

ProtoTRAK® FHM5 & FHM7

Safety, Installation, Maintenance, Service & Parts List Manual

Document: P/N 25083
Version: 081513



Southwestern Industries, Inc.

2615 Homestead Place

Rancho Dominguez, CA 90220

T | 310.608.4422 | F | 310. 764.2668

Service Department: 800.367.3165

e-mail: sales@southwesternindustries.com | service@southwesternindustries.com

web: southwesternindustries.com

Copyright © 2012, Southwestern Industries, Inc. All rights are reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, mechanical, photocopying, recording or otherwise, without the prior written permission of Southwestern Industries, Inc.

While every effort has been made to include all the information required for the purposes of this guide, Southwestern Industries, Inc. assumes no responsibility for inaccuracies or omission and accepts no liability for damages resulting from the use of the information contained in this guide.

All brand names and products are trademarks or registered trademarks of their respective holders.

Southwestern Industries, Inc.

2615 Homestead Place
Rancho Dominguez, CA 90220-5610
Phn 310.608.4422 ◆ Fax 310.764.2668

Service Department

Phn 800.367.3165 ◆ Fax 310.886.8029

Table of Contents

1.0 Safety			
1.1	Safety Publications	1	
1.2	Danger, Warning, Caution, Note Labels & Notices as Used in this Manual	1	
1.3	Safety Precautions	3	
2.0 Installation			
2.1	Floor Plan, Layout & Space Requirements	5	
2.2	Uncrating	7	
2.3	Shortages: Inventory Checklist	8	
2.4	Installation Instructions & Checklist	9	
2.5	Machine Specifications	10	
2.6	Maximum Work Capacities	11	
2.7	ProtoTRAK SMX Control Hardware	11	
2.8	Lifting and/or Moving the Machine	14	
	2.8.1 Lifting the Machine	16	
2.9	Releasing the Head Counterweight Supports	17	
	2.9.1 Releasing Supports	17	
2.10	Cleaning	18	
2.11	Leveling: Tolerance for FHMV is .0005"/10"	18	
2.12	Electrical Connection	19	
	2.12.1 Phase Converters	20	
2.13	Air Connection	20	
2.14	Mounting the Display Pendant	22	
2.15	Cable Interconnections	22	
2.16	Lubrication	25	
	2.16.1 Lube Pump Operation	25	
	2.16.2 Factory Default Values	25	
2.17	ProtoTRAK SMX Euclid Block Procedure	26	
3.0 Troubleshooting by Symptom			
3.1	Problems Relating to Machining Results	28	
	3.1.1 Poor Finish	28	
	3.1.2 Circles Out of Round	29	
	3.1.3 Taper Cut on a Programmed Straight Line Move	30	
	3.1.4 Parts Have Incorrect Dimensions	30	
3.2	Problems Regarding Motion of Machine	32	
	3.2.1 Run Away Axis	32	
	3.2.2 Slow Down Axis	32	
	3.2.3 Axis Will Not Jog	33	
	3.2.4 Axis Motor Motion Is Not Smooth	33	
	3.2.5 Vibration in Motion	34	
3.3	Problems Relating to Operation of Control	34	
	3.3.1 Display Blanks	34	
	3.3.2 Bad Picture on Display	35	
	3.3.3 Keyboard Lockup	35	
	3.3.4 Fault X, Y or Z	35	
	3.3.5 Problems Reading Floppy Disk	36	
	3.3.6 System Will Not Turn on or Boot Up	36	
	3.3.7 System Reboots by Itself	37	
	3.3.8 System Shuts Off	37	
	3.3.9 Will Not Hold Calibration	37	
	3.3.10 Auxiliary Functions Not Working	38	
	3.3.11 E-Stop Error	38	
	3.3.12 Limit Switch Error	39	
3.4	Problem with the Measurements	40	
	3.4.1 X, Y & Z-Axis Measurements Do Not Repeat	40	
	3.4.2 X, Y & Z-Axis Measurements Are Not Accurate	41	
	3.4.3 The DRO Is Not Counting	41	
	3.4.4 X, Y & Z-Axis DRO Counting in Wrong Direction	42	
	3.4.5 X, Y and Z-Axis Electric Hand-wheels Turn in Wrong Direction	42	
3.5	Problems with the Machine Tool	42	
	3.5.1 Z-Axis Noisy	42	
	3.5.2 Spindle Stalls or Turns Off During Machining	43	
	3.5.3 Spindle Motor Hums or Will Not Run	43	
	3.5.4 Spindle Runs Backwards	44	
	3.5.5 Head Noise	44	
4.0 Diagnostics			
4.1	The Machine Tool & Set-Up	46	
	4.1.1 The Milling Machine Checklist	46	
	4.1.2 A Special Word About X/Y/Z Gibs	47	
	4.1.3 Lubrication	47	
	4.1.4 Machining Set-Up	47	
4.2	The Mechanical Drive Train (X, Y)	48	
	4.2.1 Keys to Ball Screw Alignment	50	
4.3	Computer/Pendant Diagnostics	51	
	4.3.1 Checking Floppy Drive	52	
4.4	Motor Diagnostics	52	
	4.4.1 Cable Connections	52	
	4.4.2 To Check the Motor Encoders	52	
	4.4.3 Encoder Counts to Pendant	52	
	4.4.4 Moving Problem From One Axis to Another	53	
4.5	Servo Drivers	53	
4.6	Glass Scales	54	
	4.6.1 Alignment of Scales	54	
	4.6.2 Measurements Do Not Repeat	54	
4.7	TRAK Sensors FHM5 Only	56	
	4.7.1 Faulting Axis	56	
	4.7.2 Measurements Do Not Repeat	56	
4.8	Electrical	58	
	4.8.1 Main Electrical Box	58	
	4.8.2 Checking AC Voltage	60	
	4.8.3 Checking Fuses	60	
	4.8.4 Cable Breakout Box Connections	61	
	4.8.5 Cable Connections	61	
	4.8.6 Spindle Control Module LEDs	61	
4.9	Service Codes	62	
	4.9.1 Software Codes	62	
	4.9.2 Machine Set-up Codes	64	
	4.9.3 Diagnostic Codes	68	
	4.9.4 Operator Defaults/Options Codes	69	
	4.9.5 Lube Pump Codes	70	

5.0	Procedures for Replacements & Maintenance	
5.1	Replacements	71
5.1.1	Servo Motor Replacement	71
5.1.2	Servo Driver Replacement	71
5.1.3	Computer Module & LCD Enclosure Replacement	72
5.1.4	System Flash Disk Replacement	76
5.1.5	AC Drive Replacement	77
5.1.6	Cable Routing in on Machine	77
5.1.7	Electronic Handwheels	78
5.1.8	TRAK Sensor (FHM5 Only)	78
5.1.9	Glass Scale Replacement	81
5.1.10	Power Drawbar	83
5.1.11	Ball Screw Replacement, X-Axis (Table), FHM5	85
5.1.12	Ball Screw Replacement, X-Axis (Table), FHM7	87
5.1.13	Ball Screw Replacement, Y-Axis FHM5	91
5.1.14	Ball Screw Replacement, Y-Axis (Saddle), FHM7	93
5.1.15	Z-Axis Ball Screw Removal & Replacement	98
5.1.16	Air Solenoid Replacement	104
5.1.17	Spindle Motor Replacement -FHM5	104
5.1.18	Spindle Motor Replacement - FHM7	107
5.1.19	Spindle Assembly Replacement - FHM5	108
5.1.20	Spindle Assembly Replacement - FHM7	109
5.1.21	Spindle Motor Wiring	111
5.2	Maintenance	112
5.2.1	Gib Adjustments	112
5.2.2	Calibration & Backlash Constants	118
5.2.3	Tramming the Head	120
5.2.4	X, Y & Z Limit Switch Adjustments	121
6.0	Parts Lists & Drawings	
6.1	Counter Balance System Drawing	126
6.2	Lubrication System Drawings	127
6.3	Bed Parts List	131
6.4	Table/Saddle Spare Parts List	131
6.4.1	Table/Saddle Spare Parts List	131
6.5	Manual Ram Elevation Drawing	132
6.6	Coolant Pump Mounting	133

List of Figures

Fig. 1	Machine Footprints	5
Fig. 2	Overall Dimensions FHM5	6
Fig. 2A	Overall Dimensions FHM7	7
Fig. 3	FHMV Component Identification	12
Fig. 4	FHMV Rear View	13
Fig. 5	Lifting the Machine, Method 1	14
Fig. 6	Lifting the Machine, Method 2	15
Fig. 7	Lifting the Machine, FHM7	16
Fig. 8	Placement of Levels	19
Fig. 9	Leveling Screws	19

Fig. 10	Wiring the FHM5 & FHM7	20
Fig. 11	Air Regulator/Solenoid Assembly	21
Fig. 12	Pendant Cable Connections, Left Side	23
Fig. 13	Pendant, Right Side	24
Fig. 14	Euclid Block	27
Fig. 15	Electrical Cabinet	59
Fig. 16	Servo Driver Replacement	72
Fig. 17	Computer Module and LED Enclosure	74
Fig. 18	Flash Disk Replacement	75
Fig. 20	M5 Base Mounting	78
Fig. 21	TRAK Sensor Mounting	79
Fig. 22	FHM5 Sensor Assembly	80
Fig. 23	Glass Scale Alignment	82
Fig. 25	Power Drawbar Assembly	84
Fig. 26	FHM5 X Drive Train	86
Fig. 27	FHM7 X Drive Train	89
Fig. 28	FHM5 Y Drive Train	92
Fig. 29	FHM7 Y Drive Train	95
Fig. 30	FHM5 Z-Axis Drive Train	99
Fig. 31	FHM7 Z-Axis Drive Train	101
Fig. 31.1	FHM5 Head	106
Fig. 32	FHM7 Head	110
Fig. 33	Spindle Motor Wiring	111
Fig. 34	Table Gib & Saddle Bottom Gib Adjustment	113
Fig. 35	Saddle Side Gib Adjustment	114
Fig. 36	Ram Back Gib Adjustment	116
Fig. 37	Ram Side Gib Adjustment	118
Fig. 38	Calibration Set-Up	119
Fig. 39	Tramming the Head	121
Fig. 40	Limit Switch Installation	122
Fig. 41	Limit Switches FHM5	125
Fig. 42	Counter Balance System Drawing (FHM5)	126
Fig. 43	FHM Lubrication Drawing Pump & Ram	127
Fig. 44	FHM5 & 7 Lubrication Drawing	129
Fig. 45	Manual Ram Elevation Drawing (FHM5)	132
Fig. 46	Coolant Pump Mounting	133
Fig. 47	FHM7 Table & Saddle	134
Fig. 48	FHM7 Bed	136
Fig. 49	FHM7 Bed	137
Fig. 50	FHM7 Column Parts	140
Fig. 51	FHM7 Column Parts	141
Fig. 52	FHM7 Column Parts	142
Fig. 53	FHM7 Column Parts	143

1.0 Safety

The safe operation of the FHM Bed Mill depends on its proper use and the precautions taken by each operator.

- Read and study this manual and the *FHM Safety, Operation & Programming Manual*. Be certain every operator understands the operation and safety requirements of this machine *before* its use.
- Always wear safety glasses and safety shoes.
- Always stop the spindle and check to ensure the CNC control is in the stop mode before changing or adjusting the tool or workpiece.
- Never wear gloves, rings, watches, long sleeves, neckties, jewelry, or other loose items when operating or around the machine.
- Use adequate point of operation safeguarding. It is the responsibility of the employer to provide and ensure point of operation safeguarding per OSHA 1910.212 - Milling Machine.

1.1 Safety Publications

Refer to and study the following publications for assistance in enhancing the safe use of this machine.

Safety Requirements for Manual Milling, Drilling and Boring Machines with or without Automatic Control (ANSI B11.8-2001). Available from The American National Standards Institute, 1819 L Street N.W., Washington D.C. 20036

Concepts And Techniques Of Machine Safeguarding (OSHA Publication Number 3067). Available from The Publication Office - O.S.H.A., U.S. Department of Labor, 200 Constitution Avenue, NW, Washington, DC 20210.

1.2 Danger, Warning, Caution, Note Labels & Notices as Used in this Manual

DANGER - Immediate hazards that **will** result in severe personal injury or death. Danger labels on the machine are red in color.

WARNING - Hazards or unsafe practices that *could* result in severe personal injury and/or damage to the equipment. Warning labels on the machine are orange in color.

CAUTION - Hazards or unsafe practices that *could* result in minor personal injury or equipment/product damage. Caution labels on the machine are yellow in color.

NOTE - Calls attention to specific issues requiring special attention or understanding.



DANGER
HIGH VOLTAGE

NOTICE: The manufacture is not liable (responsible) for any damages or injury of any kind to persons or property caused by or resulting from the improper or unauthorized use, operation, maintenance, alteration, modification, change in configuration of this machine or any of its component parts, or the use of this unit with any third party accessories or parts.

.i00775

115 Volts
208-240 Volts

Safety & Information Labels Used On The FHM Bed Mill

It is forbidden by OSHA regulations and by law to deface, destroy or remove any of these labels.

SOUTH WESTERN INDUSTRIES
 2615 HOMESTEAD PLACE
 RANCHO DOMINGUEZ, CA 90220

MODEL
 S/N

ELECTRICAL RATINGS:
 VOLTS AMPS PHASE
 Hz

FLA OF LARGEST MOTOR AMPS
 SHORT CIRCUIT INTERRUPT AMPS
 ELECTRICAL DRAWING #:

CNC CONTROL ELECTRICAL RATINGS:
 IF APPLICABLE
 115 VOLTS 8 AMPS 1 PHASE
 60 Hz

MACHINE (ONLY) MADE IN "XXXXXX"

i00774

Power Requirements at 220 Volts, 3-phase 60 HZ		
Model	Full-load Amp of Machine	Full-load Amp of Largest Motor
FHM5	17.5	17.5
FHM7	37.5	37.5

1.3 Safety Precautions

1. Do not operate this machine before the *FHM Safety, Operation, & Programming Manual* has been studied and understood.
2. Do not run this machine without knowing the function of every control key, button, knob, or handle. Ask your supervisor or a qualified instructor for help when needed.
3. Protect your eyes. Wear approved safety glasses (with side shields) at all times.
4. Don't get caught in moving parts. Before operating this machine remove all jewelry including watches and rings, neckties, and any loose-fitting clothing.
5. Keep your hair away from moving parts. Wear adequate safety headgear.
6. Protect your feet. Wear safety shoes with oil-resistant, anti-skid soles, and steel toes.
7. Take off gloves before you start the machine. Gloves are easily caught in moving parts.
8. Remove all tools (wrenches, check keys, etc.) from the machine before you start. Loose items can become dangerous flying projectiles.
9. Never operate a milling machine after consuming alcoholic beverages, or taking strong medication, or while using non-prescription drugs.
10. Protect your hands. Stop the machine spindle and ensure that the CNC control is in the stop mode:
 - Before changing tools

- Before changing parts
 - Before you clear away the chips, oil or coolant. Always use a chip scraper or brush
 - Before you make an adjustment to the part, fixture, coolant nozzle or take measurements
 - Before you open safeguards (protective shields, etc.). Never reach for the part, tool, or fixture around a safeguard
11. Protect your eyes and the machine as well. Don't use a compressed air hose to remove the chips or clean the machine (oil, coolant, etc.).
 12. Stop and disconnect the machine before you change belts or pulleys.
 13. Keep work area well lighted. Ask for additional light if needed.
 14. Do not lean on the machine while it is running.
 15. Prevent slippage. Keep the work area dry and clean. Remove the chips, oil, coolant and obstacles of any kind around the machine.
 16. Avoid getting pinched in places where the table, saddle or spindle head create "pinch points" while in motion.
 17. Securely clamp and properly locate the workpiece in the vise, on the table, or in the fixture. Use stop blocks to prevent objects from flying loose. Use proper holding clamping attachments and position them clear of the tool path.
 18. Use correct cutting parameters (speed, feed, depth, and width of cut) in order to prevent tool breakage.
 19. Use proper cutting tools for the job. Pay attention to the rotation of the spindle: Left hand tool for counterclockwise rotation of spindle, and right hand tool for clockwise rotation of spindle.
 20. Prevent damage to the workpiece or the cutting tool. Never start the machine (including the rotation of the spindle) if the tool is in contact with the part.
 21. Check the direction (+ or -) of movement of the table when using the jog or power feed.
 22. Don't use dull or damaged cutting tools. They break easily and become airborne. Inspect the sharpness of the edges, and the integrity of cutting tools and their holders. Use proper length for the tool.
 23. Large overhang on cutting tools when not required result in accidents and damaged parts.
 24. Prevent fires. When machining certain materials (magnesium, etc.) the chips and dust are highly flammable. Obtain special instruction from you supervisor before machining these materials.
 25. Prevent fires. Keep flammable materials and fluids away from the machine and hot, flying chips.
 26. Interlocked table guards. Interlocked table guards may be purchased from Southwestern Industries, Inc. if deemed necessary by the user.

2.0 Installation

Read and understand this entire installation section before beginning the installation procedure.

