly (Figure 3-6). As the pipette moves back into the clamping slot, the spigot must align with the plate holder as shown. Skip to the next step if this is correct. If not, the X and Z coordinates will need to be adjusted to achieve this alignment.

> ***Note**: If only a slight adjustment to the coordinates is necessary, it is easier to check for proper alignment at the alignment Vees shown in Figure 3-7. For coarser adjustments, begin with the spigot alignment, then move to the alignment Vees.*

> ***Note**: If an error occurs, choose **Recovery Options** followed by **Abort the Operation**. The coordinates can then be modified and the attempt repeated.*

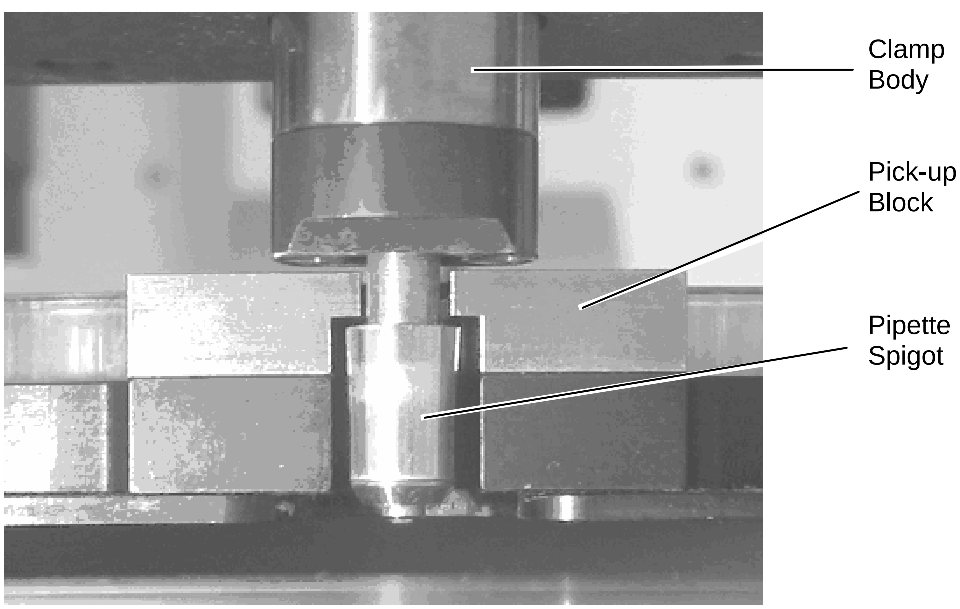

Figure 3-6 Pipette Entering Plate Holder Assembly Prior to Clamping

4 As clamping begins (i.e. the clamp body drives into the pick-up block), refer to Figure 3-7 for correct positioning in the Y direction. Adjust the Y coordinate as necessary. With the alignment Vees positioned as shown, the plate holder assembly is approximately five to ten steps from the rear of the plate carrier. This is the ideal positioning (i.e. with the plate holder closer to the rear of the carrier than to the front).

5 Select **Put Plate** while observing the positioning of the plate carrier and the plate holder assembly alignment Vees (Figure 3-7). They should align as shown; if not, adjust the X or Y coordinates.

6 The optimal Z alignment is best observed as the plate is released during the Put Plate operation. At the start of the command, the plate holder is held by the pipette approximately 2.5 cm (1 inch) above the plate carrier. When the **Put Plate** button is selected, the pipette moves down to place the plate holder into the plate carrier after the drawer extends. At this point (i.e., before the plate is unclamped), there should be approximately 0.5 mm (0.02 inch) between the bottom of the holder and the top of the carrier. Adjust the Z coordinate to achieve this gap.

7 Several attempts of putting and getting the plate may be required to obtain the optimal results. When finished, click **OK** to save the values. If you make any changes and exit without selecting **OK**, the values will not be saved.

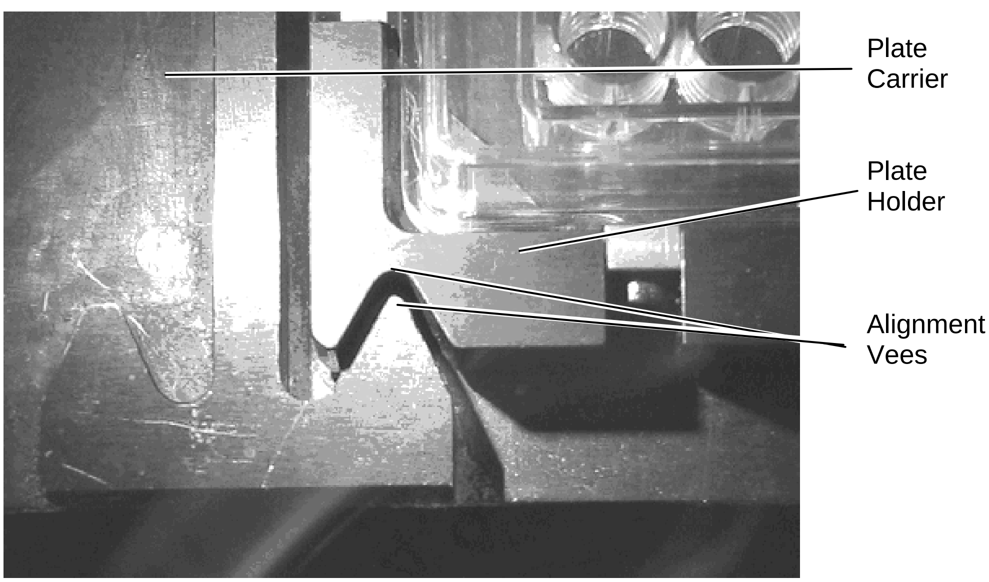

Figure 3-7 Plate Alignment Vees

3.5.7 Cycle Test

In Revelation software, access the Enter cycle count dialog box (Figure 3-8) by:

1. Selecting **Manual Control** on the **Tools** menu.
2. Selecting **Testing** in the left column.
3. Selecting **Plate Movement** in the right column.
4. Enter the number of times to perform the Cycle Count and select **Do It**.

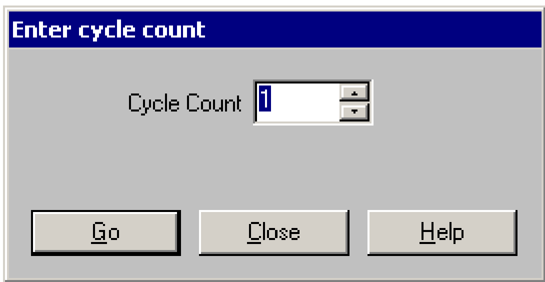

Figure 3-8 Enter Cycle Count Dialog Box

Enter the number of cycles that should be performed. Each cycle involves the movement of the plate from the ambient drawer to another module and back. The movements are performed on a randomized basis and a value of at least 36 should be entered to make sure that all modules are checked a few times.

Each movement should be smooth (i.e. no jerking, hesitation or interference). If the movement is not smooth, repeat the calibration described in section entitled *Drawer Calibration* on page 3-11.

3.5.8 Tip Alignment Test

Perform the Tip Alignment test described in the section entitled Manual Control Operations on page 5-2.

3.5.9 Manual Wash Plate Test

Check that the tubing has been fitted correctly without kinks to ensure proper dispense and aspiration of the wash fluid. In addition, check that the wash head can move properly.

In Revelation software, access the Enter cycle count dialog box (Figure 3-9) by:

1. Selecting **Manual Control** on the **Tools** menu.
2. Selecting **Washer** in the left column, load some fluid from the right column and select **Do It**.
3. Select the fluid to load, the volume and select **OK**. The program will show the location to load the washer fluid; select the green check mark when complete. The program will return to the *DSX* Manual Control dialog box.
4. The Washer should still be highlighted in the left column, select wash a plate from the right column and select **Do It**.

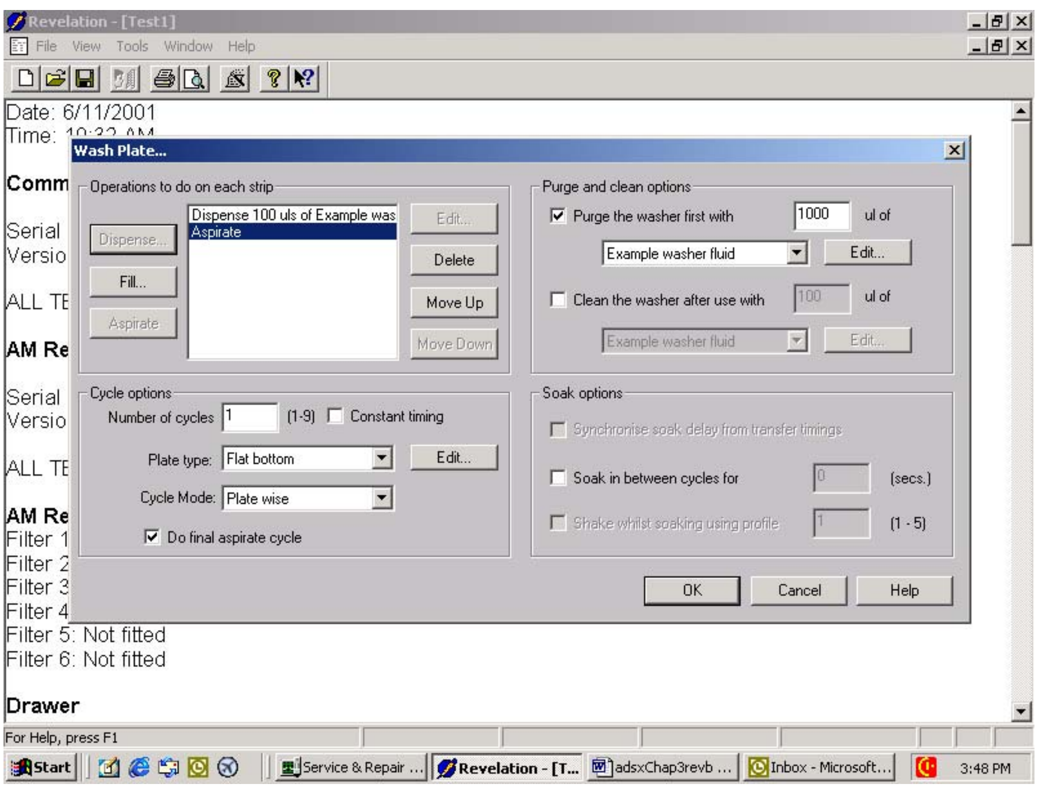

Figure 3-9 DSX *Manual Control Washer Wash Plate Dialog Box*

5 In the *Operations to do on each strip* section, select the **Dispense** option and then select **Aspirate**. In the *Purge and clean options* section, select **Purge the washer first with**, and enter a value of **1000ul**. In the *Cycle Options* section, enter the Plate Type and Cycle Mode, and select **Do final aspirate cycle**. Insert a carrier with the appropriate plate and select **OK**.

6 The unit will perform the operation.

> ***Note****: This is a basic example of a simple wash; it can be tailored to operate differently depending on the desired outcome.*

3.6 Returning Components

When a component (for example, a washer) is to be returned to DYNEX Technologies, the user or service engineer is expected to obtain a return authorization number before shipping the unit and must include an Equipment in Transit form (Figure 3-10). For international locations, please contact your local DYNEX Technologies facility.

DYNEX
TECHNOLOGIES

EQUIPMENT IN TRANSIT

IMPORTANT: Please include a copy of this form with each instrument. If your instrument contains a hard drive please retain back-up copies of any stored files. Failure to do so may result in loss of those files.

Return Authorization Number: ____________
Contact Technical Service, DYNEX Technologies
Phone: (800) 228-2354
Fax: (703) 631-7816
Equipment: ____________
Serial Number: _________

EQUIPMENT DECLARATION

Clearly indicate fault condition or reason for return.

CERTIFICATE OF DECONTAMINATION

I certify that the equipment described above has been disinfected/decontaminated*
and is clean, dry and fit for transport.

Signed: ____

Title: ____

Date: __________________

(DYNEX Technologies reserves the right to refuse improperly cleaned equipment)

Shipping address: DYNEX Technologies
Attn: (Above return number)
14340 Sullyfield Circle
Chantilly VA 20151-1683

*** Suggested decontamination methods:**

Readers - Wipe all surfaces with a cloth moistened with 10% bleach or 70% alcohol. If using the bleach solution, follow with a mild detergent solution. Subjecting surfaces to prolonged exposure to 10% bleach is not recommended.
Washers - Please follow the “Decontamination Procedure” found in the manual.

Figure 3-10 Equipment in Transit Form

Chapter 4 Troubleshooting

4.1 Overview

Although the *DSX Automated ELISA System* consists of several components, troubleshooting can be simplified by a consideration of the following guidelines:

- In almost all cases there is a single proximate cause for a problem.
- A fundamental knowledge of each component in the system is extremely useful in diagnosing the problem.
- The availability of critical spare parts in the system is extremely useful. A list of spare parts for the system and supplies is provided in the chapters that describe service for each module.
- If any aspect of the system is changed, run a before and after experiment to verify that the effect of the change is well understood. Do not consider any change as trivial. As an example, if the user has changed the brand/model of microplates, check that all settings are correct.

A detailed troubleshooting table is presented as part of the on-line help file.

Three types of problems are typically observed:

- Initialization Problems - the system does not power up (refer to the section entitled, Initialization on page 4-2).
- System Problems – the instrument powers up successfully but does not appear to be functioning properly. In some cases, there is a communication fault; while in other cases, a component of the system is faulty and must be repaired or replaced. Examples of this type of problem include the inability of the system to deliver the desired volume of sample into the wells or the inability of the lamp in the reader module to illuminate (refer to the section entitled, System Problems on page 4-6).
- Application Problems - in some situations, the system appears to be operating in an acceptable manner but invalid concentration readings are presented. The service engineer should note that there may be a problem with the reagents, the assay protocol, etc. In this situation, it is worthwhile to use standards, independent test solutions or a different assay to verify that the system is functioning properly (refer to the section entitled, Application Problems on page 4-10).

4.2 Initialization

Failures that occur when the system is initially powered up generally fall into two broad categories:

- The Instrument Fails to Power up
- The System Cannot Communicate with the Computer

4.2.1 The Instrument Fails to Power up

The causes for failure of the instrument to power up are presented in Table 4-1. If the instrument fails to power up, the LED on the front panel will not be lit.

Table 4-1 Troubleshooting Failure of the Instrument to Power Up

Symptom	Probable Cause	Resolution
The instrument fails to power up.	The power cord is not connected	Check that the cord is plugged into the instrument electrical outlet (bottom rear of right panel).
	Power is not supplied to the system	Verify that the electrical outlet is not controlled by a switch or timer.
		Verify that there is power at the electrical outlet by plugging in and checking another device (for example, the power line circuit is tripped).
	The fuse is blown	Replace fuse on the side of the main assembly.
	The breaker on the mains power line is tripped	Reset the breaker.
	The power supply is defective	Replace the power supply in the EPOD.

4.2.2 The System Cannot Communicate with the Computer

4.2.3 General Information

When the instrument is powered up and the program is loaded, the system goes through an initialization protocol whereby the system and the personal computer establish communication. The causes for failure of the instrument to communicate are presented in Table 4-2.

Table 4-2 Troubleshooting Failure of the Instrument to Communicate with the Computer

Symptom	Probable Cause	Resolution
COM Error	Incorrect COM port assigned	Check Communications Port (normally the computer is interfaced via Com Port 1). See Checking the Communication Link on page 4-4.
Error Setting COM State	Incorrect COM port assigned	Check Communications Port (normally the computer is interfaced via Com Port 1). See Checking the Communication Link on page 4-4.
Hardware Link	Hardware not present	Check communication setting and cables.
Password Error	Wrong password	Enter correct password (See Incorrect Password on page 4-5).

4.2.4 Checking the Communication Link

If the communication cannot be established, the *DSX Communication Module Error: System is not responding* dialog box is presented (Figure 4-1).

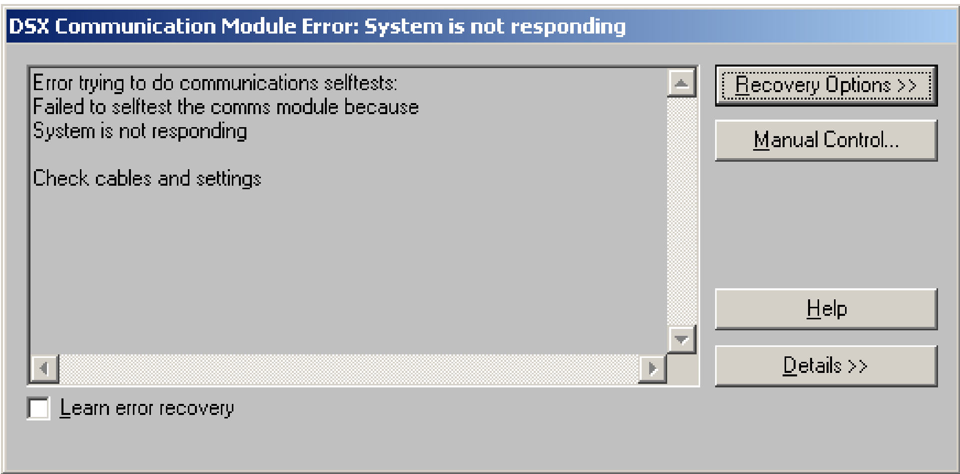

Figure 4-1 DSX *Communication Module Error Dialog Box*

Press the **Recovery Options** button to present the options that are available at this point (Figure 4-2).

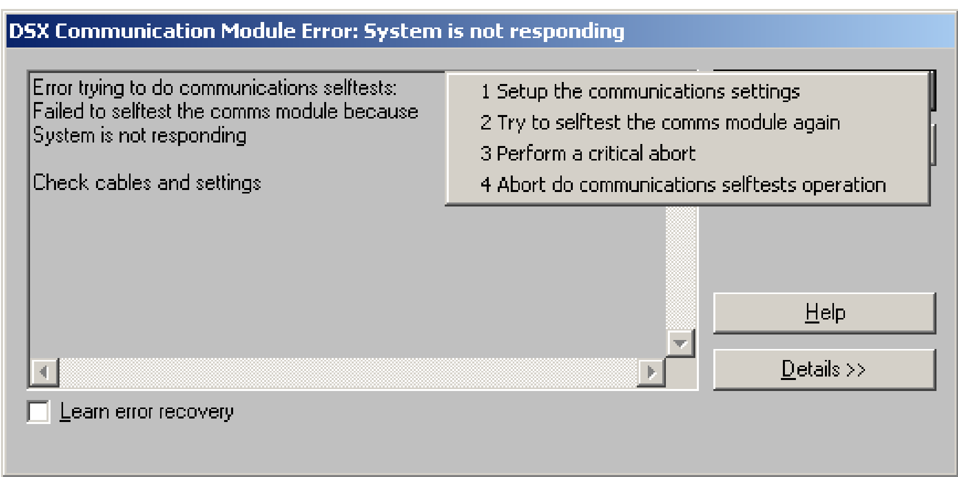

Figure 4-2 Recovery Options Dialog Box

The *Setup the communications settings* option presents the *Setup DSX* dialog box (Figure 4-3), which is used to select the desired communications port. In most cases, the problem is that you have not connected the *DSX™ Automated ELISA System* to the indicated communications port on the personal computer. If this is the problem, select the correct port (at this point, do not worry about the rest of the tabs). In almost all cases, the system should be connected to COM1.

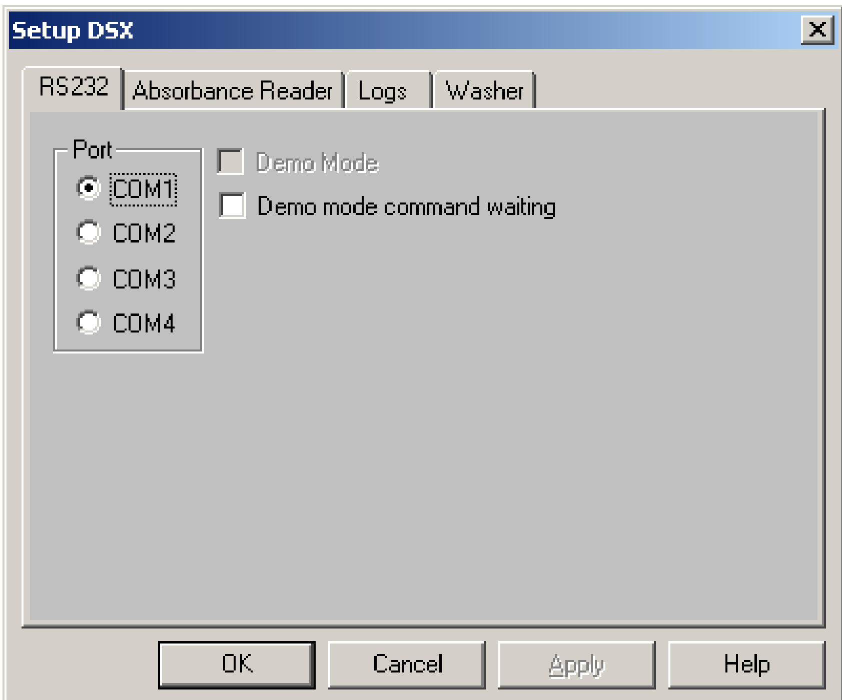

Figure 4-3 Setup DSX *Dialog Box-RS-232 Tab*

4.2.5 Incorrect Password

The user is prompted to enter a password whenever the application program is opened (when the instrument is shipped, the default password is **Dynex**). The operator can establish a new password via the Password command on the **Tools** menu

If the user loses or forgets the password, it will not be possible to employ the program (nor will it be possible to copy the password or edit it). The program will continued to be stored in memory.

If necessary, the system can be started by deleting the hidden file **Password.Pas** from the Revelation directory and re-starting the program. When the password prompt is presented, enter **Dynex** or **Thermo** (depending on the version). The program will then operate in the normal fashion, and a new password can be entered.

> ***Note***: *This information must not be provided to end-users.*

4.3 System Problems

> ***Note**: The application program displays a number of messages on the display during the normal operation of the system. If a fault occurs, it is likely that an error message will be presented. These messages are designed to help you locate the cause of the problem, and they often suggest possible solutions.*

4.3.1 Communication Problems

This section describes situations in which information from the computer cannot be transmitted to the system or vice versa.

Table 4-3 Troubleshooting Communication Problems

Symptom	Probable Cause	Resolution
Application Error REVEL caused a General Protection Fault.	A fault has occurred in the program.	Close down the program and Windows and try again. If the problem persists, reload the program.
Checksum Error in File.	A file has become corrupted.	If the file is a test, plate data, or curve data file, recreate it.
Command Failed.	A memory conflict has occurred between applications.	Close down the program Windows and try again.
Command retry error. **Command Time out.**	An error has occurred while sending the commands to a module.	Check the communication settings and cables.
Computer control command error.	The command was not accepted by the module.	Check the communication settings and cables.
Device already/not open.	The command was not accepted by the module	Check the communication settings and cables.
Directory nnn does not exist.	Program could not find the specified directory	Make sure the drive and directory are correct.

Symptom	Probable Cause	Resolution
Error ____ loading DLL ____.	Program could not find the required DLL file	Re-install the program.
Error building DCB.	Program could not find a device.	Check the communication settings and cables
Error importing file nnn. Check that the file is of the correct type.	Program could not open the file you asked for	Check that the file is present and of the correct type.
Error importing SID file.	Program could not open the file you asked for.	Make sure that the file is correctly formatted. See the File Format Conventions section in user's manual.
Error opening file nnn.	Program could not find the file you asked for.	Recreate the file.
Error reading assay.	Program could not open the required assay file because it is not of the correct type.	Change the Reader settings to the type that was used to create the file, or try using the **File** menu, Import facility to import it.
Error setting comm state.	Communication between systems lost	Check the communication settings and cable.
File ___ is not the correct version. File ___ is not a Revelation format file.	The file you have tried to open is not a standard format used by this version of Revelation	Error setting comm state. Try importing the file using the **File** menu Import option.
Hardware link...Hardware not present.	Cable accidentally disconnected	Check the communication settings and cables.
Installation Failure.	During installation, Revelation tried to use a file that was being used by another Windows program.	Close down all other programs and run the Setup program again. If Microsoft Office is running, remove its icon from the Startup group and reload Windows. You can replace Office in the Startup group once Revelation is loaded.

Symptom	Probable Cause	Resolution
Insufficient Memory.	A memory conflict has occurred.	If running a complex test, try to simplify it. If you are running other applications, close them.
Internal Application Error.	A fault has occurred in the program	Try repeating the command or reboot the program
Invalid byte size.		Check the communication settings and cables.
Invalid data file format.	The data file you are trying to open is not a standard format used by Revelation.	To open the file, try using the **File** menu, Import facility.
Module Not Loaded.	This assay contains operations that are not available for your Reader model, or you have selected the wrong Reader.	Remove the unsupported operation, set Revelation up for the correct module or check to see if the correct module is installed.
No timers available.	Revelation can not run correctly because of memory conflicts	Close down some of the other applications and try again; if the error persists try resetting the PC.
OLE 2.0 Initialization failed.	A fault has occurred in the program	Try repeating the command or reboot the program
Unable to allocate queues.		Check the communication settings and cables

4.3.2 Problems in a Specific Module

In most instances, if there is a problem within a module, the problem will be obvious (for example, the plate in an incubator is not ejected as expected). If a module appears to be malfunctioning, the typical service response is to replace the entire module and return the defective module for repair. For many problems, error messages will be presented on the status line of the Revelation window.

Specific troubleshooting information and error messages for a given module are presented in the chapter that describes the replacement of components for that module (for example, Troubleshooting information and Error Messages for the Reader module is presented in Chapter 10). If the service engineer is required to repair the defective module on site and has the appropriate spare parts, replacement of the component can be performed.

The service engineer can perform a wide variety of operations (such as ejecting a plate from the reader module) via the *DSX* Manual Control feature, which is described in Chapter 5). In addition, a large number of primary functions (for example, advancing the plate motor one step) can be performed via the advanced manual control feature, described in section entitled, Manual Control Operations on page 5-2. Since these operations can be performed independently of an assay, they can be very powerful tools to assist in troubleshooting.

4.4 Application Problems

Two general types of problems may be noted with the *DSX Automated ELISA System*:

- **Hardware/Software Problem**: When a hardware or software fault is noted, the service engineer is expected to repair, replace, or remedy the problem as described in this manual. Typically, the system is functioning in a satisfactory manner but a fairly straightforward action is performed (for example, the lamp in the reader module is to be changed).
- **Application Problem**: In some instances, all components of the system are functioning in an acceptable fashion but the reported results are incorrect or are not being reported. In this situation, it may be necessary for the service engineer to determine if there have been any changes in the assay protocol.

> ***Note**: Most application issues are due to small and seemingly trivial changes that are made in the overall assay protocol.*

If it is believed that the problem is due to an application issue, we suggest the following steps:

- Verify that the assay file has not been edited or modified in any way.
- Run standards (if they are not part of the assay protocol)
- If any changes have been made in the assay protocol (for example, different lot, pipette tips from a different manufacturer), run a before and after to determine if the change (no matter how seemingly small) has caused the difficulty.
- If the laboratory prepares wash solutions, reagents, etc., it may be necessary to ensure that the quality of all components of these solutions has remained constant.
- Determine if there has been any change in the laboratory environment or laboratory personnel. While the standard operations that the technician must perform is quite straightforward, it is not unlikely that a new technician may unwittingly introduce a small difference that can lead to an error.
- Run a different assay on the system. If the results from the new assay are acceptable, investigate the details of the suspect assay.

Chapter 5 Manual Operation of the System

5.1 Overview

The *DSX Automated ELISA System* is normally operated via an assay protocol in which the various steps in the program are performed to execute the desired assay. If desired, the service engineer can perform individual operations (for example, ejecting the reader plate or moving the pipette) on a manual basis to test the various components.

To access the manual mode of operation, press *DSX* Manual Control… on the **Tools** menu. As an alternative, the manual mode of operation can be accessed if the system is not properly initialized (see the Overview in Chapter 2 on page 2-1).

CAUTION*:* UNDER CERTAIN CIRCUMSTANCES, IT IS POSSIBLE TO DAMAGE THE SYSTEM IN MANUAL MODE (A MESSAGE TO THAT EFFECT IS PRESENTED WHEN MANUAL MODE IS ACCESSED). SOME SAFEGUARDS THAT ARE BUILT INTO THE STANDARD OPERATING PROGRAM ARE NOT OPERATIONAL IN MANUAL MODE AND THE ENGINEER SHOULD MAKE SURE THAT COMPONENTS ARE NOT DRIVEN PAST THEIR PHYSICAL LIMITATION.

5.2 Manual Control Operations

5.2.1 Selecting the Desired Operation

When Manual Control is selected, the *DSX* Manual Control dialog box (Figure 5-1) will be presented. The left column indicates the devices that can be tested and the right column indicates the operation that can be tested for the selected device. To select a different device, move the highlight in the left column to the appropriate entry, to perform a different operation for the selected device, move the highlight in the right column to the desired operation.

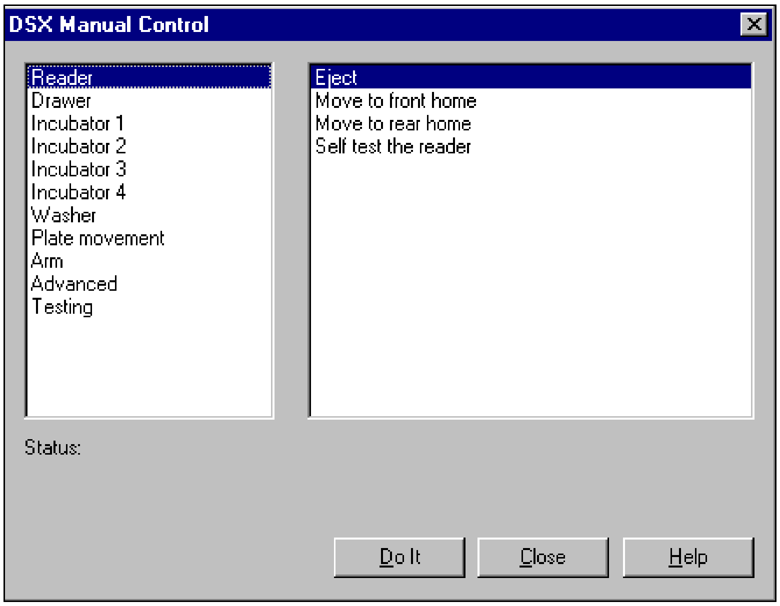

Figure 5-1 DSX *Manual Control Dialog Box (Reader Selections)*

5.2.2 Performing the Operation

Once you have selected the desired operation, press the **Do It** button.

- In many instances, the indicated action will be performed automatically. As an example, if ejection of the Reader is selected (Figure 5-1), the Status line in the dialog box will indicate:

  Doing a move to front home operation

At the completion of the test operation, the Status line will indicate:

Finished a move to front home operation

- In some instances, a dialog box will be presented for additional information. As an example, if Arm is selected in the left column and Move Arm is selected in the right column (see the section entitled, Arm on page 5-9); the Manual Arm Movement dialog box is presented. This dialog box is used to indicate the direction of movement and the distance that the arm is to be moved (Figure 5-2).

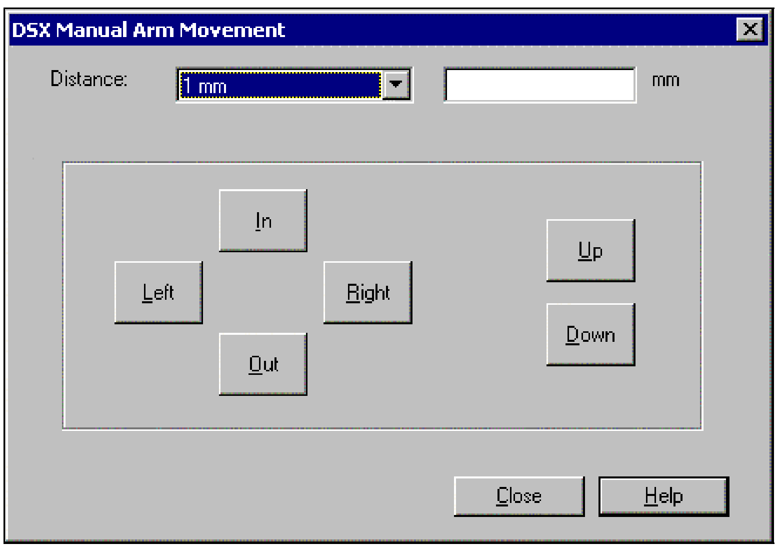

Figure 5-2 DSX *Manual Arm Movement Dialog Box*

5.2.3 Testing the Reader

The Reader test selections are listed in the right column of Figure 5-1. The self-test operation incorporates all of the individual operations.

When you click on the **Do It** button, the status line in the dialog box will indicate that the system is performing the operation (for example, Doing a move to front home operation). At the completion of the test operation, the message will indicate that the operation has been performed (for example, Finished a move to front home operation.

5.2.4 Testing the Drawer

The Drawer test selections are listed in the right column of Figure 5-3. The self-test operation incorporates all of the individual operations.

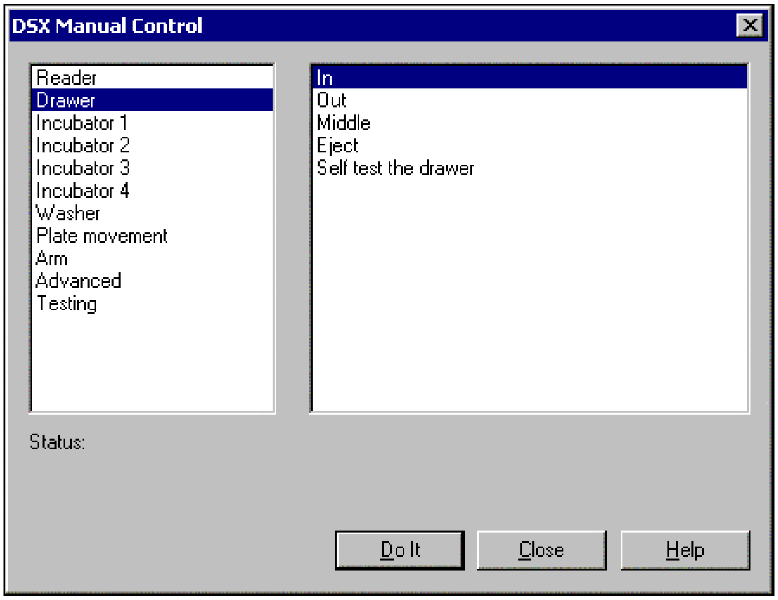

Figure 5-3 DSX *Manual Control Dialog Box (Drawer Selections)*

When you click on the **Do It** button, the status line will indicate that the system is performing the operation (for example, Doing a Drawer Out Operation). At the completion of the test operation, the message will indicate that the operation has been performed (for example, Finished a Drawer Out operation).

5.2.5 Incubators

The Incubator test selections are listed in the right column of Figure 5-4. The self-test operation incorporates all of the individual operations.

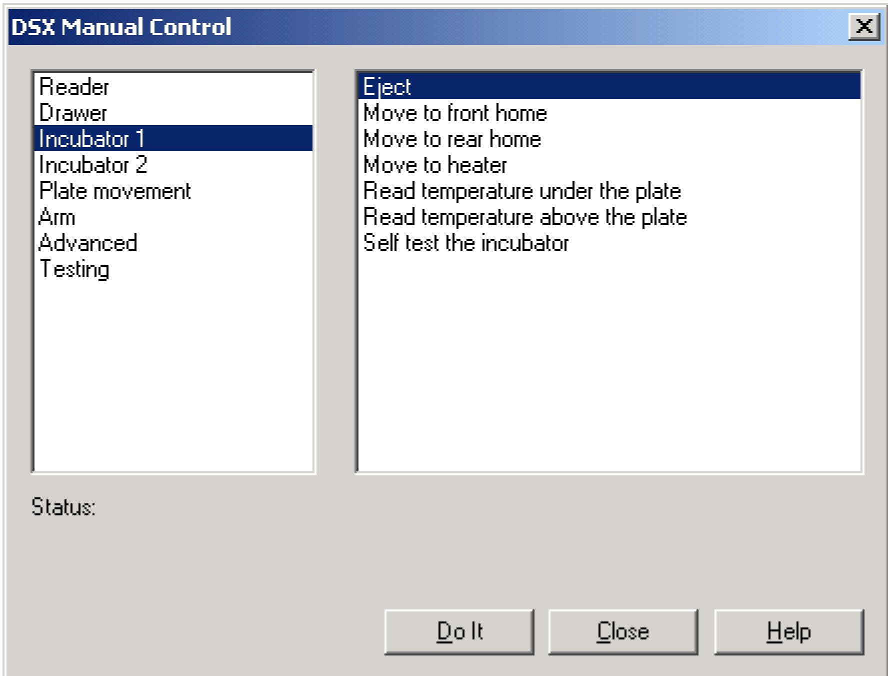

Figure 5-4 DSX *Manual Control Dialog Box (Incubator Selections)*

When you click on the **Do It** button, the Status line will indicate that the system is performing the operation (for example, Doing a Move to Front Home operation). At the completion of the test operation, the message will indicate that the operation has been performed (for example, Finished a Move to Front Home operation).

The testing is identical for the four incubators.

5.2.6 Washer

The Washer test selections are listed in the right column of Figure 5-5. The self-test operation incorporates all of the individual operations.

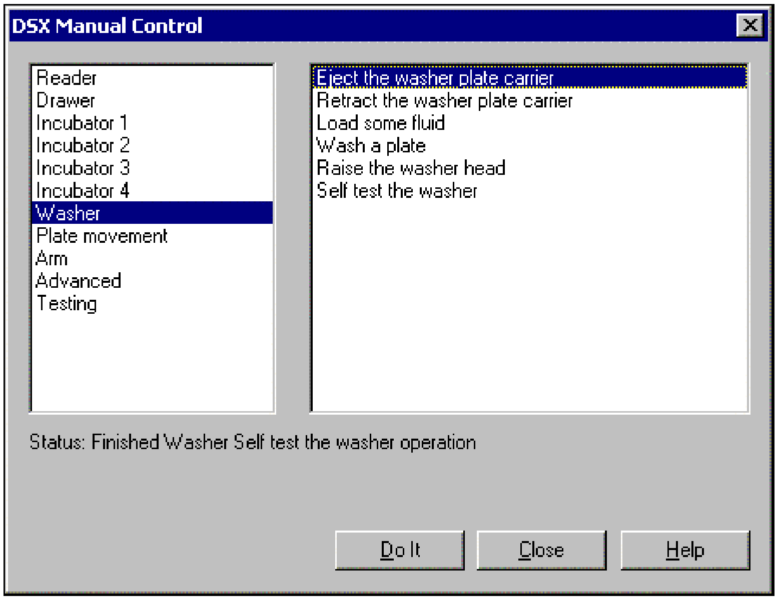

Figure 5-5 DSX *Manual Control Dialog Box (Washer Selections)*

For the Eject the washer plate carrier, Retract the washer plate carrier, Raise the washer head and Self test the washer operations: When you click on the **Do It** button, the Status line will indicate that the system is performing the operation (for example, Doing a Washer Eject the washer plate carrier operation). At the completion of the test operation, the message will indicate that the operation has been performed (for example, Finished a Washer Eject the washer plate carrier operation).

For the Load Some Fluid operation: The Load Some Fluid operation is used to indicate that you wish to use a given fluid for the "Wash a Plate" operation. When you click on the **Do It** button, the Select the fluid you want to load dialog box (Figure 5-6) is presented.

Figure 5-6 Select the Fluid you want to Load Dialog Box

Indicate the desired fluid and the volume and press OK. The system will present a screen indicating the present fluid level and indicate the container (Figure 5-7).

> ***Note**: Be sure to load wash fluid before attempting to perform a wash.*

Figure 5-7 Loading Fluid Screen

After you have loaded the desired volume, click the check box.

For the Wash a plate Operation: The Wash a plate operation is used to indicate that you want to develop a plate washing protocol. When you click on the **Do It** button, the Wash Plate dialog box (Figure 5-8), which is used to indicate the desired operations is presented. A detailed discussion of this operation is presented in the section entitled, Washing A Plate on page 5-13.

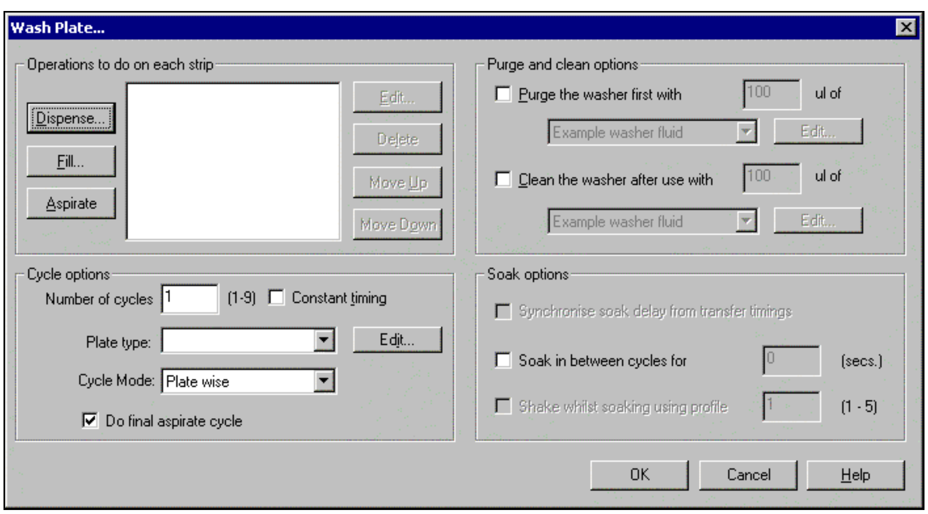

Figure 5-8 Wash Plate Dialog Box

5.2.7 Plate Movement

The Plate Movement test selections are listed in the right column of Figure 5-9.

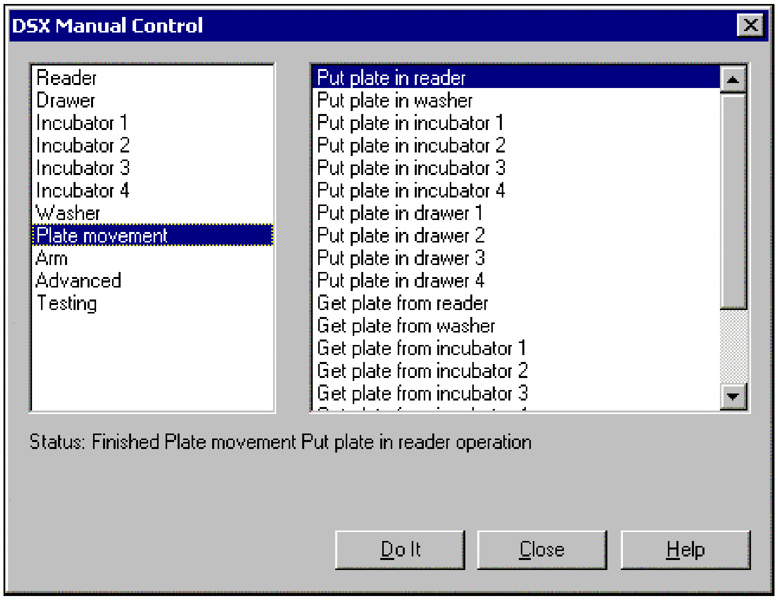

Figure 5-9 DSX *Manual Control Dialog Box (Plate Movement Selections)*

When you click on the **Do It** button, the Status line will indicate that the system is performing the operation (for example, Doing a Plate Movement Putting Plate in Reader operation). At the completion of the test operation, the message will indicate that the operation has been performed (for example, Finished Plate Movement Putting Plate in Reader operation).

5.2.8 Arm

The Arm test selections are listed in the right column of Figure 5-10.

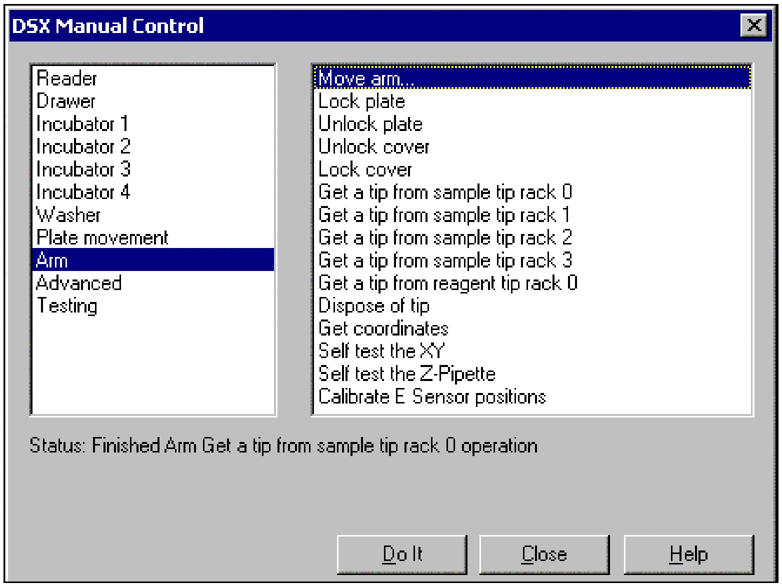

Figure 5-10 DSX *Manual Control Dialog Box (Arm Selections)*

For **Lock plate**, **Unlock plate**, **Lock cover**, **Unlock cover**, **Dispose of tip**, **Self test the XY**, **Self test the Z-Pipette** and **Calibrate E Sensor** positions: When you click on the **Do It** button, the Status line will indicate that the system is performing the operation (for example, Doing a Dispose of Tip operation). At the completion of the test operation, the message will indicate that the operation has been performed (for example, Finished Dispose of Tip operation).

For the **Get a tip from sample tip rack 0,1,2,3** entries and the **Get a tip from reagent tip rack 0** entries, the display presents a dialog box similar to Figure 5-11.

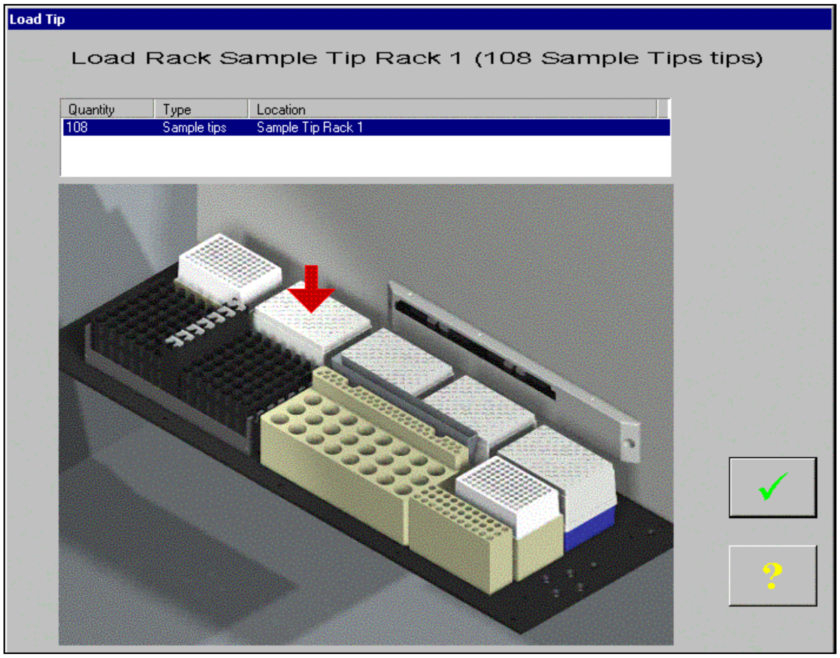

Figure 5-11 Load Tip Window

Make certain that a tray of tips is positioned in the appropriate area, then click the check box. The pipette will pick up a tip from the tray.

The Status line will indicate that the system is performing the operation (for example, Doing an Arm Get a tip from sample tip rack 0 operation). At the completion of the test operation, the message will indicate that the operation has been performed (for example, Finished Arm Get a tip from sample tip rack 0 operation).

For the Get Coordinates entry, the status line will indicate that the system is performing the operation. At the completion of the operation, the status line will indicate that the operation is complete. The dialog box will include the coordinates as shown below:

Coordinates are 3362, 44, 0

5.2.9 Advanced

The Advanced test selection is used to send primary commands to a module to check more specialized operations on a customized basis. When Advanced is selected, the Send command(s) operation is presented (Figure 5-12).

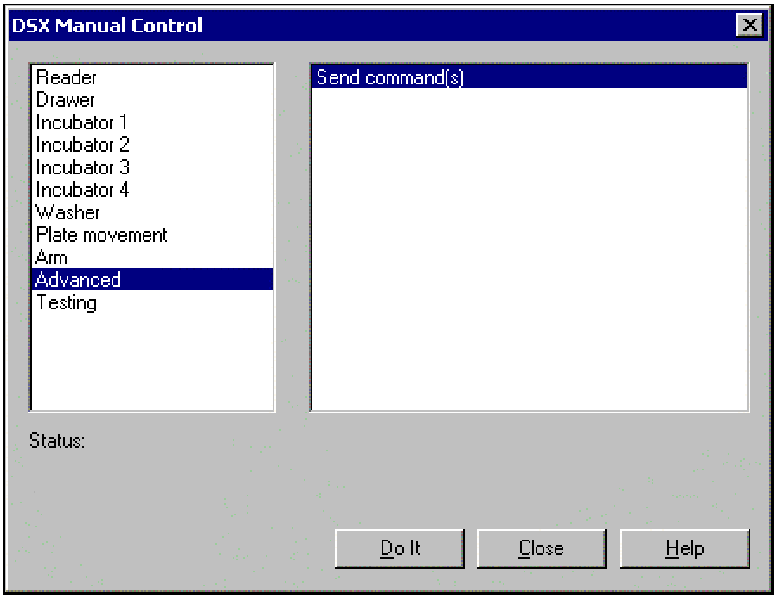

Figure 5-12 DSX *Manual Control Dialog Box (Advanced Selection)*

When you press the **Do It** button, the Command Direct dialog box (Figure 5-13) is presented.

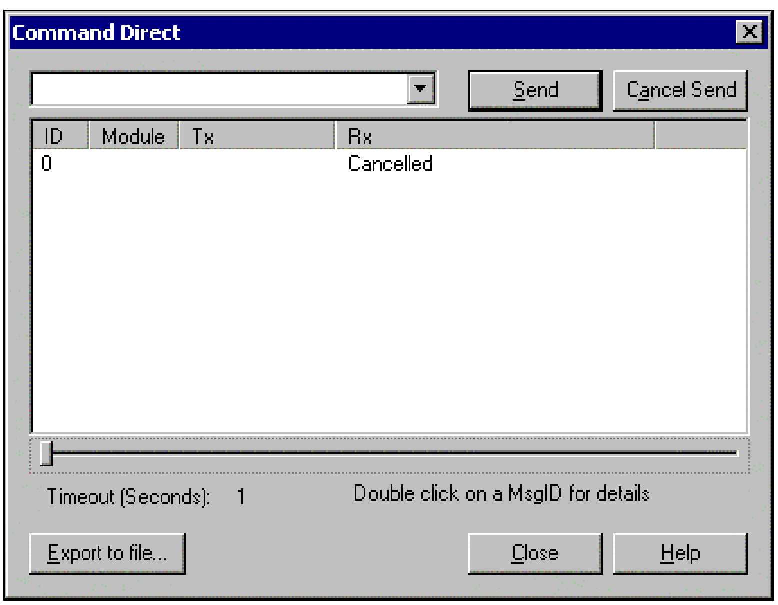

Figure 5-13 Command Direct Dialog Box

The Command Direct option is reserved for in-house service personnel.

5.2.10 Testing

The Testing test selections are listed in the right column of Figure 5-14.

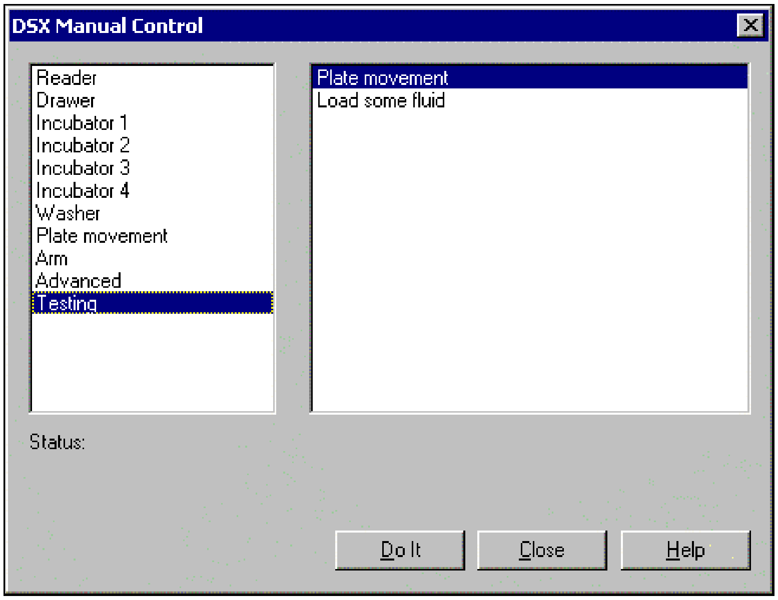

Figure 5-14 DSX *Manual Control Dialog Box (Testing Selection)*

Plate Movement presents a dialog box to prompt the engineer to indicate how many cycles are desired. When the cycle number is indicated, the engineer is prompted to place a plate in the left front drawer position. When the test is initiated, the plate movement will be performed for the indicated number of cycles.

Load Some Fluid presents the Select the fluid you want to load dialog box (Figure 5-15). Select the desired fluid and volume and click **OK**.

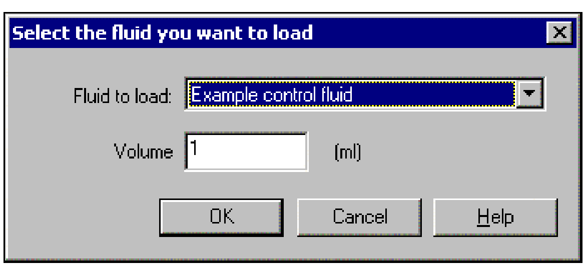

Figure 5-15 Select the Fluid you want to Load Dialog Box

The Load Fluid window (Figure 5-16) will be presented. Place the indicated volume in the indicated position and press the check mark to initiate the test. This process can be performed with several vials.

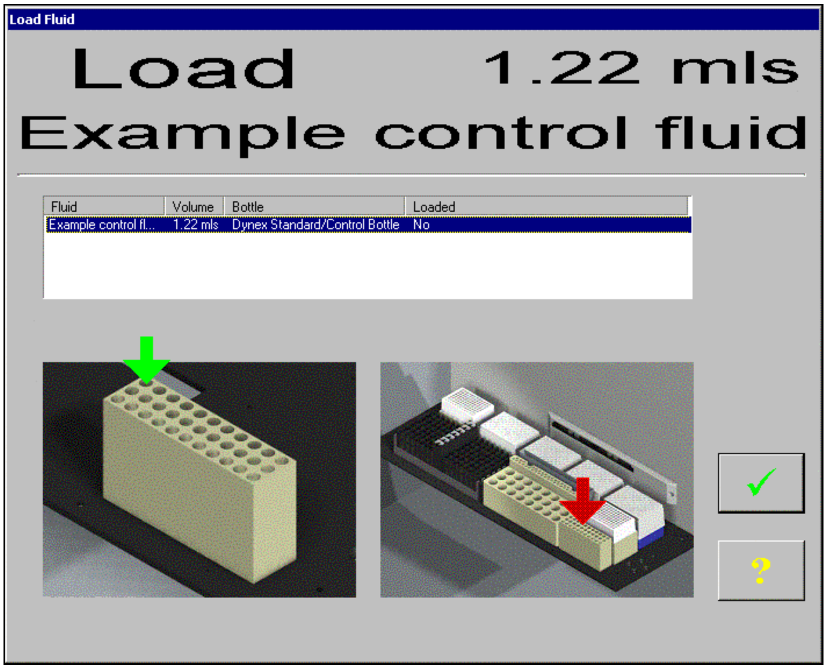

Figure 5-16 Load Fluid Window

5.3 Washing A Plate

When the Wash a Plate selection is made on the Washer activity list (Figure 5-5), the Wash Plate… dialog box (Figure 5-17) is presented to indicate the conditions for the test.

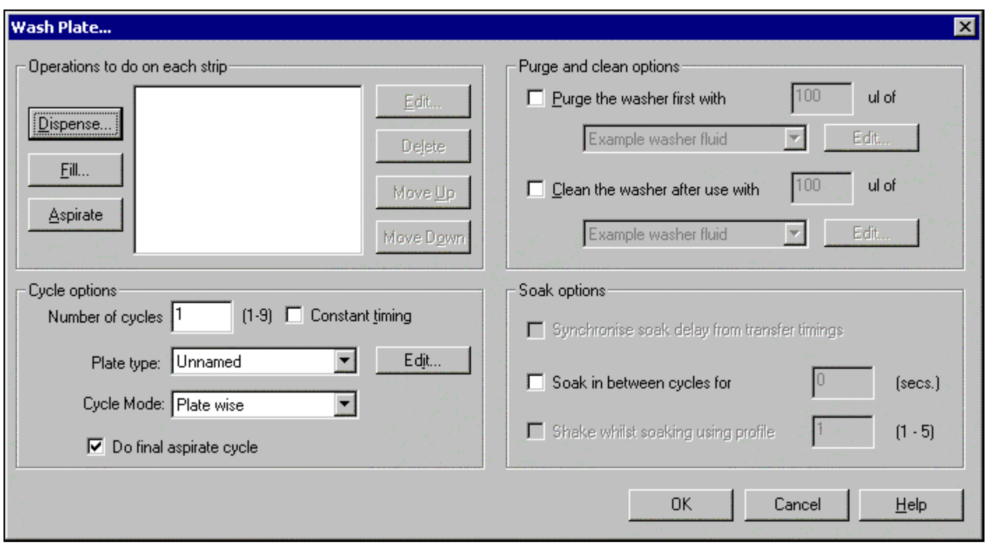

Figure 5-17 Wash Plate… Dialog Box

The service engineer should establish the washing protocol that is desired, using **Dispense**, **Fill** and **Aspirate** steps as appropriate. In addition, the desired Cycle options (for example, select the appropriate plate type), Purge and clean options and Soak options should be entered. When a dispense operation is selected, the Wash Strip dialog box (Figure 5-18) is presented and when a fill operation is selected, the Fill settings dialog box is presented (Figure 5-19).

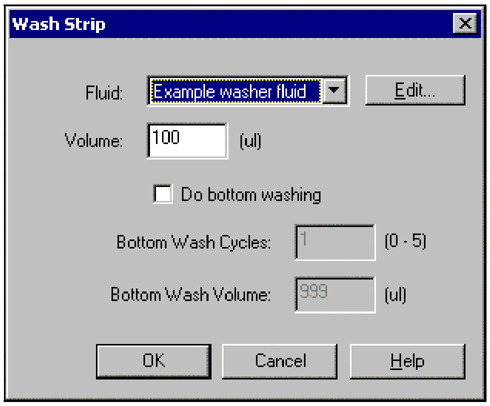

Figure 5-18 Wash Strip Dialog Box

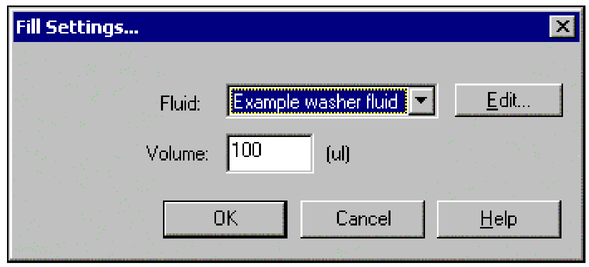

Figure 5-19 Fill Settings Dialog Box

A typical wash plate sequence is presented in Figure 5-20.

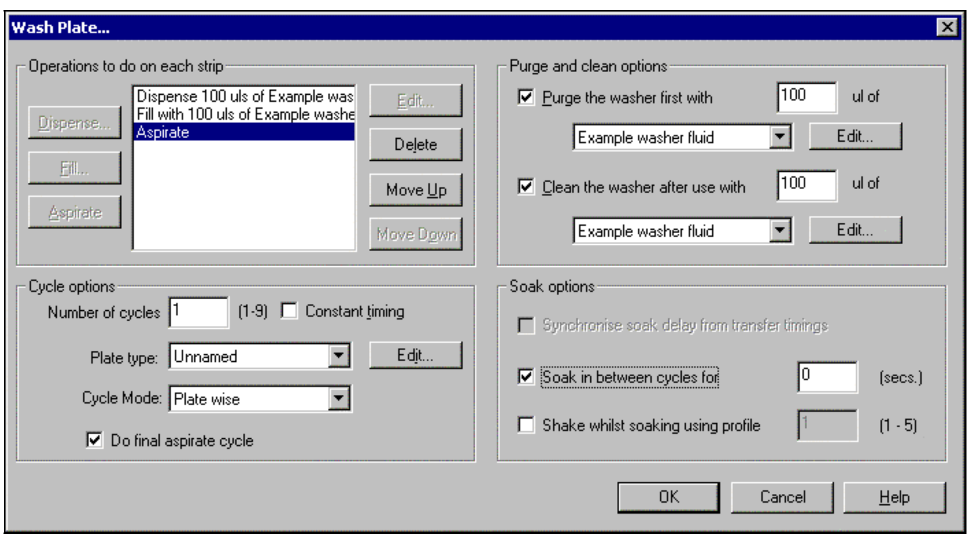

Figure 5-20 Typical Wash Plate Sequence

After the entries have been established, click **OK** to execute the operation. The status line will indicate that operation is proceeding and will indicate when it is finished.

Chapter 6 The Pipette Module/XYZ Drive

6.1 Overview

The Pipette Module is used to:

- Pick up pipette tips from the pipette trays in the work area.
- Aspirate the various fluids (for example, samples, controls, blanks) from the appropriate containers
- Dispense the various fluids into the desired wells on the microplate
- Deliver used tips to waste.
- Move the plate from one module to another (for example, from the ambient tray to the reader).

The present position of the pipette module and the coordinates of each "device" are stored in memory. The pipette module is moved by the XYZ drive as determined by the microcomputer, which calculates the number of steps in each direction that must be taken to position the module to perform the desired task. As an example, if the pipette module is at position a, b, c and has to go to position d, e, f to pick up a plate from the incubation module, the microcomputer will move the pipette module d-a steps in the X direction, **e-b** steps in the Y direction and **f-c** steps in the Z direction.

In addition to monitoring the position of the pipette module, the microcomputer:

- Monitors the usage of pipette tips so that the pipette module can be positioned to pick up the next pipette tip on the pipette tray (rather than being sent to a position that does not have a pipette).
- Monitors the location of the various samples, standards, blanks as well as the volume in the standards and blank tubes.

When the pipette module is in the desired position, the microcomputer will issue a signal to perform the desired operation, which might be to lift the plate from the incubator tray or to withdraw an amount of liquid from the sample vial.

In normal operation, the position of the pipette module and the activity to be performed are determined by the steps in assay that is being run. As an alternative, the service engineer can use the *DSX* Manual Control command on the **Tools** menu to manually perform the desired operations (instead of running an assay.) as described in Chapter 5.

The service engineer is expected to be able to replace a number of components of the X-Drive, Y-Drive, and Z-Drive such as the drive belts, motors, transition boards, etc. In the event of a failure in the Pipette Module, the entire pipette module is to be replaced. A discussion of the various repair/replacement activities is presented in Chapter 7 that includes troubleshooting information.

The X-Drive and Y-Drive components are discussed in the section entitled *The X-Drive and Y-Drive* on page 6-3, while the Z-Drive and the Pipette Module are discussed in the section entitled *The Z-Drive and the Pipette Module* on page 6-11.

6.2 The X-Drive and Y-Drive

6.2.1 General Design of the Drive Mechanisms

The XY module controls the movement of the pipette arm in the X- and Y- directions. The pipette tip can be driven in either direction on an independent basis or can be driven in both directions simultaneously.

The X and Y-Drive mechanisms each include a stepper motor under the control of a transition board (printed circuit board) as shown in Figure 6-1 through Figure 6-4. The stepper motor drives a belt that moves the pipette module in the specified direction. An encoder/counter is associated with each motor to ensure correct positioning and an optical sensor is mounted on the rail as a reference.

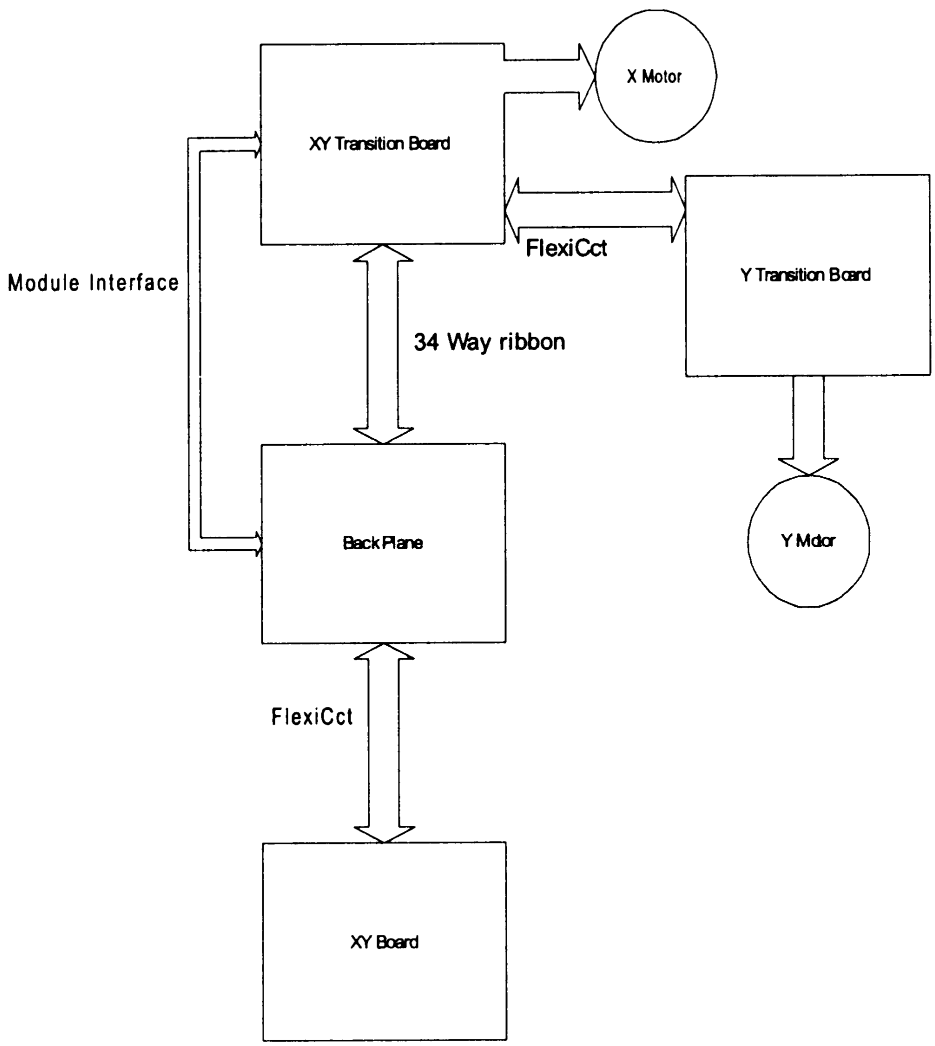

Figure 6-1 Circuit Board Diagram – Board Breakdown

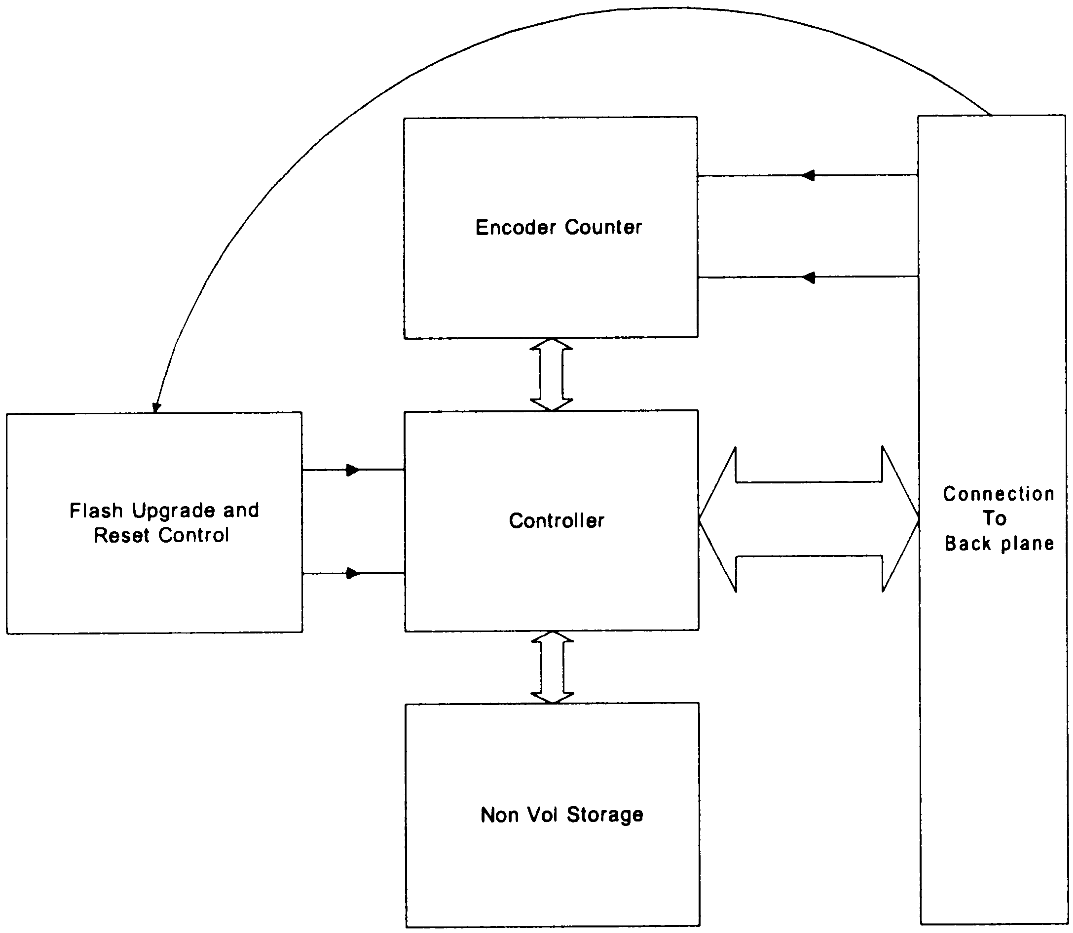

Figure 6-2 XY Control Diagram

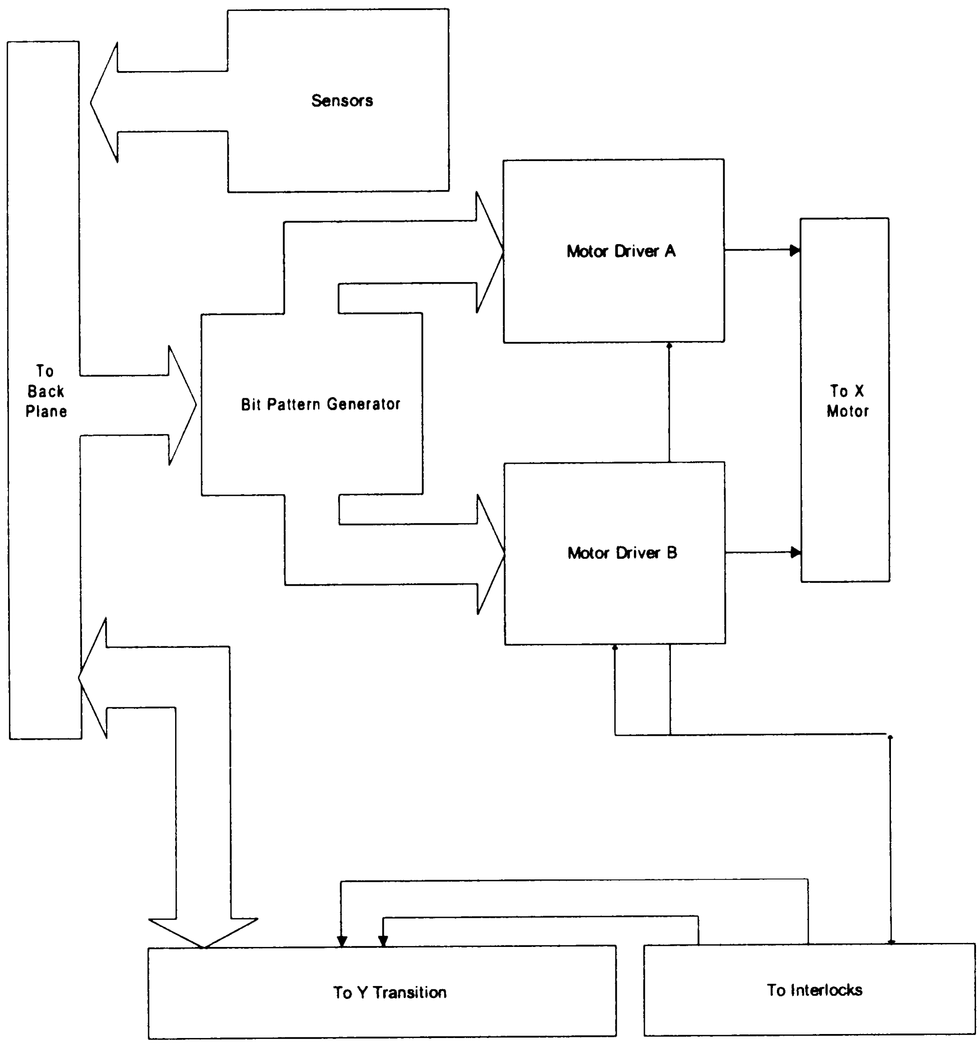

Figure 6-3 X Motor Drive Transition

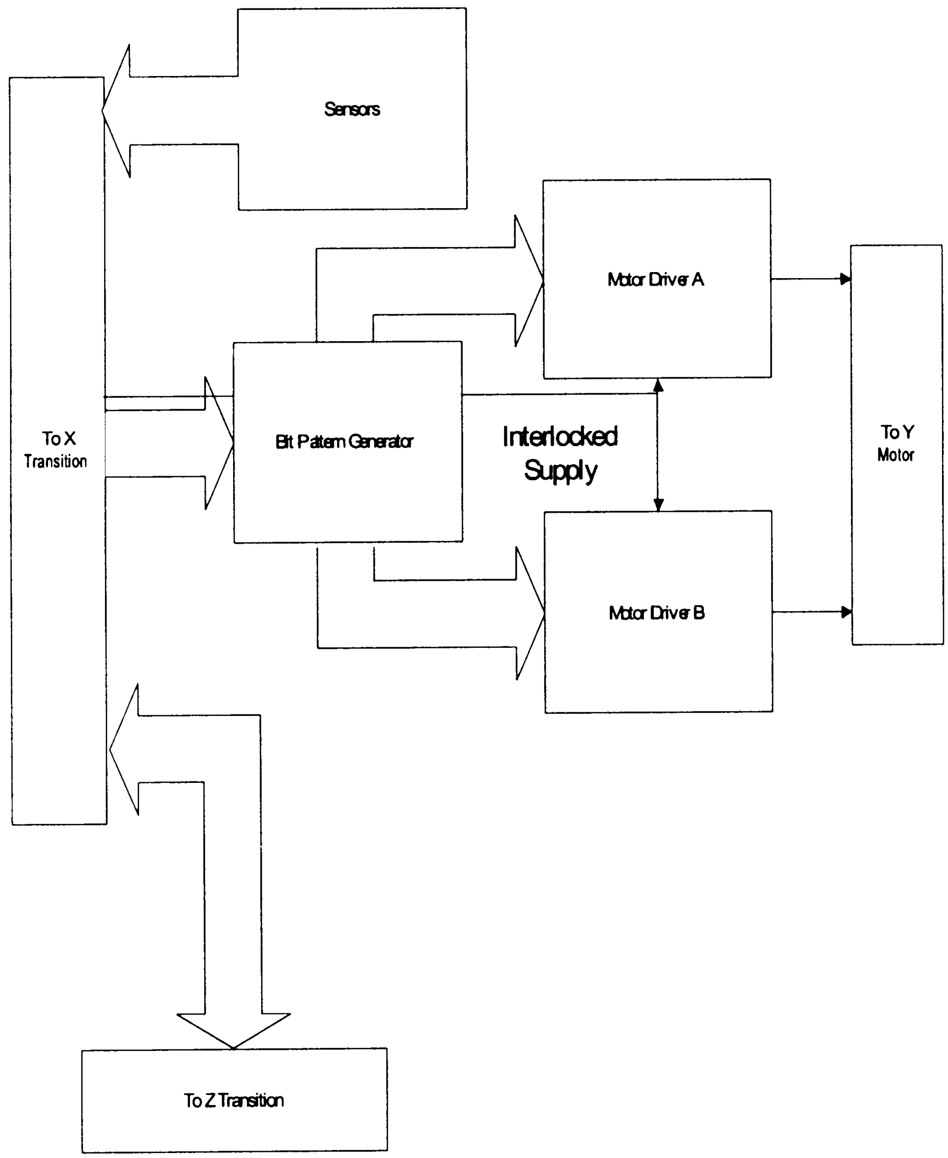

Figure 6-4 Y Motor Drive Transition

Components of the XY module are located in different parts of the system, as follows:

1. The main XY module circuit is in the Electronics pod assembly (EPOD).
2. The X-Drive board is near the X motor at the right-hand end of the X track.
3. The X encoder and X home sensor are both at the left-hand end of the X track.
4. The Y-Drive board, the Y motor, the Y home sensor and the Y encoder are all grouped together and are located at the end of the Y arm above the X track.

6.2.2 Command Types

Commands for the X-Drive and Y-Drive fall into two general categories:

- Motion commands cause the XY program to drive the X and/or Y motors and to read their encoders to check that the correct position has been achieved. The home sensors, one for each motor, are used to position each motor at its 'home' position before setting its encoder to zero.
- Data commands cause the XY program write and/or read the state of internal variables such as the value of the home offsets, and external variables such as the value of the encoders.

A data flow diagram is presented in Figure 6-5.

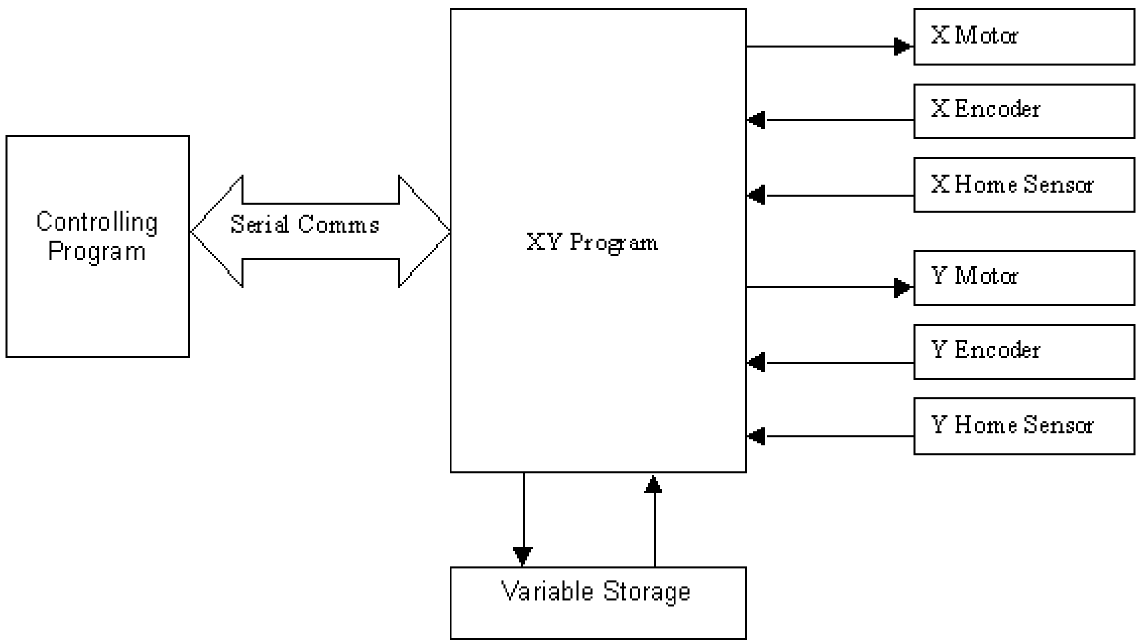

Figure 6-5 Data Flow Diagram

6.2.3 Top Level Functional Design

The top-level functional design is presented in Figure 6-6. When the XY program starts, it initializes the Input/Output ports, the global variables, the position encoders and the Serial communications sub-function. Then the program enters a continuous loop in which it checks the Serial port for incoming traffic and corrects the absolute position of the X-Drive and Y-Drive. On detecting an incoming command, the program decodes it, executes it and replies with the result.

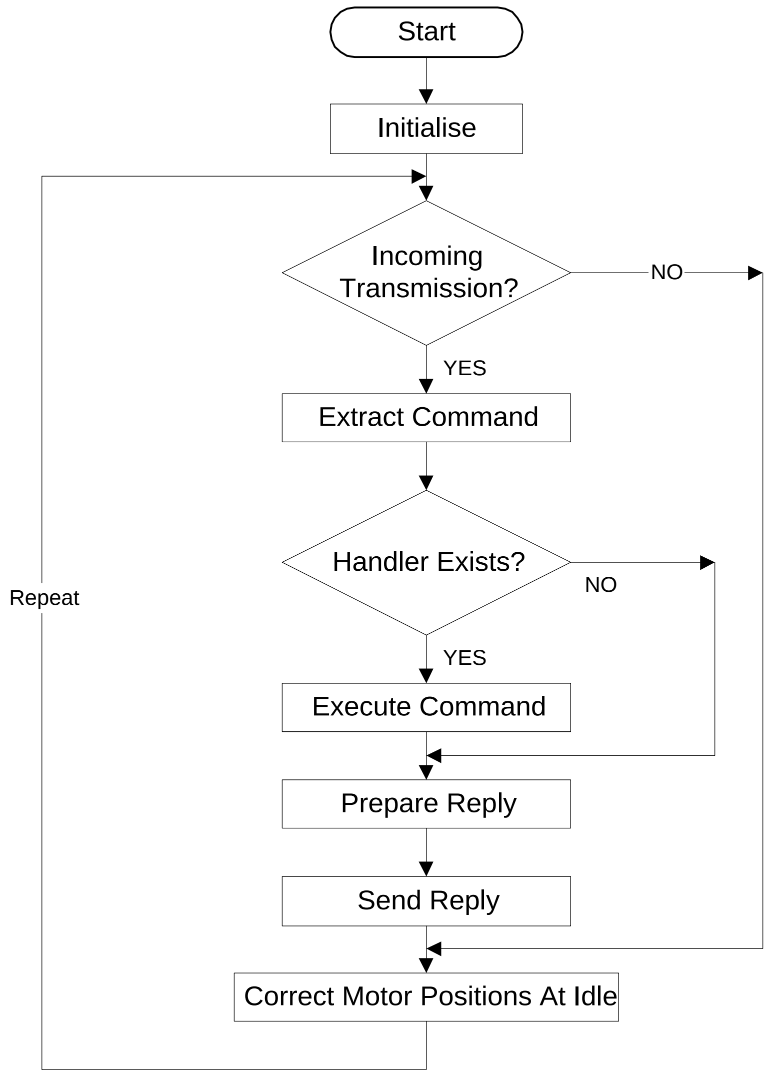

Figure 6-6 Top-Level Functional Design XY Program

6.2.4 Hardware Considerations

6.2.4.1. Motors and Drive Mechanism

The XY module drives and controls two stepping motors which can be operated singly or both can be driven at the same time. The position of the two axes is verified using encoders and a slotted-opto switch is provided for reference. The XY module communicates via a standard Trilogy module interface which is routed from the back Plane via the X transition and drive board.

The motor drive supply is 48V so that the motors can develop the torque and speed required to drive the arms. The Bit Pattern generator is a MACH211 device that with Direction and Step produces the bit patterns required to drive the motors in quarter step mode.

Additional current control is supplied by the boost signal which when held low reduces Vref and thus reduces the current at which the current chopper cuts in. This is to allow the motor current to be reduced when the motor is stationary and thereby reduces the heat dissipation of the motor and driver chips.

The brake signal momentarily short circuits the motor drives causing the motor current to be reduced rapidly to bring the motor to a halt.