2.1 Floor Plan, Layout & Space Requirements – FHM5 & FHM7

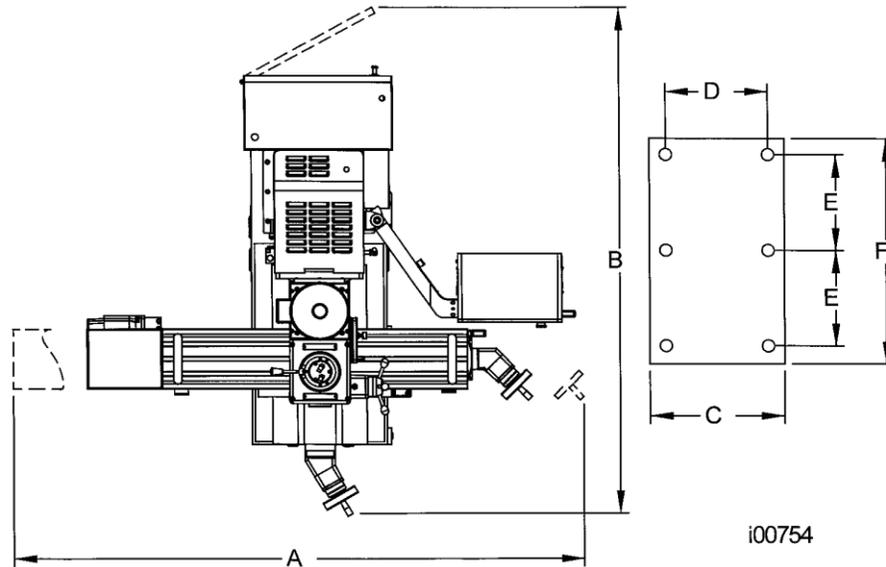
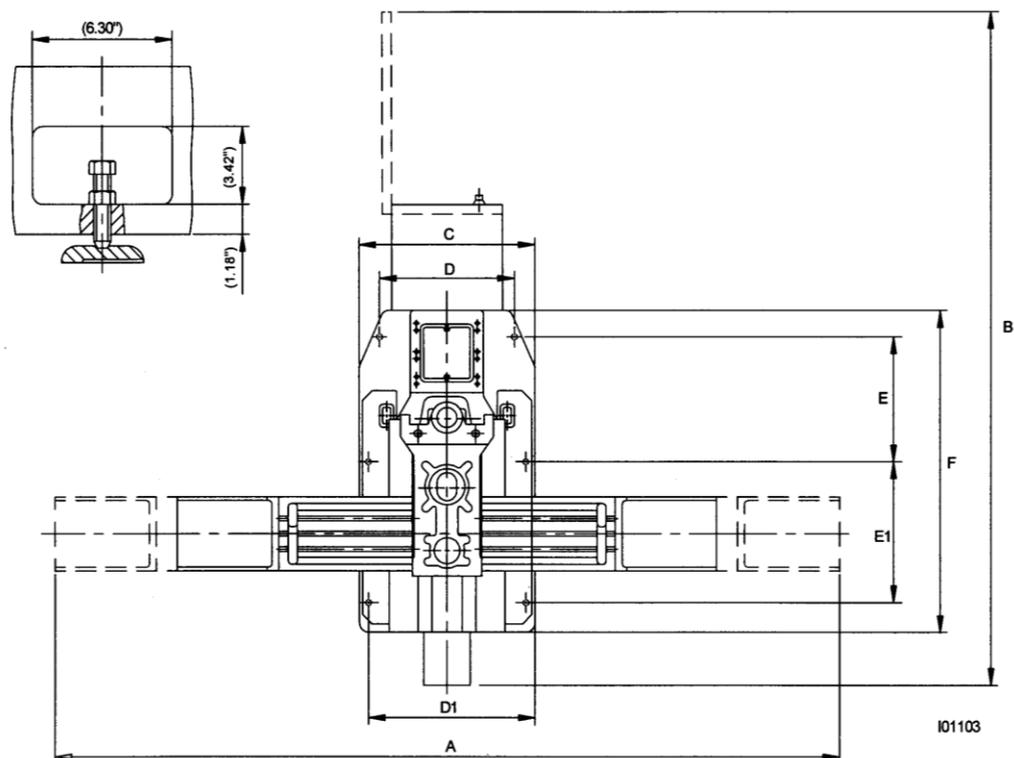


Figure 1 - FHM5 & FHM7 - Machine Footprint



	FHM5	FHM7
Footprint of Machine	24" x 48.4"	42.52" x 63"
Weight (approximate) net	4400 lbs.	7650 lbs.
Weight (approximate) shipping	4700 lbs.	7975 lbs.
Pallet Size	6' x 6'	90.5" x 84"
A Overall width	136"	171.65"
B Overall length	105"	119.5"
C Bed width	24"	42.52"
D Bed width between leveling screws	21.7"	27.87"
D1 Bed width between leveling screws	N/A	39.76"
E Distance between leveling screws	20.5"	26.57"
E1 Distance between leveling screws	N/A	26.57"
F Bed length	48.4"	63"

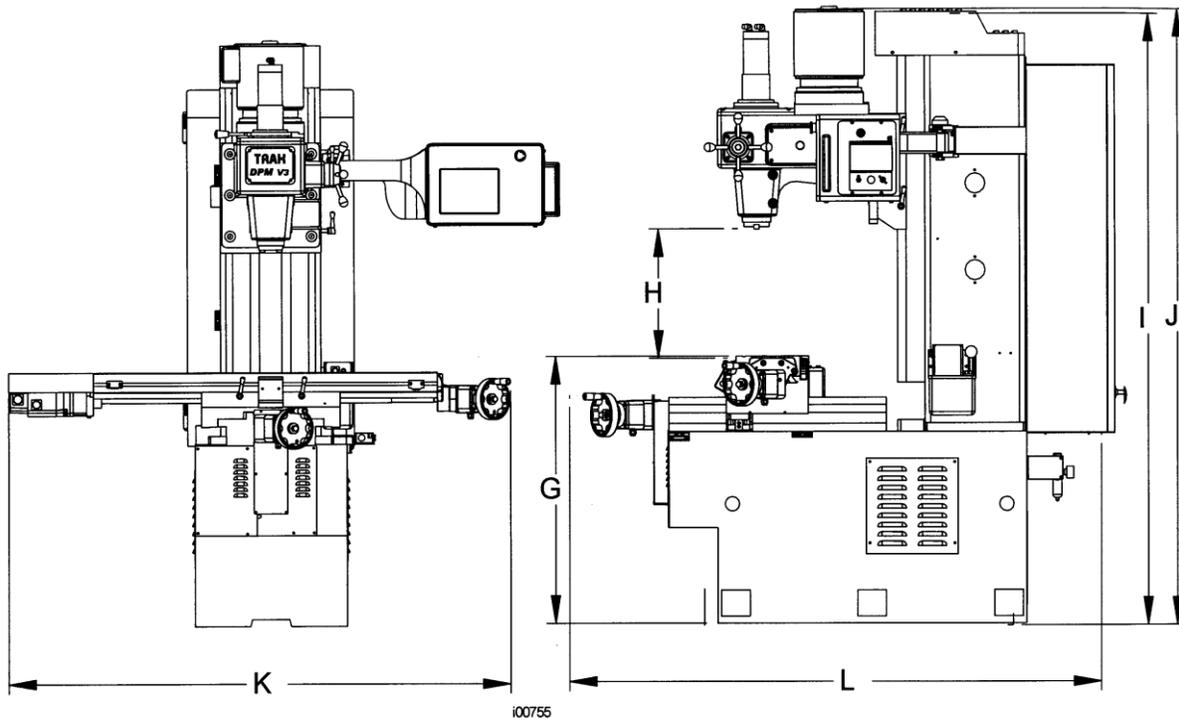


Figure 2 - Overall Dimensions - FHM5

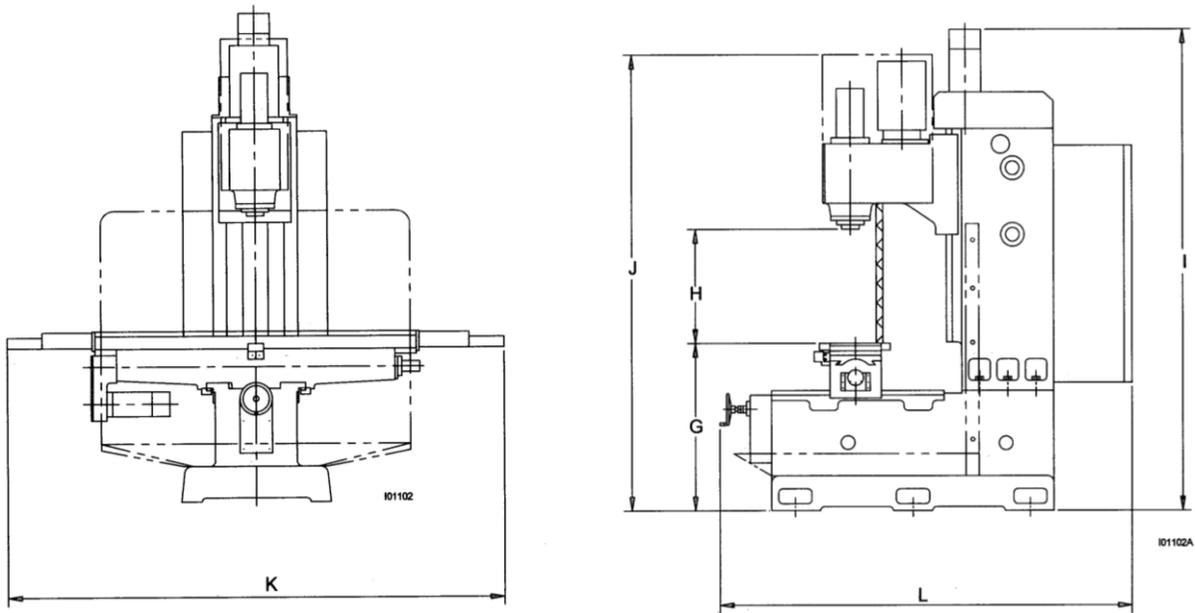


Figure 2A - FHM7 - Overall Dimensions

		FHM5	FHM7
G	Height of table from bottom of bed	41"	38.25"
H	Maximum distance from spindle nose to table	24"	24"
I	Height of machine from bottom of bed to top of column cover. NOTE: Top of Z-axis motor for FHM7	85.5"	91.75"
J	Height of machine from bottom of bed to top of spindle motor	99"	92.5"
K	Width of machine including table	94"	110.5"
L	Length of machine with electric box door closed	80"	93.75"

2.2 Uncrating

Carefully remove the wood crate and protective packaging, paying attention not to scratch, damage, or mar any parts of the machine.

FHM5 - Remove the cardboard boxes with the PENDANT DISPLAY (handle carefully), the box containing the TOOL BOX and Z crank. The leveling pads and screws for the machine can be found in the toolbox. The Y-axis way covers are shipped in a separate tube. The lower Z way cover can be found in a box as well.

Remove two steel bars - 1.0 inch in diameter. These items are necessary for lifting and moving the machine.

Loosen and remove 4 screws and nuts holding the machine to the wood pallet.

FHM7 – Remove the cardboard boxes with PENDANT DISPLAY (handle carefully), the box containing the TOOL BOX. The leveling pads and the screw for the machine can be found in the toolbox. The table steel way covers, Y-axis front steel way cover, retractable rear saddle/ram bottom cover and top column covers are shipped separate with the machine.

See Section 2.8 for details on lifting/moving the machine.

ATTENTION!

Immediately report, in writing, any damages observed at this time that can be attributed to the transportation or improper handling/moving of the machine.

2.3 Shortages: Inventory Checklist

- _____ Machine (check model and serial number)
- _____ FHM5 - Manual drawbar (P/N 23284) with washer (P/N 22116)
- _____ FHM7 - Manual drawbar (P/N 24538) with washer (P/N 24539)
- _____ Leveling pads (B239) and screws (B240) (6 each)
- _____ Pendant Display with four 1/4-20 screws for mounting
- _____ Pendant Arm assembled to the column
- _____ Toolbox with various tools (FHM5 P/N 24965 or FHM7 P/N 24503)
- _____ FHM5 & FHM7 Safety, Operation & Programming Manual (P/N 25083)
- _____ FHM5 & FHM7 Safety, Installation, Maintenance, Service & Parts List Manual (P/N 25083)
- _____ Table trays (FHM5)
- _____ Manual Z-axis crank (P/N 16526)
- _____ Table way covers FHM7 – (P/N 24505) (2 each)
- _____ Way covers FHM5 – front (B268) and rear (B267-1) of saddle
- _____ Way covers FHM7 – front (P/N 24504) and rear (P/N 24506) of saddle
- _____ Column covers FHM5 - bottom on column (B202), top on column (B201)
- _____ Column covers FHM7 - top on column (P/N 24522)

In case of shortages, contact the representative from whom you purchased the machine.

2.4 Installation Instructions & Checklist

Installer: Use this checklist to assure a complete set-up of the FHM5 or FHM7.

<input type="checkbox"/>	1.	Shut off power to the machine.
<input type="checkbox"/>	2.	Visually inspect the 220-wiring going into the electrical panel. Visually verify the wiring is correct per our wiring diagram. Make sure a strain relief is being used where the wiring enters the cabinet. Have the customer repair any wiring discrepancies.
<input type="checkbox"/>	3.	Clean the machine if needed and remove any remaining grease.
<input type="checkbox"/>	4.	Unlock the table, saddle, and ram gib locks.
<input type="checkbox"/>	5.	Install the manual Z-axis hand crank. (FHM5 only)
<input type="checkbox"/>	6.	Use a M8 Allen wrench on the Z-axis ball screw end at the top of the column to manually lower or raise the spindle head/ram. (FHM7 only)
<input type="checkbox"/>	7.	Release the counterweight support. See Section 2.9 and 2.9.1 for details.
<input type="checkbox"/>	8.	Remove the manual Z-axis hand crank. (FHM5 only)
	9.	Remove the M8 Allen wrench on the Z-axis ball screw end.
<input type="checkbox"/>	10.	Install the table way covers to both ends of table. (FHM7 only)
<input type="checkbox"/>	11.	Mount the pendant to the pendant arm using (4) 1/4-20 x 3/4" socket head cap screws.
<input type="checkbox"/>	12.	Make and check all the proper electrical connections from the pendant to the electric box. See the pendant and electric box wiring diagrams.
<input type="checkbox"/>	13.	If applicable, load TRAK sensors. (FHM5 only)
<input type="checkbox"/>	14.	Turn on the power to the machine and to the pendant. Make sure that the 220V line is plugged in.
<input type="checkbox"/>	15.	Lubricate all the way surfaces and the ball screws. Under service codes press the lubrication switch button to operate the lube pump.
<input type="checkbox"/>	16.	Jog the table, saddle, and ram back and forth until the way surfaces are well lubricated. Oil should be visible on all the way surfaces. Service Code 300.
<input type="checkbox"/>	17.	Check the level of the machine. The machine should be level to within 0.0005" front to back and 0.0005" side to side. Even though it is the responsibility of the customer, make any adjustments if necessary.
<input type="checkbox"/>	18.	Make sure all 3 electronic handwheels are functional. Use Service Code 132 to test.
<input type="checkbox"/>	19.	Check to make sure that the E-Stop button is functioning correctly.
<input type="checkbox"/>	20.	Perform Service Code 12, Feed Forward Constant.
<input type="checkbox"/>	21.	Perform Service Code 123 to calibrate the X and Y-axis using a 150mm standard.
<input type="checkbox"/>	22.	Perform Service Code 11 to automatically calculate the backlash for the X and Y-axis of a dual feedback machines (i.e. TRAK sensor or glass scale with a motor encoder).
<input type="checkbox"/>	23.	Perform Service Code 127 and 128 to manually calculate the backlash for the X and Y-axis of single feedback machines (i.e. motor encoder only).
<input type="checkbox"/>	24.	Check for positional accuracy and repeatability on the X and Y-axis using programs XREPEAT.PT4 and YREPEAT.PT4 respectively. Positioning and repeatability values should be less than or = to 0.0005". Programs can be found on hard drive under the PT4 folder followed by the SWI TEST PROGRAMS folder.
<input type="checkbox"/>	25.	Perform Service Code 123 to calibrate the Z-axis ram using a 75mm standard.
<input type="checkbox"/>	26.	Perform Service Code 127 and 128 to manually calculate the backlash for the Z-axis ram.
<input type="checkbox"/>	27.	Check for positional accuracy and repeatability on the Z-axis using program ZREPEAT.PT4 Positioning and repeatability values should be less than or = to 0.0005".
<input type="checkbox"/>	28.	Perform Service Code 100 in both directions for the X, Y, and Z-axis to verify that the feed rate shown on the display is at least 300 ipm.
<input type="checkbox"/>	29.	Run the spindle at 1000 rpm for 5 minutes and then at 5000 rpm for 5 minutes.
	30.	Install the Y-axis front and rear way covers. (FHM5 only)
<input type="checkbox"/>	31.	Install the Y-axis front steel way cover. (FHM7 only)
	32.	Install the retractable rear saddle/ram bottom cover. (FHM7 only)

<input type="checkbox"/>	33.	Install the Z-axis upper way cover and Z-axis lower cover and bracket. (FHM5 only)
	34.	Install the Z-axis upper column cover. (FHM7 only)
<input type="checkbox"/>	35.	Use accessory key on pendant and make sure solenoid fires. The accessory key should be in the ON position to test solenoid. Make sure air is hooked up to the machine during the test. Make sure the solenoid is plugged in.
<input type="checkbox"/>	36.	If the machine has a power drawbar option, check to make sure that the tools load and unload properly.
<input type="checkbox"/>	37.	Cut a Euclid block. The total run out of the circle frame on the Euclid block must be within 0.002". Visually inspect the finish on the Euclid block and make any necessary adjustments to the machine. See the Euclid block instructions.
<input type="checkbox"/>	38.	Wipe down the machine prior to leaving.

2.5 Machine Specifications

Specifications	FHM5	FHM7
Table Size	50" x 12"	76" x 14"
T-Slots (number x width)	3 x 16mm	4 x 16mm
Travel (X, Y, Z axis)	40" x 20" x 20"	60" x 23" x 20.5"
Spindle Taper	40 taper	40 taper
Spindle Speed Range	160 – 4000 RPM	200 – 5000 RPM
Spindle Nose to Table (max part height)	0- 20.5"	0- 23
Spindle Center to Column Face	20 1/2"	23 3/4"
Spindle Motor Power	5 HP	7.5 HP
Voltage	220 V	220 V
Phase/Cycle	3 phase/60 Hz	3 phase/60 Hz
Current (Full-load amps)	17.5 FLA	37.5 FLA
Machine Net Weight	4400 lbs	7650 lbs
Maximum Weight of Workpiece	1760 lbs	2200 lbs
Power – control	110v 1 phase, 15 amp	110v, 1 phase, 15 amp

2.6 Maximum Work Capacities

FHM5

Drilling Mild Steel	1" dia.
Tapping Mild Steel	5/8"
Milling (metal removal rate/mild steel)	5 inch ³ /min

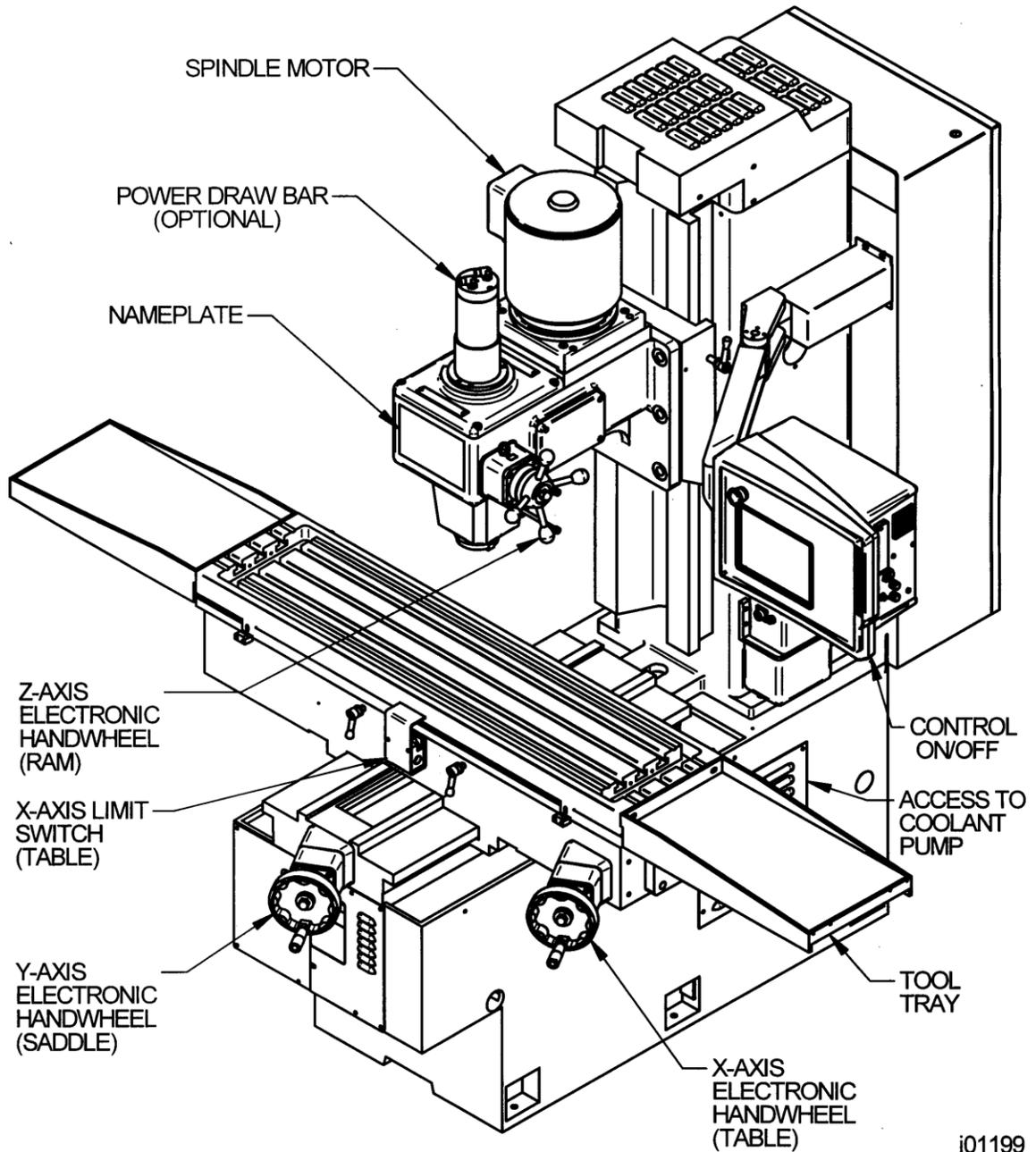
FHM7

Drilling Mild Steel	1"
Tapping Mild Steel	5/8"
Milling (metal removal rate/mild steel)	7 inch ³ /min

Maximum work capacities are dependent on a lot of variables that cannot be controlled by the machine manufacturer. Each one of the following will have an impact on the above numbers: speeds, feeds, cutter, cutter sharpness, material, setup, coolant and machine adjustments. The numbers above assume all conditions are optimal and may be higher or lower depending on material composition.

2.7 ProtoTRAK SMX Control Hardware

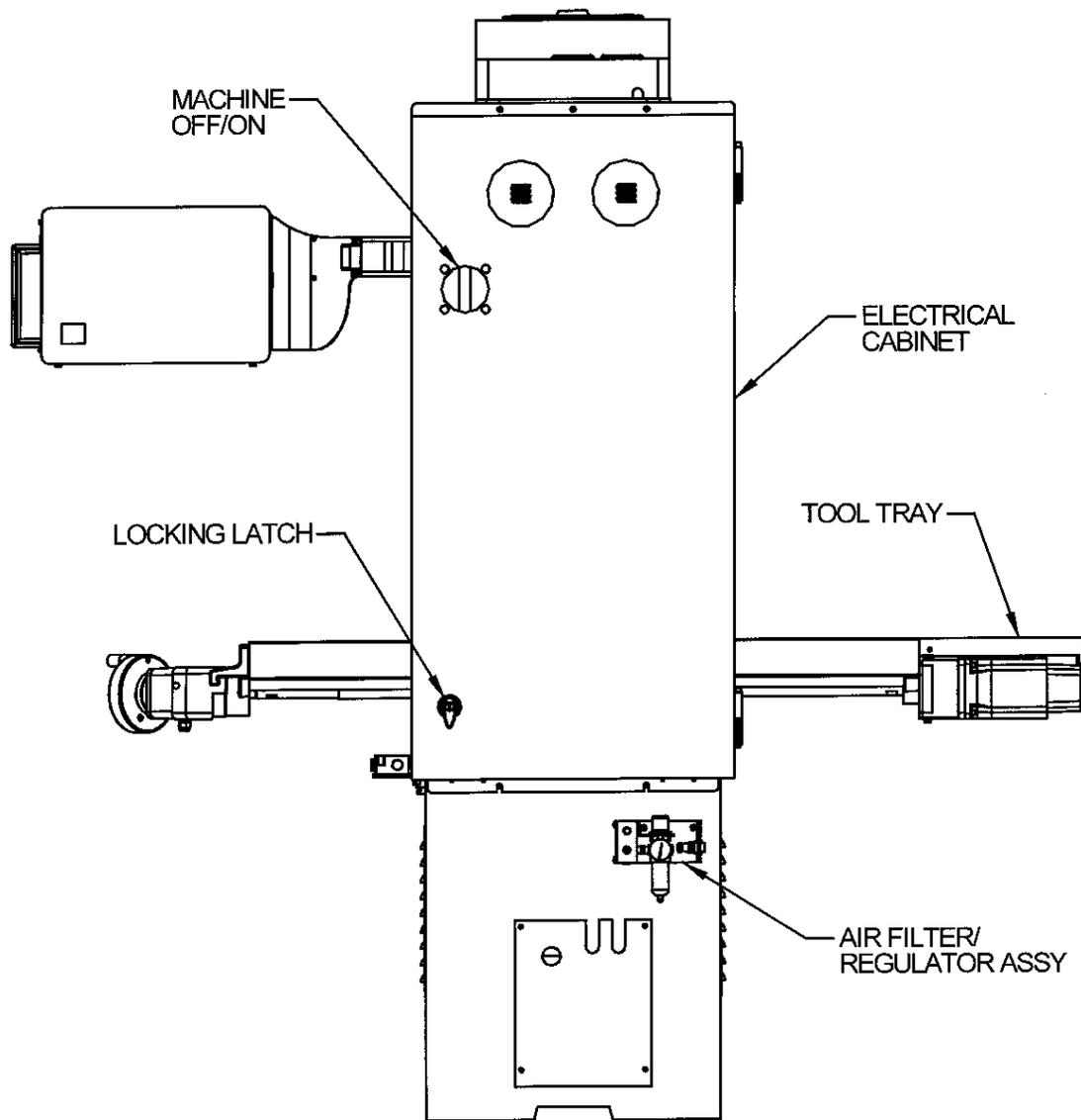
- 3-axis CNC, 3-axis DRO
- 400 mhz PC-based processor
- 256 MB of RAM
- D.C. Servo Motors rated at 560 in-oz continuous torque for X, Y and Z-axes
- Precision ground ballscrews in the table, saddle and ram to ensure smooth accurate contours without backlash
- Feedrate override of programmed feedrate and rapid
- Programmable Spindle Speed
- Speed override of programmed spindle speed
- Polycarbonate sealed membrane and gasket sealed control enclosure to lock out contamination
- 10 1/2" color LCD for clear presentation of prompts, status information and part graphics
- Modular design simplifies service and maximizes uptime
- 256 mb compact flash drive
- Single floppy disk drive for additional part program storage
- Auxiliary function box for control of spray mist coolant, spindle off, a 110 AC outlet (coolant pump) and a programmable rotary table or indexer
- Limit switches for the X, Y and Z-axes that are installed on the table, saddle and ram to prevent crashes.
- Electronic handwheels on the X, Y and Z-axes.
- 2 USB ports



i01199

Figure 3 & Parts List Shown - FHM Component Identification

Part Number		Description
FHM5	FHM7	
23326	24525	Spindle Motor
24000-1		SMX Pendant
21946		X & Y-Axis Handwheels (Saddle & Table)
21774		Z-Axis Handwheel (Ram)
22291-1		Lube Pump
24428		X, Y or Z Motor



i00756-V3-1

**Figure 4 -
FHM Rear View**

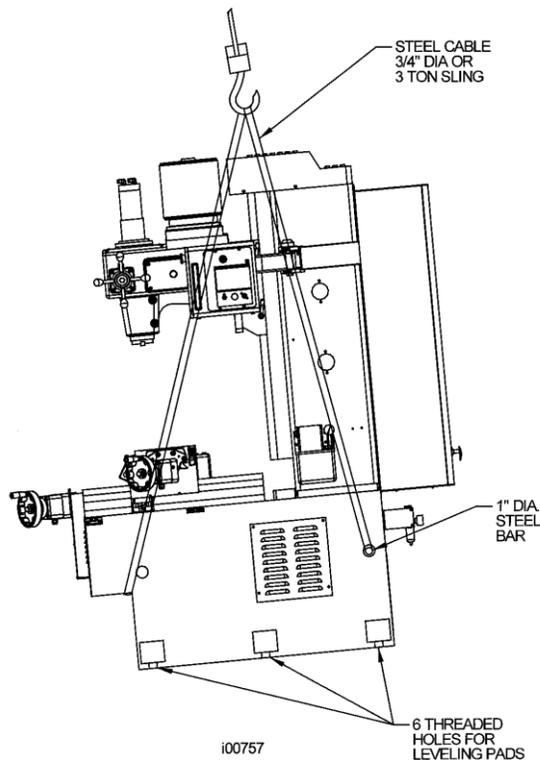
2.8 Lifting and/or Moving the Machine – FHM5

CAUTION!

The FHM5 machines weigh approximately 4400 lbs. Proper equipment of sufficient capacity must be used when lifting and/or moving the machine.

Method 1 (see Figure 5):

1. Insert a steel bar 1.0" dia x 36" long through the rear side holes of the bed (under column).
2. Use a steel cable (with protective sleeving) min. 3/4" dia. or a 3 ton sling.
3. Use cardboard pieces or other suitable protective sheets on both sides of the machine to prevent scratching.
4. Remove the 4 nuts and screws holding the machine to the wood skid.
5. Lift the machine (the front side of the machine should be lower than the back side).
6. Insert the 6 screws for leveling pads in their place in the bed.
7. Place the machine in its location (see floor plan and bed footprint drawing) carefully positioning each leveling pad under each leveling screw.
8. Remove the lifting cable or sling, the steel bar and all protective cardboard.



**Figure 5 - FHM5 -
Lifting the Machine -
Method 1**

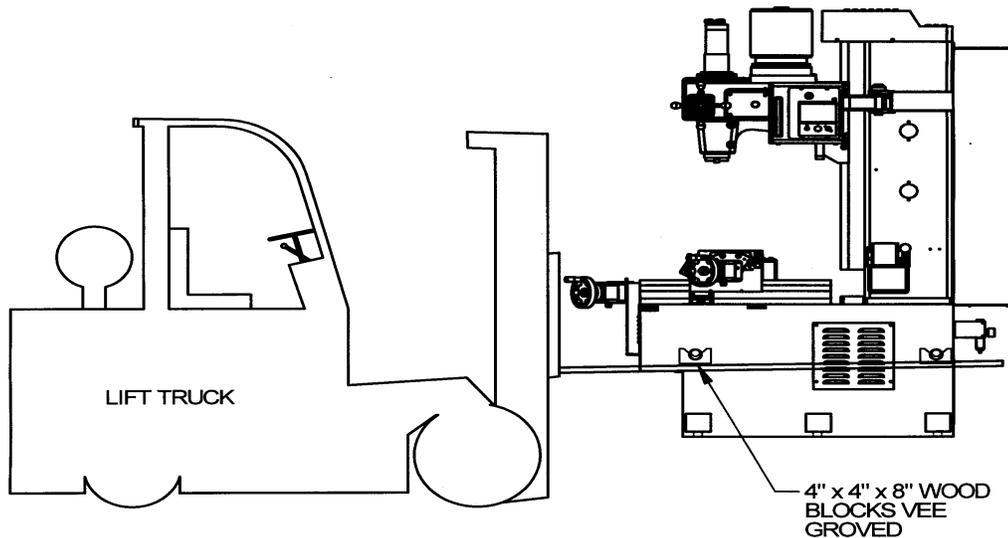
Method 2 (see Figure 6):

1. Insert 2 steel bars 1" dia x 36" long through both sides in the existing holes in the machine base (front and back).
2. Position 4 (two each side) wood vee blocks under the steel bars and over a suitable lift truck.
3. Lift the machine up (somewhat tilted towards the front) 4-6" from the ground and move it to its floor plan position.

WARNING!

The lift truck must have sufficient lifting capacity (5 tons) and be equipped with suitably long forks. When lifting the machine on the pallet, the center of gravity of the machine while on the pallet is 36" from the edge of the pallet

4. Insert the 6 screws for the leveling pads in their place in the bed.
5. Place the machine in its location (see floor plan bed/footprint) carefully positioning each leveling pad under each leveling screw.



i00758

**Figure 6 - FHM5 -
Lifting the Machine -
Method 2**

2.8.1 Lifting the machine - FHM7 (See Figure 7)

CAUTION!

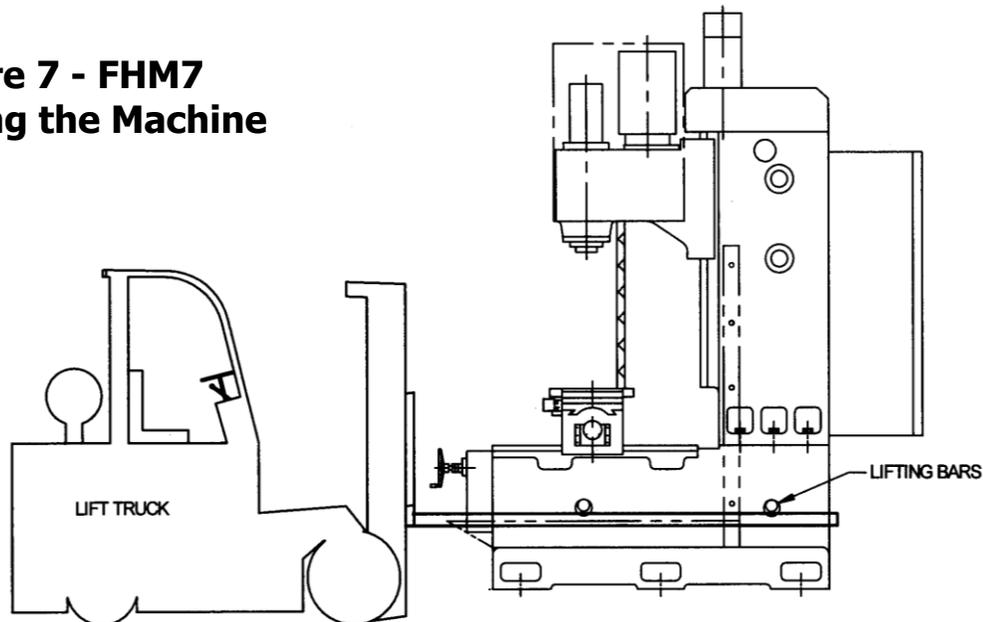
The FHM7 machines weigh approximately 7650 lbs. Proper equipment of sufficient capacity must be used when lifting and/or moving the machine.

1. Using the recommended size forklift, lift the pallet with the machine on thru the fork pocket. (Note: The center of gravity (CG) of the machine while on the pallet is 42" from the edge of the pallet.)
2. Using (4) pieces of 4" x 4" x 6" high steel block. Equally, position the steel blocks to the front, back and side of the machine base.
3. Gradually lower the lift and let the machine base rest on the (4) steel blocks. (Note: Machine weight must be equally distributed and well supported by the (4) steel blocks also make sure that the position of the blocks does not obstruct the skid.)
4. Remove forklift from steel pallet.
5. Remove the (4) bolts securing the machine base to the pallet and let the steel pallet rest on the floor.
6. Carefully lift the machine thru the fork access cut out on the side of the machine.
7. Remove steel pallet under the machine.
8. Insert the (6) leveling screws into place.
9. Position and lower the machine to its location (see floor plan bed/footprint). (Note: Make sure to position each leveling pads under each leveling screws.)

WARNING!

The lift truck must have sufficient lifting capacity (15000 lbs.) with a 24" load center or equivalent, and be equipped with 6 ft. extension forks.

**Figure 7 - FHM7
Lifting the Machine**



2.9 Releasing the Head Counterweight Supports – FHM5

In order to move (raise or lower) the spindle head/ram it is first necessary to remove the 2 steel rods (with flanges) inserted through the holes in the column. These rods support the counterweight during shipping to prevent damage to the counterweight chains and sprockets.

1. Release the spindle head/ram gib locks.
2. Using the ram crank, slowly raise the spindle head/ram and remove the wood block that supports the spindle head/ram during shipping.
3. Lower the head slowly with the ram crank until the chain between the ram and counterweight is tight.
4. Lower a little further until the 2 support steel rods are loose. Remove the 2 steel rods and store them for future machine moves or transportation.
5. Remove the panel on the bottom rear of the bed. . Verify that the lower end of the counterbalance rod guide at the bottom of the column is attached using the (2) socket-head cap screws supplied. Replace the panel.
6. Do not continue to move the head/ram until all ways have been cleaned.

CAUTION!

Do not remove the steel rods unless they are loose.

2.9.1 Releasing the Head Counterweight Supports – FHM7

In order to move (raise or lower) the spindle head/ram, it is first necessary to remove the retaining plug that supports the counterweight located on the right side of the machine. The retaining plug support the counterweight during shipping to prevent damage to the counterweights chains and sprocket.

1. Release the spindle head/ram gib lock.
2. Using an M8 Allen wrench, turn the Z-axis ballscrew at the top of the column to slowly raise the spindle head/ram. Remove the wood block that supports the spindle head/ram during shipment.
3. Remove the (3) socket head cap screws that secure the counterweight-retaining plug to the column.
4. Using an M14 Allen wrench, remove the bolt that secures the retaining plug to the counterweight.
5. Lower the spindle head/ram slowly until the chain between the ram and the counterweight is tight.
6. Lower the spindle head/ram a little further until the retaining plug is loose. Remove retaining plug and store them for future use.
7. Do not continue to move the spindle head/ram until all ways have been cleaned.

2.10 Cleaning

1. Remove rust protective coating from the machine before moving any slideways (table, saddle, ram/spindle head, etc.).
2. The coating is best removed with clean, dry rags. Do not use a cleaning solution that may damage the rubber way scrapers, plastic parts, or paint.

WARNING!

Do not use gasoline or other flammable cleaning agents for cleaning the machine.

3. It may be necessary to move back and forward, left and right, and up and down the table, saddle and the ram. Always release the clamp levers (two in front of the table, one underneath the saddle on each side, and two on the ram on the right side of the column) before attempting to move the above parts.

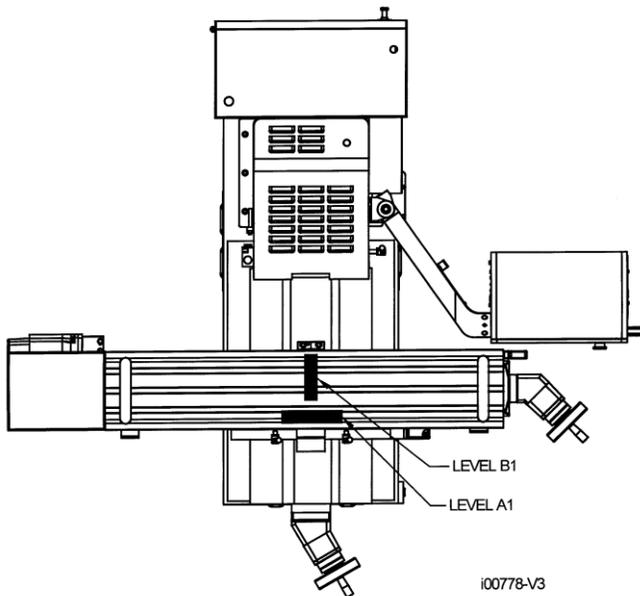
CAUTION!

**Never move any of the above parts over ways that were not previously cleaned.
Serious damage to the TURCITE surface of slideways can occur.**

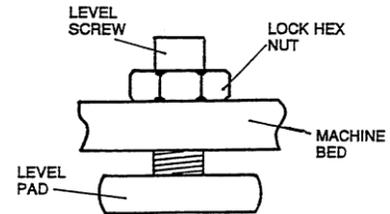
4. Be certain the table, saddle, head/ram, and spindle move freely and smoothly over their entire length.