6.2.4.2. Voltage Generation and Regulation

- **Motor Supplies** - The motor supply (48v) is supplied from the Interlock switches directly to the X transition board. It arrives on the board as two separate 24 V supplies. One supply is tied to ground, via the 0 V line, at the Back Plane. On the Transition board the second 0v line is tied to the first 24v volts. This produces 24 V and 48 V supplies for the stepper motors. The 24 V motor supply is not used for the X-Drive or Y-Drive, but is routed through for the Z-Drive.
- **Logic and Control supplies** - The +12 V from the module interface is used directly for the flash programming voltage (FVPP), it is also the input to a dc\dc converter which provides the 5 V logic supply. The logic GND is star connected to chassis on the Back Plane.

6.2.4.3. Microcomputer

The XY Module hardware is based around the Hitachi H8/3337F single-chip microcomputer. This microcomputer provides 60Kbytes of Flash ROM and 2Kbytes of RAM and operates at 16 MHz. The H8/3337F has the following internal peripheral capabilities:

- 9 ports, providing 58 I/O and 8 Input lines
- Two 8-bit timers (TMR0, TMR1)
- One 16-bit free-running counter (FRC)
- Two digital to analog channels (DA0, DA1), with 8-bit resolution
- Eight analog to digital channels (AN0 through AN7), with 10-bit resolution
- Two serial communications channels (COM0, COM1)
- Two pulse width modulation channels (PWM0, PWM1)

6.2.4.4. Port Configurations and Operating Mode

The I/O ports are configured to allow maximum software control of all XY functions within the limitations of timing and functionality of the H8/3337 and to minimize external hardware.

To maximize this capability, the H8/3337 is configured in the single-chip mode to allow all port pins to be available. The “single-chip” mode of operation implies that there are no external program memory resources available to the software. The entire program must fit within the confines of the 60Kbyte internal ROM space, and all variables, stack, and heap space must be restricted to the 2Kbytes of internal RAM.

An external ST93C46CB1 serial EEPROM connected to port P1 is used to store setup and calibration information for the XY Module.

An MAX705 microprocessor supervisor IC is connected to the Reset input on the H8 to provide reset on power up.

6.2.4.5. Serial Communications with Controller

Commands and test data are transferred between the H8 microprocessor and the communications controller via a serial RS-232 interface. Interface drivers and receivers are used between the COM1 serial communications channel on the H8 microprocessor and the interface connector to provide proper RS-232 signal levels to the controller.

DSR is signalled via Port 8-6.

6.3 The Z-Drive and the Pipette Module

6.3.1 General Design of the Drive Mechanisms

The Z/Pipette module consists of the Z-Drive, the Pipette and the "Load and Eject" mechanism. The roles of these three components are as follows:

- The Z component is responsible for moving the module up and down its arm as required.
- The Pipette component is responsible for detecting fluid, dispensing it and aspirating it.
- The Eject component is responsible for holding a plate carrier and for ejecting a tip.

The Z/Pipette module controls the movement of the Z motor, the Pipette motor and the Eject motor, either individually or together.

The electronics of the Z/Pipette module is presented in Figure 6-7 and Figure 6-8.

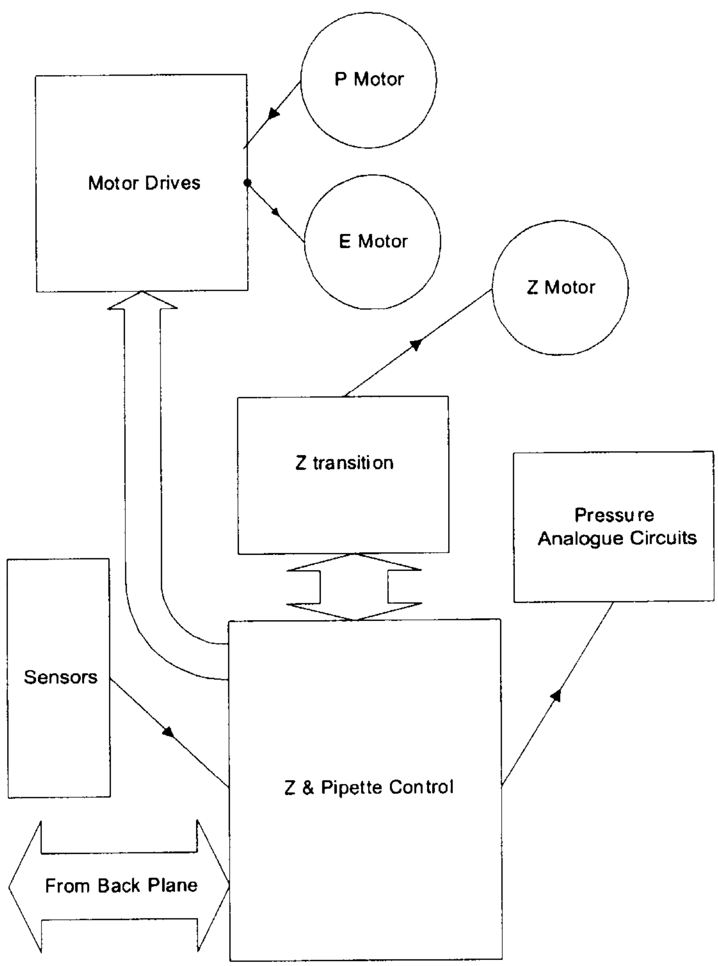

Figure 6-7 Circuit Board Mechanism

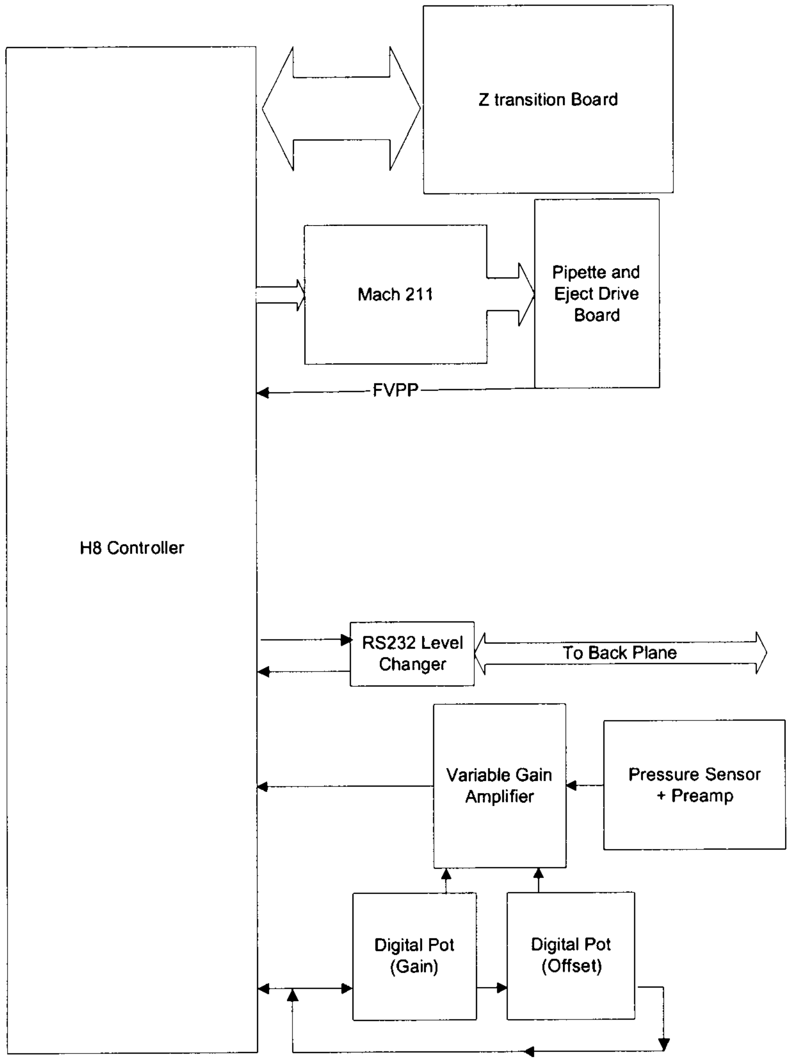

Figure 6-8 XY Control Diagram

Components of the Z Pipette module are located in different parts of the *DSX*, as follows:

- The Z Pipette main board is in the Z module, which is moved up and down the Z arm.
- The Z-Drive board and Z home sensor are near the Z motor at the top end of the Z track.
- The Z encoder is at the bottom of the Z track.

6.3.2 Command Types

Command types for the Z-axis and pipette module fall into the following two categories:

- Motion commands cause the Z/Pipette program to drive the Z, P or E motors and to read the Z encoder to check that the correct Z position has been achieved. The home sensors, one for each motor, are used to position each motor at its home position and setting its step position to zero.
- Data commands cause the Z/Pipette program to write and/or read the state of internal variables such as the value of the home offsets, and external variables such as the value of the Z encoder.

The Data Flow diagram is presented in Figure 6-9.

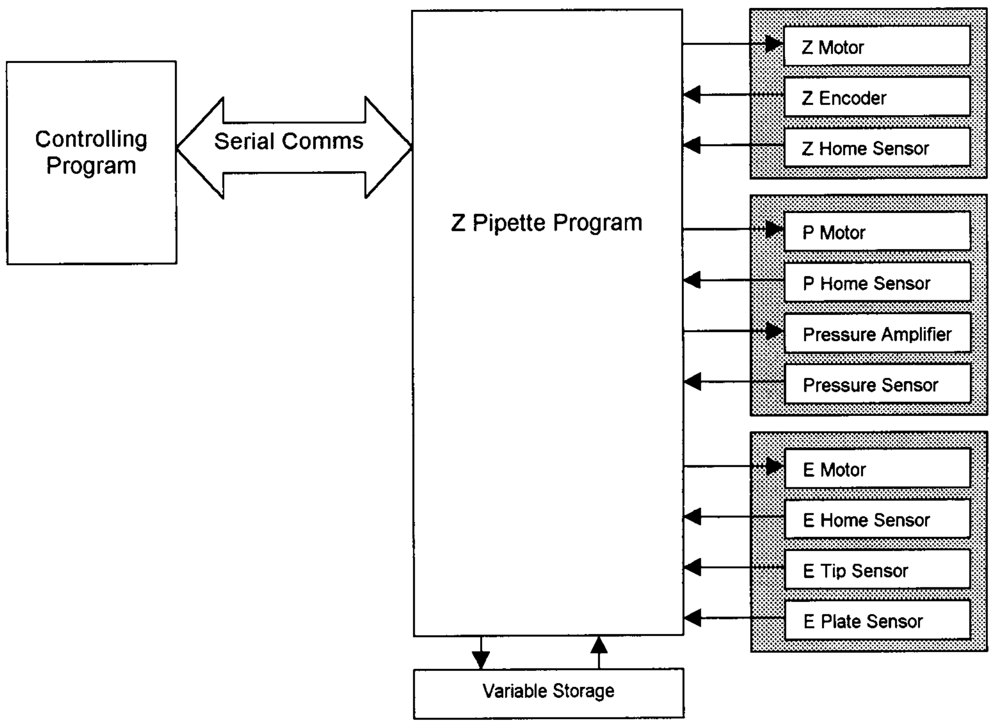

Figure 6-9 Data Flow Diagram

6.3.2.1. Functional

The following scenario describes the main function of the Z Pipette module.

- When the XY arms have repositioned the Pipette module over a tip container, the Z component moves the Eject component up and pipette down so that the spigot is pushed into a new tip, thus loading a new tip. The Z component is then moved up, with the loaded tip.
- When the XY arms have repositioned the Z Pipette module over a fluid container, such as a bottle or sample tube or deep well, the Z component moves the tip down into the fluid. The fluid level is detected by using the pressure sensor to detect the change in pressure when the tip enters the fluid.
- The Pipette component then aspirates the required amount of fluid into the tip. The Z component may move down to track the falling level of the fluid, if required, while the fluid is aspirated. The Z component is then moved up, with the tip loaded with fluid.
- When the XY arms have repositioned the Z Pipette module over the required fluid container, such as a microplate well or deep well, the Pipette component dispenses the required amount of fluid into the well. The XY arms then dispense some fluid to the next well, and so on.
- When all operations with the current tip have been performed, the XY arms reposition the Z Pipette module over the used-tip container, and the Eject component pushes the tip down so that it falls off the spigot, thus ejecting the tip.
- When the XY arms have repositioned the Z Pipette module in front of the required plate carrier, the Z component moves the module down. Then the Y motor moves the Z Pipette module inwards, to engage in the slot of the plate carrier. Then the Eject component is moved down so that it clamps the plate carrier on the spigot. The Z component is then moved up, holding the plate.
- When the XY arms have repositioned the Z Pipette module at the required destination, the Z component moves down to position the plate in the carrier holder. The Eject component moves up so as to disengage the plate carrier, thus loading the plate carrier into the new position. The XY arms then move the Z Pipette module away without the plate.

6.3.3 Top Level Functional Design

On starting, the Z Pipette initializes the IO ports, the variables, the Z encoder and the communications sub-function and the program continuously checks the serial port for incoming information. On detecting an incoming command, the program decodes it, executes it and replies with the result as shown in Figure 6-10.

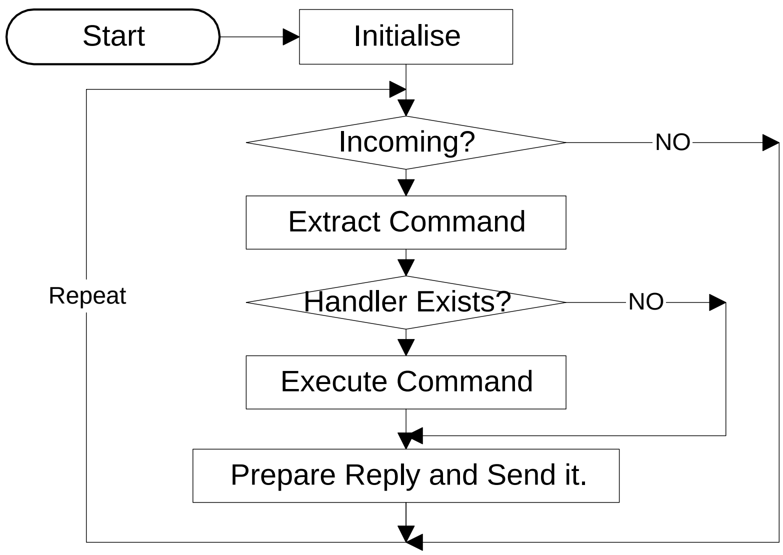

Figure 6-10 Top Level Z/Pipette Module Program

6.3.4 Hardware Considerations

6.3.4.1. Motor Drivers Pipette and Eject

The Pipette and Eject motor drivers are similar, using the A2919, and set for 0.5 amps. The pipette actuator is only rated for 350 mA with a software boost, and driven in quarter steps. The Eject motor runs in half steps.

6.3.4.2. Motor Driver Z Motor

The Z Motor is driven via two National Semi Conductor H drivers ICs. These are mounted on the Z Transition board on the Z-axis arm. The motor voltage is 24V and the H drivers use current limiting to produce a driving current of 1.5A with boost and 0.9 Amps without boost.

6.3.4.3. Pressure Sensing

The SDX-A family of sensors produces a voltage directly proportional to the pressure applied. This voltage for a 12 volt supply is +/- 11mv full scale span. This equates to +/- 1 psi. An AD 620 instrumentation amplifier is used for the first stage of amplification. This is followed by an op-amp with a gain that can be adjusted from 1 to 50 in 512 steps, by use of a Digital potentiometer. At zero voltage there may be an offset of +/- 0.3 mV, there may also be an offset of +/- 0.5mV due to temperature fluctuations. These are removed by the use of a second digital potentiometer. The amplified signal is level shifted by 2.5 volts to ensure that negative pressures can be measured.

6.3.4.4. Voltage Generation and Regulation

The Vcc is for the Control and driver board utilize a Newport Power NMA 2405S that provides +/5v for a total of 2 Watts.

The Vcc for the Transition board is derived from a Newport Power NME 2405S which provides 1 Watt @ +5v.

6.3.4.5. Microcomputer

The Z & Pipette Module hardware employs the Hitachi H8/3337F single-chip Microcomputer operating at 16 MHz. This microcomputer provides 60Kbytes of Flash ROM and 2Kbytes of RAM. The H8/3337F has the following internal peripheral capabilities:

- 9 ports, providing 58 I/O and 8 Input lines
- Two 8-bit timers (TMR0, TMR1)
- One 16-bit free-running counter (FRC)
- Two digital to analog channels (DA0, DA1), with 8-bit resolution
- Eight analog to digital channels (AN0 through AN7), with 10-bit resolution
- Two serial communications channels (COM0, COM1)
- Two pulse width modulation channels (PWM0, PWM1)

6.4 Serial Communication with the Controller

Commands and test data are transferred between the H8 and the external PC controller via a serial RS-232 interface. Interface drivers and receivers are used between the COM1 serial communications channel on the H8 and the interface connector to provide proper RS-232 signal levels to the controller. DTR is signalled via Port 8-7

Chapter 7 Replacing Components - Pipette/XYZ Axis Assemblies

7.1 Overview

This chapter describes the servicing and replacement of the Pipette Assembly plus a number of other items on the XYZ Axis Drive Assemblies.

- **Pipette Assembly**: The pipette assembly is used to withdraw liquids from a variety of sources (for example, samples, standard solutions, etc.) and deliver them to the well plate. In addition, the pipette assembly is used to move the well plate to various positions in the system. The pipette assembly is considered as an integrated unit that is replaced as a module because it includes a number of components that must be specifically calibrated at the manufacturing facility. Replacement of the entire assembly is described in the section entitled *Replacing the Pipette Assembly* on page 7-4.
- **X-Axis Drive Assembly**, **Y-Drive Assembly**, and **Z-Drive Assembly**: The X- Axis Drive Assembly, Y-Drive Assembly and Z-Drive Assembly are used to position the Pipette Assembly at the appropriate location for a specific task (for example, move the Pipette Assembly to a well to deliver a reagent). Each drive assembly includes a number of components that can be readily replaced by the service engineer (for example, the drive belt, the controller board, the drive pulley, the drive motor, etc). While the general mode of operation is identical for all three-drive assemblies, we will describe the replacement of the components for each drive in a separate section, as the design of each of the assemblies is different. The Z-Drive is described in *The Z-Drive Assembly* section on page 7-16, the Y-Drive is described in *The Y-Drive Assembly* section on page 7-31, and the X-Drive is described in *The X Axis Drive Assembly* section on page 7-43.

This chapter describes the replacement of components for which there is a reasonable expectation that the service engineer may be required to replace. The following conventions are used:

- Removal of components that are structural in nature and unlikely to be serviced will not be described.
- It is assumed that the service engineer will remove all appropriate cables from an item before it is removed from the system. The service engineer should remove the cable as close as possible to the item to be removed and note the position of the cable for reinstallation.

After the component is reinstalled, it is necessary to perform the post-service checkout protocol as described in the Post-Service Checkout Protocol section on page 3-6.

7.2 Troubleshooting

Troubleshooting information presented in Table 7-1 is for problems that occur after the system has been initialized. If necessary, the service engineer can check individual operations for the X-, Y-, and Z-Drives via the manual mode of operation described in Chapter 5. The information below assumes that the system is, in general, working properly, except for the defective component (i.e. the X-Drive and Y-Drive are functioning properly but the Z-Drive is not functioning). If all drives are defective, it is probable that the problem is not in the drive mechanism (for example, the door is not closed).

Table 7-1 Troubleshooting the Pipette and XYZ Axis Assemblies

Symptom	Probable Cause	Resolution
X-Drive Not Functioning or does not travel correct distance	X-Drive Belt not in place or defective	Tighten or replace the belt (refer to page 7-53 for the procedure).
	X Transition Board defective	Replace the X Transition Board (refer to page 7-51 for the procedure).
	X-Drive Motor Defective	Replace the X-Drive Motor (refer to page 7-43 for the procedure).
	X Optointerrupter Defective	Replace the Optointerrupter (refer to page 7-43 for the procedure).
	X Encoder Defective	Replace the X Encoder (refer to page 7-44 for the procedure).
	X Pulley Misaligned	Align one or both pulleys (refer to page 7-50 for the procedure).
Y-Drive Not Functioning or does not travel correct distance	Y-Drive Belt not in place or defective	Tighten belt or replace belt (refer to the *Removing the Y-Axis Drive Belt* section).
	Y Transition Board defective	Replace Y transition board (refer to the *Removing the Y-Transition Printed Circuit Board* section).
	Y-Drive Motor Defective	Replace Y-Drive Motor (refer to the *Removing the Y Axis Motor* section).
	Y Optointerrupter Defective	Replace Optointerrupter (refer to the *Removing the Y Optointerrupter* section).
	Y Encoder Defective	Replace Encoder (refer to the *Replacing the Encoder* section).
	Y Pulley Misaligned	Align one or both pulleys (refer to page 7-50 for the procedure).

Symptom	Probable Cause	Resolution
Z-Drive Not Functioning or does not travel correct distance	Z-Drive Belt not in place or defective	Tighten belt or replace belt (refer to page 7-22 for the procedure).
	Z Transition Board defective	Replace the Transition Board (refer to page 7-30 for the procedure).
	Z-Drive Motor Defective	Replace the Z-Drive Motor (refer to page 7-27 for the procedure).
	Z Optointerrupter Defective	Replace the Z Optointerrupter (refer to page 7-21 for the procedure).
	Z Encoder Defective	Replace the Z Encoder (refer to page 7-20 for the procedure).
	Z Pulley Misaligned	Align one or both pulleys (refer to page 7-50 for the procedure).
Pipette does not withdraw or deposit liquid	Defective Pipette Assembly	Replace the Pipette Assembly (refer to page 7-4 for the procedure).
	Pipette Assembly clogged	Remove the blockage.
Pipette dispenses incorrect volume	Defective Pipette Assembly	Replace the Pipette Assembly (refer to page 7-4 for the procedure).
Pipette does not lift or deposit plates	Defective Pipette Assembly	Replace the Pipette Assembly (refer to page 7-4 for the procedure).
	Defective Z-Drive	See *Z Drive Not Functioning or does not travel correct distance* above.
Pipette does not pick up or deposit pipette tips	Defective Pipette Assembly	Replace the Pipette Assembly (refer to page 7-4 for the procedure)
	Defective Z-Drive	See *Z Drive Not Functioning or does not travel correct distance* above.

7.3 Replacing the Pipette Assembly

To Remove the Pipette Assembly (Field Replacement):

1 Remove the Pipette Cover (Part No. 204010400) by removing the five M3 x 6 BHCS screws and five M3 shakeproof washers (Figure 7-1).

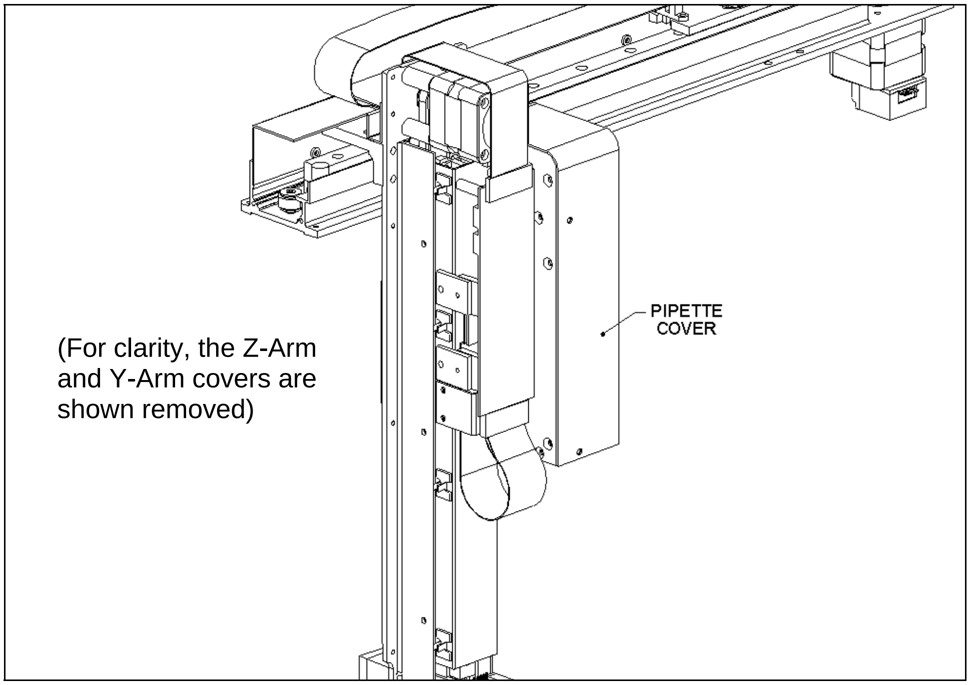

Figure 7-1 Removing the Pipette Cover

> ***Note**: When replacing the cover, make certain that the cover is flush with respect to the mount.*

2 Remove the Cable from the Pipette Controller Board (Figure 7-2).

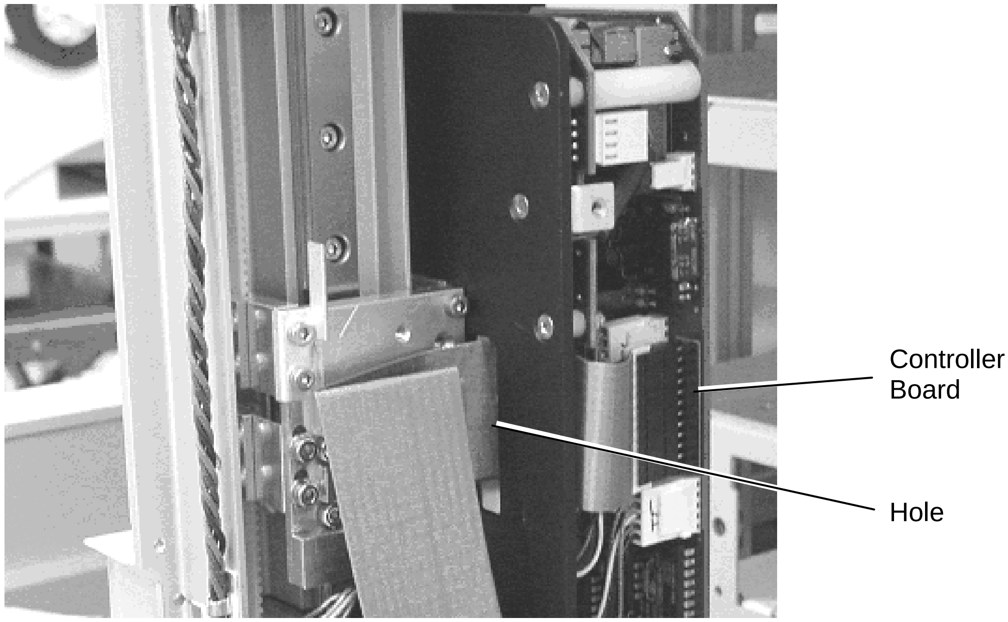

Figure 7-2 Unplugging the Cable from the Controller Board

3 Remove the Pipette Assembly from the Z-Drive Assembly by removing the two M3 x 12 SHCS screws that attach the Pipette Assembly to the Drive Assembly (Figure 7-3). The block is pinned in the center, so rocking the pipette from left to right will frequently aid in removing the module from the Z mount.

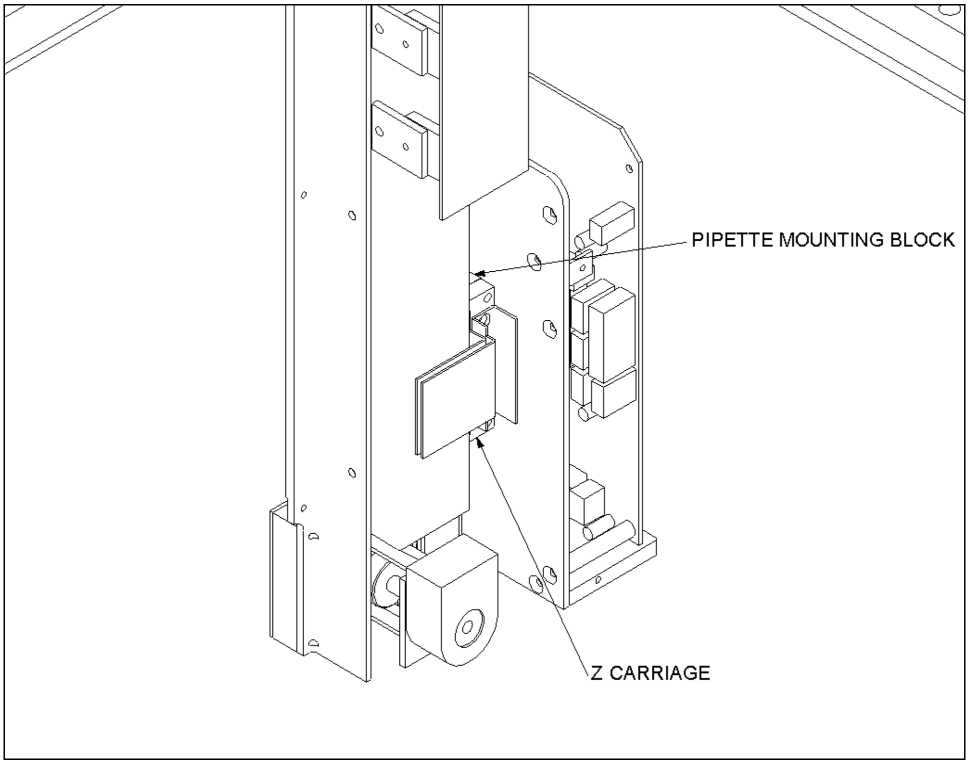

Figure 7-3 Mounted Pipette Assembly

4 When you replace the pipette assembly, it will be necessary to align the pipette to the base plate using the Pipette alignment jig (jig number PMFIX017-A). The base plate should be mounted on the jig as shown in Figure 7-4. The pipette alignment jig should be positioned on the baseplate in the reagent rack location.

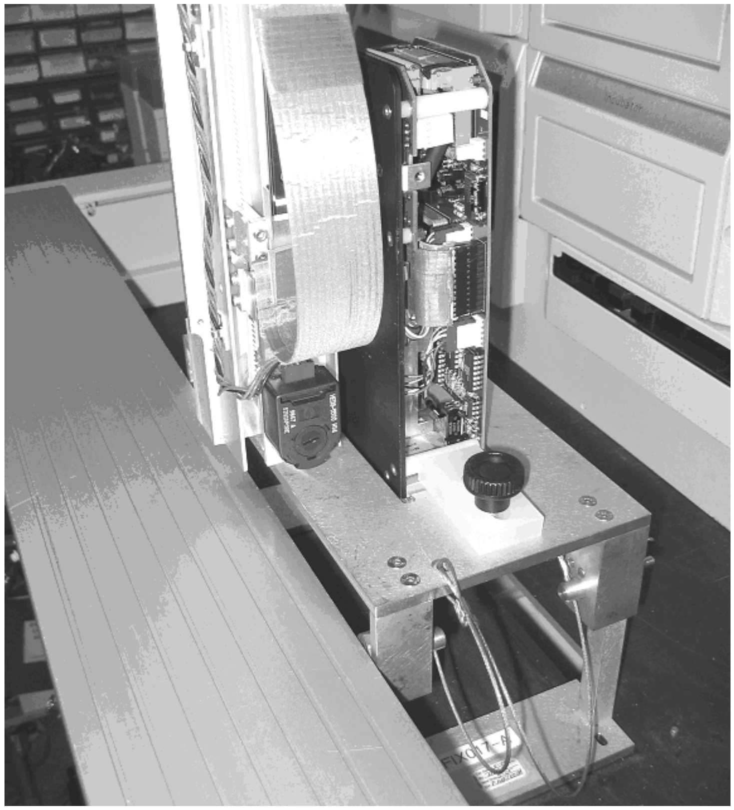

Figure 7-4 Mounting the Pipette on the PMFIX017-A Jig

To Align the Pipette:

1 Loosen the two screws for adjustment in the X plane.

2 Gently move the X-arm, Y-arm, and pipette until the pipette is inserted in the jig.

3 Hold the pipette against the fixture, then tighten the two Y-plane screws.

4 Ensure that the pipette bottom plane is parallel to the fixture. If it is not parallel to the Y-plane, readjust as noted in Steps **1** through **3**. If it is not parallel to the X-plane, readjust as noted on page 7-15.

To Remove the Pipette Assembly (Alternate Method):

1 Remove the Z-Axis Top Cover (Part No. 204018000) from the Z-Axis Drive Assembly by removing the three M3 x 6 Button Head screws and three shakeproof washers (Figure 7-5).

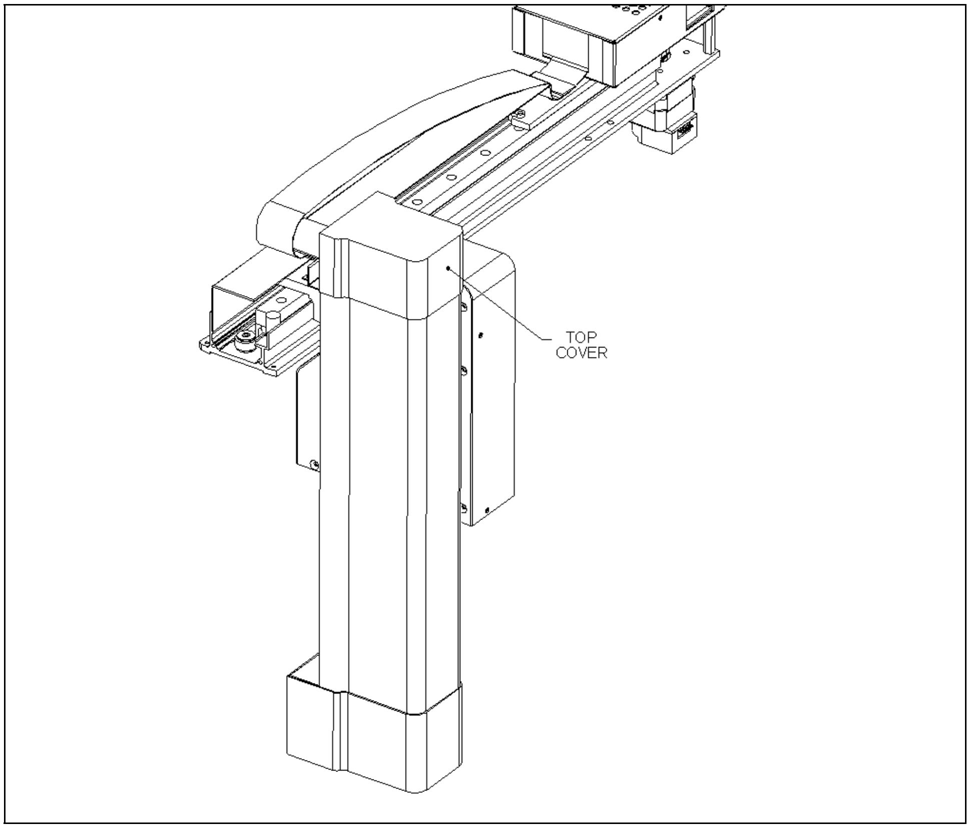

Figure 7-5 Z-Axis Drive Assembly: Top Cover

2 Remove the Z-Axis Lower Cover (Part No. 204005100) by removing the three M3 x 6 Button Head screws and shakeproof washer. There are two screws on the bottom and one on the side with a shakeproof washer (Figure 7-6).

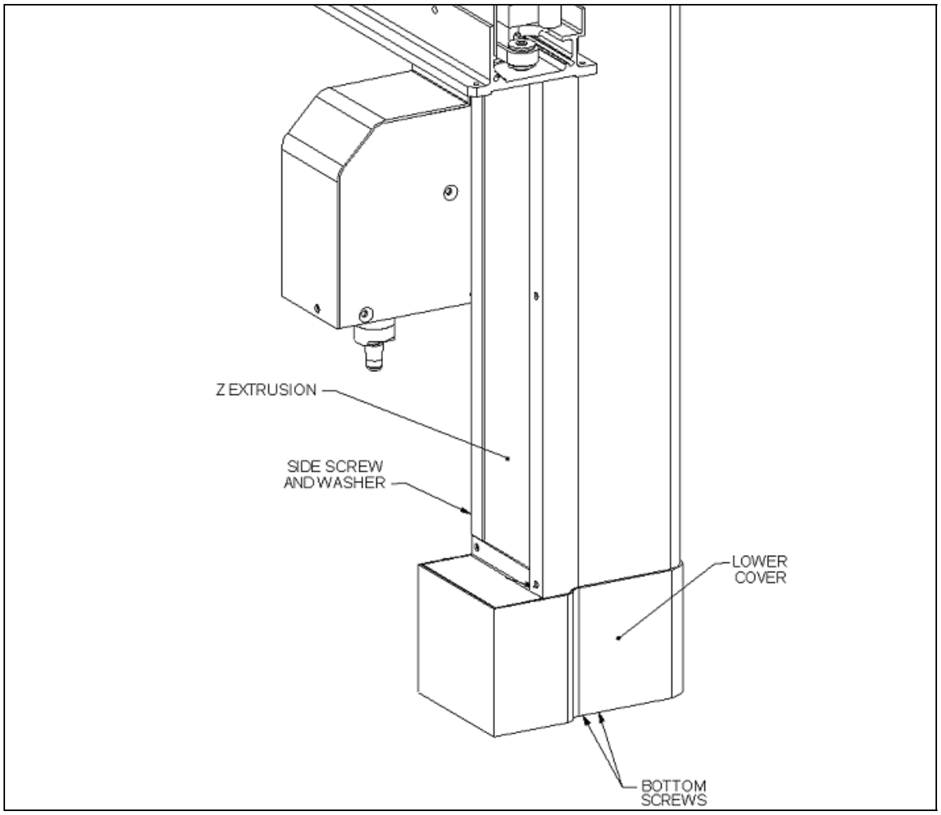

Figure 7-6 Z-Axis Drive Assembly: Bottom Cover

3 Remove the Z-Axis Drive Assembly Mid Cover (Part No. 204004900) by removing the two M3 x 6 Button Head screws and two M3 shakeproof washers that attach the cover to the Drive Assembly and unsnapping it from the body (Figure 7-7).

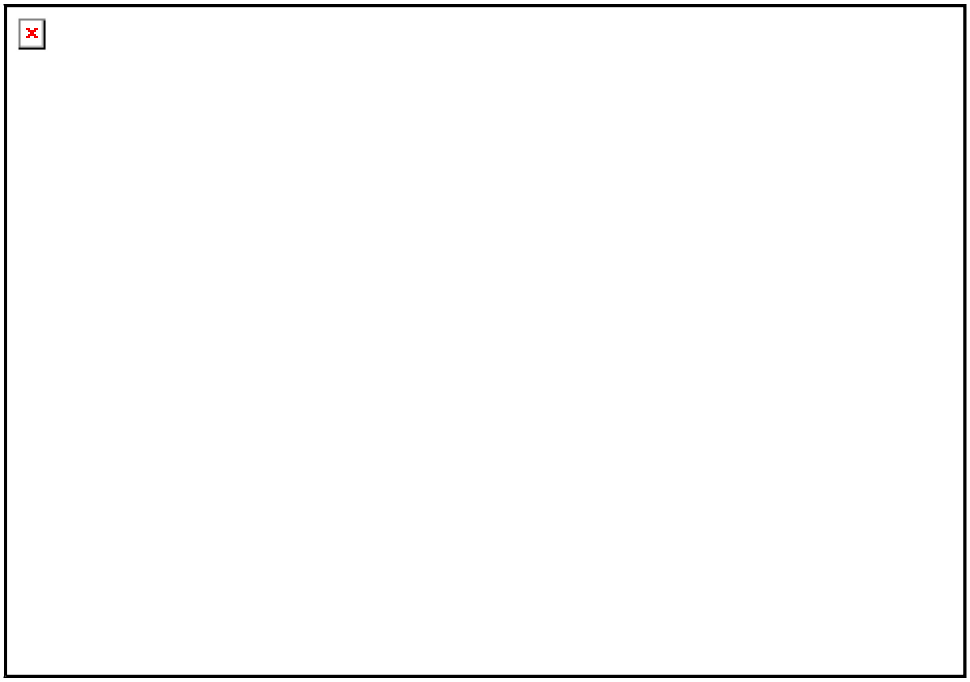

Figure 7-7 Removing the Z-Axis Drive Assembly Mid Cover

4 Remove the Z-Drive Spring Cover (Part No. 22001010) by removing the two M3 BHCS screws that secure the cover to the extrusion (Figure 7-8).

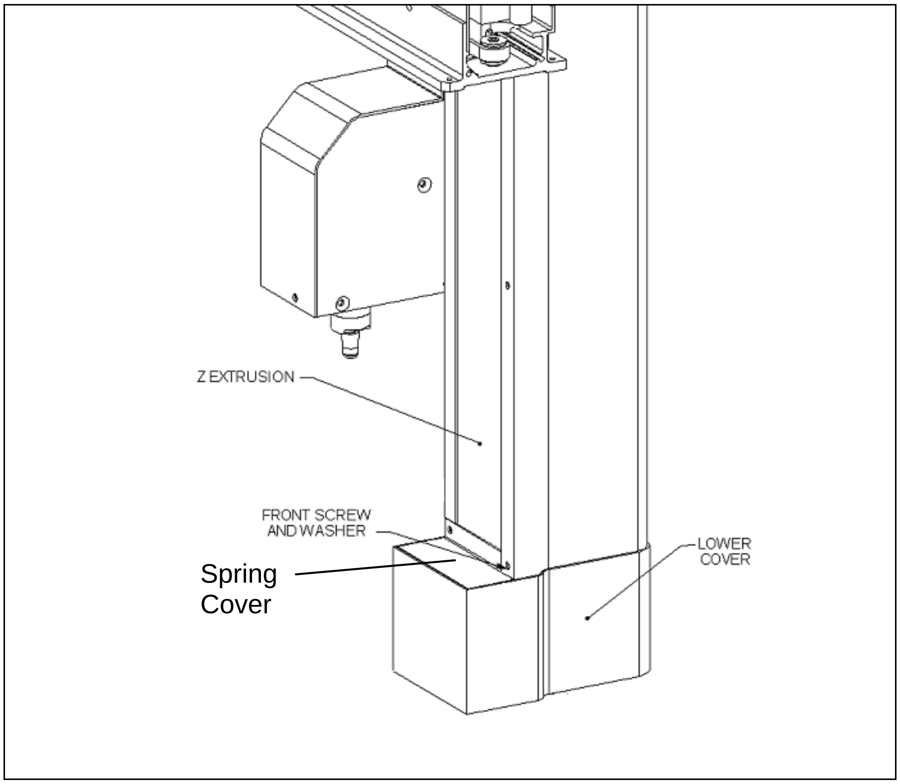

Figure 7-8 Removing the Spring Cover

5 Remove the Pipette Cover (Part No. 204010400) by removing the five M3 x 6 BHCS screws and five M3 shakeproof washers (Figure 7-9).

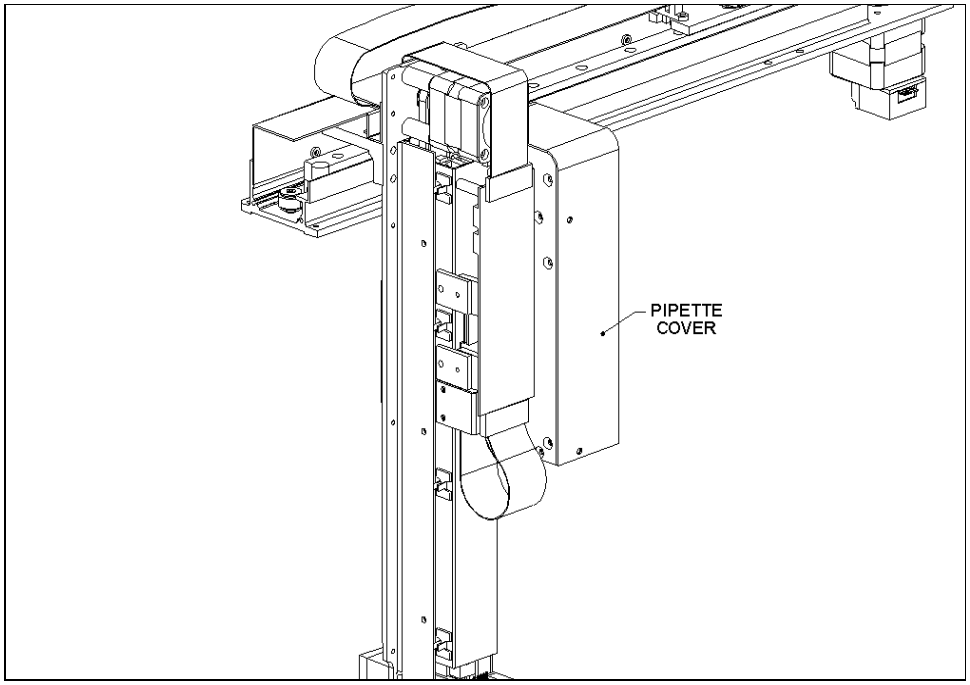

Figure 7-9 Removing the Pipette Cover

> ***Note**: When replacing the cover, make certain that the cover is flush with respect to the mount.*

6 Remove the Cable from the Pipette Controller Board (Figure 7-10).

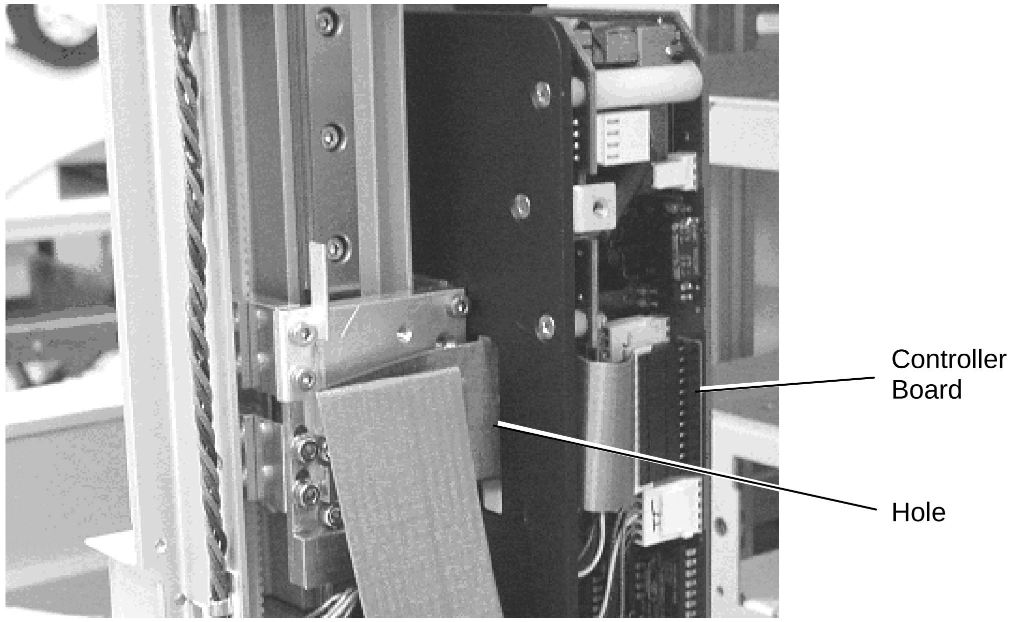

Figure 7-10 Unplugging the Cable from the Controller Board

7 Remove the Pipette Assembly from the Z-Drive Assembly by removing the two M3 x 12 SHCS screws that attach the Pipette Assembly to the Drive Assembly (Figure 7-11). The block is pinned, so rocking the pipette from left to right will frequently aid in removing the module from the Z mount.

8 Remove the Z flex cable plate.

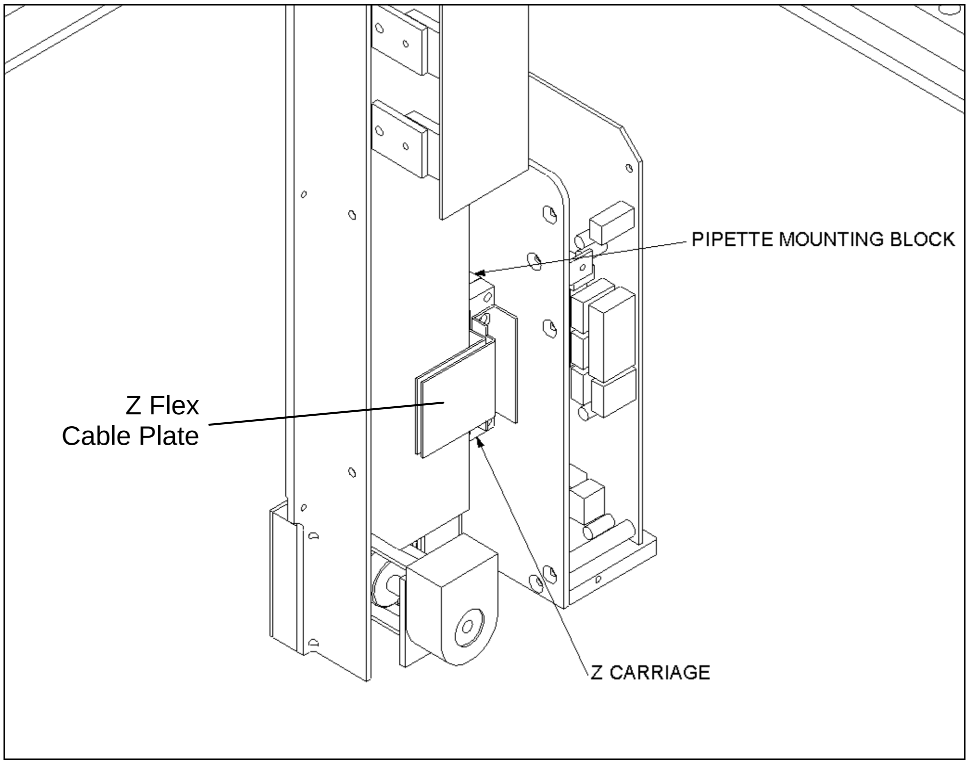

Figure 7-11 Mounted Pipette Assembly

9 When replacing the pipette assembly, it will be necessary to align the pipette to the base plate using the Pipette alignment jig (jig number PMFIX014, or jig number PMFIX017A for field replacement). The base plate should be mounted on the jig as shown in Figure 7-12. The pipette alignment jig should be positioned on the base plate in the reagent rack location.

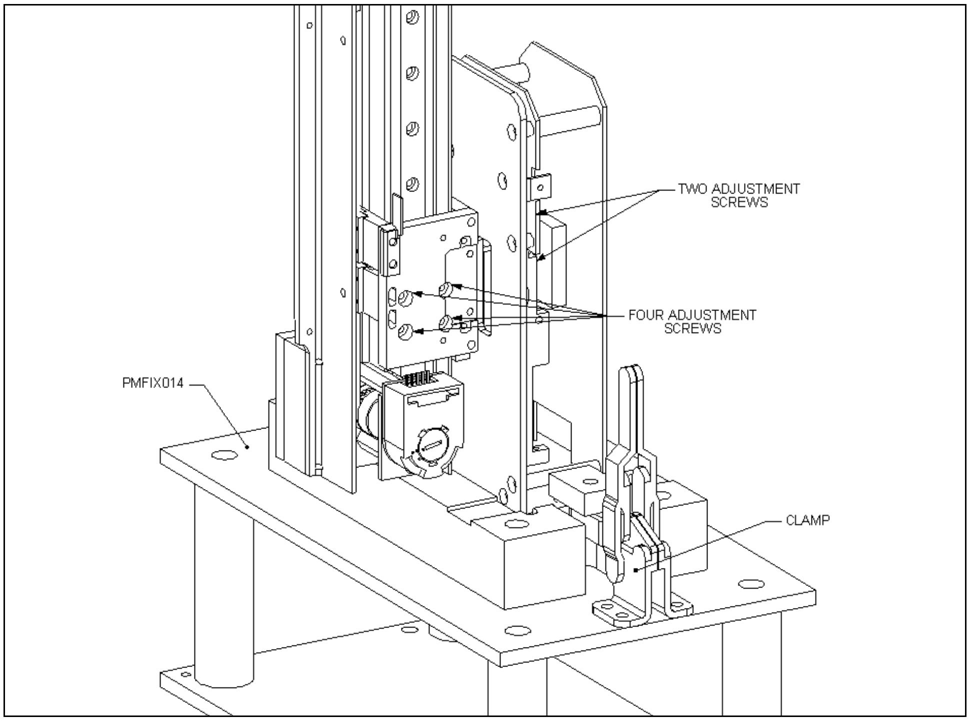

Figure 7-12 Mounting the Pipette on the Jig

To Align the Pipette:

1 Loosen the four screws for adjustment in the X plane.

2 Loosen the two screws for adjustment in the Y plane.

3 Gently move the X arm, Y arm, and pipette until the pipette is inserted in the jig. The pipette base plate should fit evenly in the jig when you are ready to proceed to the next step.

4 Tighten the two clamps to secure the pipette firmly to the jig.

5 Remove each of the six adjustment screws (one at a time) and then re-install and tighten each screw using Loctite 222.

6 Release the clamp, and ensure that the pipette bottom plate is parallel to the fixture. If the pipette bottom plate is not parallel to the fixture, readjust as outlined above.

7 Remove the fixture from the system.

7.4 The Z-Drive Assembly

7.4.1 Removing the Z-Drive Assembly

The Z-Drive Assembly is attached to the Y-Drive Assembly (Figure 7-13) with four M4 x 10 cap head screws and M4 flat washers.

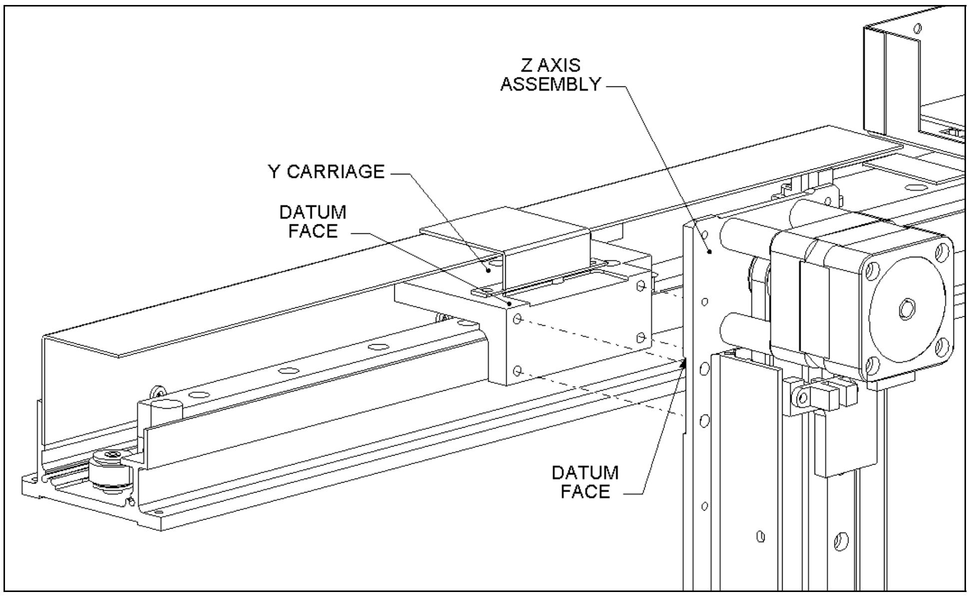

Figure 7-13 Mounting the Z-Drive Assembly

> ***Note**: When the Z-Drive Assembly is reattached to the Y-Drive Assembly, make certain that the Z-Drive Assembly is held tightly against the datum edge (Figure 7-13). After the screws are tightened, secure them with Loctite 222.*

7.4.2 Replacing the Z-Drive Spring Assembly

CAUTION	**CAUTION: WHEN REMOVING THE SPRING ASSEMBLY, TAKE CARE TO AVOID AN INJURY FROM THE SPRING AFTER THE COVER IS REMOVED.**

To Replace the Z-Drive Spring Assembly:

1 Remove the lower cover for the Z-Drive (refer to the *Replacing the Pipette Assembly* section on page 7-4).

2 Remove the 4 M 3 x 30 flat head screws that attach the cover to the mechanism (Figure 7-14).

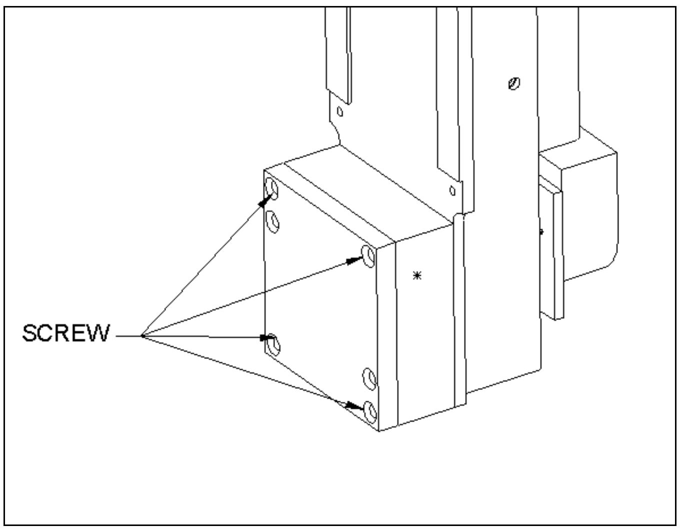

Figure 7-14 Removing Housing Cover Screws

> ***Note**: When reassembling the Spring Assembly housing, rotate the cover eight times counter-clockwise before attaching the screws.*

3 Remove the two M3 x 12 Posi screws shown in Figure 7-15.

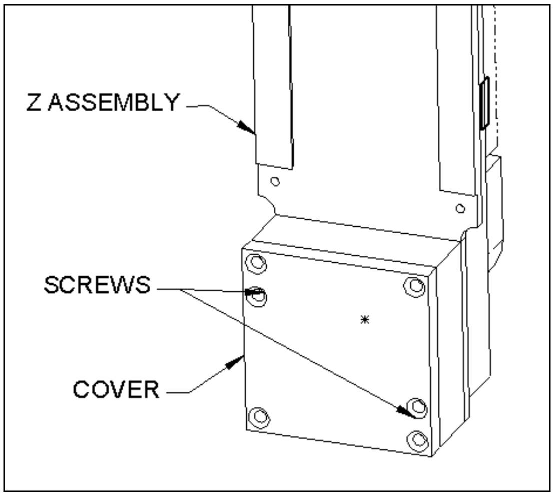

Figure 7-15 Cover Screws

4 Remove the spring Retainer Assembly from the Drive (Figure 7-16).

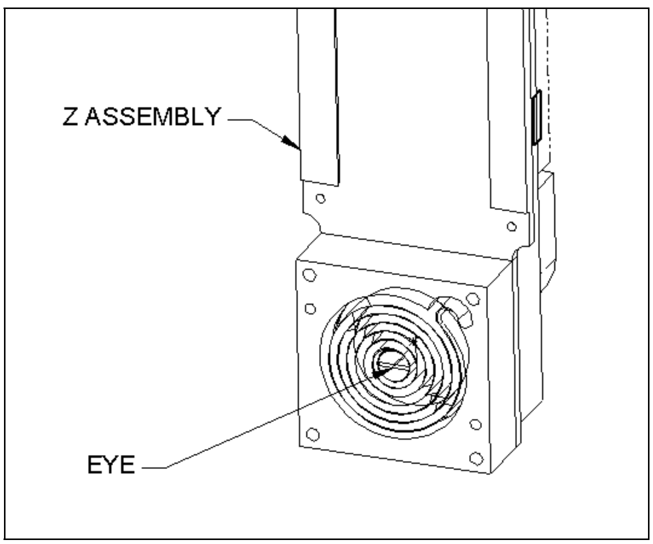

Figure 7-16 Spring Assembly

***Caution**: When removing the spring from the housing, be aware that the spring will expand rapidly and may cause injury.*

***Note**: When reinstalling the spring assembly, make sure that the eye lines up with the groove in the shaft and take care to ensure that the spring remains inside the housing.*

5 Carefully remove the Rotary Spring (Part No. 324600400) and place a new one on the housing (Part No. 204026700) as shown in Figure 7-17, allowing the retainer to slide off while pushing the spring into the housing fully. Discard the retainer.

6 Move the Z drive block to the end of the rail closest to the motor. Ensure it remains there while winding the spring.

7 Place the spring assembly onto the Z assembly, ensuring that the eye lines up with the slot in the Z idler shaft and being careful not to push the spring out of the housing. Orient the housing so that the two screw holes on the side of the housing are facing towards the end of the Z assembly extrusion.

8 Attach the cover (Part No. 204026800) to the housing using two M3x12 flat head screws.

9 Rotate the spring assembly eight complete revolutions counter-clockwise (as observed from the spring assembly). Secure the assembly to the extrusion using four M3x30 flat head screws.

> ***Note**: Ensure that the assembly is square and flush with the extrusion and that the two tapped holes in the housing are on the bottom when completed.*

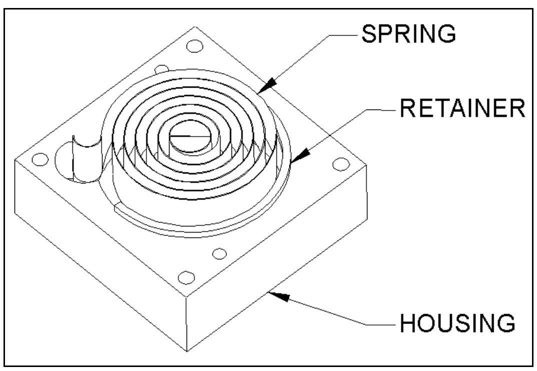

Figure 7-17 Insertion of Rotary Spring

7.4.3 Removing and Replacing the Z-Drive Encoder

The Encoder is mounted on the Encoder Mounting plate as shown in Figure 7-18.

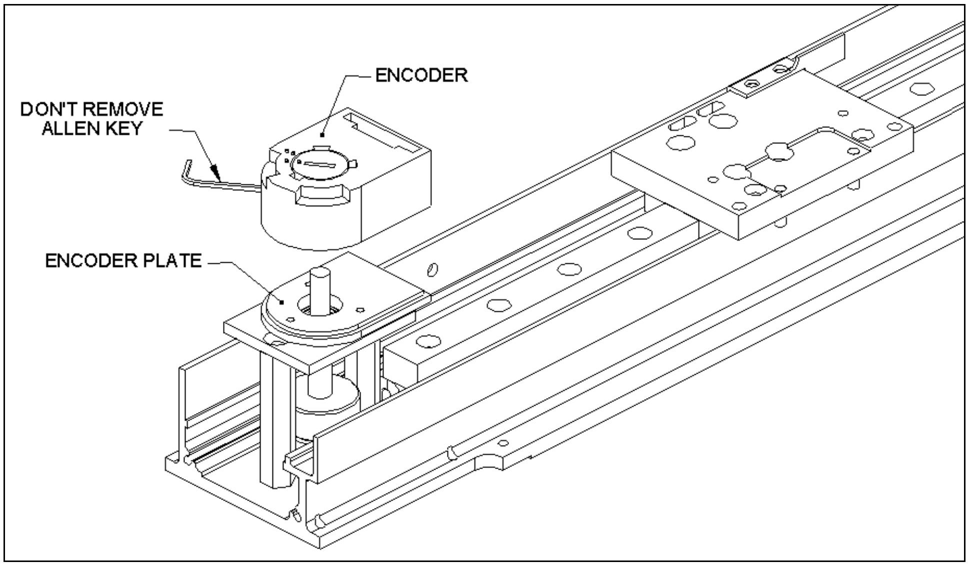

Figure 7-18 Z- Encoder

To remove the encoder, use an Allen key to loosen the encoder from the shaft. When the encoder is loose, it can be readily removed.

To replace the encoder, use the Allen key to tighten it to the shaft. After you have tightened the encoder, rotate the cover from the open position to the closed position by inserting a small screwdriver into the notch and rotating.

In Figure 7-18, the cover is shown in the open position, and the cover should be rotated approximately 15 degrees counter clockwise (the position is indicated by the correspondence of the dot on the notch and the dot on the housing).

7.4.4 Replacing the Z-Drive Optointerrupter Assembly

The Z-Drive Optointerrupter Assembly (Part No. 204005200) (Figure 7-19) is mounted on the Z Sensor Plate (Figure 7-20).

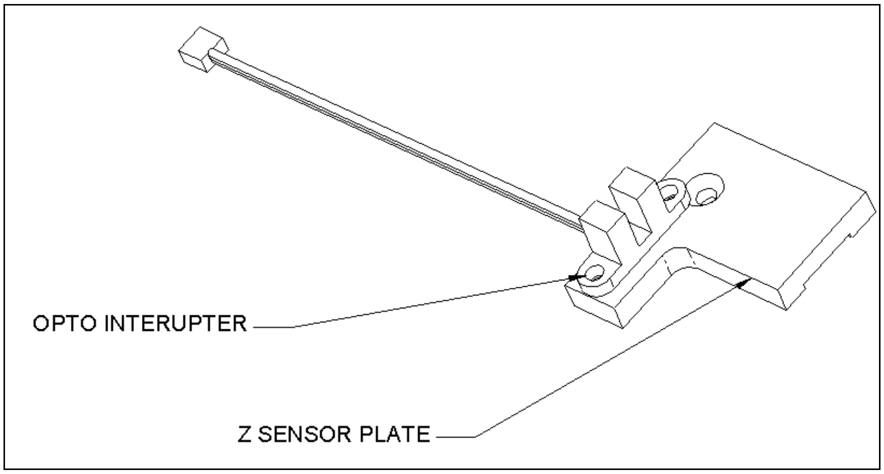

Figure 7-19 Z-Drive Optointerrupter Assembly

To remove the sensor assembly, remove the two M3X6 Cap Head Screws and 2 M3 Shakeproof washers. When you replace the assembly, ensure that the Z sensor Flag passes through the middle of the sensor.

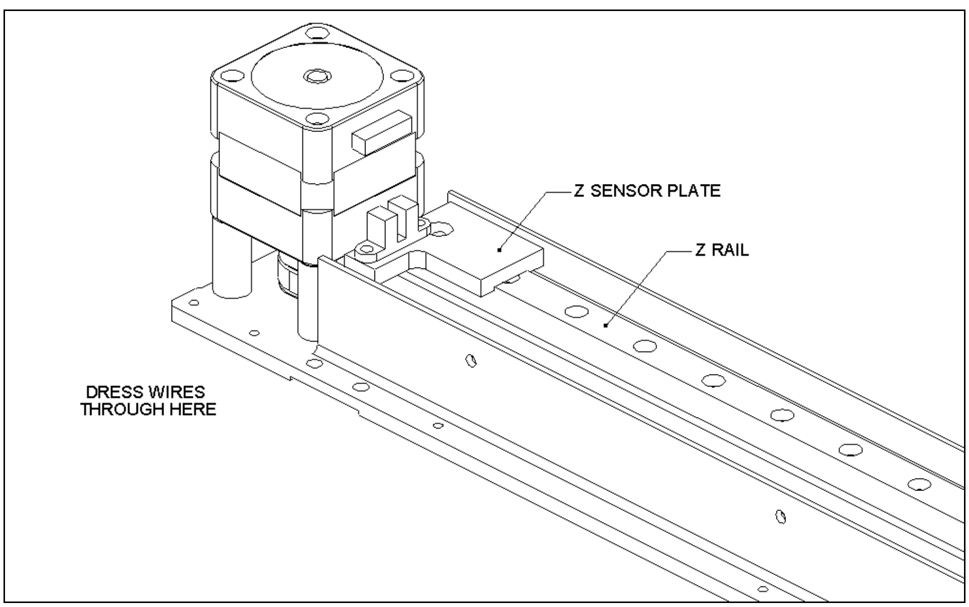

Figure 7-20 Z-Axis Sensor Plate

7.4.5 Replacing The Z-Drive Belt

To Remove the Z-Drive Belt:

1 Remove the Z-Drive Block Assembly from the Linear Bearing Block by unscrewing the four M3 x 6 Cap Head Screws (Figure 7-21). The Z Sensor Breaker Flag is attached to the Z-Drive Block Assembly and should also be removed (Figure 7-22).

2 Remove the Blocks that are attached to each end of the belt from the Linear Bearing Block.

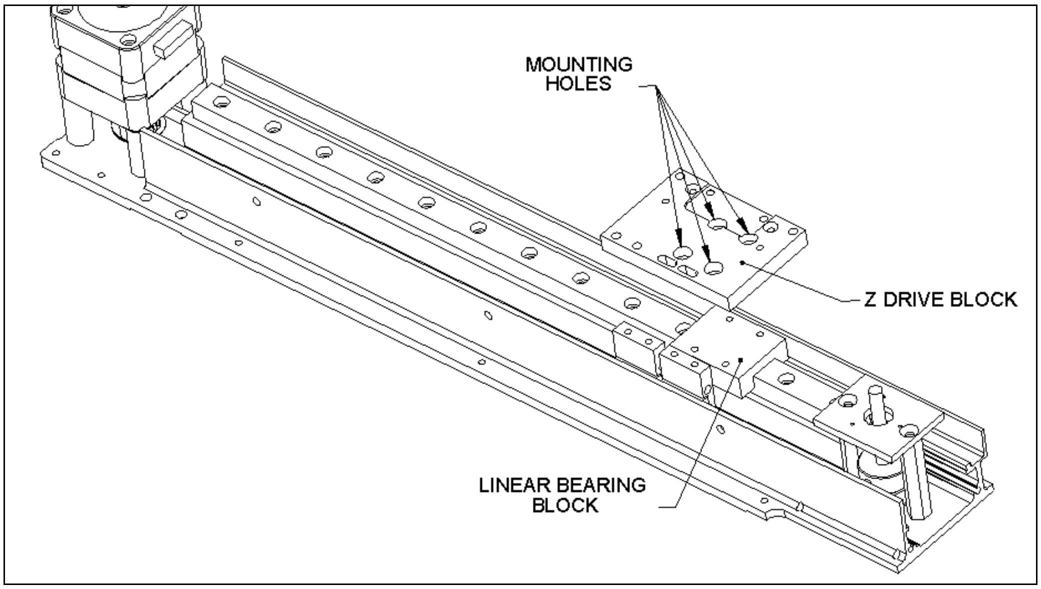

Figure 7-21 Removing the Z-Drive Block

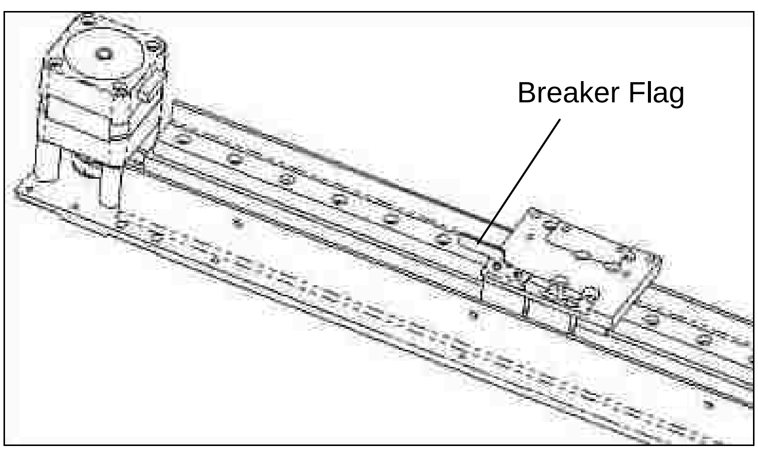

Figure 7-22 Location of the Z Sensor Breaker Flag

To Replace the Z-Drive Belt:

1 If necessary, obtain a new timing belt (Part No. 400000050, 772 mm long). Draw it through the extrusion so that it is around the Idler Pulley and the Motor Pulley (the motor pulley is shown in Figure 7-23).

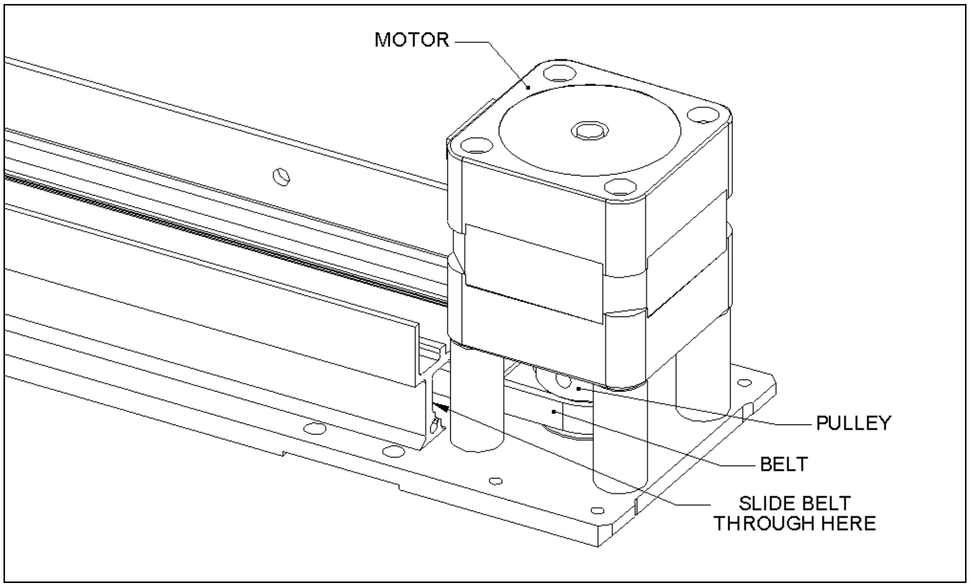

Figure 7-23 Motor Pulley

2 Fit the Fixed Belt Block (Part No. 04003300) and the Belt Clamp (Part No. 204012400) to the motor end of the belt using two M3 x 8 Cap Head Screws and Loctite 222 (Figure 7-24). Ensure that the belt covers all three teeth in the belt block.

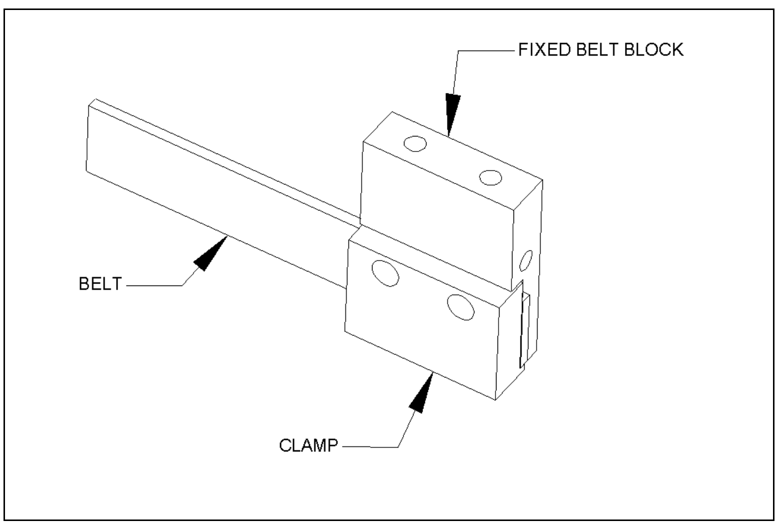

Figure 7-24 Placing the Fixed Belt Block on the Motor End of the Drive Belt

3 Fit the Adjustable Belt Block (Part No. 204003400) and the Belt Clamp (Part No. 204012400) to the idler end of the belt using two M3 x 8 Cap Head Screws and Loctite 222 (Figure 7-25). Ensure that the belt covers all three teeth in the belt block.

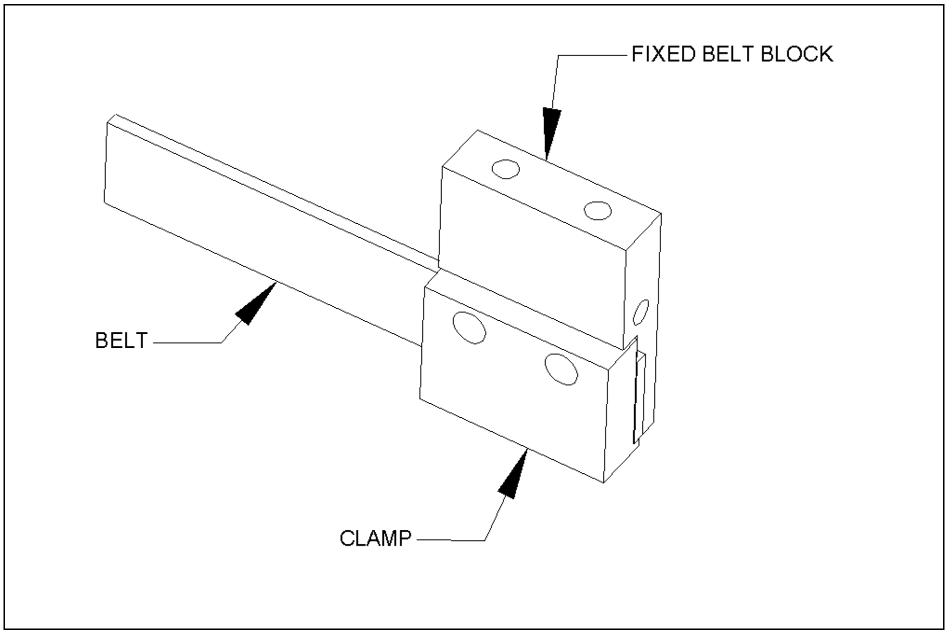

Figure 7-25 Placing the Adjustable Belt Block on the Idler End of the Drive Belt

4 Place the Adjustable Drive Block and the Fixed Drive Block in position and the place the Z-Drive block (Part No. 204004600) onto the linear bearing block (Figure 7-26). Fit the Z-Drive Block to the Linear Bearing Block using the four M3 x 6 Cap Head screws.

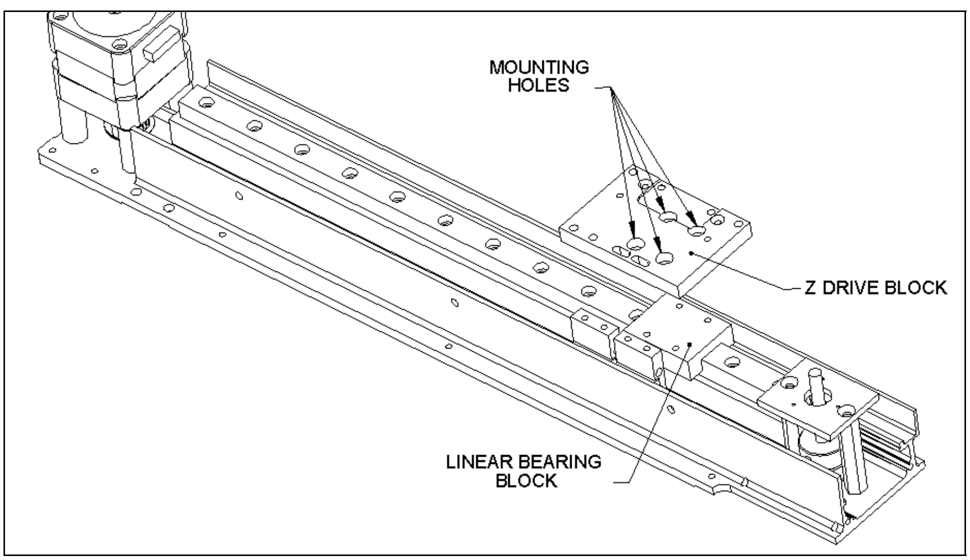

Figure 7-26 Z-Drive Block and the Linear Bearing Block

5 Place the Z sensor breaker flag (Part No. 204011300) on to the top of Z-drive block, attach the Z-drive block to the fixed block with two M3 X 12 cap head screws and apply Loctite 222 to the tightened screws (Figure 7-27).

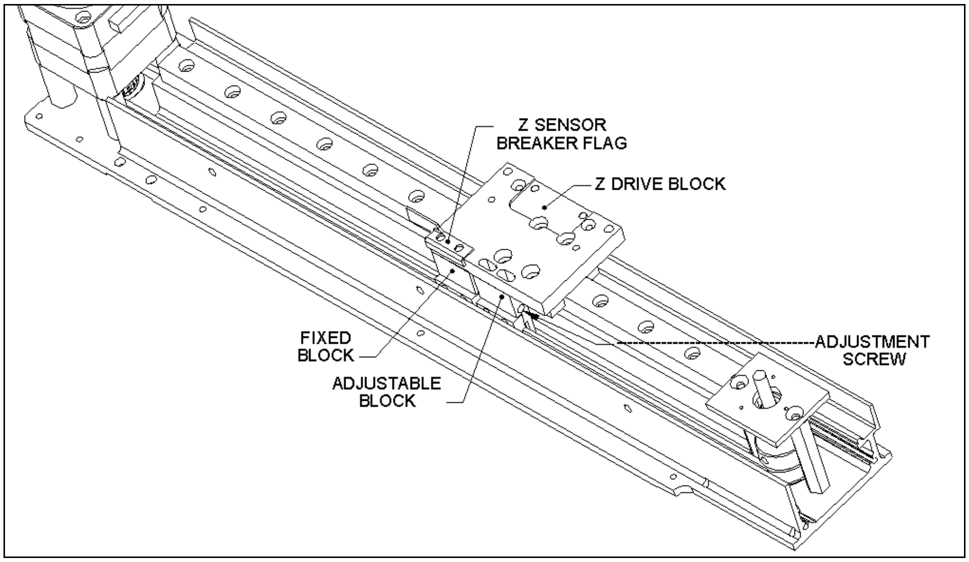

Figure 7-27 Mounting the Z Sensor Breaker Flag, Z-Drive Block, and the Linear Bearing Block

6 Mount the adjustable Belt Block in the slotted holes using two M3 x 12 cap head screws and two M3 flat washers but do not tighten. Insert one M3 x 30 button Posi head screw through the adjustable belt block and into the fixed belt block.

7 Locate the pipette carriage fully away from the motor and position the Z Belt Tensioning Jig (ZMFIX010) with the end face in line with rail mounting screw 6 (from the motor end) as shown in Figure 7-28. Tighten the belt adjustment screw) until the belt pushes the plunger flush to the face of the jig body, then remove the jig. Individually remove and re-install each screw in the adjustable block, including the long adjustment screw, applying Loctite 222 to each screw and then tightening.

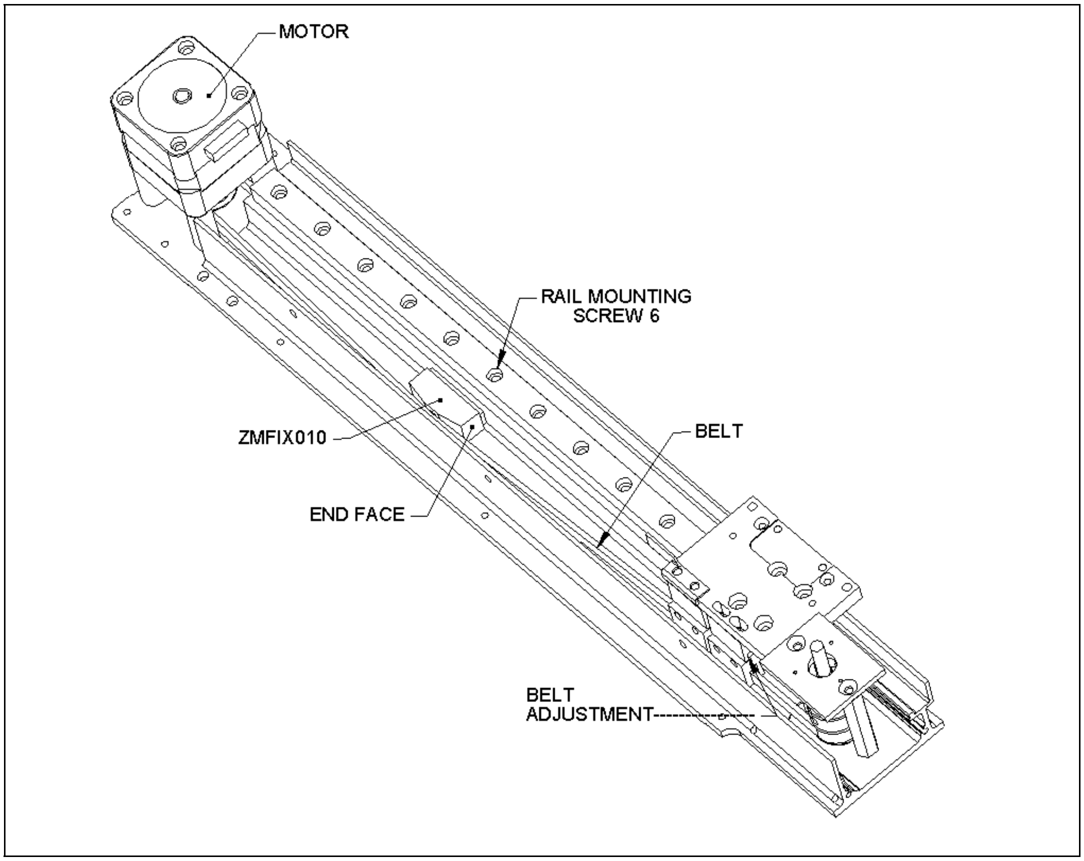

Figure 7-28 Location of Positioning Jig

7.4.6 Replacing the Z Motor

To remove the Z motor assembly, unscrew the four M3 x 30 Flat head screws (Figure 7-29) and disconnect the wires.