2.11 Leveling: Leveling Tolerance for FHM is .0005"/10"

1. Set the machine on its 6 leveling pads on a solid, level floor prepared in accordance with the state and local rules for machine tool installation.
2. Put one or two precision Spirit Levels or Electronic Levels in the center of the table in the positions illustrated in A1 and B1.
3. Adjust the 4 corner leveling screws on their pads until the machine is level to .0005 in/10 in. Snug the 2 middle leveling screws being careful to not affect the level.
4. If the machine must be anchored to the floor, follow the general instruction for installing machine tools and use for leveling any well-known methods: shims, etc.).
5. If the machine must be installed on vibration mounts/pads (rubber, commercially available leveling and vibration mounts, etc.) follow the instructions delivered with the mounts/pads, ordering them to satisfy the load of the machine and the maximum weight of the workpiece.
6. When machine is correctly level, lock the adjusting screws in place with their hex nuts.



**Figure 8 -
Placement of Levels**



**Figure 9 -
Leveling Screws**

2.12 Electrical Connection, FHM5 & FHM7

The FHM5 & FHM7 Bed Mills can only be configured for 208-240 volt 3 phase electricity. To run at 440V, you will need a step down transformer from 440V to 220V. These machines also require a 110v power source to power the control.

DANGER!

Be certain that 200-volt electricity (typical range 208 – 240V) is used only with a machine labeled 220 volts at the motor and at the electrics box on the back of the column.

WARNING!

440 Volts will damage expensive electrical components if machine is wired by mistake as 440 volts. These components are not covered under warranty. The circuit breaker for the machine should be a minimum of 17.5 amps (FHM5) and 37.5 amps (FHM7).

DANGER!

The 208-240 volt line must originate from a dedicated and independent fused box with a manual shut-off lever. It is the responsibility of the purchaser to supply a wired box that meets all local codes and regulations.

The 208-240 volts wired to the machine through the electrical box located on the back of the column. The wire enters the main on/off switch through a hole on the top of the box on the left side.

DANGER!

Only a qualified electrician should wire the 208-240 volt 3 phase electricity.

Southwestern Industries recommends the machine be earth grounded by driving a copper rod into the ground. It is the responsibility of the customer to install this rod.

2.12.1 Phase Converters

For those machines that will be run with a phase converter it must be a CNC rated rotary type rather than a static phase converters. Rotary phase converters allow for varying loads in the system. The electrical load on the machine will vary based on the type of cut taken and the speed of the motor.

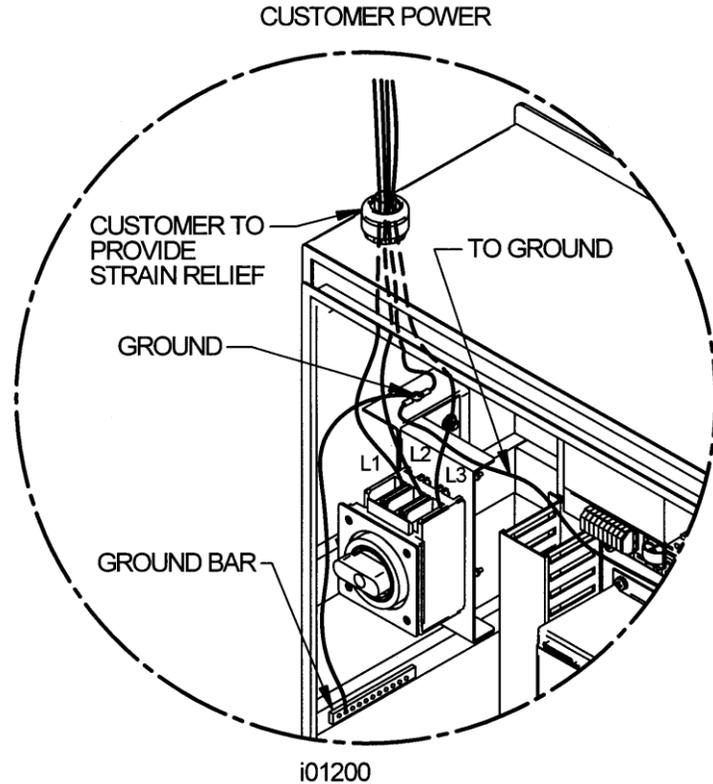
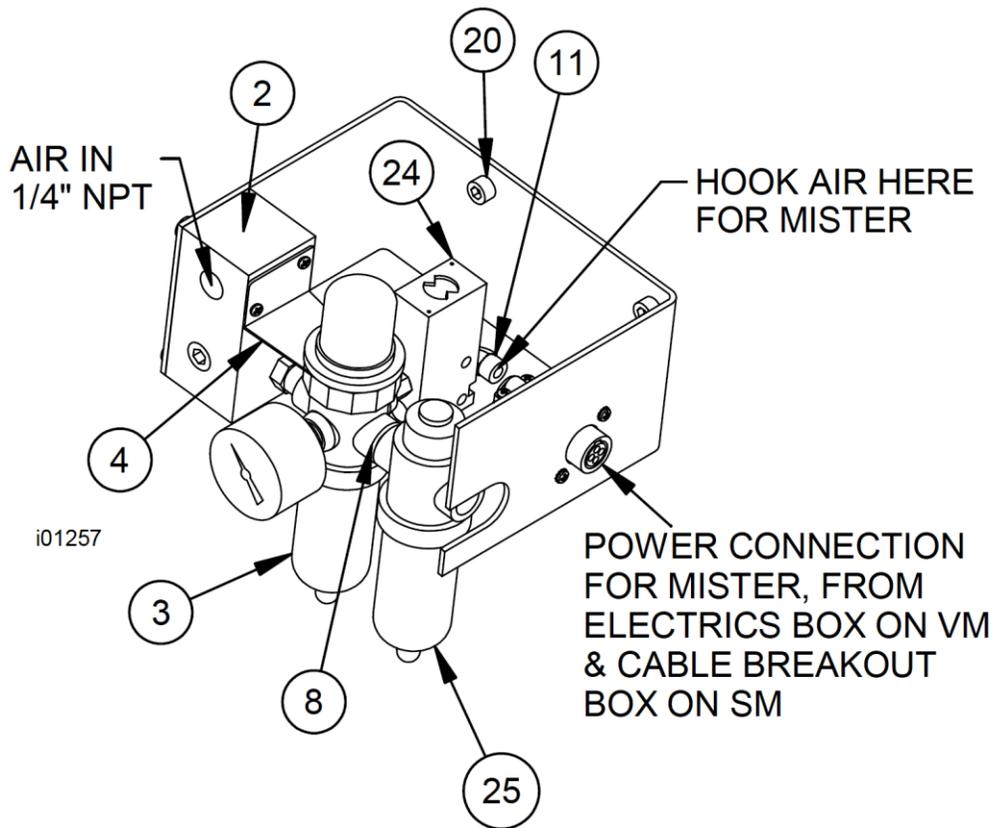


Figure 10 - FHM5 & FHM7 - Wiring

2.13 Air Connection

The FHM machines have an air hookup in the rear of the machine. It includes an air regulator, air manifold, air solenoid and an oiler for a power drawbar, if the machine was ordered with this option. The air fitting is ¼ NPT. Within the manifold there is an additional airline port in case the user wants to hook up an airline to clean chips. Remove the plug to gain access to this port.

The air regulator is set to 90 psi at the factory for the power drawbar unit. See Section 5 for more information on the power drawbar unit. The air comes in through the manifold, and then into the air regulator that tees off into an oiler for the power drawbar unit and into an air solenoid. The solenoid is used for a misting system the user may install later on this machine. There is a ¼" quick disconnect air fitting on the solenoid where the mister air hose can be plugged into. See the figure below for an illustration.



**Figure 11 & Parts List Shown - FHM5 & FHM7 -
Air Regulator/Solenoid Assembly - P/N: 22380-1**

Item	P/N	Title	Qty
2	22378	MANIFOLD-PT4 AIR	1
3	22607	FILTER/REGULATOR-PT4	1
8	22644-4	PLUG-1/4 NPT HEX SOCKET	3
9	22645-4	NIPPLE-1/4 NPT x 1.37 LG	1
11	22646-4	ADAPTOR-ELBOW MALE 1/4 x 1/8 NPT	1
12	22647-2	NIPPLE-1/8 NPT x 0.750" LG	1
18	4-40X3/8 31B	SCREW-PH-PHIL-EXT SEMS-STL-BO	2
19	10-32X3/8 10B	SCREW-PH-PHIL-STL-BO	2
20	M6-1.0X25 25B	SCREW-SHCS-STL-BO	2
24	22772	SOLENOID ASSY- AIR REGULATOR	1
25	22773	OILER	1

i22380-1

2.14 Mounting the Display Pendant

The ProtoTRAK SMX display pendant mounts to the pendant arm with four 1/4-20 x 3/4 SHCS that are shipped screwed into the left side of the display. There is a locating screw on the pendant arm to help align the pendant with the mounting holes.

CAUTION!
The locating screw in the arm is used for positioning. Keep a hold of the pendant until the screws are fastened.

If the pendant arm rotates too freely, remove the painted cap on the bracket attached to the column and tighten the hex nut to adjust it. Replace the cap.

2.15 Cable Interconnections

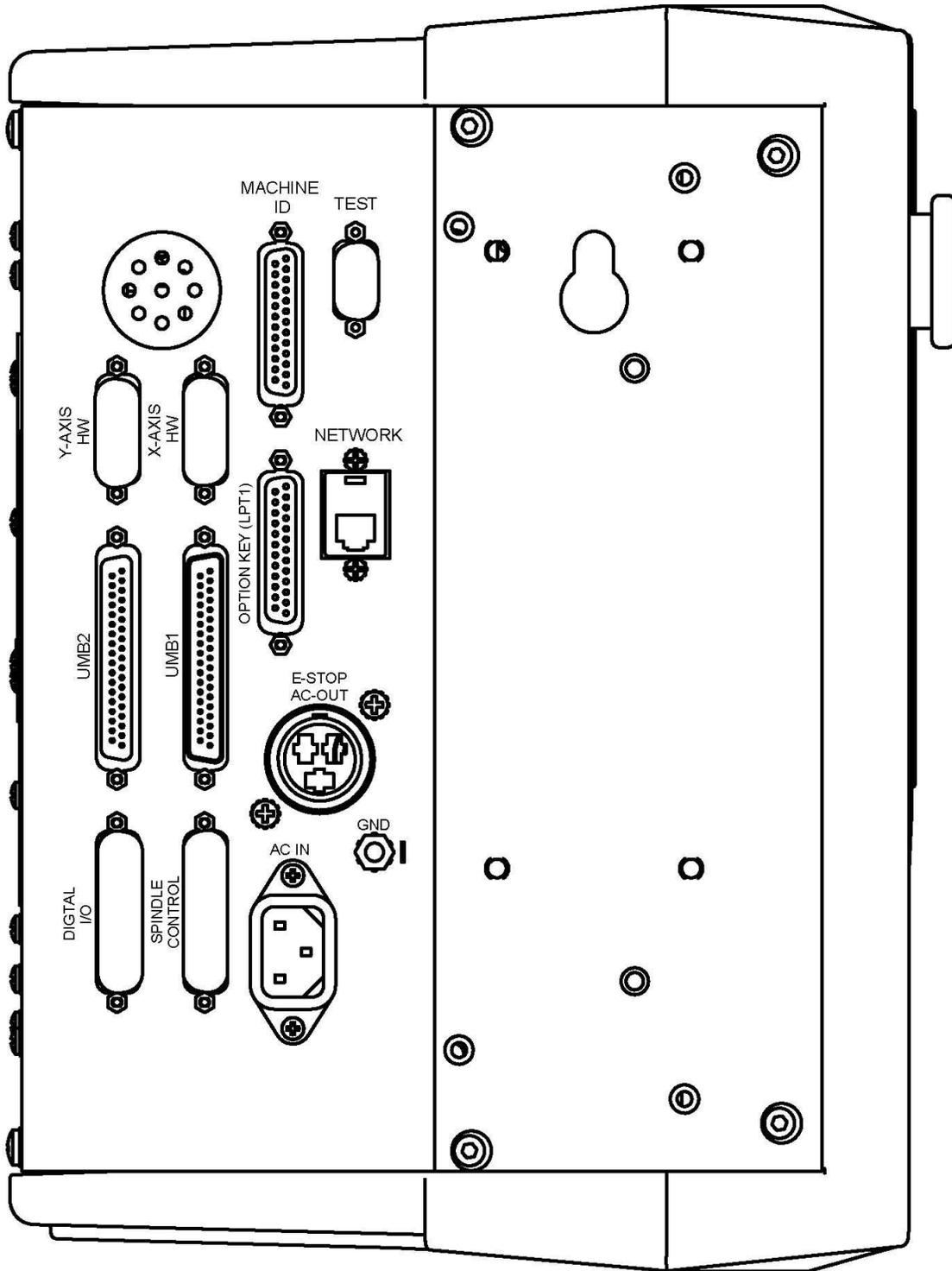
All cable interconnections are made at the factory except for those connecting to the pendant display. There are a total of 8 cables that need to be connected to the pendant.

With the main power to the machine turned off plug in the connectors that are bundled on the pendant arm. Each cable mates to only one connector on the pendant display back panel. Each cable is labeled with a sticker. Use the key on the pendant to match up the connectors with the correct port. The parallel port will have a key plugged into this port. The monitor port, RS232 and network ports will be left empty during installation.

Make sure there is sufficient slack in the cables for when the pendant is rotated about the pendant arm. The worst case is when the pendant is all the way forward toward the operator. The following drawing describes all of the cable connections to the pendant.

Make sure there is a hardware (option) key plugged into the parallel port of the pendant. This key activates any converters or options ordered. The part # for this key is 22648. The key must be programmed according to the type of machine it is on and the options ordered.

CAUTION!
Make sure the main power switch is turned off on the back of the electrical cabinet before plugging in the cables.



i2400-7 Lf

**Figure 12 - Pendant Cable Connections - Left Side -
P/N: 24000-1 or -7**

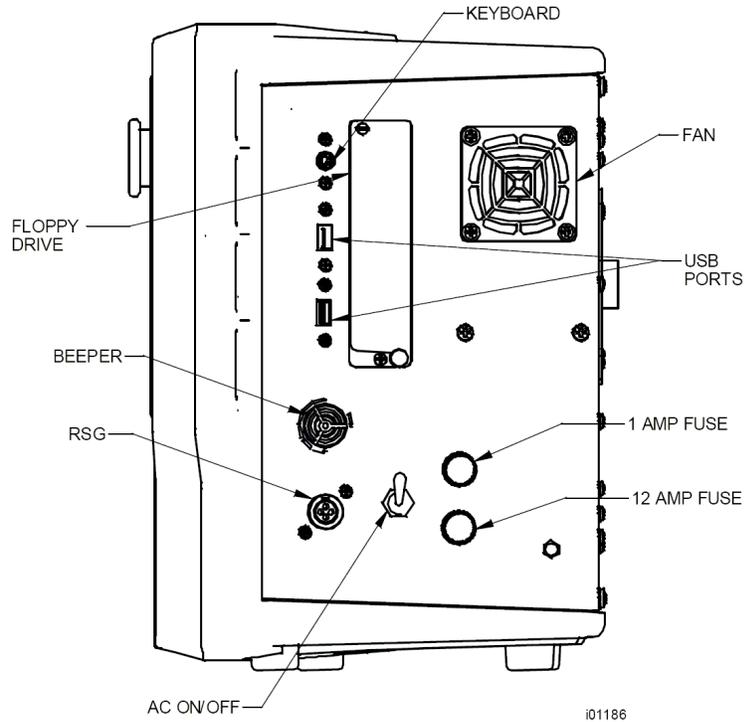


Figure 13a - Pendant Cable Connections - Right Side w/ Floppy Drive - P/N: 24000-1

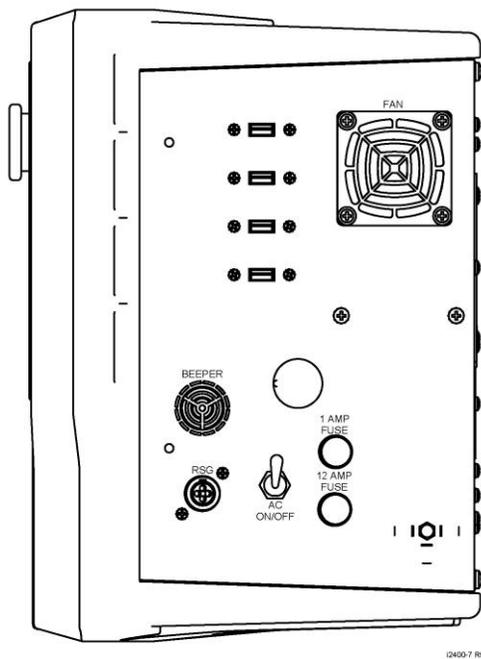


Figure 13b - Pendant Cable Connections - Right Side w/USB Ports - P/N: 24000-7

2.16 Lubrication

The FHM5 and FHM7 auto lube system provides centralized automatic lubrication for the table, saddle and ballscrews. The lube pump has a 2-liter reservoir filled with Mobil Vactra Oil No. 2 or equivalent.

CAUTION!

Oil that is too heavy and viscous such as 50W or 90W oil can clog oil line tubing. Do not mix detergent type automotive or multi-purpose oils with the Mobil Vactra Oil No. 2 used in this application.

The lube pump has electronic memory, which acts as an internal clock to keep track of the running time of the axis motors. Even when the spindle is turned off, the lube pumps internal clock will not reset. The interval between pump cycles is based on axis movement motor time.

2.16.1 Lube Pump Operation

The pumping output can be regulated electronically to control the Interval Time between pumping cycles, and the Discharge Time of each pumping cycle. The pump can also be run manually through a key found under service codes. The following describes the steps used to program the lube pumps Interval and Discharge times.

- Setting Interval time: Service Code 301
Press "Mode", "Set up", "Service Codes", "C" (Machine Setup), Code 301, and then enter the desired Interval time in minutes.
- Setting Discharge time: Service Code 302
Press "Mode", "Set up", "Service Codes", "C" (Machine Setup), Code 302, and then enter the desired Discharge time in seconds.
- To manually pump oil: Service Code 300
Press "Mode", "Set up", "Service Codes", press "E", and then press Code 300 (Lubrication Pump Switch). The pump will pump oil for the amount of time programmed in Code 302. The spindle does not need to be turned on.

2.16.2 Factory Default Values

Interval Time - 60 min.

Discharge Time - 15 sec

Discharge Pressure - Approximately 100 - 150psi

To adjust the amount of Discharge Pressure displayed on the lube pump gauge, loosen the jam nut and turn the adjustment screw located on the top right side of the lube pump while the lube pump is activated. To activate the lube pump use Service Code 300.

CAUTION!

Failure to properly lubricate the mill will result in the premature failure of ball screws and sliding surfaces.

CAUTION!

Failure to manually activate the pump at the beginning of each day, or allowing the Auto Lube to run dry may cause severe damage to the FHM5 or FHM7 mill way surfaces and ballscrews.