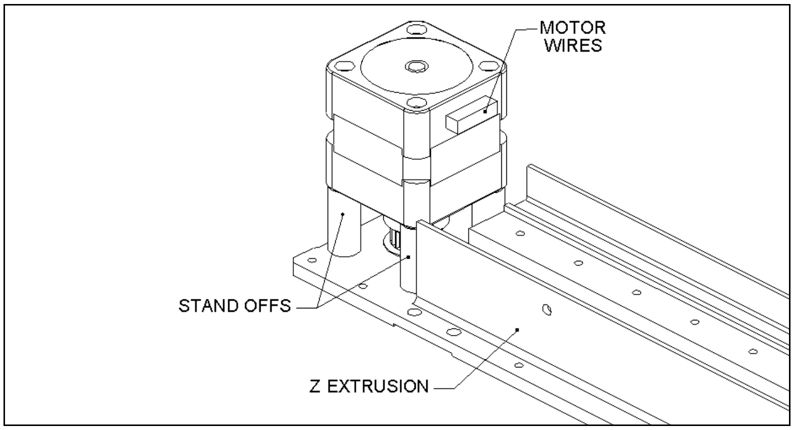

Figure 7-29 Replacing the Motor Assembly

To Replace the Motor:

1. Remove the Z-Motor Pulley from the old motor and place it on the new motor
2. Using the Z Motor Pulley Height Setting Jig (ZMFIX011), fit the pulley (Part No. 320101000) to Z Motor (Part No. 528300900) using one M4X6 Cone Point Set Screw Part No. 307400406) and Loctite 222 (Figure 7-30). Discard the setscrew supplied with the pulley. If the jig is not available, set the distance between the pulley and the motor base to 2.2 mm.
3. When reattaching the motor, use Loctite 222 on the screws and ensure that the wires are facing the Idler Assembly.

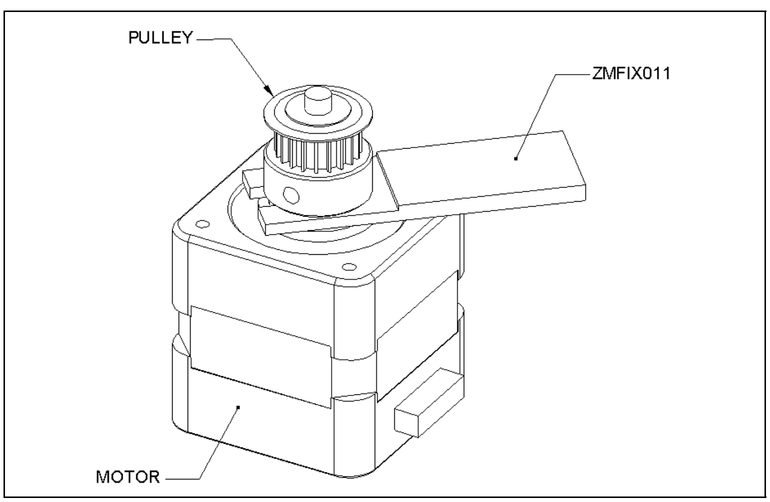

Figure 7-30 Affixing the Pulley to the Motor

7.4.7 Replacing the Idler Assembly

To Remove the Idler Assembly:

1 Remove the bearing plate (Part No. 20400440) by removing the 2 flat head screws (Figure 7-31).

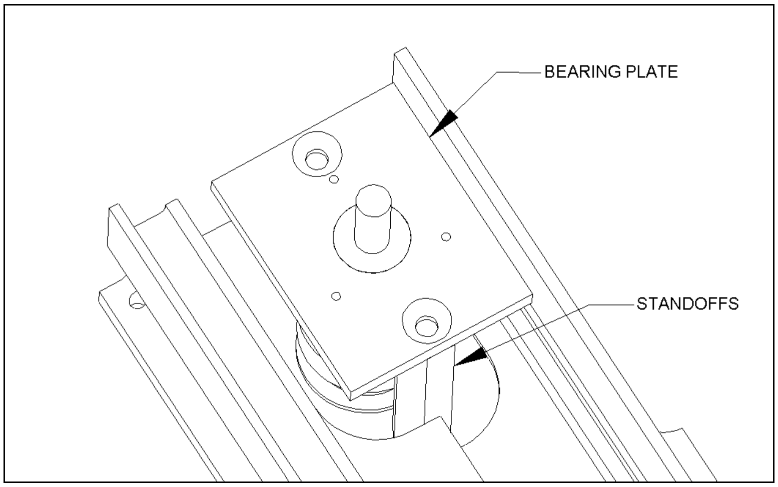

Figure 7-31 Bearing Plate Cover

2 Remove the pulley from the shaft by removing the M4 x 6 cone Point Set Screw (Figure 7-32).

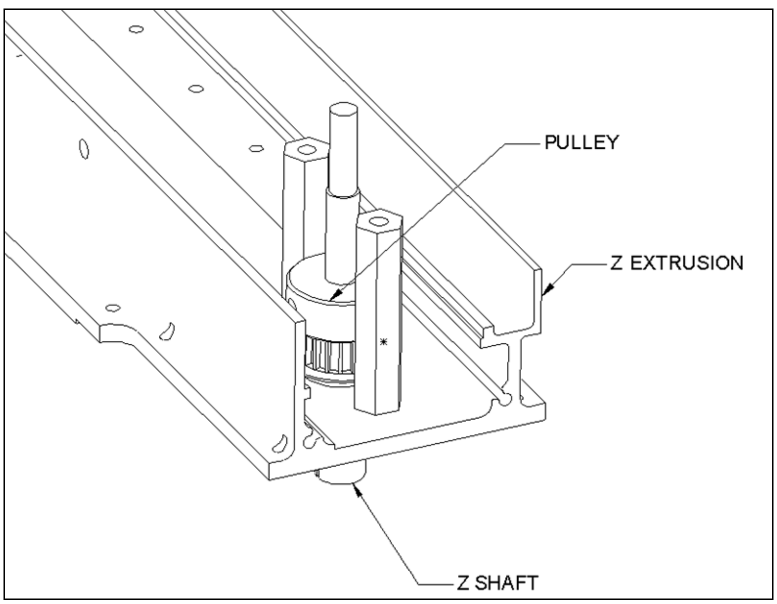

Figure 7-32 Pulley Assembly

To Replace the Pulley:

Place the Pulley (Part No. 23001650) onto the Z shaft as shown in Figure 7-32. Push the pulley and the shaft together to take up all the slack. Secure the pulley to the shaft using one M4 x 6 Cone Point Set Screw (Part No. 307400406) and Loctite 222 (discard the supplied setscrew). Ensure that there is no play in the mechanism.

7.4.8 Replacing the Z Axis Transition Board

The Z Axis Transition Board is attached to the Z Flexi Cable Cover.

To Remove the Board:

1 Remove the two M3 x 8 Button Head screws and Nylon shoulder washers (Figure 7-33).

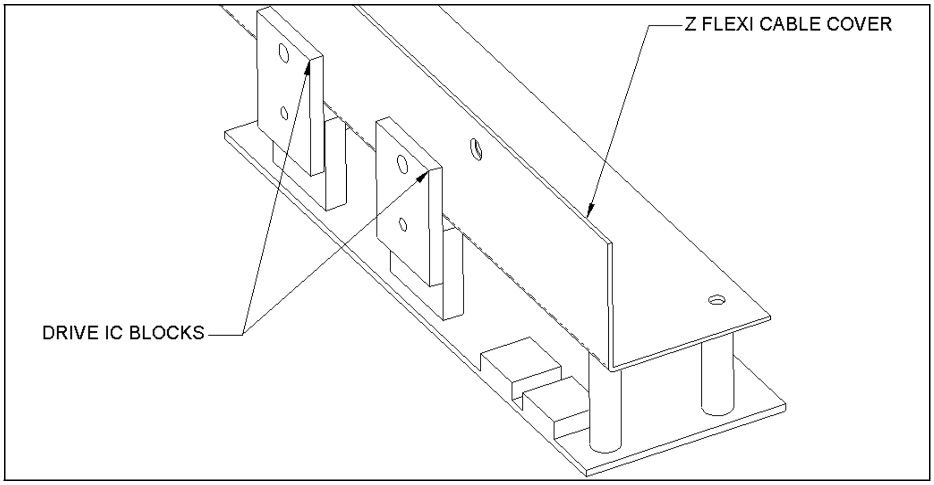

Figure 7-33 Z Transition Board

2 Remove the two M3 x 6 buttonhead screws that hold the board to the standoffs (Figure 7-34).

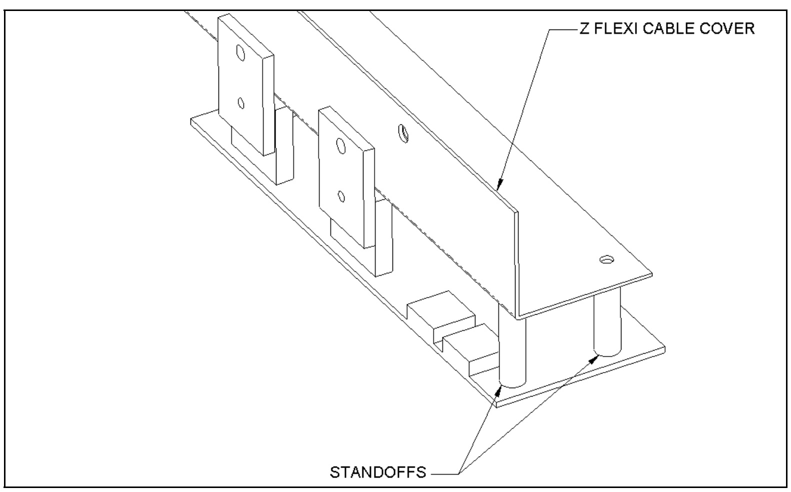

Figure 7-34 Location of Standoffs/Z Transition Board

> ***Note**: When replacing the board, make certain that the insulation pads (Part No. 344001201) are placed between the Drive IC blocks and the flexi cable cover.*

7.5 The Y-Drive Assembly

7.5.1 Removing the Y-Drive Assembly

The Y-Drive Assembly is attached to the X-Drive Assembly as shown in Figure 7-35. To remove the Y-Drive Assembly, remove the four M4 x 10 SHCS Screws and 4 M4 washers that attach the Y-Drive Assembly to the X assembly (Figure 7-35).

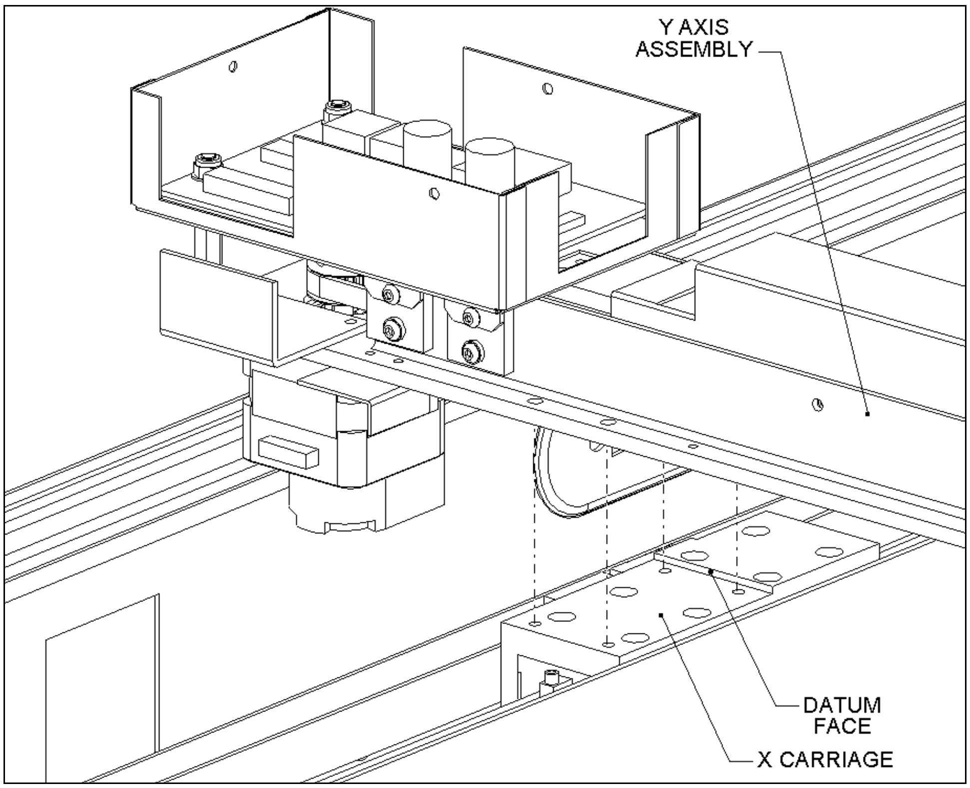

Figure 7-35 Mounting the Y-Drive Assembly on the X-Drive Assembly

When re-attaching the Y-Drive assembly to the X-Drive Assembly, hold the Y-Drive Assembly tight against the datum edge, and tighten the screws.

> ***Note**: Apply Loctite 222 to the screw before tightening them.*
>
> *Be sure to hold the Y-Drive Assembly tight against the datum edge when reassembling. Otherwise there may not be sufficient travel along the Y-axis, causing problems when the seventh rack is handled.*

7.5.2 Removing the Y-Transition Printed Circuit Board

The Y-transition printed circuit board (Part No. 582050502) is mounted in the EMC box mounted as shown in Figure 7-36.

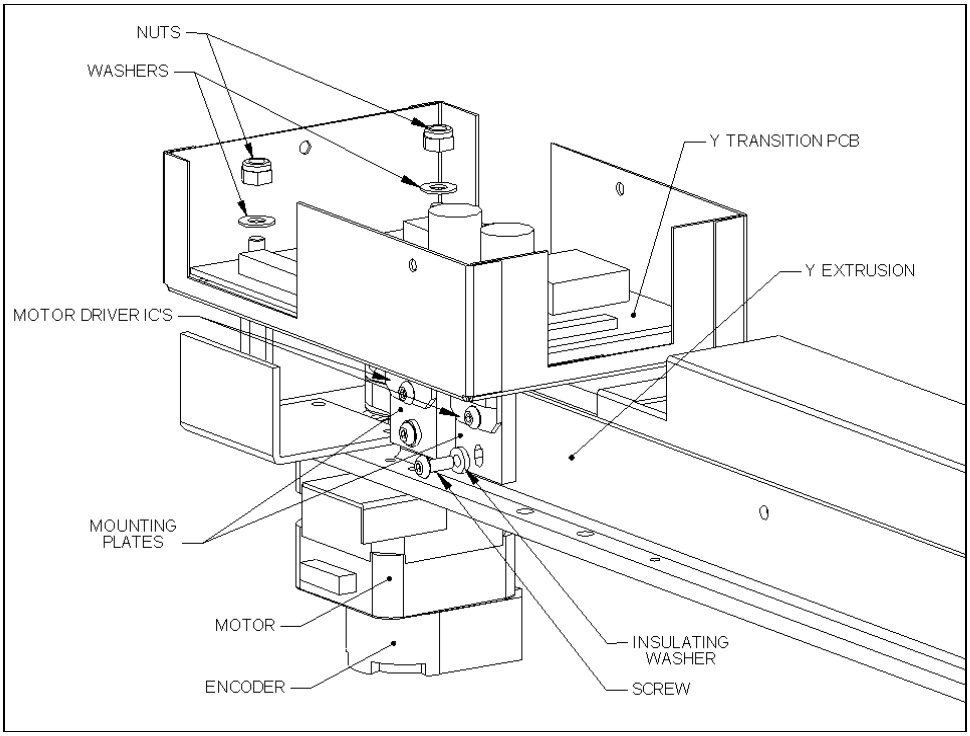

Figure 7-36 Y Transition Board Mounted in EMC Box

To Remove the Board:

1 Disconnect the motor cable from J1, the encoder harness from J6 and Y-Axis Optical Interrupter from J5.

2 Remove the 2 M4 Nyloc Nuts and M4 Nylon Washers that attach the board to the EMC box.

3 Remove the IC Mounting Plates to the Y extrusion using 2 M3 x 8 buttonhead screws.

When you replace the board, slide insulation (Part No. 344001201) between the motor driver IC plates and the Y extrusion and secure the IC mounting plates to the extrusion and assemble in reverse order.

***Note**: The cover for the EMC box should be added after the Y-axis is mounted on the system.*

7.5.3 Replacing the Encoder

The encoder is mounted on top of the Y motor as shown in Figure 7-37.

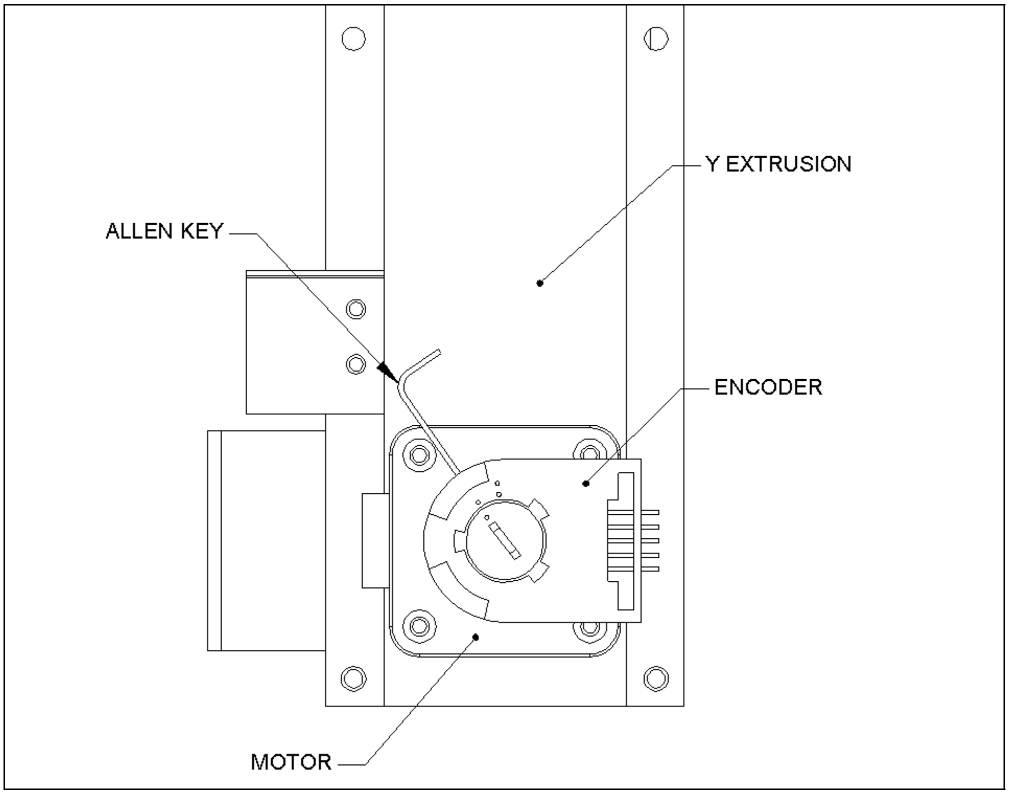

Figure 7-37 Y Encoder

To remove the encoder, release the Allen screw that holds the assembly to the motor shaft. When the screw is released, the cover will be easily removed.

To replace the encoder, place it on top of the Encoder Mounting Plate as shown in Figure 7-38.

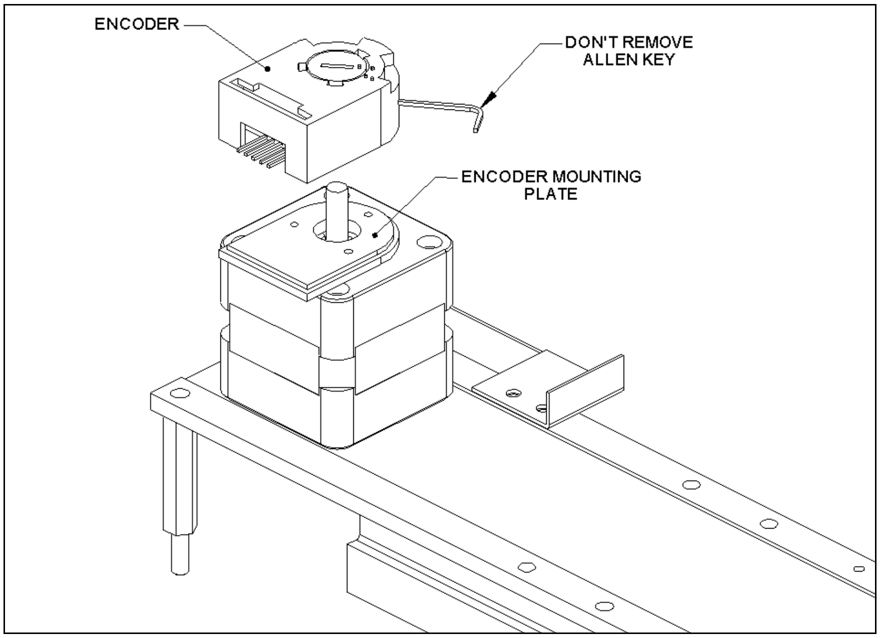

Figure 7-38 Mounting the Y-Encoder

After you have mounted the encoder, tighten the Allen screw, then rotate the encode cover from the open to the closed position (Figure 7-39).

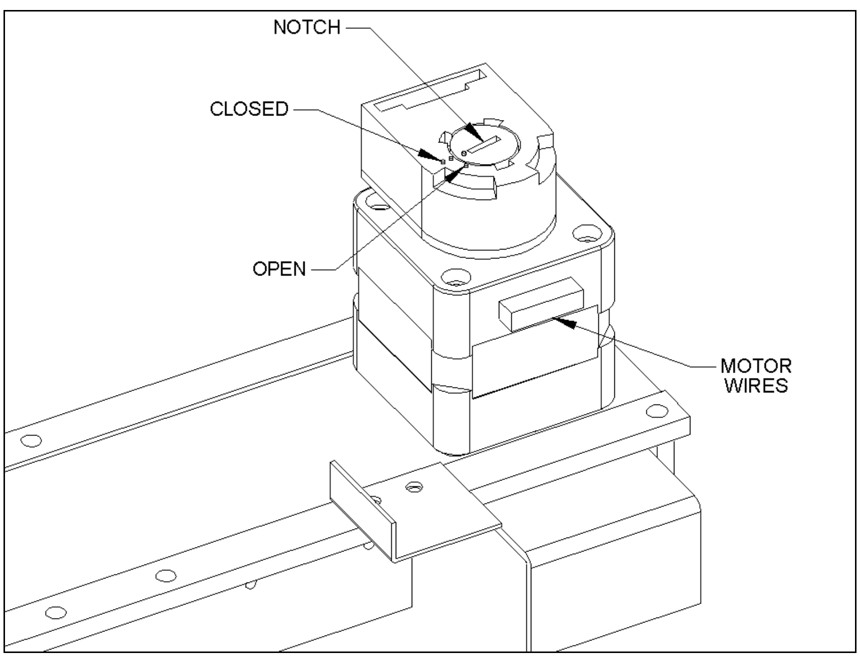

Figure 7-39 Positioning the Y-Axis Encoder

7.5.4 Removing the Y-Axis Drive Belt

To Remove the Y-Axis Drive Belt:

1 Remove the Y flexicable Platform bracket (Part No. 204003700) from the Y-Drive Block by removing the 2 M3 x 6 cap head screws (Figure 7-40).

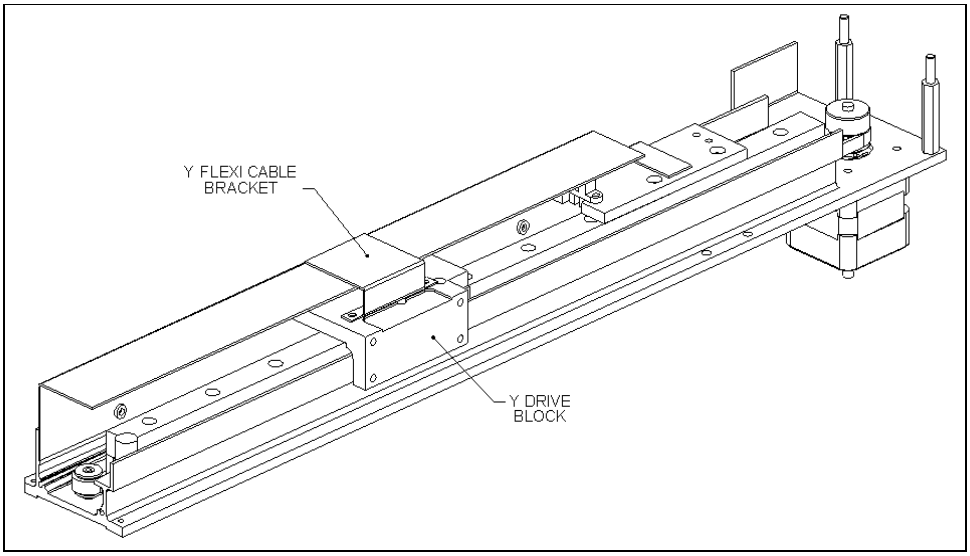

Figure 7-40 Y-Flexicable Bracket

2 Remove the Y-flexicable Run bracket (Part No. 204003800) from the Y-Drive Axis (Figure 7-41) by removing the 3 M3 x 6 caphead screws (when this is replaced, secure the screws with Loctite 222).

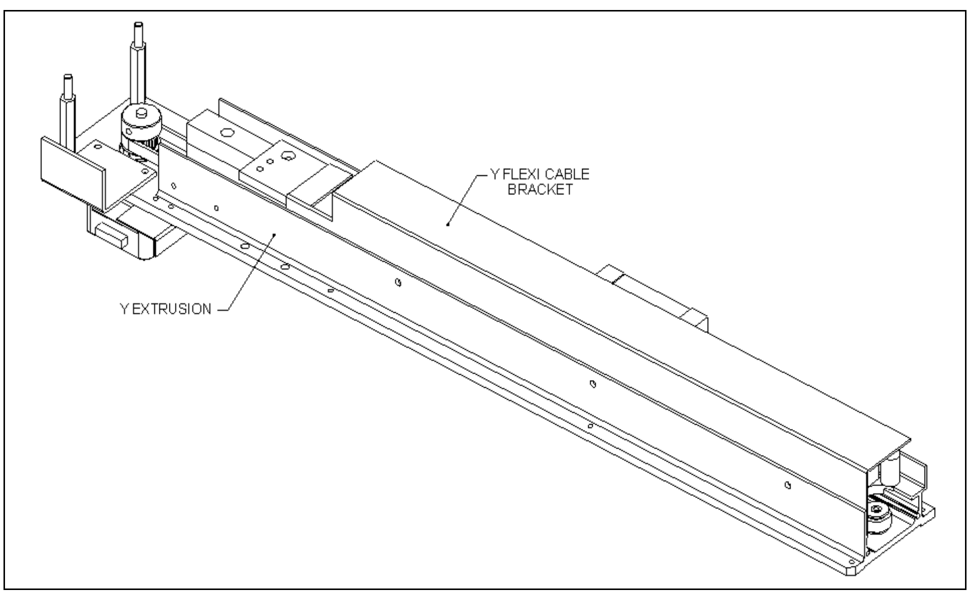

Figure 7-41 Flexicable Run Bracket

3 Remove the M3 x 30 button Posi head screw (adjustment screw) that connects the Y Belt Fixed Block and Y Belt Adjustment block. Remove the Y sensor breaker flag and the Y Belt Fixed Bracket (Figure 7-42) by removing the 2 M3 x 12 Cap head screws and remove the Y adjustable block by removing the two M 3 x 30 Posi screws.

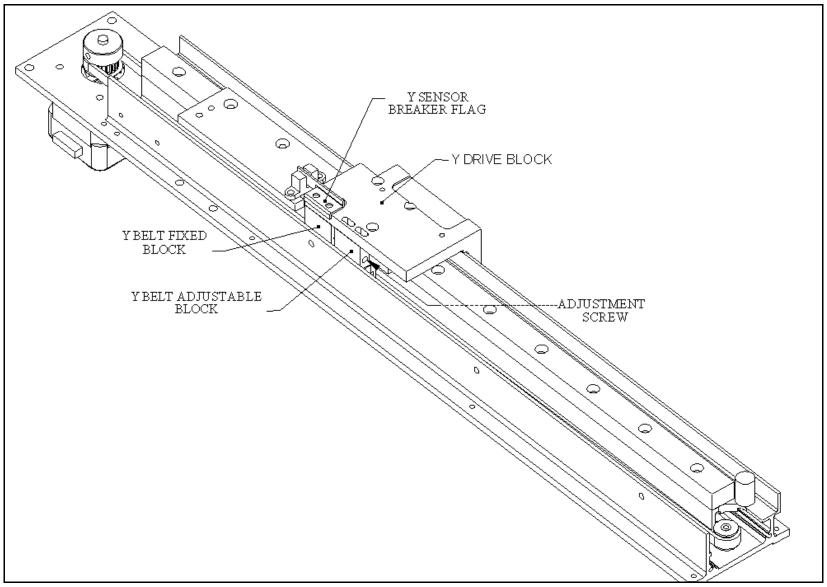

Figure 7-42 Removing the Sensor Flag and Belt Blocks

4 Remove the Y-Drive block from the linear bearing block by removing the four M3 x 6mm cap head screws (Figure 7-43).

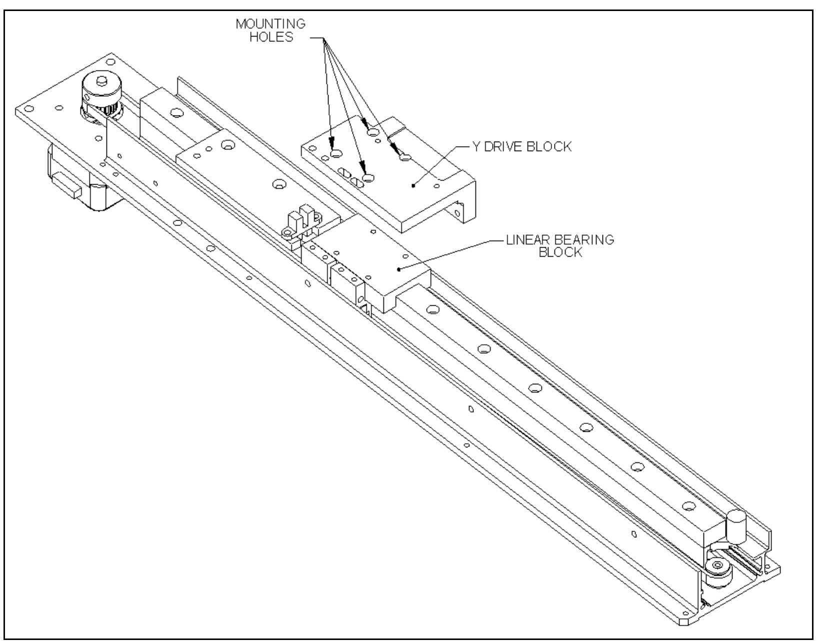

Figure 7-43 Removing Y-Drive Block

To Replace the Belt:

1 Prepare a new belt (Part No. 40000050), which is 998 mm long and placed as shown in Figure 7-44. The belt should be wrapped around the motor and idler pulleys. Assemble the idler pulley belt end with a Y-belt adjustable block (Part No. 204010600) using one clamp block (Part No. 204012400) and two M3 x 8 cap head screws. On the motor end of the belt install the Y-belt fixed block (Part No. 204010500) using one clamp block (Part No. 204012400) and two M3 x 8 cap head screws. After the blocks are prepared, use Loctite 222 to secure the screws.

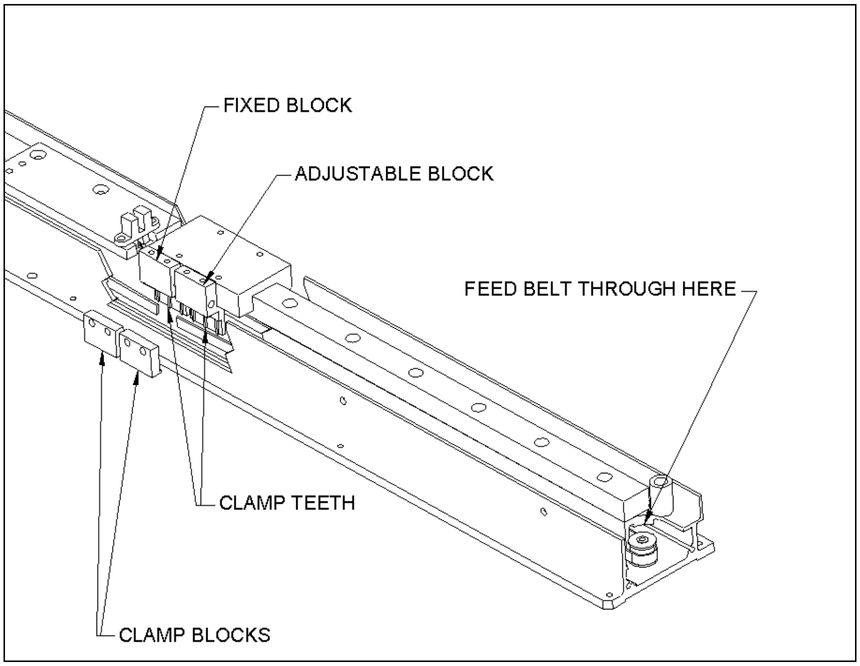

Figure 7-44 Y Belt Assembly

2 Mount the Y-drive block (Part No. 204003200) to the linear bearing block using four M3 x 6mm-cap head screws and Loctite 222 (Figure 7-45). Ensure the Y-Drive block lip is flush with the linear slide as well as the side facing the motor.

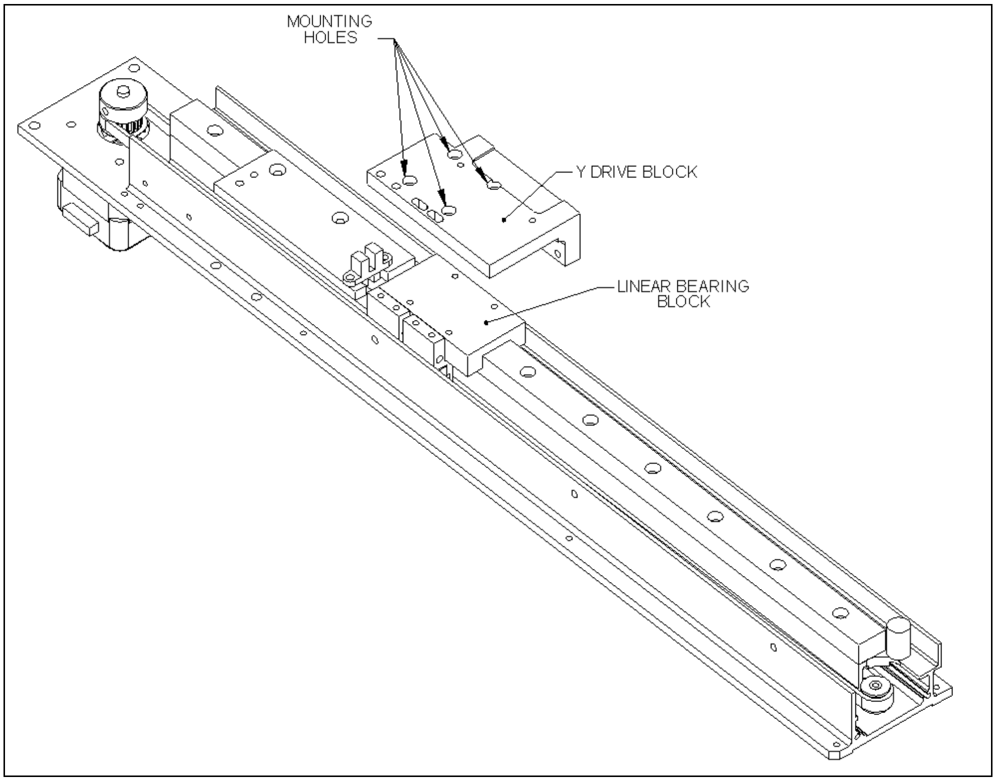

Figure 7-45 Y-Drive Block Design

3 Place the Y sensor breaker flag (Part No. 204003600) on to the top of y-drive block (Part No. 204003200) and mount to the fixed block with two, M3 X 12 cap head screws. Use Loctite 222 to secure the screw. Mount the Y adjustable block in the slotted holes using two M3 x 12 cap head screws and two M3 flat washers, do not tighten. Insert one M3 X 30 button Posi head screw through the adjustable belt block and into the fixed belt block.

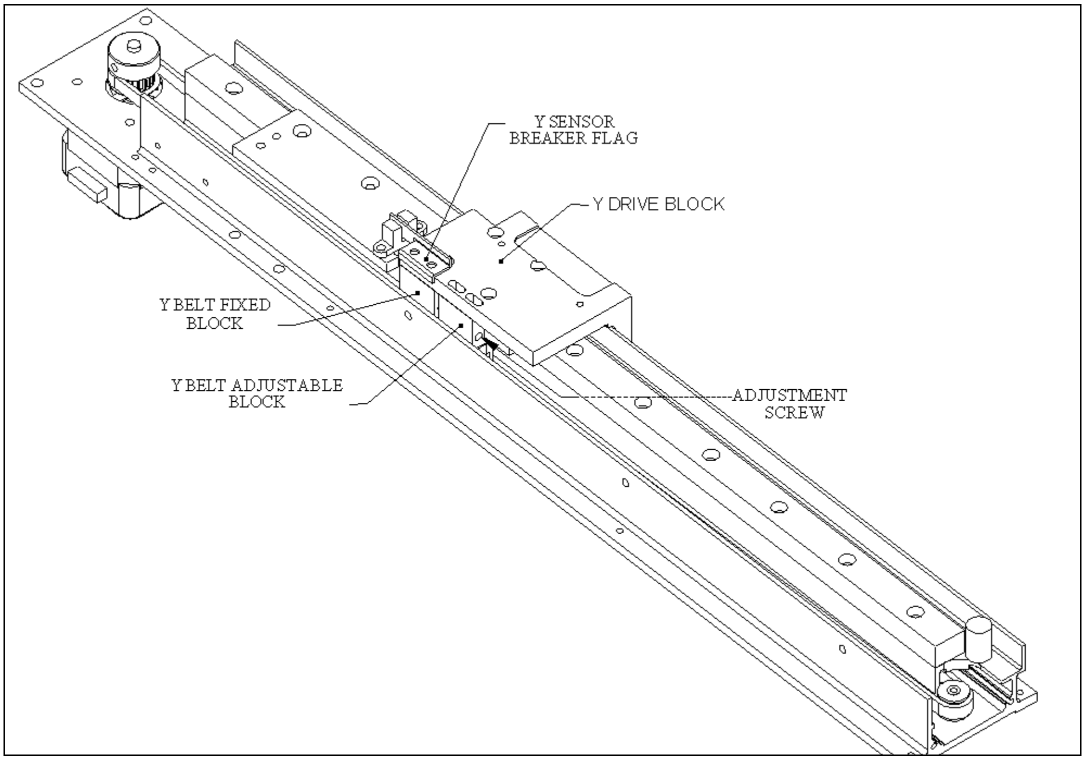

Figure 7-46 Y-Drive Cable Bracket Closed

4 Position Y belt tension Jig *DSX*FIX012 as shown in Figure 7-47 between slide rail mounting screws 5 and 6 (from the motor end), with the Z carriage fully away from the motor. Tighten the belt adjustment screw until the belt pushes the plunger flush to face of the body of the jig. Tighten the adjustable block screws and remove the jig. Individually remove and re-install each screw in the adjustable block (including the long adjustment screw) by applying Loctite 222 to each screw and then tightening. Ensure that the Y sensor flag passes through the middle of the sensor.

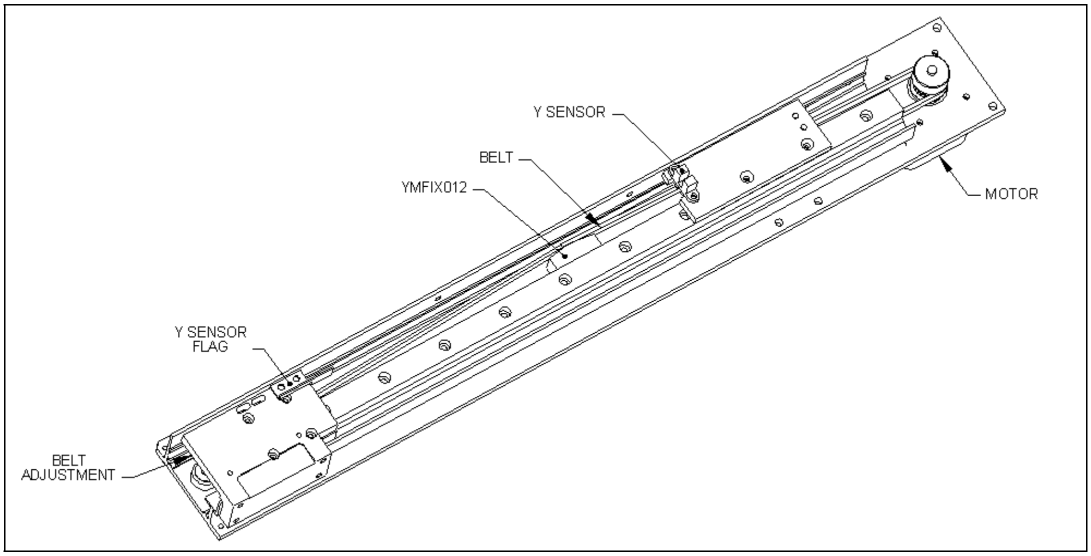

Figure 7-47 Tightening the Y-Drive Belt

7.5.5 Removing the Y Optointerrupter

The Y Optointerrupter is mounted as shown in Figure 7-47. To remove the Y sensor, remove the two screws. When you replace the sensor, make certain that the Y-Flag travels through the center of the sensor.

7.5.6 Removing the Pulley

The Y axis pulley (Part No. 528101000) is mounted on the motor (Part No. 528301000) and attached via a M4 x 6 mm skt set screw

When remounting the pulley, use a jig (Part No. YMFIX010) and Loctite 222 (Figure 7-48). If the jig is not available, use a micrometer to set a distance of 3.2 mm. The pulley must be attached to the long shaft of the motor.

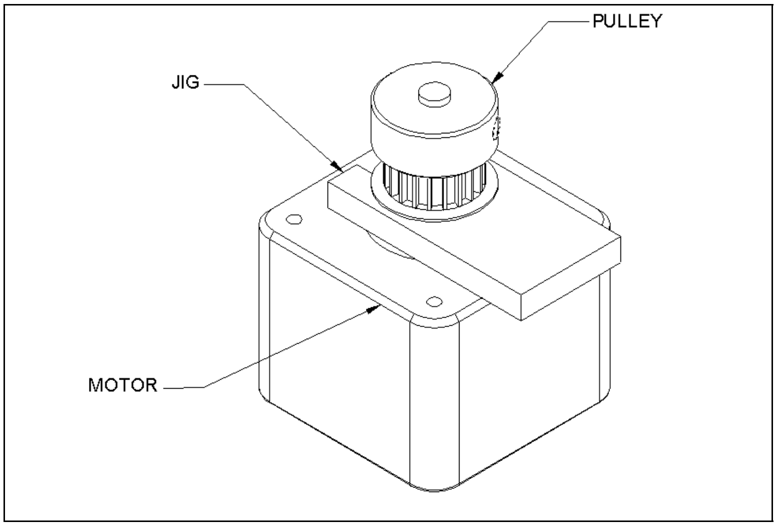

Figure 7-48 Replacing Motor Pulley

7.5.7 Removing the Y Axis Motor

The Y Axis motor (Part No. 528301000) is attached to the Y-Axis extrusion via two M3 x 8 mm cap head screws and two M3 x 10 mm cap head screws as shown in Figure 7-49.

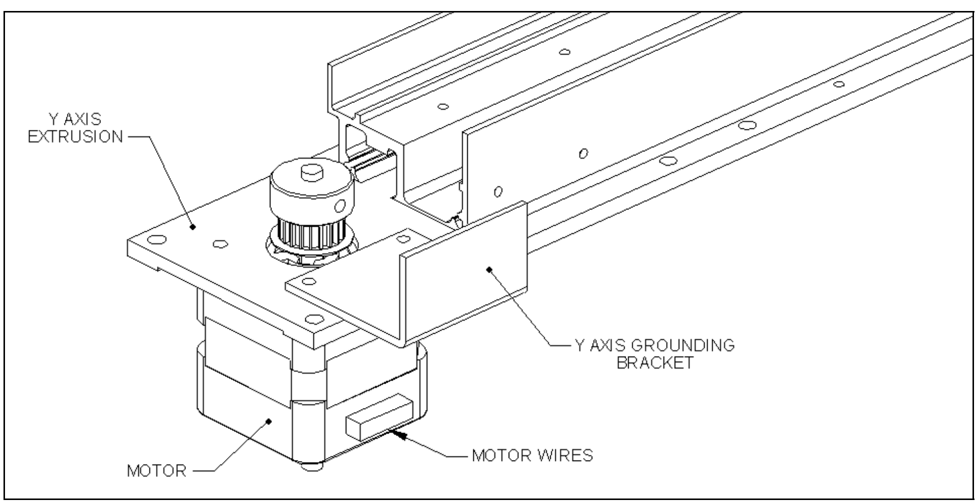

Figure 7-49 Mounting the Y Axis Motor

7.5.8 Replacing the Idler Pulley

The Idler Pulley is made from two flanged bearings (Part No. 322000801) as shown in Figure 7-50. To remove the bearing, unscrew the M3 x 6 cap head screw and flat washer. When replacing the bearings, use Loctite 222 and secure the screw.

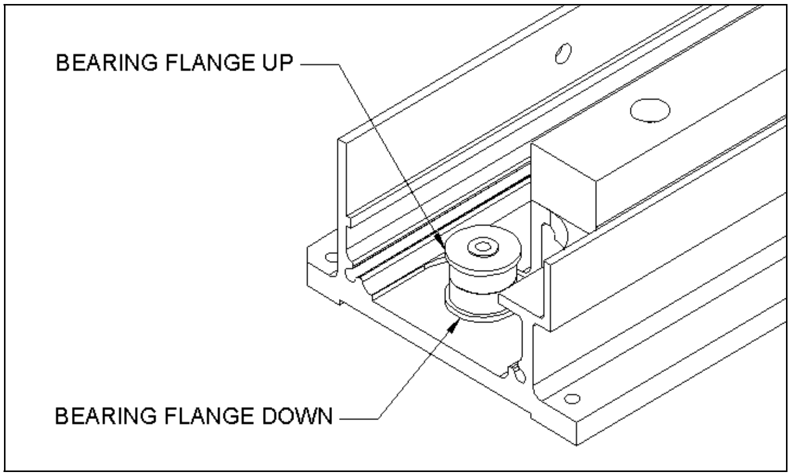

Figure 7-50 Replacing the Idler Pulley

7.6 The X Axis Drive Assembly

7.6.1 Replacing the Optointerrupter

The Optointerrupter (Part No. 15001130) is mounted near the X-axis idler pulley as shown in Figure 7-51. It is removed by removing the two M3 x 25 buttonhead screws and M3 shakeproof washers.

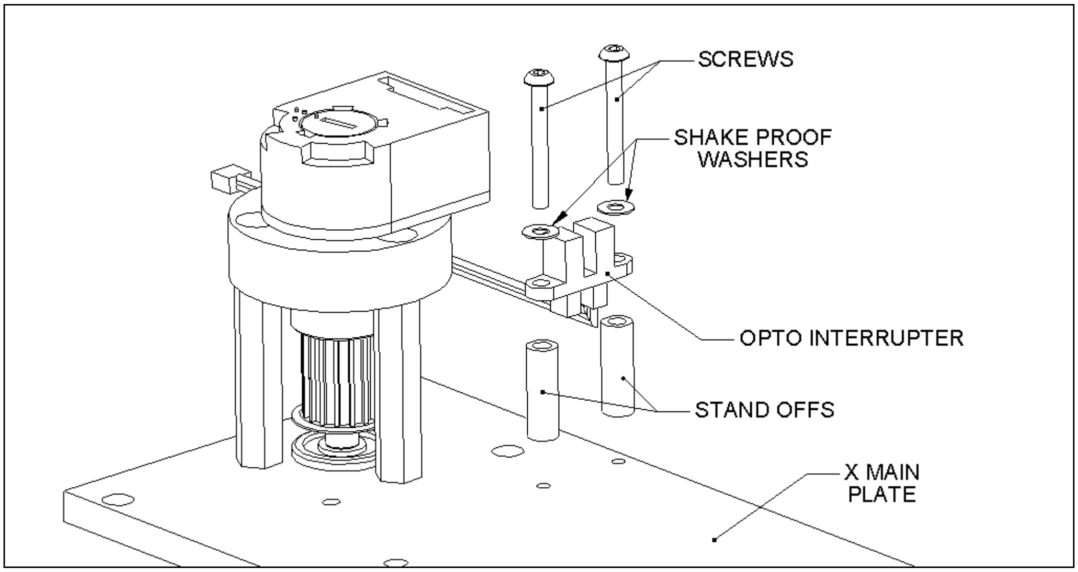

Figure 7-51 X Axis Optointerrupter

7.6.2 X-Axis Motor

To remove the X-Axis motor (Figure 7-52), remove the three M4 x 16 SKT cap screws that attach the motor to the motor mount. When replacing the motor, secure the screws using Loctite 222.

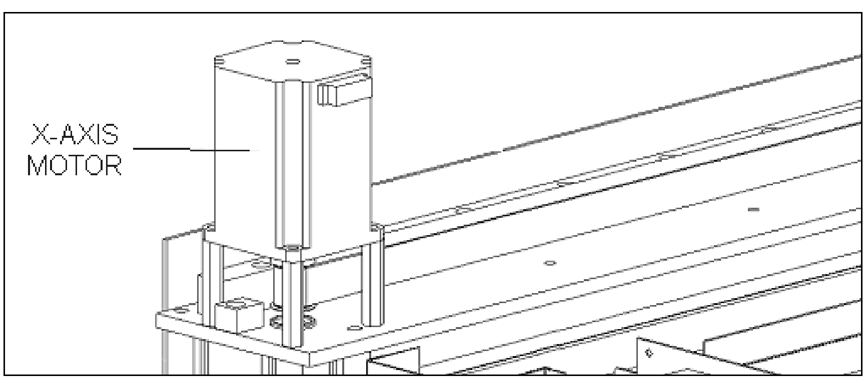

Figure 7-52 Location of X-Axis Motor

7.6.3 Replacing the Encoder

The encoder is mounted on the idler pulley as shown in Figure 7-53. To remove the encoder, loosen the wheel using an Allen wrench. When the encoder is sufficiently loosened, it is easily removed.

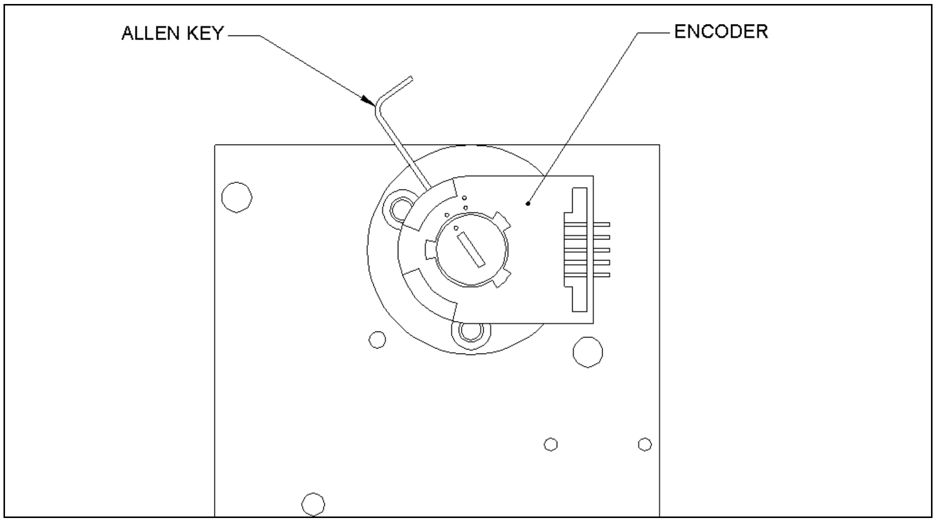

Figure 7-53 X-Drive Encoder

To Reinstall the Encoder

1 Place the encoder on top of the encoder mounting plate as shown in Figure 7-54. It will snap into place.

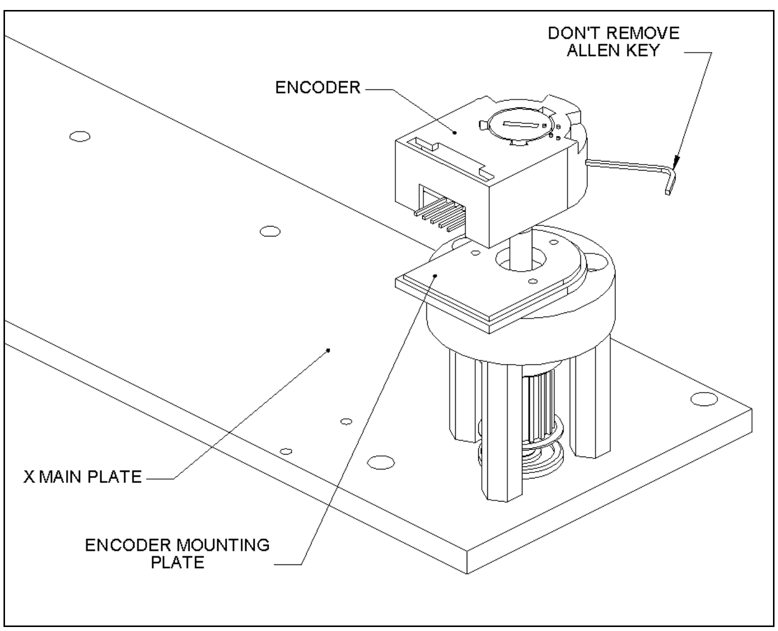

Figure 7-54 Mounting the X-Encoder

2 Tighten the encoder wheel to idler shaft (Figure 7-54) using the Allen key.

3 Rotate encoder cover from the open to closed position by inserting a small flat blade screwdriver into the notch and rotating. The encoder cover is shown in the closed position in Figure 7-55.

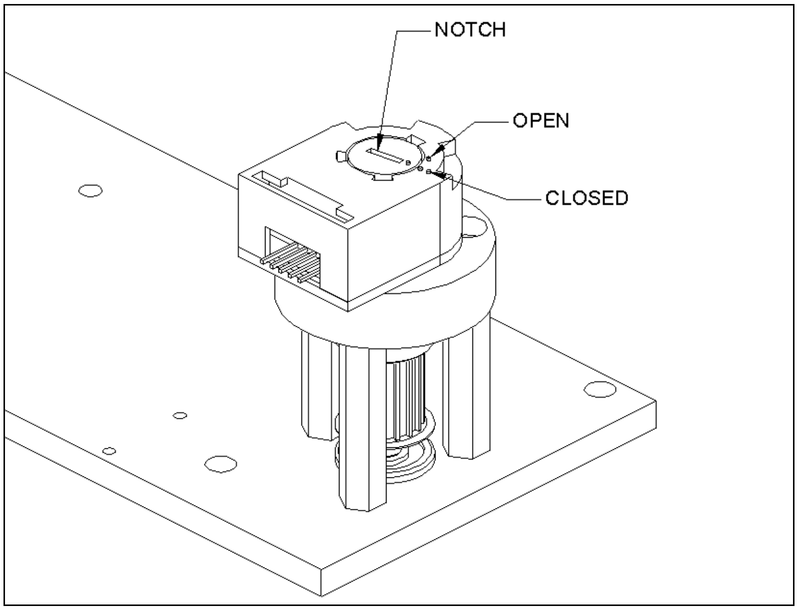

Figure 7-55 X-Encoder Position

7.6.4 Removing the Pulley from the X-Drive Motor

The Pulley (Part No. 23001660) is attached to the X-Drive motor (Part No. 528300800) by two M4 x 6 cone point set screws as shown in Figure 7-56.

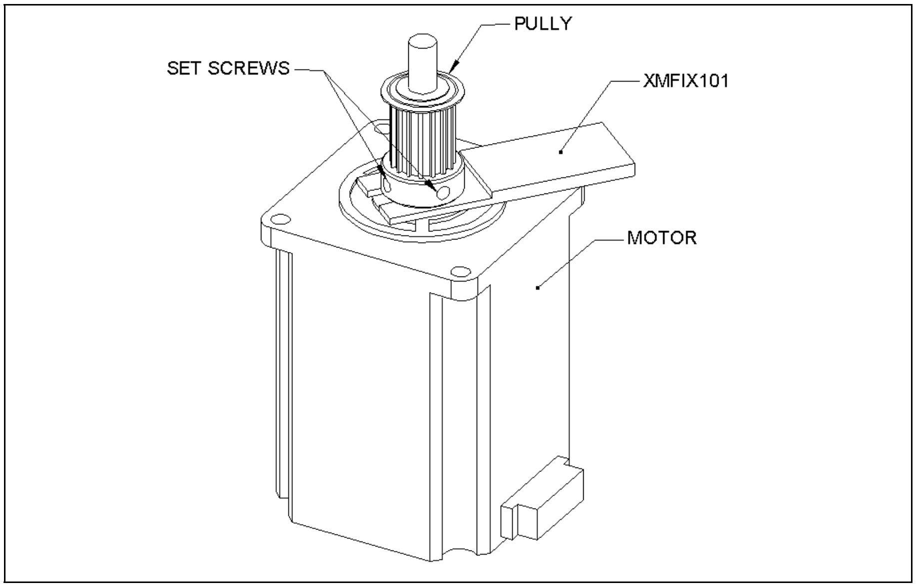

Figure 7-56 Affixing the Pulley to the X-Drive Motor

When attaching a new pulley, use the pulley height setting jig (XMFIX010) to set the proper height. If the jig is not available, use a micrometer to set the distance from the bottom of the pulley to the top of the motor housing to 2.2 mm. The screws supplied with the pulley should be discarded, use M4 x 6 cone point set screws (Part No. 307400406) instead.

7.6.5 Replacing the X Idler Pulley Assembly

The X-Drive Idler Pulley Assembly is mounted on the X Main plate as shown in Figure 7-57.

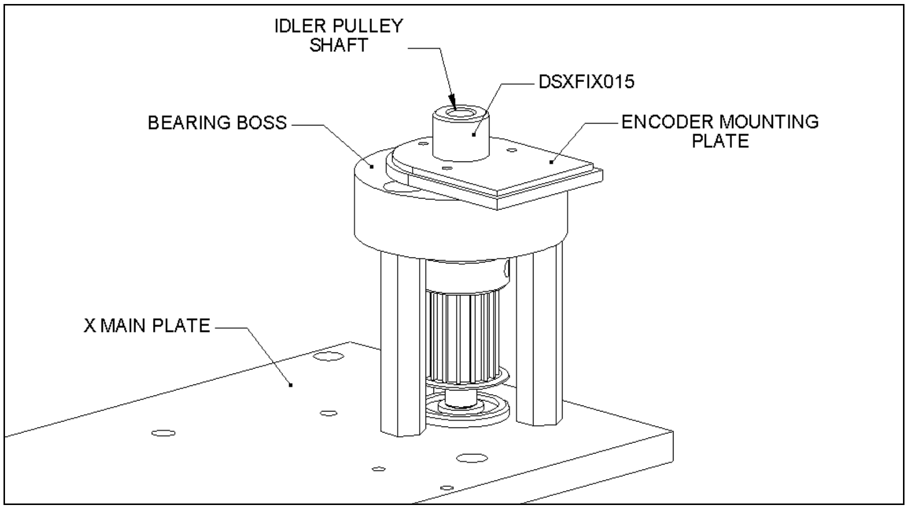

Figure 7-57 Idler Pulley

To Remove the Idler Pulley Assembly:

1 Remove the X-axis encoder as described (see *Replacing the Encoder* on page 7-44).

2 Remove the Encoder Mounting Plate (Part No. 409010000) by removing the three M1.6 x 6 posi pan screws.

3 Remove the Bearing Boss (Part No. 2040003100) by removing the 3 M4 x 16 skt cap screws (Figure 7-58).

4 Remove the pulley assembly from the main plate.

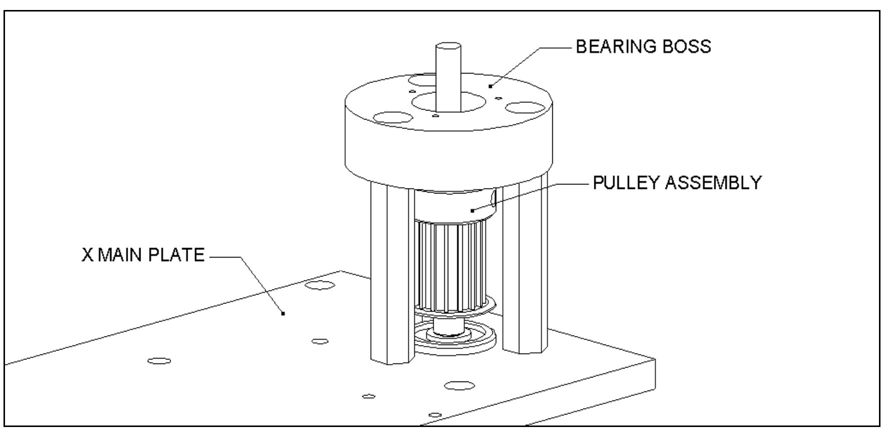

Figure 7-58 Bearing Boss X-Pulley

To Install a New Idler Pulley Assembly:

1 Position the new Idler Pulley Assembly onto the X main plate so that the bottom bearing of the new Idler Pulley Assembly is resting in the counter-bore of the X main plate (Figure 7-59). Insert, but do not tighten, the three M4X16 cap head screws that secure the X Idler Pulley Assembly to the three standoffs.

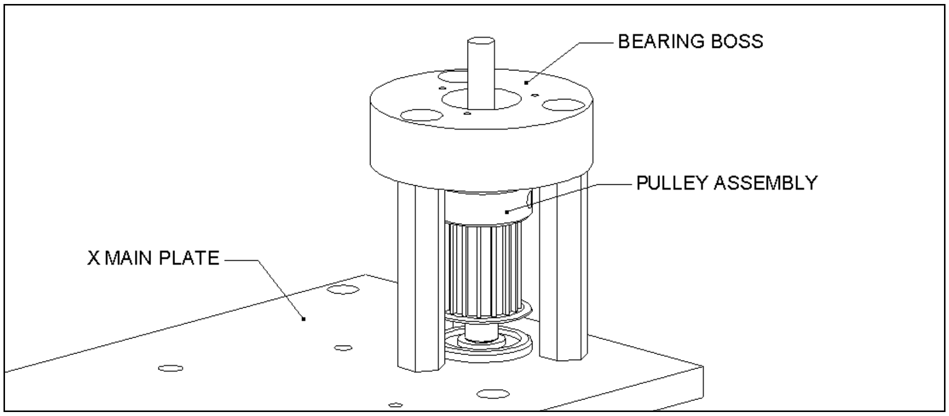

Figure 7-59 Mounting the Idler Pulley Assembly Onto the X Main Plate

2 Place the X Drive Encoder Pulley Alignment Tool (DSXFIX035) around the Idler Pulley assembly as shown in Figure 7-60. Hold the bottom of the tool flush with the X Main Plate, then tighten the wing nuts of the fixture.

> ***Note**: The Alignment Tool (DSXFIX035) has a clearly marked top and bottom orientation. To ensure the tool is assembled correctly, check to see that the smaller relief that is cut into the center hole of the fixture is at the top when the tool is assembled on the X Plate.*

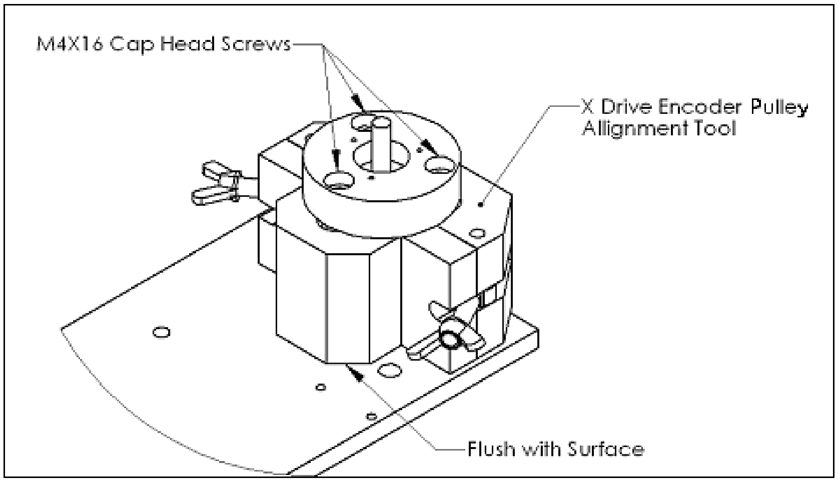

Figure 7-60 Positioning the Alignment Fixture Around the Pulley Assembly

3 Remove each of the three M4X16 cap head screws (one at a time), apply Loctite 222, reinstall, and tighten.

4 Remove the X Drive Encoder Pulley Alignment Tool.

5 Attach the mounting plate, which is part of the Encoder (419010000), to the bearing boss using the Encoder Mounting Jig (DSXFIX015) and three M1.6X6 Pan Head Screws (303800106).

> ***Note****: Ensure that the mounting plate is centralized around the pulley idler shaft.*

6 Continue by mounting the encoder (see *Replacing the Encoder* on page 7-44).

7.6.6 Adjusting the X-, Y-, or Z- Motor Pulley and Idler Pulley

The Drive Motor Pulley and Idler Pulley must be properly positioned on their respective shafts. Otherwise, the X-, Y-, or Z- Drive Belt may contact the edge of one or both pulleys during operation.

1 Observe the Drive Motor Pulley while manually moving the drive back and forth along the drive axis.

2 If the drive belt contacts the edge of the Drive Motor Pulley while the drive is moved back and forth, stop at the point where the drive belt begins to contact the edge of the pulley. Then, loosen the two M4 x 6mm cone screws that secure the Drive Motor Pulley to the shaft, slide the pulley 2 mm away from the edge of the belt, and retighten the two screws.

3 Perform an Arm self test by selecting **DSX Manual Control** from the *Tools* menu, responding **Yes** to the prompt, and then selecting **Arm** in the left panel and **Self-Test the XY** or **Self-Test the Z** (as appropriate) in the right panel. Then select **Do It** to begin the test. During the test, observe the drive belt to determine if it rides near the center of the pulley through its travel.

> ***Note****: Step* ***3*** *can be omitted if the system cannot be powered up at this point.*

4 Repeat Steps **2** and **3** until the belt rides near the center of the pulley. If the results are satisfactory, replace the M4 x 6mm cone screws with new screws one at a time, replacing and tightening the first screw before the second is replaced.

> ***Important****: The old M4 x 6mm cone screws must be replaced with new screws. Use Loctite 222 on the new M4 x 6mm cone screws. .*

5 Repeat Steps **1** through **4** for the Idler Pulley.

7.6.7 Replacing the X Transition Printed Circuit Board

The X Transition Printed Circuit Board is mounted on the left side of the system as shown in Figure 7-61.

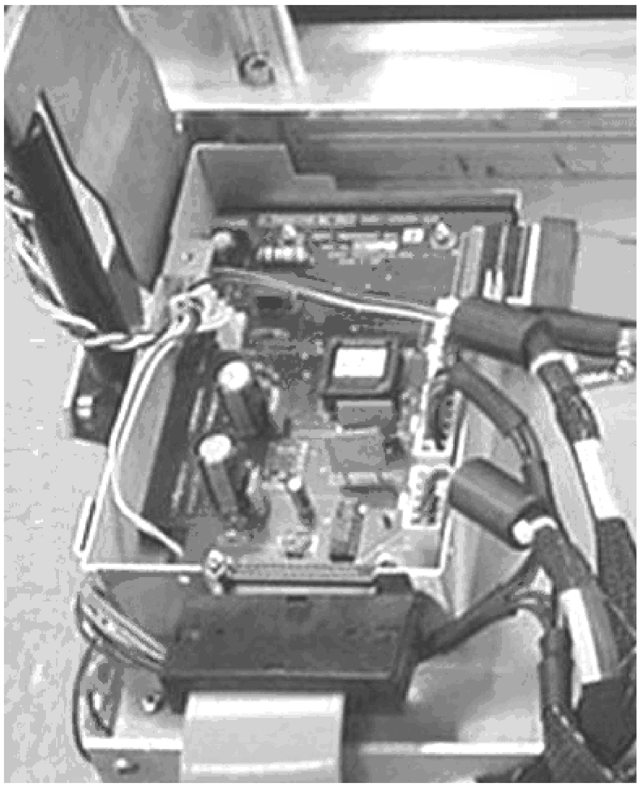

Figure 7-61 Location of X-Transition Printed Circuit Board

To Remove the X-Transition Printed Circuit Board (Part No. 582050902):

1. Remove the two M3X6 Cap Screws and washers that secure the heat sink on the underside of the X-Transition PCB to the right frame panel.
2. Disconnect the solenoid cable from J9 on the X-Transition PCB.
3. Remove the four M3 Nylock nuts that secure the X transition PCB to the standoffs.

> ***Note****: The side panel must be removed to access the X-Transition PCB.*

To Install a New X-Transition Printed Circuit Board:

1. Fit the X-Transition PCB to the ribbon cable tray standoffs using four M3 Nylock nuts and four M3 Nylon washers. Do not tighten the nuts at this time.
2. Connect the solenoid cable to J9 on the X-Transition PCB.
3. Secure the heat sink on the underside of the X-Transition PCB to the right frame panel using two M3X6 Cap Screws and washers.
4. Tighten the four M3 Nylock nuts and four M3 Nylon washers that secure the X-Transition PCB to the tray.

7.6.8 Replacing the X-Drive Belt

To Remove the X-Drive Belt:

1 Loosen (by one-half turn only) the four screws that secure the adjustable block to the X carriage (Figure 7-62).

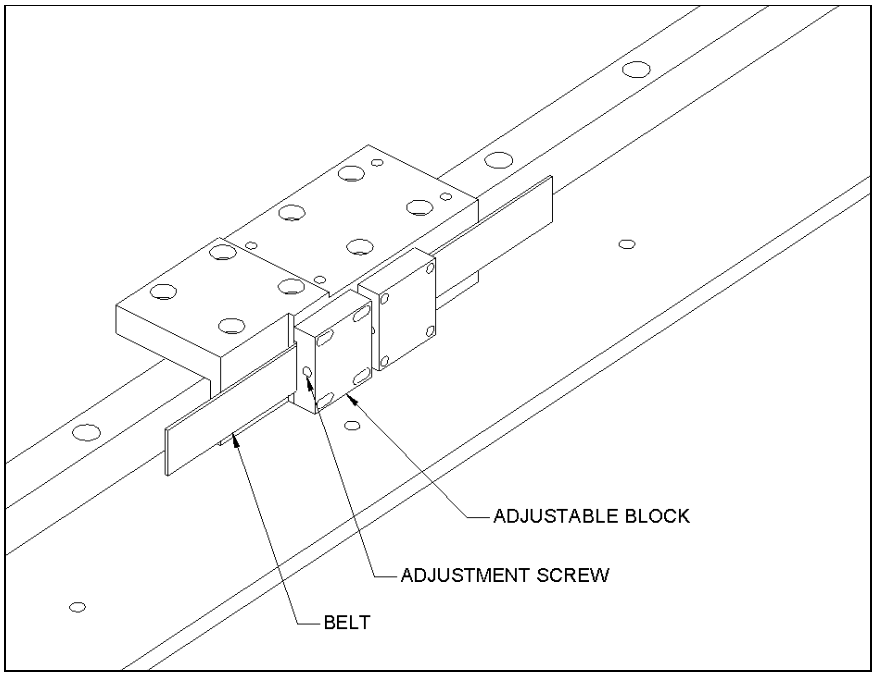

Figure 7-62 X-Drive Belt Adjustment Block

2 Remove the adjustment screw completely.

3 Loosen the adjustable block and the fixed block enough to free the ends of the belt.

To Replace the X-Drive Belt:

1 Fit the Fixed X Belt Block (Part No. 204002600), with the belt (Part No. 40000160) to the end of the datum face (Figure 7-63). Ensure that the belt is properly located and flush with the end of the block. Use 4 M3 x 12 skt cap screws; apply Loctite 222 and secure the screws.

> ***Note**: The threaded hole must face to the left.*

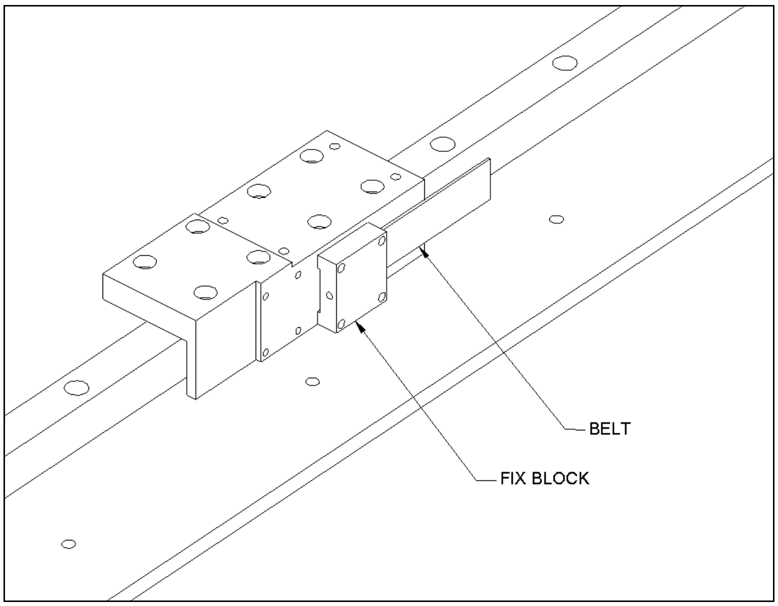

Figure 7-63 Mounting the Fixed Block

2 Route the belt around the pulleys, then fit the Adjustable X Belt Block (Part No. 204002700) to the left end of the datum block (Figure 7-64). Make sure that the belt is properly located and flush with the end of the block and affix using 4 M3 x 12 skt cap screws, 4 M3 Washers and Loctite 222.

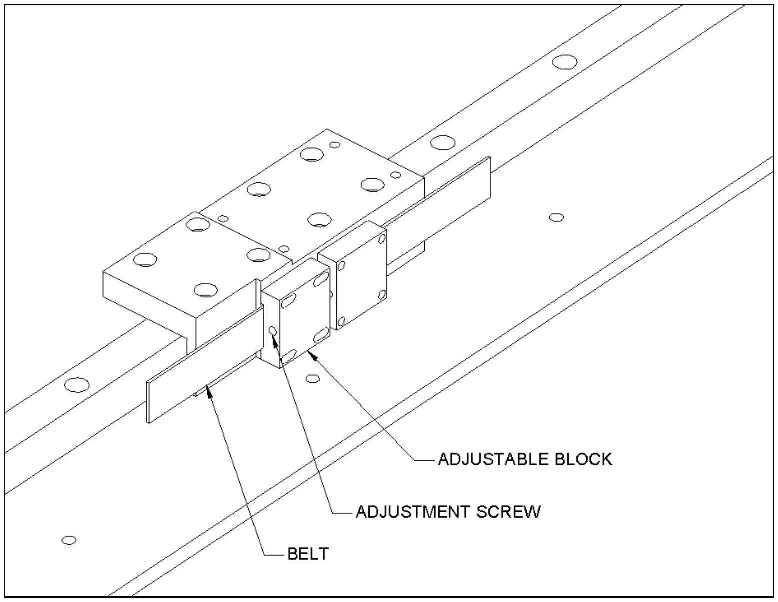

Figure 7-64 Mounting the Adjustable Block

3 Fit the adjustment screw (Part No. 303000335) through the adjustable block and into the fixed block (Figure 7-64).

4 Tighten the X Belt according to the following procedure.

To Tighten the Belt and Check the Belt Tension:

1 Position the Tension Meter (Brecoflex Model SM3) over the rear section of the X belt as shown in Figure 7-65.

> ***Note**: The sensor must be **3** to **6** mm above the belt and perpendicular to the belt.*

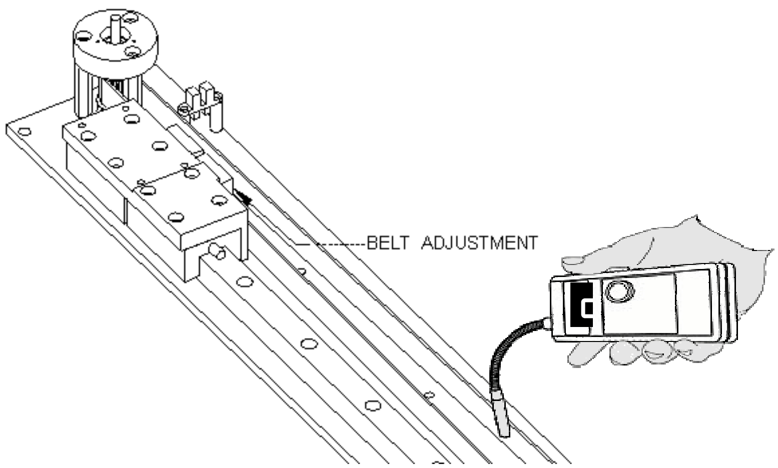

Figure 7-65 Checking the Belt Tension

2 Tap the belt to cause it to oscillate.

> ***Note**: The belt must only oscillate in the horizontal plane. If the belt twists, the readings will not be correct.*

3 While the belt is oscillating and the sensor is above the belt, press and hold the red button on the tension meter.

> ***Note**: Discard any readings that are less than **14** or greater than or equal to **40**.*

4 Record the resulting tension reading.

5 Repeat the above steps until ten valid readings are recorded.

6 Total the readings and divide by ten to calculate the average. Record these values.

7 If the resulting average is not within **25 ± 0.5**, adjust the adjustment screw in quarter turn increments until the proper tension is read. Then repeat the above steps to record ten new readings and calculate the average.

8 Tighten the four screws in the adjustable block. Then double-check the belt tension.

7.7 Spare Parts and Jigs

The following listing of parts includes all parts that are likely to be replaced by the service engineer (screws, washers, wire and other common items are not included). In some instances, the service engineer has the option of replacing an entire subassembly or replacing the specific component that is defective. These components are either crucial to operation or may be subjected to wear and tear during normal operation.

7.7.1 Z-Drive Assembly (13001440)

Description	Part Number
Rotary Spring	324600400
Spring Retainer Housing	204026700
Z-Encoder	419010000
Assy., Z Home Sensor	15001180
Timing Belt (772 mm long)	400000050
Fixed Belt Block	204003300
Belt Clamp	204012400
Adjustable Belt Block	204003400
Z-Drive Block	204004600
Z-Sensor Breaker Flag	204011300
Z-Motor Pulley	320101000
Z-Motor	528300900
Z-Home Sensor	15001180
Z Sensor Plate	204005200
Bearing Plate	204004400
Idler Pulley	23001650
M4 x 6 Cone Point Set Screw	30700406
Z-Axis Transition Board	582050402
IC Mounting Plates	204026600
Insulation Pads	344001201
Pipette Assembly	13001450
Linear Bearing, 12 x 320 mm	322002000
Z Flexi Cable	15001030

7.7.2 Y-Drive Assembly (13001430)

Description	Part Number
Y-Transition Board	582050502
Y-Encoder	419010000
Y-Axis Flexicable Platform Bracket	204003700
Y-Axis Flexicable Run Bracket	204003800
Y-Axis Flexicable	15001020
Timing Belt (998 mm long)	400000050
Y-Belt Fixed Block	204010500
Y-Belt Adjustable Belt Block	204010600
Y-Drive Block	204003200
Y-Clamp Block	204012400
Y-Sensor	15001160
Y-Sensor Breaker Flag	204003600
Y-Sensor Plate	204003000
Y-Axis Pulley	320101000
Y-Motor	528301000
Idler Shaft	204002900
IC Mounting Plates	204031400
Idler Pulley Bearings (2)	322000801

7.7.3 X-Drive Assembly (13001420)

Description	Part Number
X-Transition Board	582050902
X-Encoder	419010000
X-Axis Flexicable Platform Bracket	204003700
X-Axis Flexicable Run Bracket	204003800
Timing Belt (1851 mm long)	40000160
X-Belt Fixed Block	204012600
X-Belt Adjustable Belt Block	204002700
X-Drive Block	204002500
IC Mounting Plate	204031400
Thin IC Mounting Plate	204011010
X-Sensor Breaker Flag	204005700
X-Axis Pulley	23001660
X-Motor	528300800
X-Main Plate	204002200
Bearing Boss	204003100
X-Opto Interrupter	15001130
X-Axis Linear Way	322001800

7.7.4 Jigs

Description	Part Number
X-Motor Pulley Height Setting Jig	XMFIX010
X-Belt Tensioning Jig	Brecoflex Meter
Y-Motor Pulley Height Setting Jig	YMFIX010
Y-Belt Tensioning Jig	YMFIX012
Z-Motor Pulley Height Setting Jig	ZMFIX010
Z-Belt Tensioning Jig	ZMFIX012
Encoder Jig	DSXFIX015

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Chapter 8 The Incubator Module

8.1 Overview

The Incubator Module is used to maintain the temperature of the well plate at a user-specified temperature for a user-specified period of time so that the reaction to form the product that is measured in the reader module can proceed. The period of time and the temperature setting is established in the application program for the specific assay for which the DSX Automated ELISA System is employed.

When a well plate is to be placed in the module, the plate carrier is ejected from the module and the plate is delivered to the module via the pipette arm. The plate carrier is then drawn back in the incubation module. At the end of the user specified period, the well plate is ejected by the module and picked up by the pipette arm to be delivered to another station (e.g. the reader module).

The service engineer is expected to replace the Incubator Module in the event of a problem with the module. The defective module should be returned to the local DYNEX Technologies service center for repair (in some situations, the service engineer may be able to repair the module on site).

A discussion of a variety of replacement/repair activities is presented in Chapter 9.

8.2 Design of the Incubator Module

The Incubator Module is a microprocessor-controlled warming chamber that is designed to heat the well plate for a user-specified period of time.

A well plate is placed inside the Incubator Module by means of a plate carrier. The plate carrier extends from the Incubator Module to accept a well plate delivered to the module via the pipette arm. The plate carrier containing the well plate is then drawn into the Incubator Module. At the end of the user specified warming period, the plate carrier containing the well plate is ejected, and the well plate is picked up by the pipette arm and delivered to another station (such as the reader module).

8.3 Electrical/Control Considerations

All activities of the Incubator Module (e.g. movement of the plate carrier) are performed under the direct control of the program that is being executed by the Revelation application program.

A circuit block diagram of the Incubator Module is presented in Figure 8-1.

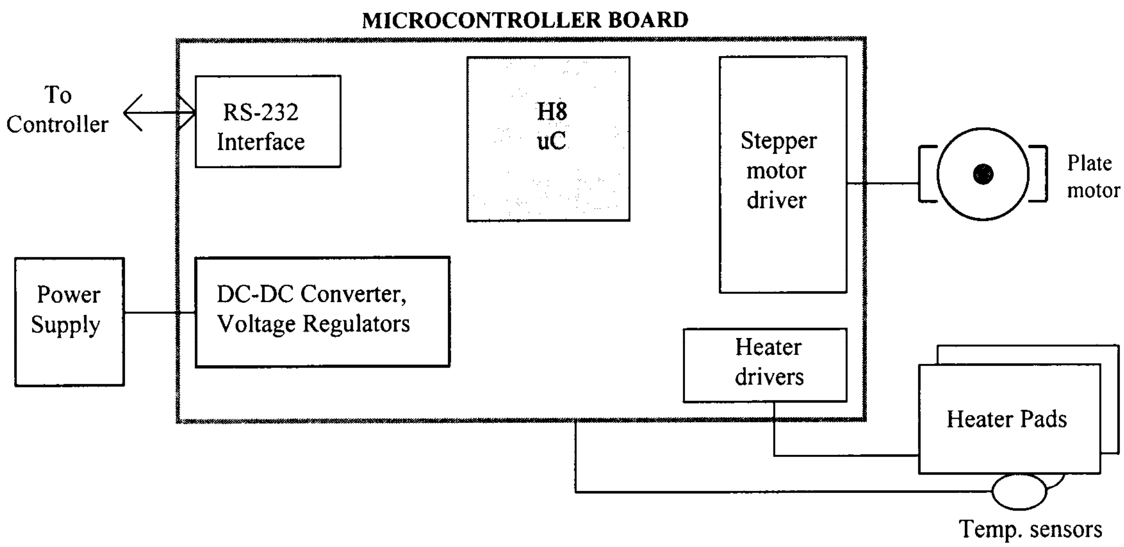


Figure 8-1 Circuit Block Diagram - Incubator Module

The following components are included in the control of the module:

MICROPROCESSOR: Provides overall operation/control of this module. The operation of the incubation module is based around the Hitachi H8/338 single-chip microcomputer, which provides 48Kbytes of ROM (program/data space) and 2Kbytes of RAM. The H8/338 has the following internal peripheral capabilities:

- 9 ports, providing 58 I/O and 8 Input lines
- Two 8-bit timers (TMR0, TMR1)
- One 16-bit free-running counter (FRC)
- Two digital to analog channels (DA0, DA1), with 8-bit resolution
- Six analog to digital channels (AN0 through AN5), with 8-bit resolution
- Two serial communications channels (COM0, COM1)
- Two pulse width modulation channels (PWM0, PWM1)

RS-232 C INTERFACE: Provides serial communications between the incubation module and the controller. Commands and test data are transferred between the microprocessor and the external PC controller via a serial RS-232 interface. Five-volt only interface drivers and receivers are used between the COM0 serial communications channel on the H8 and the interface connector to provide proper RS-232 signal levels to the controller. The interface IC used is the MAX232CD IC, which contains 2 drivers and 2 receivers in a single package. The IC uses +5 volts to produce the required drive voltages using 4 external capacitors. The three interface signals used are TD, RD, and DSR. Since the Incubator Module is configured as a DCE device, TD is an input to the IM and RD and DSR are outputs from the Incubator Module.

STEPPER MOTOR DRIVER/ PLATE MOTOR: Used for plate positioning control. The test plate is positioned within the Incubator Module by a single stepper motor. The stepper motor is powered by +12 volts from the external supply, and is controlled by the microcomputer through an Allegro UDN2916B PWM motor driver IC. The driver allows the motor to be driven at current levels of 1/3, 2/3, and full value. This allows control of the torque and power consumption of the motor. The motor is driven in the constant torque half stepping mode utilizing the current control capability of the UDN2916B driver.

POWER SUPPLY/ DC-DC CONVERTER/VOLTAGE GENERATION: DC voltages of +5 and +12 volts are provided to the Incubator Module from an external power supply. The +5 volt supply is used to provide Vcc for the digital logic, and the +12 volts is used to power the stepper motors.

HEATER DRIVERS/ HEATER PADS/ TEMPERATURE SENSORS: The foil heater pads used to maintain the elevated temperature of a heated test plate are controlled using the PWM0 and PWM1 outputs of the microprocessor. The PWM0 and PWM1 outputs are connected to power transistors that directly drive the two heaters. The duty cycle of the PWM's are varied to control the amount of heat generated by the heaters.

The temperature of the heaters is monitored using sensors, which produce a current output proportional to the temperature. The current from each sensor is selected using an analog switch controlled by P82 on the microprocessor. The current is then converted by an op amp circuit to a voltage and applied to A/D input AN1 on the microprocessor. The microprocessor then uses the temperature information to control the power applied to the heaters to maintain the required temperature of the test plate.

8.4 Operational Activities for the Incubator Module

The following actions occur when a **Plate Insert** command is received by the Incubator Module:

1. The temperature sensor checks to verify that the temperature in the Incubator Module matches the value indicated in the assay to be performed.
2. The plate carrier is ejected from the module. The movement of the plate carrier is terminated when the eject sensor determines that the plate carrier is driven to the full extended position.
3. The well plate is inserted into the plate carrier by the pipette tip.
4. The plate carrier is drawn into the module. The movement of the plate carrier is terminated when the sensor determines that the plate carrier is driven to the full internal position.

At the termination of the desired incubation period, the following actions occur:

1. The plate carrier is ejected from the module. The movement of the plate carrier is terminated when the eject sensor determines that the plate carrier is driven to the full extended position.
2. The well plate is removed from the plate carrier by the pipette tip.
3. The plate carrier is drawn back into the module. The movement of the plate carrier is terminated when the sensor determines that the plate carrier is driven to the full internal position.

Chapter 9 Servicing the Incubator Module

9.1 Routine Maintenance/Service Procedures

***Note**: The Incubator Module is a service replaceable item. If a defect is observed, the normal response is to replace the module. Replacement or repair of specific items should be performed only on as needed basis if replacement of the module is not possible and the service engineer has the appropriate components on hand. After the module has been repaired, use the alignment plate to ensure that the module is properly aligned as described in the Post-Service Checkout Protocol section on page 3-6.*

9.2 General Troubleshooting

Symptom	Probable Cause	Resolution
Plate motor fails to work	There is a fault on the IM Module Main board.	Replace IM Module Main board.
Plate motor runs at the incorrect speed.	There is a fault on the IM Module Main board.	Replace IM Module Main board.
Plate carrier does not move to the home position	Plate home sensor is faulty.	Replace faulty sensor.
	There is a fault on the IM Module Main board.	Replace IM Module Main board.
Plate carrier drives fully into the IM Module.	Plate front sensor is faulty.	Replace faulty sensor.
	IM Module Main board is faulty.	Replace IM Module Main board is faulty.

Symptom	Probable Cause	Resolution
Plate carrier does not move	Broken, disconnected drive belt or drive belt too tight.	Re-attach, replace or decrease belt tension.
	Dirty or damaged plate carrier bearings or bearing shaft.	Clean or replace damaged plate carrier bearings or bearing shaft.
	Idler bearing damaged.	Replace Idler bearing.
	Plate motor is faulty.	Replace motor.
	Faulty IM Module Main board.	Replace IM Module Main board.
RS232 and parallel ports neither send nor receive data	Faulty IM Module board.	Replace IM Module board.
RS232 communications problems	Incorrect communications settings or faulty hardware.	Check that the sending and receiving instruments are using the proper communications protocols. Check that the RS232 cable is correctly connected. Replace RS232 cable. Replace Chassis Microcontroller board.
SETUP parameters have been lost	Fault on the IM Module board.	Replace IM Module board.
Plate carrier hangs before ejecting.	Insure that plate carrier is not hitting the Bezel opening.	Loosen and reposition the bezel until interference is removed.
Plate carrier moves but does not eject near the back.	Belt bracket not positioned properly (hitting rear pulley).	Loosen and then reposition the belt bracket.

9.3 Removing External Components

9.3.1 The Top Cover

The top cover (Part No. 22000800) is removed by loosening the 3 M3 x 6mm BHCP screws and then lifting the top cover off (Figure 9-1).

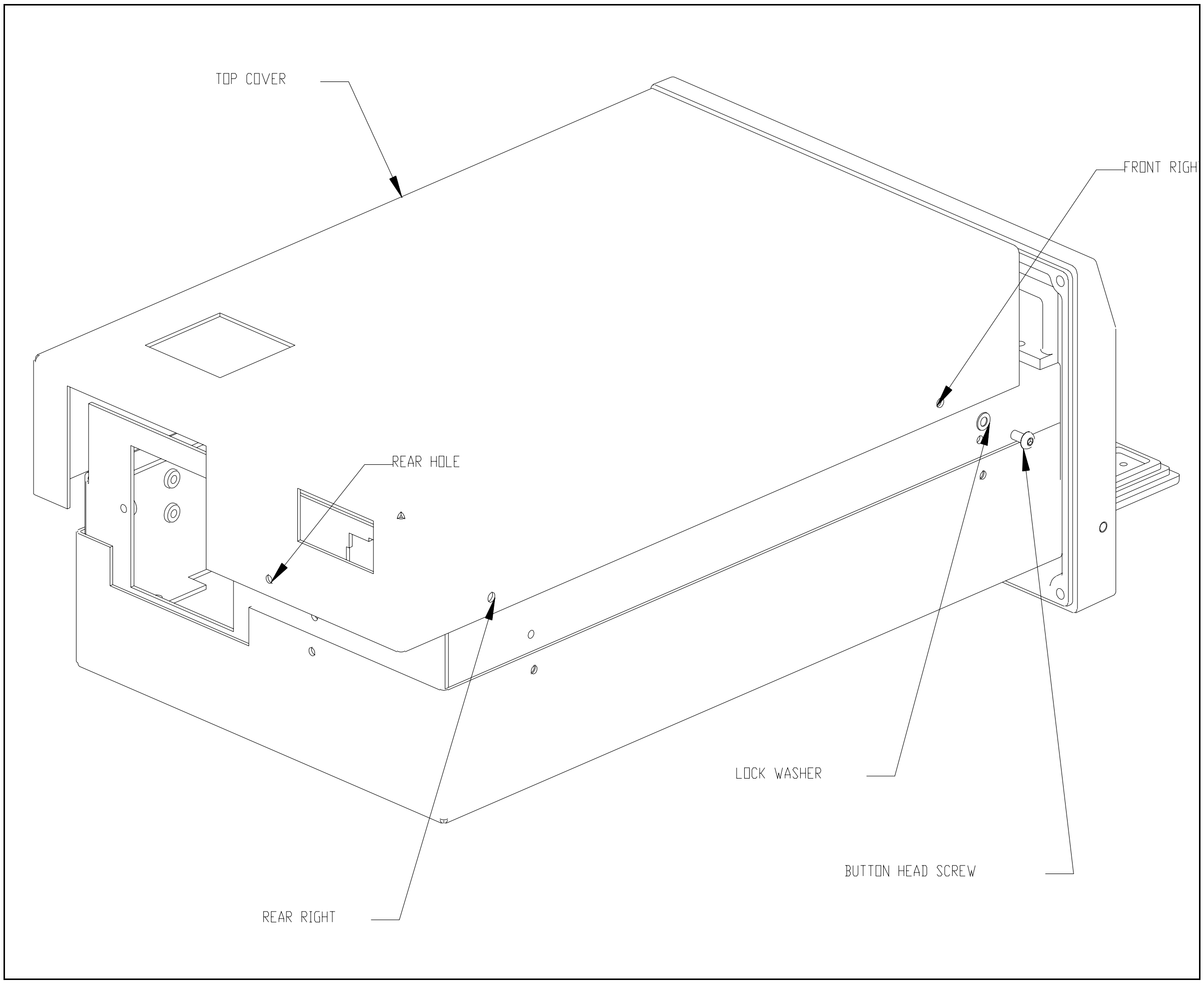


Figure 9-1 Removing the Top Cover

9.3.2 The Bottom Cover

The bottom cover (Part No. 22000780) can be removed by removing the 3 M3 x 6mm button head screws and then lifting the bottom cover off (Figure 9-2).

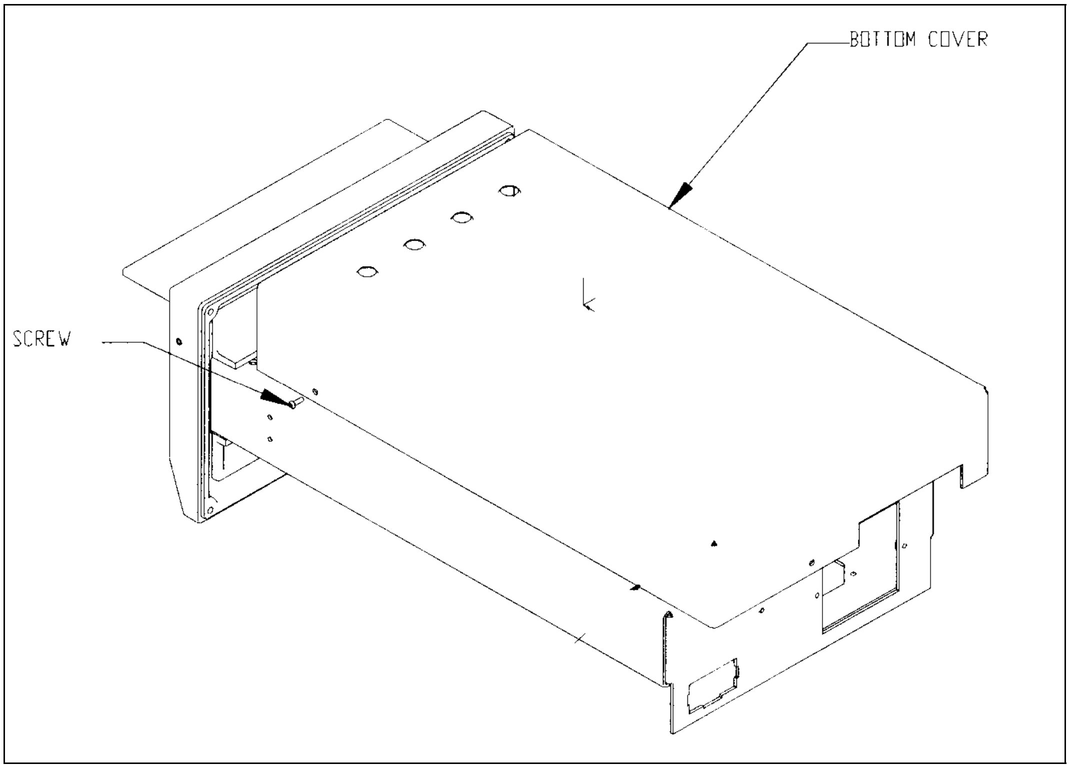


Figure 9-2 Removing the Bottom Cover

9.3.3 The Front Bezel

The front bezel can be removed from the chassis by unscrewing 4 M3 x 8mm socket head cap screws. (Figure 9-3).

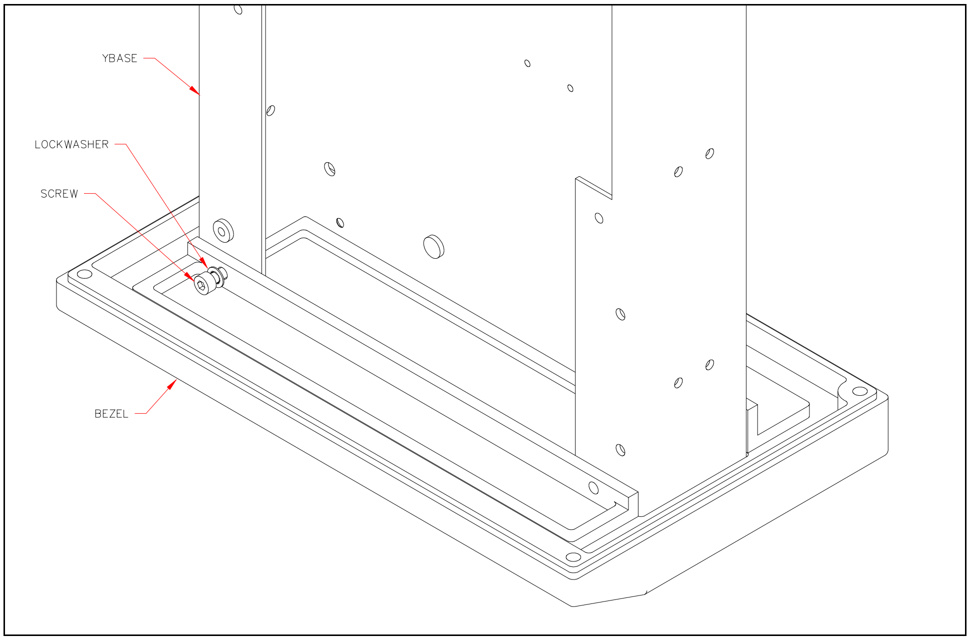


Figure 9-3 Removing the Front Bezel

To reattach the bezel to the chassis, use 4 M3 x 8mm socket head cap screws and M3 washers. Insure that the flat washer is against the bezel, not the lock washer.

9.3.4 Removal/Replacement of the Plate Carrier Door

To Remove the Plate Carrier Door:

1 Insert a long punch through the side of the bezel and push the pin through the door hinge (Figure 9-4).

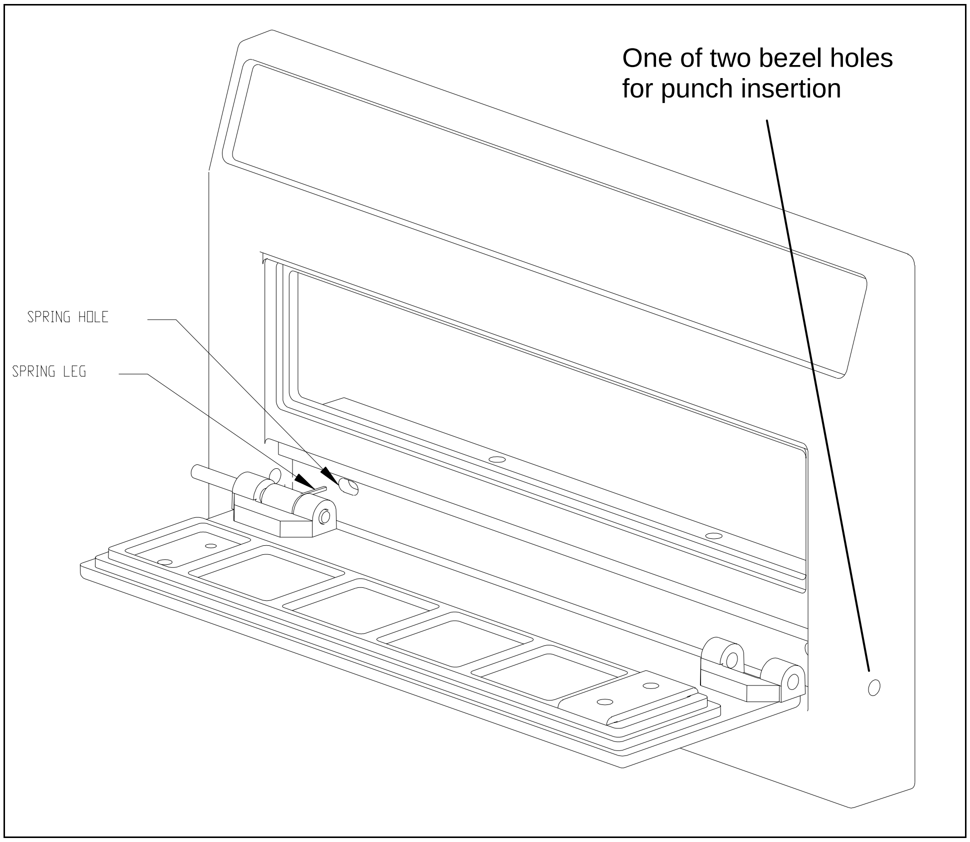


Figure 9-4 Bezel Holes for Hinge Pin Removal

2 Remove the springs and pins from the door by pushing the pins out of the door with a punch (Figure 9-5).

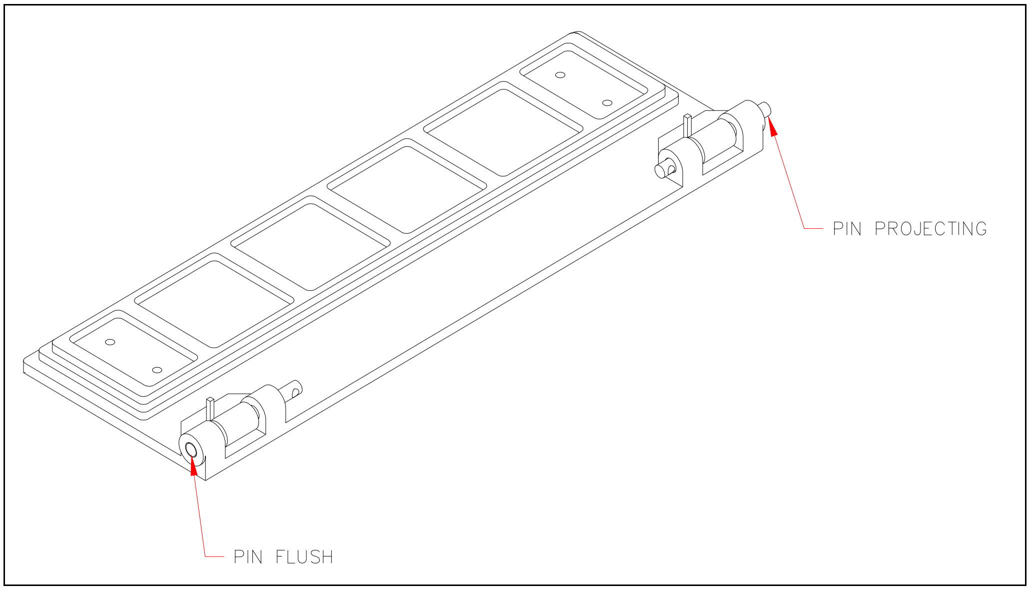


Figure 9-5 Removing Door Pins

3 To reassemble the door, partially insert 2 M3 x 32mm spring pins into the door. Then insert the 2 torsion springs into the hinge recess with its L-shaped leg in the spring hole and engage the pins to hold the springs (Figure 9-6).

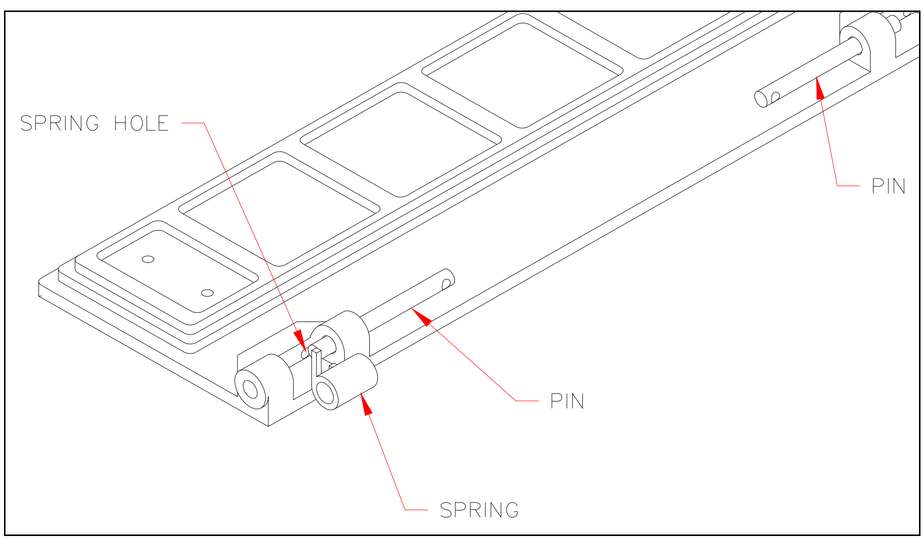


Figure 9-6 Reinstalling the Door

4 Adjust the pins so that one pin is flush and the other is projecting 1/8”. Insert the projecting pin of the door into the bezel. As you do this, deflect the spring with a screwdriver so that it is pointing back and will enter the spring recess in the bezel shown in Figure 9-7. Do this with both springs. Insert the other end of the door. Engage the pin by pressing with a screwdriver. Use a miniature friction lock quick-grip clamp to press in the pins into the bezel.

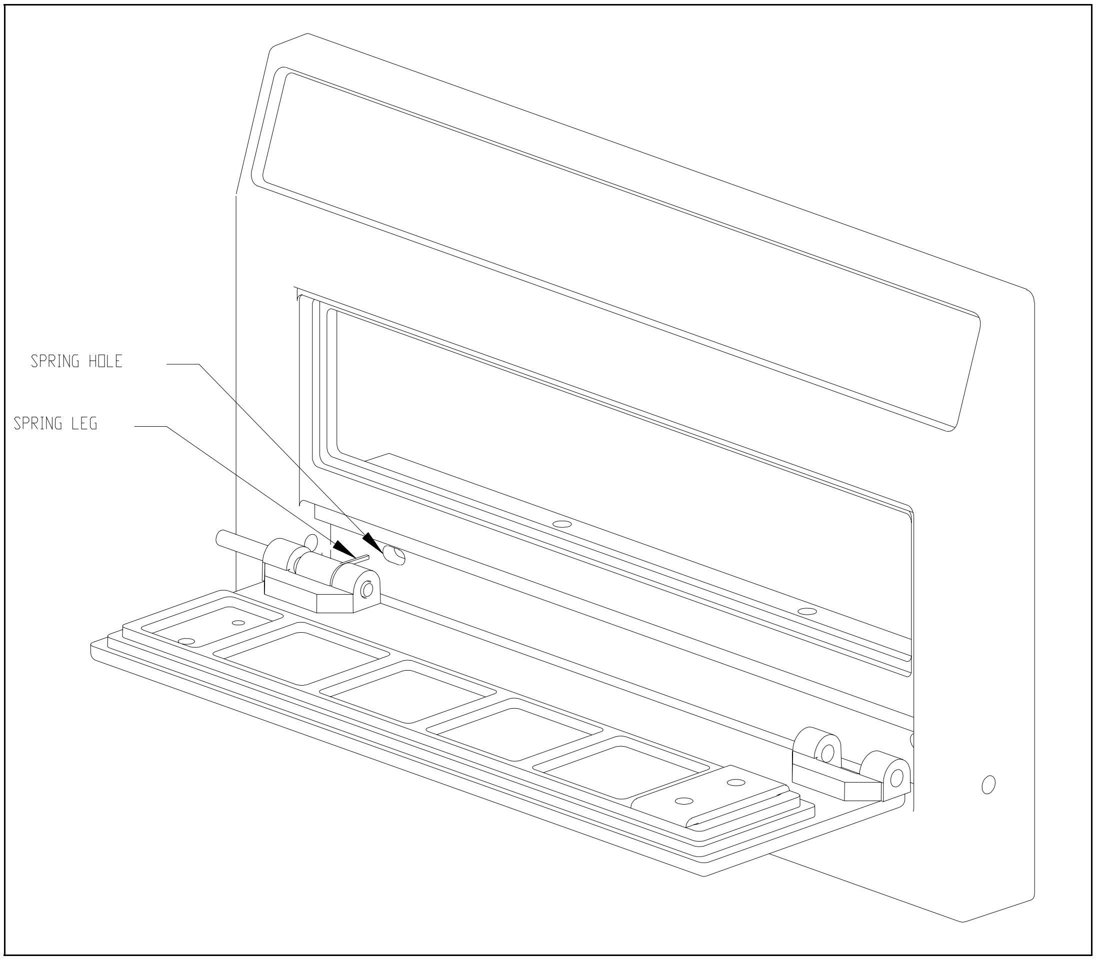


Figure 9-7 Position of Spring Hole and Leg

If needed, use a 2mm Allen wrench to align the pin with bezel pinhole until the pin is started. Test the door by opening it and then letting go 5 times. The door should shut by itself. If it does not shut properly, use a 3mm Allen wrench to push out the pins and begin the installation procedure again.

9.4 Repairing/Replacing Internal Components

This section describes the repair/replacement of components of the Incubator module.

> ***Note**: The Incubator Module is considered as a service replaceable item. If a defect is observed, the normal response is to replace the entire module. The information in this chapter should be used only if it is necessary to repair or replace the module on-site.*

In most cases, replacement of a component is the reverse of the installation. For the sake of brevity, we will not describe re-installation unless there is a difference between the two activities.

9.4.1 Removal/Replacement of the Main Circuit Board

The Main Circuit Board (Part No. 14000300) is mounted on the bottom of the base (Figure 9-8).

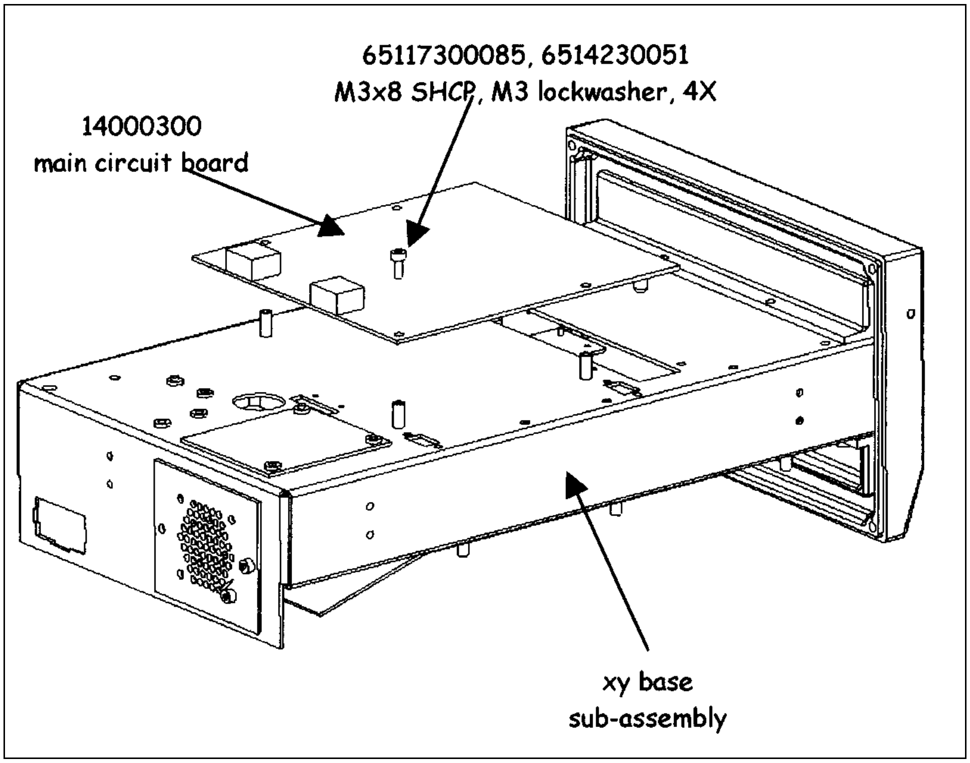


Figure 9-8 Mounting the Main Circuit Board

To Remove the Main Board:

1 Disconnect the connectors from the board.

Fan (where installed)	**J1**
LED (where installed)	**J3**
Heater (Carrier)	**J4**
Power Connector	**J5**
Heater (Top)	**J6**
Motor	**J7**
Home Sensor	**J8**
Eject Sensor	**J9**

2 Unfasten the board by removing the 4 M3 x 8 mm socket head cap screws and M3 lock washers.

3 Lift the board off of the standoffs.

To Install the Main Board:

1 Installation is the reverse of the removal procedure.

2 After installation, the module must be tested and calibrated using DynexTest software and a calibrated thermometer.

9.4.2 Replacing the Top Heater Plate Assembly

The Top Heater Plate Assembly is mounted to the Base Assembly as shown in Figure 9-9.

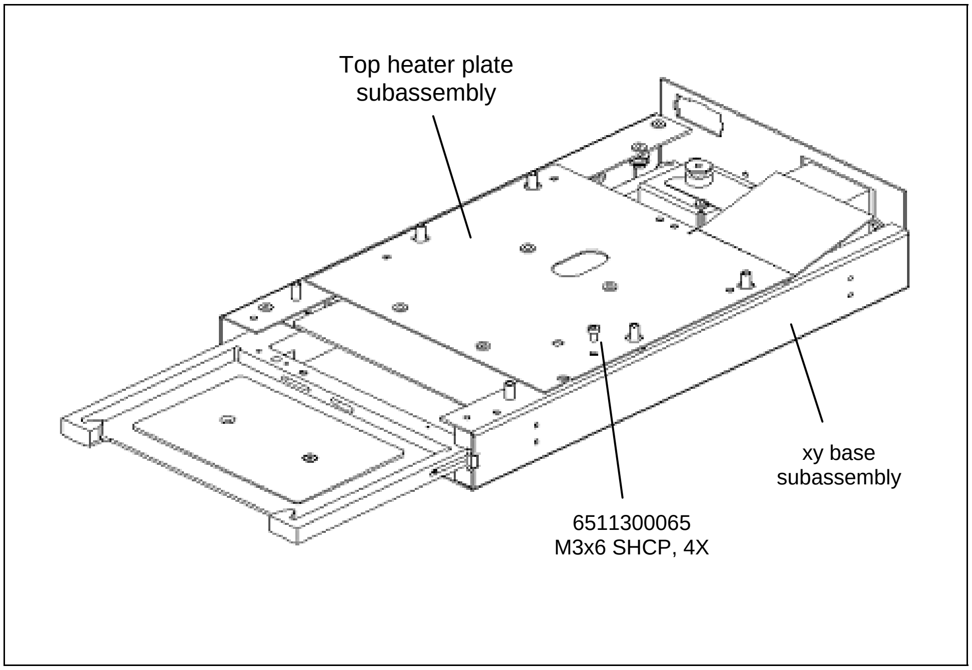


Figure 9-9 Top Heater Plate Assembly

Remove the Top heater plate assembly by unscrewing the 4 M3 x 6mm socket head cap screws as shown in Figure 9-9.

Preparing the Plate Assembly:

1 Attach adhesive backed heater foil (Part No. 24000740) to the heater plate (Part No. 22000910 using the alignment jig (IMFIX0001). The heater foil should be attached to the surface opposite the countersunk mounting holes as shown in Figure 9-10.

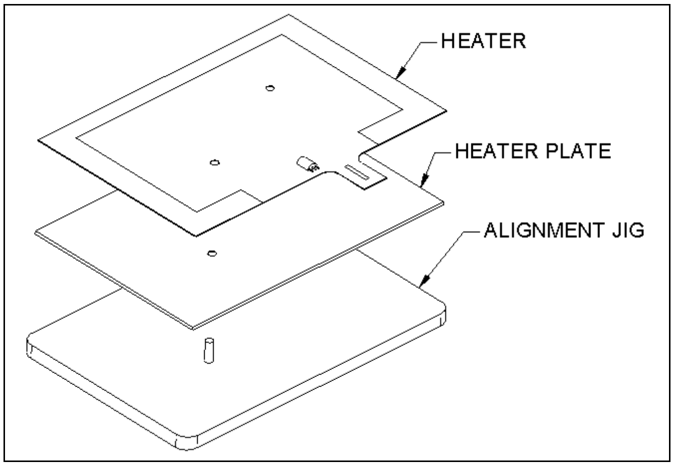


Figure 9-10 Attaching Heater Foil to Heater Plate

> ***Note**: If you are reusing the heat plate and/or the heater mounting plate, make sure that all old adhesive is removed from the plate.*

2 Attach the heater plate assembly to the heater mounting plate (Part No. 22000920) as shown in Figure 9-11.

3 Place the assembly in position and tighten the screws (Figure 9-9).

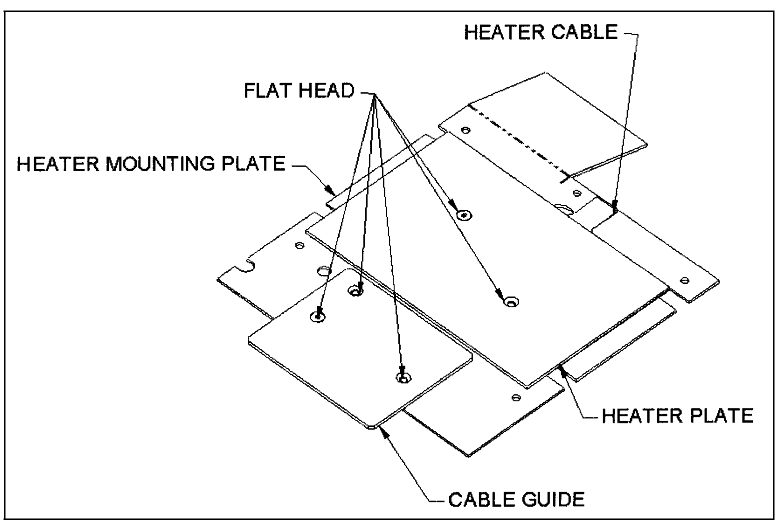


Figure 9-11 Mounting Heat Plate Assembly to Heater Mounting Plate

9.4.3 Removal of the Eject Sensor

To Remove the Eject Sensor (Part No. 15000580):

1 Remove the two M3 x 10 SHCP screws and two M3 lock washers (Figure 9-12).

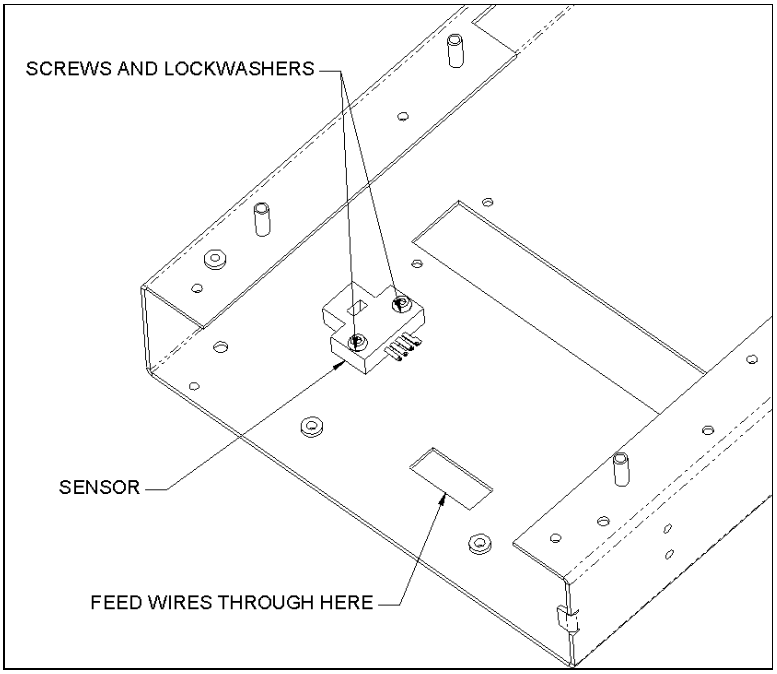


Figure 9-12 Eject Sensor

> ***Note**: When re-installing the cable, route it through the cut-out as shown. Ensure that cable from eject sensor lies flat on chassis to prevent interference with plate carrier movement.*

> ***Note**: After replacement, the eject sensor requires calibration using DynexTest software.*

9.4.4 Removing the Position Sensor

The position sensor (Part No. 15000430) is mounted on the base as shown in Figure 9-13 and is removed by unscrewing the two M3 x 6mm Socket Cap screws and lock washers.

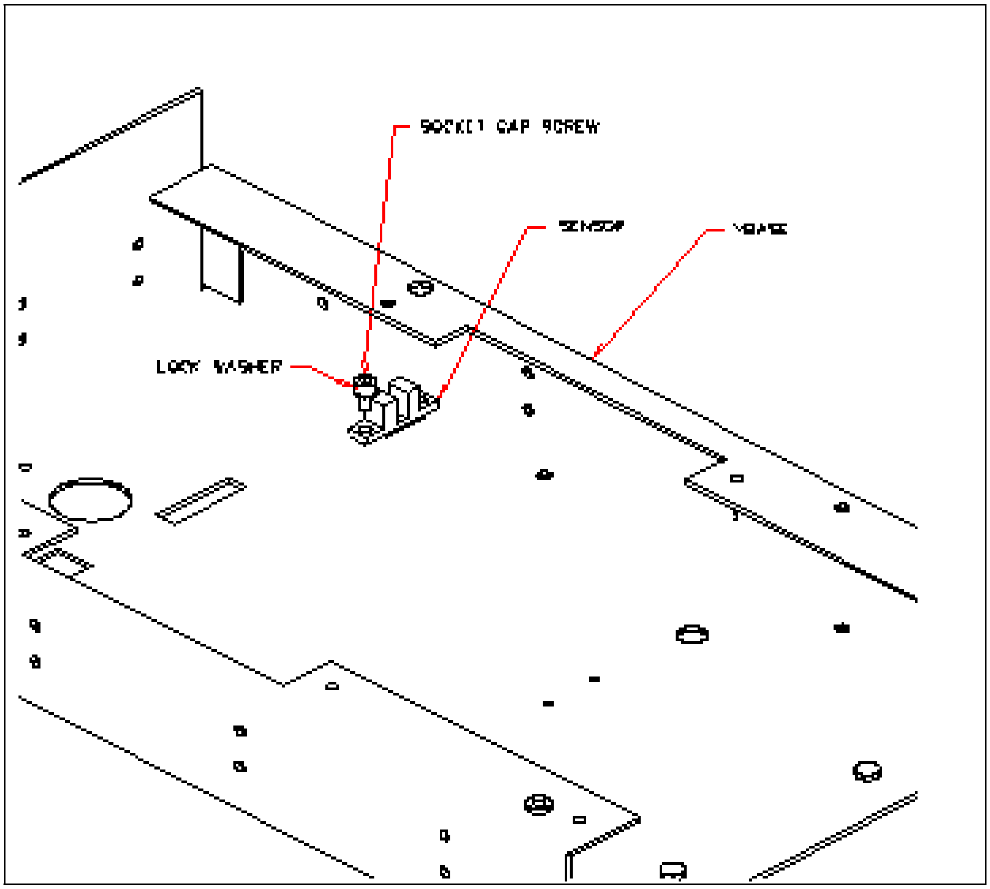


Figure 9-13 Position Sensor

9.4.5 Removal/Replacement of the Drive Belt

The drive belt draws the plate into the module, and delivers the plate from the module in position. It is powered by the plate carrier motor and is wrapped around three idlers as shown in Figure 9-14.

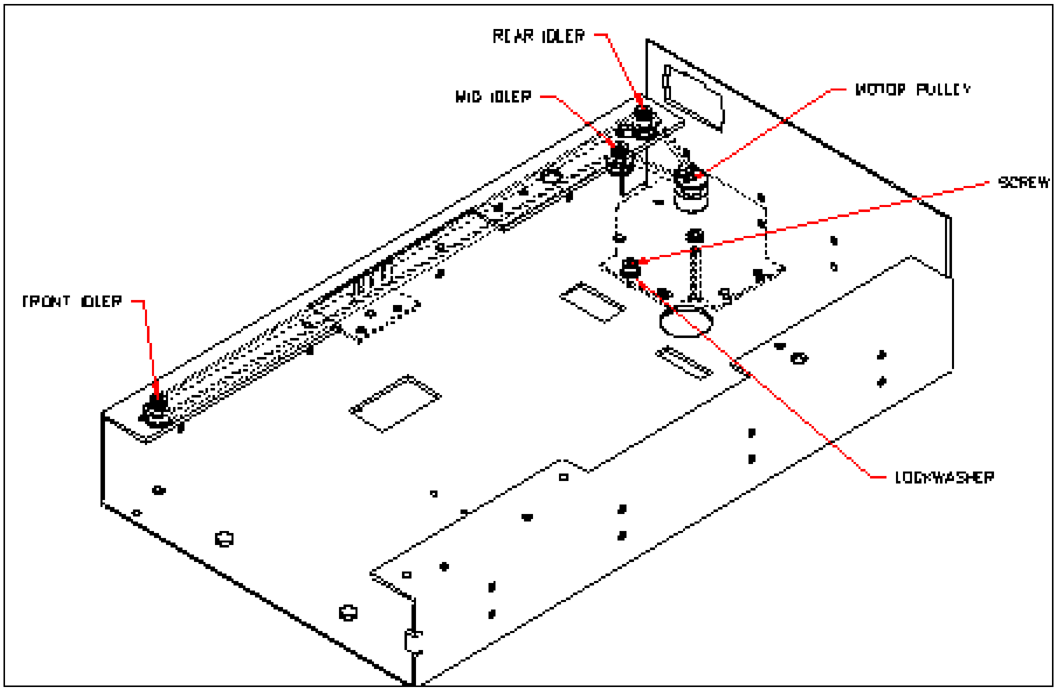


Figure 9-14 Incubator Drive Belt

To remove the drive belt, loosen the 3 M3 x 6 mm Button Head Screws that attach the belt mount to the plate carrier assembly (Figure 9-15).

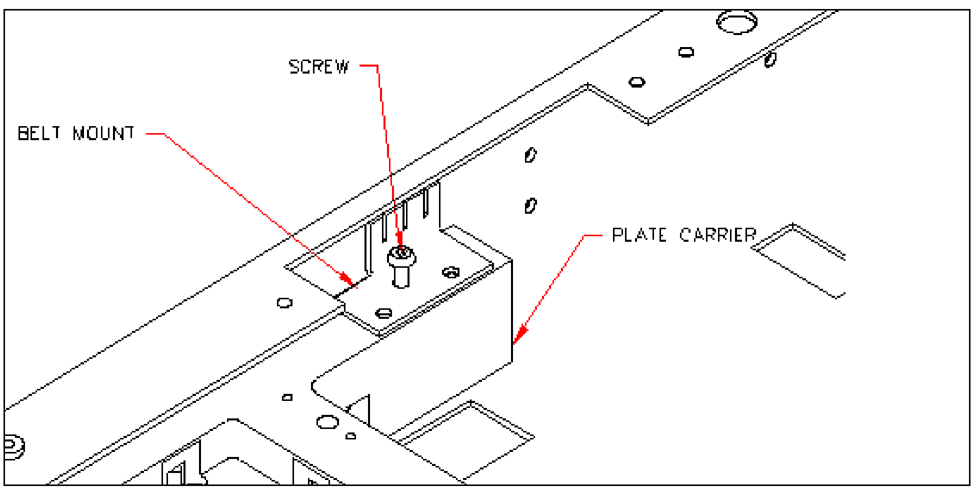


Figure 9-15 Belt Mount

To Install a New Belt:

1 Cut a 24.7" length of belt (Part No. 40000100) and install it into the belt mount (Part No. 220000790) as shown in Figure 9-16. Make sure that there are two front teeth installed and four back teeth installed.

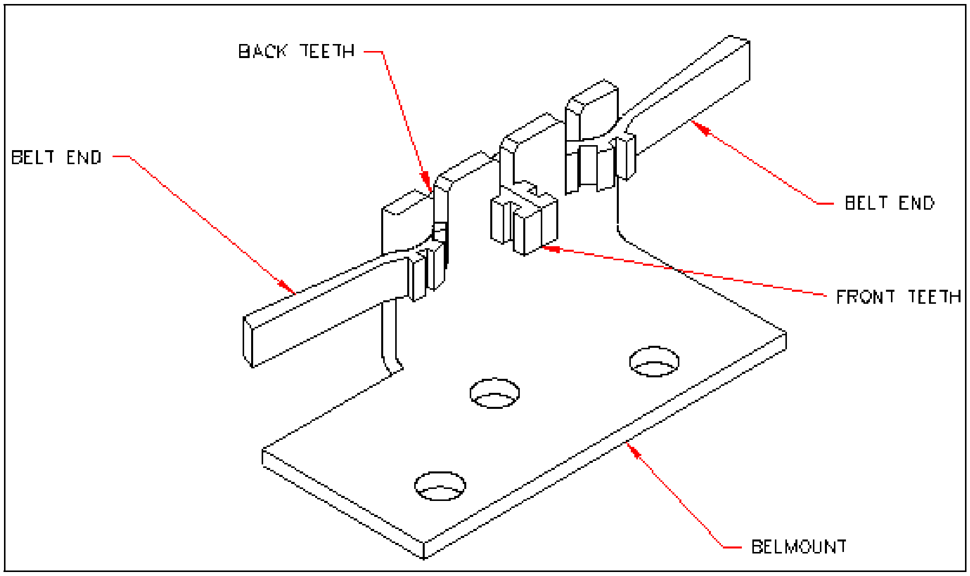


Figure 9-16 Belt Mount

2 Attach the belt mount assembly to the Plate Carrier Assembly (Figure 9-15).

3 Loosen the motor from the chassis (Figure 9-14) by slightly unscrewing the four 4 M3 x 6mm socket head cap screws.

4 Wrap the belt around the middle idler, around the back idler, and around the front idler (Figure 9-14), then loop it around the motor assembly. Pull motor to right until tight and tighten the screws.

9.4.6 Removing the Plate Carrier Motor

To Remove the Plate Carrier Motor:

1 Remove the drive belt from the motor by removing the 4 M3 x 6mm socket head screws securing the motor mount to the chassis and unwrap the belt from the pulley.

2 Remove the Motor bracket from the chassis (Figure 9-18).

3 Remove the pulley assembly from motor shaft by loosening the set screw (Figure 9-14

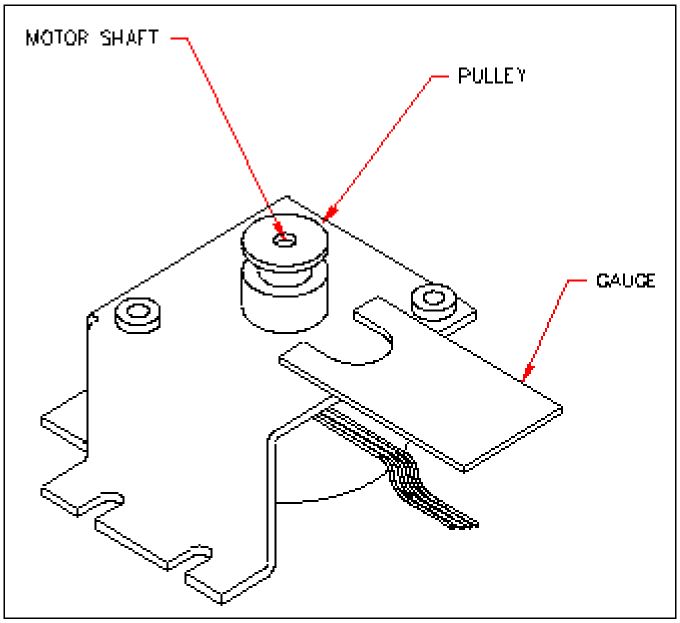


Figure 9-17 Drive Pulley Mechanism

4 Remove the pulley assembly from motor shaft by loosening the setscrew and then remove the two socket head cap screws that fasten the motor to the mount.

5 Remove the Motor (Part No. 15000440) from the motor mount (Part No. 220000760) by removing the two M3 x 6mm socket head screws and M3 Lock Washers (Figure 9-18).

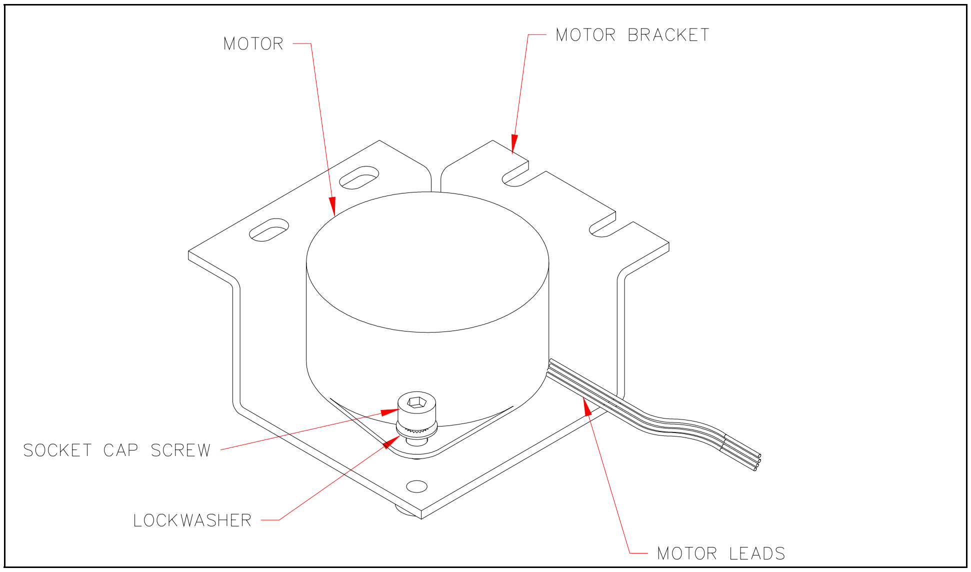


Figure 9-18 Motor and Mount

6 When you replace the pulley on the new motor, secure the setscrew with Loctite 242

7 Place the pulley on the motor shaft (Figure 11-13). Set the position of the pulley using the pulley gauge P/N AMFIX002. Fasten the pulley using the setscrew and Loctite #242.

8 Rewrap the belt around the motor pulley. Loosely fasten the motor to the chassis using 4 M3 x 6mm socket head cap screws, M3 flat washers, and M3 lock washers. Route the wire from the motor to the right in the back. Apply 7 in-lbs of torque to tighten the screws.

> ***Note**: When tightening the screws, use torque driver SN160 to tighten the screws to 7 in-lbs.*

9.4.7 Removal/Replacement of the Plate Carrier Assembly

The Plate Carrier Assembly is mounted in the module as shown in Figure 9-19.

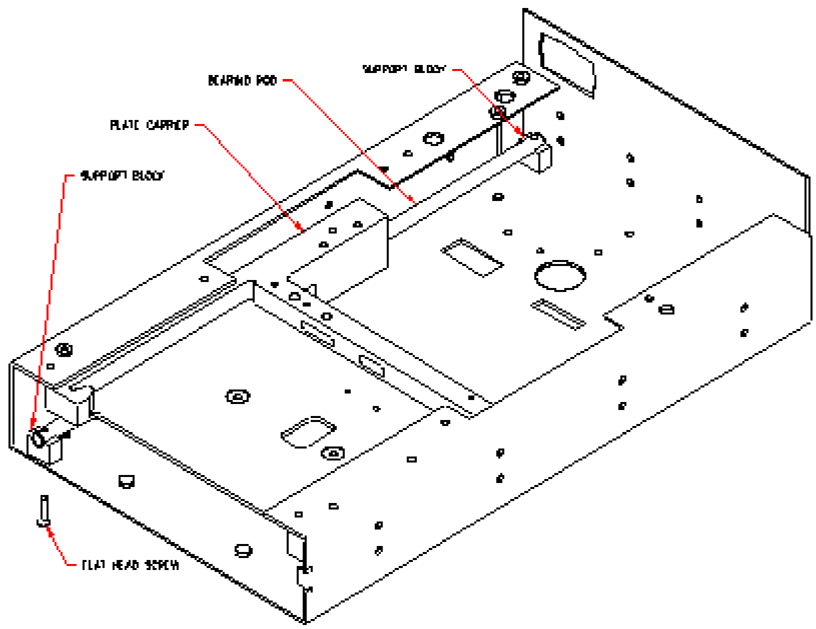


Figure 9-19 Mounting of the Plate Carrier Assembly

To Replace the Plate Carrier Assembly:

1. Remove the two support blocks (Part No. 23001250) by unscrewing the two M2.5 x 12mm Flathead screws from the bottom of the module chassis.
2. Lift and remove the Plate Carrier from the module chassis.
3. Remove the bearing shaft as shown in Figure 9-20.

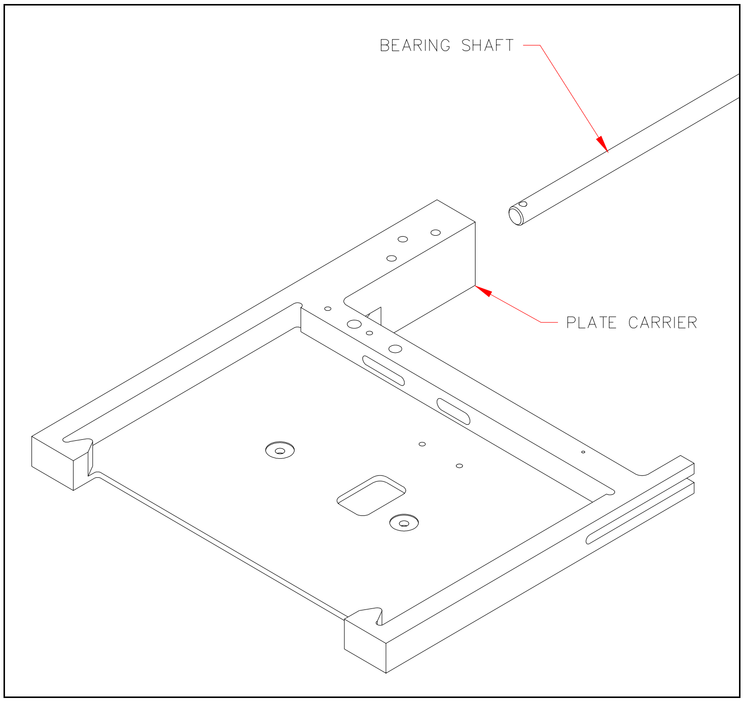


Figure 9-20 Plate Carrier Assembly

9.4.8 Replacement of Lower Heater Assembly

The lower heater assembly is mounted to the plate carrier as shown in Figure 9-21.

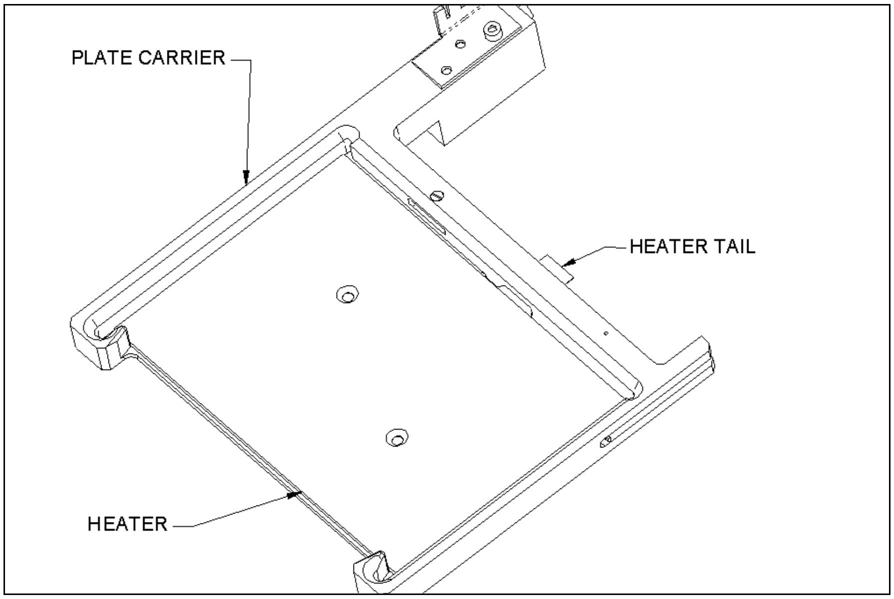


Figure 9-21 Lower Heater Assembly

To Replace the Lower Heater Assembly:

1 Attach adhesive backed heater foil (Part No. 24000740) to the heater plate (Part No. 22000910 using the alignment jig (IMFIX0001). The heater foil should be attached to the surface opposite the countersunk mounting holes as shown in Figure 9-22.

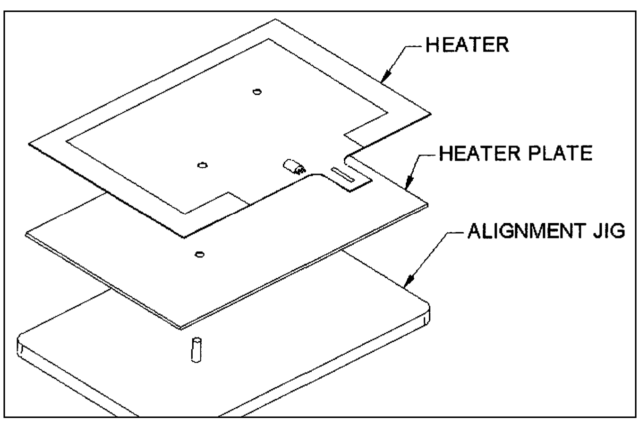


Figure 9-22 Attaching Heater Foil to Heater Plate

> ***Note**: Remove all adhesive from the plate carrier. If you are reusing the heater plate, make sure that all old adhesive is removed from the plate.*

2 Slide the heater cable through the slot in the plate carrier (Figure 9-23).

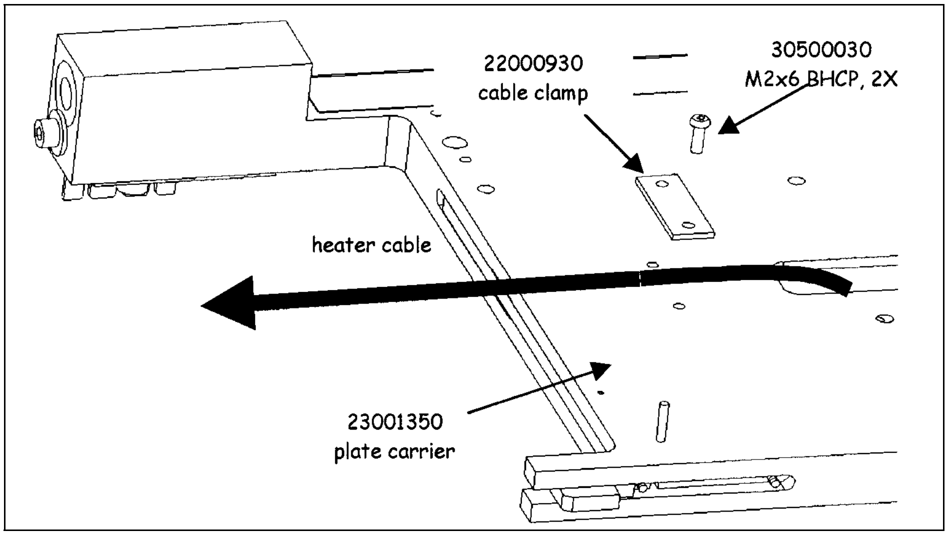


Figure 9-23 Routing the Heater Cable

3 Attach the heater to the plate carrier using the adhesive backed section of the heater pad (Figure 9-24).

4 Secure the heater cable to the plate carrier by sandwiching two heater wire clamps (22000930), one below the wire and one above the wire, using two M2x6 button head screws and Loctite 222 (Figure 9-23).

> ***Note**: The cable should be flat, with minimal slack between the heater and the heater clamps. If reusing the original clamps, ensure the sharp edges are facing away from the heater cable.*

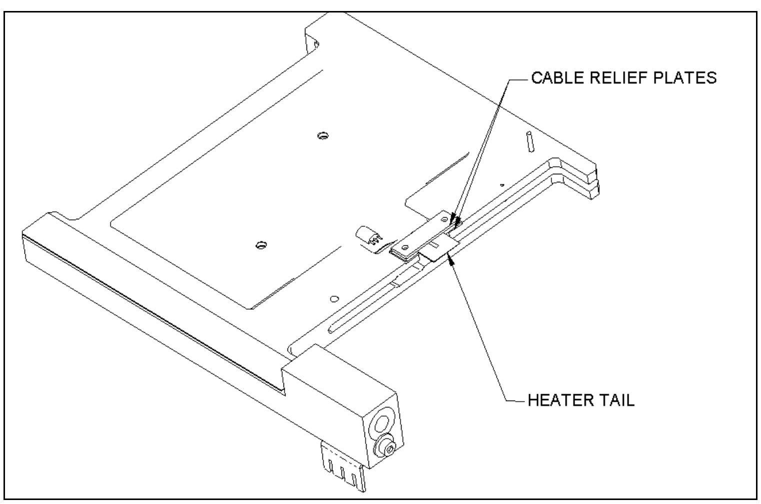


Figure 9-24 Plate Carrier/Heater

9.4.9 Removal/Replacement of Locking Lever/Pivot/Spring

The plate is held in place by the Locking Lever/Pivot/Spring mechanism shown in Figure 9-25.

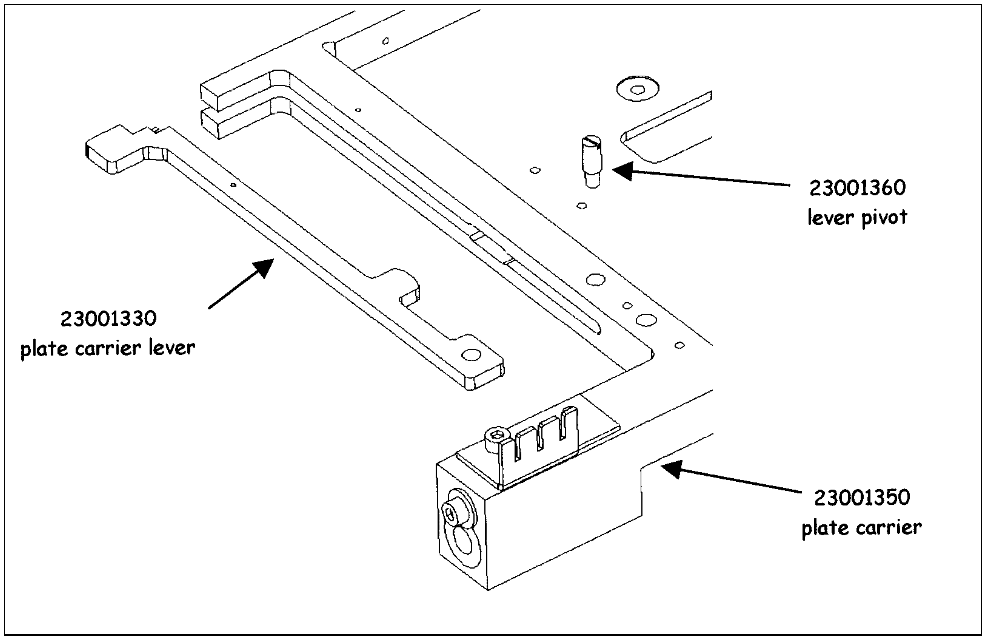


Figure 9-25 Locking Lever/Pivot and Spring

To Remove the Locking Lever/Pivot and Spring

1 Remove the spring (Part No. 42000311) from the pin on the plate carrier and plate carrier lever (Figure 9-26).

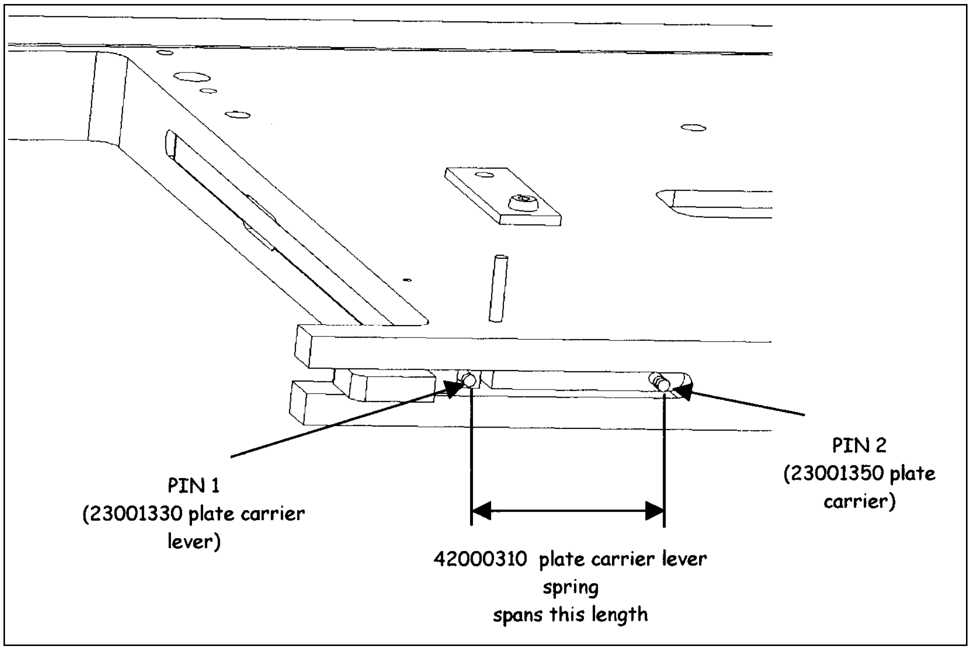


Figure 9-26 Lever/Spring Mechanism

2 Remove the Lever Pivot (Part No. 23001360) (Figure 9-25).

> ***Note**: When you reinstall the lever mechanism, stretch the spring far enough to reach the pins on the plate carrier and the plate carrier lever, but do not overstretch.*

3 If it is necessary to remove the pivot and/or locking lever, use a small flat screwdriver.

> ***Note**: When replacing the spring, take care that the spring is not over-stretched.*

.

9.4.10 Removal/Replacement of the Plate Carrier Bearings

To Replace the Plate Carrier Bearings:

1 Remove the M3 x 6mm socket head cap screw, M3 lock washer, and M3 fender washer (Figure 9-27).

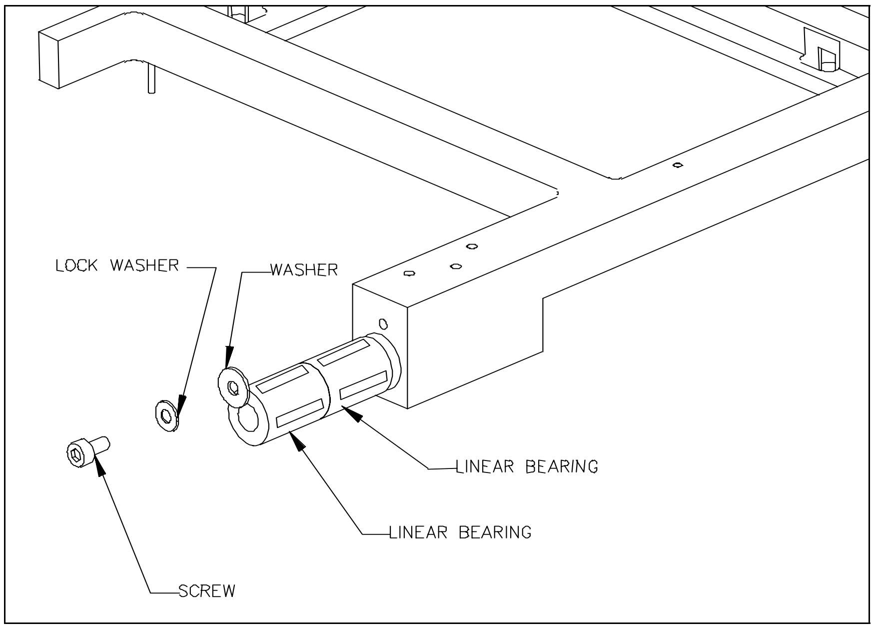


Figure 9-27 Replacing Plate Carrier Bearings

2 To reinstall the bearing (Part No. 627304002), make sure the 4 silver pad surfaces of the bearing are facing up and down and left and right (note diagram) and lock in place using one M3 fender washer, one M3 x 6mm socket head cap screw and one M3 lock washer.

9.5 Spare Parts

Description	Part Number
Motor	*15000440*
Pulley	*40000110*
Bearings	*6273040002*
Plate Carrier	*23001350*
Springs	*42000311*
Lever	*23001330*
Foil Heater	*24500740*
Heater Mounting Plate	*22000910*
Bearing	*40000090*
Idler Shaft	*23001240*
Narrow Bearing	*4000080*
Drive Belt (24.7")	*40000100*
Belt Mount	*22000790*
Fan	*50800110*
Sensor	*15000430*
Upper Gravity Block	*23001370*
Lower Gravity Block	*23001220*
Rod	*23001260*
Eject Sensor	*15000580*
Plate Presence LED Assembly	*15000590*
LED Holder	*50200480*
Incubator Printed Circuit Board	*14000300*

9.6 Jigs

Description	Part Number
Heater Foil Jig	IMFIX001
Pulley Gauge	AMFIX002

Chapter 10 The Reader Module

10.1 Overview

The Reader Module is used to determine the optical density of the contents of each well in the well plate. This information is transmitted to the personal computer and the Revelation application program is used to determine (and report) the concentration of the compound(s) of interest.

The service engineer is expected to replace the lamp and replace filters. These activities are described in the section entitled, Removing External Components on page 11-11.

If there is a fault in the Reader Module (other than a defective lamp or filter), the normal service activity is the replacement of the module. The defective module should be returned for repair. In some situations, the service engineer may be able to repair the module on site. A description of a broad variety of replacement/repair activities is presented in the section entitled, Spare Parts on page 11-49.

10.2 Design of the Optical Module

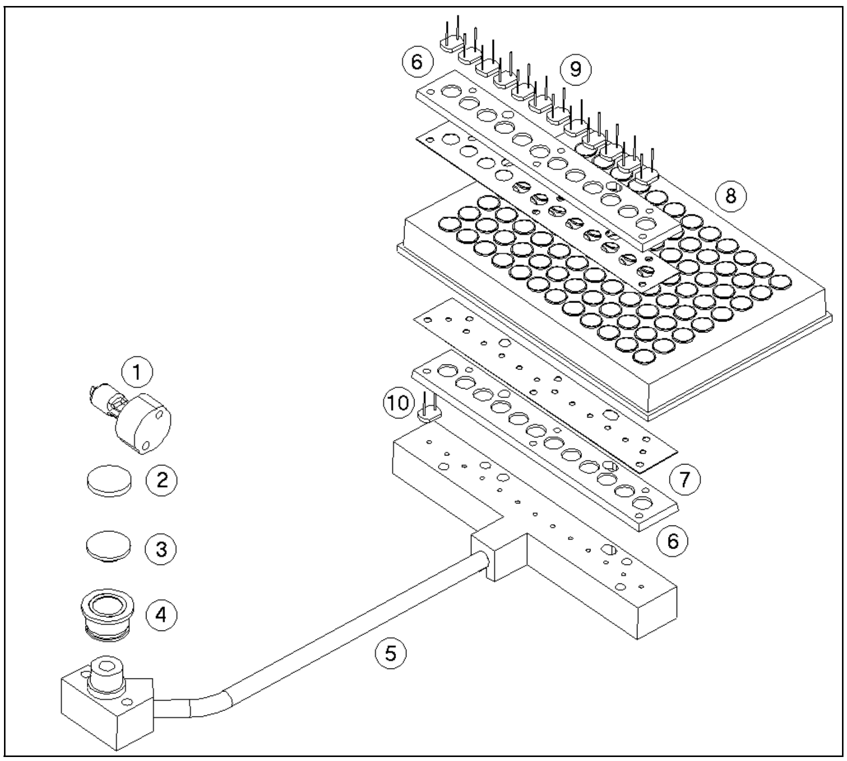
10.2.1 General Characteristics

The Reader Module is a microprocessor-controlled photometer module designed to measure the optical density of fluid samples in 96 well microplates. The module has a wavelength range from 405 nm to 690 nm and can read in single, dual or multiple wavelength modes. The reading time is less than 10 seconds in single wavelength mode and less than 20 seconds in dual wavelength mode. The Verification Plate can be used to check performance of the reader upon installation or during periodic maintenance checks.

The unit has a sequence of self-test diagnostics that are performed each time the unit is powered up, these tests provide the user with the assurance that the instrument is functioning within acceptable parameters.

10.2.2 Optical Considerations

A schematic diagram illustrating the optical path through the Reader Module is presented in Figure 10-1. A tungsten halogen lamp projects a light beam vertically through a heat-absorbing filter. This beam is focused by an aspheric lens and passes through a bandpass filter located in the filter wheel. The filters exclude all light with the exception of the desired wavelength. The beam is then separated into 13 channels; one of these channels is used as a reference channel to monitor the light output of the lamp while the other 12 beams are directed upwards through a row of 12 wells on the microplate onto an array of silicon photodiodes. The silicon photodiodes quantify the intensity of light transmitted through the cells in a row of the well plate solution. The transmittance of each solution is thus measured, compared to the signal of the reference channel and the concentration of the compound of interest can be determined.



1	***Lamp***	***6***	***Lenses***
2	***Heat Filter***	***7***	***Optic Stops***
3	***Lens***	***8***	***Microplate***
4	***Filter***	***9***	***Photodiodes***
5	***Optic Fibers***	***10***	***Reference Diode***

Figure 10-1 Optical Path

The lamp used in the reader is the Gilway Technical lamp # L7416, which has a nearly square aspect ratio. The square aspect ratio is important to optimize coupling to the fiber optic and this optimizes the amount of light that is focused on the wells. If a user were to replace the bulb with a different lamp, the useful intensity of the lamp (and thus the sensitivity) could drop by as much as 70%.

An aspheric lens is used to focus the light to provide even illumination and minimize the incident angles on the bandpass filter. The bandpass filter has a 10-mm diameter clear aperture.

10.2.3 Electrical/Control Considerations

Activities of the Reader Module (e.g. movement of plate carrier, changing the filter) are performed under the direct control of the program that is being executed by the Revelation application program for calculation of the concentration of the compound(s) of interest in each sample.

A functional diagram of the Reader Module is presented in Figure 10-2.

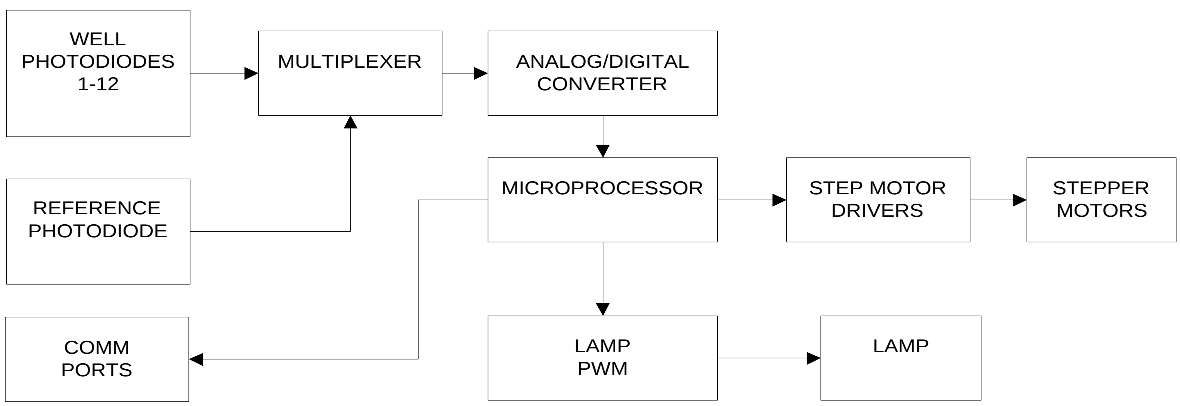


Figure 10-2 Functional Diagram of the Reader Module

The following components are included in the control of the system:

- **MICROPROCESSOR –** Overall operation of the module is based on the 84-pin PLCC version of the Hitachi H8/3337 single-chip microcomputer, which provides 60Kbytes of flash memory (program/data space) and 2Kbytes of RAM. The H8/3337 has the following internal peripheral capabilities. The I/O ports are configured to allow maximum software control of all AM functions within the limitations of timing and functionality of the H8/3337 and to minimize external hardware.
- **ANALOG/DIGITAL CONVERTER –** The Analog to Digital Converter is a single chip, 20-bit, charge digitizing IC manufactured by Burr-Brown which is configured in the bipolar mode to accept both positive and negative inputs to allow for internal circuit offsets. The converter obtains its sensitivity and low noise by performing multiple integrations of the current produced by the photodiode light sensors in each optical channel. Each photodiode output is individually switched to the A/D input by the use of an analog multiplexer.
- **MULTIPLEXER –** The 1 reference and 12 channel photodiodes are selected for A/D conversion using a DG406 (1 of 16) Analog multiplexer. The multiplexer allows the use of a single A/D converter to read multiple analog inputs.
- **WELL PHOTODIODES –** A single photodiode is used for each of the 12 optical channels to read the 12 wells in the test plate row. The photodiode currents are measured in sequence from channel 1 to channel 12.
- **REFERENCE PHOTODIODE –** The Reference Diode is an additional photodiode which is used to regulate the lamp intensity during plate reads. The diode is exposed to a portion of the filtered lamp illumination at all times and is part of the closed loop lamp intensity regulation system composed of the diode, an op-amp gain stage and a Pulse Width Modulation driver IC.
- **LAMP PULSE WIDTH (PWM) MODULATION –** The lamp PWM IC provides control of the lamp intensity by rapidly switching the voltage to the lamp ON and OFF. The ratio of the ON to OFF time determines the lamp's intensity. An external power transistor is used to perform the actual voltage switching. The control input to the PWM IC is a variable analog voltage supplied by the D/A output of the microcomputer.
- **LAMP REGULATION –** The intensity of the lamp is maintained by the PWM IC, which compares the input control voltage from the microcomputer to the amplified signal from the Reference Diode. As the lamp intensity drifts lower or higher, the signal from the Reference Diode follows. The difference between the amplified diode signal and the applied control voltage is sensed by the PWM IC which then increases or decreases the ON time to the lamp to bring the resultant diode signal back to the required matching value. This action occurs very rapidly so that the lamp intensity deviations are minimized and are not reflected in the plate reading results.

- **STEPPER MOTOR DRIVE SYSTEM –** The stepper motor drive system consists of two UDN 2916 bipolar stepper motor controllers (Allegro Microsystems). The stepper motor drivers maintain a constant current through the motor windings using a pulse width modulation technique. The current to the motors can be reduced, under software control, when the motors are stationary. This reduces the heating in both the driver chips and the motors, which reduces the load on the 12V-power supply.

The system acts in Master/Slave Mode with respect to the personal computer. When the system is powered up, the following tests are performed:

- **FILTER MOTOR TEST OPTION –** This option is responsible for verifying the functionality of the filter motor and the filter wheel home sensor. This will be accomplished by rotating the filter wheel at least one complete rotation and checking the filter wheel index position.
- **BACKGROUND LIGHT LEVEL TEST OPTION –** This option is responsible for verifying the light tight soundness of the AM Module and the accuracy of the plate carrier dark read position. This will be accomplished by turning the lamp off, verifying that all 12 photodiodes read between 520,000 < counts < 525,000, turning the lamp on, moving the plate carrier into the dark read position and verifying that all 12 photodiodes read between 520,000 < counts < 525,000.
- **LAMP VOLTAGE TEST OPTION –** This option is responsible for verifying the functionality of the lamp. It is accomplished by turning the lamp on and reading the voltage drop across the lamp.
- **LAMP MARGIN TEST OPTION –** This option is responsible for verifying that the system will perform under degraded power conditions. This is accomplished by moving to the filter 1 position and adjusting the lamp duty cycle to maximum and ensuring the minimum channel reads above 200,000 counts.
- **LAMP CALIBRATION TEST OPTION –** This option is responsible for calibrating the lamp duty cycle at each installed filter wavelength. This is accomplished by assigning all lamp duty cycles an arbitrary number moving to each installed filter position and adjusting the lamp duty cycle until the minimum channel reads 170,000 counts above the dark reading and the maximum channel reads less than 275,000 counts above the dark reading.
- **EEPROM TEST OPTION –** This option is responsible for verifying the functionality of the EEPROM. This is accomplished by reading the entire EEPROM and comparing the data to the EEPROM mirror values.

When a Plate Read command is received, the following actions occur:

1. The lamp is turned ON and start a 3 second timer
2. The required filter is selected.
3. The plate is retracted towards the HOME position.
4. At the end of the 3 sec time period, take 100% transmission readings on all channels.
5. The plate is moved to the DARK position and dark readings on all channels are taken.
6. The plate is moved to row A and wells 1 through 12 are read.
7. The plate is moved to each remaining row, all wells in each row are read.

When the plate read routine is completed, the plate is ejected and the plate data is transmitted to the Revelation program.

Chapter 11 Servicing the Reader Module

11.1 Routine Maintenance/Service Procedures

The service engineer is expected to be able to replace the lamp and change the filters on the Reader Module on the DSX Automated ELISA System. Typically, the filters are installed on a unit for a specific application and need not be changed unless they become cracked or cloudy, which may lead to a loss of transmission. If the application for the DSX Automated ELISA System is changed, it may be necessary to install different filters.

If the Reader Module is defective, the normal service mode is to remove the reader module and replace it with a new module (except for lamp and filter replacement). When the module is replaced, use the alignment plate to verify that the module is properly aligned.

11.1.1 Replacing the Lamp

CAUTION

CAUTION*:* THE OPTICS ASSEMBLY MAY BE HOT. ALLOW AT LEAST FIVE MINUTES FOR THE INSTRUMENT TO COOL BEFORE OPENING THE OPTICS ASSEMBLY.

To Replace the Lamp:

1 Remove the Reader Module from the system by rotating the two Allen screws counter clockwise ¼ turn and pulling the module from the system.

2 Remove the Filter Access panel on the rear of the Reader Module to expose the optical assembly. The bulb is mounted in the upper portion of the optical assembly.

CAUTION

CAUTION*:* WEAR GLOVES WHEN THE LAMP IS BEING REPLACED.GLOVES ARE NECESSARY TO PREVENT SKIN OILS FROM DAMAGING THE LAMP. GLOVES ARE ALSO WORN AS A SAFETY PRECAUTION SHOULD THE GLASS BULB ACCIDENTALLY BREAK DURING REPLACEMENT OF THE LAMP.

3 Grasp the lamp with plastic tweezers and pull the lamp out of its receptacle.

4 Grasp the lamp tines of the new lamp with a pair of needle nose pliers and align the tines with the corresponding holes in the lamp socket as shown in Figure 11-1 and firmly insert the lamp into the socket

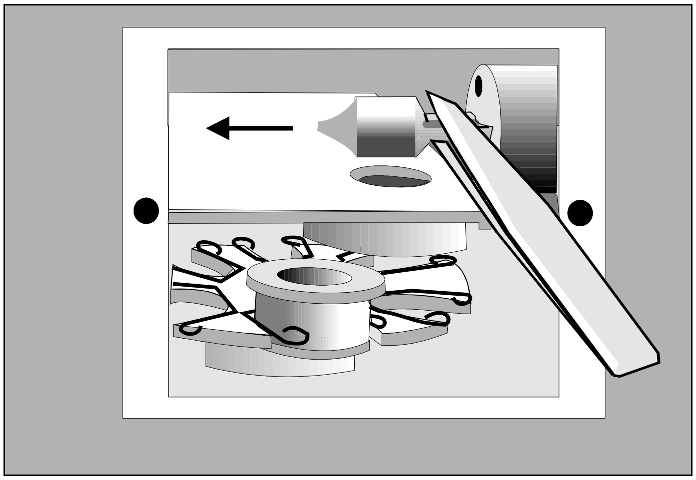


Figure 11-1 Removing the Lamp

> ***Note**: If you see any fingerprints or foreign material on the lamp, remove them using a lint-free cloth saturated with methanol.*

5 Replace the Filter Access Panel and reinstall the Reader Module in the system.

11.1.2 Removing and/or Installing a Filter

A filter should be replaced if it is cracked or cloudy. If the application for which the system is used is changed, it may be necessary to replace one or more filters (depending on the chemistry of the assay).