The settings for the lube pump can be viewed by doing the following: press Service Codes, press "A" (software), press Code 313. This screen lists the values programmed for the cycle time and discharge time.

See Section 6 for diagrams of how the oil lines are routed on the FHM.

2.17 ProtoTRAK SMX Euclid Block Procedure

The test part should be machined at the completion of the installation.

The material for the Euclid block test part is found in the toolbox.

- Material Specification: Aluminum, 6061-T6 or T4
- Blank Size: (minimum dimensions) 3 x 3 x 1", provided in tool box
- Tool: .750 end mill, 2 flute, high speed steel, **sharp**
- Coolant: Flood coolant, Cool-Tool or Kerosene

1. Mount vise and indicate the back jaw parallel to the table within .0005".
2. Clamp material in vice with a minimum of .800" above the vise jaws.
3. Load in the Euclid block program from the ProtoTRAK SMX hard drive, it is part number euclid.PT4. It is found under the PT4 folder followed by the SWI TEST PROGRAMS folder.
4. Use an edge finder to set Absolute 0 on X and Y. Absolute zero is the front left corner of the block as viewed from in front of the machine.
5. Load the .750 end mill and set Z Absolute 0 at the top of the part, and set Z reference positions in the SET UP mode. Set Z-retract a few inches above the part.
6. Begin to run the program. The part will be machined in the following sequence:

Event(s) #	Description	Depth of Cut
1	circle pocket – cuts middle circle	-0.250"
2	circle frame – cuts outer 1.830 diameter circle	-0.250"
3	circle frame – cuts material from corners remaining on Euclid block	-0.250"
4 - 12	cuts triangle on Euclid block	-0.500
13	rectangular frame – cuts outer 2.750" rectangle	-0.750"
14 – 21	finish cut for triangle section – tool #2	-0.500"

7. After the program runs, the program will locate to the following position.
 - X = 1.318
 - Y = 1.318
8. Mount a dial indicator in the quill and check the circles.
9. Check the runout of the sides of the square frame.
10. Inspect the machined surfaces for smoothness.

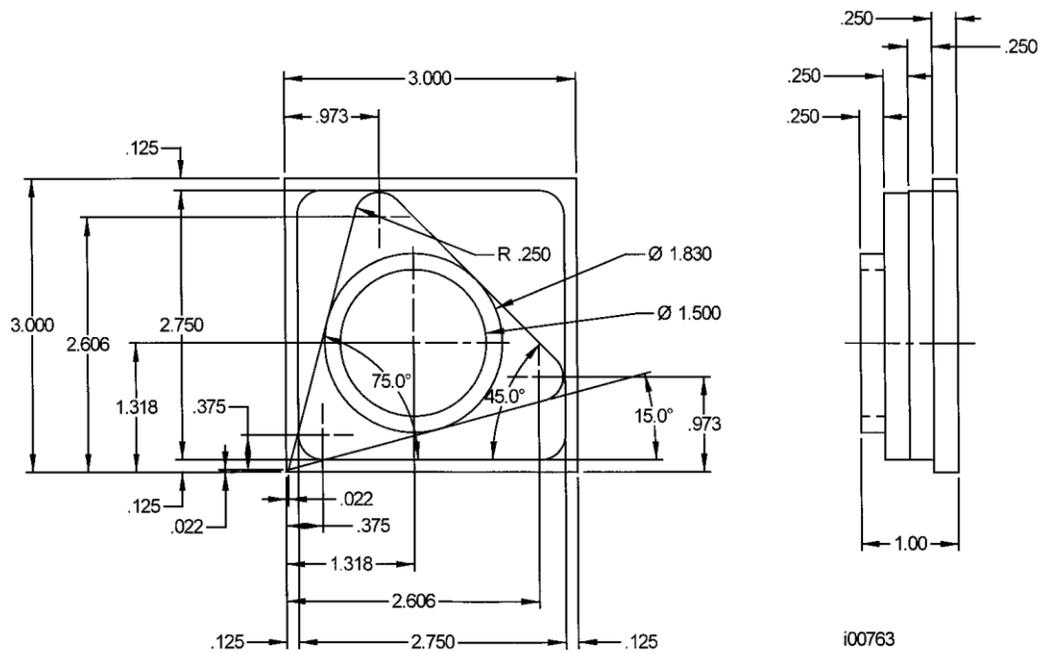


Figure 14 - Euclid Block

3.0 Troubleshooting by Symptom

Use this section to begin the process of resolving a service problem. Each problem type is described in a few words and then more fully described in an explanatory paragraph. Following this is a chart that directs in the most logical steps.

3.1 Problems Relating to Machining Results

3.1.1 Poor Finish

The part finish is marred with scallops or is very rough. It should be determined whether the cut is straight along the X or Y-axis, or at a diagonal.

Do the following Service Codes:

- **Code 33** Software Identification. This is needed if you call SWI Customer Service.
- **Code 11** Measures backlash in the system (Only used on Dual Feedback systems)
- **Code 12** Feed Forward Constant
- **Code 127** Measures backlash in the system (not used on Dual Feedback systems)
- **Code 128** Enter backlash compensation

Possible Cause	Check This
Too much backlash entered for code 128 or calculated with code 11.	Verify nothing is mechanically loose and the backlash values are not higher than what physically is in the system.
Machine Tool & Setup problem	Check for any looseness in the setup (Tool, Tool holder, Part, Vise, or Fixture). Check the condition and type of cutter being used, type of material, RPM and Feedrate, etc. See Machine Tool & Setup Section 4.1
Table, Saddle, or Ram Locks are locked	Make sure the Table, Saddle, and Ram Locks are unlocked. Never use gib locks with a CNC machine.
Inadequate or no Lubrication to Ballscrews and Way surfaces	Make sure all the Way surfaces are getting proper lubrication. If not, check to make sure that the lube pump is functioning properly. Also check for any pinched or blocked oil lines. See Lubrication Section 4.1.3
X, Y, and Z-axis Gibs are not adjusted properly	Check the adjustment of the X, Y, and Z-axis Gibs. See X, Y, and Z-axis Gib Adjustments in Section 5.2.1.
X & Y-axis Drive Trains are loose	Check Repeatability using the Repeatability and Positional Accuracy procedure. Step by step, carefully inspect the Drive Train for any looseness. It may be necessary to disassemble and then reassemble the Drive Train. See Mechanical Drive Train (X, Y) Section 4.2
Way surfaces are pocked, scarred, or excessively worn	Visually check the condition of all the Way surfaces. For machines that may have excessively worn Way surfaces you may need to adjust the Gibs in this area. This will affect performance when using the machine outside of this area. Check lubrication to affected areas.

3.1.2 Circles Out of Round

Circles are not round within 0.002" TIR over 3.0" DIA. This is best measured by placing a dial indicator in the quill and sweeping around the part.

Note: The typical slideway-milling machine is not capable of achieving more precise results. Although careful adjustments to a new milling machine have produced better results, you should not expect the same level of accuracy from a machine of this class. If more precise circles are required, then it is recommended to use a precision boring head/boring bar.

Do the following Service Code:

- **Code 33** Software Identification. This is needed if you call SWI Customer Service.
- **Code 11** Measures backlash in the system (Only used on Dual Feedback systems)
- **Code 12** Feed Forward Constant
- **Code 127** Measures backlash in the system (not used on Dual Feedback systems)
- **Code 128** Enter backlash compensation

Possible Cause	Check This
Torque values on X and Y-axis are too high.	Make sure torque is lower than 20 in-lbs. Normal values for a machine that is aligned and adjusted properly should be between 10 and 15 in-lbs. Make sure torque is consistent across axis travel.
Machine Tool and Setup problem	Check for any looseness in the setup (Tool, Tool holder, Part, Vise, or Fixture). See Machine Tool & Setup - Section 4.1
Machine not level	Verify that the machine is level to specification.
Head is not Trammed	Verify that the Head is Trammed to specification. See Tramming the Head
X, Y, and Z-axis Gibs are not adjusted properly	Check the adjustment of the X, Y, and Z-axis Gibs using the X, Y, and Z-axis Gib adjustment procedures. Section 5.2.1
Calibration or Backlash problem	Recalibrate the machine. Reset the Backlash. Check Repeatability and Positional Accuracy. See Calibration & Backlash Constants Section 5.2.2
TRAK Sensor or Glass Scale problem	Make sure that the Sensor or Glass Scale is installed correctly according to the Sensor or Glass Scale Installation procedures. Check for any loose brackets or misalignment etc. Also, check to make sure the Sensor or Glass Scale assemblies are functioning correctly. See TRAK Sensors or Glass Scales Sections 4.6 & 4.7.
X & Y-axis Drive Trains are loose	Check Repeatability using the Repeatability and Positional Accuracy procedure. Step by step, carefully inspect the Drive Train for any looseness. It may be necessary to disassemble and then reassemble the Drive Train. See Mechanical Drive Train (X, Y) Section 4.2
Spindle Shaft is loose	Verify using a dial indicator whether or not the Spindle Shaft is loose. If so, it could possibly be either bad spindle bearings or loose quill etc.

3.1.3 Taper Cut on a Programmed Straight Line Move

An unwanted tapered cut occurs, when the machine is programmed to move in a straight line along either the X or Y-axis. The DRO shows motion of a few thousandths of an inch in the axis that is not supposed to be moving.

Explanation: For straight line cuts along the X or Y-axis, the control is designed to lock the motor of the axis that is not moving. A taper is created when there is play in the system. The force of the tool shoves the table or saddle out of position. The system will respond to being pushed out of position by making an adjustment at the end of the move.

An unwanted tapered cut is the result of looseness in the system.

Do the following Service Codes:

- **Code 33** Software Identification. This is needed if you call SWI Customer Service.
- **Code 11** Measure's the backlash in the system. Only used on machines with Dual Feedback systems.
- **Code 12** Feed Forward Constant
- **Code 127** Measure's the backlash in the system. Only used on machines with no Dual Feedback
- **Code 128** Enter backlash compensation

Possible Cause	Check This
Machine Tool & Setup problem	Check for any looseness in the setup (Tool, Tool holder, Part, Vise, or Fixture). See Machine Tool & Setup Section 4.1
X, Y, and Z-axis Gibs are loose	Check the adjustment of the X, Y, and Z-axis Gibs using the X, Y, and Z-axis Gib adjustment procedures. See Section 5.2.1
X and Y-axis Drive Trains are loose	Check Repeatability using the Repeatability and Positional Accuracy procedure. Step by step, carefully inspect the Drive Train for any looseness. It may be necessary to disassemble and then reassemble the Drive Train. See Mechanical Drive Train (X, Y) Section 4.2

3.1.4 Parts Have Incorrect Dimensions

Parts are being machined with dimensions that are different than those programmed. Typical accuracy expectations should be:

- **Circles:** 0.002" TIR over 3.00" DIA
- **Positional Accuracy:** 0.0005"
- **Repeatability:** 0.0005"

Note: The typical slideway-milling machine is not capable of achieving more precise results. Although careful adjustments to a new milling machine have produced better results, you should not expect the same level of accuracy from a machine of this class

Furthermore, the system should be expected to repeat within the resolution of the displayed DRO numbers of 0.0005".

Do the following Service Code:

- **Code 33** Software Identification. This is needed if you call SWI Customer Service.
- **Code 123** Calibration
- **Code 11** Measure's the backlash in the system. Only used on machines with Dual Feedback systems.
- **Code 12** Feed Forward Constant
- **Code 127** Measure's the backlash in the system. Only used on machines with no Dual Feedback
- **Code 128** Enter backlash compensation

3.1.4.1 Every Part Has the Same Error

Possible Cause	Check This
Machine Tool & Setup problem	See Machine Tool & Setup Section 4.1
Programming Error	In the program, look for common errors in programming such as transposing numbers, tool diameters, and pressing INC SET when ABS SET is meant. This is especially suspected if the dimensional errors are larger than a few thousandths. See the Controls Programming, Operations and Care manual.
Configuration file that contains calibration file and backlash constants has been erased or corrupted.	Verify configuration file (Code 313) does not read default values. Load save configuration file from floppy disk in electrics cabinet with Code 141.
Calibration or Backlash problem	Recalibrate the machine. Reset the Backlash. Check Repeatability and Positional Accuracy. See Calibration & Backlash Constants – Section 5.2.2

3.1.4.2 The Dimensional Errors Are Random or Accumulate in Size Over the Part Program Run

Possible Cause	Check This
Machine Tool & Setup problem	See Machine Tool & Setup Section 4.1
TRAK Sensor or Glass Scale problem	Make sure that the Sensor or Glass Scale is installed correctly according to the Sensor or Glass Scale Installation procedures. Check for any loose brackets or misalignment etc. Also, check to make sure the Sensor or Glass Scale assemblies are functioning correctly. See TRAK Sensors or Glass Scales Sections 4.6 & 4.7
X and Y-axis Drive Trains are loose	Check Repeatability using the Repeatability and Positional Accuracy procedure. Step by step, carefully inspect the Drive Train for any looseness. It may be necessary to disassemble and then reassemble the Drive Train. See Mechanical Drive Train (X, Y) Section 4.2

3.2 Problems Regarding the Motion of the Machine

3.2.1 Run Away Axis

The axis makes an unwanted move at rapid speed in one direction and faults out. This is usually caused by an encoder signal being interrupted.

Do the following Service Codes:

- **Code 33** Software Identification. This is needed if you call SWI Customer Service.
- **Code 100** Axis open loop test. Used to check the maximum feedrate of an axis and if the encoders are counting.

Possible Cause	Check This
The home positions or tools are not set correctly	See the Controls Programming, Operations and Care manual.
The Sensor or Glass Scale is not reading.	See TRAK Sensors or Glass Scales diagnostic Section 4.6 or 4.7
Bad Motor Encoder	See Motor diagnostics Section 4.4

3.2.2 Slow Down Axis

The axis slows down and moves at a feedrate that is lower than rapid or than the programmed feedrate.

Do the following Service Codes:

- **Code 33** Software Identification. This is needed if you call SWI Customer Service.
- **Code 100** Axis open loop test. Used to check the maximum feedrate of an axis and if the encoders are counting.
- **Code 129** Set's the maximum allowable arc accuracy error. This applies to arcs only.

Possible Cause	Check This
The maximum allowable Arc Accuracy is set too low.	This value will only slow down the machine during arc moves. The factory default is set at 0.001". Perform Code 129 to check or change this value. See Service Codes section
Incoming AC voltage is inadequate	Perform Code 100. See Service Codes - Section 4.9 and Electrical Section 4.8
Table, Saddle, or Ram Locks are locked	Make sure the Table, Saddle, and Ram Locks are unlocked.
Inadequate or no Lubrication to Ballscrews and Way surfaces	Make sure all the Way surfaces are getting proper lubrication. If not, check to make sure that the lube pump is functioning properly. Also check for any pinched or blocked oil lines. See Lubrication Section 4.1.3
X, Y, and Z-axis Gibs are not adjusted properly	Check the adjustment of the X, Y, and Z-axis Gibs using the X, Y, and Z-axis Gib adjustment procedures.- Section 5.2.1
Binding in the Drive Train	Check Repeatability using the Repeatability and Positional Accuracy procedure. Check the torque reading of the Drive Train. Step by step, carefully inspect the Drive Train for any binding. It may be necessary to disassemble and then reassemble the Drive Train. See Mechanical Drive Train (X, Y) Section 4.2
Servo Drive failure	See Servo Drive Section 4.5
Motor failure	See Motor Section 4.4

3.2.3 Axis Will Not Jog

The system powers up but will not respond to the jog command.

Do the following Service Codes and procedures:

- **Code 33** Software Identification. This is needed if you call SWI Customer Service.
- **Code 100** Axis open loop test. Used to check the maximum feedrate of an axis and if the encoders are counting.

Possible Cause	Check This
Improper Boot-up	Shut down the system and wait 10 seconds before rebooting
E-Stop is pressed in	Check E-Stop. Especially if both axes will not jog
Servo Drive failure	Especially, if only one axis will not jog; See Servo Driver Section 4.5
Shorted motor	See Motor Section 4.4
Poor cable or wiring connections	See Electrical Connection Section 2.12
Computer/Pendant failed	See Computer/Pendant diagnostics Section 4.3

3.2.4 Axis Motor Motion Is Not Smooth

While under motor power, the motion is not smooth. The motion appears to be "rough" or jerky".

Do the following Service Codes and procedures:

- **Code 33** Software Identification. This is needed if you call SWI Customer Service.
- **Code 11** Measure's the backlash in the system. Only used on machines with Dual Feedback systems.
- **Code 12** Feed Forward Constant
- **Code 127** Measure's the backlash in the system. Only used on machines with no Dual Feedback
- **Code 128** Enter backlash compensation
- **Code 100** Axis open loop test. Used to check the maximum feedrate of an axis and if the encoders are counting.

Possible Cause	Check This
X, Y, and Z-axis Gibs are not adjusted properly	Check the adjustment of the X, Y, and Z-axis Gibs using the X, Y, and Z-axis Gib adjustment procedures. Section 5.2.1
TRAK Sensor or Glass Scale problem	Make sure that the Sensor or Glass Scale is installed correctly according to the Sensor or Glass Scale Installation procedures. Check for any loose brackets or misalignment etc. Also, check to make sure the Sensor or Glass Scale assemblies are functioning correctly. See TRAK Sensors or Glass Scales Section 4.6 & 4.7
Calibration or Backlash problem	Recalibrate the machine. Reset the Backlash. Check Repeatability and Positional Accuracy. See Calibration & Backlash Constants Section 5.2.2
Binding in the Drive Train	Check Repeatability using the Repeatability and Positional Accuracy procedure. Check the torque reading of the Drive Train. Step by step, carefully inspect the Drive Train for any binding. It may be necessary to disassemble and then reassemble the Drive Train. See Mechanical Drive Train (X, Y) Section 4.2

3.2.5 Vibration in Motion

While axis is moving there is vibration or noise coming from the X or Y-axis.

Do the following Service Codes and procedures:

- **Code 11** Measure's the backlash in the system. Only used on machines with Dual Feedback systems.
- **Code 12** Feed Forward Constant
- **Code 127** Measure's the backlash in the system. Only used on machines with no Dual Feedback
- **Code 128** Enter backlash compensation

Possible Cause	Check This
Too much backlash entered in Code 128 or Code 11.	Recheck the machines backlash.
Inadequate or no Lubrication to Ballscrews and Way surfaces	Make sure all the Way surfaces are getting proper lubrication. If not, check to make sure that the lube pump is functioning properly. Also check for any pinched or blocked oil lines. See Lubrication section
X, Y, and Z-axis Gibs are not adjusted properly	Check the adjustment of the X, Y, and Z-axis Gibs using the X, Y, and Z-axis Gib adjustment procedures. - - Section 5.2.1
Gibs not making good contact.	Pull gibs out and mark with a blue die to check where the gibs are making contact. It is recommended that the gibs uniformly contact at least 80% of the surface.
Binding or looseness in the Drive Train	Check Repeatability using the Repeatability and Positional Accuracy procedure. Check the torque reading of the Drive Train. Step by step, carefully inspect the Drive Train for any binding or looseness. It may be necessary to disassemble and then reassemble the Drive Train. See Mechanical Drive Train (X, Y) Section 4.2
Axis Motor belt too tight.	Loosen belt.
Misalignment of ball screw	See Mechanical Drive Train (X, Y) Section 4.2

3.3 Problems Relating to the Operation of the Control

3.3.1 Display Blanks

The display is completely blank.

Possible Cause	Check This
Screen saver has been activated	Press any key to turn back on. All LED keys on pendant will blink when the screen saver is on. Press any key to deactivate. Hitting this key will not activate any feature on the control.
The system has shut down	Turn the power switch off, check the computer/ pendant fuses and cable connections. See Electrical Section 4.8
Poor cable connection from Computer Module to LCD (Liquid Crystal Display)	Double-check the connection from the computer module to the LCD.
Fuse blown in pendant	Remove fuse and check continuity
Computer/Pendant failed	See Computer/Pendant Section 4.3

3.3.2 Bad Picture on the Display

The display has strange characters, horizontal bars or other unfamiliar images, or the display continually rolls.

Possible Cause	Check This
Poor cable connection from Computer Module to LCD (Liquid Crystal Display)	Check connections on computer module.
Computer/Pendant failed	See Computer/Pendant Section 4.3

3.3.3 Keyboard Lockup

The screen display is normal, but the system will not respond to key presses.

Do the following Service Codes and procedures:

- **Code 81** press each key on the pendant. The screen will display a keypad that signifies if a key is working. The pendant will also beep.

Possible Cause	Check This
Voltage drop/spike has occurred	Shut down the system and wait 10 seconds to reboot the system.
Remote Stop-Go (RSG) switch has a short (if connected)	Remove the RSG. Turn the system off and then on again. If the problem goes away and then re-appears when the RSG is plugged-in, replace the RSG.
Poor cable connections from the Computer Module to the Distribution Board and from the Distribution Board to the Keyboard	Re-seat cable connectors by pulling out and pushing back in.
Computer/Pendant failed	See Computer/Pendant Section 4.3
Electromagnetic interference has entered through the RS232 cable (if connected); especially if intermittent	Especially suspected if the RS232 cable is run near any electrical conduit. If the problem is chronic, remove the cable for a while to see if there is a difference.

3.3.4 Fault X, Y or Z

The program run or jogging operation is interrupted with a Fault Message on the display.

Do the following Service Codes and procedures:

- **Code 33** Software Identification. This is needed if you call SWI Customer Service.
- **Code 11** Measure's the backlash in the system. Only used on machines with Dual Feedback systems.
- **Code 12** Feed Forward Constant
- **Code 100** Axis open loop test. Used to check the maximum feedrate of an axis and if the encoders are counting.

Possible Cause	Check This
Table, Saddle, or Ram Locks are locked	Make sure the Table, Saddle, and Ram Locks are unlocked. High torque on any axis may cause faulting problems during alignment routine.
X, Y, and Z-axis Gibs are adjusted extremely tight	Check the adjustment of the X, Y, and Z-axis Gibs using the X, Y, and Z-axis Gib adjustment procedures. See X, Y, and Z-axis Gib Adjustments Section 5.2.1
Excessive friction in the slideways	See Machine Tool & Setup Section 4.1
Binding or looseness in the Drive Train	See Mechanical Drive Train (X, Y) Section 4.2
Incoming electrical power	Incoming voltage. See Electrical Section 4.8
Measurement system not functioning properly	See Section 4.6 or 4.7
Servo Drive failure	See Servo Driver - Section 4.5
Motor failure	See Motor diagnostics, Section 4.4
Computer/Pendant failure	See Computer/Pendant diagnostics, Section 4.3

3.3.5 Problems Reading the Floppy Disk; Programs Not Saved Properly

The floppy drive will not read or write programs from a disk.

Possible Cause	Check This
Improper Boot-up	Shut down the system and wait 10 seconds before rebooting
Floppy Disk failure	The Floppy Disk may be bad. See if the Floppy Disk can be read by a Personal Computer. Does the green light on the floppy drive come on when you access the disk? If so, power is getting to the floppy drive. If not check connections of floppy drive inside the computer module. See Computer/Pendant Section 4.3 for more information.
Floppy Disk full	Put the Floppy Disk into a Personal Computer to see how many bytes remain.

3.3.6 System Will Not Turn On or Boot-Up

Nothing happens when the switch is turned on or the system does not boot-up.

Possible Cause	Check This
Main Disconnect switch is off	Check the Main Disconnect switch.
Pendant On/Off switch is Off.	Check the Pendant On/Off switch
Fuse blown in pendant or the electrical cabinet	Remove fuses and check continuity.
110V line is not plugged in	Check incoming 110v power source to electrical cabinet

Possible Cause	Check This
Flash Drive failure	When the Computer Module starts the boot-up process, look at the 8 th line on the Display Screen. If the Mother Board of the Computer Module is communicating with the Flash Drive you will see "Detecting IDE Primary Master. If the Mother Board of the Computer Module is not communicating with the Flash Drive you will see "Detecting IDE Primary Master ... None". Also, check the wiring connection between the Flash Drive and the Mother Board. See Computer/Pendant diagnostics Section 4.3
Computer/Pendant has failed	See Computer/Pendant diagnostics Section 4.3

3.3.7 System Reboots by Itself

During operation, the screen suddenly blanks and then shows that the system has begun the boot-up sequence.

Possible Cause	Check This
Interruption of 110v power to pendant.	Using a voltmeter, check the incoming 100 AC to the pendant.
Poor wiring and cable connections	Check for any loose wiring.
Computer/Pendant failed	See Computer/Pendant diagnostics Section 4.3

3.3.8 System Shuts Off

During operation, the system shuts off and will not turn back on.

Possible Cause	Check This
Fuse blown in pendant	Remove fuse and check continuity
Poor wiring and cable connections	Check for any loose wiring. Also, check the 110VAC Power Cable connection from the 110VAC Power Strip to the Pendant. See Electrical Section 4.8
Flash drive failure	Check the flash drive connections in the computer module.
Computer/Pendant has failed	See Computer/Pendant diagnostics Section 4.3

3.3.9 Will Not Hold Calibration

The control will not hold calibration. Go to the "Configuration Values" screen and write down the calibration values for the motor encoders (Encoder) and the position feedback encoders (Scales). The calibration values are written in Hexadecimal. Recalibrate the system and see if the values change. Turn the system off and on and see if the values are held.

Do the following service codes and procedures:

- **Code 33** Software Identification. This is needed if you call SWI Customer Service.
- **Code 313** Configuration Values
- **Code 123** Calibration Mode

Possible Cause	Check This
Not saving Calibration values	Replace Computer/Pendant module. See Computer/Pendant

If calibration factors are being saved, but the measurements are not repeating or are not accurate:

- See Measurements Are Not Repeating
- See Measurements Are Not Accurate

3.3.10 Auxiliary Functions Not Working

The Auxiliary Functions will not turn on or off at the programmed times. There are 3 Auxiliary Functions:

1. Activates or deactivates a "110VAC Receptacle" typically used for a coolant pump or solenoid for mister.
2. Sends an electrical signal to rotate the turret on a "Haas Indexer".
3. Turns the "Spindle Off" at the end of a programmed event.

In order to run the above auxiliary functions in run mode the accessory key on the front of the pendant must be in the AUTO mode.

All of the auxiliary function signals are carried down to the cable breakout box through umbilical #2. Each function then has its own relay inside this box. If one of these relays fail then these features will not work.

Do the following service code and procedures:

- **Code 33** Software Identification. This is needed if you call SWI Customer Service.

Possible Cause	Check This
Bad 110VAC "Coolant or solenoid" receptacle fuse	Check if the fuse light indicator next to the plug is lit. Verify that the fuses are good or bad by checking the resistance of the fuses using an Ohmmeter.
Poor cable connections	Check all the cable connections on the cable breakout box, Coolant Pump, and Air Solenoid (Located on the Air Regulator). In particular check umbilical # 2 cable, which carries the auxiliary function signals.
Faulty "Indexer" connector	Check for continuity between pins 3 and 4, when the output of the Haas Indexer connector is activated.
Bad cable breakout box	Check 110 V power coming out of the AC E-stop port with the E-stop in the out position. This will cause the spindle to not run.

3.3.11 E-Stop Error

The E-Stop turns the power off to the axis. This is done by stopping 110V power from reaching the cable breakout box through the use of a relay in the pendant.

Once power reaches the cable breakout box it distributes power to the axis motors, auxiliary functions and 110V power to the spindle contactor. A 5-volt signal is sent to the spindle control board, which energizes a relay, which then enables the AC drive.

If the E-Stop button is depressed, and no message is displayed on the screen, then either the E-Stop button or the Computer Module is at fault.

Possible Cause	Check This
Faulty E-Stop switch	Check the cable connections from the computer module to the E-Stop switch. Check the E-Stop switch for functionality.
Bad pendant	Does 110 V power come out of the cable breakout box power cord on the pendant? If yes, and the screen has an E-stop message, replace the pendant.

3.3.12 Limit Switch Error

Limit switches are installed on the table, saddle, and ram to prevent serious damage to the machine in the event of a crash. In the event a limit switch is triggered, a limit switch error will appear on the screen.

Critical Error 64: Servo Error
X-axis Limit Switch
 Correct the fault condition and continue.

To return the machine to its normal state of operation, perform the following procedure:

1. Use the electronic hand wheel to move the table, saddle, or ram off the limit switch.
2. Press the "Mode" or "Return" key to reset the control
3. Press the "DRO" key to enable the machine to once again jog.

Possible Cause	Check This
Limit Switches are triggered	Reset the Limit Switches using the procedures described above.
Poor Limit Switch Cable connection	Check for any pins that are loose, pushed in, or bent. Verify that there is a good connection between the cables on the cable breakout box.
Limit Switch failure Try this Switch 2 limit switch cables on the cable breakout box.	Does the limit switch problem move to the other axis? If it does then the switch is most likely the problem. If it stays with the original axis then it could be the cable breakout box.

3.4 Problem with the Measurements

3.4.1 X, Y and Z-axis Measurements Do Not Repeat

With a dial indicator mounted to the bottom of the spindle, touch off a fixed surface either in the X or Y-axis direction and then set the DRO equal to 0. Crank away several inches and then touch off again at the same place. If the reading has not returned to 0 on the DRO, zero the display and repeat the procedure. If the measurement does not repeat, you have a repeatability problem that must be resolved.

Test for accumulative error by moving the axis a number of times to see if the error gradually grows by a small amount. If so, it may be caused by a misaligned sensor or scale. If the error abruptly changes by a large amount, it may be caused by a bad encoder.

Expected repeatability numbers should be 0.0005" or less.

Do the following service codes and procedures:

- **Code 304** Toggle X sensor/glass scale on/off
- **Code 305** Toggle Y sensor/glass scale on/off

Possible Cause	Check This
Machine Tool & Setup problem	Check for any looseness in the setup (Tool, Tool holder, Part, Vise, or Fixture). Make sure there is sufficient contact between the tool holder and the spindle. See Machine Tool & Setup Section 4.1
X, Y, and Z-axis Gibs are loose	Check the adjustment of the X, Y, and Z-axis Gibs using the X, Y, and Z-axis Gib adjustment procedures. – Section 5.2.1
TRAK Sensor or Glass Scale problem	Make sure that the Sensor or Glass Scale is installed correctly according to the Sensor or Glass Scale Installation procedures. Check for any loose brackets or misalignment etc. Also, check to make sure the Sensor or Glass Scale assemblies are functioning correctly. Use service codes 304 for X and 305 for Y to turn off the suspect encoder. Does problem still exist after turning it off? – Section 4.6 & 4.7
X and Y-axis Drive Trains are loose	Check Repeatability using the Repeatability and Positional Accuracy procedure. Step by step, carefully inspect the Drive Train for any looseness. It may be necessary to disassemble and then reassemble the Drive Train. See Mechanical Drive Train (X, Y) Section 4.2
Encoder Disk or Reader Head on motor are loose	Swap the motor in question with a known good motor. For example, swap the X-axis motor with the Y-axis motor. If the symptom stays with the motor in question, then replace the motor. If not, then the motor is not at fault and something else is causing the problem.

Possible Cause	Check This
Spindle and/or Quill are loose	Use a Dial Indicator and check for side-to-side movement between the Spindle and the Head. Next, check for side-to-side movement between the Quill and the Head. There should be no more than 0.0003" of side-to-side movement. Make sure that there is a few thousandths gap between the Spindle Collar and the Quill after tightening.
Ram bolts are loose	Tighten Ram bolts

3.4.2 X, Y, and Z-axis Measurements Are Not Accurate

Measurements repeat, but with a dial indicator mounted to the bottom the spindle, traversing the length of a gage block or some other measurement standard, the measurement is not accurate.

Note: If your part has incorrect dimensions, see Parts Have Incorrect Dimensions, Section 3.1.4.

Note: First check for repeatability of the DRO: With a dial indicator mounted to the bottom of the spindle, touch off a fixed surface either in the X, Y, or Z-axis direction and set the DRO equal to 0. Crank away several inches and touch off again at the same place. If the reading has not returned to 0 on the DRO, zero the display and repeat the procedure. If the measurement does not repeat, you have a repeatability problem that must be resolved before the accuracy problem can be resolved. See Measurements That Do Not Repeat, Section 3.4.1.

Possible Cause	Do This
The Calibration is incorrect	Recalibrate the machine. See Calibration & Backlash Constants Section 5.2.2
Incorrect backlash values	If the machine does not repeat bi-directionally, check the backlash on the axis in question. See Section 5.2.2

3.4.3 The DRO Is Not Counting

The DRO for one axis is not counting when an axis is moved. Often times if this is the case the axis will fault. See section on faulting.

Do the following Service Codes:

- **Code 33** Software Identification. This is needed if you call SWI Customer Service.
- **Code 100** Axis open loop test. Used to check the maximum feedrate of an axis and if the encoders are counting.
- **Code 132** Electronic handwheel test
- **Code 304 & 305** Turns off X and Y sensor or scale.

Possible Cause	Check This
Electronic handwheel failure	Each handwheel should count 0.200" per revolution in both directions in fine mode and 0.800" per revolution in course mode.

Possible Cause	Check This
Servo driver failure	See Servo driver Section 4.5
Motor Encoder not counting	See Motor diagnostics (not applicable with Glass Scale option) Section 4.4
Glass Scale or Sensor Failure	Does axis now count? If so, replace scale.
Computer/Pendant failure	See Computer/Pendant diagnostics

3.4.4 X, Y, and Z-axis DRO Counting in Wrong Direction

The DRO is counting in the wrong direction.

The positive directions for each axis are:

- **X-axis** – Table moves to the left
- **Y-axis** – Saddle moves toward the front of the machine
- **Z-axis** – Ram moves up

Do the following service code and procedures:

- **Code 33** Software Identification. This is needed if you call SWI Customer Service.
- **Code 313** Check the line that specifies the product.
Product = 2 is a FHM5
Product = 35 is a FHM7

If the product does not match the machine then the machine ID key will need to be replaced.

3.4.5 X, Y, and Z-axis Electric Handwheels Turn in Wrong Direction

The Electric Handwheels turn in the wrong direction.

The positive directions for each Electric Handwheel are:

- **X-axis** - Electric Handwheel turns clockwise
- **Y-axis** - Electric Handwheel turns counterclockwise
- **Z-axis** - Electric Handwheel turns clockwise

Do the following service code and procedures:

- **Code 308** Reverse X-axis Handwheel Direction
- **Code 309** Reverse Y-axis Handwheel Direction
- **Code 310** Reverse Z-axis Handwheel Direction

3.5 Problems with the Machine Tool

3.5.1 Z-axis Noisy

While jogging or cutting in the Z-axis direction, the axis makes unusual noises. See below for head noise.

Possible Cause	Check This
Machine Tool and Setup problem	Check for any looseness in the setup (Tool, Tool holder, Part, Vise, or Fixture). See Machine Tool & Setup Section 4.1
Ram Locks are locked	Make sure the Ram Locks are unlocked.
Inadequate or no Lubrication to the Ballscrew and Way surfaces	Make sure all the Way surfaces are getting proper lubrication. If not, check to make sure that the lube pump is functioning properly. Also check for any pinched or blocked oil lines. See Lubrication Section 4.1.3
Z-axis Gibs are not adjusted properly	Check the adjustment of the Z-axis Gibs using the Z-axis Gib adjustment procedure. See Z-axis Gib Adjustments Section 5.2.1
Mechanical Drive Train	Misalign ballscrew, or top and lower bearing failure.
Z-axis motor failure	Replace Z-axis motor See Motor Diagnostics Section 4.4

3.5.2 Spindle Stalls or Turns-Off during Machining

During machining, the spindle turns off and loses power. First check incoming voltage and connections.

Possible Cause	Check This
Machine Tool and Setup problem	Check the type of material being cut, type and size of cutting tool, RPM, and Feed rate. Also check the condition of the cutter to verify that the cutter is not dull. See Machine Tool & Setup Section 4.1
Drive Belt in the head is slipping	Check the alignment, condition, and tension of the Drive Belt.
Cut more than the machine is capable	Check width and depth of cut
Auxiliary Function "Spindle Off" is being used in the program	Check how the program is written. Also, check the program for any programming errors regarding the Auxiliary Functions. See the Controls Programming, Operations and Care manual.
Spindle Drive Thermal Overload Relay has tripped	IOUT - Current Out (located on the Spindle Drive). The current has exceeded the limit of the drive. When the Overload Relay is enabled, an "oL1" error occurs shutting off the Spindle Drive. The harder the Spindle Motor works trying to make heavy cuts, the more current the Spindle Motor utilizes. This can be caused by a cut so large that it exceeds the machine capability, or a problem with the spindle motor or AC drive.
Spindle Drive parameters are not correct	May need to re-download the Spindle Drive parameters. Contact Customer Service for assistance.

3.5.3 Spindle Motor Hums or Will Not Run

The spindle motor makes a constant humming noise during operation or will not turn on.

Note: machines can only be wired for 220 volts. 440 volts will ruin electrical components in the machine. These components will not be covered under warranty.

Possible Cause	Check This
Wrong voltage	Check the 220v voltage to the machine
Poor wiring connections	Check all the wiring connections to the electrics box
Defective cables or poor cable connections	Check all cable connections
Improper wiring/jumper configuration on the Spindle Motor	Check to make sure that the Spindle Motor has the correct wiring/jumper configuration for 220VAC. See Electrical wiring section.
Spindle Drive may be in "Local Mode" and can not be run from the Pendant	On the Spindle Drive, push the "DSPL" button until "LO/RE" lights up. Use the "Up" and "Down" arrow keys to choose between "Lo" - <u>Local</u> (Run Spindle Motor from Spindle Drive) or "rE" - <u>Remote</u> (Run Spindle Motor from the Pendant).
Spindle Motor is bad	Check the resistance of the Spindle Motor windings on the Spindle Motor between L1 & L2, L2 & L3, and L1 & L3, using an Ohmmeter. The resistance should range from "0.5 Ohms" to "2 Ohms". If the Ohmmeter reads "0 Ohms" or "OL", then replace Spindle Motor. Next, check the resistance between L1 & Ground, L2 & Ground, and L3 & Ground, using an Ohmmeter. The resistance should read "OL". If not then replace Spindle Motor.
Spindle Drive contains incorrect parameters and is not programmed correctly	Contact customer service.

3.5.4 Spindle Runs Backwards

The spindle motor runs in the opposite direction. The spindle should always spin in the clockwise direction when the forward key on the pendant is pressed.