To Replace a Filter:

1 Remove the Reader Module from the system by rotating the two Allen screws counter clockwise ¼ turn and pulling the module from the system.

2 Remove the Filter Access Panel on the rear of the Reader Module to expose the optical assembly. The filters are mounted on the filter wheel as shown in Figure 11-2.

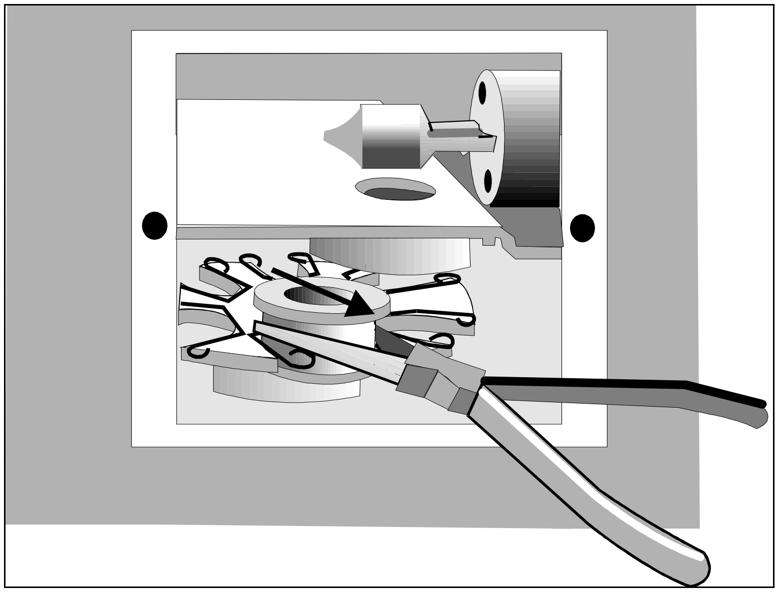


Figure 11-2 Removing the Filter Wheel

3 Locate the filter that is to be removed. Firmly grasp the exterior filter housing with a pair of needle nose pliers and pull the filter out of the spring-loaded slot.

> ***Note**: Filters must be installed in adjacent filter positions in the increasing order of their wavelength. There must not be any empty filter positions between the lowest wavelength and highest wavelength filters.*

4 To install a new filter, firmly grasp the exterior filter housing with a pair of needle nose pliers and push the filter wheel into the spring-loaded slot. Replace the filter access panel.

> ***Note**: The bottom groove of the filter must be firmly seated in the filter wheel. If the groove is aligned with the spring on the filter wheel, the filter has been installed incorrectly and will result in invalid instrument performance.*

> ***Note**: The 405 nm filter must be installed in **Position 1**.*

11.2 Troubleshooting the Reader Module

> ***Note**: The Reader Module is a service replaceable item. If a defect is observed, the normal response is to replace the module. Replacement or repair of specific items should be performed only on as needed basis if replacement of the module is not possible and the service engineer has the appropriate components on hand. After the module has been repaired, use the alignment plate to ensure that the module is properly aligned.*

11.2.1 Error Messages upon Power up

When the DSX is powered up, the module goes through the self-test described in Section 9.2.3. If a fault is observed, an error message is presented as follows:

Symptom	Probable Cause	Resolution
Front Sensor Failed ON	Sensor plugged into the wrong connector.	Check connections.
	Sensor wiring shorted or open.	Replace sensor.
	Sensor slot is blocked by debris.	Clean sensor.
Rear Sensor Failed OFF	Plate carrier not fully retracting.	Check for obstructions.
	Locating pin not blocking the sensor.	Check height of pin.
	Bent locating pin.	Straighten/replace pin.
	Sensor plugged into the wrong connector.	Check connections.
	Sensor wiring shorted or open.	Replace sensor.
Front Sensor Failed ON, Rear Sensor Failed OFF	Check the conditions listed for the individual error above.	See above.

Symptom	Probable Cause	Resolution
Rear Sensor Failed ON	Sensor plugged into the wrong connector.	Check connections.
	Sensor wiring shorted or open.	Replace sensor.
	Sensor slot is blocked by debris	Clean sensor.
Front Sensor Failed OFF	Locating pin not blocking the sensor.	Check height of pin.
	Bent locating pin.	Straighten or replace pin.
	Sensor plugged into the wrong connector.	Check connections.
	Sensor wiring shorted or open.	Replace sensor.
Front Sensor Failed OFF, Rear Sensor Failed ON.	Check the conditions listed for the individual error above.	See above.
Sensor Distance Too Small	Bent locating pin.	Straighten pin.
	Loose drive belt.	Re-tension belt.
	Loose sensor mounting.	Tighten mounting.
	Incorrect position offset value.	Recalibrate alignment.
Sensor Distance Too Large	Bent locating pin.	Straighten pin.
	Loose drive belt.	Re-tension belt.
	Loose sensor mounting.	Tighten mounting.
	Incorrect position offset value.	Recalibrate alignment

Symptom	Probable Cause	Resolution
Filter Motor Test Failed	Filter home switch not adjusted.	Readjust filter switch.
	Filter wheel loose on motor shaft.	Retighten filter wheel collar.
	Filter motor not plugged in.	Check connection.
	Filter motor wires shorted or open.	Replace filter motor.

11.2.2 General Troubleshooting

Symptom	Probable Cause	Resolution
Both plate and filter motors fail to work	There is a fault on the AM Module Main board.	Replace AM Module Main board.
Filter motor fails or runs roughly	Motor is faulty.	Replace motor.
	There is a fault on the AM Module Main board.	Replace AM Module Main board.
Filter wheel rotates continuously	Filter Switch is faulty or out of adjustment.	Replace Filter Switch or adjust as required.
	There is a fault on the AM Module Main board.	Replace AM Module Main board.

Symptom	Probable Cause	Resolution
Incorrect/ Inconsistent OD Readings	Dust or grease on the lamp or reflector.	Clean dust from lamp using a photographic blower. If lamp is contaminated with greasy deposits, replace.
	Cracked heat filter, or dirty or cracked aspheric lens.	Replace heat filter.
	Dirty or cracked filter.	Clean or replace aspheric lens.
	Lens strip, lens stop or collector ferrule is dirty.	Clean or replace filter. Clean or replace lens strip.
	An optical fiber is damaged.	Replace Fiber Optic Array.
	Light is entering the reading chamber.	Check that the front door closes correctly.
	There is a fault on the AM Module Main board.	Replace AM Module Main board.
Lamp does not light	Lamp has blown.	Replace lamp.
	Loose connections.	Check the connections to the lamp assembly.
	There is a fault on the AM Module Main board.	Replace AM Module Main board.
Lamp is permanently on.	There is a fault on the AM Module Main board.	Replace AM Module Main board.
Plate and/or filter motors run at the incorrect speed.	There is a fault on the AM Module Main board.	Replace AM Module Main board.
Plate carrier does not move to the home position	Plate home sensor is faulty.	Replace faulty sensor.
	There is a fault on the AM Module Main board.	Replace AM Module Main board.

Symptom	Probable Cause	Resolution
Plate carrier drives fully into the AM Module.	Plate front sensor is faulty.	Replace faulty sensor.
	AM Module Main board is faulty.	Replace AM Module Main board is faulty.
Plate carrier does not move	Broken, disconnected drive belt or drive belt too tight.	Re-attach, replace or decrease belt tension.
	Dirty or damaged plate carrier bearings or bearing shaft.	Clean or replace damaged plate carrier bearings or bearing shaft.
	Idler bearing damaged.	Replace Idler bearing.
	Plate motor is faulty.	Replace motor.
	Faulty AM Module Main board.	Replace AM Module Main board.
SETUP parameters have been lost	Fault on the AM Module board.	Replace AM Module board.

Symptom	Probable Cause	Resolution
UNDER and OVER readings are more common than expected	OVER limit is set too high.	Change the limit using the Main Menu.
	Photodiode array is dirty or faulty (assay or plate related issues).	Carefully clean the Upper and Lower optics or replace as required.
Plate carrier hangs before ejecting.	Insure that plate carrier is not hitting the Bezel opening.	Loosen and reposition the bezel until interference is removed.
Plate carrier moves but does not eject near the back.	Belt bracket not positioned properly (hitting rear pulley).	Loosen and then reposition the belt bracket.
Plates running into the upper optics block or upper optics block button head screws for the upper stop.	Check that the customer's plate is less than the specified 15 mm maximum plate height.	If not recommend use of different type of plate that meets specifications.

11.2.3 Measurement Errors

Symptom	Probable Cause	Resolution
Accuracy Error	Lamp Filter.	Replace Lamp Replace Filter.
Light leaks	Door not closed.	Check door.
	Rear panel not installed.	Reinstall lamp door.
	Chassis covers not secured	Resecure covers.
Incorrect filter installation or selection	Filters in wrong locations.	Check filter locations.
	Filter wavelengths entered incorrectly.	Re-enter filter wavelengths.

Symptom	Probable Cause	Resolution
Sample value outside of measurement range	Value greater than maximum readable.	
Poor lamp intensity regulation	Faulty power supply.	Replace power supply.
	Faulty lamp control circuit. Obstruction on reference channel	Replace AM Module Main board.
Skewed optics alignment	Loose optical component mounting.	Resecure mounting and realign.
Precision Error	Light leaks.	Insure covers are secured.
	Door not closed.	Check for obstructions or broken springs.
	Rear panel not installed.	Install lamp access door.
	Lamp Defective	Replace Lamp
	Filter Defective	Replace Filter
	Chassis covers not secured.	Secure Chassis covers
Poor plate positioning repeatability	Loose drive belt.	Re-tension belt.
	Excessive bearing clearance.	Check plate carrier bearings.
	Loose optical component mounting.	Resecure mounting and realign.
	Loss of chassis electrical ground.	Check ground connections.
	Noisy A/D circuit.	Replace AM Module Main board.
	Excessive external vibration.	Move unit to a stable bench.

11.3 Removing External Components

11.3.1 The Top Cover

The top cover is removed by loosening the 3 M3 x 6mm screws and then lifting the top cover off (Figure 11-3).

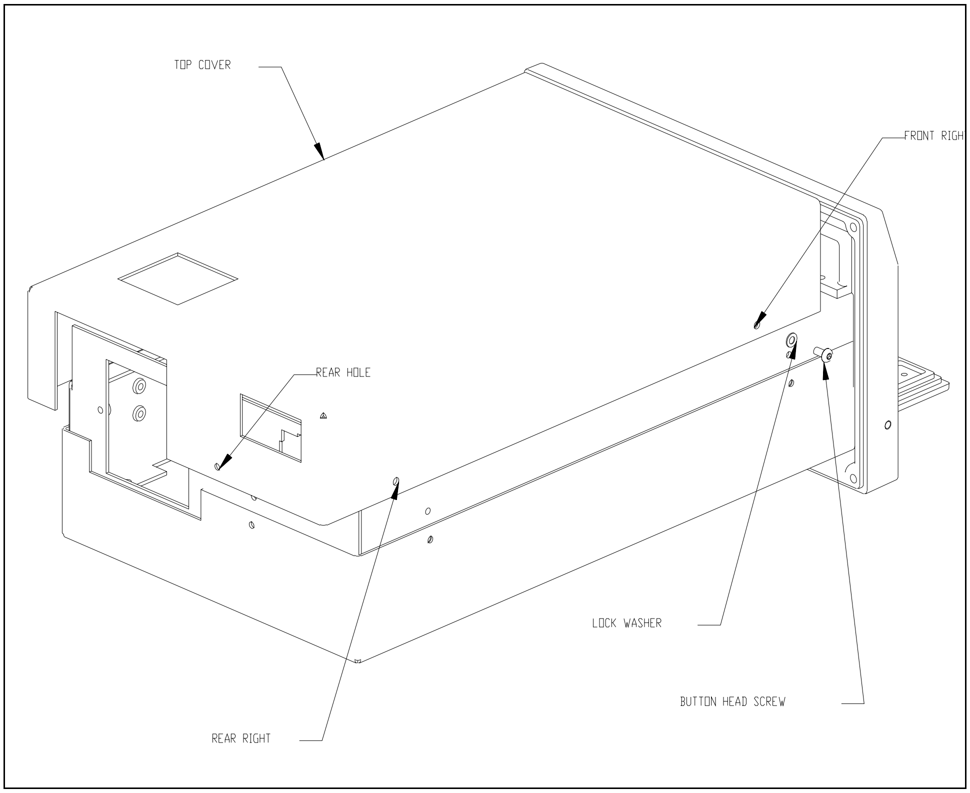


Figure 11-3 Removing the Top Cover

11.3.2 The Bottom Cover

The bottom cover can be removed by removing the 3 M3 x 6mm screws and then lifting the bottom cover off (Figure 11-4).

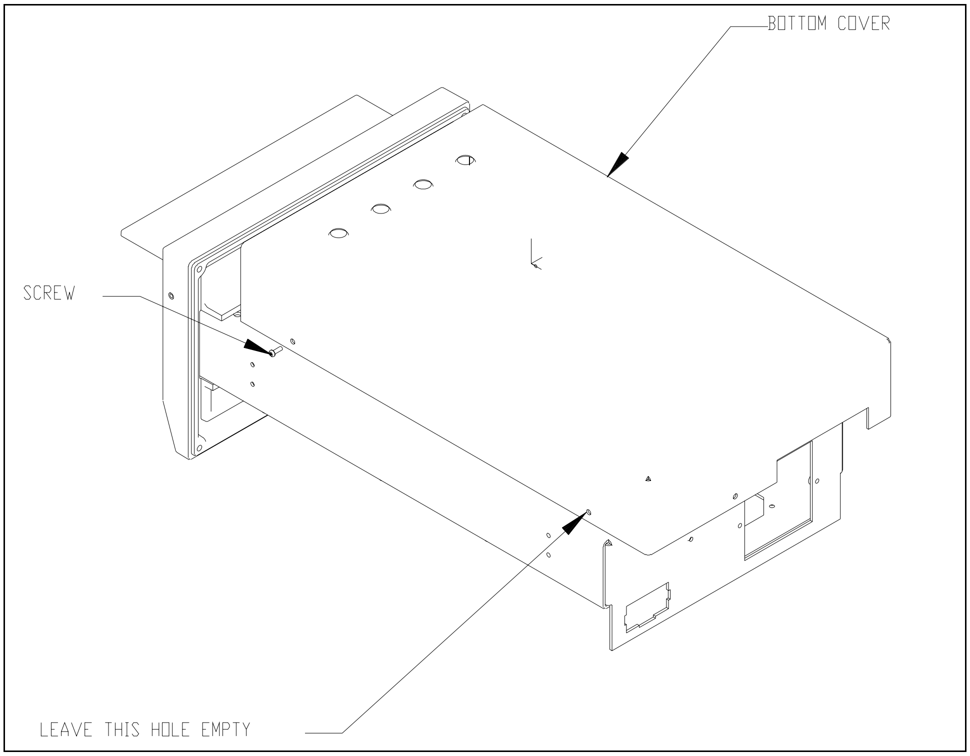


Figure 11-4 Removing the Bottom Cover

11.3.3 The Front Bezel

The Front Bezel can be removed from the chassis by unscrewing 4 M3 x 8mm socket head cap screws. (Figure 11-5).

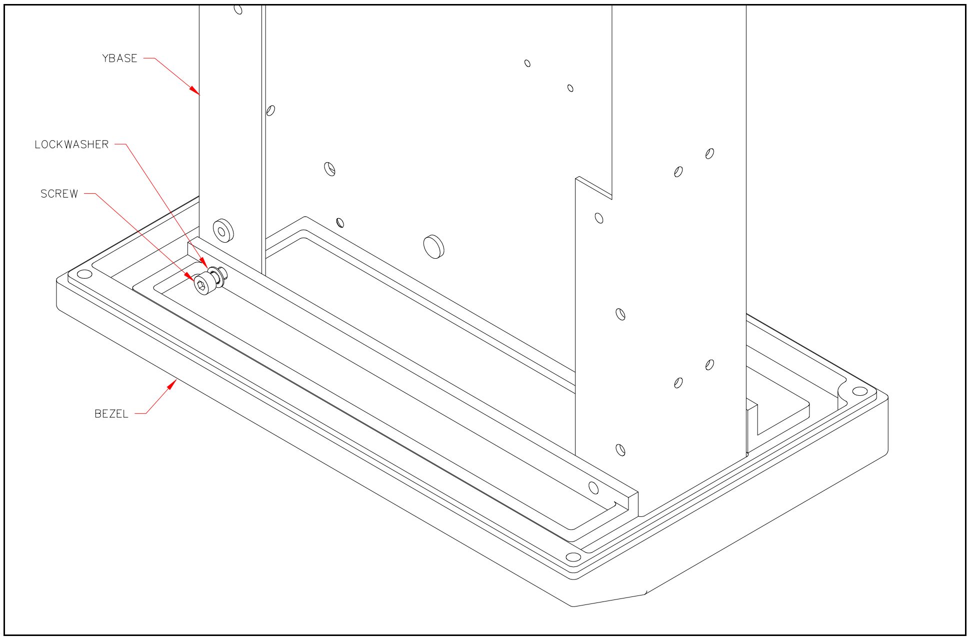


Figure 11-5 Removing the Front Bezel

To reattach the bezel to the chassis, use 4 M3 x 8mm socket head cap screws and M3 washers. Insure that the flat washer is against the bezel, not the lock washer.

11.3.4 Removal/Replacement of the Plate Carrier Door

To Remove the Plate Carrier Door:

1 Using a long punch, insert it through the side of the bezel and push the pin through the door hinge (Figure 11-6).

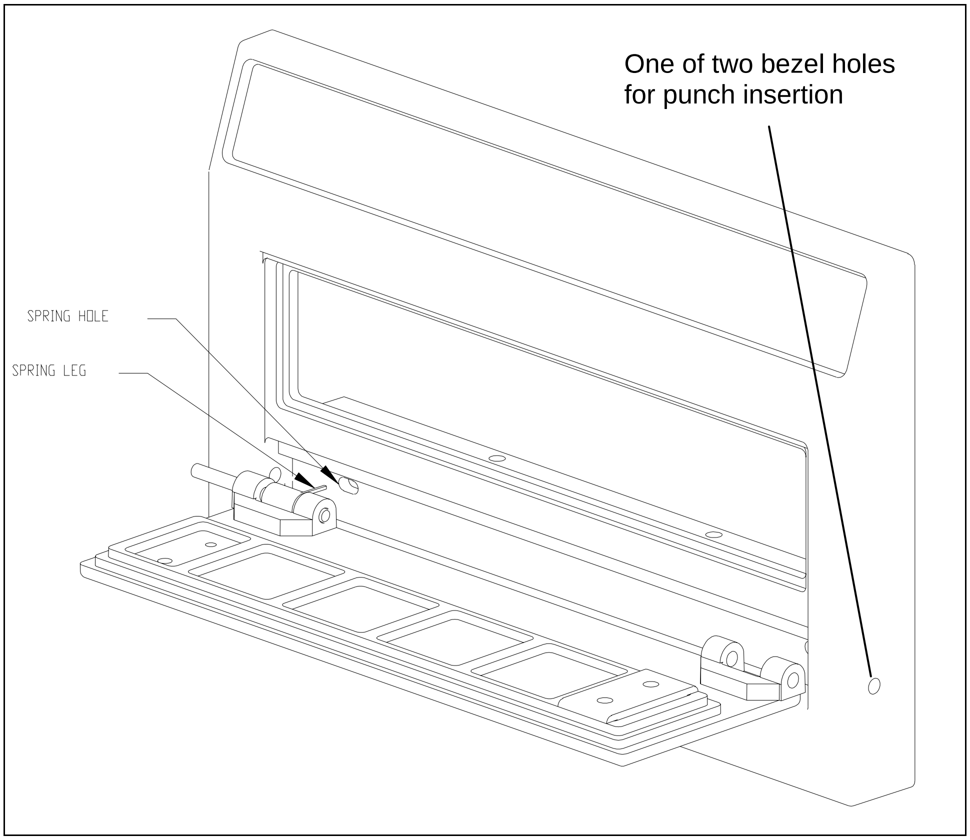


Figure 11-6 Positioning the Punch Removing the Pins for the Door Hinge

2 Remove the springs and pins from the door by pushing the pins out of the door with a punch (Figure 11-7).

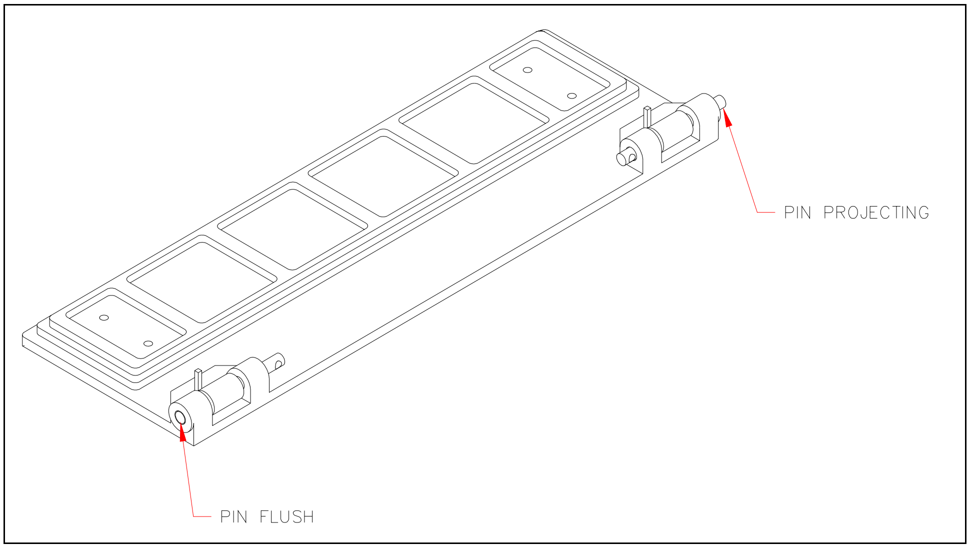


Figure 11-7 Removing Door Pins

3 To reassemble the door, partially insert 2 M3 x 32mm spring pins into the door. Then insert the 2 torsion springs into the hinge recess with its L-shaped leg in the spring hole and engage the pins to hold the springs (Figure 11-8).

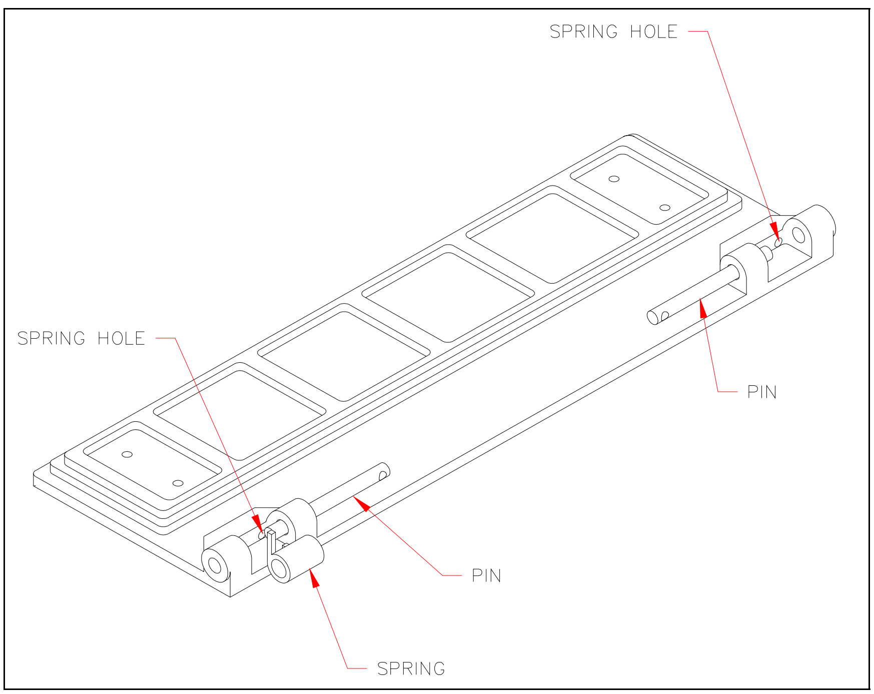


Figure 11-8 Reinstalling the Door

4 Adjust the pins so that one pin is flush and the other is projecting 1/8". Insert the projecting pin of the door into the bezel. As you do this, deflect the spring with a screwdriver so that it is pointing back and will enter the spring recess in the bezel shown in Figure 11-9. Do this with both springs. Insert the other end of the door. Engage the pin by pressing with a screwdriver. Use a miniature friction lock quick-grip clamp to press in the pins into the bezel.

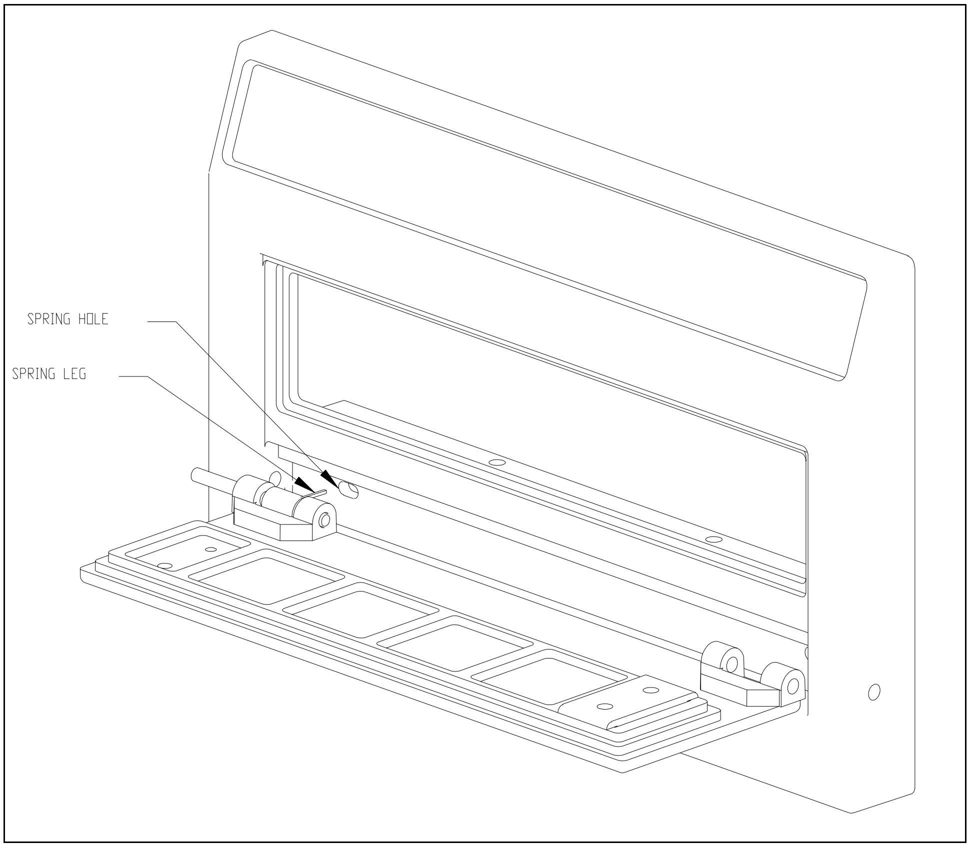


Figure 11-9 Position of Spring Hole and Leg

If needed, use a 2mm Allen wrench to align the pin with bezel pinhole until the pin is started. Test the door by opening it and then letting go 5 times. The door should shut by itself. If it does not shut properly, use a 3mm Allen wrench to push out the pins and begin the installation procedure again.

11.4 Repairing/Replacing Internal Components

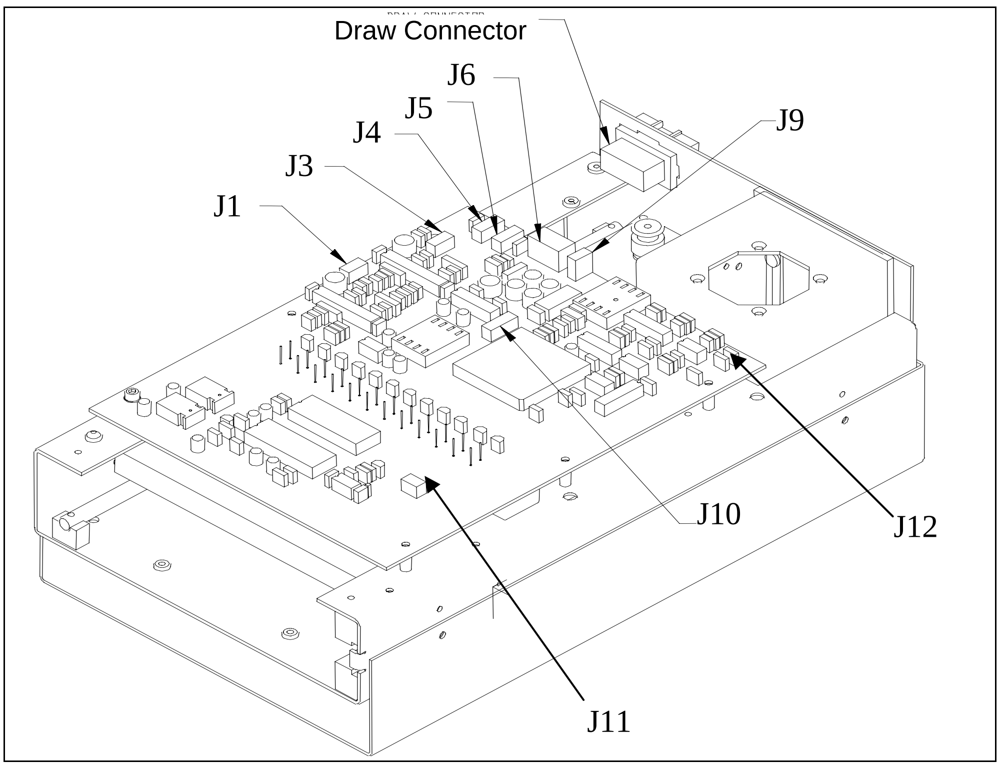
This section describes the repair/replacement of components of the reader module.

> ***Note**: The Reader Module is considered a service replaceable item. If a defect is observed, the entire module is normally replaced. The information in this chapter should be used only if it is necessary to repair or replace the module on-site.*

In most cases, replacement of a component is the reverse of installation. For the sake of brevity, re-installation is not described unless there is a difference between the two activities.

11.4.1 Removal/Replacement of the Main Board

The Main Board (Figure 11-10) provides local control of the reader module and communicates with the personal computer. It contains the sample and reference photodiodes.



Wire	Function	Wire	Function
J1	**Carrier motor**	**J7**	**N/A**
J2	**(Not Used)**	**J8**	**(Not Used)**
J3	**Filter motor**	**J9**	**Lamp**
J4	**Front sensor**	**J10**	**Filter home switch**
J5	**Home sensor**	**J11**	**Reference diode**
J6	**Power harness**	**J12**	**Fan**

Figure 11-10 Main Board

To Remove the Main Board:

1. Disconnect the connectors from the board and unfasten the Main Board by removing the 6 M3 x 8mm socket head cap screws and 6 M3 lock washers.
2. Lift the board off of the standoffs.

= CAUTION

CAUTION: SINCE THE PHOTODIODES ARE EXPOSED DURING THIS OPERATION, CARE SHOULD BE EXERCISED WHEN HANDLING OR STORING THE BOARDS TO ENSURE THAT THEY ARE NOT DAMAGED.

To Install the Main Board:

1. Installation is the reverse of the removal.
2. After installation, test and calibrate the module using DynexTest software.

11.4.2 Removal/Replacement of the Plate Carrier Motor

The plate carrier motor drives the carrier belt that draws the plate into the module, positions each row for measurement and holds the plate in position (Figure 11-11).

***Note**: If the plate carrier, plate carrier motor or the drive belt is removed or replaced, use the alignment plate before running samples again.*

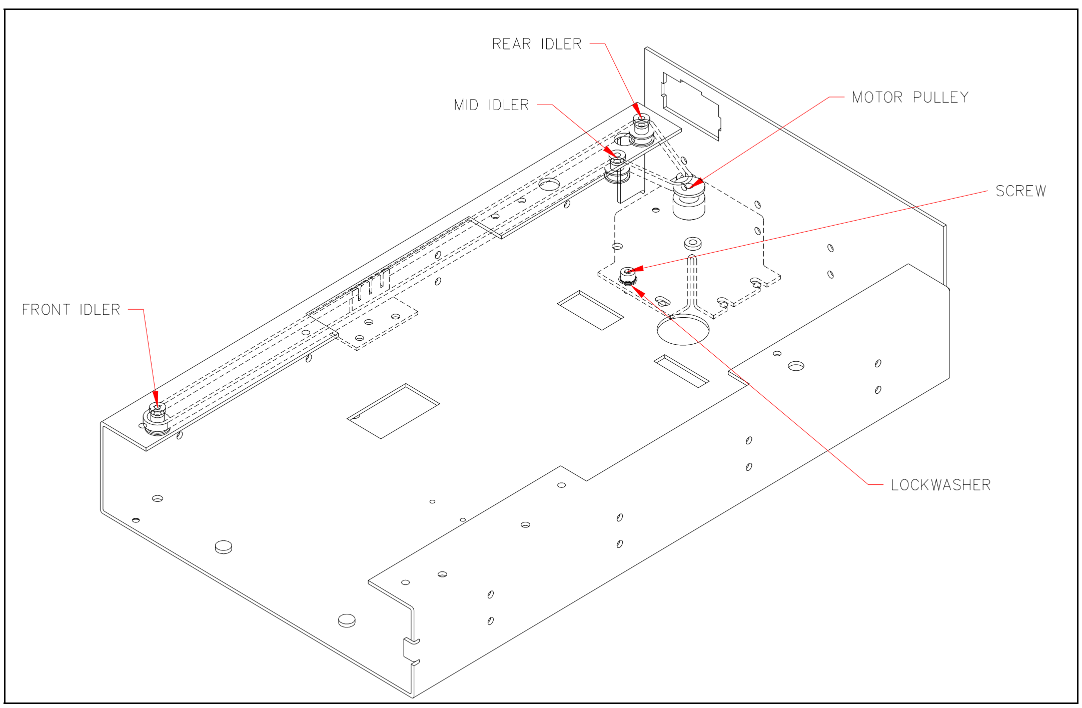


Figure 11-11 Plate Carrier Drive

To Remove the Plate Carrier Motor:

1 Remove the drive belt from the motor by removing the 4 M3 x 6mm socket head screws securing the motor mount to the chassis and unwrap the belt from the pulley.

2 Remove the Motor mount from the chassis (Figure 11-12).

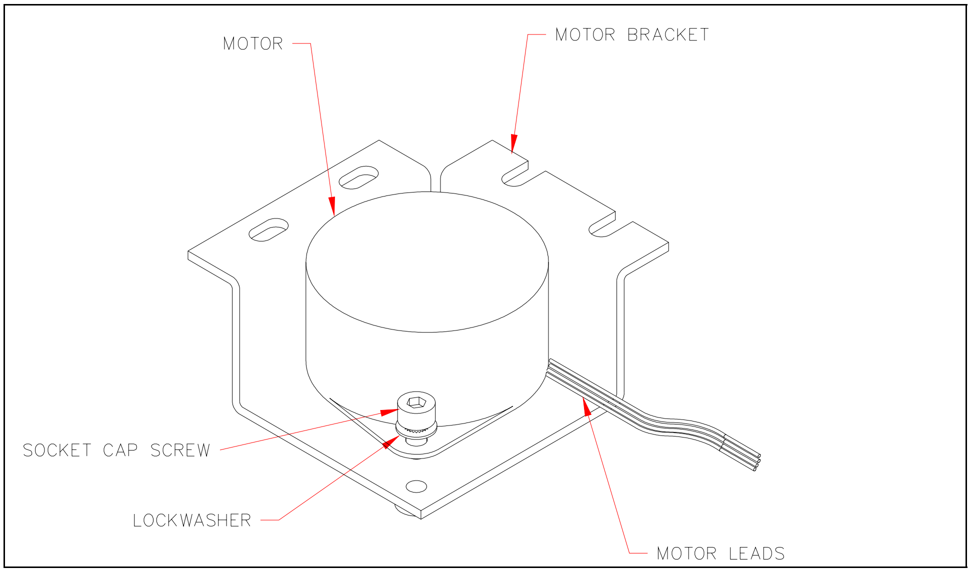


Figure 11-12 Motor and Mount

3 Remove the pulley assembly from motor shaft by loosening the setscrew and then remove the two socket head cap screws that fasten the motor to the mount.

4 Place the pulley on the motor shaft (Figure 11-13). Set the position of the pulley using the pulley gauge P/N AMFIX002. Fasten the pulley using the setscrew and Loctite #242.

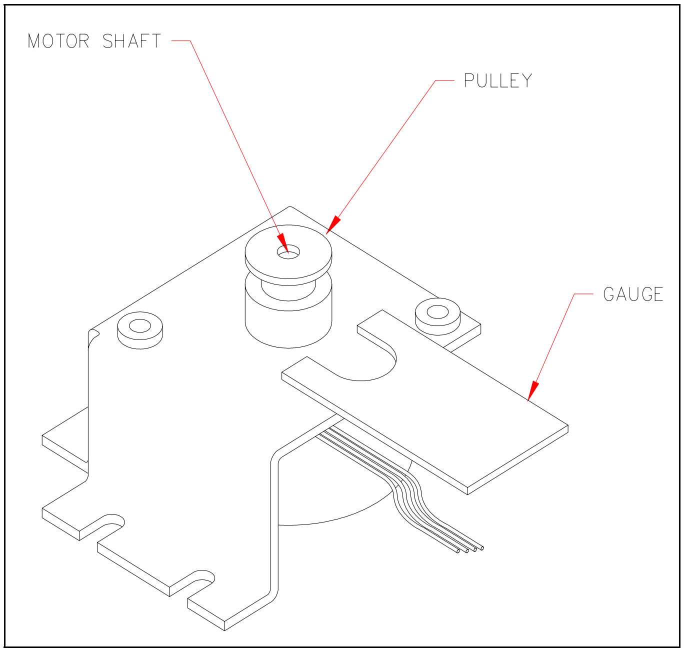


Figure 11-13 Motor and Pulley

5 Rewrap the belt around the motor pulley. Loosely fasten the motor to the chassis using 4 M3 x 6mm socket head cap screws, M3 flat washers and M3 lock washers. Route the wire from the motor to the right in the back. Apply 7 in-lbs of torque to tighten the screws.

> ***Note**: When tightening the screws, use torque driver SN160 to tighten the screws to 7 in-lbs.*

11.4.3 Removal/Replacement of the Drive Belt

The drive belt draws the plate into the module, positions each row for measurement and holds the plate in position. It is powered by the plate carrier motor.

To Remove or Replace the Drive Belt:

1 Remove the Belt Mount from the Plate Carrier Assembly by removing the three M3 x 6mm button head screws (Figure 11-14).

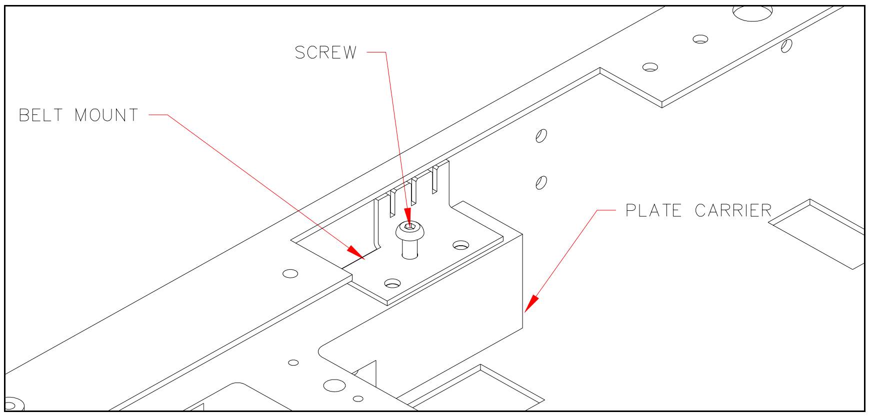


Figure 11-14 Motor Belt Mount

2 Loosen the Motor Assembly by loosening the 4 M3 x 6mm socket head screws and unwrap the belt from the motor, middle, back and front idlers.

3 Slide the belt out of the mount (Figure 11-15) and discard the old belt.

4 Cut a 24.7” length of belt material. Install this belt into the belt mount so that there are two front teeth exposed and four back teeth as shown in Figure 11-15.

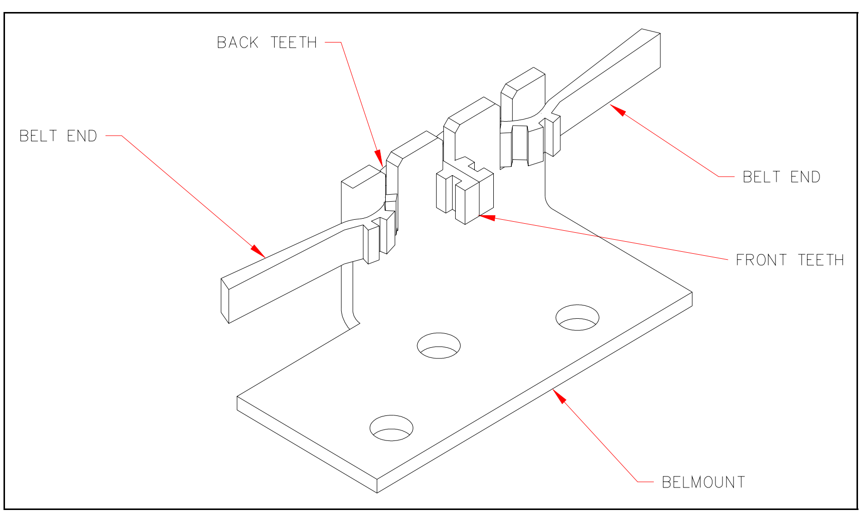


Figure 11-15 Belt Mounting

5 Wrap the new belt around the middle idler, the rear idler and the front idler, then loop it around the motor assembly.

6 Loosely fasten the motor to the chassis using 4 M3 x 6mm socket head cap screws, M3 flat washers and M3 lock washers.

7 Route the wire from the motor to the right in the back. Apply 7 in-lbs of torque to tighten the screws.

> ***Note**: When tightening the screws, use torque driver SN160 to tighten the screws to 7 in-lbs.*

11.4.4 Removal/Replacement of the Plate Carrier Assembly

1 Remove the assembly by unscrewing the two support blocks and two M2.5 x 12mm Flathead screws from the bottom of the module chassis.

2 Lift and remove the Plate Carrier from the module chassis.

3 Remove the plate carrier from the bearing shaft as shown in Figure 11-16.

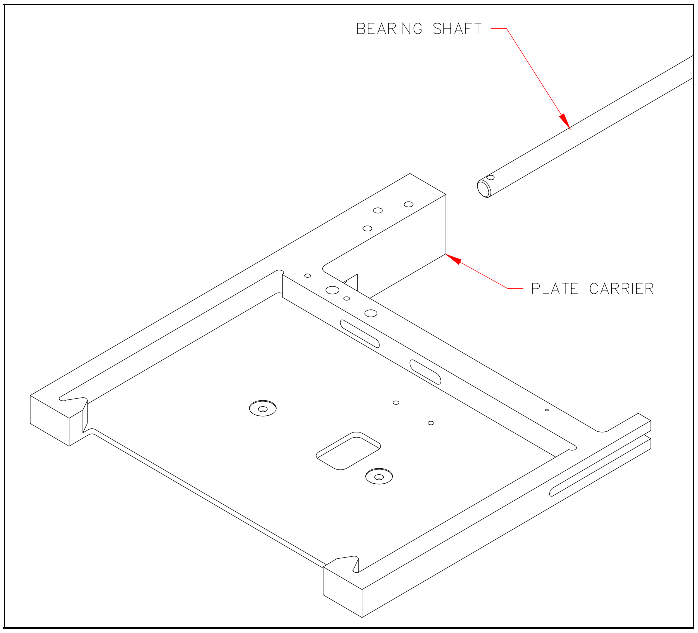


Figure 11-16 Plate Carrier Assembly

11.4.5 Removal/Replacement of Locking Lever/Pivot/Spring

The plate is held in place by the Locking Lever/Pivot/Spring mechanism shown in Figure 11-17.

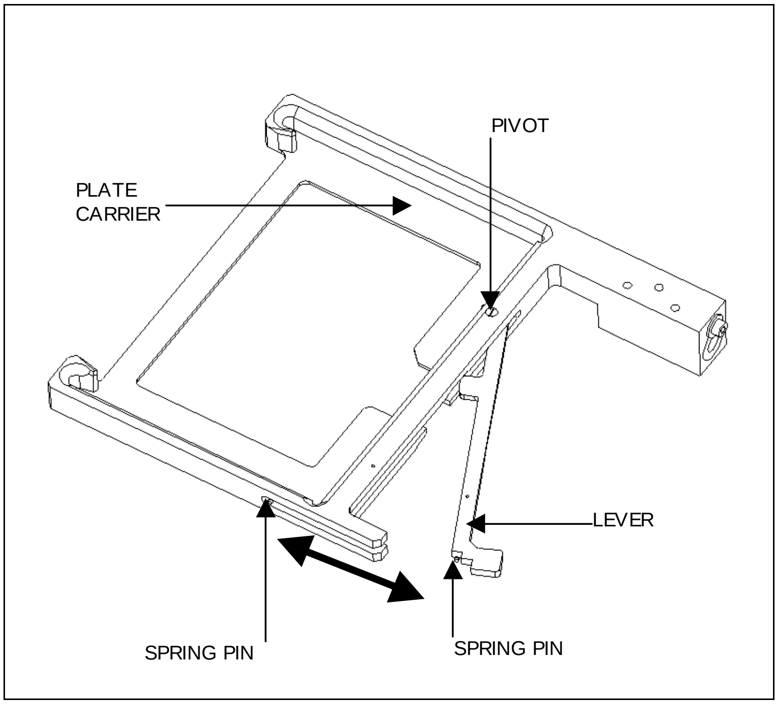


Figure 11-17 Locking Lever/Pivot and Spring

To Remove the Locking Lever/Pivot and Spring:

1 Remove the spring (Part No. 42000311) from the lever spring pin and plate carrier spring pin.

2 If it is necessary to remove the pivot and/or locking lever, use a small flat screwdriver.

> ***Note****: When replacing the spring, be sure that the spring is not over-stretched.*

11.4.6 Removal/Replacement of the Plate Carrier Bearings

1 Remove the M3 x 6mm socket head cap screw, M3 lock washer and M3 fender washer (Figure 11-18).

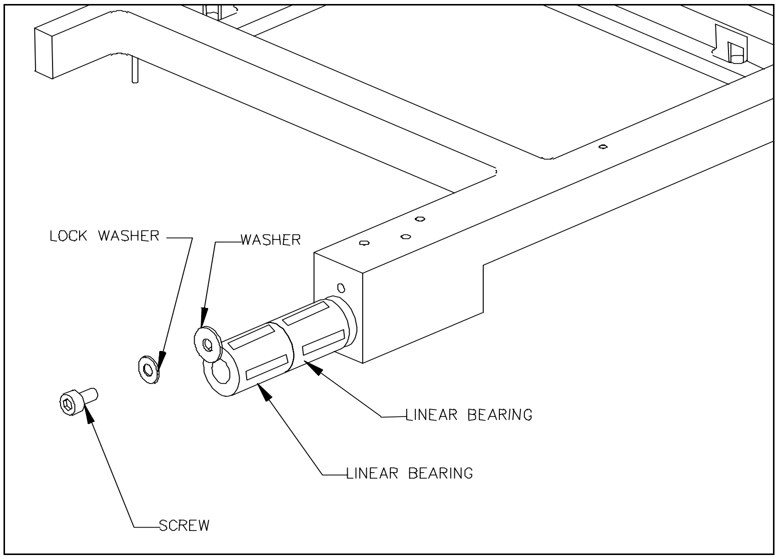


Figure 11-18 Replacing Plate Carrier Bearings

2 To reinstall, make sure the 4 silver pad surfaces of the bearing are facing up and down and left and right (note diagram) and lock in place using one M3 fender washer, one M3 x 6mm socket head cap screw and one M3 lock washer.

11.4.7 Installing the Plate Carrier

1 Slide the bearing shaft into the Plate Carrier Assembly (Figure 11-16).

2 Install this assembly into the chassis (Figure 11-19) using two support blocks and two M2.5 x 12mm Flathead screws using Loctite 222.

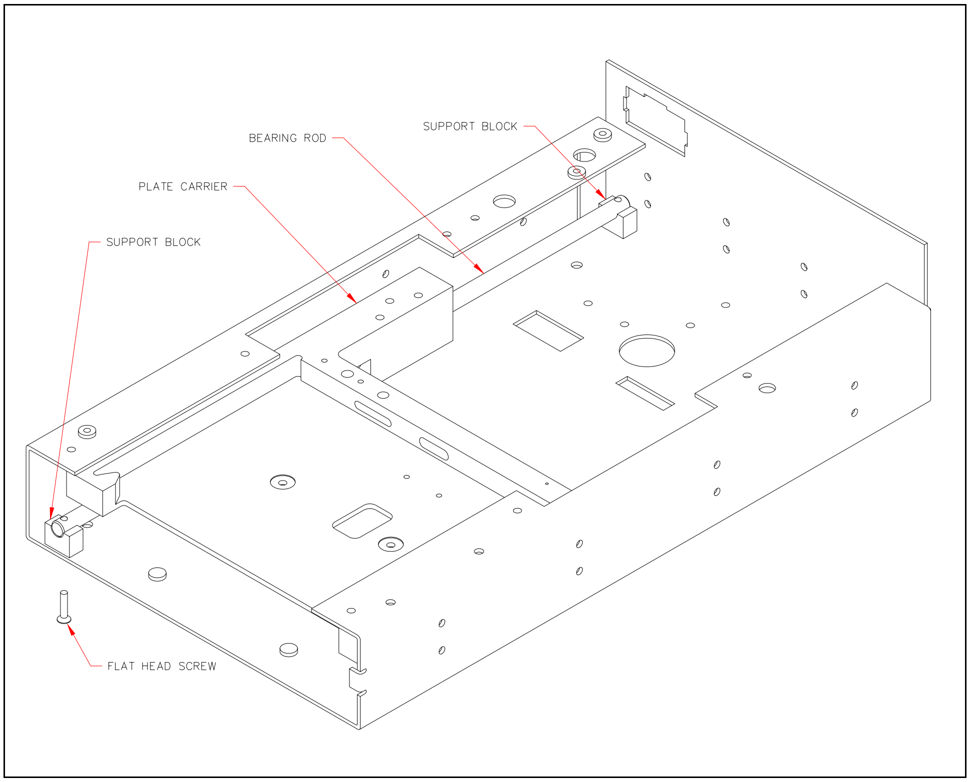


Figure 11-19 Installing Bearing Shaft

3 Fasten the belt mount to the plate carrier assembly using 3 M3 x 6mm button head screws and Loctite 222 (Figure 11-20).

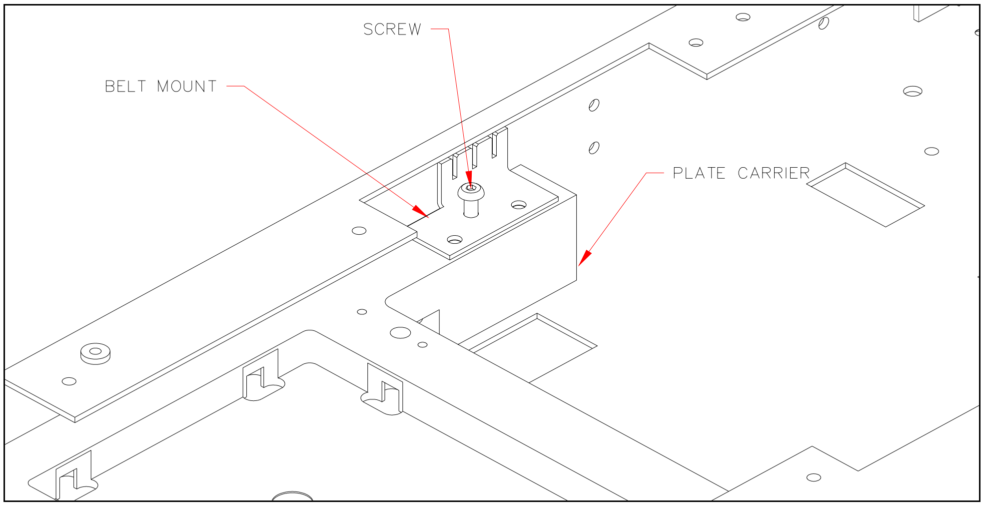


Figure 11-20 Tightening the Belt Mount

11.4.8 Removal/Replacement of the Idler Bearings

The Drive Belt Idler Bearings (Figure 11-21) defines the pathway for the drive belt:

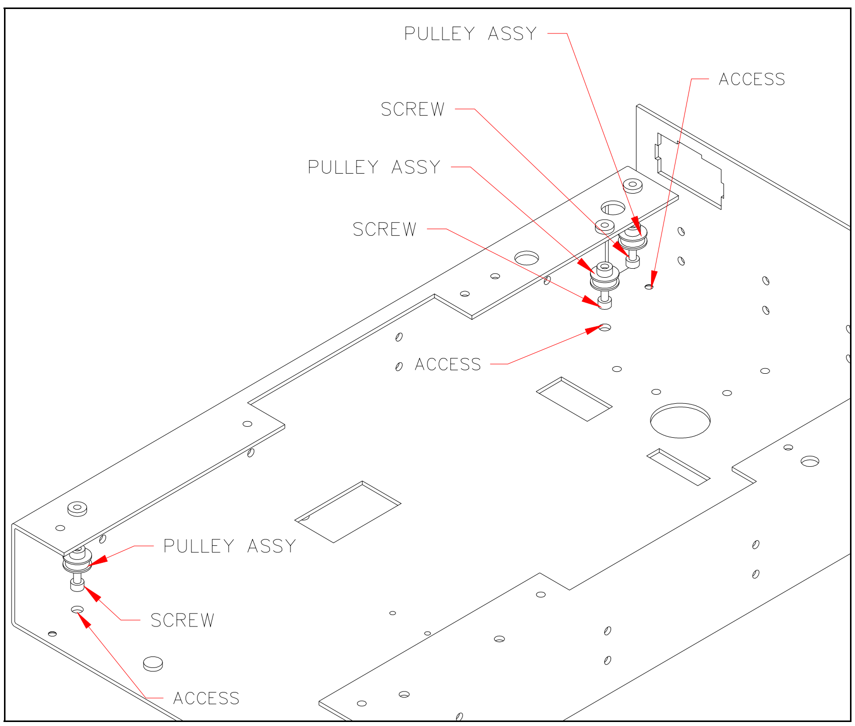


Figure 11-21 Idler Bearings

To Replace the Idler Bearings:

1 Remove the Plate Carrier (Section 11.4.4) and the drive belt (Section 11.4.3). Unscrew the 3 M2.5 x 12 screws that fasten the 3 idler assemblies to the chassis.

2 Install the new wide bearing on the idler shaft first, then install the new narrow bearing on the idler shaft (Figure 11-22). Repeat for each assembly.

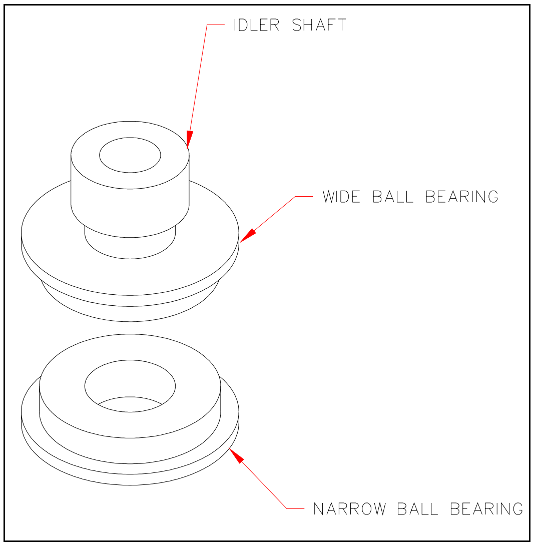


Figure 11-22 Idler Bearing Assembly

3 Reinstall the three idler assemblies into the chassis using three M2.5 x 12 mm screws and Loctite 242. Refer to Section 11.4.3 and Section 11.4.4 to reinstall the drive belt and plate carrier.

11.4.9 Removal/Replacement of the Fiber Optic Bundle

1 Remove the two M3 x 22mm socket head cap screws, M3 lock washers and gently pull the optic bundle from the optics cube.

2 Remove the four M3 x 20 socket head cap screws and M3 lock washers that secure it to the lower block.

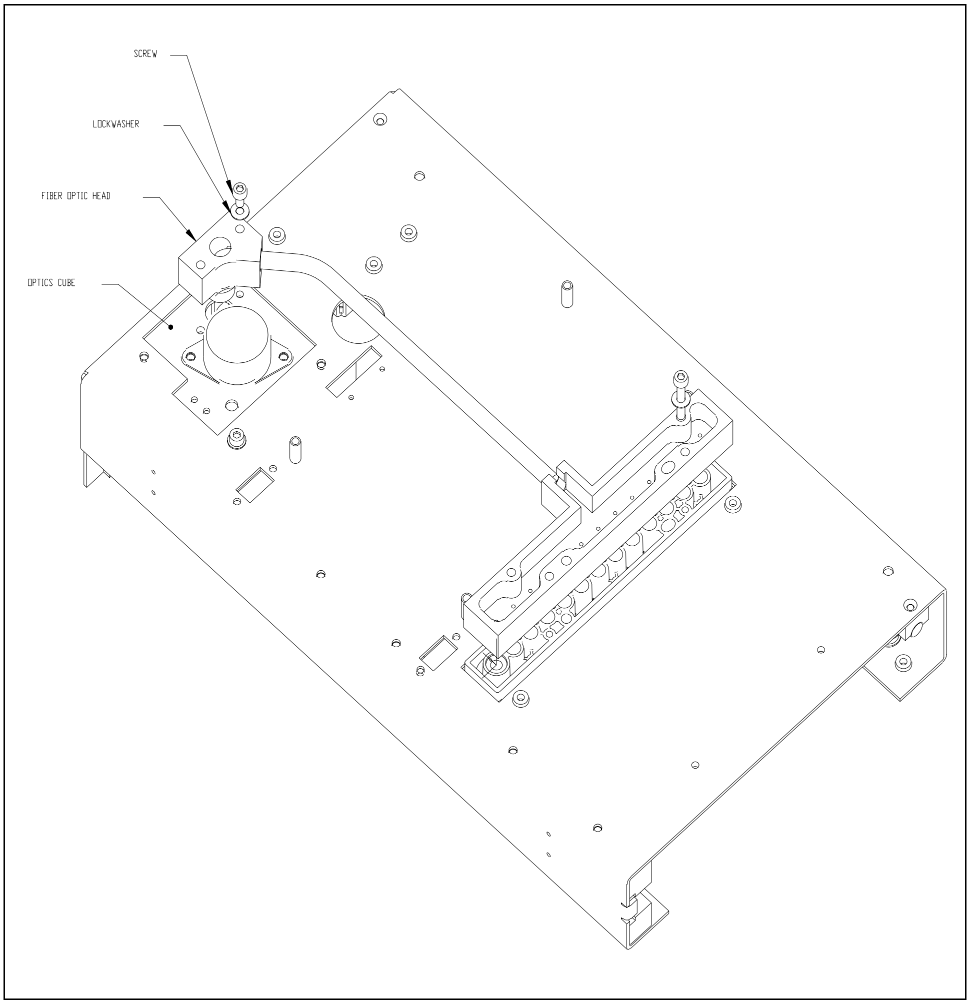


Figure 11-23 Fiber Optic Bundle

11.4.10 Removal/Replacement of the Optics Cube

1 Remove the fiber bundle from the cube.

2 Cut the Tie-wraps securing the wires from the cube to the base and then remove the 3 M3 x 6mm socket head cap screws and 3 M3 lock washers securing the Optics Cube to the chassis.

3 Pull the stepper motor and filter switch wires through the hole in the base and remove the cube (Figure 11-24).

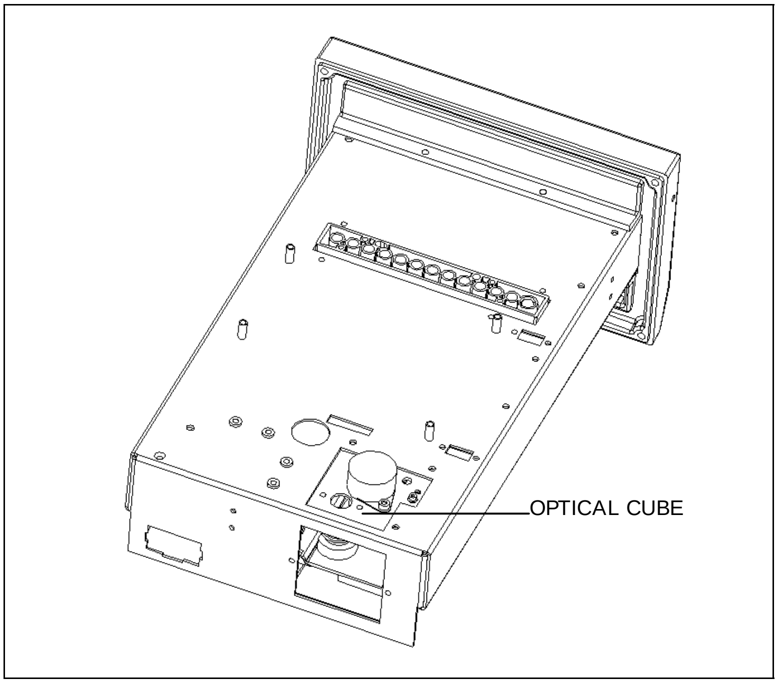


Figure 11-24 Optical Cube and Chassis

11.4.11 Removal/Replacement of the Lens Holder

Remove the 2 M3 x 6 socket head cap screws and M3 lock washers (Figure 11-25).

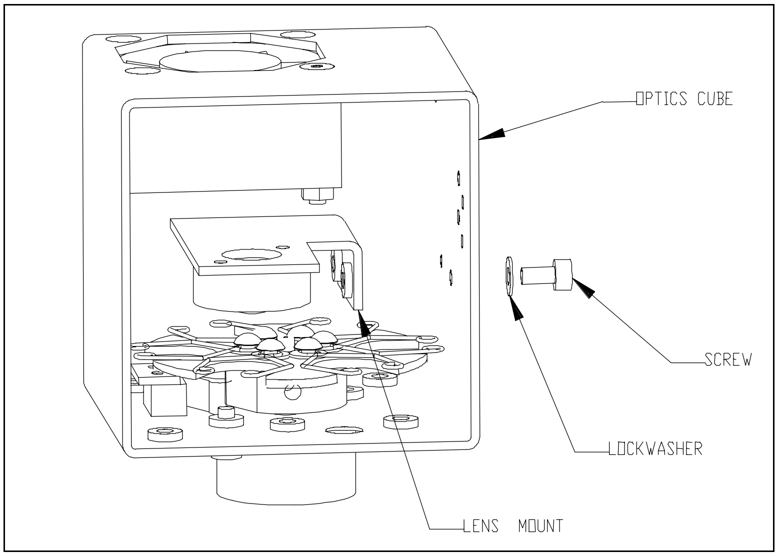


Figure 11-25 Optical Cube

11.4.12 Removal/Replacement of the Optics in the Lens Bracket

> ***Note**: Always handle optical components with gloves or tweezers.*

1 Remove the 2 M2 x 6mm socket head cap screws from the lens-retaining ring and remove from bracket (Figure 11-26).

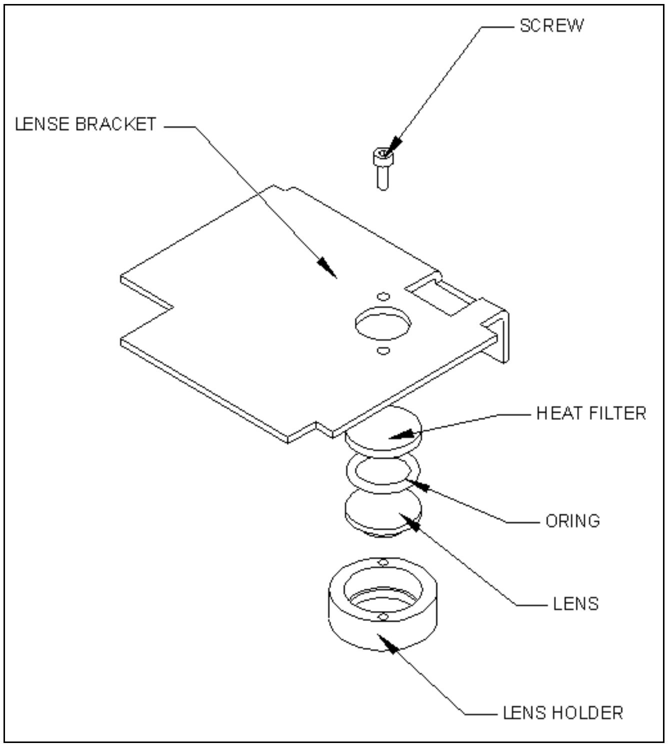


Figure 11-26 Taking the Lens Assembly Apart

To Clean (or Replace as Necessary) and Reassemble the Optics:

1 Drop lens in lens retaining ring.

2 Place o-ring on top of the lens.

3 Place the heat-absorbing filter on top of o-ring.

4 Mount this group to the lens bracket using 2 M2 x 6mm socket head cap screws and Loctite 242.

> ***Note**: Ensure the Loctite does not migrate to the lenses.*

11.4.13 Removal/Replacement of the Lamp Holder

To Remove the Lamp Holder:

1. Remove the 2 M3 x 6mm socket head screws and M3 lock washers (Figure 11-27).
2. Remove wires from lamp connector and remove lamp holder.

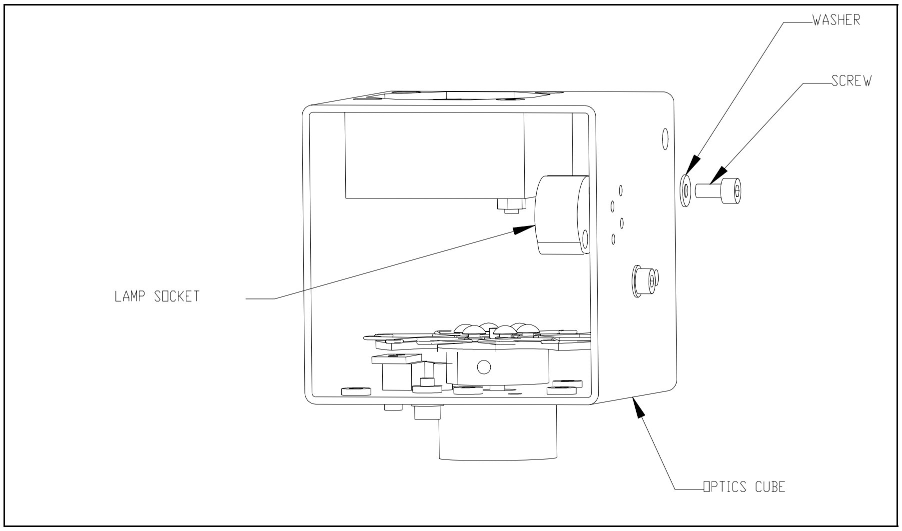


Figure 11-27 Remove the Lamp Holder

To Replace the Lamp Holder:

1. Mount the lamp holder into the cube using two M3 x 6mm socket head cap screws washers and M3 lock washers.
2. Route both lamp holder wires through two wire holes.
3. Terminate wires at the Molex connector of the lamp using two terminal crimps. The final terminated wire length should be 4.0 inches.

11.4.14 Removal/Replacement of the Optics Cube Fan

To Remove the Optics Cube Fan:

1 Remove the fan from the optics cube by removing the 4 M3 x 25mm flat head screws that secure it to the cube (Figure 11-28).

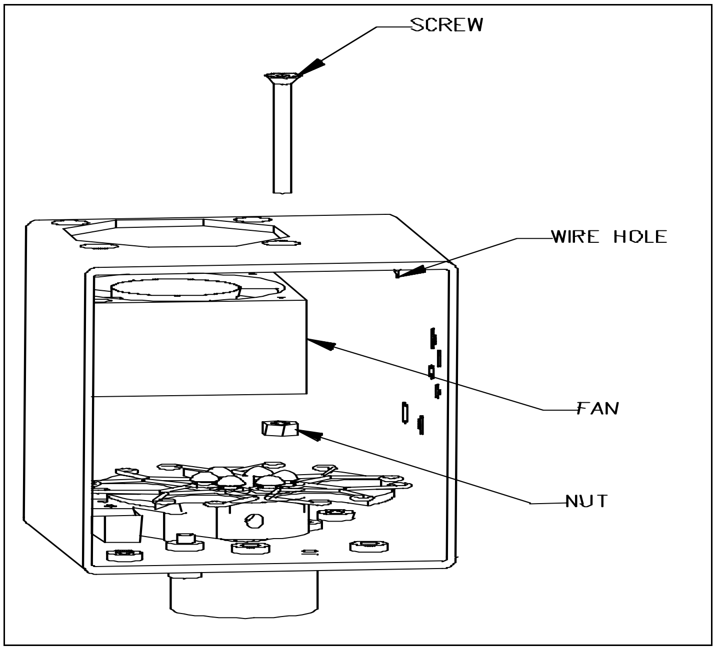


Figure 11-28 Optics Cube Fan

2 Carefully cut away the RTV around the fan wires and remove the connector from the wires.

3 Pull the fan out of the cube.

To Reassemble the Optics Cube Fan:

1 Mount the fan in the optics cube using the four M3 x 25mm flat head screws and Loctite 242.

2 Install the fan to blow into the cube with the wire going out the access hole on the right. Attach the 2mm 2-pin connector to fan wires using 2 contact crimps. Pin 1 connects to the Black wire and Pin 2 connects to the red wire. The connector has a small notch that indicates the position of Pin 1. The wires should be twisted 1 turn per inch before termination. The final length of the terminated wires should be 5.25 inches.

11.4.15 Removal/Replacement of the Filter Wheel

To Remove the Filter Wheel:

1. Remove the filter wheel by loosening the set screw tightened against the motor shaft and remove (Figure 11-29).

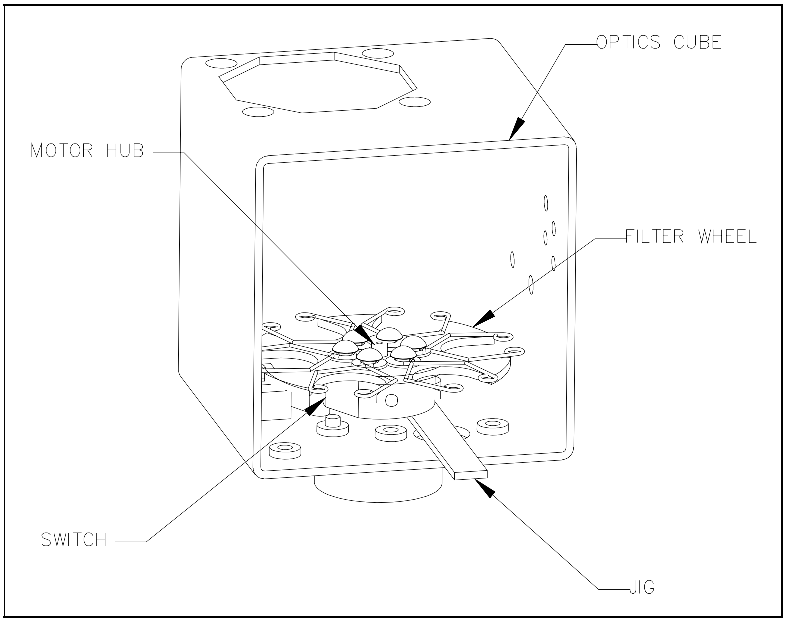


Figure 11-29 Removing the Filter Wheel

To Replace the Filter Wheel:

1. Mount the filter wheel to the motor shaft using one M3 x 6mm setscrew and Loctite 242. When pressing the filter wheel down on the shaft, depress the switch arm so it clears the filter wheel hub and avoids damaging the switch.
2. Set the gap using the jig (AMFIX005) and tighten the setscrew.

11.4.16 Removal/Replacement of the Filter Motor

To Remove the Filter Motor:

1 Remove the filter wheel.

2 Remove the 2 M3 x 6mm socket head cap screws and 2 M3 lock washers fastening the motor and remove it from the cube (Figure 11-30).

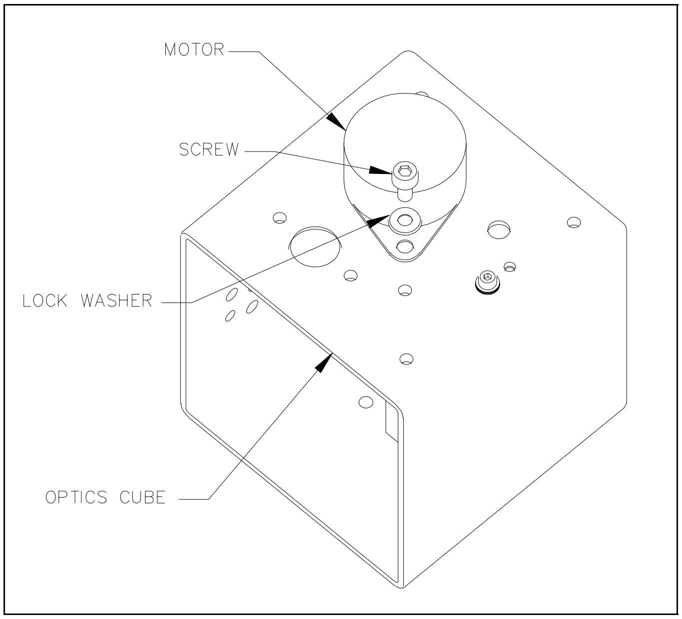


Figure 11-30 Filter Motor

To Replace the Motor:

1 Mount the replacement filter motor to the base of the optics cube using two M3 x 6mm socket head cap screws and two M3 lock washers.

2 Reinstall the filter wheel.

11.4.17 Removal/Replacement of the Filter Switch

To Remove the Filter Switch:

1. Remove the filter wheel.
2. Remove the filter switch by undoing the two M2 x 10mm screws and the 6 M2 washers (3 per screw) from the nut plate.
3. Carefully cut away the RTV from the switch wires, release the wires from the connector and remove the switch from the cube (Figure 11-31).

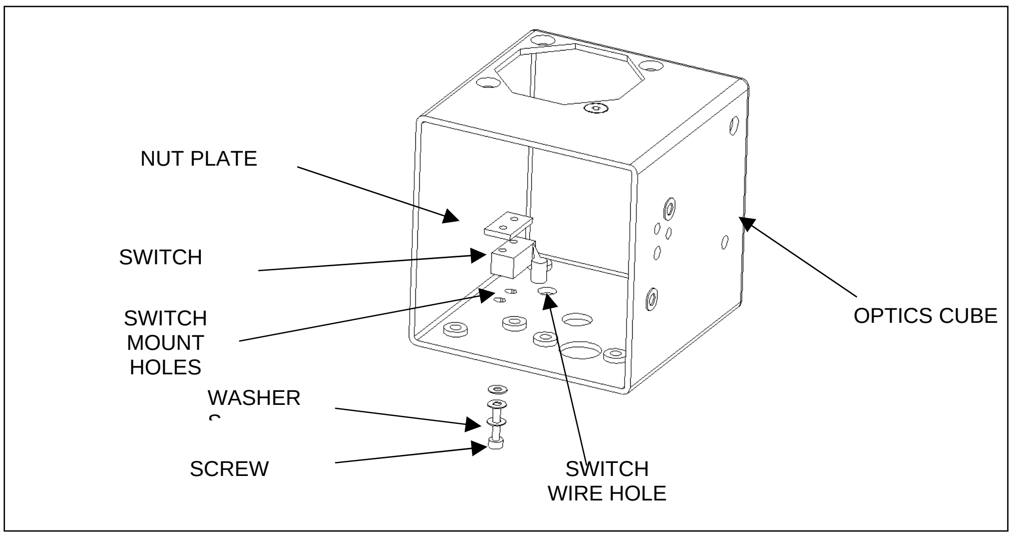


Figure 11-31 Filter Switch

To Replace the Filter Switch:

1. Unsolder wires from the old switch and solder them to the new switch.
2. Mount the new filter switch to the floor of the optics cube using two M2 x 10mm screws, 6 M2 washers (3 per screw), nut plate and Loctite 242.
3. Orient the switch and route wires through the hole as noted above.
4. Reinstall the connector. Attach the filter wheel switch wires to the leads of a digital voltmeter with an audible continuity checker.
5. Slowly rotate the filter wheel clockwise by hand and listen for when the beep of the continuity checker stops. The beep should stop when the flat of the hub is in contact with the switch. The beep should be continuous when the round of the hub is in contact with the switch.

6 If the beep is not continuous, then move the switch closer to the motor by loosening the two M2 filter switch screws and using another Allen wrench to relocate while re-tightening the screws. Repeat the continuity meter test. If the beep is still not continuous then loosen the filter motor screws and push the motor closer to the switch, then retighten the two M3 filter motor screws. Repeat the continuity meter test.

11.4.18 Removal/Replacement of the Slide Blocks

To Remove the Slide Blocks (Gravity Blocks):

1 Remove the upper gravity block (or plate in later models) in the XY base by removing the 2 M3 x 6mm button head screws and 2 M3 lock washers (Figure 11-32).

2 Remove the lower gravity block in the XY base by removing the 4 M3 x 6mm button head screws and 4 M3 lock washers.

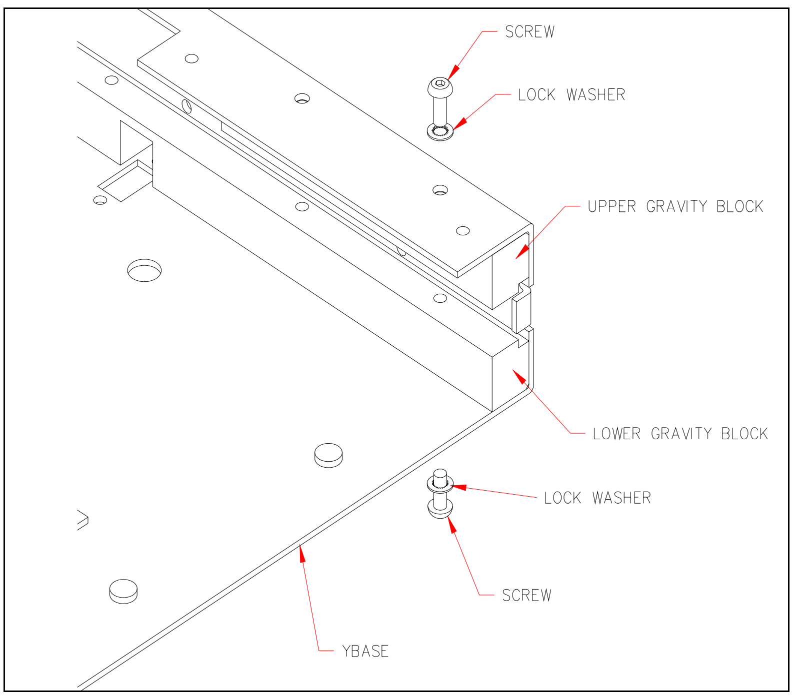


Figure 11-32 Removing the Gravity Blocks

To Replace the Gravity Blocks:

1 Place upper gravity block or plate in later models in XY base. Fasten with two M3 x 6mm button head screws and 2 M3 lock washers.

2 Place lower gravity block in XY base. Fasten with three M3 x 6mm button head screws and 3 M3 lock washers.

11.4.19 Removal/Replacement of the Plate In and Out Sensors

Removing the In and Out Sensors:

1 The Plate Home Sensor (Figure 11-33) is removed by unscrewing the two M3 x 6mm socket cap screws and two M3 lock washers.

2 Removal of the Plate front sensor requires removing the lower slide block and then removing the two M3 x 6mm socket cap screws and two M3 lock washers.

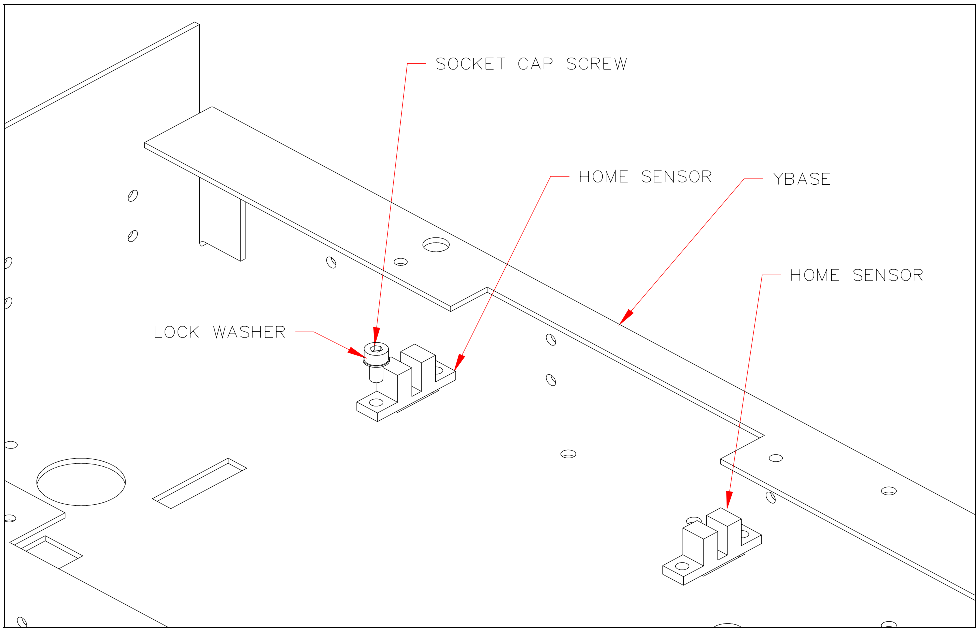


Figure 11-33 Plate Home Sensors

Replacing Plate Home Sensors:

1 Place home sensors into the XY Base.

2 Fasten the home sensor with 2 M3 x 6mm socket cap screws and 2 M3 lock washers.

3 Fasten the Plate front sensor with 2 M3 x 6mm socket cap screws and 2 M3 lock washers and reinstall lower slide block.

11.4.20 Removal of the Eject Sensor

To Remove the Eject Sensor (Part No. 15000600):

1 Remove the two M3 x 10 SHCP screws and two M3 lockwashers (Figure 11-34).

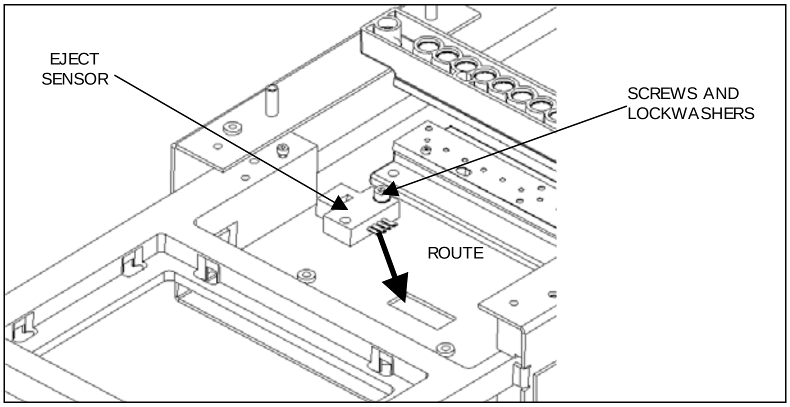


Figure 11-34 Eject Sensor

2 Remove the cable as shown in Figure 11-35.

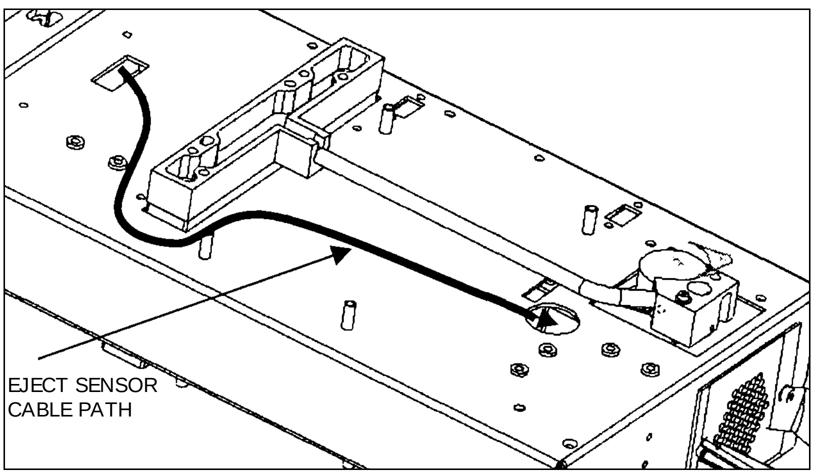


Figure 11-35 Cabling for Eject Sensor

> ***Note**: When re-installing the cable, route cable through cut-out as shown. Ensure that cable from eject sensor lies flat on chassis to prevent interference with plate carrier movement.*

> ***Note**: After installation, the eject sensor must be calibrated using DynexTest software.*

11.4.21 Removal/Replacement of the Upper Optic Block

To Remove the Upper Optic Block:

1 Remove the AM Main Module Board.

2 Remove the upper optic block by unscrewing the 2-M3 x 10mm socket head cap screws and 2-M3 lock washers (Figure 11-36).

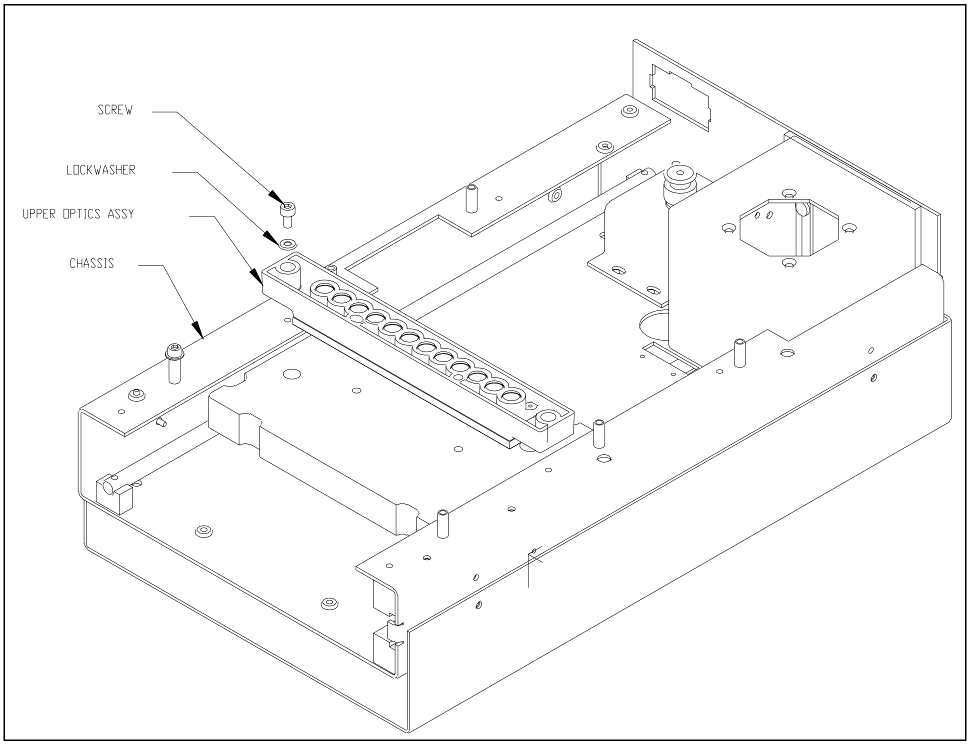


Figure 11-36 Removing Upper and Lower Optical Blocks

11.4.22 Separating the Upper Block Components

To Separate the Upper Block Components:

1 Unscrew the 6-M2 x 8mm button head screws holding the assembly together (Figure 11-37).

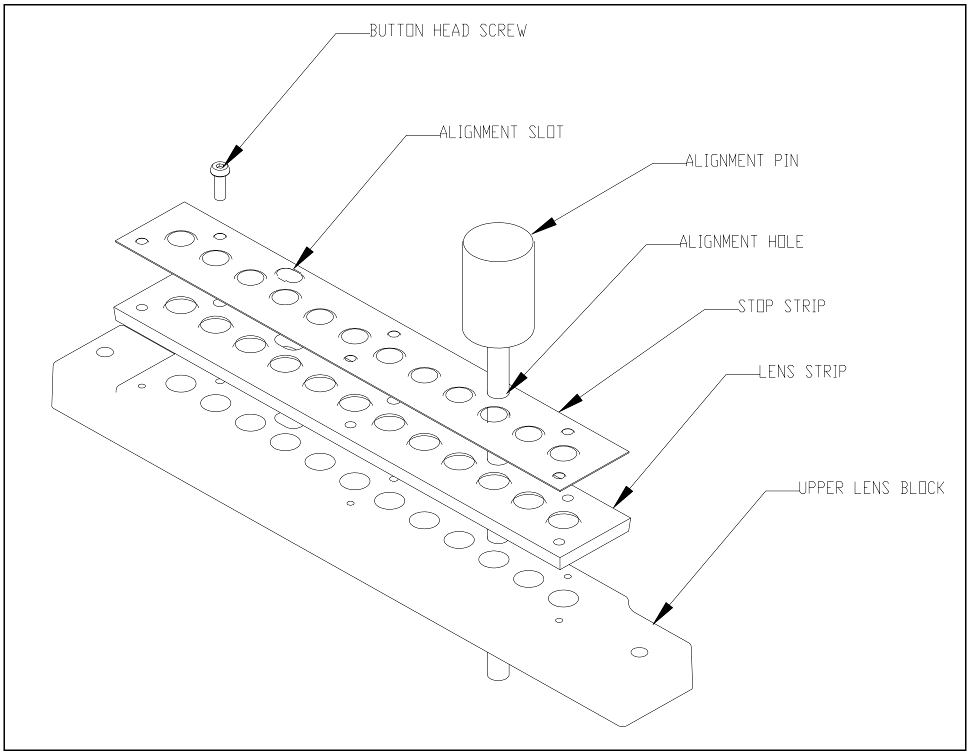


Figure 11-37 Upper Block Components

2 Separate the lens strip

> ***Note***: *Use care in handling or cleaning components. They are plastic and very susceptible to scratches.*

To Replace, Clean, and Reassemble Components:

1 Place the upper lens strip on the upper optics block.

2 Place the upper lens stop on top of the lens strip. Align all the parts by inserting an AMFIX004 alignment dowel in the alignment hole and an AMFIX004 alignment dowel in the alignment slot.

3 Fasten the assembly together using 6-M2 x 8mm button head screws and fasten to module chassis using 2-M3 x 6mm socket head screws.

11.4.23 Removing/Replacing the Lower Optic Block

To Remove the Lower Optic Block:

1 Turn the unit over and remove the 4-M3 x 20mm socket head caps screws and M3 lock washers that secure the fiber optic bundle to the lower block. Set aside the reference diode O-ring for reassembly (Figure 11-38).

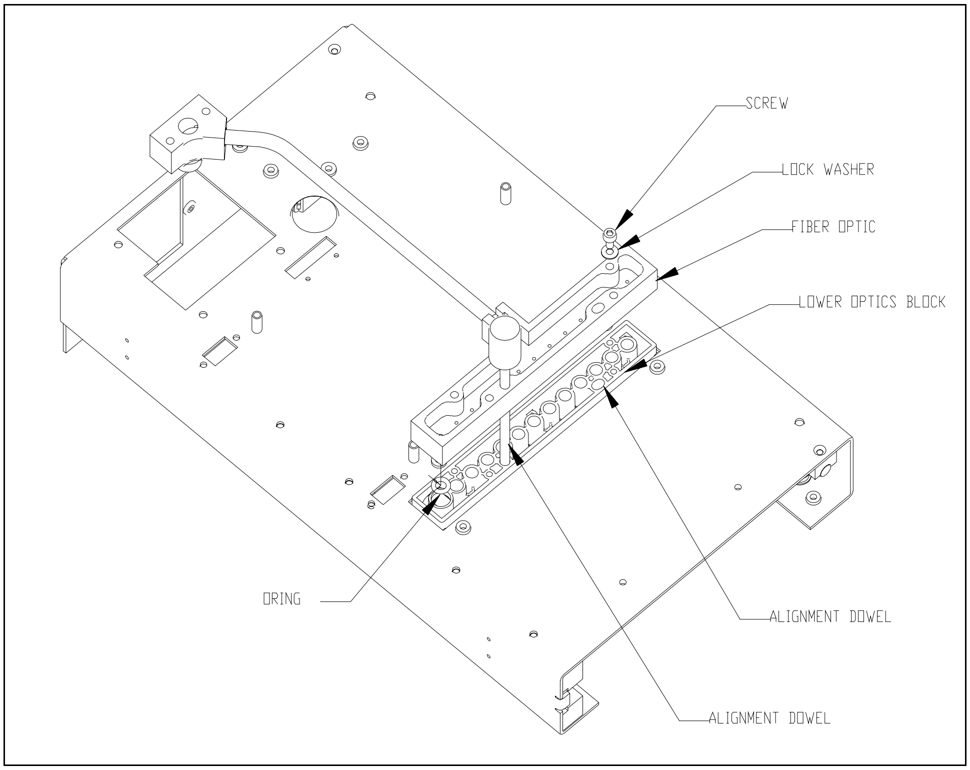


Figure 11-38 Lower Optic Block

2 Remove the lower optic block by unscrewing the 4-M3 x 6mm socket head screws and M3 lock washers (Figure 11-39).

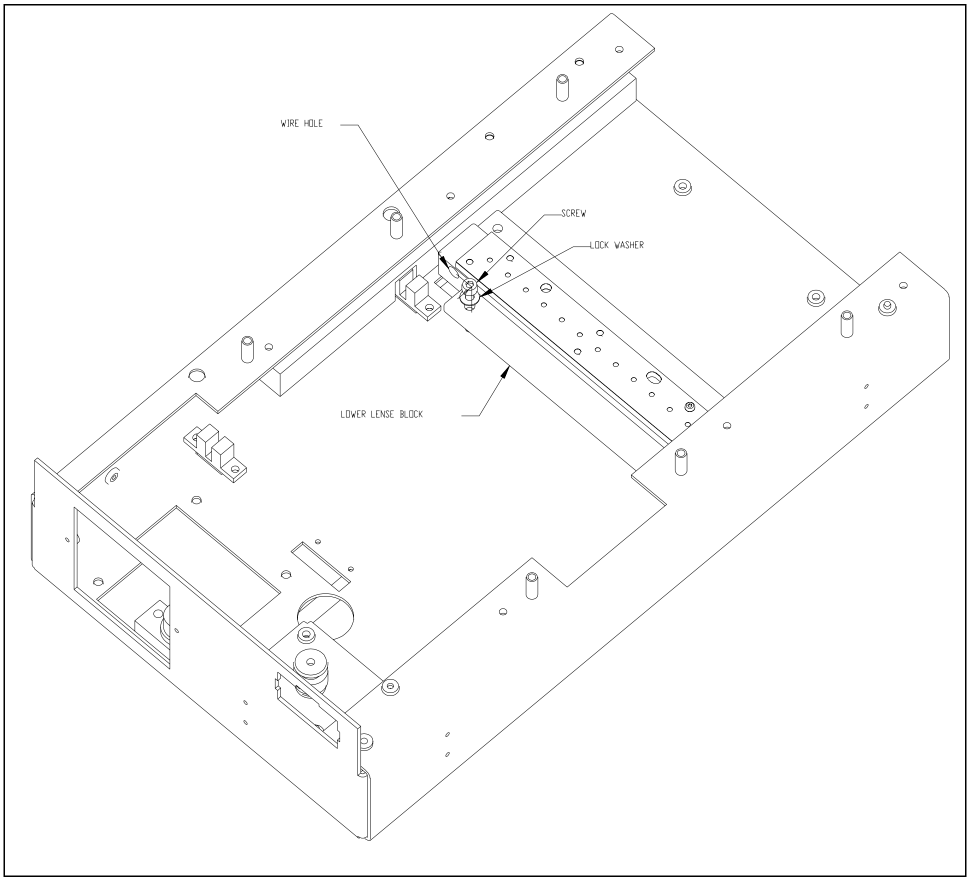


Figure 11-39 Removing Lower Optic Block

11.4.24 Separating the Lower Block Components

To Separate the Lower Block Components:

1 Unscrew the 6-M2 x 8mm button head screws holding the assembly together, separate the various lens components (Figure 11-40).

> ***Note***: *Use care in handling or cleaning the plastic lens strip. It is very susceptible to scratches.*

2 Replace/Clean components as required.

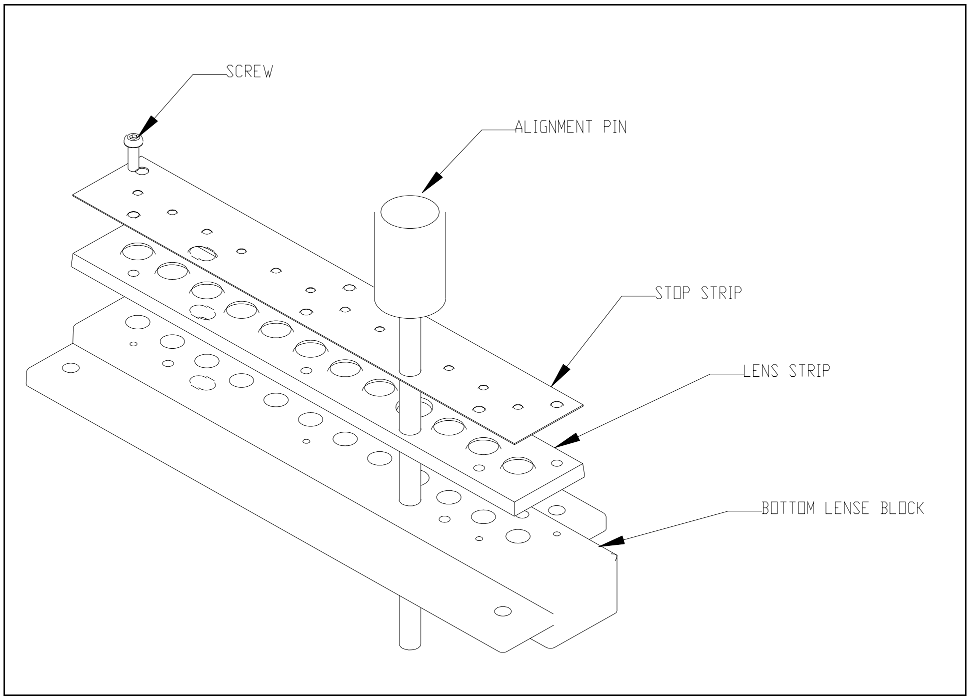


Figure 11-40 Optical Block Components

11.4.25 Rebuilding the Lower Optic Block

To Rebuild the Lower Optical Block:

1 Place the lower lens strip on the lower optics block.

2 Place the lower lens stop on top of the lens strip. Align all the parts by inserting an AMFIX004 alignment dowel in the alignment hole and an AMFIX004 alignment dowel in the alignment slot (Figure 11-41).

3 Fasten the assembly together using 6 M2 x 8mm button head screws.

4 Route the wires for the reference photodiode in the lower optics block (Figure 11-41).

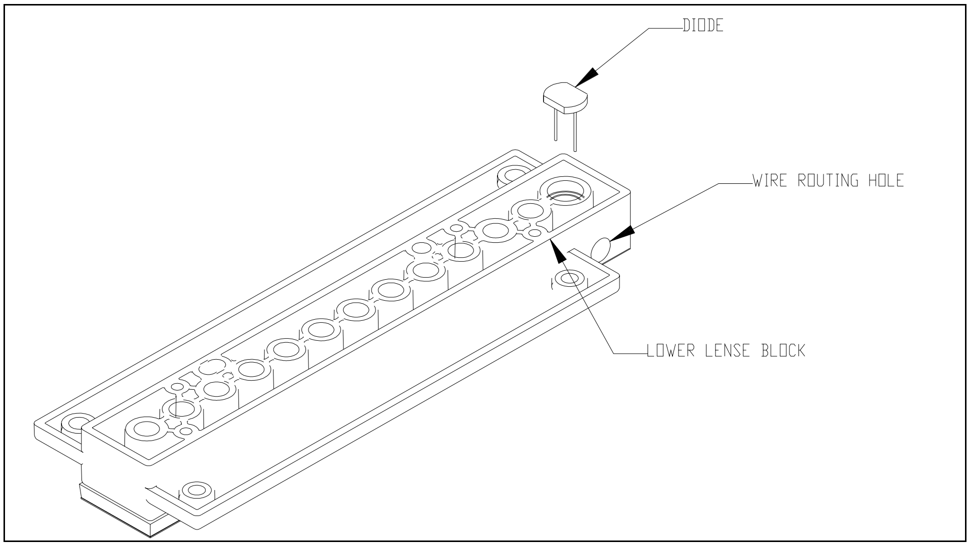


Figure 11-41 Rewiring Block

5 Loosely mount the lower optic block assembly in the chassis using four M3 x 6mm screws and M3 lock Washers (Figure 11-42).

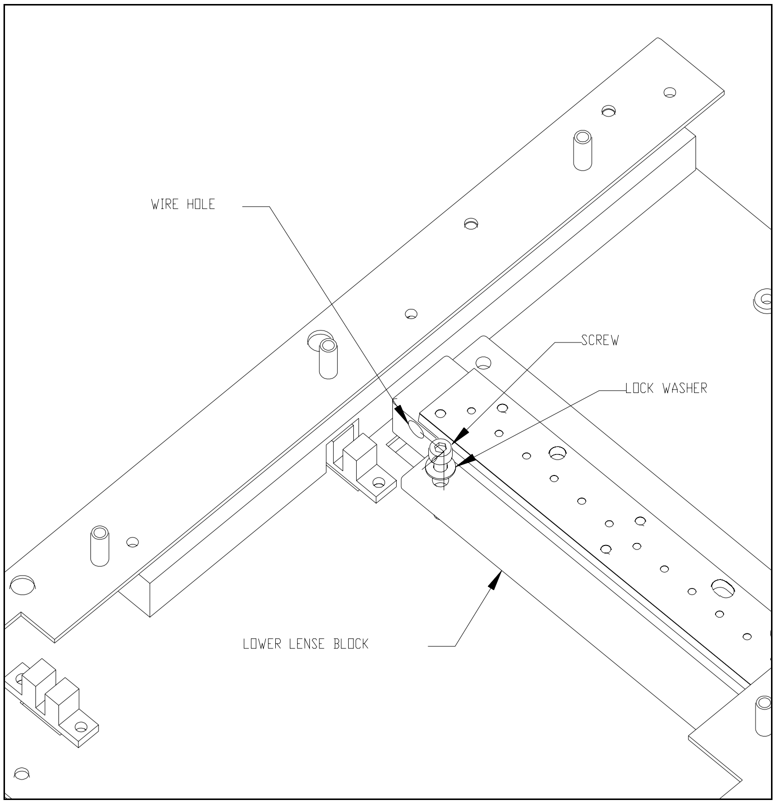


Figure 11-42 Mounting Lower Optics Assembly

6 Turn the unit over and place an o-ring on top of the reference diode.

7 Place the fiber optic assembly on top of the lens block.

8 Insert 4mm alignment pins (AMFIX004) into the alignment holes. Fasten the block with four M3 x 20mm socket head caps screws and M3 lock washers (Figure 11-43).

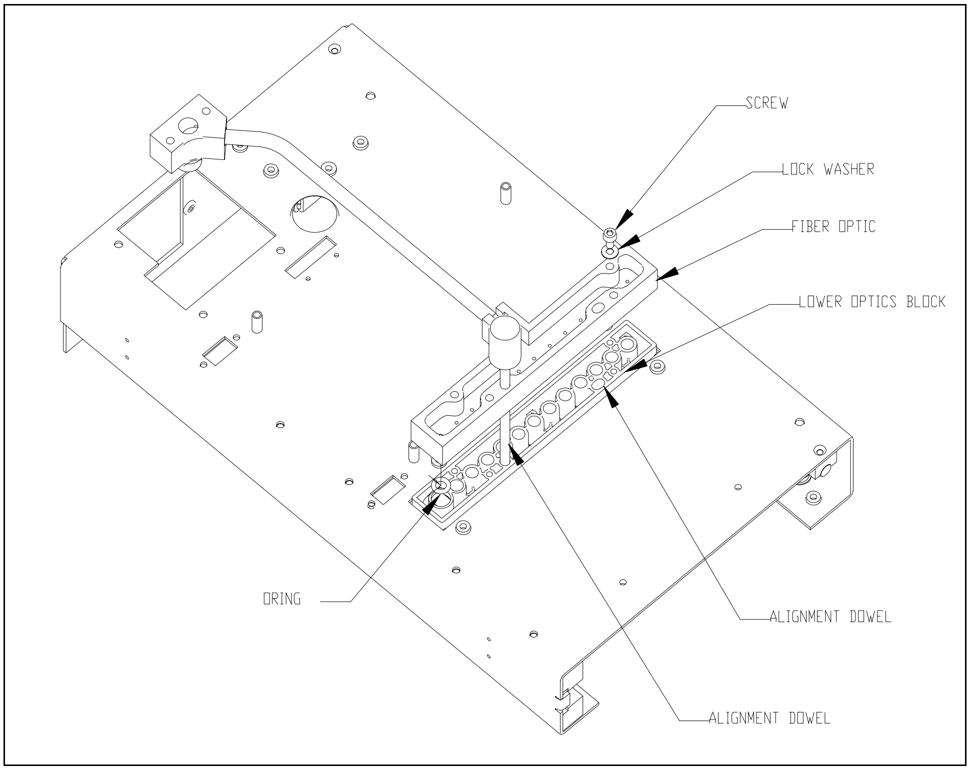


Figure 11-43 Alignment of the Lens Assembly

9 Place the optics alignment jig (AMFIX003) into the plate carrier.

10 Insert the M4 alignment pins (AMFIX004) through the upper optics, the jig and the bottom optics.

11 Tighten the two screws on the top optics. Tighten the screws on the bottom optics. Remove the jigs and tighten the remaining screws.

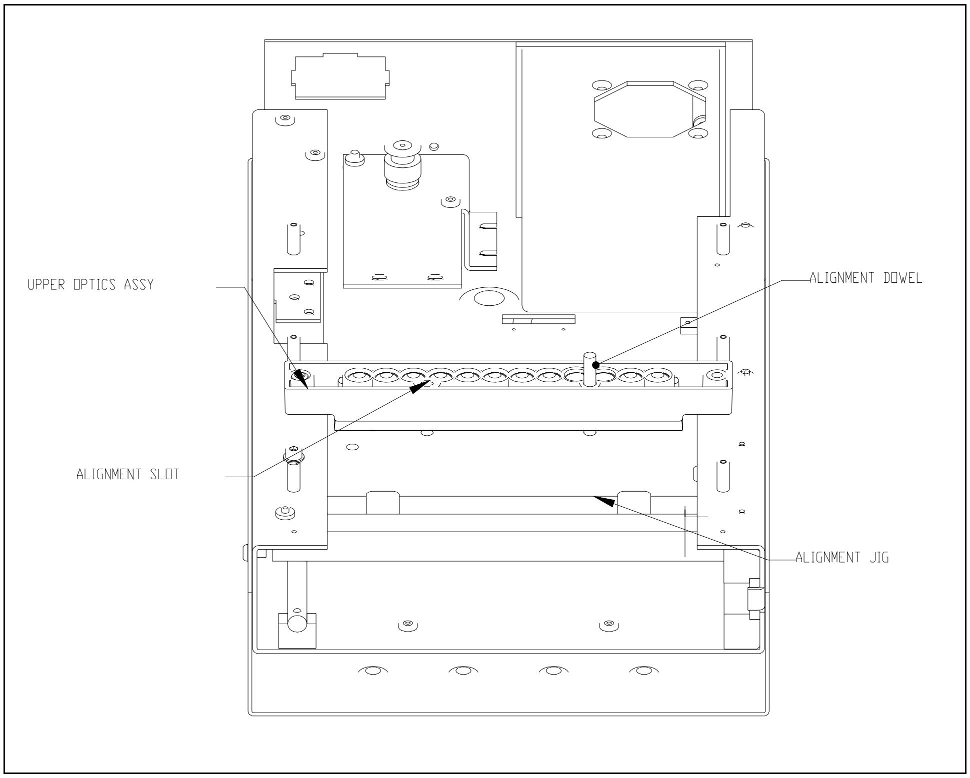


Figure 11-44 Alignment of Upper Optic Assembly

11.5 Spare Parts

Description	Part Number
Optics Cube	13001010
AM module	13001020
AM Module Main board	14000290
Reference Photodiode	15000390
Drawer Connector (Module Board)	15000400
Home Sensor	15000420
Front Sensor	15000430
Filter Motor Assembly	15000450
Upper Lens Stop	22000740
Lower Lens Stop	22000750
Motor mount	22000760
Lamp access door	22000770
Module bottom cover	22000970
Belt mount	22000790
Module top cover	22000800
Nut Plate	22000830
Lens Bracket	22000840
Plate Carrier	23001350
Wear Pads	23001180
Filter Wheel	23001190
Lens Retaining Ring	23001200
Lower Gravity Block	23001220
Upper Gravity Block	23001370
Idler Shaft	23001240
Bearing Shaft Support Blocks	23001250
Bearing Shaft	23001260
Fiber Optic Assembly	24500550
Module Front Bezel	24500590
Plate Carrier Door	24500600
Upper Optics Block	24500610
Lower Optics Block	24500620
M2.5 x 12mm Flathead screws	30100080
M2 x 6mm socket head cap screws	30200040

Description	Part Number
M3 x 20mm socket head caps screws	30200070
M3 x 10mm socket head cap screws	30200200
M2.5 x 12 screws	30200220
M3 x 22mm socket head cap screws	30200230
M3 x 25mm flat head screws	30200240
M2 x 10mm screws	30200250
M2 x 4mm button head screws	30500010
M2 x 8mm button head screws	30500020
M3 fender washer	32000060
M3 flat washers	32000060
M2 washers	32000070
Narrow Idler Bearing	40000080
Wide Idler Bearing	40000090
Belt material	40000100
Pulley assembly	40000110
Lower Lens Strip	41000090
Upper Lens Strip	41000090
Heat Absorbing Filter	41000110
Lens	41000120
405nm Filter	41500405
Spring Pins (Door) M3 x 32mm	42000240
Torsion Springs	42000250
Fiber Optic O-ring	44000050
O-ring (lens bracket)	44000060
Lamp	50200410
Fan Connector	50400563
Lamp Connector	50400582
Terminal Crimps (Lamp Connector)	50400583
Lamp Holder	50400590
Filter Switch	50700090
Fan	50800110
Plate Carrier Motor	15000440
Plate Carrier Bearing	6273040002
M3 x 6mm socket head cap screws	6511300065
M3 nuts	6513130021

Description	Part Number
M3 flat washers	6514130011
M3 lock washers	6514230051
M3 x 6mm button head screws	65117300065
M3 x 8 socket head cap screws	65117300085

11.6 AM Module Jigs and Fixtures

Description	Part Number
Pulley Spacer Jig	AMFIX002
Alignment Plate	AMFIX003
Alignment Pin	AMFIX004
Filter Wheel Jig	AMFIX005
Filter Switch Adjustment Jig	AMFIX006
Needle Nose Pliers	42000270

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Chapter 12 The Washer Module

12.1 Overview

The Washer Module is a microprocessor controlled microplate washer that performs wash protocols that are defined in the assay. The unit is designed to be used with microplates for any standard microplate reader and washes all 8 wells in a column of a 96-well plate, then moves the wash head to the next column.

Different user-defined wash protocols can be performed via the washer. In addition, the system can be configured with various plate types so that the wash head position for each plate type can be specified. The system can accommodate flat-bottom, C-bottom, U-bottom and V-bottom microplates.

The wash head on the washer module contains two sets of wash pins that are fixed to the wash head. The shorter pins (the dispense pins) dispense fluid and the longer pins (the aspirate pins) aspirate fluid.

During operation the wash head assembly can be moved in the X or Z direction to properly position the wash head assembly. As examples, the wash head is lowered to insert the wash pins into the wells or raised to remove the wash pins from the wells. Lowering the wash head assembly allows the well contents to be aspirated or a bottom wash to be performed. Raising the wash head allows it to be moved to another column for washing or filling.

Detailed discussion on troubleshooting and service of the Washer Module is presented in Chapter 13.

12.2 The Wash Delivery System and Waste Delivery System

The Wash Delivery System includes four plastic bottles, which contains the wash solutions. A submersible pump, operated under computer control is located in each bottle. The wash solution is delivered through the Dispense Valve to the wash head that delivers it to the microplate.

The Waste Solution System includes an aspirate pump to aspirate the wash solution from the microplate via the wash head and deliver it to the waste container. The waste container includes a level sensor to detect when it is full and terminate operation of the washer.

The service engineer is expected to replace the washer module in the event of a problem with the module. The defective module should be returned to the local DYNEX Technologies service center for repair (in some situations, the service engineer may be able to repair the module on site). A discussion of a variety of replacement/repair activities is presented in Section 13.3 through Section 3.

All activities of the Washer Module are performed under the direct control of the program that is being executed by the application program.

12.3 The Drive Assemblies

***Note**: For the sake of brevity, only the X-Drive assembly is described in this section. The general mode of operation of the Y-Drive and Z-Drive assemblies is similar to that of the X-Drive, but the position and configuration is different. For additional information, see Chapter 13.*

The X-Drive Assembly, shown in Figure 12-1 through Figure 12-3, includes a stepper motor that is mounted on a carriage that travels along the X-Shaft Assembly between the two side plates of the Drive Assembly. The X-Drive timing belt is used to drive the assembly and is installed between the X-Drive Motor and an idler bearing (Figure 12-3).

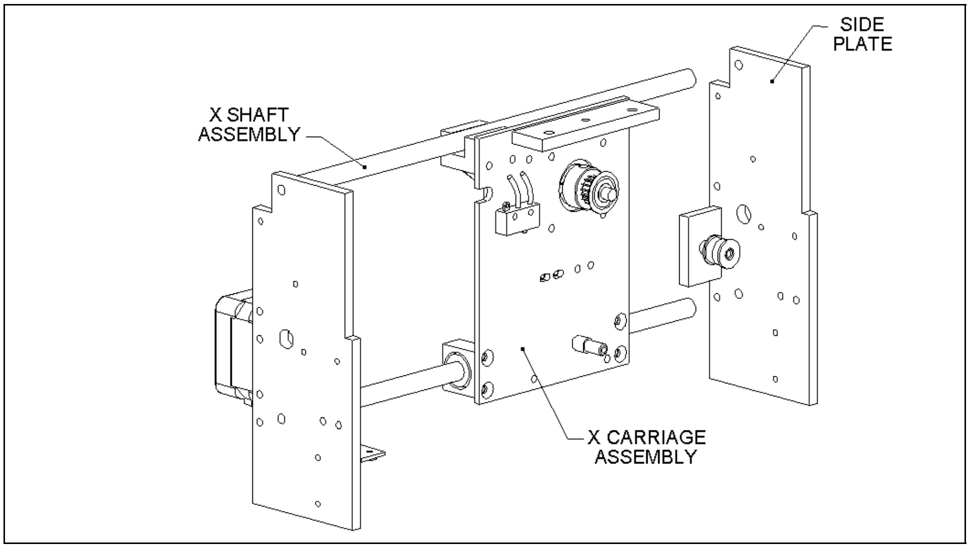

Figure 12-1 X-Drive Assembly

A microswitch is installed on the left side panel of the drive assembly (Figure 12-2) to detect if the X-Drive Assembly has reached its home.

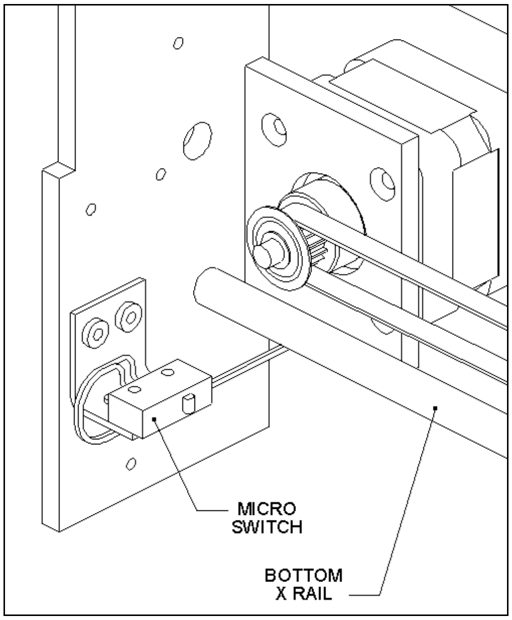

Figure 12-2 X-Motor Mounting Detail

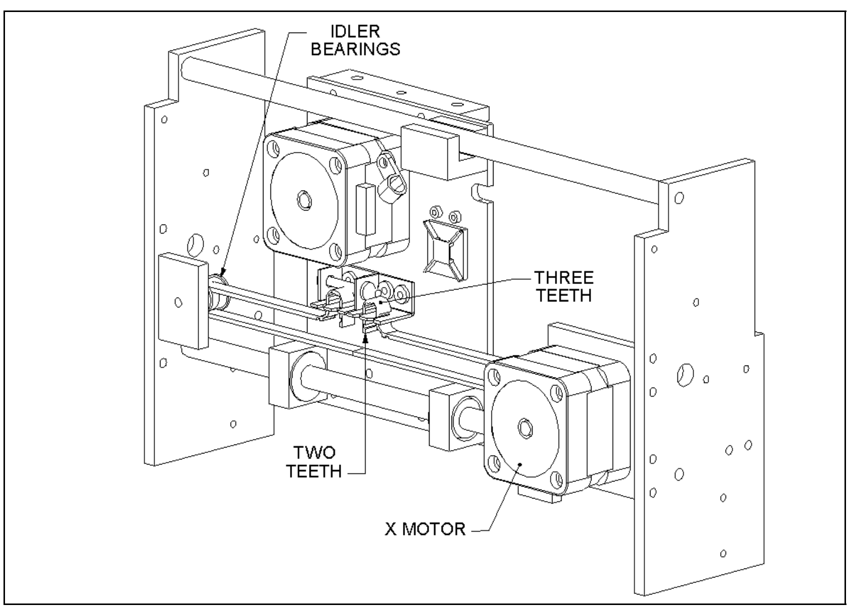

Figure 12-3 X-Drive Belt

12.4 Basic Operations of the Plate Washer

This section describes basic operations that occur when the plate washing activities are performed. The various processes are selected as part of an assay via the application program described in the operator's manual. As an alternative, these steps can be performed on a manual basis as described in Section 5.2.6.

The basic operations of the Microplate Washer include:

- Initialization
- Purge
- Dispense
- Aspirate
- Soak
- Fill
- Bottom Wash
- Sweep
- Move to Strips
- Terminate
- Clean

12.4.1 Initialization

Initialization occurs at the beginning of a protocol and involves the powering up of the Aspirate Pump as well as homing of the X, Y and Z motors.

12.4.2 Purge

The Purge step is used to dispense wash fluid to the Dispense wash pins to remove any air bubbles that may be in the pins. This step is usually performed at the start of a wash protocol and when the washhead is positioned over the purge tray.

Table 12-1 The Purge Step

Step	Operation
1	Move the wash head back to the X home position (over the purge tray)
2	Run the dispense pump to deliver the required volume at the “Purge Pump Pressure” speed
3	Move the wash head to the pre-defined purge height
4	Wait 1 second
5	Energize the dispense valve for the required duration
6	Wait 1 second
7	Move the wash head back up to the home position height

12.4.3 Dispense

The Dispense step is used to deliver the indicated volume of wash fluid (range 50-999 µL) into the wells and then aspirate the wash solution from the wells. If a bottom wash is desired, the Wash Head is lowered to the bottom wash position so that the fluid will be aspirated from the bottom of the wells while the fluid is being dispensed. The dispense height for a particular plate is specified during system configuration. When the Dispense operation is called, the steps indicated in Table 12-2 are performed:

Table 12-2 The Dispense Step

Step	Operation
1	Check that the Waste Bottle is not full and that the vacuum pump is functioning
2	Run the Dispense Pump to deliver the required volume of fluid
3	Perform 1 aspirate step
4	If Bottom Wash is required, move the Wash Head to the appropriate position
5	Move the Wash Head back up to the Dispense height
6	Energize the Dispense valve for the required duration
7	Move the Wash Head back up to the home position height

Dispense and Aspiration steps can be combined, but an aspiration step is not always a part of a dispense step.

12.4.4 Aspirate

The Aspirate step is used to remove the contents of the wells in the indicated row (column). During this step the wash pins are positioned at the aspiration height and the aspiration pump will withdraw fluid for the indicated time. The aspirate height for a particular plate type is specified during system configuration. If desired, the wash pins can be moved back and forth during an aspiration cycle via the Sweep option (Section 12.4.8). When this operation is called, the steps indicated in Table 12-3 are performed:

Table 12-3 The Aspirate Step

Step	***Operation***
1	If this is the first cycle, set the Z motor ramp to a slower speed
2	Move the wash head down to the required aspirate height
3	If this is the first cycle, set the Z motor ramp back to the normal speed
4	If Sweep is required, perform a sweep, otherwise wait 1 second
5	Repeat for the required number of cycles
6	Move the Wash Head back up to the home position height if this Aspirate command is not part of a Wash command

12.4.5 Soak

The Soak step is used to allow the wash fluid to remain in the wells after the Dispense step (range 1-999 sec). A Soak step can be performed as part of a Move cycle or as an independent step. When this operation is called, the steps indicated in Table 12-4 are performed:

Table 12-4 The Soak Step

Step	**Operation**
1	Wait for the required number of seconds

12.4.6 Fill

The Fill step is used to deliver wash fluid to the wells in the row (column). When this operation is called, the steps indicated in Table 12-5 are performed.

Table 12-5 The Fill Step

Step	Operation
1	Move the Wash Head back up to the dispense height
2	Run the Dispense Pump for required fluid at the required pump speed
3	Energise the Dispense valve for the required duration
4	Move the wash head back up to the home position height

12.4.7 Bottom Wash

The Bottom Wash operation is used if it is desired to wash the very bottom of the wells. This operation is an optional step that can be incorporated into the Dispense operation. When this operation is called, the steps indicated in Table 12-6 are performed.

Table 12-6 The Bottom Wash Operation

Step	Operation
1	Move the Wash Head down to the bottom wash height
2	Energise the Dispense Valve for the required duration
3	Move the Wash Head back up to the aspirate height
4	Repeat for the required number of cycles

12.4.8 Sweep

The Sweep operation is used to move the Wash Head slightly in the x direction to allow for more effective washing. This operation is optional and can be incorporated into the Aspirate step. When this operation is called, the steps indicated in Table 12-7 are performed.

Table 12-7 The Sweep Operation

Step	Operation
1	*Wait for 0.1 seconds*
2	*Set the X motor ramp to the sweep speed*
3	*Lift the Wash Head up to the Sweep height*
4	*Move the Wash Head to the left side of the well by half the X sweep steps*
5	*Lower the Wash Head down to the Aspirate height*
6	*Wait for 0.2 seconds*
7	*Lift the Wash Head up to the Sweep height*
8	*Move the Wash Head to the right side of the well by the X sweep steps*
9	*Lower the Wash Head down to the Aspirate height*
10	*Wait for 0.2 seconds*
11	*Lift the Wash Head up to the Sweep height*
12	*Move the Wash Head back to the middle of the well*
13	*Lower the Wash Head down to the Aspirate height*
14	*Set the X motor ramp to the normal speed*

12.4.9 Move to Strips

The Move to Strips operation is used to set the Wash head to the first row (column) of the microplate to be washed. This operation is performed when a protocol is initiated, and the steps indicated in Table 12-8 are performed.

Table 12-8 The Move to Strips Operation

Step	Operation
1	*Evaluate where the starting strip is*
2	*Move the Wash head to the starting strip.*

12.4.10 Terminate

The Terminate operation is executed after the last programmed operation. The steps indicated in Table 12-9 are performed.

Table 12-9 Terminate

Step	Operation
1	*Move the Wash Head back to the X home position (over the Purge tray).*
2	*Stop the Dispense pump*
3	*Stop the Aspirate pump*

12.4.11 Clean

The Clean operation is used to deliver wash solution to the head at a user-specified interval to remove the present wash fluid from the line and refresh the fluid. During this operation, the head is positioned over the purge tray. If necessary, the operation may re-prime the head. When this operation is called, the steps indicated in Table 12-10 are performed.

Table 12-10 The Clean Operation

Step	*Operation*
1	*Move Wash head back to Purge Tray*
2	*Run the Dispense Pump for required fluid at the required Pump speed*
3	*Move the Wash Head down to the Aspirate height*
4	*Energise the Dispense Valve for the required duration*
5	*If required to re-prime the Wash Head, run the dispense pump for the required re-prime fluid at the required Pump speed*
6	*If re-priming the Wash Head, energize the Dispense Valve for the required duration*
7	*Raise the Wash Head back to the home position*

***Note**: This operation is not designed to clean the wash head. If particulate matter has been deposited in the Aspirate or Dispense tips they should be removed with cleaning wire.*

12.5 Control of the Washer Module

12.5.1 Block Diagrams

This section is provided to describe the interaction of the Washer Module Electronics to control all of the internal functions and the operation of various sensors. The service engineer should note that the typical response to an electronic problem is module level or board level replacement. For this reason, this discussion (and other discussions of electronic problems) will be aimed at providing a good understanding of the general control of the system, rather than a detailed discussion of each circuit or component.

Figure 12-4 through Figure 12-6 present a series of block diagrams that describe the communication between the various components of the system.

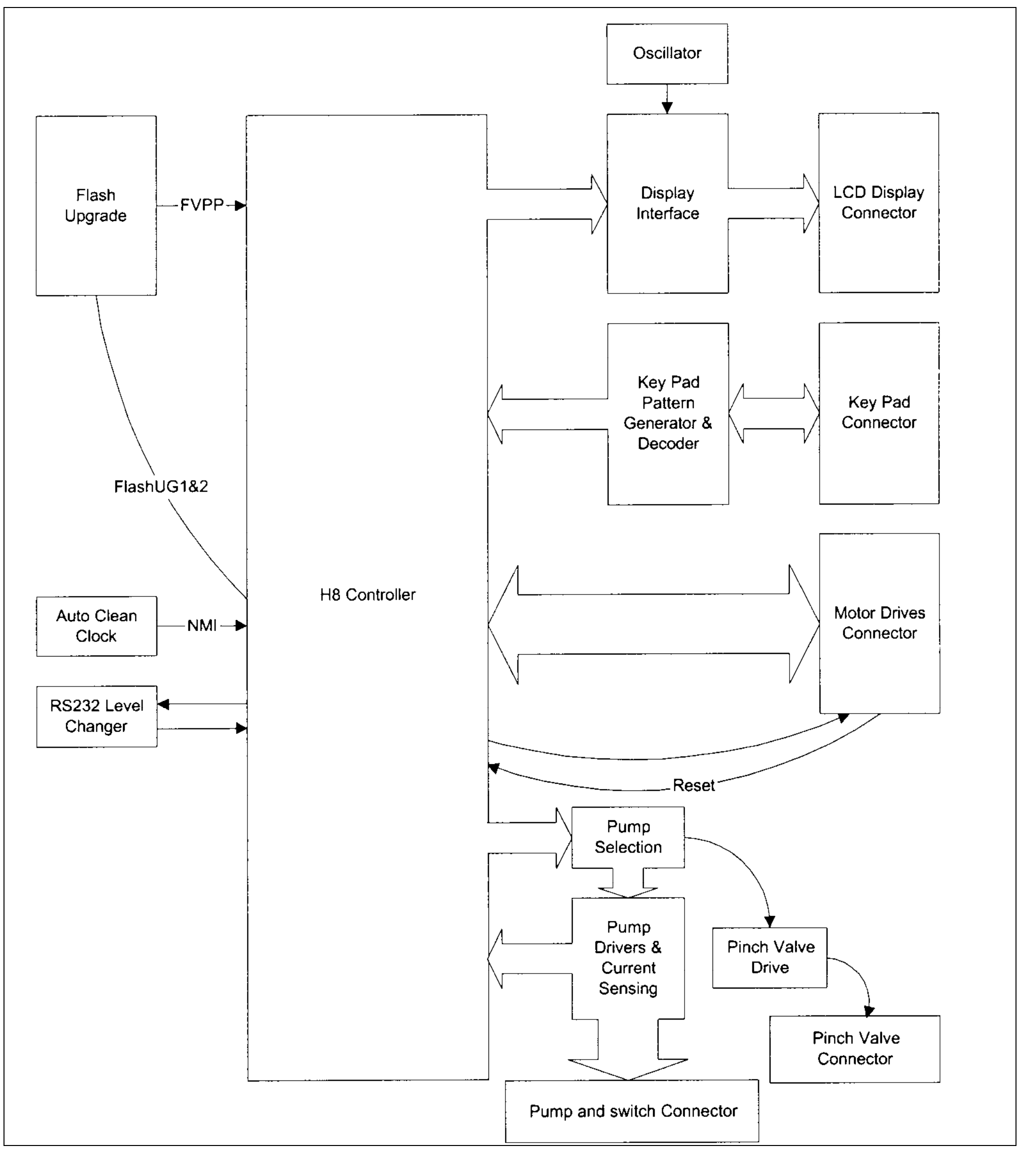

Figure 12-4 Washer Control

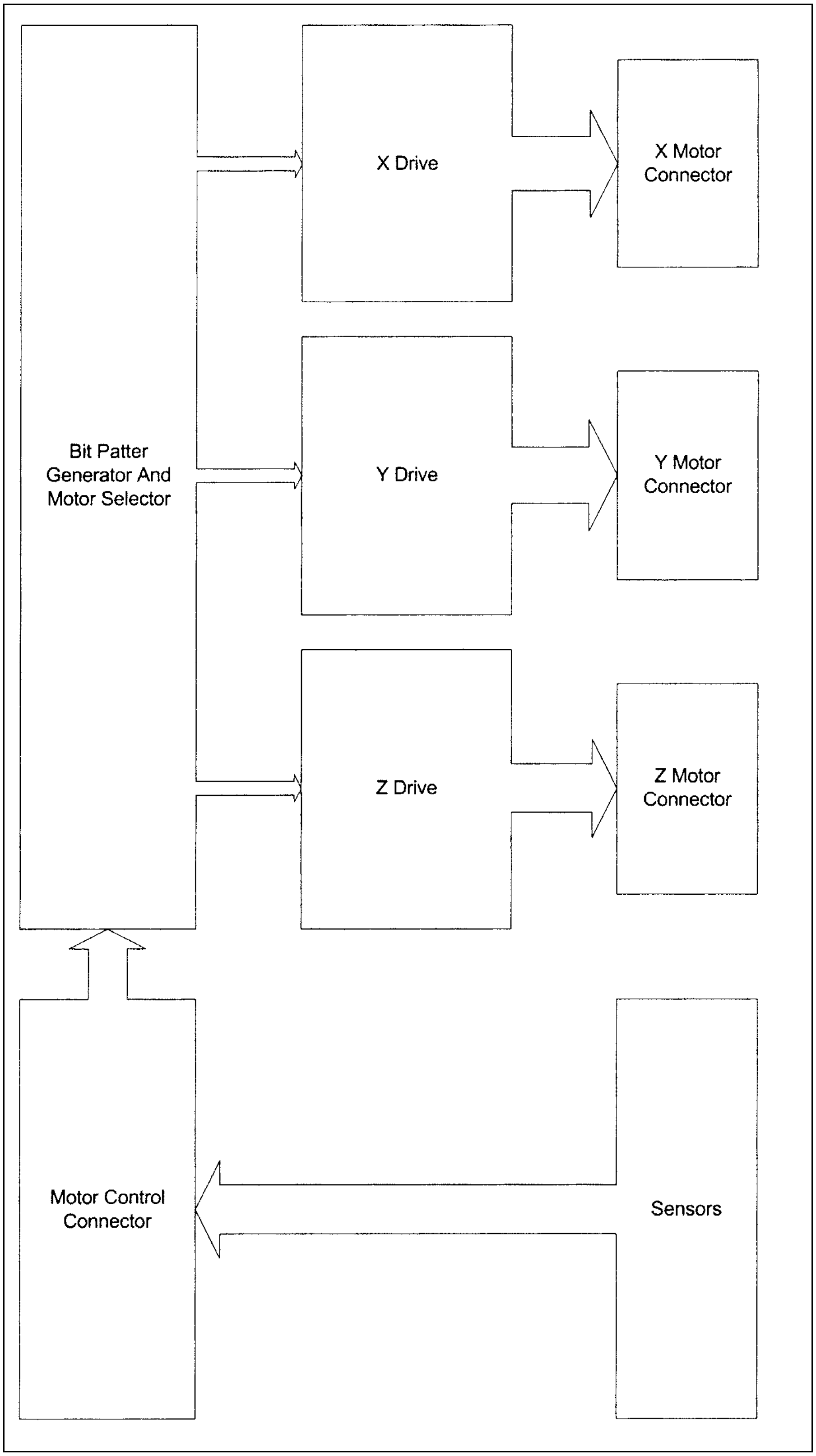

Figure 12-5 Motor Drives

12.5.2 Components of the Washer Module Electronics

The following components provide the control of the washer:

MICROPROCESSOR –

Overall operation of the module is based on the Hitachi H8/3337F single-chip microcomputer. This microcomputer provides 60Kbytes of Flash ROM and 2Kbytes of RAM. The XTAL operating frequency is 16 MHz.

The H8/3337F has the following internal peripheral capabilities:

- [2] 9 ports, providing 58 I/O and 8 Input lines
- Two 8-bit timers (TMR0, TMR1)
- One 16-bit free-running counter (FRC)
- Two digital to analog channels (DA0, DA1), with 8-bit resolution
- Eight analog to digital channels (AN0 through AN7), with 10-bit resolution
- Two serial communications channels (COM0, COM1)
- Two pulse width modulation channels (PWM0, PWM1)

ANALOG/DIGITAL CONVERTER

The analog to digital converter is used to check the state of the waste switch (basically a digital signal), to sense the current through the four dispense current and to check the state of the vacuum switch (a digital signal).

SERIAL COMMUNICATION

Is used to communicate with the controlling computer system. Commands and test data are transferred between the H8 and the external PC controller via a serial RS-232 interface. Interface drivers and receivers are used between the COM1 serial communications channel on the H8 and the interface connector to provide proper RS-232 signal levels to the controller.

BIT PATTERN GENERATOR AND MOTOR SELECTOR

This is a MACH211 device, which is programmed to:

- Produce the bit patterns required for quarter stepping for each of the three motors.
- Enable the Y or the Z motor to be driven independently or simultaneously with the X motor.
- Enable Y and Z motors to be driven simultaneously but independently only in direction
- Enable the X motor to be driven independently of the other two

Each motor requires Direction and Reset. The X motor has its own dedicated clock while the Y and Z each share the SHARED CLOCK.

Using YZ CLK the SHARED CLOCK can be switched from Y (Logic 0) to Z (Logic 1).

If TWO CLK is set to a logic 1 then both Y and Z motors are pulsed with the SHARED CLOCK this condition over-rides the SHARED CLOCK.

MOTOR DRIVERS

The three motor drivers are identical, using the A2919, and are all set for 0.5 Amps peak current. Using the above Bit pattern generator the motors are driven in quarter steps (1/4).

PUMP SELECTION, DRIVES AND CURRENT MONITORING

Pump speed is controlled by regulation of the mean dc current to the motor. That regulation is via the PWM outputs of the H8 controller. The frequency of the PWM is set and the on period of the cycle is adjusted to produce the duty cycle required for the pump output necessary. This frequency is determined by test and is preset for each motor.

The PWM output for the dispense pumps is gated to one of four pumps, using DP1-DP4 to enable the required dispense pump. These signals also enable the required pinch valve.

All four dispense pump drives are identical. The current is switched via a FET employing low side switching. The return current passes through a one-ohm resistor; the resulting voltage drop is integrated, amplified and then passed to the analogue inputs of the H8 controller. The voltage read is proportional to the actual current drawn by the motor.

The actual current drawn is proportional to the PWM duty cycle, the frequency (fixed) and the load on the motor. The current will increase if the motor is stalled and it will decrease from the norm if the motor is running with a light load (i.e. not pumping fluid). The controller, and corrective action taken can detect any large difference from the norm.

CAUTION

CAUTION*:* AT LOW NOMINAL CURRENTS (LOW PWM PERIOD) THERE MAY BE NO (OR UNDETECTABLY LOW) DIFFERENCES BETWEEN THE CURRENT LEVELS IN THE DIFFERENT STATES.

VOLTAGE GENERATION AND REGULATION

The Vcc is derived from +12 volts via a linear regulator LM7085CT fitted with a 17°C/Watt heatsink.

12.6 Printed Circuit Boards

12.6.1 Main Board

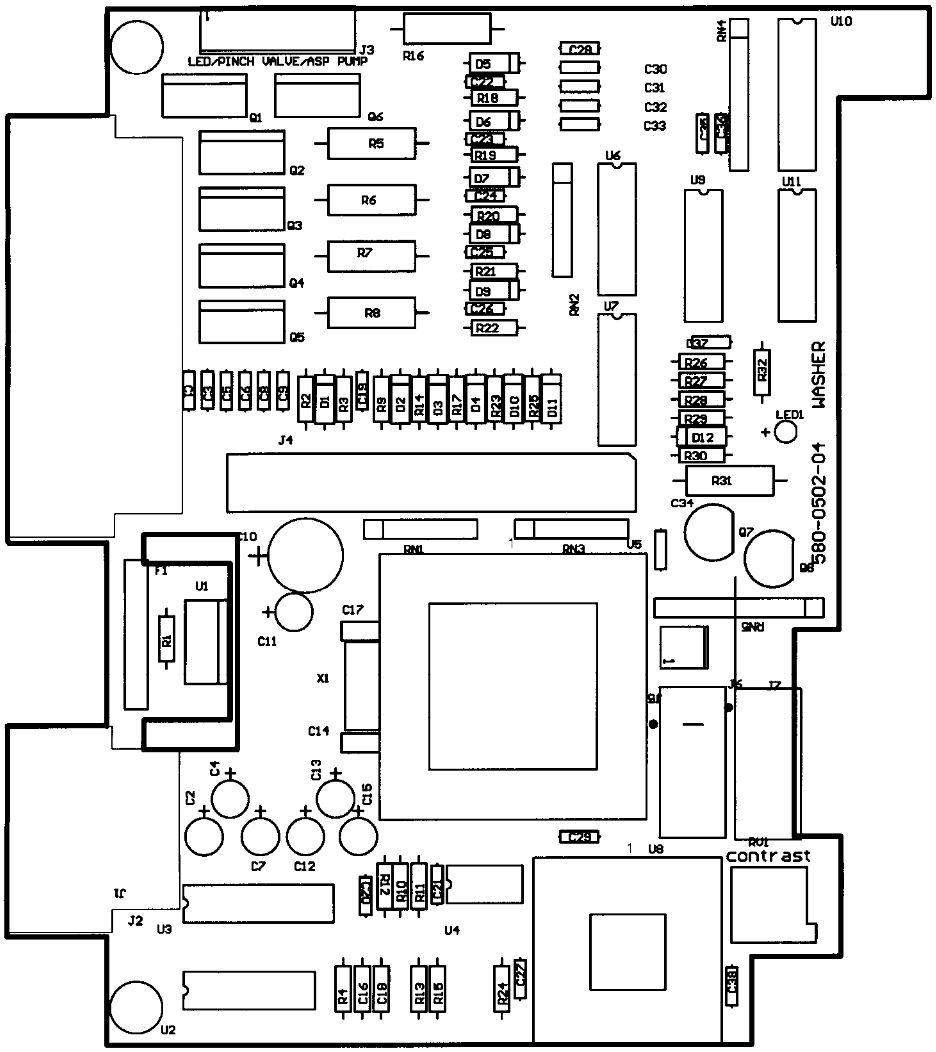

Figure 12-6 Main Board

12.6.2 Daughter Board

The Daughter Board (Figure 12-7) controls the motor drives and communicates with the microswitches.

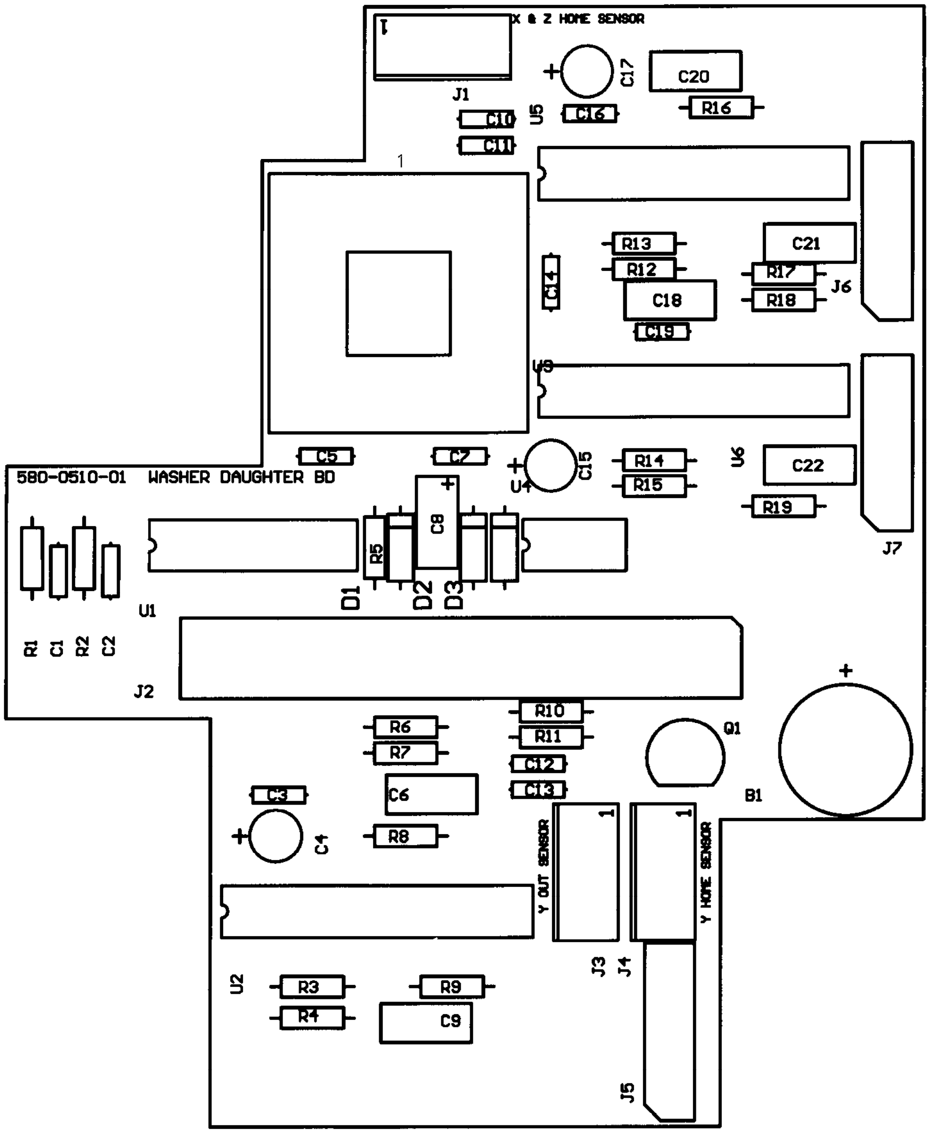

Figure 12-7 Daughter Board

This section intentionally left blank.

Chapter 13 Replacing Washer Module Components

13.1 Overview

> ***Note**: For the purposes of this manual, the washer module is defined to include all items that are involved with the washing of the microplate. This includes certain components that are physically external to the washer module, such as the dispense bottles or the aspirate pump.*

The Service Engineer is expected to be able to replace the pump and related components of the Dispense fluid system, the float valve in the waste bottle, and other items described in section on Troubleshooting.

If the Washer Module is defective (other than the replaceable items described in the Troubleshooting section), the normal service mode is to remove the module and replace it with a new one. When the module is replaced, the plate pick-up coordinates must be verified and the dispense pumps must be calibrated.

13.2 Troubleshooting

While the Washer Module is a service replaceable item, many problems can be easily solved by the service engineer (e.g. defective dispense tubing).

For internal components (e.g. the circuit boards, motors, etc.), module replacement is the standard response and the defective washer module should be sent to the nearest service center (these items are indicated below as “Module Replacement”). Replacement of these items should be performed only on an as needed basis if replacement of the module is not possible and the service engineer has the appropriate components on hand. After the module has been repaired or replaced, use the alignment plate to ensure that the module is properly aligned.

> ***Note**: Replacement of the main pcb requires DynexTest software for calibration as a stand-alone module prior to being installed into the DSX.*

Symptom	Probable Cause	Resolution
The module does not operate	The module is not properly seated in the system	Remove the module and re-install
	The waste container is full	Empty the waste container
	The waste level sensor cable is not plugged in	Connect the waste level sensor cable
	The waste level sensor connector is defective	Replace the sensor Assembly (refer to the section entitled Waste Bottle Assembly on page 13-11).
	Main Board is Defective	Replace the Main Board (refer to the section entitled *Replacing the Printed Circuit Board Assembly* on page 13-20).
Dispense problems	The dispense tubing is sealed shut at the Dispense Valve	Remove the tubing from the Dispense Valve and massage the tubing to re open it. Replace the tubing into the Dispense Valve at a different location. Purge the tubing more frequently Replace the tubing.
	The wash head manifold tubing is blocked.	Remove the Wash Head assembly and clean it using the manifold head cleaning wire. Then run a purge.
	There is a pressure leak	Check the seals and tubing for leaks. Check for air leaks. Reseat the tubing in the Dispense Valve.
	The Dispense Pump is faulty	Replace the pump (refer to the section entitled *Dispense Bottle Assembly* on page 13-7).
	The pump fuse is broken	Replace pump fuse.
	The waste container is full	Empty the waste container.
	The waste level sensor cable is not plugged in	Connect the waste level sensor cable.

Symptom	Probable Cause	Resolution
Dispense problems (Cont'd)	The waste level sensor connector is defective	Replace the sensor assembly.
Aspirate pump does not operate	Defective pump	Replace the pump (refer to the section entitled *Replacing The Aspirate Pump Assembly* on page 13-13).
	Defective Main Board	Replace the Main Board (refer to the section entitled *Replacing the Printed Circuit Board Assembly* on page 13-20).
Aspiration is not complete.	The aspiration pins are clogged	Remove the Wash Head assembly and clean it using the manifold head cleaning wire.
	The aspiration pin height is set too high	Repeat the plate set-up procedure.
	The seal on the waste container is leaking	Check the seal and waste tubing for leaks.
	The wash protocol is not optimized	Add additional aspiration cycles to the wash protocol.
	Aspiration tubing may be blocked or kinked	Check the aspiration tubing and remove any blockages or kinks.
	The vacuum exhaust may be blocked	Remove any obstructions at the vacuum exhaust.
	The vacuum pump may be contaminated by overflow	Clean the vacuum pump.
	The wash head is not correctly positioned on the arm	Reposition the wash head on the arm so it is level with the plate bottom when inserted in the plate carrier.

Symptom	Probable Cause	Resolution
X, Y, Z position is incorrect	Incorrect type of plate indicated	Enter correct plate type
	Incorrect height parameters entered	Enter correct height parameters
	The dispense bottle is faulty	Replace the faulty dispense bottle
	The drive belt is slipping	Check the belt, motor mount and pulley mount. Replace the belt if necessary: X-Drive: See page 13-26 for the procedure. Y-Drive: See page 13-32 for the procedure. Z-Drive: See page 13-30 for the procedure.
	Dirty Bearings/Guide Rods	Clean the bearings. Replace the bearings if necessary:
	Microswitch is defective	Replace the microswitch (modular replacement) X-Drive - See page 13-27 for the procedure. Z-Drive – See page 13-31 for the procedure.
	The motor is defective	Replace the motor (Module Replacement) X-Drive - See page 13-24 for the procedure. Y-Drive - See page 13-36 for the procedure Z-Drive - See page 13-28 for the procedure
	Daughter Board is defective	Replace the Daughter Board (refer to the section entitled *Replacing the Printed Circuit Board Assembly* on page 13-20).
The waste container is deformed.	The waste tubing is blocked	Remove the waste tubing from the rear of the instrument. Check the waste tubing (and aspiration tubing) and remove any blockages or kinks.
	The waste container is damaged or defective	Replace the waste container

Symptom	Probable Cause	Resolution
Liquid is dispensed continuously from the dispense pins	The dispense tubing is not inserted in the dispense valve	Insert the dispense tubing into the dispense valve
	Faulty dispense valve	Replace the valve
Liquid is not dispensed from the dispense pins	Wash bottle is empty	Refill the wash bottle.
	The dispense pins are clogged	Remove the wash head assembly and clean it using the manifold head cleaning wire, then run a purge. If problem persists, examine composition of wash solution.
	The washheads are incorrectly defined	Check the system configuration and wash protocol.
	The dispense tubing or dispense pump power supply is not connected	Verify that dispense tubing or dispense pump power supply are connected.
	The dispense tubing is sealed shut at the dispense valve	Remove the tubing from the dispense valve and massage the tubing to release it. Replace the tubing into the dispense valve at a different location. Purge the tubing more often. Replace the tubing.
	The dispense valve is defective	Replace the valve.
	The dispense pump is faulty	Replace the dispense pump.
	The wash head manifold tubing is blocked	Remove the wash head and clean it using the manifold head cleaning wire and run a purge. If problem persists, examine composition of the wash solution.

Symptom	Probable Cause	Resolution
Liquid is not dispensed from the dispense pins (Cont'd)	There is a pressure leak	Check the seals and tubing for leaks
		Check for air leaks
		Reseat the tubing in the dispense valve
	Faulty Main Board	Replace the Main Board (refer to the section entitled *Replacing the Printed Circuit Board Assembly* on page 13-20).
The dispense valve does not open	The dispense valve is not connected properly	Check that the dispense bottle assembly is connected to the proper connector.
	Faulty Main Board	Replace the Main Board (refer to the section entitled *Replacing the Printed Circuit Board Assembly* on page 13-20).
Dispense volumes are incorrect or variable	The dispense pins are leaking	Check the pins, seals, and tubing for leaks.
	The dispense pressure is low	Check the seals and tubing for leaks.
		Check for air leaks.
		Reseat the tubing in the dispense valve.
	The dispense pins are clogged.	Remove the wash head assembly and clean it using the manifold head cleaning wire. Then run a purge. Select a wash fluid that does not contain particulate matter.
	The dispense pump requires calibration.	Calibrate the dispense pump using the Dynex Washer Calibration Software.

13.3 Replacing External Components

13.3.1 Dispense Bottle Assembly

The dispense bottle assembly includes a pump to deliver the fluid and a float to detect when the fluid supply is exhausted. The dispense bottle assembly is normally replaced as a unit. Instructions are also provided for replacing the dispense pump if needed.

To Replace the Dispense Bottle and Pump Assembly:

1. Remove the dispense bottle assembly (Figure 13-1) from the system.
2. Obtain the replacement dispense bottle assembly.
3. Place the replacement dispense bottle assembly on the system.
4. Calibrate the dispense pump using the Dynex Washer Calibration Software.

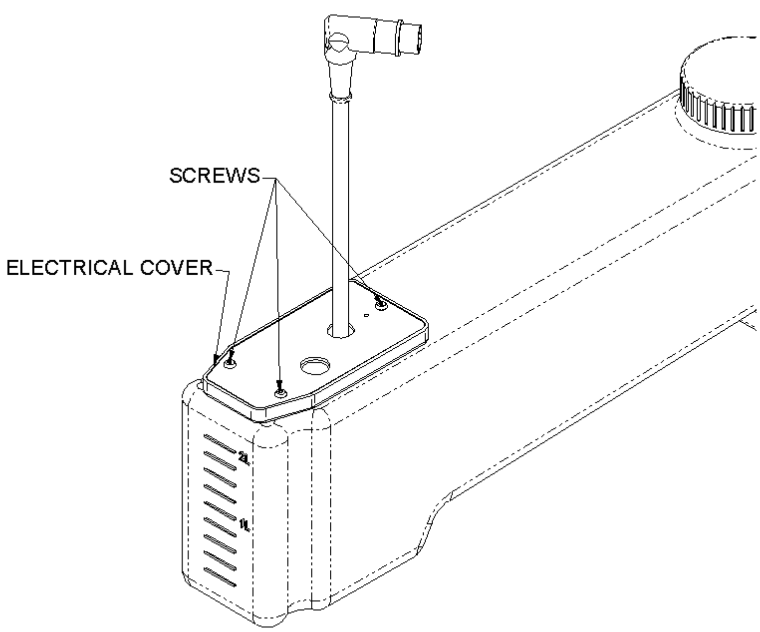

Figure 13-1 Dispense Bottle Assembly

To Replace the Dispense Pump Assembly:

1 Remove the dispense bottle assembly (Figure 13-1) from the system.

2 Remove the three screws (and accompanying washers) that secure the electrical cover to the dispense pump assembly (Figure 13-1).

3 Peel off the internal gasket that was located between the pump assembly and the electrical cover. The pump assembly mounting screws are now accessible (Figure 13-2).

> ***Note****: The mounting screws are sealed in place with silicone rubber cement (RTV). This must be removed using a spatula or similar tool.*

4 Remove the four mounting screws. Then lift the dispense pump assembly off the dispense bottle.

> ***Note****: When removing the pump assembly, the rectangular plate that secures the mounting screws may fall out of its position inside the dispense bottle. If necessary, keep the rectangular plate in position by inverting the bottle when replacing the pump assembly (see below).*

5 Obtain the replacement pump assembly. Holding the dispense bottle upside down so that the rectangular plate stays in position, secure the pump assembly to the dispense bottle using a 3 in.lb. torque driver.

6 Seal the mounting screws are sealed in place with silicone rubber cement (RTV). Then replace the internal gasket and electrical cover.

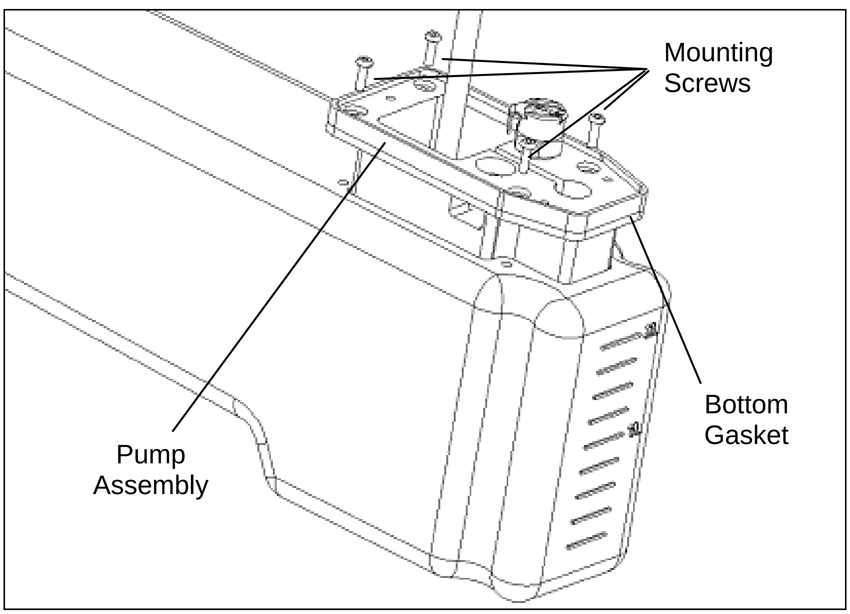

Figure 13-2 Dispense Pump Assembly

To Calibrate a Dispense Pump:

> ***Note**: The following materials are required to calibrate a pump:*
>
> - *Calibrated gravimetric balance with 0.01g resolution (minimum range:0.01 - 100.00g)*
> - *Deionized water or suitable wash buffer*
> - *Clean, flat bottom microplates for use in the Verification test*
> - *A plate-sized, low-sided vessel capable of containing approximately 50ml of fluid without spillage (microplate wells are too small to contain the volume of fluid used in the pump calibration).*

1 Load the Pump Calibration software.

2 Select the Pump letter.

3 Purge the washer until it is verified visually that no air bubbles are present in the fluid line between the dispense bottle and wash head.

4 Follow the instructions provided by the program. When *Perform First Dispense?* is displayed, answer **Yes**.

5 Follow the instructions provided by the program. When *Perform Second Dispense?* is displayed, answer **Yes**.

6 The program will indicate if the slope and intercept values are acceptable.

- The slope should be between 0 and 6.5 (typically this value will be in the range of 1.5 to 2.5).
- The intercept should be between 0 and 512 (typically this value will be in the range of 25 to 40).

7 If the calibration is acceptable, select **Yes** to write changes to EEPROM.

> ***Note**: After new slope/intercept values for any pump are saved to the EEPROM, the DSX must be powered off and back on to use those values before any additional testing is performed on that pump.*

To Verify Dispense Pump Calibration (Checking the Dispense Accuracy):

1 Select a Pump letter.

2 Purge the washer until it is visually verified that no air bubbles are present in the fluid line between the dispense bottle and wash head.

3 Follow protocol instructions.

4 The program prompts the user to weigh a clean and dry microtiter plate. After the washer dispenses liquid into the plate, the user is prompted to weigh the plate again. The software provides a pass or fail result for the verification.

> ***Note**: The Dispense Accuracy test protocol tests the dispense accuracy of the DSX washer module for a volume of 300 µL per well. To pass, the error must be less than or equal to **± 10%**.*

13.3.2 Waste Bottle Assembly

The Waste bottle Assembly includes a float that senses when the bottle is filled. When the bottle is full, the system is halted.

To Remove the Float:

1. Disconnect the float connector from the front extrusion.
2. Remove the Extension tube nut (Part No. 204030500) from the bottle and then remove the float switch assembly (Figure 13-3).

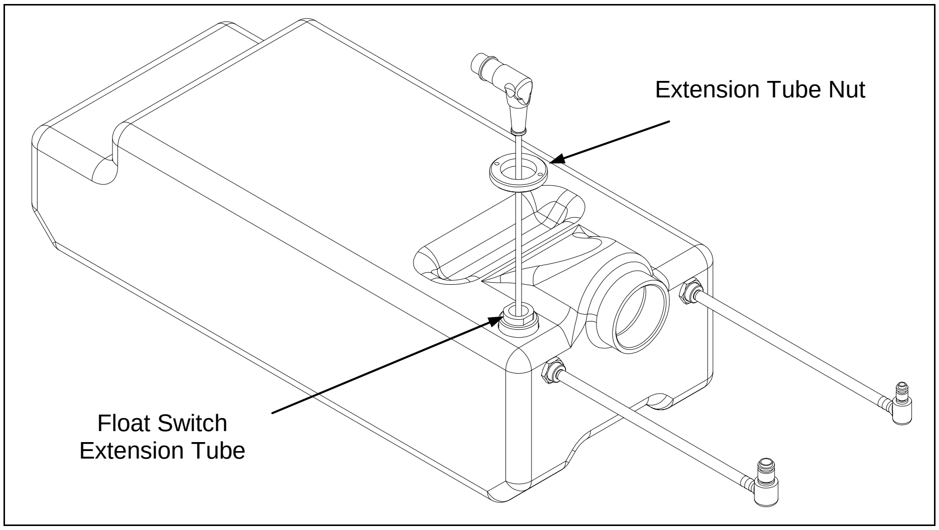

Figure 13-3 Float Switch Assembly

3 When installing a new float, place the O-ring (Part No. 44000100) over the Float Switch Harness as shown in Figure 13-4.

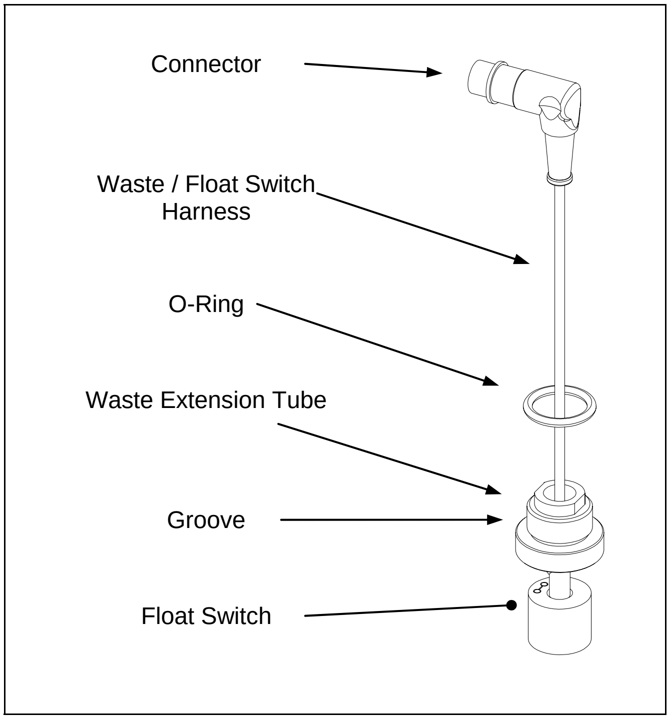

Figure 13-4 Float Switch Harness

13.3.3 Replacing The Aspirate Pump Assembly

The Aspirate Pump Assembly (Part No. 13001480) supplies a vacuum so that fluid can be aspirated from microtiter plate wells. The Aspirate Pump Assembly is located at the rear of the system as shown in Figure 13-5.

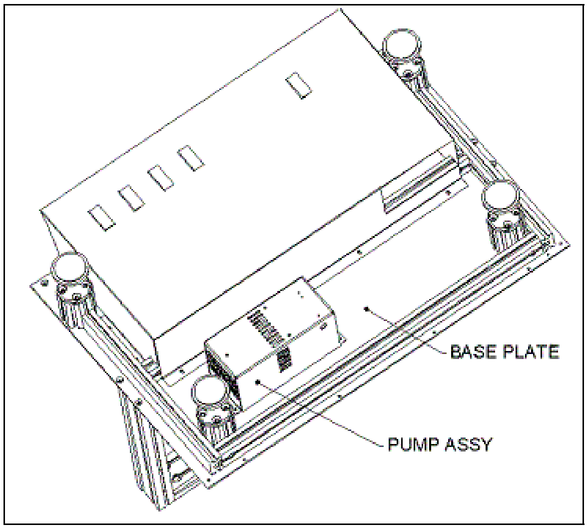

Figure 13-5 Aspirate Pump Assembly

To remove the pump assembly, unscrew the four M4 x 8 SKT cap screws.

When replacing the pump, secure the screws with Loctite 222. Ensure that the wires and the 300 mm tubing from the straight barb fitting on the pump are passed thru the grommet.

13.3.4 The Plate Carrier Assembly and Wash Head

The Plate Carrier Assembly and Washhead can be removed from the system without removing the washer module from the system (Figure 13-6).

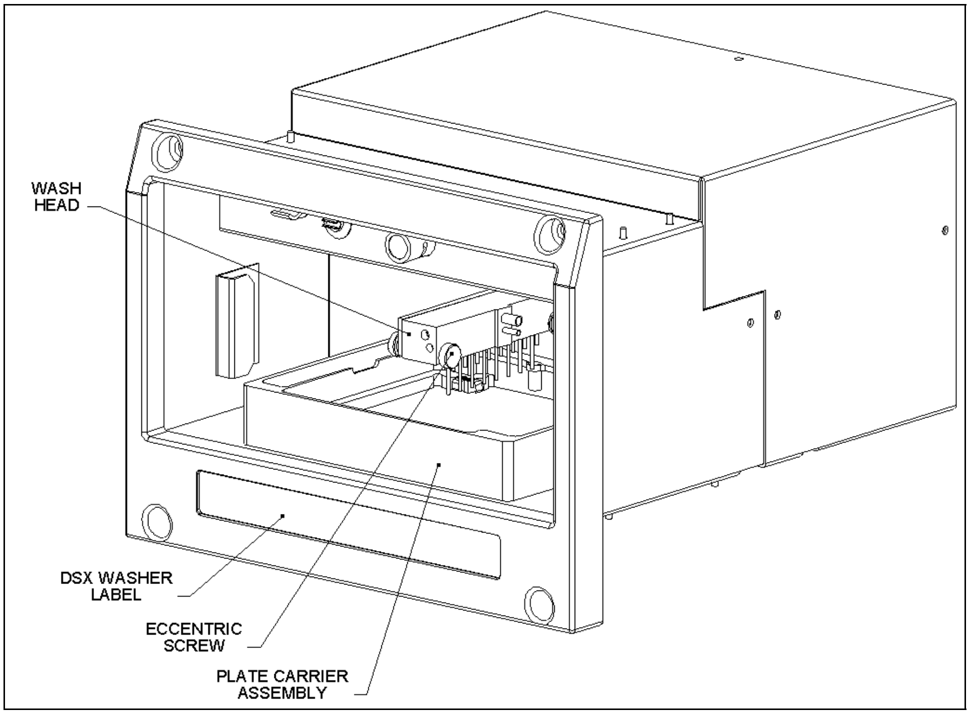

Figure 13-6 Washer Module

The Plate Carrier Assembly (Part No. 13001790) is attached to rails on the base of the washer and can be readily removed by lifting it.

The 8-Way Wash Head Assembly (Part No. 204025300) is attached to the arm via the eccentric screw.

13.3.5 Replacing the Vacuum Switch

The vacuum switch (Part No. 564400200) is connected to the left side of the unit as shown in Figure 13-7. To remove the vacuum switch, disconnect the Silicon tubing from port A on the vacuum switch, disconnect the wires, and remove the switch.

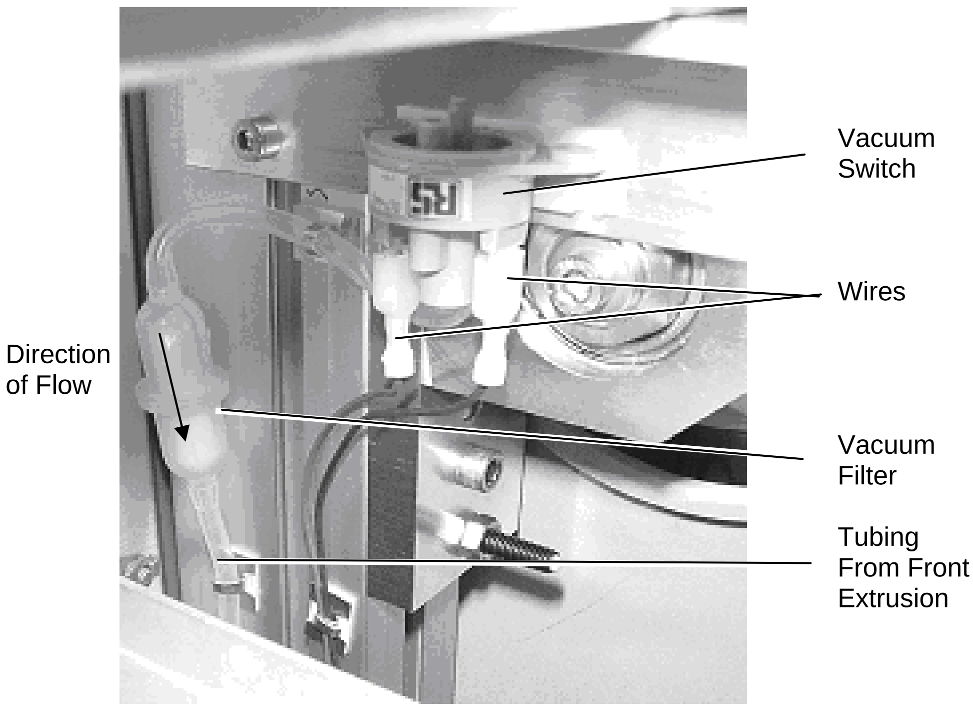

Figure 13-7 Vacuum Switch Parts

To Install a New Vacuum Switch:

1 Attach the silicon tubing (Part No. 816400700) to port “A” on the vacuum switch.

2 Attach the Vacuum Filter (Part No. 43000340) between the other end of the 100mm tubing and the free end of the tubing from the front extrusion. Ensure that direction of the arrow on the vacuum filter is away from the vacuum switch as shown.

Note*: The vacuum switch must be calibrated after it is installed.*

During calibration, the waste bottle must be empty and the washer module must be present with a wash head in the DSX.

To Calibrate the Vacuum Switch:

1 Disconnect the small tube to the center barb of the “T” fitting in the DSX side panel area. Connect this tube to the center barb of the “T” fitting in the manometer tubing assembly.

2 Connect the large tube from the manometer “T” fitting to the center barb of the “T” fitting in the DSX side panel area.

3 Turn ON the DSX and start the Revelation software.

4 Choose **Manual Control** from the *Tools* menu.

5 In the *DSX Manual Control* window, select **Advanced** in the first column, select **Send Command(s)** in the second column, and click **Do It**.