Possible Cause	Check This
3-Phase wires backwards	Need to switch any 2 of the 3 wires either coming out of the Spindle Drive (T1, T2, and T3) or going into the Spindle Motor (U, V, and W). Caution: Be sure to shut off all power to the machine before attempting to switch any wires.

3.5.5 Head Noise

Head noise pertains to any unusual noises coming from the head under load and no load situations. Most often head noise will only be noticeable under load situations. It is important to try to distinguish between problems with components in the head versus problems caused by the setup or tooling being used on a particular job. Use the table below to try to pinpoint the possible cause.

Possible Cause	Check This
Machine setup or tooling problem	If the noise is most evident under load (cutting situations) then it is important to look at setup and tooling being used. Ask the following questions. Is the cutter dull? Is the tool loose in the holder? Am I taking a bigger cut than is possible on the machine? Is the part moving in the vice? Am I using realistic speeds and feeds? Any one of these can have a significant impact.
Belt is loose	Check to make sure the tensioning device is properly fastened. Make sure the lock nut is tight that holds this device in place.
The belt is not lined up with the grooves on the pulleys.	Make sure the 8-grooves on the belt are lined up with the 8-grooves on the 2-pulleys. Remove the upper spindle cover to verify. If the belt is frayed then replace the belt.
Verify nosepiece is tight on bottom of spindle. FHM5 Only.	To check if the nosepiece is bottomed out try to insert a piece of paper in between the nosepiece and the quill. If a piece of paper does fit then this may be the problem. Before tightening or loosening the nosepiece make sure to loosen the setscrew that holds it in place.
Spindle bearings are worn out	This is categorized by a high pitch sound and is most evident at high RPM's. It should also cause chatter under load. Replace the spindle if this is the case. See spindle replacement in Section 5.

4.0 Diagnostics

This section explains the diagnostic procedures used to isolate service problems.

4.1 The Machine Tool & Set-Up

4.1.1 The Milling Machine Checklist

The following is a quick reference for the types of problems that may arise if problems are noticed in these areas.

Problems With:	Can Contribute To:	Most Suspect When (and why):
Spindle bearings See Spindle Replacement	Noisy head; Parts incorrect; Circles out of round	Older machines, machines that are pushed hard
Lubrication system	Premature wear of ball screws, wear surfaces, poor finish	New installations (may not be hooked up or line sheared)
Inadequate lubrication habits	Premature wear of ball screws, wear surfaces Poor finish	New installations (more motion than the machinist is used to with a manual mill) Lubricate machine every morning before use.
Gib locks - on X and Y axis	If locked can lead to axis faults	<i>Note: when using the CNC to machine, never tighten the gib locks!</i>
X and Y gibs loose See Gib Adjustment - Section 5.2.1	Taper on straight Y moves Poor finish Circle out of round	When machine hasn't been serviced in a long while.
Gibs too tight	Not getting to position, does not repeat, axis faults Poor finish	N/A
Gibs floating	Not getting to position, does not repeat, axis faults Poor finish	Contact area of gibs. May need to be scraped. Very old machines may not have any more adjustments on gib. A new gib will need to be fit on the machine.
Gibs defective - bowed, scarred	Excess play when gib is checked side to side	Inadequate gib contact
Way surfaces pocked, scarred, or excessively worn	Poor finish Out of round circles Faulting	Inadequate lubrication
Ram gibs loose	Parts incorrect dimensions Head out of tram in Y direction.	Vibration or jerky motion in Z-axis
Machine not level Weight not distributed evenly on all 6 screws. See Leveling procedures	Parts incorrect Machine geometry off, i.e. tram.	New installation or heavy crash.
Head out of tram See Trimming Head – Section 5.2.3	Leaves uneven surfaces on bottom of pockets.	Machine not level, ram gibs loose.
Spindle belt loose	Machine stalls during a heavy cut	Make sure belt tensioning device is locked in place. Belt is worn after many years of use.

4.1.2 A Special Word About X/Y/Z Gibs

The slideway surfaces are vital to the performance of the bed mill.

Gibs should be:

- flat
- free of twist
- free of burrs
- free of blockages in the oil passages and channels

Defective or scarred gibs must be replaced. Shimming of gibs will not yield acceptable results.

It is good machining practice to avoid the use of shop air to clean the chips off a machine. This risks blowing chips into the sliding way surfaces and compromising the performance of the machine.

Gibs that are not adjusted correctly will affect the performance of the machine. It will lead to positioning and repeatability problems. The gibs should be adjusted at least twice a year.

See Gib Adjustments Section 5.2.1.

4.1.3 Lubrication

Lubrication is one of the single, most important maintenance issues and plays a key role in assuring the performance and durability of the bed mill. At the beginning of each day manually supply oil to the way surfaces by doing Service Code 300.

Lack of lubrication can lead to a variety of problems with your machine motion due to increased friction in the sliding ways. This increased friction may lead to part inaccuracies and decreased life expectancies of your ball screws and way surfaces.

4.1.4 Machining Set-Up

The machining set-up itself is always something that can greatly influence the performance of the your mill. The following are some things to keep in mind.

Problems With	Can Contribute To:
Feed and Speeds (spindle rpm) See below	Poor finish Machine chatter Excessive speeds and feeds can break cutting tools or wear tools prematurely.
Tooling Using the wrong cutter for an application Entering the wrong size diameter and programming with tool compensation.	Poor finish Parts incorrect size
Cutting too deep	Part dimensions incorrect Driving and cutting forces cause deflections, since no material is totally rigid Machine chatter
No coolant	Poor finish, decrease the life of the cutter

4.1.4.1 Spindle Speeds

Spindle speeds are influenced by a number of variables:

- Material
- Rigidity of the Machine Setup
- Coolant
- Cutter type, material and diameter
- Cutting Depth

As a general rule:

- Lower spindle speeds are used to machine hard or tough material or where heavy cuts are taken.
- Higher spindle speeds are used to machine softer materials in order to achieve better surface finishes. Higher speeds also apply when using small diameter cutters for light cuts on frail work pieces and delicate setups.

Note: Cutter diameter greatly affects spindle speeds. The larger the diameter, the lower the spindle speed.

4.1.4.2 Feedrates

Factors that affect feedrates:

- Depth and width of cut
- Design or type of cutter
- Sharpness of the cutter
- Workpiece material
- Type of finish or accuracy required
- Climb or conventional milling

If a fine finish is required, reduce the feed rather than increase the spindle speed. Cutters are dulled by higher spindle speeds rather than high feedrates.

4.2 The Mechanical Drive Train (X,Y)

Indications:

- Troubleshooting instructions indicate that the drive train is potentially the problem and other (more easily checked variables) have been exhausted.
 - Roughness, looseness, tightness or jamming movement in the table or saddle.
1. Check for machine considerations, especially gib locks and gib adjustments. See Gib Adjustments section
 2. Check the torque of the axis in three places (both ends and center of ball screw) along the length of the ball screw. The torque should be within 2 or 3 in-lbs across the length of the ball screw. If it is not, chances are the ball screw is misaligned. A misaligned ball screw can lead to parts being out of round and servo problems at low feedrates. A bad ball screw can also cause high torque, although this is highly unlikely. See Sections 4.2.1 and 4.2.2 for more information.

The following steps take you in logical sequence through the assemblies for both the FHM5 and FHM7. For drawings of these assemblies see Figures 26, 27, 28 and 29 in Section 5. These instructions break the machine down from fully assembled and point out the areas to look at specifically.

3. Check that the belt is properly tightened. A loose belt can lead to excessive backlash compensation values on motor encoder only machines. To adjust belt tension, loosen the (4) screws that secure the motor to the bracket. Adjust motor for proper belt tension as necessary. See the drawings for illustrations.
4. Check that the nut that tightens up against the ball screw pulley is tight. If this is loose the pulley may not run true on the ball screw.
5. FHM5 X-axis only - Check that the tapered sleeve that seats the pulley has not clamped to the ball screw prematurely. It should be seated firmly against the pulley. Tightening the nut may not have ensured this. Also make sure the pulley is keyed to the ball screw.
6. FHM5 X-axis & Y-axis bearing housings - Ensure that the bearing housing is clamped in place by the bracket. This design uses the bracket to secure the bearing housing in place. It should not allow the bearing housing to float between the bracket and machine. For the FHM7, verify the bearing housing cover is properly fastened.
7. FHM5 X-axis & y-axis - Ensure that the Clamp Nut is secured. The following applies to the clamp nut:
 - When loosening, make sure to back out the 10-32 screw from the clamp nut.
 - When tightening, snug the 10-32 screw so the clamp goes onto the ball screw thread with some drag. Thread it onto the ball screw and torque the clamp nut to 50 ft/lbs and then tighten the screw down.

For the FHM7 verify the nut on the X-axis, and double nut on the Y-axis is tight.

8. Take out the angular contact bearings and inspect them. They should roll smoothly and be lightly greased. If not, replace them. When putting the bearings back into the housing make sure to put them in correctly. Failure to do this will cause problems. The thin race of each bearing should be facing inward toward the spacer ring.

Note: FHM5 - the bearing housing and spacer ring are matched sets - keep them together.

9. Check the ball screw mounting to the yoke. Make sure the SHCS are tight.
10. Inspect the ball screw, ball nut and yoke for the potential problems shown in the chart on the next page.

CAUTION!
Unlike a lead screw, do not unscrew the ball screw from its nut. This will destroy the ball screw!

Potential Problem:	Check By:
Bad ball screw	<ul style="list-style-type: none"> • Visually inspecting the ball nut - if the nylon seal is broken or deformed, if contamination has visibly entered the ball nut or if balls are out of the ball nut, replace the ball screw. • Cranking the ball screw through a significant part of its travel. If it jams, feels loose or has rough spots, replace the ball screw. • Using the dial indicator on a vertical flat of the ball screw to check for backlash between the ball screw and ball nut.

Potential Problem:	Check By:
Ball nut not tightened to the yoke	<ul style="list-style-type: none"> • Inspection for space between the head of the bolt and the ball nut i.e. the retaining bolt has bottomed out in its thread and is not securing the ball nut to the yoke properly.
Yoke loose in the saddle	<ul style="list-style-type: none"> • Inspection for any motion of the yoke or looseness in the Yoke mounting screws.
Oil lines sheared	<ul style="list-style-type: none"> • Visual inspection.
Oil line blockage	<ul style="list-style-type: none"> • Pump the oil and ensure that it flows evenly to the ways and ball screw.
Ball screws not aligned properly	<ul style="list-style-type: none"> • Measure from the ball screw to the back of the saddle on both sides of the yoke (the table must be removed). The measurements must be within $\pm .005$" end-to-end. See above explanations.

Note: Ball screws are inspected throughout their entire travel for backlash and consistent torque. A ball screw should be good for millions of inches of travel if installed properly. Do not be too quick to replace a ball screw if there is insufficient indication that it is bad; this will just be a costly delay to resolving the real problem.

4.2.1 Ball Screw Alignment

- X-axis – there are 3 components that can cause misalignment: the yoke, the left side bearing housing bracket, and the right side bearing housing. This machine has 2 separate yokes for the X and Y-axis. The yoke is bolted to the table on the X-axis.
- FHM5 - X Axis Yoke – the yoke is aligned at the factory. If you suspect the yoke is misaligned, the bolts for the yoke can be accessed from an opening on the bottom left side of the saddle. Break these bolts free and move the table back and forth along its travel and then retighten the bolts.
- Left side table bearing housing – To align the bracket, move the yoke (table left) as close to the bracket as possible. Loosen the bracket bolts and then retighten. This should allow the bearing housing to align itself up with the yoke.
- Right side table bearing housing – once again move the yoke as close to the bearing housing as possible (table right). Loosen the bearing housing and retighten. This should allow the bracket to align itself. If you do not move the table toward the yoke the ball screw will tend to bend down slightly and cause misalignment.
- Y-axis – the only component that can cause a misalignment problem is the motor mounting bracket. To align this bracket, move the saddle as far to the front of the machine as possible. Loosen the bracket and then retighten it. Once again moving the saddle forward allows the yoke to be as close to the bearing housing as possible. The yoke is pinned at SWI should not become misaligned unless the machine has been repeatedly crashed.

4.3 Computer/Pendant Diagnostics

The pendant consists of 2 separate modules: the computer module, and LCD screen enclosure.

In general, the pendant/computer module is best diagnosed by eliminating all other possible alternatives. The following table lists some problems and what these problems can lead to. Unplug accessories, such as the keyboard, Remote Stop Go and mouse. Check to see if the problem is resolved.

Possible Problems	Can lead to
Poor cable connections	There are 8 cable connections to the left side of the pendant. Make sure all cables are properly fastened.
Pendant locks up	Press the E-stop button and see if lock up clears if not then do the following: Turn the pendant off, wait at least 30 seconds, and turn it back on and check to see if the malfunction has been reset.
Low voltage to flash drive or slave board.	Can cause the system to lock up and the flash drive to act abnormally. Check voltage to power cable at flash drive module with voltmeter. It should be 4.8 volts and above. Lower values than this can cause problems.
Flash Disk failure	If the flash disk fails, the system will not boot up or operate. It will need to be replaced. All programs and machine configurations will be lost. Make sure to back up your flash disk from time to time.
Floppy disk failure	Will not allow user to save or pull up programs from a floppy disk. Can the floppy drive format a disk? See instructions below.
LCD backlight burns out	Check all cable connections to LCD, distribution board and computer module. Make sure the power is turned off before doing so.
Faulty E-stop switch	It can be stuck open or closed (pressed). If it is stuck closed the pendant will need to be replaced because the user will have no way to get rid of the message. If it is open it will allow the machine to still operate but it will be unsafe for the user. The pendant will still need to be replaced.
Axis faults on screen	Servo driver cables at pendant are loose. Make sure cable connection bracket is fastened down. Make sure cable clips into female portion on the top and bottom. Sometimes the clips tend to stick.
Overlay failure (keys on pendant)	Certain buttons on overlay do not work. Do code 81 to verify each key beeps.
Low voltage to pendant or current spikes	1 amp fuse in pendant blows. Pendant will not turn on.
Slave board not functioning	Machine will not run. If you run Code 33 and no slave software version is shown, the slave board is not functioning.

4.3.1 Checking Floppy Drive by Formatting a Disk

1. Find a new disk and install in floppy drive.
2. Install keyboard into middle port.
3. Press CTRL ESC to get to start menu.
4. Press R for run.
5. Type Format a: - press enter.
6. If the format works your disk drive is working. If format does not work, reboot control and see if it now works. If it does not work replace the computer module.
7. Press ALT ESC to get back to PT4 software.

4.4 Motor Diagnostics

The Motor subsystem is comprised of 2 parts: The Motor Encoder and the Motor. The motors are powered by 110 VAC voltage. The servo driver is also an integral part of servo system, which is discussed in detail in the next section.

WARNING!

Do not work with the motors unless the power is disconnected from the machine. The motors are run by 110 VAC. There is possibility of death by electrocution!

Rarely do both the X and Y motor/servo systems fail at the same time and in the same way. So, if your problem is occurring on both axes, its source is probably somewhere else.

4.4.1 Cable Connections

Check the motor cable connections on the cable breakout box. Verify there are no pushed in pins on the connector.

4.4.2 To Check the Motor Encoders

If the motor encoder inside the motor has failed or is not reading the machine will fault out on that axis. Do the following to verify this problem:

Motor encoder only machines – run Service Code 100 or 131. This will display on the DRO if the motor encoder is counting. If this number does not move then the encoder is not counting. This means either the encoder or the cable is the problem. Visually check the cable for any problems. If the encoder has failed the motor must be replaced.

Motor encoder and secondary feedback machines – run Service Code 100 or 131. Both the motor encoder and sensor or glass scale encoder should count on the DRO screen. The motor value should be displayed under the Z-axis and the sensor or glass scale under the X or Y-axis depending on what axis you are doing.

4.4.3 Encoder Counts to Pendant

Before replacing the motor due to a bad motor encoder it is a good idea to check the cables that take those signals back to the pendant. If these signals are not getting back to the pendant then the axis will fault. Check the following cable connections.

- Umbilical #1 and #2 at the cable breakout box
- Umbilical #1 and #2 at the pendant
- Umbilical #1 carries the X & Y axis signals Umbilical #2 carries the z signals
- Check the servo driver connections at the pendant and also at the servo driver

4.4.4 Moving Problem from One Axis to Another

Another way to troubleshoot a problem with a particular axis is to swap parts from 1 axis to another to see if the problem moves. If the problem moves then that component is faulty. See the example below.

Symptom – X Axis will not move and faults

This particular problem can happen because of any of following reasons: bad motor, servo driver, power cable, or computer module. In some cases it is not always obvious which component is causing the problem. This example will help us pinpoint the problem through a trial and error process.

Let's assume we have narrowed it down to the servo or electrical systems and the Y-axis has no problems. Lets also assume it is not an obvious problem like a loose connection. This particular example was done on a machine with motor encoders only.

Swap these components	Results
Physically switch the X and Y motors	Has problem moved to Y-axis? If yes, replace motor. If no, the motor is not the problem.
	NOTE: Motors are always replaced with the servo driver.

4.5 Servo Driver

Note: the Servo Driver is located in the black box on the side of each motor.

Indications:

- Problems moving just one axis, including hard turning in one direction.

Servo Types:

- X, Y and Z servos are identical

Objective:

- Isolate the problem to the particular Servo Driver

Steps:

1. Turn off and unplug the system.

WARNING! Do not work with the Servo Driver unless the power is disconnected from the machine. There is possibility of death by electrocution!
--

2. Physically swap the servo module from the axis that is not working to one that is.

Note: To avoid pulling the wires out of the connector, use the loop to pull the connector from the Servo Driver.

If the problem moves to the other axis and clears up from the original axis, replace the Servo Driver.

4.6 Glass Scales

Glass scales are used on the X and Y-axis for secondary feedback. They are optional on the FHM machines.

4.6.1 Alignment of scales

- **X Axis** - The X-axis scale must be aligned within 0.005" in the up and down direction over the length of the scale for proper operation. Misalignment can cause the scale to not read in the certain areas of the scale that are not aligned with the reader head. If this happens, the axis will mostly likely fault out in this area. Also make sure the mounting hardware for the reader head is tight. Loose hardware can cause excess backlash when reversing direction.

To align the scale, place a 0.001" indicator on the bed ways and on top of the scale extrusion. Move the table along its full travel from one end to another to verify it is aligned. If the scale is misaligned loosen the 2 screws at either end to shift the scale up or down as needed. You will also need to loosen the center support bracket to allow the scale to pivot.

- **Y Axis** - The Y-axis must be aligned in the up and down direction and must be parallel to the Y-axis way surface. Both surfaces must be aligned to within 0.005". Failure to align the scale properly could cause the same problems as mentioned above. Mount your 0.001" indicator on the saddle and move the Y-axis back and forth along its travel.

Note: In order to run the machine with the electronic handwheels and align the scale you will need to turn the scale system off with a service code. See service code section.

See Figure 23 in Section 5 for an illustration of how to align the glass scales.

4.6.2 Measurements Do Not repeat

1. Determine if the error in repeatability is random or accumulating:
 - Mount a dial indicator in the quill.
 - Touch off a fixed point on the table and set the DRO to 0.
 - Traverse away approximately 6 inches.
 - Return the touch off again.
 - Write down the reading on the DRO.
 - Do not Re-zero the DRO, traverse away and return several times.
 - Write down the DRO readings

Random error will be unpredictable and give scattered readings, adding and/or subtracting the error after each traverse with no pattern. See Step 2.