6 In the input box, enter **C0MAP**, then click **Send** to map the DSX.

7 In the input box, enter **W0STS**, then click **Send** to self-test the Washer Module.

8 In the input box, enter **W0APCY**, then click **Send** to start the aspirate pump.

9 With the aspirate pump running and the waste bottle cap tight, the vacuum must be greater than **0.60 psi**.

10 Monitor the green (positive) and blue (negative) terminals of the vacuum switch with a voltmeter.

11 Loosen the waste bottle cap slightly until the manometer reads a line vacuum of **0.43 - 0.47 psi**.

12 Tweak the adjustment screw on the vacuum switch until the voltage just switches from **5V** to **0V** at **0.43 - 0.47 psi**.

13 Retighten the waste bottle cap.

14 Disconnect the large fitting between the waste bottle and the front extrusion to release the pressure. Then, reconnect the large fitting.

15 Monitor the voltmeter and the manometer, and confirm that the voltage switches from **5V** to **0V** when the manometer reads a line vacuum of **0.43 - 0.47 psi**.

> ***Note**: If the voltage and pressure are not correct, readjust the vacuum switch, and then recheck the values.*

16 In the input box, enter **W0SHT**, then click **Send** to stop the aspirate pump.

17 Exit Revelation and turn OFF the DSX.

18 Reconnect the tubing and fittings to the original configuration.

13.4 Repairing/Replacing Internal Components

***Note**: The Washer Module is considered as a service replaceable item. If a defect is observed, the normal response is to replace the entire module. The information in this chapter should be used only if it is necessary to repair or replace the module on-site.*

13.4.1 Accessing Internal Components

Removing the Bezel Assembly

1 The Bezel Assembly is mounted to the front cover (Figure 13-8) via four 4 M4 Hex Nuts and four M3 Flat washers.

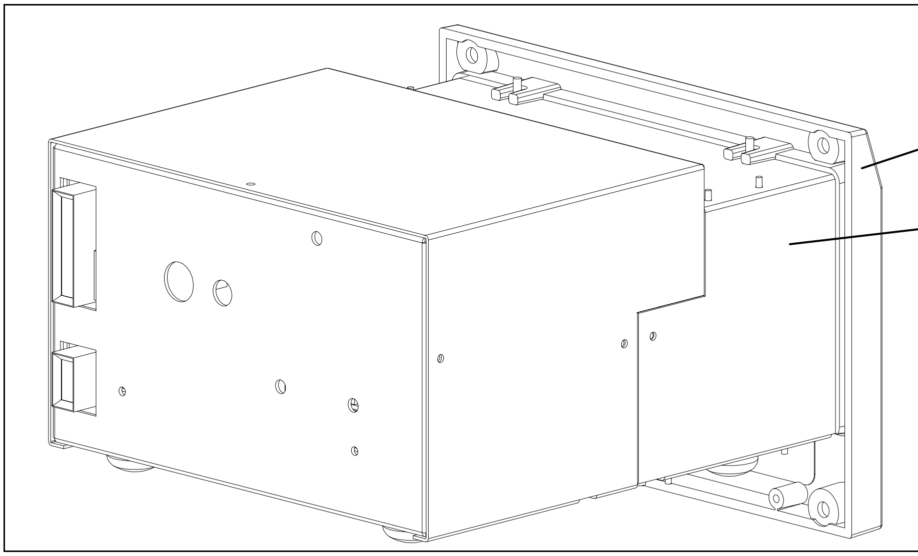

Figure 13-8 Bezel Assembly

Removing the Rear Cover

1 The rear cover of the Washer Module is attached to the unit with three M3 x 6 Pan Head Screws (top hole and two rear side holes), two M3 x 10 Pan Head Screws (front side holes), and four M 3 x 6 Cap Head Screws with four M3 Flat Head washers in the bottom holes. After removing all the screws, it may be necessary to stretch the cover slightly to remove it

2 When reinstalling the cover, it may be necessary to stretch the cover slightly to place it in position. Secure the screws in the bottom holes with Loctite 222.

13.4.2 Replacing the Pinch Valve

1 Remove the Valve Mounting Assembly, which is mounted to the front cover of the Washer Module (Figure 13-9). To remove the assembly, remove the four M3 Nyloc Nuts and M3 washers.

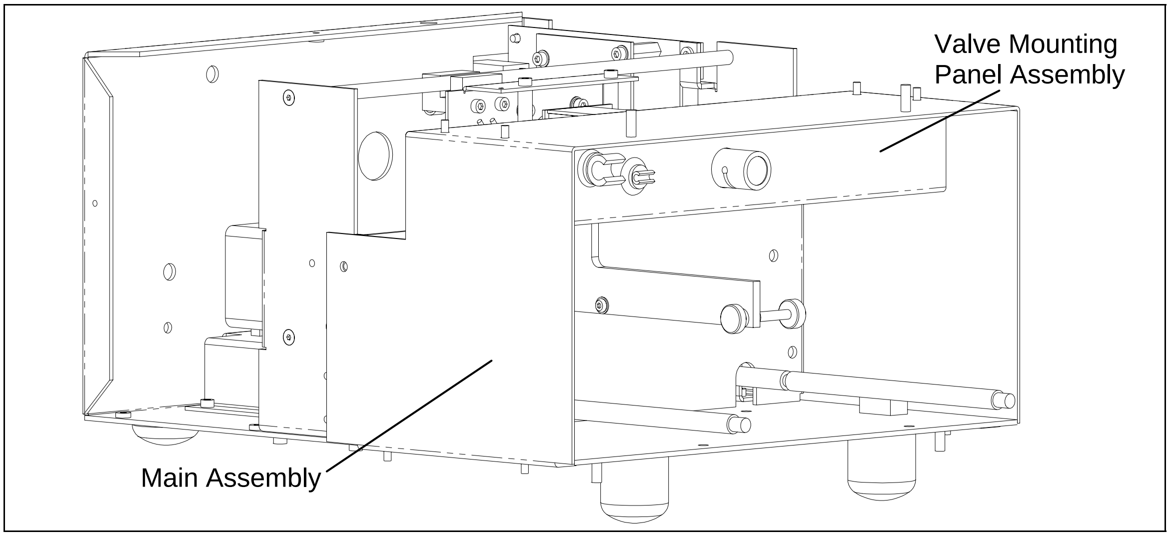

Figure 13-9 Valve Mounting Panel Assembly

> ***Note**: When reinstalling the assembly, take care that the wires are not pinched between the panels and secure the pinch valve wires to the tyrap base on the side plate.*

2 Remove the Ring Terminal by removing the M4 Nyloc Nut, M4 flat washer and M4 External tooth washer (Figure 13-10).

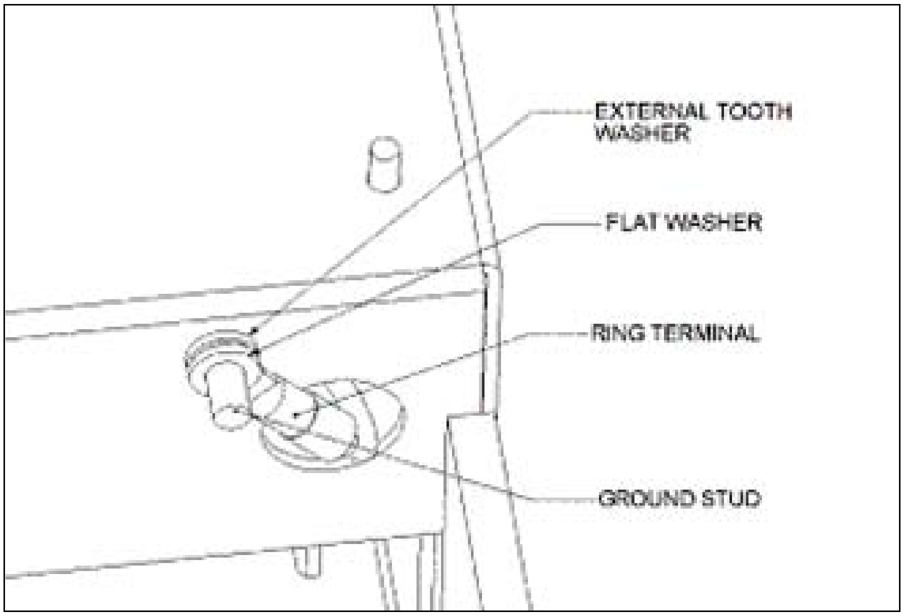

Figure 13-10 Ring Terminal Design

3 Withdraw the pinch valve thru the access hole in the front cover (Figure 13-11).

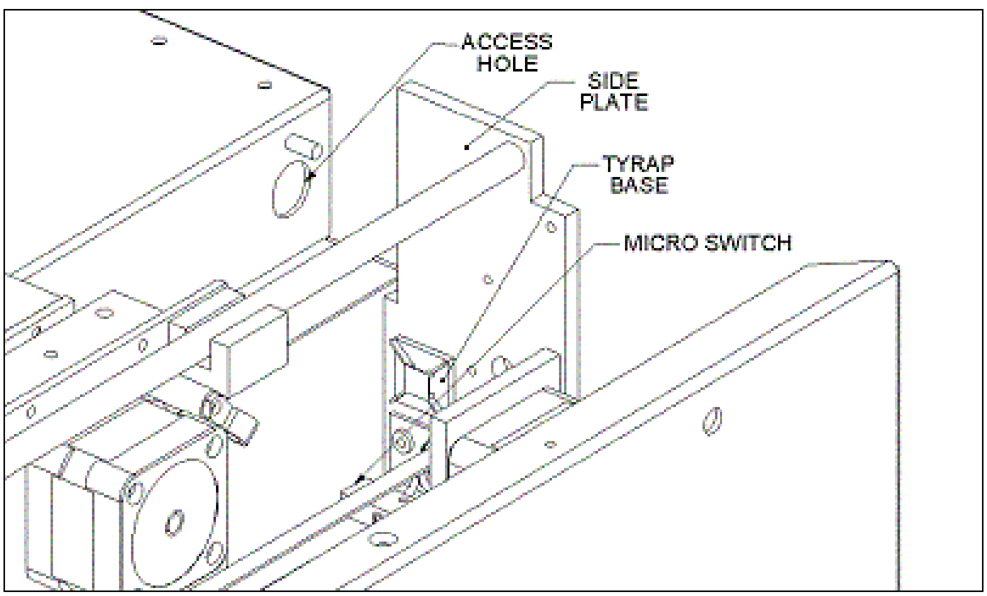

Figure 13-11 Access Hole

4 Disconnect the Pinch Valve Harness.

13.4.3 Replacing the Printed Circuit Board Assembly

There are two printed circuit boards in the Washer Module, a daughter board and the main board. The daughter board is attached to the main board by pressing it into the mating connector and securing it to the standoffs with three M3 x8 Cap Head Screws and 3 nylon washers.

To Replace the Printed Circuit Board Assembly:

1 Remove the two screws and Nylon washers that secure the assembly to the PCB mounting bracket (Figure 13-12)

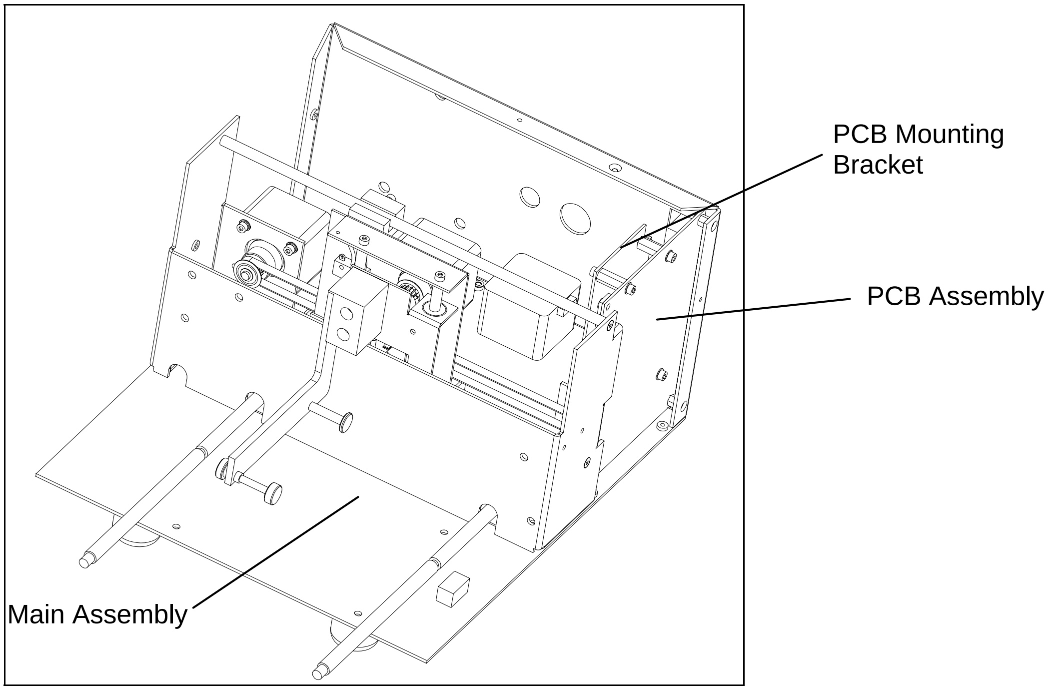

Figure 13-12 Printed Circuit Board and PCB Bracket

2 Remove the screw and Nylon washer that secures the assembly to the front mounting bracket.

3 Replace the PCB by reversing the disassembly proedure

> ***Note**: When replacing the screws, secure them with Loctite 222.*

> ***Note**: When replacing the main pcb, it must be calibrated using DynexTest software and the Dynex Washer Calibration Software.*

13.4.4 Mounting the X/Z Subassembly

> ***Note**: The X/Z Subassembly can be replaced as a unit or various components can be replaced by the service engineer. In this section, we describe the removal and re-installation of the entire sub-assembly, to replace individual components, refer to page 13-22.*

The X/Z subassembly is removed from the baseplate by removing the four M3 x 10 Caphead Screws (Figure 13-13)

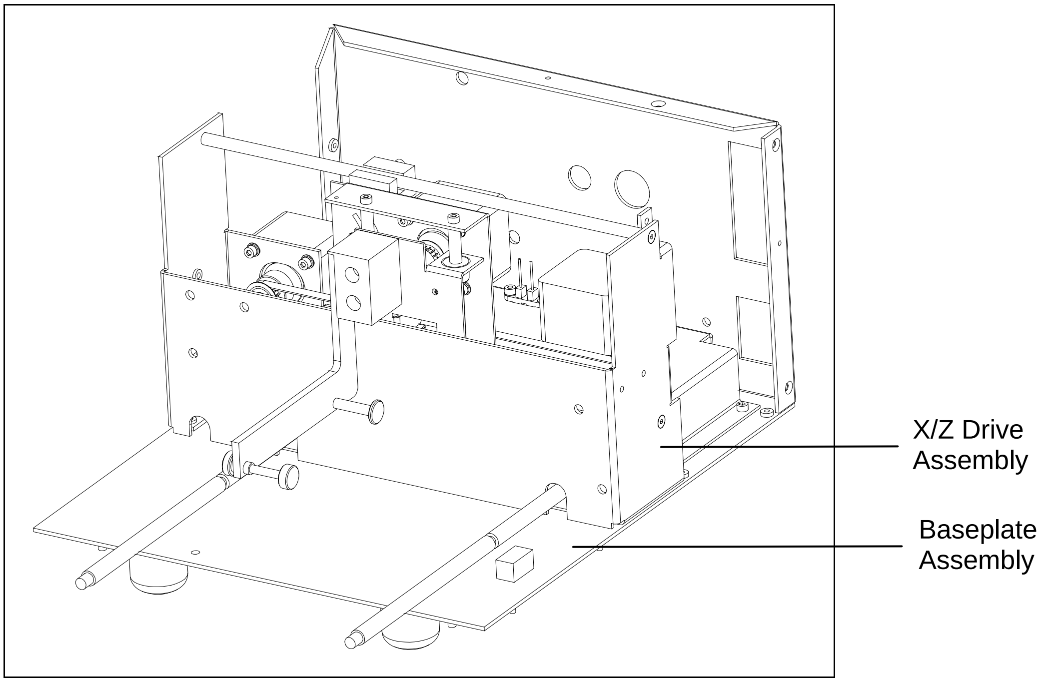

Figure 13-13 Mounting the Wash X-Z Subassembly

> ***Note**: When replacing the screws, secure them with Loctite 222.*

13.4.5 Mounting the Y Subassembly

> ***Note**: The Y Subassembly can be replaced as a unit or various components can be replaced by the service engineer. In this section, we describe the removal and re-installation of the entire sub-assembly, to replace individual components, refer to page 13-31.*

The Y sub-assembly is removed from the baseplate by removing the four M3 x 10 Caphead Screws (Figure 13-14).

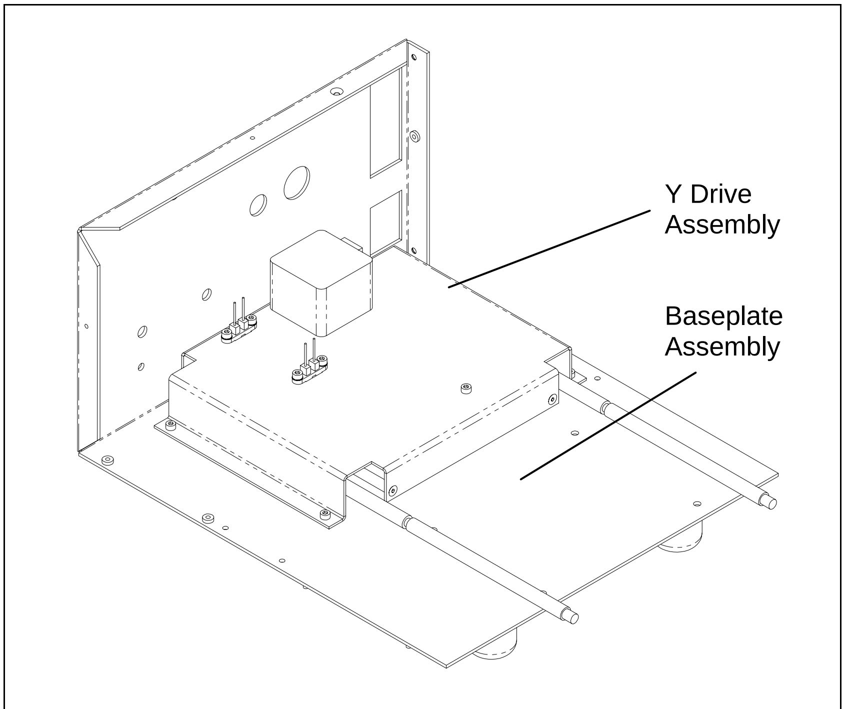

Figure 13-14 Installing the Wash Y-Drive Assembly

> ***Note**: When replacing the screws, secure them with Loctite 222.*

13.5 Replacing Components - Wash X/Z Subassembly

13.5.1 Removing the Lower Front Panel

1 Remove the two M3 X 6mm Caphead screws that attach the lower front panel to the X-Drive and Z-Drive assembly (Figure 13-15).

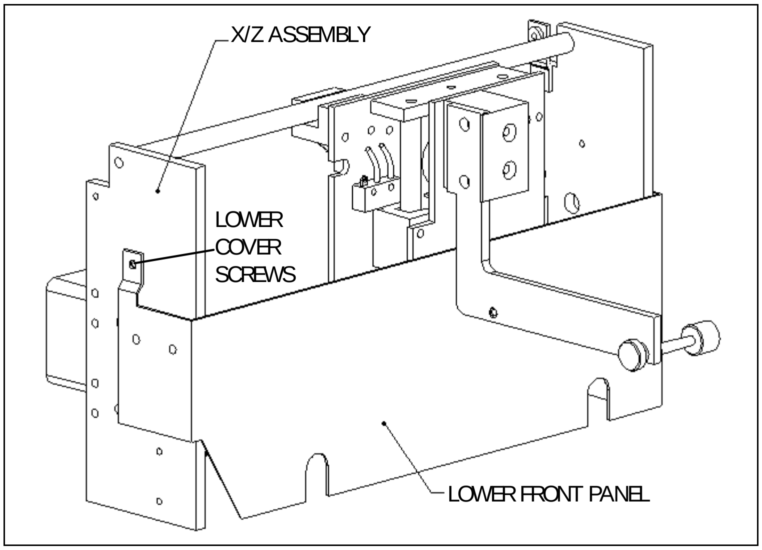

Figure 13-15 Removing the Lower Front Panel

2 Cut tie-wraps from tie-bases and disconnect the harnesses from the daughter board and the main board.

13.5.2 Removing the Wash X-Drive Motor

1 Remove the two M3 X 10mm Caphead screws that mount the motor to the left side of the X-Drive and Z-Drive assembly (Figure 13-16) and remove the motor from the belt that drives the wash head in the X direction.

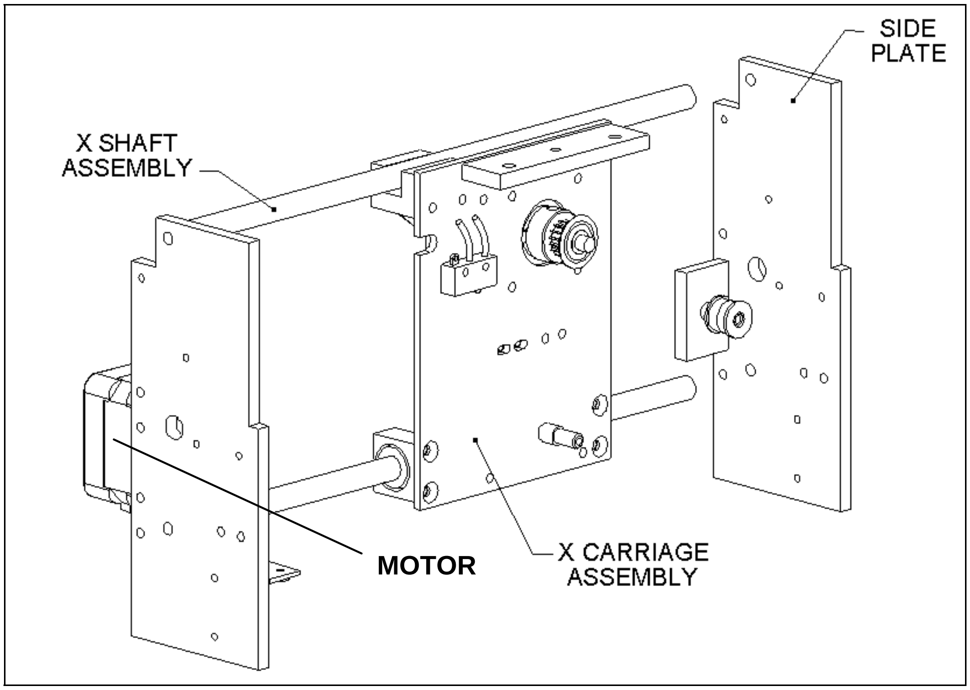

Figure 13-16 Wash X-Drive Motor Assembly

2 Disconnect the motor cable from J6 on the main printed circuit board.

3 Remove the four M3 x 8mm Flathead screws that mount the motor to the bracket (Figure 13-17).

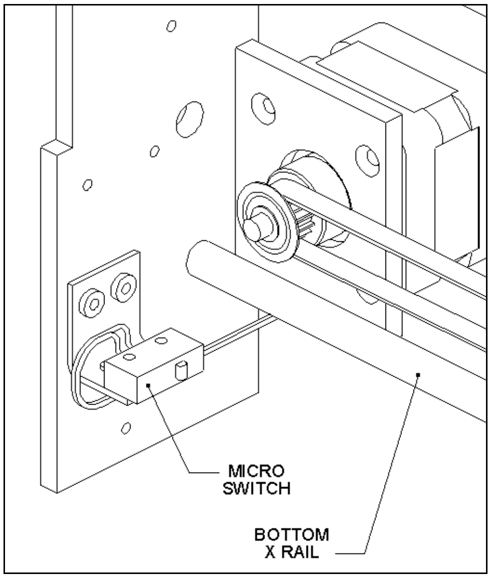

Figure 13-17 X Motor Mounting Detail

4 Remove the Pulley from the motor by loosening the M4 x 6mm setscrew.

The motor is replaced in the reverse order. To correctly position the pulley, use the Washer X Motor Pulley Height Setting Jig (Part No. WMFIX012) as shown in Figure 13-18. If the jig is not available, place the pulley 1.65 mm from the motor. After you have set the pulley, tighten the setscrew using Loctite 222.

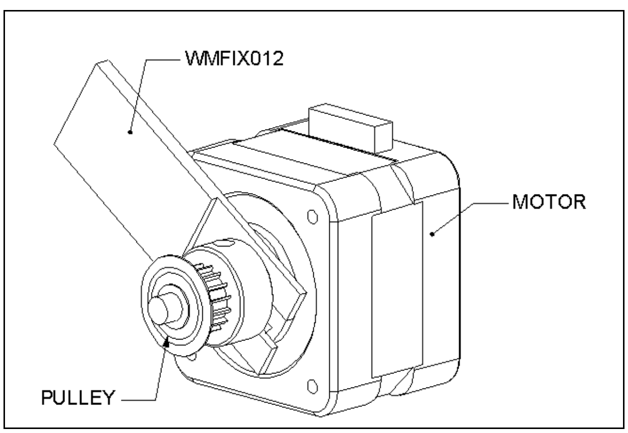

Figure 13-18 Positioning the Pulley on the X-Drive Motor

***Note**: After you have remounted the motor, it may be necessary to reset the tension on the timing belt.*

13.5.3 Replacing the Wash X-Drive Timing Belt

The X-Drive Timing Belt is used to drive the X-Drive assembly. It is installed between the X-Drive Motor and the Idler bearings (Figure 13-19).

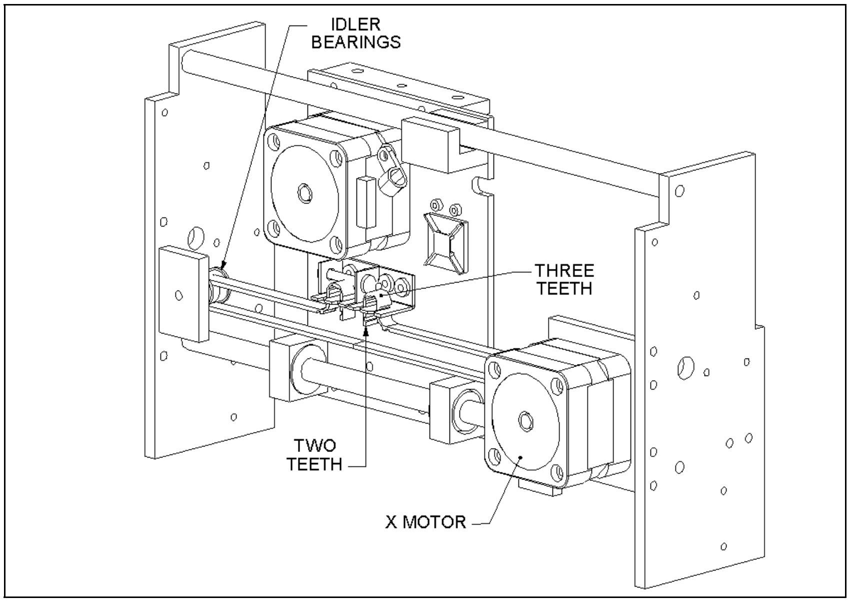

Figure 13-19 X-Drive Belt Installation

To Remove the Belt:

1. Unscrew the adjustment screw.

To Install a New belt:

1. Place the belt into the belt brackets, with two teeth protruding from the ends and three teeth in each loop.
2. Place the belt around the Motor and Idler.
3. Tighten the adjustment screw on the belt bracket.
4. Tighten the screws that connect the belt bracket to the Z-Plate.

13.5.4 Replacing the X-Drive Microswitch

The X-Drive Microswitch is mounted on the left plate (Figure 13-17).

To Remove the Microswitch:

1 Remove the two M2 x 12mm Pozi Panhead screws, which mount the microswitch to the plate.

2 Unsolder the two wires from the existing switch and re-solder them to the replacement switch.

> ***Note**: When you reconnect the wires, use good soldering technique and make certain that the junction is protected via shrink-wrap.*

13.5.5 Replacing the Z-Drive Motor

To Remove the Z-Drive Motor:

1. Remove the lower front cover in front of the X/Z assembly (see Section 13.5.1).
2. Remove the six M3 X 6mm screws that attach the X-Carriage plate to the carriage assembly bearing blocks and the two M3 X 8mm Cap Screws securing the slider block (shown in Figure 13-20).

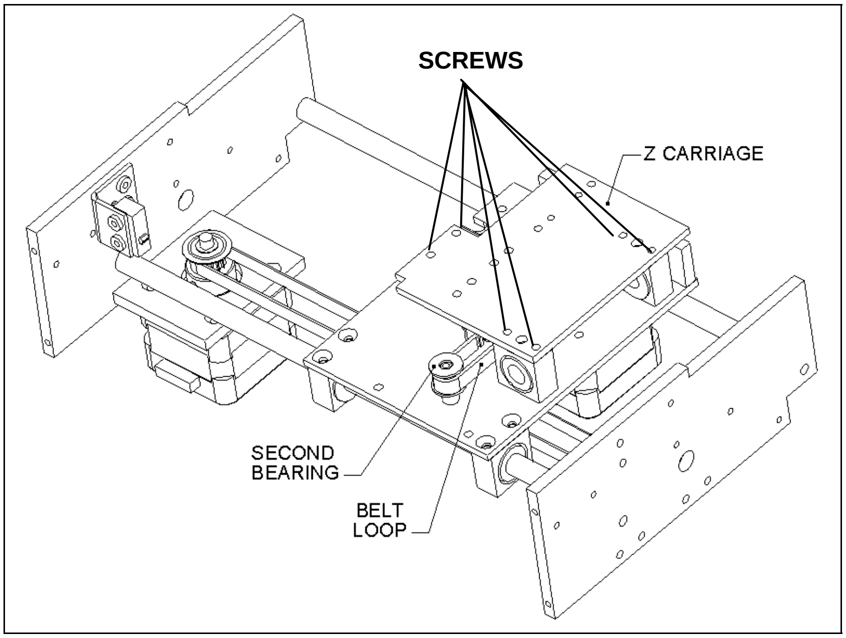

Figure 13-20 Z Carriage Assembly

3 Remove the second bearing on the idler shaft (the screw is in the center of the idler axle) (Figure 13-21).

4 Slide off the Z carriage plate with the belt loop.

5 Remove the pulley from the motor.

6 Remove the motor from the motor bracket.

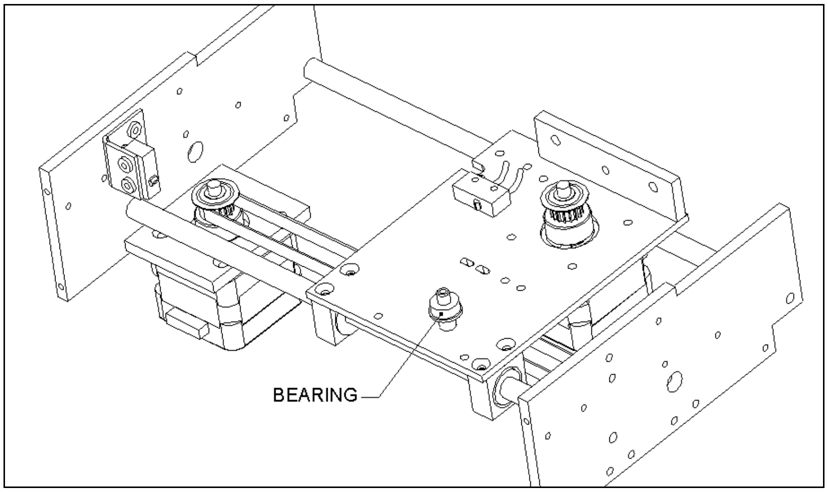

Figure 13-21 Motor Mounting Screws

Replacing the Motor:

The motor is replaced in the reverse order. To correctly position the pulley, use the Washer Z Motor Pulley Height Setting Jig (Part No. WMFIX014) as shown in Figure 13-22. If the jig is unavailable, set the pulley 1.0 mm from the motor. Apply Loctite 222 and tighten the setscrew.

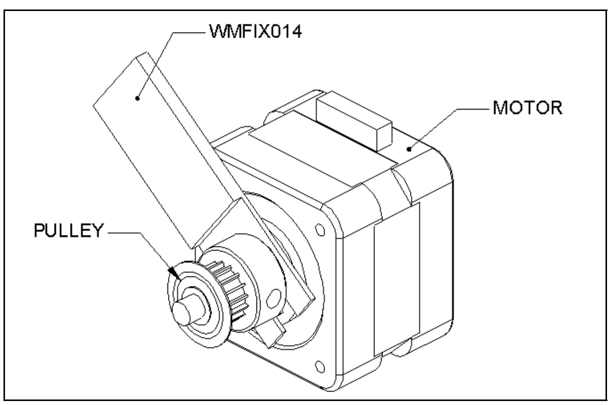

Figure 13-22 Positioning the Pulley on the Z-Drive Motor

When rebuilding the assembly, it may be necessary to re-install the belt on the Z carriage as described in Section 13.5.6).

13.5.6 The Wash Z-Drive Belt

Replacing the Z-Drive Belt:

1 Remove the lower front panel that covers the front of the X/Z assembly (see Section 13.5.1).

2 Remove the 6 screws that attach the Z carriage plate to the carriage assembly (shown in Figure 13-20).

3 Remove the second bearing on the idler shaft (the screw is in the center of the idler axle.

4 Slide off the z carriage plate with the belt loop.

5 Insert a new timing belt (Part No. 32000600). The belt should have three teeth in each loop and two teeth protruding from the end as shown in Figure 13-23.

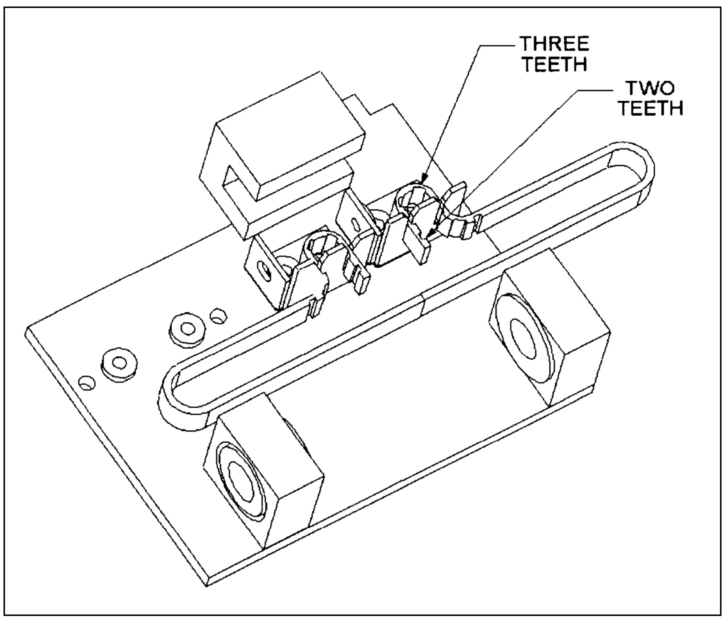

Figure 13-23 Mounting the Z-Drive Belt

13.5.7 The Wash Z Microswitch

The Z Microswitch is a mounted on the Z-drive assembly in the upper left corner (Figure 13-21).

To Replace the Switch:

1 Disconnect the two M2 x 12 mm Pozi Pan screws.

2 Remove the solder the wires from the switch and re-solder to the new switch.

> ***Note**: When you reconnect the wires, use good soldering technique and make certain that the junction is protected via shrink-wrap.*

3 Secure the switch using the two screws removed in Step **1**.

> ***Note**: Push the switch upwards when tightening the screws.*

13.6 Replacing Components - Y-Drive Assembly

13.6.1 Replacing the Drive Belt

The Drive Belt (Part No. 320000600) is removed by releasing tension on the Belt Adjustment screw (Figure 13-24).

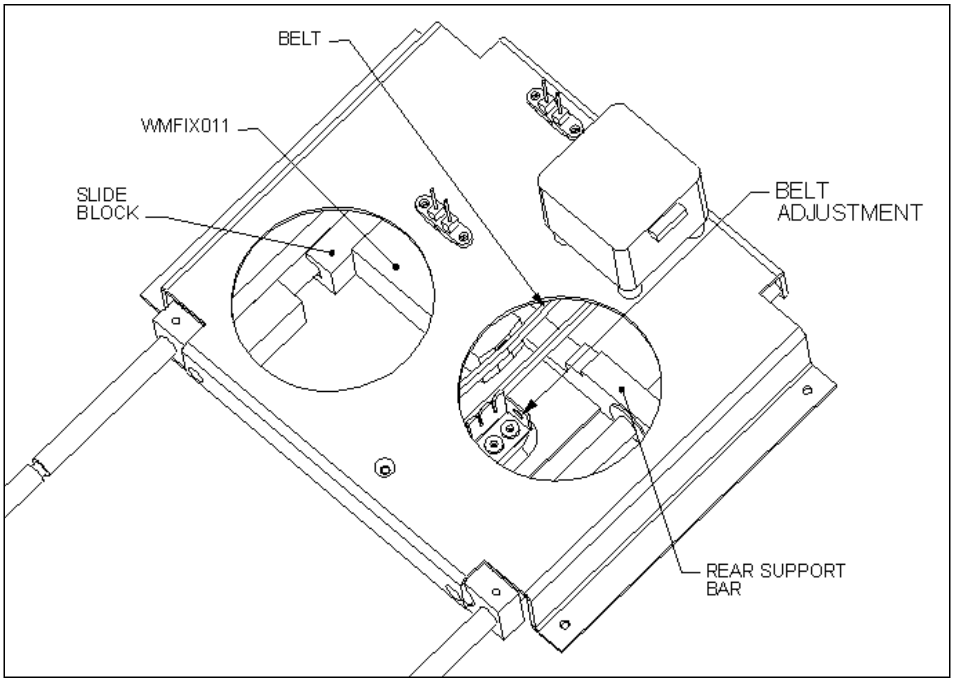

Figure 13-24 Y-Axis Assembly

To Replace the Belt:

1 Install the 282.5 mm Timing Belt (Part No. 320000600) into the belt brackets with two teeth exposed and three wrapped around and through the slot on the bracket as shown in Figure 13-25.

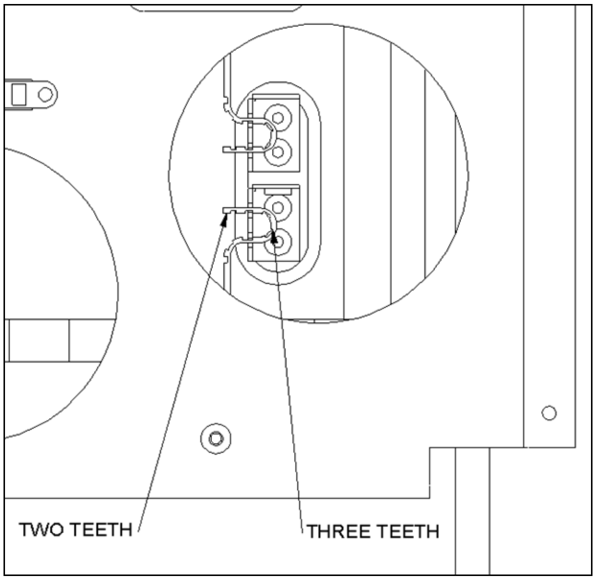

Figure 13-25 Y-Drive Belt Bracket

2 Loop belt around motor pulley and idler wheel (Figure 13-26).

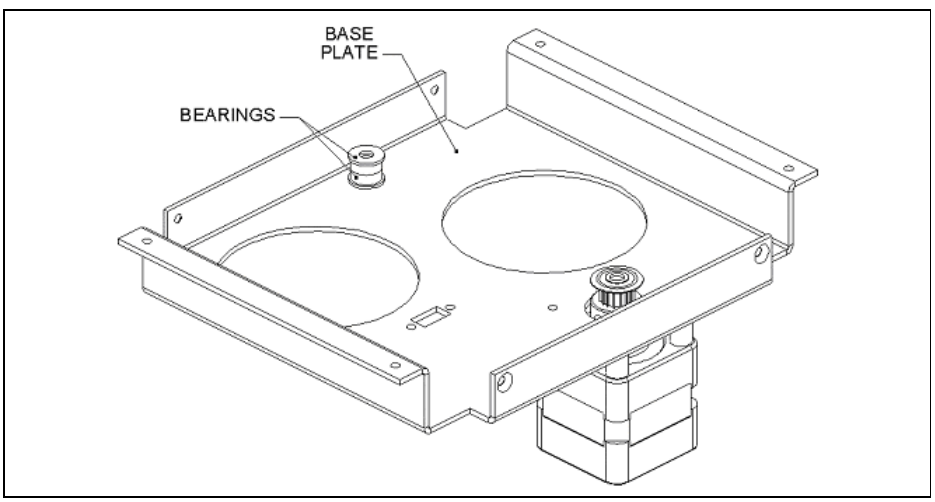

Figure 13-26 Bearing and Motor

3 Loosen the screws on the adjustable bracket. Position Y Belt Tensioning Jig (WMFIX011) as shown with Y-Drive fully extended and the jig flush against the rear support bar and slide block.

4 Tighten the belt adjustment screw until the belt pushes the plunger flush to face of the jig. Tighten the screws on adjustable belt bracket.

5 Temporarily remove and then reinstall the adjustment screw using Loctite 222. Individually remove and then reinstall the adjustable bracket screws using Loctite 222.

13.6.2 Removing the Moving Base Assembly

The moving base assembly is attached to the fixed base assembly as shown in Figure 13-27.

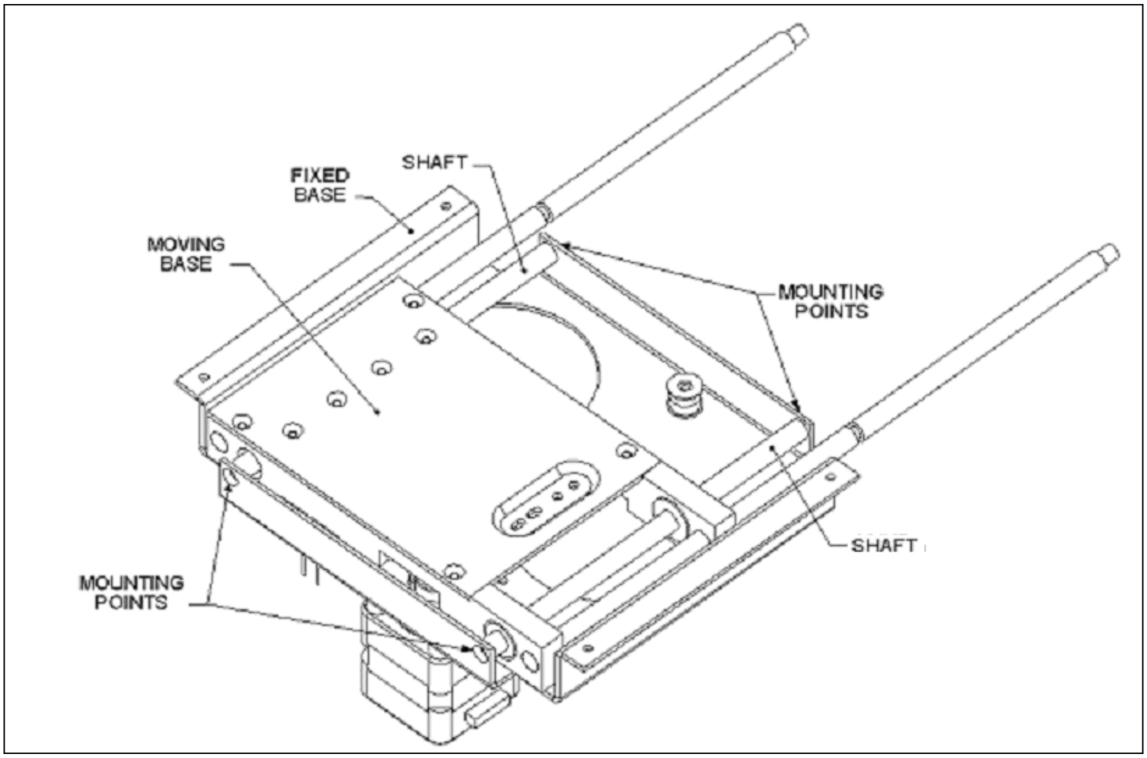

Figure 13-27 Mounting Moving Base Assembly Fixed Base Assembly

To remove the moving base assembly, detach the Y shafts using four M3 x 10 Flat head screws.

13.6.3 Replacing the Y Sensor Assemblies

The Y sensor assemblies (Part No. 15000790) are attached to the base using four M3 x 8 Cap Head Screw and four M3 Nylok Nuts from the underneath as shown in Figure 13-28.

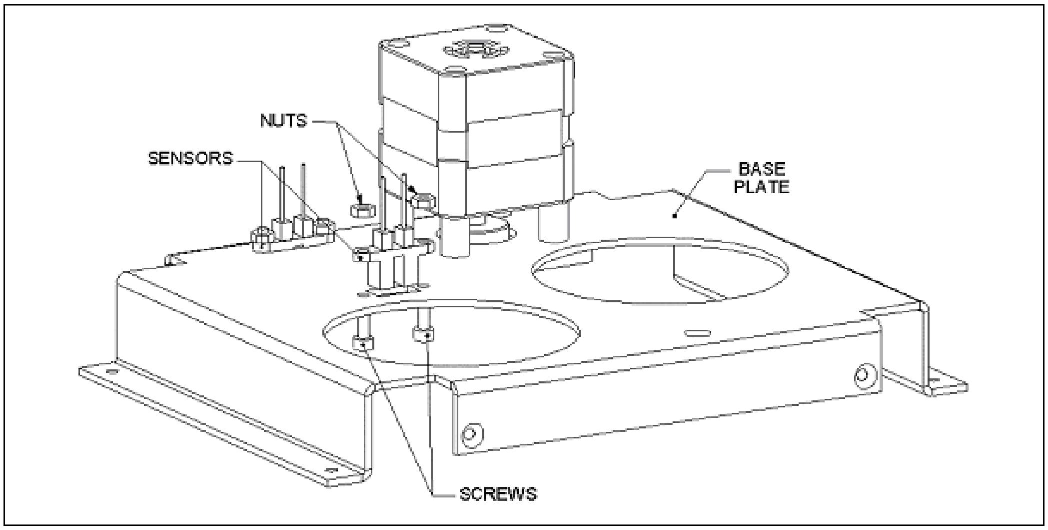

Figure 13-28 Mounting the Sensor Assemblies

13.6.4 Replacing the Bearings

The bearings are installed on the idler support pin on the baseplate as shown in Figure 13-29. The bearings are affixed to the shaft using a M3 Flat Washer and a M3 x 6 Button Head Screw. The bearing can be removed by removing the screw and washer.

When replacing the bearings, place two bearings (Part No. 322000801) with the flanges opposed.

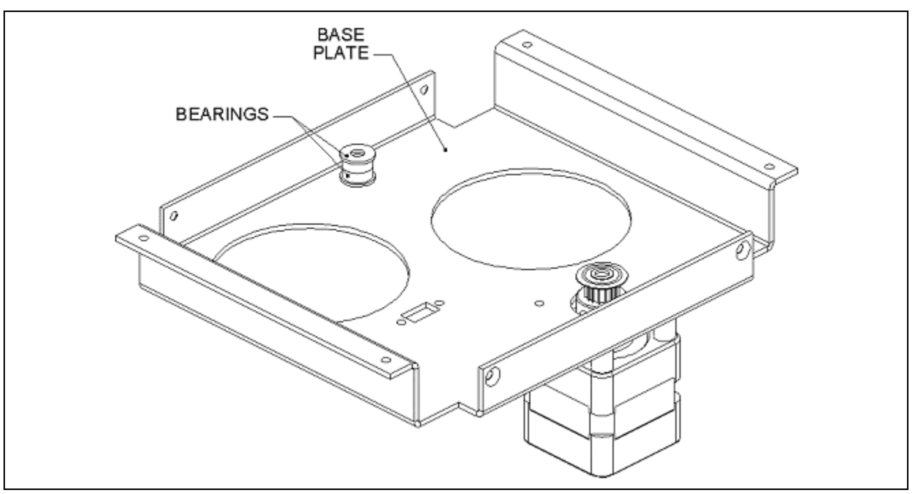

Figure 13-29 Y Bearings.

13.6.5 Replacing the Motor Assembly

To remove the Motor Assembly, remove the 4 M3 x 16 cap head screws and Motor Spacers (Figure 13-30).

When replacing the motor assembly, use Loctite 222 to secure the screws.

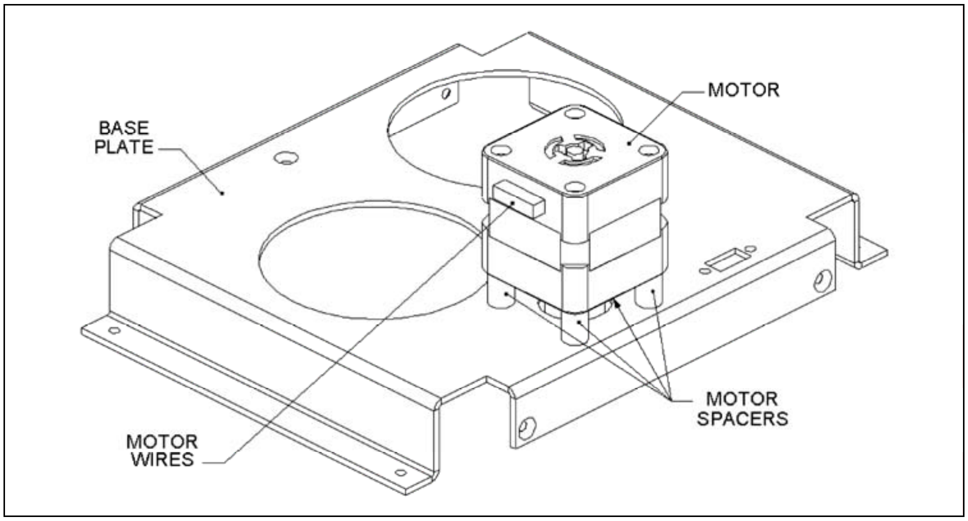

Figure 13-30 Y Motor Assembly.

13.6.6 Replacing the Motor Pulley

The Pulley (Part No. 32010800) is mounted on the motor and is removed by loosening the M 4x 6 set screw.

When replacing the pulley, the Y Motor Pulley Height Setting Jig (WMFIX013) should be used as shown in Figure 13-31. If the jig is not available, the pulley should be mounted 6.5 mm above the motor.

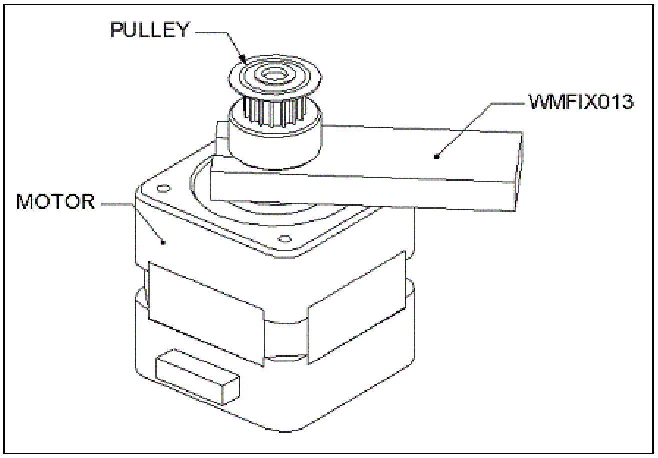

Figure 13-31: Attaching the Motor Pulley

13.7 Spare Parts

13.7.1 Dispense and Aspirate Bottle Assembly

Part Number	Description
354008300	Quick Connect Fitting (Dispense Bottle)
344001900	Rubber Washer (Waste Bottle)
354005900	Bulkhead Barbed Fitting (Waste Bottle)
029006600	Modified Bulkhead Barbed Fitting (Waste Bottle)
816400600	Silicon Tubing (Waste Bottle)
62503160070	Large Elbow Fitting (Wash Bottle)
354020300	Small Elbow Fitting (Waste Bottle)
42000370	Cap (Waste Bottle)
204016500	Head Support Arm

13.7.2 X-Drive and Z-Drive Assembly (13001571)

Part Number	Description
528300700	Motor
320100800	Pulley
40000050	Timing Belt (467.5 mm, X-Drive, 192.5 mm Z-Drive
204016700	Head Support Post
204016600	Eccentric Support
204016800	Head Locking Screw
203103300	Idler Shaft (X)
15000480	Harness, Z Motor
203103300	Idler Shaft (Z)
23001990	X -Shaft
23001980	Z-Shaft
322000801	Bearings (Idler Shaft)

13.7.3 Y – Drive Assembly (13001800)

Part Number	Description
528300901	Motor
40000050	Timing Belt (280 mm)
15000790	Sensor Assemblies
320100800	Pulley
203103300	Idler Support Pin
322000801	Bearings

13.7.4 Electronics Components

Part Number	Description
582050206	Main Board
582051002	Daughter Board
50200567	2.5 amp Fuse (Front Extrusion)

13.7.5 Miscellaneous Items

Part Number	Description
426000900	Pinch Valve
13001610	Wash Head (8 pins)
352104000	Cleaning Wire Aspirate
352101800	Cleaning Wire Dispense
312201300	Large Tube Clip

13.7.6 Jigs

Part Number	Description
WMFIX012	X Motor Pulley Height Setting Jig
WMFIX013	Y Motor Pulley Height Setting Jig
WMFIX014	Z Motor Pulley Height Setting Jig
WMFIX011	Y Belt Tensioning Jig
WMFIX017	X Belt Tensioning Jig
WMFIX015	Arm Positioning Jig

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Chapter 14 The Ambient Drawer

14.1 Overview

The ambient drawer is designed to hold plates and is used to allow plates to incubate for the appropriate period of time at room temperature (i.e. for reactions that can be readily performed at room temperature. The drawer is located directly below the modules; when the drawer is extended, it extends over the workspace.

From time to time, the system will extend the plate (under control of the assay) so that plates can be placed in the drawer or removed from the drawer. As an alternative, the service engineer can move the drawer independently of an assay using the manual mode as described in the section entitled Manual Control Operations on page 5-2.

The Drawer module is a simple DSX module, as it has only one main sub-system: the drawer motor assembly. This drawer can accommodate up to four plates on its moving plate. This plate slides in and out of the DSX front face and has four pre-defined positions, as follows:

- **Home –** The plate is fully inside the DSX structure.
- **Mid –** The plate is half out, exposing only the front left and right plate-positions.
- **Out –** The plate is fully out, exposing all four plates. All plate holders are locked.
- **Eject –** The plate is in its fully extended position. This is the position necessary to unlock all of the plate-holding mechanisms to allow for one or more of the plates to be loaded onto or unloaded from the plate.

In most instances, the service engineer is expected to replace the ambient drawer as a discrete module and replace it with a new module. The defective module is to be returned to the nearest DYNEX Technologies service center. A detailed discussion on troubleshooting and service of the ambient drawer is presented in Chapter 15.

14.2 General Electronics Design

The ambient drawer electronics control the drawer motor assembly, with feedback from the optical sensors for position control and the thermal sensor that monitors the temperature of the chamber.

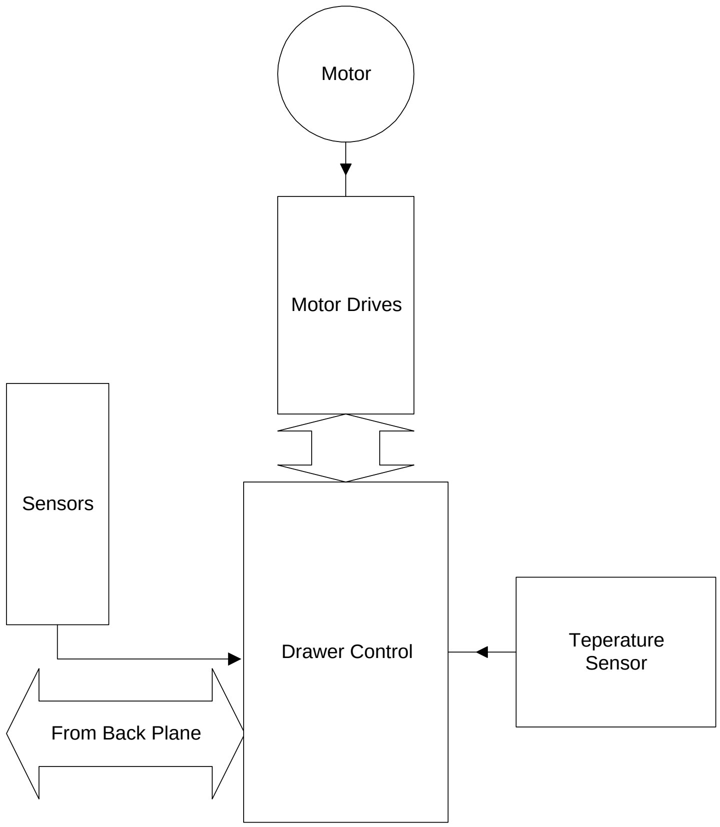

Figure 14-1 Circuit Block Diagram

14.3 Hardware Considerations

14.3.1 Motor Drivers

The motor drivers are the A2919, and set for 0.5 amps with a software boost, and driven in half steps.

14.3.2 Voltage Generation and Regulation

1. The Vcc is for the Control and driver board utilize a Newport Power NMA 2405S that provides +/5v for a total of 2 Watts.
2. The Vcc for the Transition board is derived from a Newport Power NME 2405S which provides 1 Watt @ +5v.

14.3.3 Microcomputer

1. The Hitachi H8/3337F single-chip microcomputer provides 60Kbytes of Flash ROM and 2Kbytes of RAM at a frequency of 16 MHz. The H8/3337F has the following internal peripheral capabilities:
2. 9 ports, providing 58 I/O and 8 Input lines
3. Two 8-bit timers (TMR0, TMR1)
4. One 16-bit free-running counter (FRC)
5. Two digital to analog channels (DA0, DA1), with 8-bit resolution
6. Eight analog to digital channels (AN0 through AN7), with 10-bit resolution
7. Two serial communications channels (COM0, COM1)
8. Two pulse width modulation channels (PWM0, PWM1)

14.3.4 Serial Communications with Controller

Commands and test data are transferred between the H8 and the external PC controller via a serial RS-232 interface. Interface drivers and receivers are used between the COM1 serial communications channel on the H8 and the interface connector to provide proper RS-232 signal levels to the controller. DTR is signalled via Port 8-7.

Chapter 15 Servicing the Ambient Drawer/Bar Code Scanner

15.1 Overview

The Ambient Drawer is used to store microplates when room temperature incubation in the dark is desired. The drawer extends into the work area for pipetting and when a microplate is to be transported from one device to another (e.g. to an incubator module). The drawer includes four identical microplate positions.

If the ambient drawer is defective, the normal service mode is to remove the module and replace it with a new module. The module is removed by rotating the two Allen screws counter clockwise ¼ turn and pulling the module from the system.

> ***Note**: If you work on the ambient drawer, be certain to check the alignment of the ambient drawer as described on page 15-7.*

The ambient drawer is considered as a replaceable module. The following information will be of assistance if it is necessary to repair the unit on site.

15.2 General Troubleshooting

> ***Note**: The Ambient Drawer is a service replaceable module. If a defect is observed, the normal response is to replace the module. Replacement or repair of specific items should be performed only on an as needed basis if replacement of the module is not possible and the service engineer has the appropriate components on hand. After the module has been repaired, use the alignment plate to ensure that the module is properly aligned.*

Table 15-1 Troubleshooting Table

Symptom	Probable Cause	Resolution
Drawer does not eject or is not drawn into module or does not travel correct distance	Drive Belt not in place or defective	Tighten belt or replace belt (refer to the section entitled The Drive Mechanism on page 15-4).
	Circuit Board defective	Replace Circuit Board (refer to the section entitled Replacing the Main Circuit Board on page 15-10).
	Motor Defective	Replace Motor (refer to the section entitled Replacing the Motor on page 15-8).
	Optical Sensor Defective	Replace Optical Sensor (refer to the section entitled Replacing the Optical Sensors on page 15-11).
	Defective Idler Subassembly	Replace Idler Subassembly (refer to the section entitled Replacing Idler Subassemblies on page 15-9).
Temperature error	Temperature Sensor Defective	Replace Temperature Sensor (refer to the section entitled Replacing the Temperature Sensor on page 15-12).
Well Plates not held in position	Actuating Lever or Spring defective	Replace Actuating Lever or Spring (refer to the section entitled Replacing the Actuating Levers on page 15-13).

15.3 Accessing Internal Components

This section describes the replacement of components for which there is a reasonable expectation that the service engineer may be required to replace. The following conventions are used:

- Removal of components of a structural nature will not be described
- It is assumed that the service engineer will remove all appropriate cables from an item before it is removed from the system. The service engineer should remove the cable as close as possible to the item to be removed and note the position of the cable for reinstallation.

To access the internal components of the Ambient Drawer, remove the six M3 x 5mm screws (shown in Figure 15-1) and remove the cover.

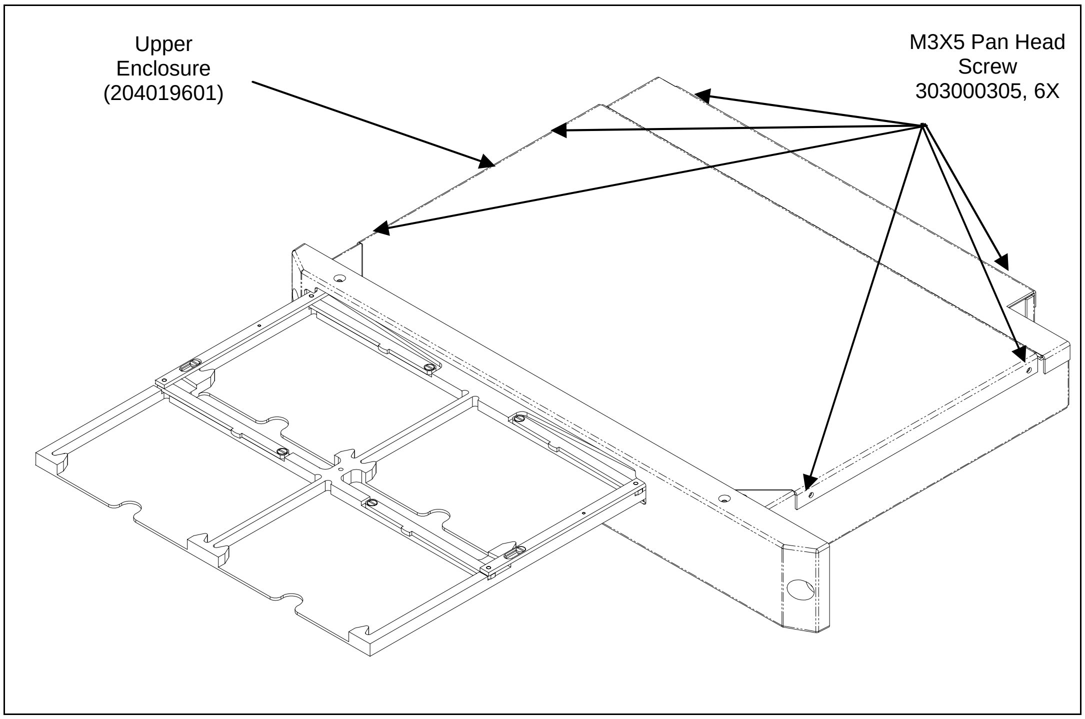

Figure 15-1 Removing the Ambient Drawer Cover

15.4 Servicing Internal Components

15.4.1 The Drive Mechanism

The ambient drawer is positioned via a drive belt that is powered by a motor. To remove the drive belt, loosen the two screws that secure the idler pulley and tensioning bracket and then unscrew and remove the belt bracket (Figure 15-2).

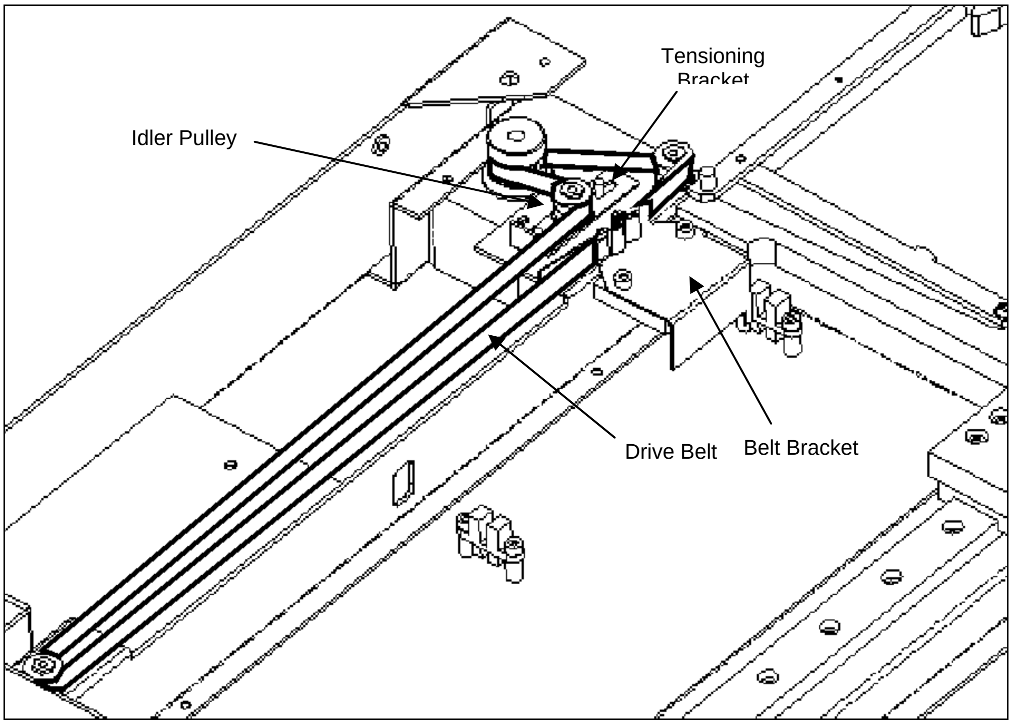

Figure 15-2 Timing Belt Bracket, Idler Pulley, and Tensioning Bracket

To Install a New Belt:

1 Install the belt in the belt bracket such that there are two front teeth exposed and four in the back as shown in Figure 15-3.

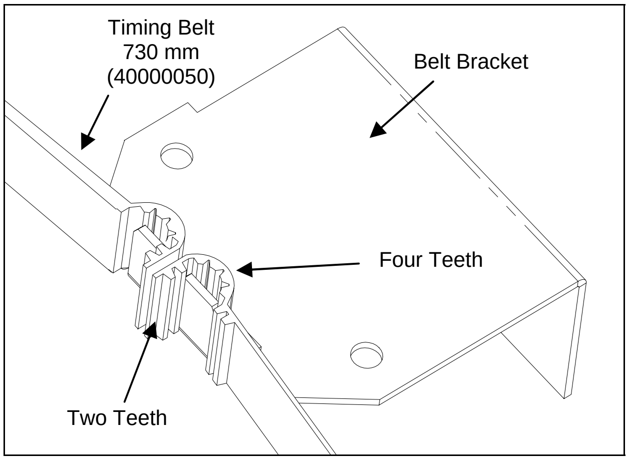

Figure 15-3 Timing Belt Bracket Region

2 Wrap the new Timing belt (Part No. 40000050) around the pulleys. The belt length should be 730 mm.

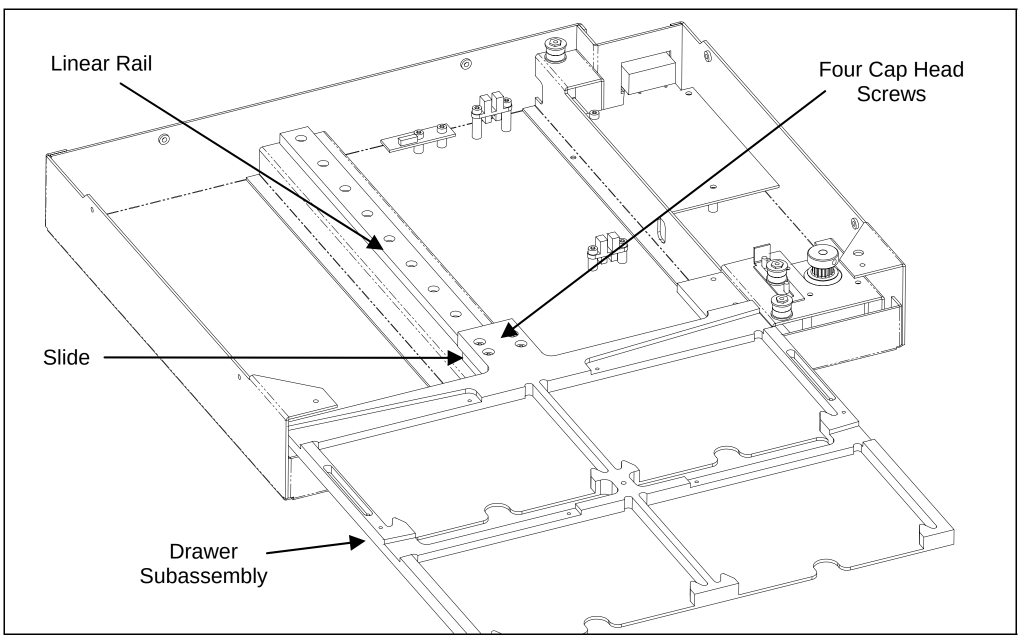

Figure 15-4 Location of the Y- Base Plate Assembly Locknuts (Bezel not Shown)

3 Replace the belt bracket. Secure it using the socket head cap screws and lock washers.

4 Using the force gauge in compression mode, engage the tab on the tensioning bracket and create between 3000 and 3750 grams (6.14 to 8.27 lbs) of tension in the belt (Figure 15-5).

5 Tighten the belt tensioner lock nuts when the required tension is achieved.

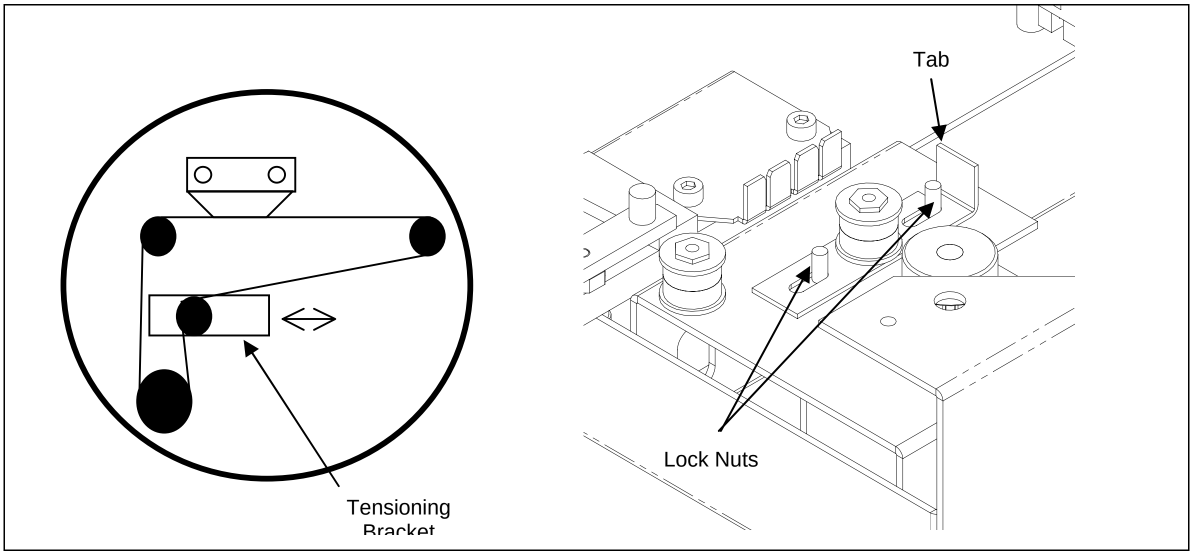

Figure 15-5 Tightening the Belt

6 Move the drawer in and out a few times to make certain that it runs freely and that the belt is aligned with the pulleys.

7 Replace the ambient drawer cover (Figure 15-1).

To Check the Ambient Drawer Alignment:

> ***Note**: This procedure is necessary only if the drawer subassembly is loosened from the linear rail or if the drawer alignment is suspect.*

1 Temporarily secure the Ambient Drawer onto alignment jig (DMFIX010) using a 4mm Allen wrench to tighten the two quarter-turn fasteners.

2 Install the drawer alignment block (part of DMFIX010). Then push the drawer out until the front edge is flush with the block, as shown in Figure 15-6. If the drawer is not parallel to the alignment block, loosen the four cap screws that hold the drawer to the linear rail. Hold the drawer flush against the alignment block, then tighten the four screws.

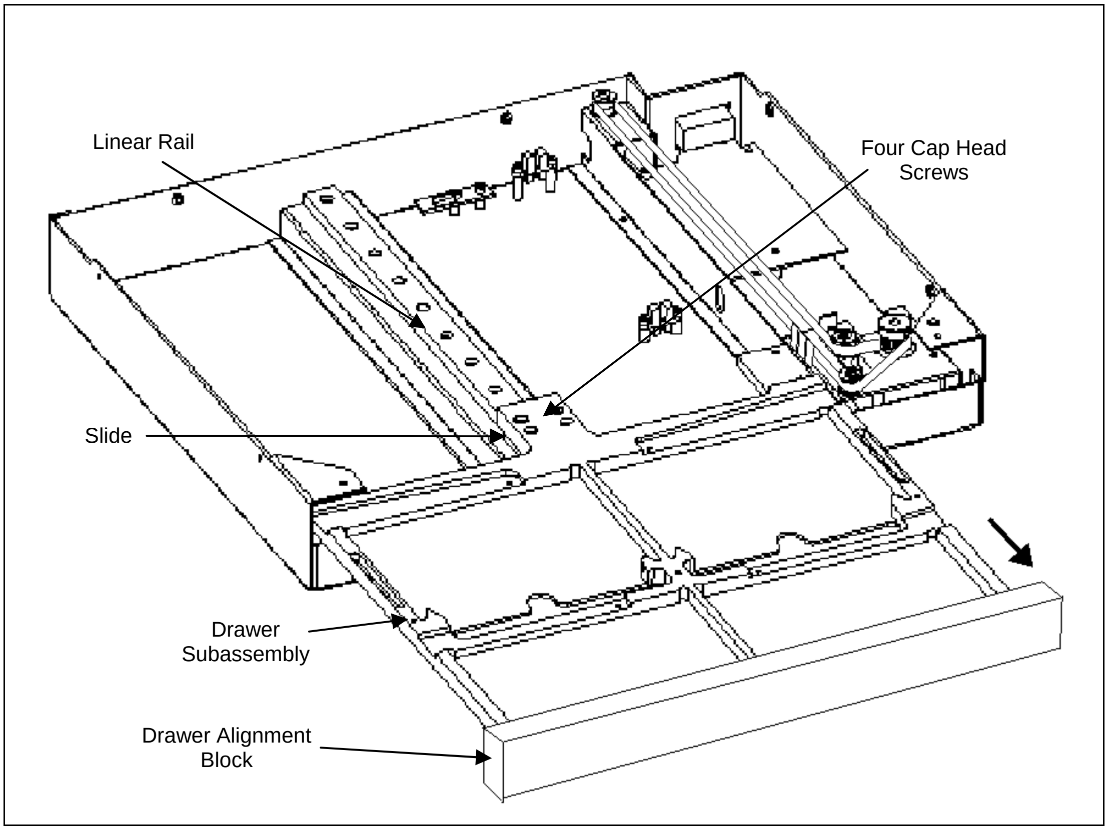

Figure 15-6 Ambient Drawer and Alignment Jig (Bezel not Shown)

15.4.2 Replacing the Motor

The Drive Motor is mounted directly onto the lower enclosure using four M3x6 button head screws. The screws are secured with Loctite 222.

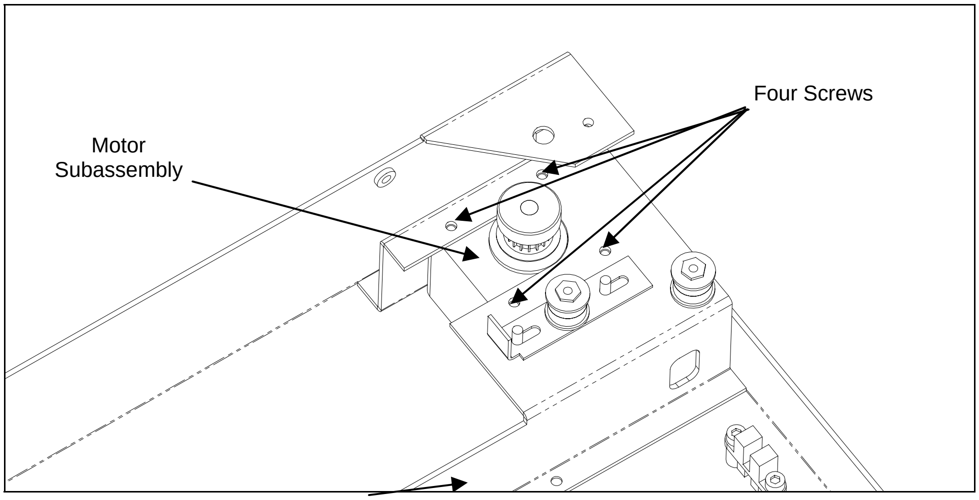

Figure 15-7 Motor Subassembly

To Replace the Drive Motor:

1 Loosen the belt and remove it from the motor pulley.

2 Remove the four mounting screws (Figure 15-7).

3 Disconnect the motor cables from the ambient drawer main circuit board. Free the cables from the cable clamp.

4 Lift out the motor subassembly.

> ***Note**: If necessary, transfer the motor pulley from the old motor assembly to the new one. The pulley is mounted on the motor using a M3 x 4mm setscrew and Loctite 222. The pulley should be flush with the end of the motor shaft.*

5 Place the new motor in position. Secure the motor using the mounting screws removed in Step **1**.

6 Route the motor cables to the ambient drawer main circuit board. Connect the motor cables to the **J6** connector on the circuit board.

7 Secure the motor cables to the wire clamp using a tie wrap.

15.4.3 Replacing Idler Subassemblies

Two of the Idler Pulley subassemblies are mounted on pins that are part of the lower enclosure. The third Idler Pulley subassembly is mounted on the tensioning Bracket. An M3 flat washer is placed under each Idler Pulley subassembly.

Each Idler Pulley subassembly consists of two bearings (Part No. 322000801), a bearing spacer (Part No. 33000390), and an Idler Support Pin (Part No. 204020600) as shown in Figure 15-8.

When replacing an Idler Pulley, secure it to the pin using a dab of Loctite 222.

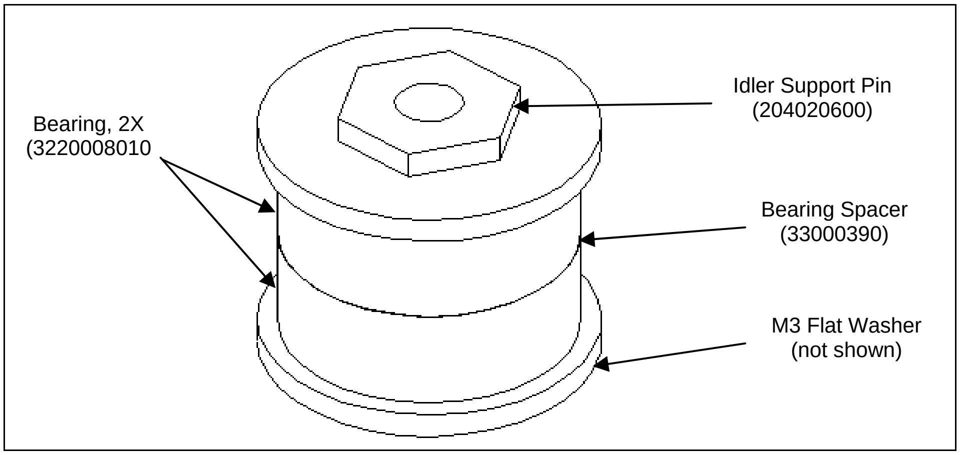

Figure 15-8 Idler Subassembly

15.4.4 Replacing the Main Circuit Board

The Ambient Drawer Main Assembly PCB (Part No. 14000570) is located in the right rear corner of the drawer (Figure 15-9).

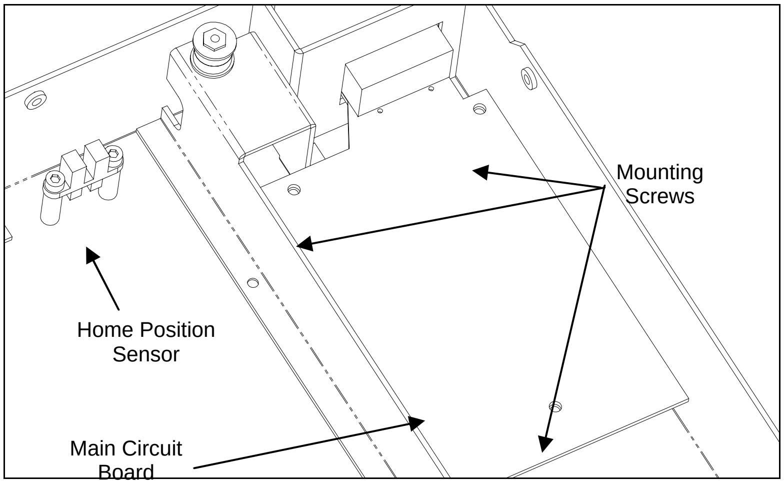

Figure 15-9 Ambient Drawer Main Assembly PCB

To Replace the Ambient Drawer Main Assembly PCB:

1. Remove the three M3 x 6mm screws and three M3 Nylon washers.
2. Remove all connectors (motor, temperature sensor, front sensor, middle sensor and rear sensor).
3. When reinstalling a new printed circuit board, remove the temperature sensor section by snapping it off (refer to Replacing the Temperature Sensor on page 15-12). In addition, note that the eject plug on the printed circuit board should be left empty.
4. Reattach the cables to the PCB connectors as shown below:

Cables	PCB Connector
Temperature Sensor	**J10**
Front Sensor	**J2**
Mid Sensor	**J3**
Home Sensor	**J4**
Motor	**J6**

> ***Note**: When replacing the main circuit board, ensure that the board does not contact the side of the lower enclosure.*

> ***Note**: After installing a new main circuit board, the module must be calibrated using DynexTest software.*

15.4.5 Replacing the Optical Sensors

Three optical sensors are mounted in the lower enclosure:

Sensor	Location
Front Sensor	Closest to the motor (see Figure 15-10)
Mid Sensor	Center of drawer travel distance (see Figure 15-10)
Home Sensor	Rear of lower enclosure (see Figure 15-9)

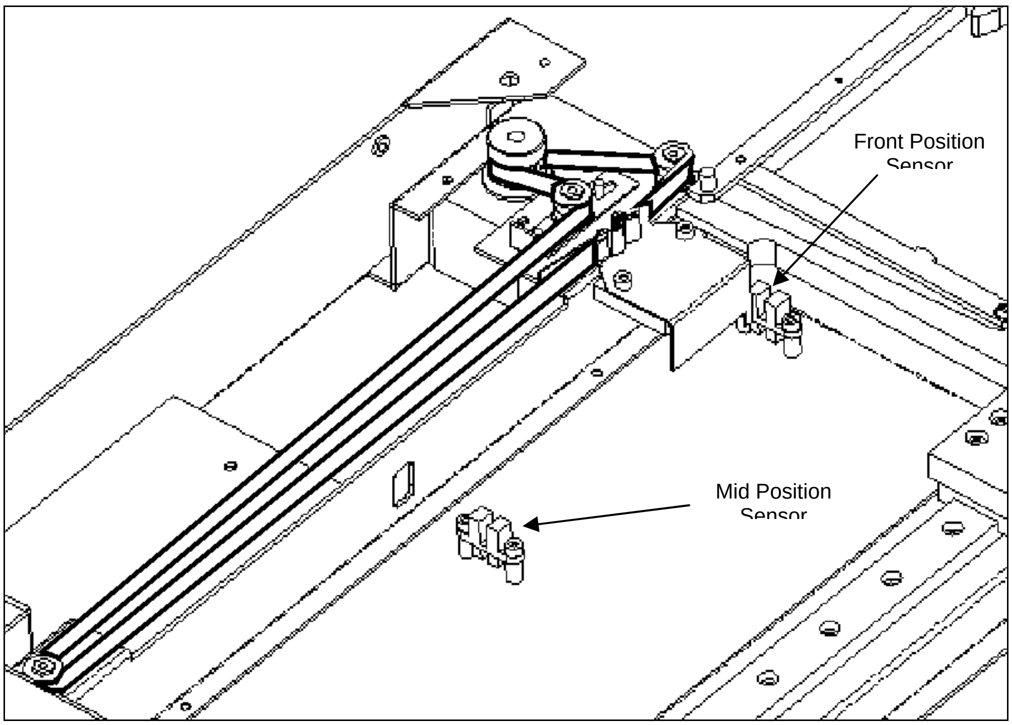

Figure 15-10 Location of Front and Mid Optical Position Sensors

To Replace a Position Sensor:

1. Unfasten the sensor by removing the two socket head screws and lock washers.
2. Disconnect the sensor cable from the ambient drawer main circuit board. Remove the cable through the access hole, noting the position of the access hole. Note where the cable is secured with a tie wrap.
3. Secure the new sensor into position, using the two socket head screws and lock washers.
4. Route the connector through the access hole noted in Step **2**. Replace any tie wraps.
5. Plug the connector into the PCB connector (see Step **4** on page 15-10).

15.4.6 Replacing the Temperature Sensor

The temperature sensor is located on a sensor-mounting bracket (Figure 15-11).

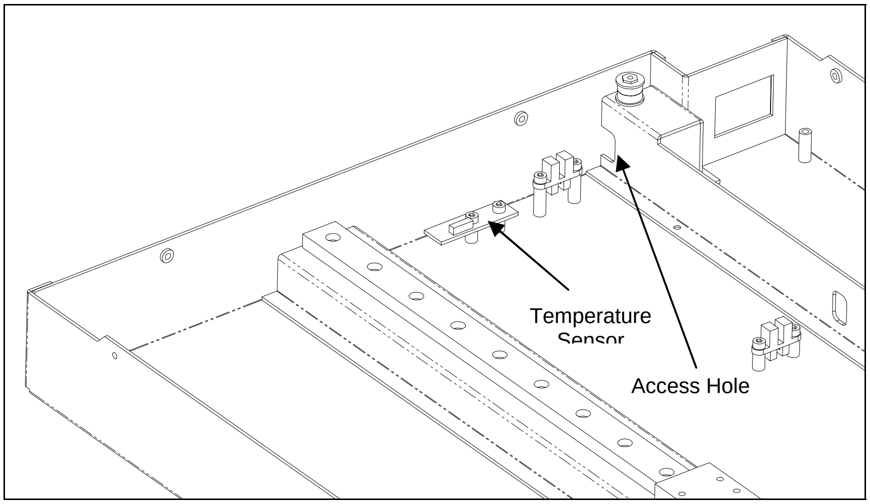

Figure 15-11 Temperature Sensor

To Replace the Temperature Sensor:

1 Remove the two button head screws and Nylon washers that secure the temperature sensor to the lower enclosure (Figure 15-11).

2 Disconnect the temperature sensor cable from the temperature sensor board.

3 Secure the new temperature sensor into position, using the two button head screws and Nylon washers removed in Step **1**.

> ***Note****: The temperature sensor board is supplied as a part of the ambient drawer printed circuit board. It should be removed from the ambient drawer board.*
>
> *When reinstalling temperature sensor board, ensure that the connector on the sensor printed circuit board faces up.*

4 Connect the cable to the connector on the circuit board.

5 Secure the temperature sensor cable to the home sensor cable using a tie wrap.

15.4.7 Replacing the Actuating Levers

Locking nubs (Figure 15-12) are used on the actuating levers to maintain the plates in position.

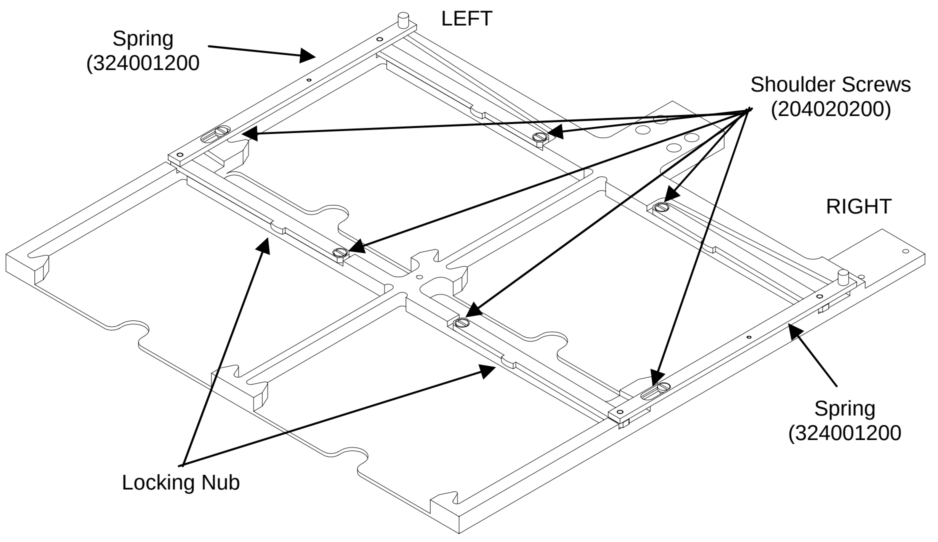

Figure 15-12 Locking Nubs on the Actuating Levers

To Replace the Actuating Lever Subassembly:

1 Remove the three shoulder screws (Figure 15-12) that secure the right (or left) actuating lever assembly to the drawer. Remove the actuating lever assembly from the drawer.

> ***Note**: When removing the actuating lever assembly, note the position of the spring (Part No. 324001200) between the spring pin on the actuating lever and the spring pin in the spring groove of the drawer.*

2 Install the new (right or left) actuating lever assembly. Be sure that the spring is installed and properly positioned.

3 Secure the actuating lever subassembly to the drawer using three shoulder screws that were removed in Step **1**.

4 Repeat the above process on the other side of the drawer using left actuating lever sub-assembly and the second spring.

15.5 Sample ID Module

15.5.1 Overview

The sample ID module is used to read the label on each sample tube or sample plate and transmit the information to Revelation software. This information is used with Revelation software to identify samples, and is incorporated with reports as appropriate.

15.5.2 Manual Testing of the Scan Module

Various operations of the Scan Module can be checked in the same manner as other components of the DSX system via the manual control feature as described in Chapter 5.

To check the Scanner Module, access the DSX Manual Control dialog box and select Sample ID to obtain a listing of the test activities for the bar code reader (Figure 15-13).

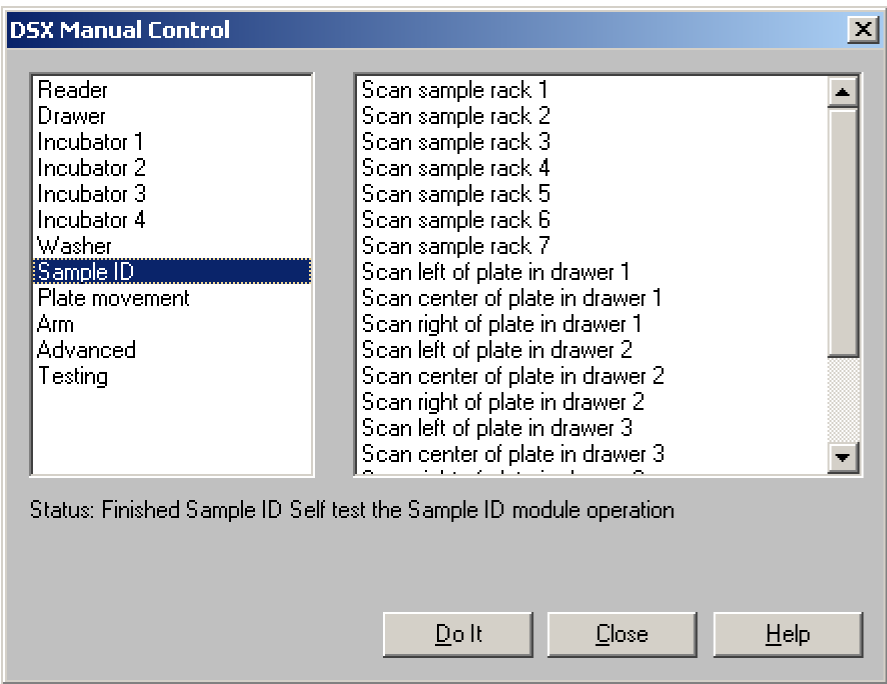

Figure 15-13 DSX Manual Control Dialog Box-Sample ID Tests

Each of the sample racks can be scanned and the left side, center and the right side of the plate in each drawer plate can be scanned. In addition, the module can be tested via the Self test the Sample ID module entry.

In each instance, the service engineer should highlight the desired test and click **Do It**. The status line will indicate that the test is being performed and will present information about the test after it is complete. If the status line indicates an error, it may be necessary to adjust the Sample Rack Scan Position or the Plate Rack Position (see Figure 15-14) or replace the Scan Module.

15.5.3 Replacing the Module

The module is removed from the DSX by rotating the two screws that attach the unit to the system (in the same manner as other modules). The module is considered as a replaceable item and a new module is installed in the same manner as other modules.

After the scan module has been installed, test the module as described in the section entitled Testing the Scan Module on page 15-16.

CAUTION

CAUTION: A CRDH CLASS II LASER IS USED TO READ THE LABEL. WHILE THIS LASER DOES NOT POSE ANY DANGER FROM MOMENTARY EXPOSURE TO THE EYE, IT IS SUGGESTED THAT YOU DO NOT LOOK DIRECTLY AT THE LASER BEAM UNLESS YOU ARE WEARING PROTECTIVE GLASSES.

Note… The above CAUTION is for the old module (serial number prefix 1SMF and below) and not for the new module (serial number prefix 1SMG and above). For the new module, the vertical barcode scanner is always Class 1.

15.5.4 Testing the Scan Module

To Test the Scan Module:

1. Select Configure System on the Tools menu to display the Setup DSX dialog box.
2. Select the Sample ID tab (Figure 15-14). The window will indicate the current scanner settings.

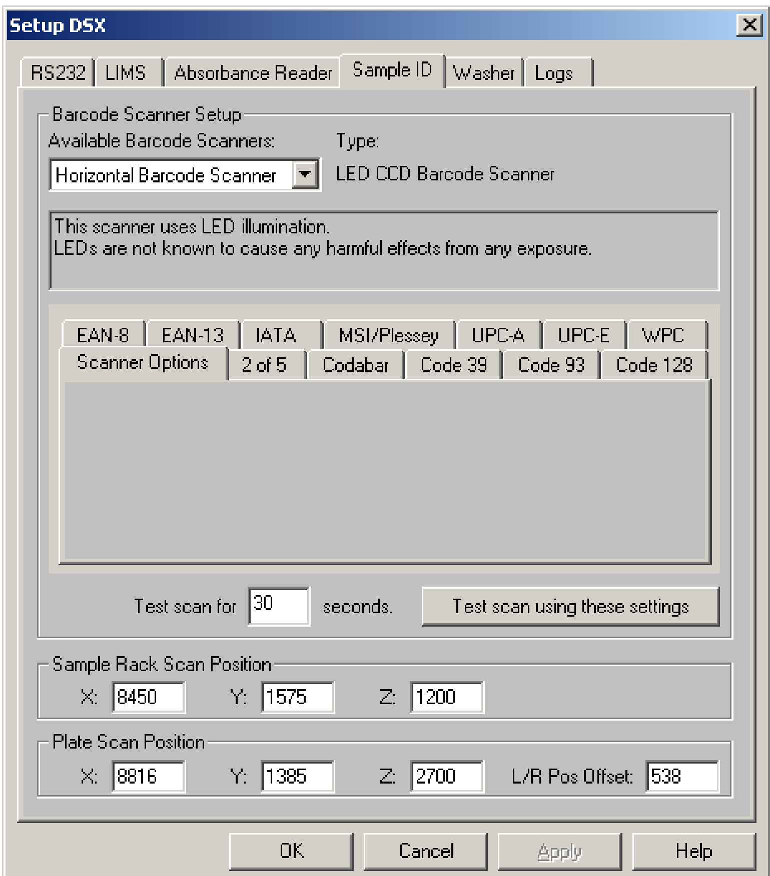

Figure 15-14 The Sample ID Tab - Horizontal Scanner

3. In the Available Barcode Scanners field of the Barcode Scanner Setup panel, choose either the Horizontal Barcode Scanner or the Vertical Barcode Scanner for testing. Both scanners can be setup to read any of the barcode types listed under 'Scanner Options'. Currently, the default setting is for both scanners to read all of the listed types.
4. When **Test scan using these settings** is selected, the scanner that is shown in the Available Barcode Scanners field operates for 30 seconds. A window appears with instructions to hold a barcode label up to the appropriate scanner window. If the barcode is read, the characters that are read are displayed.

15.5.5 Setting the Barcode Options

A number of different barcodes can be used with the DSX. Currently all of the barcode types are enabled so that any type of barcode presented to the reader can be read. To improve processing time, however, barcode types that are not being used can be disabled

To Disable One or More Barcode Types:

1 Select Horizontal Barcode Scanner or Vertical Barcode Scanner in the upper left corner of the Barcode Scanner Setup field.

2 Click on the tab for the barcode you wish to disable.

3 Uncheck the 'Enable" check box in the corresponding tab to disable a barcode type. For example, to disable Code 93 barcodes, uncheck the Enable Code 93 box in the Code 93 tab (Figure 15-15).

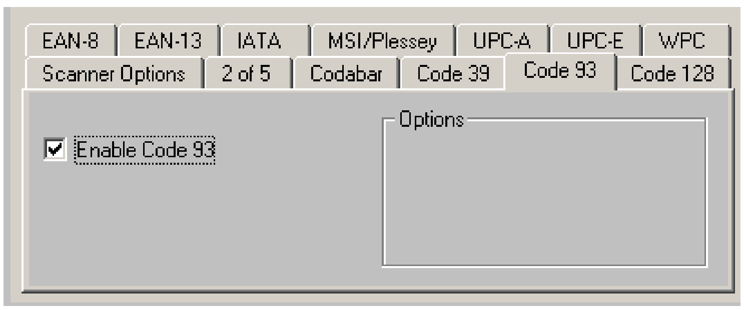

Figure 15-15 Scanner Selection-Code 93 Tab

15.5.6 Spare Parts and Jigs

The following listing of parts includes all parts that are likely to be replaced by the service engineer (screws, washers, wire and other common items are not included). In some instances, the service engineer has the option of replacing an entire subassembly or replacing the specific component that is defective. These components are either crucial to operation or may be subjected to wear and tear during normal operation.

15.5.7 Ambient Drawer Assembly

Description	Part Number
Timing Belt (742.5 mm)	40000050
Drive Motor	029060000
Idler Bearing (2)	322000801
Idler Support Pin	204020600
Ambient Drawer Main Circuit Board	14000570
Optical Position Sensor	15000430
Sensor Harness	15001190
Spring (for actuating levers)	324001200
Shoulder Screws	204020200

15.5.8 Jigs

Description	Part Number
Alignment Jig	DMFIX010

Chapter 16 Mechanical System Components

16.1 Overview

The DSX™ Automated ELISA System is an integrated system that includes a number of dedicated modules for specific tasks such as pipetting, incubation, monitoring of absorbance, etc. Each module can be readily removed for service or replacement. Servicing of these modules (and related components such as the filter for the washer module) is described earlier in this manual.

This chapter describes how the service engineer can replace or service various components that are related to overall system operation that are generally of a mechanical nature (e.g. the Cover Hinges). It should be noted that some items are directly associated with a specific module but are not physically inside the module (e.g. the vacuum sensor is associated with the washer module); such items are discussed in the chapter describing the module. A similar chapter (Chapter 17) discusses the replacement/service of items of an electrical/electronic nature.

Servicing of the components described in this chapter require that the external covers of the system be removed.

16.2 Accessing Internal Components

16.2.1 Removing the Top Cover

The top cover (Part No. 22001230) is shown in Figure 16-1.

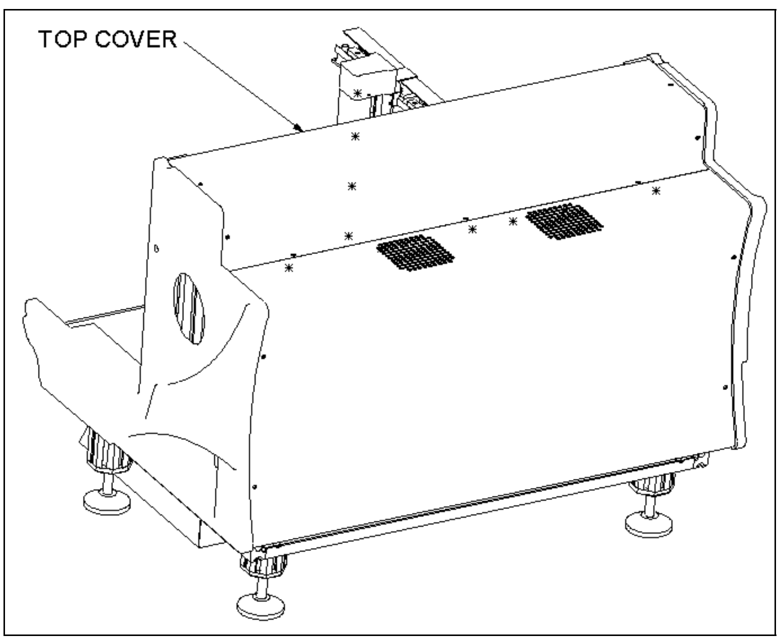

Figure 16-1 Top Cover

To Remove the Top Cover:

1 Remove the seven M5 x 10mm BHCS screws that attach it to the system.

16.2.2 Removing the Rear Cover

The rear cover (Part No. 22001220) is shown in Figure 16-2.

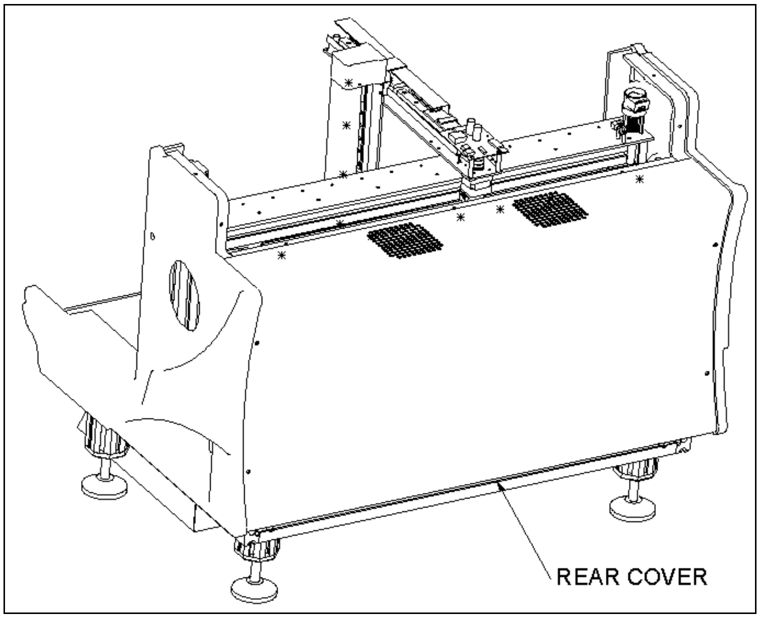

Figure 16-2 Rear Cover

To Remove the Rear Cover:

1 Remove the eight M5 X 10mm BHCS screws that attach the back cover to the system.

2 Disconnect the wires from J25 and J26 on the back plane of the system.

16.2.3 Replacing the Cover Assembly

The Cover Assembly (Part No. 13001640) is shown in Figure 16-3.

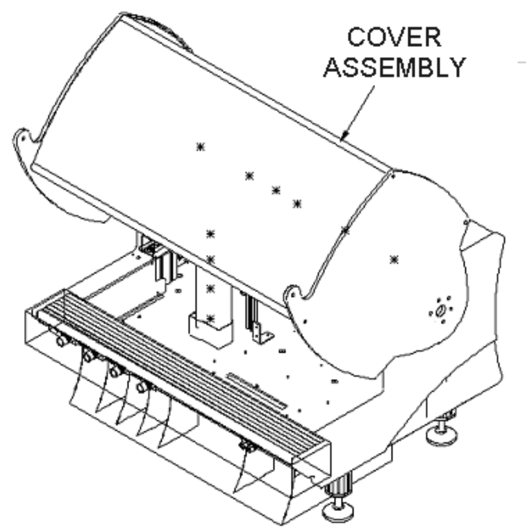

Figure 16-3 Cover Assembly

CAUTION: TWO PEOPLE ARE REQUIRED TO REMOVE AND/OR RE-INSTALL THE COVER ASSEMBLY.

To Remove the Cover Assembly:

1 Place the cover assembly in the open position (the gas springs are fully extended in this position).

2 Remove the three M8 X 25mm screws that connect the cover to the hinge assembly on each side of the cover.

3 Spread the cover assembly slightly to clear the hinge assemblies, then lift the cover off of the unit.

To Reinstall the Cover Assembly:

1 Hold the cover in the open position while spreading the cover assembly slightly to clear the hinge assemblies.

2 On one side of the cover assembly, align an Outer Cover Disc (Part No. 22001792) with the holes in the cover. Loosely install three M8 X 25mm BHCS screws and three M8 flat washers. Repeat for the other side.

3 Gently push the cover up as high as it will go. Hold in this position while tightening the six screws.

4 If there is a gap between the cover assembly and the front extrusion when the cover is closed, repeat Step **3**, then check again. Ensure that the cover lock operates properly after the installation.

16.2.4 Removing the Right Side Panel

The right side panel (Part No. 204012600) is shown in Figure 16-4.

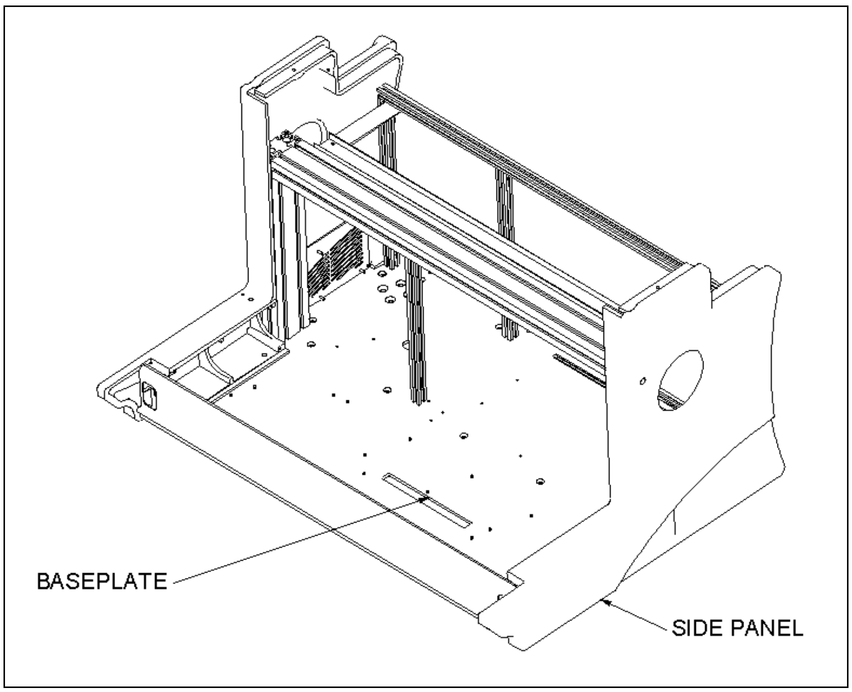

Figure 16-4 Right Side Panel

To Remove the Right Side Panel:

1. Remove the right cable cover (Part No. 204023400) by removing the four M4 x 8 BHCS Screws (Figure 16-5).
2. Remove the three M6 X 12mm BHCS screws that attach the right side panel from the top of the baseplate (two in front, one in rear) as shown in Figure 16-4.
3. Remove the M6X25mm screw and M6 flat washer from the upright extrusion spring nut.

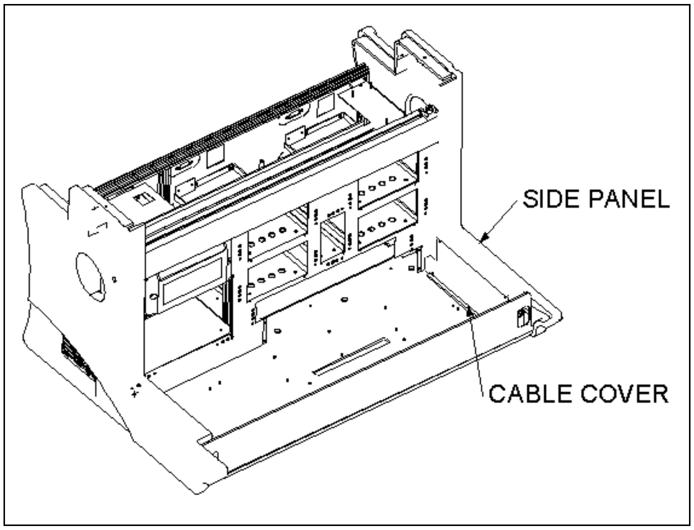

Figure 16-5 Right Cable Cover

To Replace the Right Side Panel:

1. Install the right-hand side panel enclosure (Part No. 204012600) and make sure that the spring nut in the 80 X 40 upright extrusion is aligned with hole in the side panel. If necessary, move the spring nut up (down) until it is correctly located.
2. Secure with one M6 X 25mm SHCS and M6 flat washer into the upright extrusion spring nut.
3. Secure with three M6 X 12mm BHCS screws into the top of the base plate (two in the front, one in the rear).

16.2.5 Removing the Left Side Panel

The left side panel (Part No. 204012500) is shown in Figure 16-6.

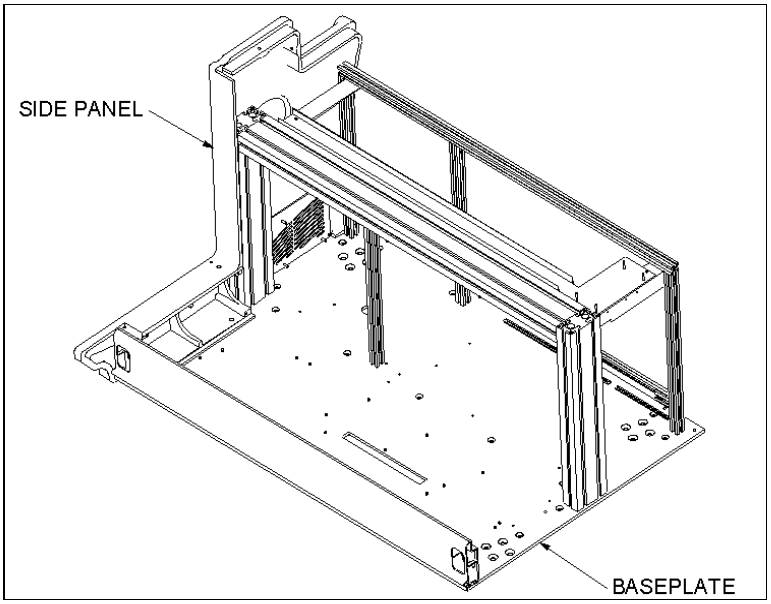

Figure 16-6 Left Side Panel

To Remove the Left Side Panel:

1 Remove the left cable cover (Part No. 204023500) by removing the four M4 x 8 BHCS Screws (Figure 16-7).

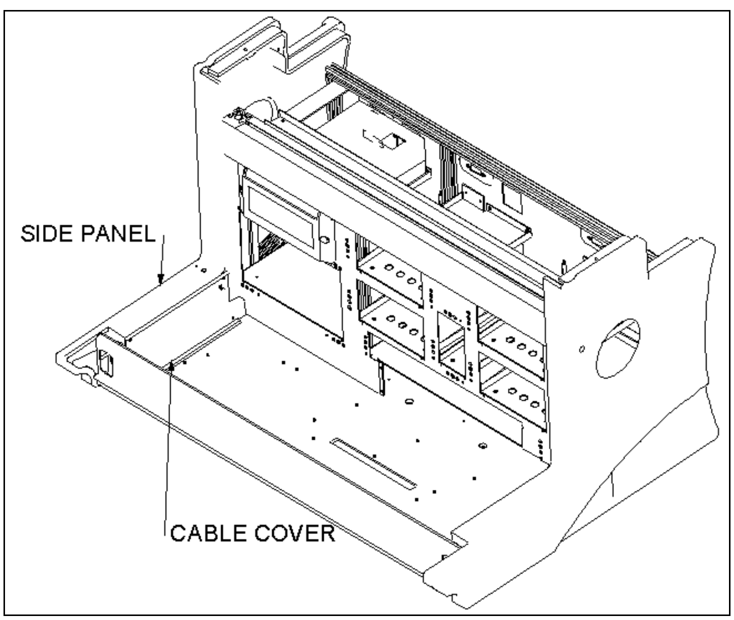

Figure 16-7 Left Cable Cover

2 Remove the three M6 X 12mm BHCS screws that attach the left side panel from the top of the baseplate (two in front, one in rear) as shown in Figure 16-6.

3 Remove the M6 X 25mm screw and M6 flat washer from the upright extrusion spring nut.

4 Disconnect dispense and aspirate tubing from the washer and pull through side panel.

To Replace the Left Side Panel

1 Install the left-hand side panel enclosure (Part No. 204012600) and make sure that the spring nut in the 80 X 40 upright extrusion is aligned with hole in the side panel. If necessary, move the spring nut up (down) until it is correctly located.

2 Secure with one M6 X 25mm SHCS and M6 flat washer into the upright extrusion spring nut

3 Secure with three M6 X 12 mm BHCS screws into the top of the base plate (two in the front, one in the rear).

4 Reroute the dispense and aspirate tubing and then reconnect the washer.

> ***Note**: It may be necessary to push the side panel to the inside as far as possible to ensure a good fit.*

16.3 Replacing the Interlock Switch

The interlock switch is used to prevent operation of the machine unless the cover is closed or the override key is inserted. The switch is located adjacent to the right hinge.

> ***Note**: The interlock switch can be overridden by inserting the override key through the slot near the right hinge of the top cover.*

To Remove the Interlock Switch:

1 Remove the cover assembly, the rear cover, and the right side panel as outlined in the previous sections.

2 Remove the harness terminals after noting their location.

3 Depress the mounting tabs on the sides of the switch to remove it from the bracket (Figure 16-8).

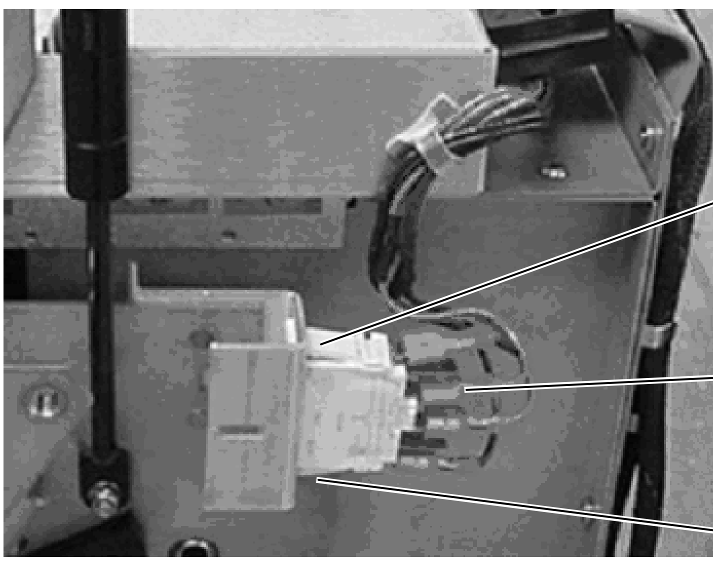

Figure 16-8 Interlock Switch

To Install a New Interlock Switch:

1 Snap the switch into the mounting bracket. Either orientation of the switch is acceptable.

2 Attach the harness terminals.

16.4 Replacing a Gas Damping Spring

Two Gas Damping Springs (Part No. 324600300) are used to support the door in the open position. Mounting of a spring is shown in Figure 16-9.

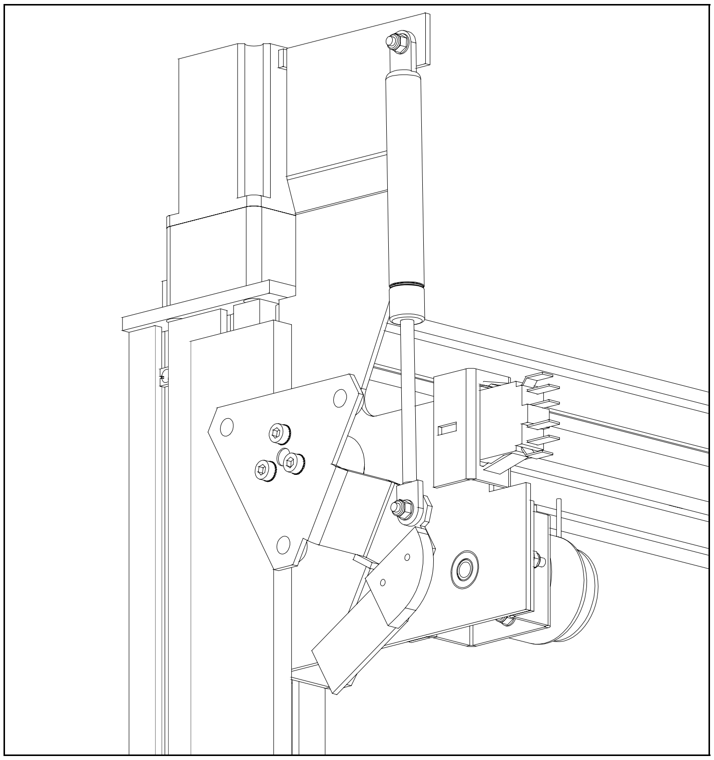

Figure 16-9 Mounting of the Gas Damping Spring

To Remove a Gas Damping Spring:

1 Remove the appropriate side panel (see *Removing the Right Side Panel* on page 16-4 or *Removing the Left Side Panel* on page 16-6).

2 Attach the Spring Compression Tool.

3 Remove the M5 Lock nuts and washers that attach the spring to the mount and the arm.

4 Slowly relieve the tension on the spring.

> ***Note**: The spring will expand when you remove it from the system.*

To Replace the Gas Damping Spring:

> ***Note**: Before you replace the springs, make certain that the arms are not rubbing against the solenoid.*

1 Compress a gas damping spring using the spring compressor jig (Part No. DSXFIX021)

2 Mount the spring to the spigots with the cylinder facing up.

3 Fasten the M5 Lock Nuts and washers.

16.5 Replacing the Left Hinge

The left hinge assembly (Part No. 13001671) is shown in Figure 16-10.

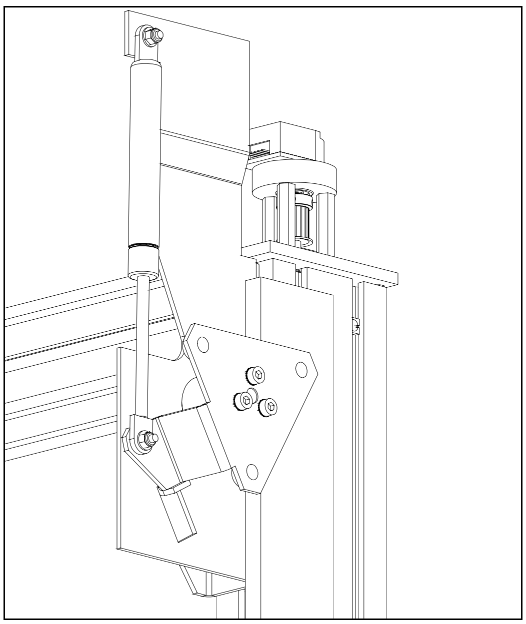

Figure 16-10 Left Hinge Assembly

To Remove the Left Hinge:

1 Remove the left side panel (see *Removing the Left Side Panel* on page 16-6).

2 Unscrew the two M6X10 Cap Head Screws (307300610) to remove the left hinge assembly.

> ***Note**: The right hinge assembly is mounted in the same manner.*

16.6 Spare Parts

Part Number	Description
22001230	Top Cover
13001640	Cover Assembly
22001220	Rear Cover
204012600	Right Side Panel
204012500	Left Side Panel
204023500	Left Cable Cover
204023400	Right Cable Cover
324600300	Gas Damping Spring
13001670	Hinge
560000500	Safety Switch
43000280	Solenoid
204027000	Plunger
42000330	Spring

16.7 Jigs

Part Number	Description
DSXFIX021	Spring Compression Tool

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Chapter 17 Electrical Support Components

17.1 Overview

The Dynex DSX™ Automated ELISA System is an integrated system that includes a number of dedicated modules for specific tasks such as pipetting, incubation, monitoring of absorbance, etc. Each module can be readily removed for service or replacement. Servicing of these of these modules (and related components such as the filter for the washer module) is described earlier in this manual.

This chapter describes how the service engineer can replace or service various components that are related to overall system operation (e.g. the Electronics Pod). Replacement/Service of the components described in this chapter may require that the external covers of the system be removed as described in Chapter 16.

17.2 Replacing the Fans

Two fans (Part No. 50800140) are installed on the rear cover of the instrument (Figure 17-1).

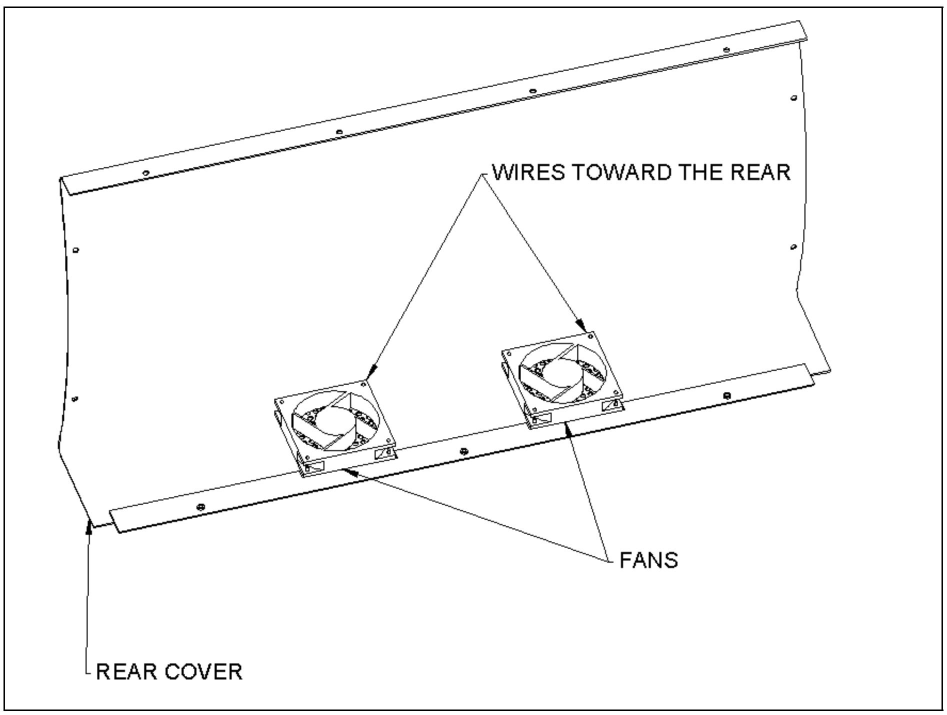

Figure 17-1 Exhaust Fans

To Remove an Exhaust Fan:

1 Remove the back cover as described in the section entitled Removing the Rear Cover on page 16-2.

2 Remove the fan cables (which are connected to J25 and J26 on the back plane board).

3 Unscrew the four M3 hex nuts and four M8 shake proof washers on the fan to be removed.

> ***Note**: When reinstalling the fan, it should be installed so that the air is forced out of the interior of the system and the wires are toward the rear.*

17.3 The Electronics Pod Assembly (EPOD)

The Electronics Pod Assembly (EPOD) provides the power to the system and provides communication between the personal computer and the various system components and sensors (e.g. the door lock). Typically, the EPOD is a replaceable module, but in certain situations, the service engineer may be required to replace components of the EPOD.

The overall design of the EPOD is shown in Figure 17-2.

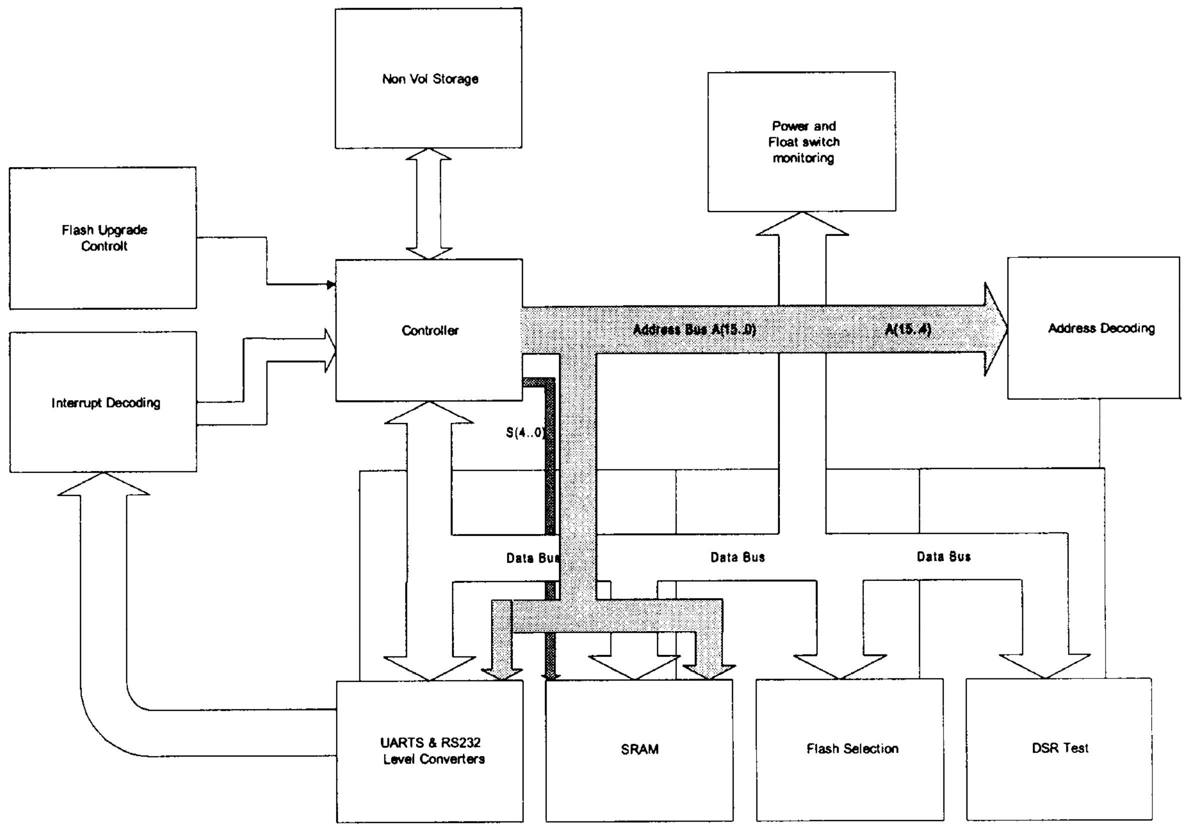

Figure 17-2 Circuit Block Diagram for the EPOD

17.3.1 Major Components of the EPOD

MICROCOMPUTER - Overall operation of the module is based on the Hitachi H8/3337F single-chip microcomputer. This microcomputer provides 60Kbytes of Flash ROM and 2Kbytes of RAM. The H8/3337F has the following internal peripheral capabilities:

- 9 ports, providing 58 I/O and 8 Input lines
- Two 8-bit timers (TMR0, TMR1)
- One 16-bit free-running counter (FRC)
- Two digital to analog channels (DA0, DA1), with 8-bit resolution
- Eight analog to digital channels (AN0 through AN7), with 10-bit resolution
- Two serial communications channels (COM0, COM1)
- Two pulse width modulation channels (PWM0, PWM1)

The H8/3337Y XTAL operating frequency is 16 MHz.

SERIAL COMMUNICATIONS WITH CONTROLLER – Commands and test data are transferred between the H8 and the external PC controller via a serial RS-232 interface. Interface drivers and receivers are used between the COM1 serial communications channel on the H8 and the interface connector to provide proper RS-232 signal levels to the controller. DTR is signalled via Port 6-7 and DSR is received on Port 6-5

VOLTAGE GENERATION AND REGULATION – DC voltage of +12 volts +/- 5% is provided to the Comm Module from a power supply that is built into the EPOD. A linear regulator converts the 12v to 5 volts to drive the logic devices.

17.3.2 Removing the EPOD

1. Remove the line power cord and the communications cable to the personal computer from the EPOD.
2. Remove the drawer module.
3. Remove the racks from the right side of the workspace and then remove the plate on the right rear side of the workspace.
4. Push the EPOD from the rear to release it from the back plane board. Considerable force is required to release the connectors from the socket in the back plane board.
5. Once the EPOD is freed from the back plane board, continue pushing it toward the front of the unit and angle it up to remove it from the system. It may be necessary to open the front extension to allow enough room for the EPOD to be removed.

17.3.3 Replacing Components in the EPOD

If it is necessary to access the interior of the EPOD, remove the lid by removing unscrewing the six M3 x 6mm Button Head screws. An internal view of the EPOD is presented in Figure 17-3.

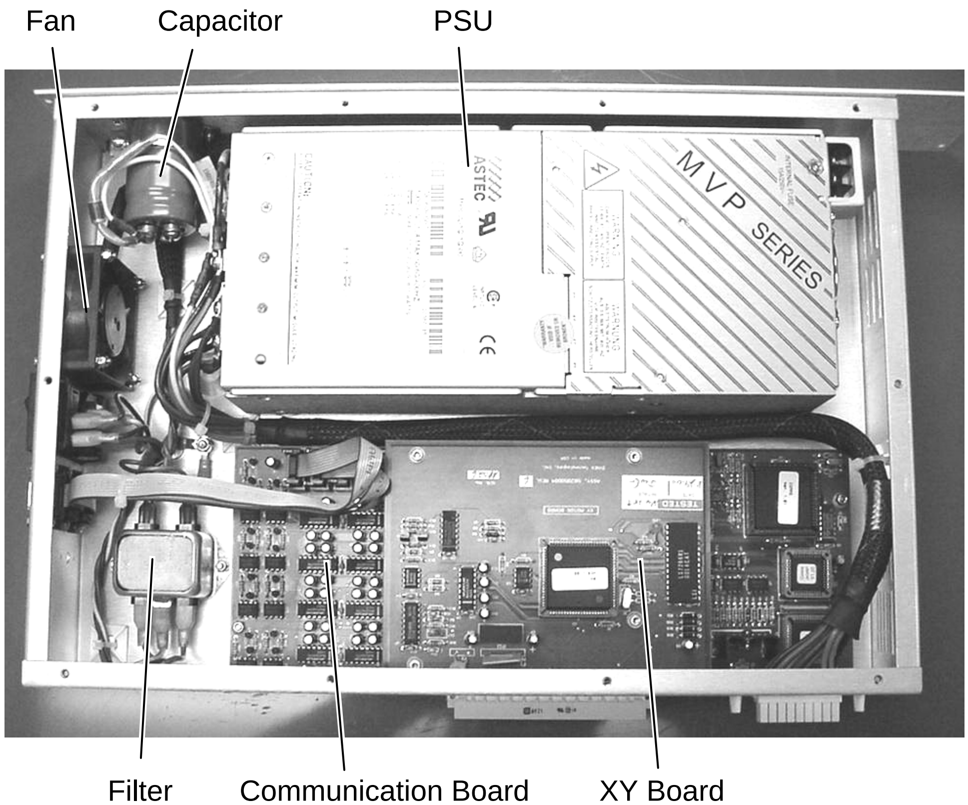

Figure 17-3 Interior of EPOD

17.3.3.1. Removing and Replacing the Inlet Switch

The Inlet Switch is shown in Figure 17-4.

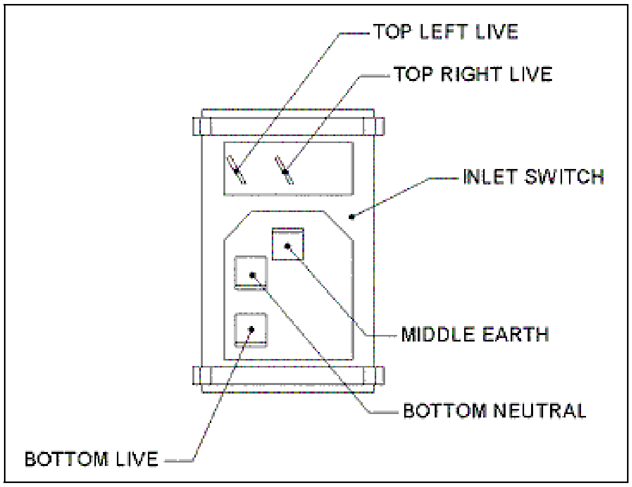

Figure 17-4 Inlet Switch

The Inlet Switch is mounted as shown in Figure 17-5.

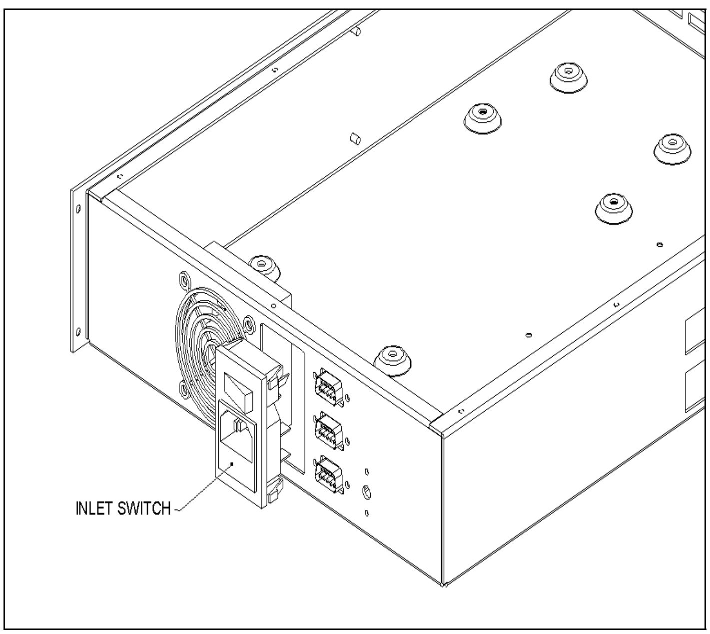

Figure 17-5 Inlet Switch Position

To Replace the Inlet Switch:

1 Remove the wires from the component that is to be replaced. The wiring for these components is as follows:

- The free end of brown Live Harness (Part No. 15001300) from the filter is connected to the Top Left Live terminal on Inlet Switch (Part No. 50500150).
- The free end of blue Neutral Harness (Part No. 15001310) is connected from the filter to the Bottom Neutral terminal on the Inlet Switch (Part No. 50500150).
- The ring terminal of the green/yellow Short Earth Harness (15001290) is connected from the Inlet Switch to the earth stud using one M4 Shakeproof Washer and one M4 Hex Nut with washer and nut on top of lug.

2 Remove the inlet switch by pushing it out of the enclosure from the inside.

> ***Note****: When replacing the inlet switch, make certain that the fuse (Part No. 50200490) is in inserted into the switch.*

17.3.3.2. Removing and Replacing the Inlet Filter

The inlet filter (Part No. 50500160) is mounted on a Tyrap base that is located in the approximately 7 mm from each corner as shown in Figure 17-6.

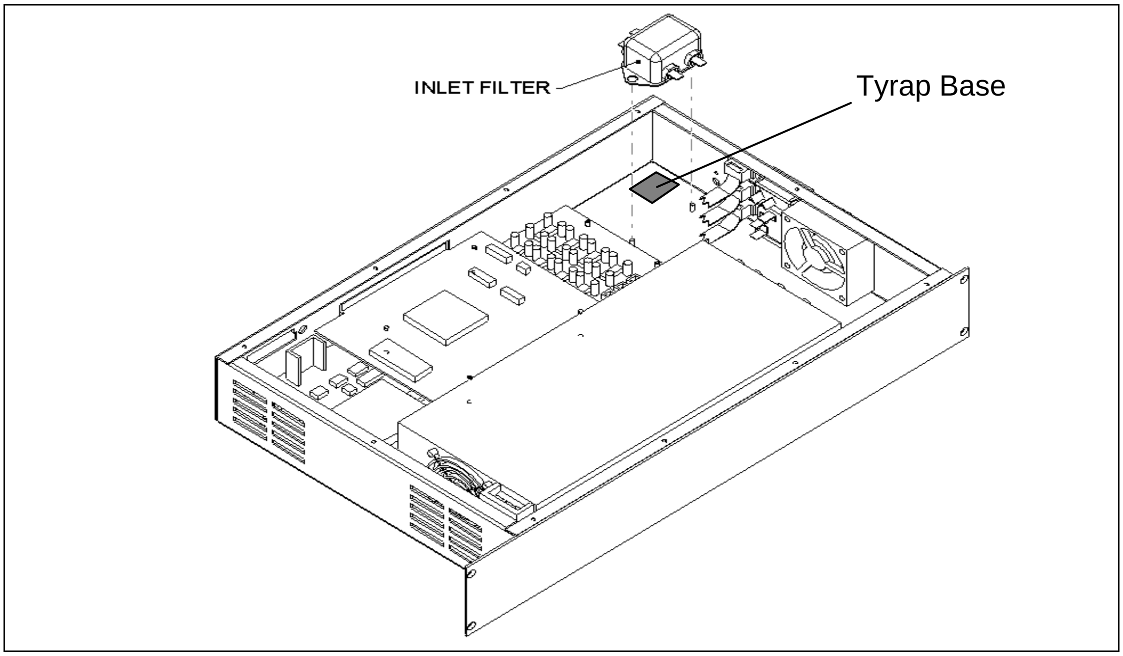

Figure 17-6 Inlet Filter

To Replace the Filter

1 Remove the two M3 Nyloc Nuts and Two M3 Flat Washers, then remove the wires from the filter.

2 One end of brown Live Harness (Part No. 15001300) is connected to P (Line Side) terminal on the filter.

3 One end of blue Neutral Harness (Part No. 15001310) is connected to N (Line Side) terminal on the filter.

4 The terminal end of green/yellow Long Earth Harness (Part No. 15001280) is connected to the Middle Earth terminal on the Filter, and twisted together with wires of brown Live Harness and blue Neutral Harness already connected to filter.

5 The ring terminal of green/yellow Long Earth Harness (Part No. 15001280) from filter and ring terminal of green/yellow wire from PSU/Filter Harness (Part No. 15001260) is attached to the earth stud in bottom of enclosure using one M4 Shakeproof Washer and one M4 Hex Nut with washer and nut on top of lugs. Make sure that the ring terminal of wire from PSU/Filter is the topmost lug on stud.

6 The free end of the twisted brown wire from the PSU/Filter Harness is connected to the P (Load Side) terminal on the Filter.

7 The free end of the twisted blue wire from the PSU/Filter Harness is connected to the N (Load Side) terminal on the Filter.

8 When reinstalling the filter, orient it so that the two-terminal side faces the capacitor in the EPOD enclosure.

17.3.3.3. Removing and Replacing the EPOD Fan

The fan (Part No. 42200300) and fan grill (Part No. 6540154003) are fitted on the enclosure as shown on Figure 17-7.

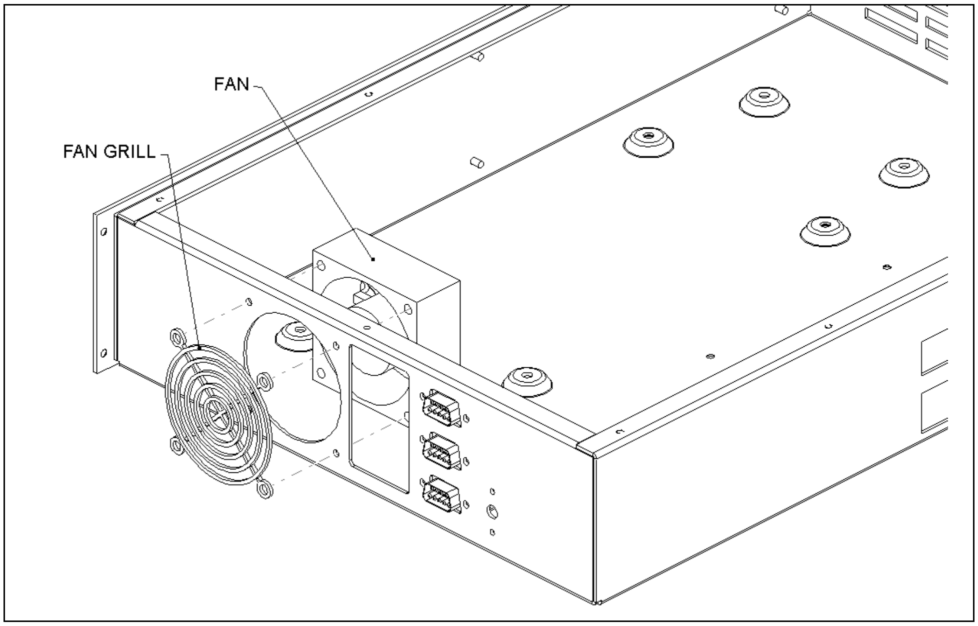

Figure 17-7 Fan Installation

The fan is secured using four M3 X 35mm Pan Head screws with four M3 Flat washers and four M3 Nyloc Nuts. The red wire from the fan is attached to V3 positive (+) and the black wire from the fan is attached to V3 negative (-) on the power supply.

When reinstalling the fan, feed wires of Fan through 175mm of Shrink Wrap Jacket (Part No. 6540060001). The fan and fan grill (Part No. 6540150003) onto the enclosure as shown, and secure using four M3X35 Pan Head Screws with four M3 Flat Washers on the outside of the enclosure and four M3 Nyloc Nuts with four M3 Flat Washers on inside of the enclosure.

***Note**: Ensure that the fan is properly installed so that fan wires are positioned on the bottom of enclosure and towards the facia plate of enclosure.*

17.3.3.4. Removing and Replacing the XY Printed Circuit Board

The XY printed circuit board (Part No. 528050004) is used in the movement of the X motor and the Y motor (either motor can be driven individually or both can be driven together). The board is mounted on top of the communications board as shown in Figure 17-8.

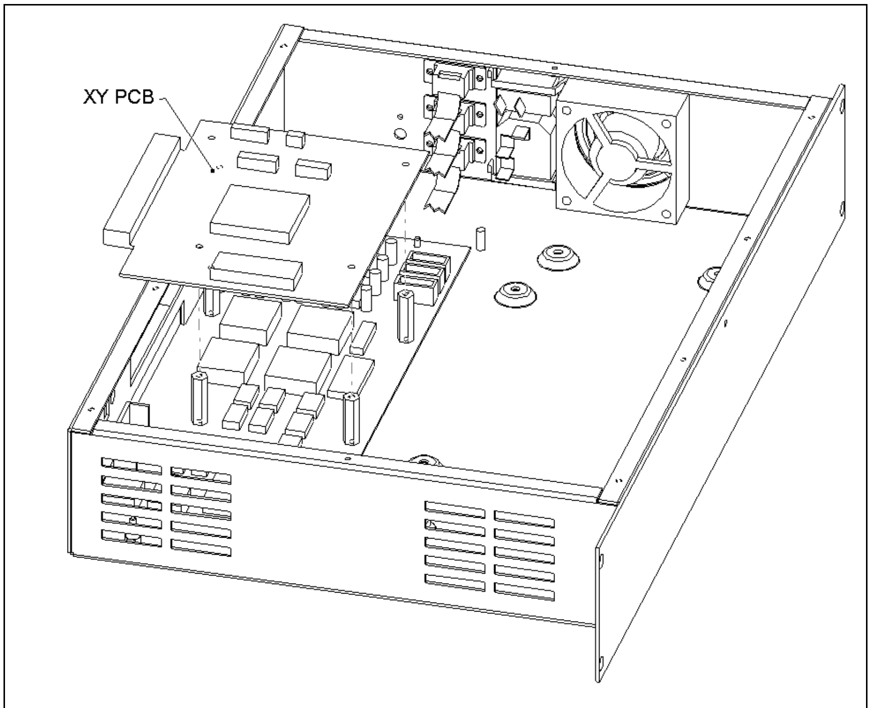

Figure 17-8 XY Printed Circuit Board

To remove the XY Printed Circuit Board, remove the four M3 X 6mm cap head screws and four M3 washers

When replacing the board, partially tighten the screws and then align the board with the PCB Alignment Fixture (Part No. EMFIX010) as shown in Figure 17-9. Tighten the four screws, then remove the fixture.

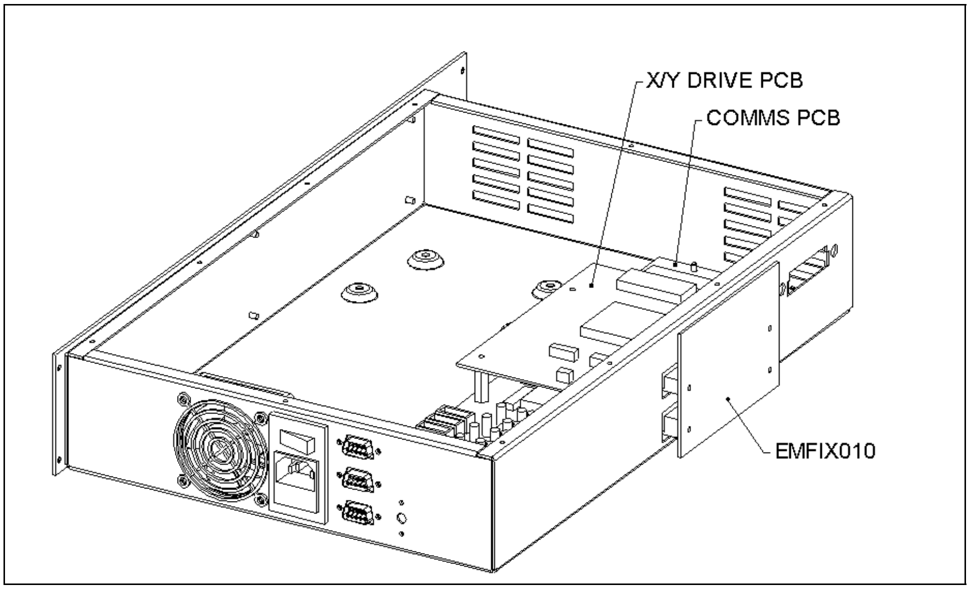

Figure 17-9 Aligning the Printed Circuit Boards

17.3.3.5. Removing and Replacing the Communications Board

The Communications Board receives information from the host computer and transmits it to the various devices on the DSX (e.g. the incubator). In addition, the communication board receives information from each of the various devices and transmits it to the host computer.

To Replace the Communications Board:

1 Remove the XY printed circuit board as described above.

2 Remove the four standoffs from the communications board as shown in Figure 17-10.

3 Remove the four M3 Nyloc Nuts and the four M3 plastic washers.

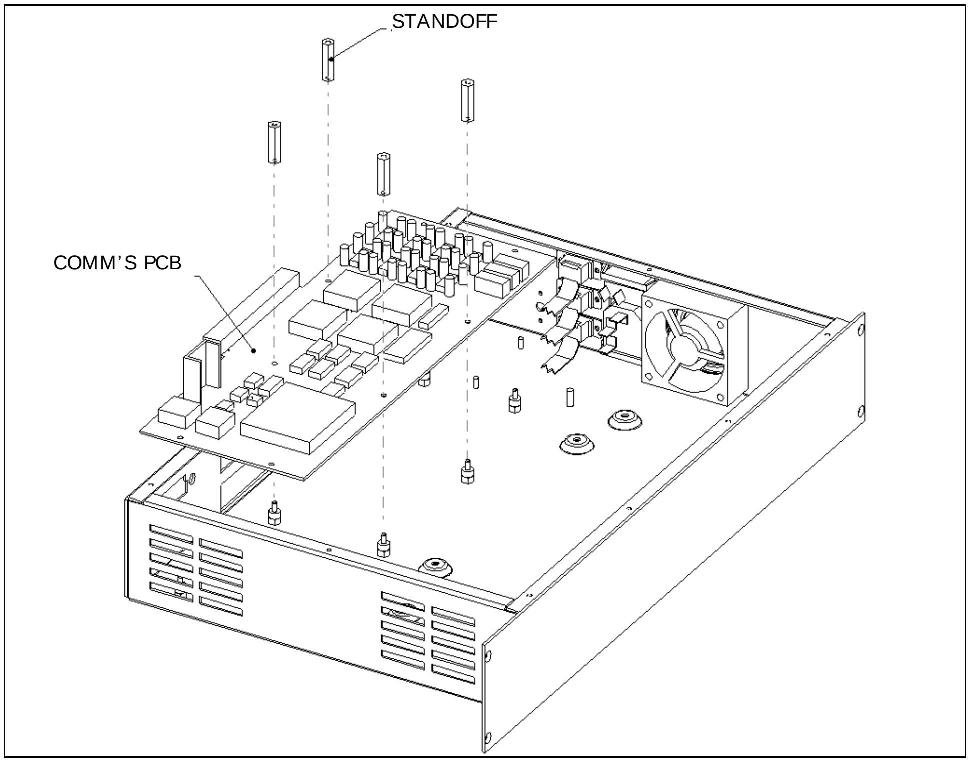

Figure 17-10 Removing the Communications Printed Circuit Board

4 Disconnect the three communication cables that connect the communications board to the right side panel (Figure 17-11).

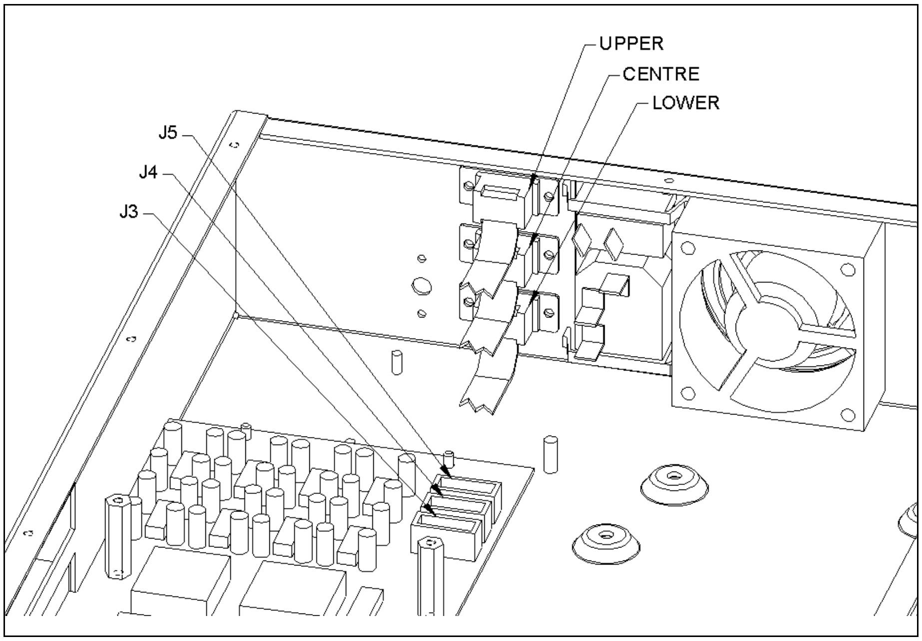

Figure 17-11 Connectors between Communication Board and Side Panel

> ***Note**: When installing a new board, align the printed circuit boards as described in Figure 17-9.*

17.3.3.6. *Removing and Replacing the Capacitor*

The 18,000 µF @ 35V DC capacitor (Part No. 50100153) is mounted on the side of the EPOD as shown in Figure 17-12.

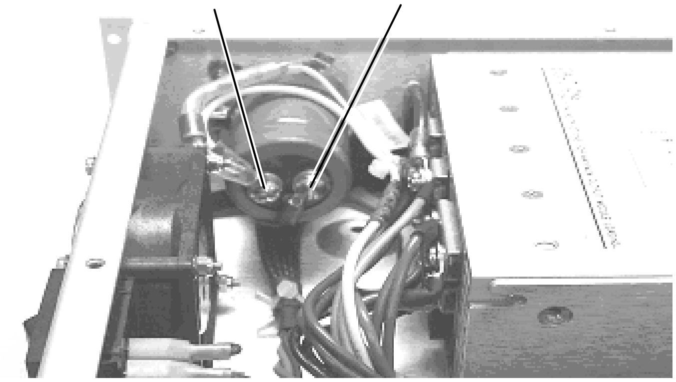

Figure 17-12 Capacitor

To Replace the Capacitor:

1. From the positive terminal, remove the single yellow wire from the backplane harness and the lug with the diode on the end of the yellow wire harness.
2. From the negative terminal, remove the blue wire harness with the large lug end
3. Loosen the M3 nut on the top most stud of the mounting bracket closest to the corner of the enclosure.
4. Loosen the clamp screw on the capacitor-mounting bracket (Figure 17-13).

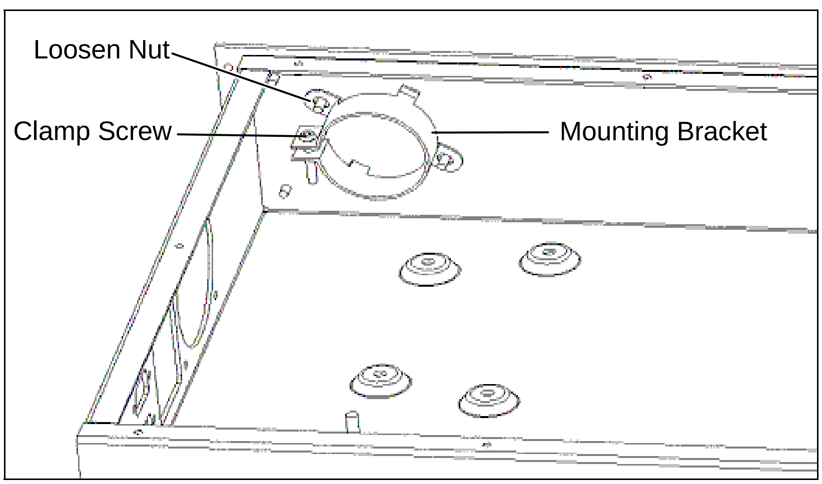

Figure 17-13 Capacitor Bracket

5 When reinstalling the capacitor, add a small drop of Loctite 222 to the inside of the clamp screw and tighten until the capacitor is snug in the mounting bracket. DO NOT OVERTIGHTEN the clamp screw or the capacitor can be crushed.

6 Tighten the M3 nut inside the top-most stud of the mounting bracket closest to the enclosure to secure the capacitor and complete the mounting bracket installation.

17.3.3.7. Removing the Power Supply Unit

To Remove the Power Supply Unit:

1 Remove the four M4 X 6mm screws and four flat head washers that attach the power supply to the enclosure.

2 Remove the Power Supply Unit (PSU) filter harness to the AC input terminals (Figure 17-14) of the power supply as follows:

- Blue wire ring terminal to the Neutral terminal on the PSU
- Brown wire ring terminal to the Live terminal on the PSU
- Green/yellow ring terminal to Earth terminal on the PSU

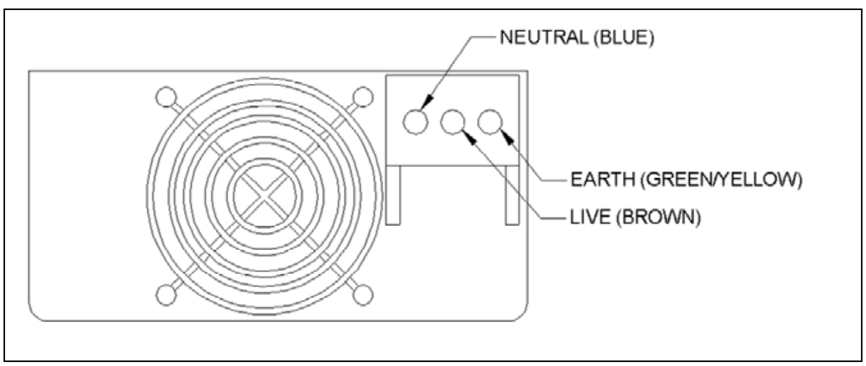

Figure 17-14 AC Input Terminals

3 Remove the backplane harness (Part No. 15001250) and PSU harness (Part No. 412001900) from the DC output terminals of the Power Supply Unit (Figure 17-15).

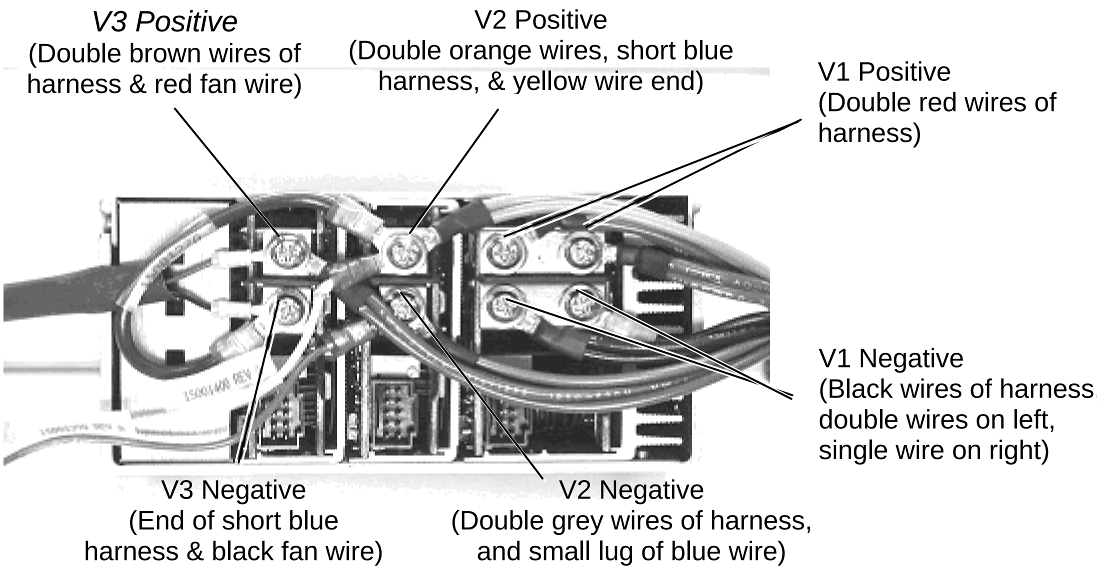

Figure 17-15 DC Output Terminals

To Reinstall the Power Supply Unit:

1 Connect the Back Plane harness, PSU harness and DC output terminals as follows:

a) Attach two double red wires of harness to V1 POSITIVE (one ring terminal to each screw).

b) Attach black wires of harness to V1 NEGATIVE (double wires on the left and single wire on the right).

c) Attach double orange wires of harness with the short blue harness, and yellow wire end of harness to V2 POSITIVE.

d) Attach double grey wires of harness and small lug end of blue wire to V2 NEGATIVE.

e) Attach double brown wires of harness (Part No. 15001250) and red wire from fan to V3 POSITIVE.

f) Attach other end of the short blue harness (Part No. 15001270) and black wire from fan to V3 NEGATIVE

g) The single yellow wire from the backplane harness and the free end of the yellow harness with the diode should be attached to the positive (+) terminal of the capacitor.

> ***Note**: When the backplane harness is installed, make certain that it is secured in a manner so that is not in contact with Crystal (X1) on the Communications printed circuit board.*

h) The free end of the single blue wire harness with the large lug should be attached to the negative (-) terminal of the capacitor. Use two terminal screws and two lock washers supplied with the capacitor (the lugs are placed on top of the lockwashers, tighten to 12 in/lbs with a torque driver.

2 Place the PSU in the enclosure and use the four M4 flat washers and four M4 x 6 button head screws to attach the PSU to the body. Use Loctite 222 to secure the screws.

> ***Note**: Before closing the Power Supply Unit, make certain that the ground wires from the filter, the power input and the power supply filter harness are firmly connected to the ground.*

17.4 Cabling

The back plane includes a series of cables and the back plane board that connect the EPOD to the various modules in the DSX system.

> ***Note**: The grooved side of all cables must face down or left. When a cable is installed, make certain to tie it down to the position it was removed from as it*

The location of these cables is presented in Figure 17-16 and Figure 17-17.

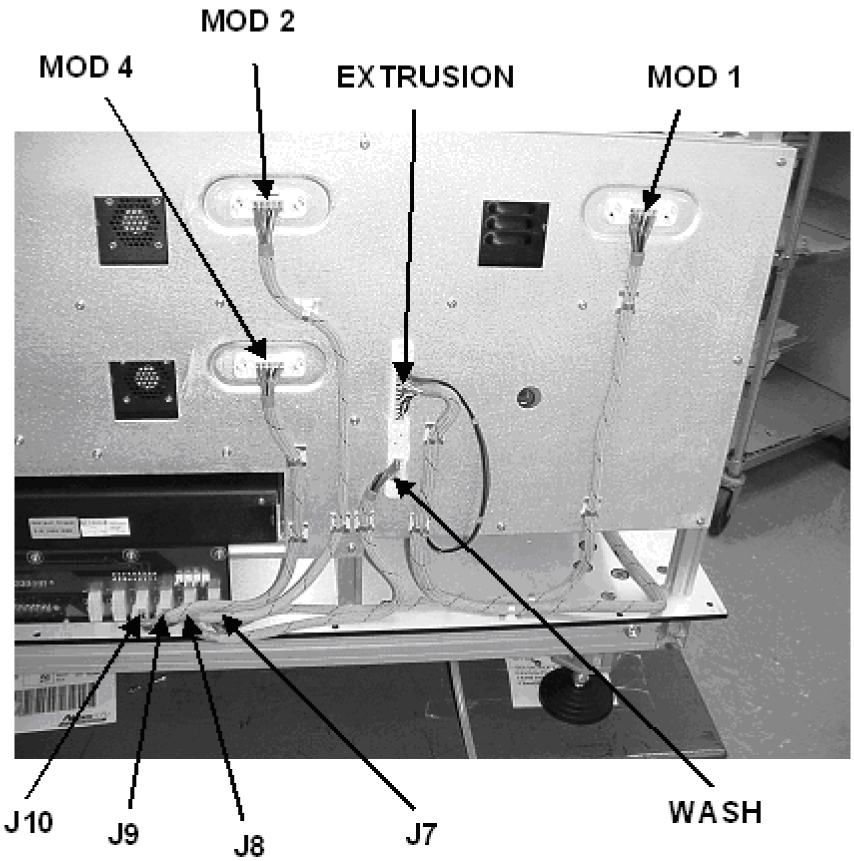

Figure 17-16 Back Panel Cabling - Panel 1

- Cable (Part No. 15001070) is connected from MOD 1 to J7 of back plane board
- Cable (Part No. 15001050) is connected from WASH to J8 of back plane board
- Cable (Part No. 15001060) is connected from MOD 2 to J9 of back plane board
- Cable (Part No. 15001050) is connected from MOD 4 to J10 of back plane board
- The front cover extrusion harness is connected into the EXTRUSION slot.
- Connect black and red wires from extrusion harness to pump wires.

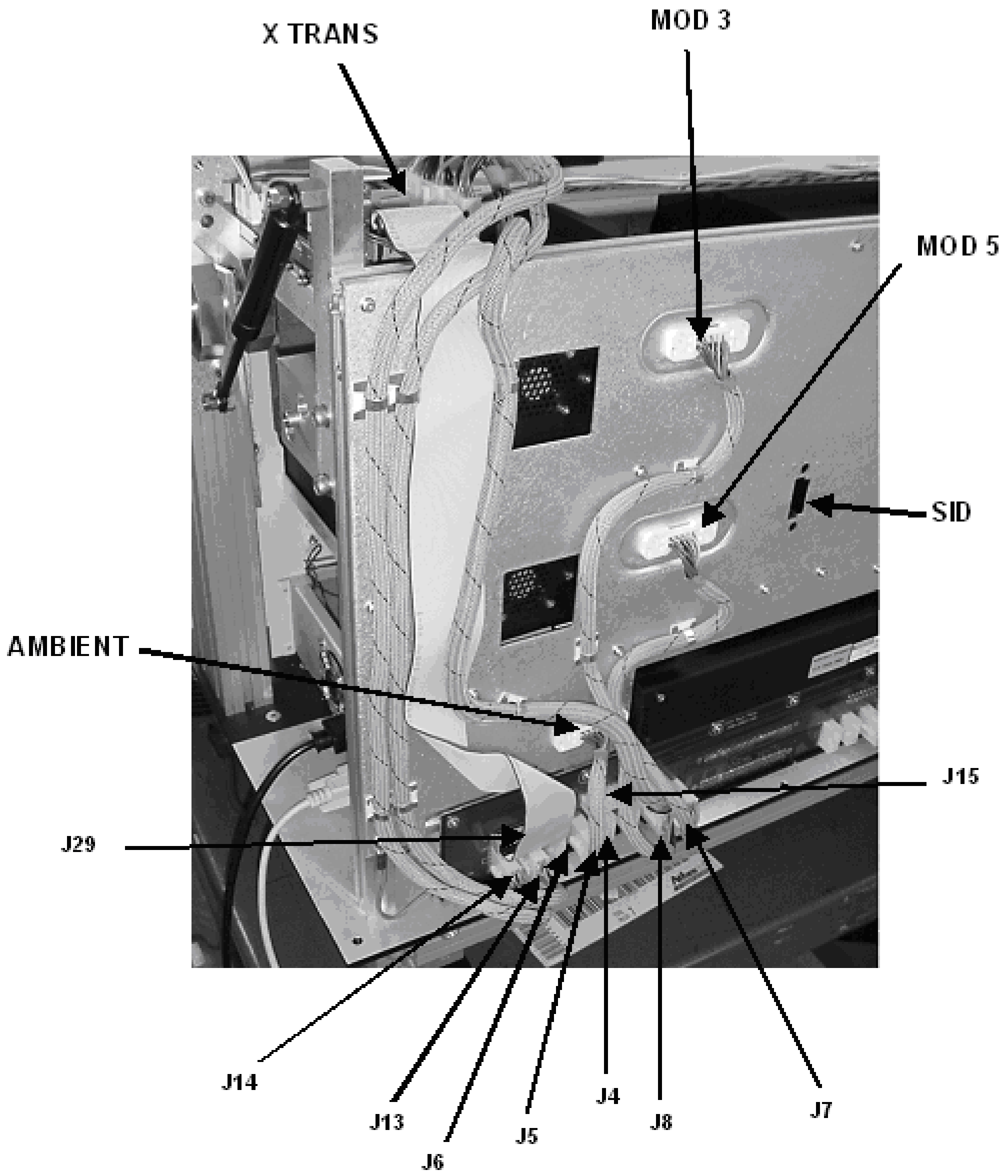

Figure 17-17 Back Panel Cabling - Panel 2

- Cable (Part No. 15001090) is connected from J3 on X-transition to J14 on back plane board
- Cable (Part No. 15001090) is connected from J2 on X-transition to J13 on back plane board
- Cable (Part No. 15001100) is connected from J15 on X-transition to J15 on back plane board
- Ribbon cable (Part No. 15001110) is connected from J7 of X-transition board to J29 on back plane board
- Cable (Part No. 150001040) is connected from ambient hole to J3 of back plane board

- Cable (Part No. 15001050) is connected from MOD 5 to J5 of back plane board
- Cable (Part No. 15001060) is connected from MOD 3 to J6 of back plane board
- Cable (Part No. 15001060) is connected from SID to J4 of back plane board (if required).
- Cable from the panel indicator LED is connected to J24 of the back plane board

17.5 Spare Parts and Jigs

17.5.1 EPOD (13001410)

Part Number	Description
50800140	Fan
13001410	EPOD
50500150	Inlet Switch
15001300	Live Harness
15001310	Neutral Harness
15001280	Long Earth Harness
15001260	PSU/Filter Harness
50200490	Fuse
50500160	Inlet Filter
42200300	EPOD Fan
654015003	EPOD Fan Grill
528050004	XY Printed Circuit Board
582050104	Communication Board
50100153	18,000 µf @35 v DC Capacitor
412001900	Power Supply
15001070	Cable - MOD 1 to J7 (BP)
15001050 15001050 15001050	Cable - WASH to J8 (BP) MOD 4 to J10 (BP) MOD 5 to J5 (BP)
15001060 15001060 15001060	Cable - MOD 2 to J9 (BP) MOD 3 to J6 (BP) SID to J4 (BP)
15001100	Cable - J15 X-Transition Board to J15 (BP)
15001090 15001090	Cable - J3 X-Transition Board to J14 (BP) J2 X-Transition Board to J13 (BP)
15001110	Cable - J7 X-Transition Board to J29 (BP)
15001040	Cable - Ambient Hole to J3 (BP)
15001250	Backplane Harness
582050703	Backplane Board

17.6 Jigs

Part Number	Description
EMFIX010	PCB Alignment Fixture

Chapter 18 Index

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