Accumulating error will add roughly the same amount to the reading after each traverse. See Step 3.

2. For random error, look for problems in the set-up of the glass scale that have resulted in a loss of rigidity. Common sources of random error include:
 - Loose scale mounting hardware.
 - Loose reader head.

- Very loose motion of the table or saddle.
3. Accumulating error is commonly the result of:
- Scale out of parallel to the axis travel.
 - Dirt or chip on the glass scale.
 - Broken glass.

4.7 TRAK Sensors (FHM5 only)

TRAK Sensors are used on the X and Y-axis for secondary feedback. They are optional on the FHM5 machines. The following section talks about some of the common symptoms associated with a problem sensor and how to isolate or fix the problem.

Common symptoms

- Faulting Axis
- The DRO measurements do not repeat
- The DRO measurements are not accurate

Objectives:

- To determine if the TRAK Sensor is bad and needs to be replaced.
- To determine if there is a problem with the sensor set-up

4.7.1 Faulting Axis

If a sensor has stop reading and you try to move an axis, the axis will run away and fault. Our control uses the counts from the sensor and motor when reading position. If either one of these signals is not working our system will fault.

1. The first thing that can be done to see if it is the sensor is to turn off the sensor on the axis in question. This will allow the system to run only on the motor encoders. If the fault continues then the sensor was not the problem. Turn the sensor back on. See the service code section for a codes needed to turn the sensors on and off.
2. The next thing to do is to visually inspect the sensor and base to determine if there has been a crash. A damaged base will usually have crinkles in the small, triangular plates on the front and back.
3. Next make sure the sensor is preloaded correctly against the running surface. There is a setscrew on the base that allows for adjustment.
4. If no outward signs of damage are present, remove the sensor from its base, and inspect the wheel for damage and wear.

If the wheel is worn smooth in the center, replace the sensor.

Note: Sensors should not wear smooth for many years of normal operation.

5. If the sensor looks normal, it is probably OK and there is a mechanical obstruction somewhere in the set-up. Look for the following possible problems:
 - Broken sensor base
 - Broken bracket
 - Sensor tilted too much (so that the wheel is not engaging the running surface)
 - Sensor chip scraper has doubled back and is pushing the wheel away from the running surface
 - Sensor chip scraper is defective or has worn and is pushing the sensor unevenly

4.7.2 Measurements Do Not Repeat

1. Determine if the error in repeatability is random or accumulating:

- Mount a dial indicator in the quill
- Touch off a fixed point on the table and set the DRO to 0.
- Traverse away approximately 6 inches
- Return and touch off again
- Write down the reading on the DRO.
- Do not re-zero the DRO, traverse away and return several times
- Write down the DRO readings

Random error will be unpredictable and give scattered readings, adding and/or subtracting the error after each traverse with no pattern. See Step 2.

Accumulating error will add roughly the same amount to the reading after each traverse. See Step 3.

2. For random error, look for problems in the set-up of the TRAK Sensor that have resulted in a loss of rigidity. Common sources of random error include:

- broken base
- broken bracket
- loose puller screws
- loose run bar
- very loose motion of the table or saddle
- loose clamp screw

3. Accumulating error is almost always the result of the wheel not traveling in a path parallel to the motion of the axis. This causes the wheel to skip at certain regular points in its travel.

- Inspect the base to determine if it has been damaged. A damaged base will usually have crinkles in the small, triangle-shaped plates on the front and back.
- Use a bubble level or an indicator to adjust the puller screws so that the base is parallel to the running surface.
- Inspect that the sensor is not cocked so that the case contacts the running surface.
- Inspect the wheel for chips that are adhered or for gouges.

4.8 Electrical

4.8.1 Main Electrical Box

The electrical box is made up of the following main components:

1. AC drive – used to control the spindle motor.
2. Braking resistors – used to break the spindle motor. There are three resistors on the FHM7 and one on the FHM5. To verify the resistors are good, measure the resistance across B1 and B2 of the AC drive. For the FHM7 it should read 10 ohms when all three resistors are good. For the FHM5 it should read 32 ohms when the resistor is good.
3. Spindle Control Module – used to control spindle related functions, gear switch input, remote e-stop and 110-volt power source for various items.
4. Cable breakout box – see section 4.8.4.

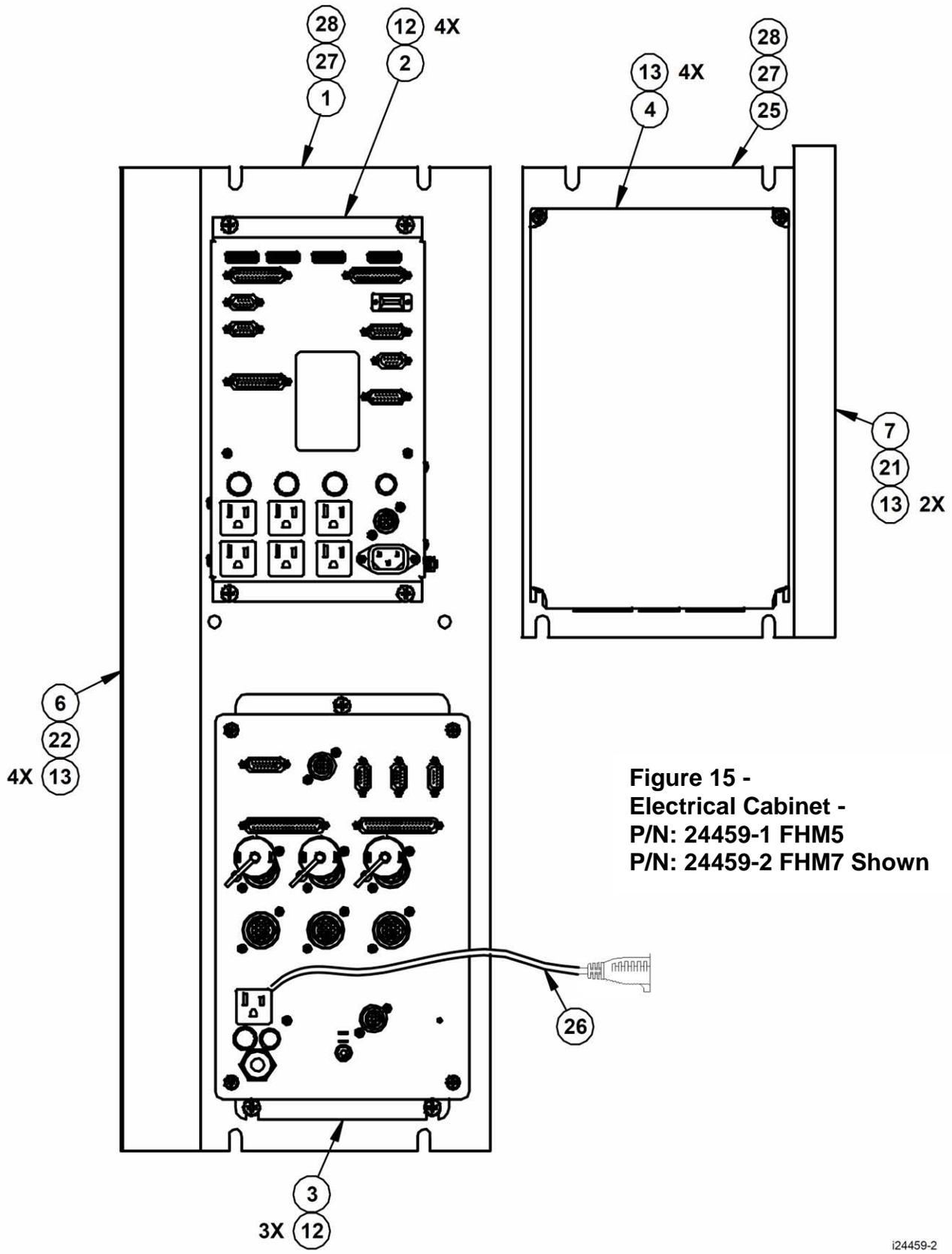


Figure 15 -
 Electrical Cabinet -
 P/N: 24459-1 FHM5
 P/N: 24459-2 FHM7 Shown

i24459-2

Parts List - FHM5 & FHM7 - Electrical Cabinet (Figure 15)

Item	P/N	Title	Qty
1	25063	SHEET METAL - AUX PANEL	0
2	24042-1	MODULE - SPINDLE CONTROL - MILLS	1
3	24999-1	ENCLOSURE ASSY- CABLE BREAKOUT BOX	1
4	24184-3	AC DRIVE ASSY-15 HP	1
	24184-4	AC DRIVE ASSY-5 HP (FHM5)	1
6	22283-2-3-30	WIREWAY- TYPE G LIGHT GRAY	1
7	22283-1-3-15	WIREWAY- TYPE G LIGHT GRAY	1
12	1/4-20X3/8 31Z	SCREW-PH-PHIL-EXT SEMS-STL-ZINC	7
13	10-32X3/8 31Z	SCREW-PH-PHIL-EXT SEMS-STL-ZINC	10
21	22392-1-15	COVER- WIREWAY- TYPE G	1
22	22392-2-30	COVER- WIREWAY- TYPE G	1
25	25064	SHEET METAL- DRIVE PANEL - 15 HP	0
	25065	SHEET METAL- DRIVE PANEL - 5 HP (FHM5)	0
26	24930	CABLE - POWER - EXTENSION	1
27	M8-1.25X20 25B	SCREW-SHCS-STL-BO	8
28	M8 70B	WASHER-FLAT USS-STL-BO	8

i24459-2

4.8.2 Checking A/C Voltage

This procedure tests for the 115V power for the control.

- Use a Voltmeter, reading A/C volts.
- Acceptable range is 100V to 130V.

Note: systems running consistently close to the low values may have problems when normal voltage fluctuations push the voltage out of the acceptable range.

Test the following in the order presented:

Problems Here:	May Indicate:
1. The wall outlet.	<ul style="list-style-type: none"> • Fuse blown in the shop electrical panel. • Incoming service from local utility is bad. Call the electric company.
2. The control power cord from the wall. Check the end that goes to the electrics box.	<ul style="list-style-type: none"> • Power cord defective.
3. Check the top fuse on the electrical cabinet. It should be an 8-amp fuse.	<ul style="list-style-type: none"> • If this is blown then power will not reach the 4 outlets on the electrical box.
3. Check the 110-power cord to the pendant.	<ul style="list-style-type: none"> • Power cord defective

4.8.3 Checking Fuses

There are 6 fuses to check in the system. There are 2 in the pendant and 4 in the electrical cabinet. There are three fuses in the spindle control module: a5a, 3a, 8a, and one 5a fuse inn the cable breakout box. The 2 fuses in the pendant are 1 amp and 12 amps. The 12-amp fuses the cable breakout box, and the 1 amp the pendant.

With the auxiliary function option there is 1 more fuse to check on the cable breakout box for the coolant or mister option.

To check fuses:

1. Use a Volt/Ohmmeter; select "OHM".
2. Remove the fuse completely from the pendant, electric's box or cable breakout box.
3. Place a lead of the meter on each end of the fuse.
 - A good fuse reads 0 (zero) or close to it.
 - A bad fuse reads Open or Infinity.

4.8.4 Cable Breakout Box Connections

This module is located in the electrical cabinet of the machine. It consists of 3 motor connections, 3 limit switch connections, 3 encoder connections and an E-stop connection.

Machines with an auxiliary function option have 2 more outlets: a 110 V outlet for a coolant pump or air solenoid and an indexer outlet.

The coolant pump signal and indexer signal comes down from umbilical #2.

4.8.5 Cable Connections

The FHM machines use 8+ cables to communicate between systems. It is often the case that what appears to be the failure of an electrical component is actually attributable to a poor connection.

Indications:

- Control problems, chronic or intermittent.
- Motor problems
- Measurement problems

Explanation:

1. Turn off and unplug the system from the wall.

WARNING!

Do not plug and unplug connectors with the system power on. This may cause damage to the connector board and harm to the technician.

2. Visually inspect the connections for excessive debris, moisture, or obvious damage.
3. Carefully clean any chips away from the connectors.
4. One-by-one, take out each connector and then plug them back in. Do the same at the computer/display.
5. Make sure to tighten up the screws on each of the connectors.

4.8.6 Spindle Control Module LED Segments

1st 10 LED Segment

1. LED labeled Gear 1 – this light should be on whenever the machine is in low gear. LEDs labeled Gear 2 thru Gear 4 are not used.
2. LED labeled SPD-FAULT – this light will be on whenever the AC drive is in a fault condition, which includes an E-stop message from the pendant.
3. LED labeled SPD-RUN – this light should be on whenever the spindle is on.
4. LED labeled SPD-ENABLE – this light should be on whenever you are in DRO, tool setup and RUN mode.

2nd 10 LED Segment

1. LED labeled E-STOP OUT – this light should be on whenever the E-stop is in the out position. When the E-stop is pressed, this light should go off.
2. LED labeled LATCH RELAY – this light should be on when the spindle is running or if the spindle is not running and the fwd/rev switch is in the off position when in DRO, tool setup or RUN mode. Note – **if spindle won't turn on and the spindle is enabled** and the e-stop is out, then either the fwd/rev switch is bad or the spindle control board is bad.
3. LED labeled TAP MODE – light should be on whenever you are not tapping. Light will be off when in the tap event. Not applicable to knee mills or retrofits.
4. LED labeled TAP REVERSE – this light will be on when the spindle changes direction at the bottom of a tap event and back off after the spindle changes direction once outside of the tap event. Not applicable to knee mills or retrofits.
5. LED labeled REV-RELAY – when fwd/rev switch is in reverse this light will be on. Note – this does not mean necessarily that the spindle will be running this direction.
6. LED labeled FWD-RELAY – when fwd/rev switch is in forward this light will be on. Note – this does not mean necessarily that the spindle will be running this direction.
7. LED labeled Z-LIMIT PLUS – this light will be on only when the Z-axis plus limit switch is triggered. This only applies to a 3rd axis product.
8. LED labeled Z-LIMIT MINUS – this light will be on only when the Z-axis minus limit switch is triggered. This only applies to a 3rd axis product.

4.9 Service Codes

Service codes are broken down into the 5 following categories: software, machine setup, diagnostics, user options/defaults and lubrication pump control.

All Service Codes are accessed in the SET-UP Mode by pressing the soft key for "SERV CODES". The service codes can be found under one of the headings listed on the main screen. Press the heading you want to access the code in question. If you know code # you want press the CODE # softkey and it will take you directly to the code in question. Press CODE #, enter the number you want, press SET.

4.9.1 Software Codes

The following codes pertain to software functions in the control. To get to any of these codes go to Service Codes, press "A" and press the code you wish to view.

Note - If you are working with the SWI Customer Service Group, write the values down for code 33 or code 313. These values will be valuable for troubleshooting.

4.9.1.1 Code 33: Software ID

The Code 33 is the software identification procedure. The two types of software in the control include:

- **Software Version** - the version of the system you have installed
- **Firmware Version** - the version of firmware software that is responsible for control to servo interface.

- **Converter Version** – the version of software that is responsible for converters and options.
- **Operating System Version** – shows the version of the XP operating system.

4.9.1.2 Code 141: Load Configuration file from floppy "A" drive

This code allows you to load your configuration file from the floppy disk to your hard drive. The configuration file consists of items such as calibration and backlash constants. This code is used when a computer module or hard drive has been replaced.

4.9.1.3 Code 142: Save Configuration file to floppy "A" drive

This code allows you to save your configuration file to a floppy disk. The configuration file consists of items such as calibration and backlash constants. This code is used when a computer module or hard drive needs to be replaced. This stores the configuration file from the hard drive to the floppy disk. It is a good idea to do this code after the machine is initially setup so these values can be saved and used in the future. If the computer or hard drive fails, then you will not have the ability to save the configuration file and the machine will need to be re-setup when the computer or hard drive is replaced.

Note: All machines will have a copy of the configuration file in the back of the electric's cabinet.

4.9.1.4 Code 313: Display Configuration File

This code displays the configuration file. This file contains pertinent information about the machine. The file will look similar to the following. If the file becomes corrupt you can load default values by pressing the F4 softkey.

Product = FHM (displays machine ID key of machine)
 Lube pump cycle time – 60 minutes
 Lube pump discharge time – 15 seconds
 Motor encoder calibration constants X242.0462 X242.0267 Z242.0312
 Secondary feedback calibration constants X3302.6107 Y3302.5345 Z3302.6433

(These numbers above are typical numbers for the calibration constants, the numbers for secondary feedback are default numbers, which means no calibration has been done, or the machine does not have secondary feedback)

Arc accuracy – **0.001"**
 Secondary feedback – 0, 1, 2 or 3
 (0 = off, 1 = X on only, 2 = Y on only, 3 = XY both on)

Limit switches – on or off
 Spindle on or off during run – On or Off
 Code 11 values X = 0.002 Y = **0.001"**
 Code 128 X=**0.001"** Y=**0.0014"** Z=**0.0016"**
 Code 12 (+) X=000005 Y=000006 Z=000006
 (-) X=000005 Y=000005 Z=000006
 Accessory Key = Mist or Coolant
 Code 100 (+) X=352.7 Y=367.2 Z=325.2
 (-) X=350.1 Y=356.7 Z=333.1

4.9.1.5 Code 316: Update Master Software

Load upgrade disk in floppy drive and press this service code. New software will automatically download and control will reboot.

4.9.1.6 Code 317: Update Slave Software

Load upgrade disk in floppy drive and press this service code. New software will automatically download.

4.9.1.7 Code 318: Activate Converters or Options

See programming and operating manual.

4.9.2 Machine Set-up Codes

The following codes are used primarily when setting up a new machine. To get to any of these codes go to Service Codes, press "B" and press the code you wish to view.

4.9.2.1 Code 11: Hysteresis

Note: This code is use only for systems with Sensors or Glass Scales on the table and saddle.

The Code 11 service routine checks the readings of the motor encoder against the sensor encoder. It is a measurement of how much motor motion is necessary to create table or saddle motion. This test helps us to look at two things:

- Play: How much backlash must be taken up when motion is reversed.
- Friction: How much the mechanical components must be "torqued up" in order to break the friction and create motion.

The Code 11 procedure is very useful and will help in diagnosing all types of motion and performance problems.

1. Position the table and saddle in the center of travel. *Note: You will lose your DRO position reference.*
2. Go into the Service Codes and input Code 11.
3. The system will run the checking routine automatically and then display the values in the position readout.

Explanation:

As an overall measure of the system hysteresis, we are looking for the X and Y values to be less than .004". A value greater than this indicates a problem with either excessive friction or play that may affect the finish or accuracy of machined parts.

4.9.2.2 Code 12: Feed Forward Constant

The Code 12 procedure helps the control "learn" the friction characteristics of the machine by sending a graduated series of motor signals and observing the results. The process takes less than 30 seconds to run. It is both a diagnostic routine that displays values, and a routine that sets the parameters of the control for the particular machine.

The Code 12 is used for diagnosing and resolving:

- Problems with machine motion.
- Machined parts come out bad – especially poor finish.

Note: Code 12 routine will set the parameters for the particular machine and its particular situation. If the machine changes its friction characteristic, the Feed Forward Constant should change too, or the system will not servo properly. Whenever gibs are

adjusted or a heavy workpiece has been added to the table, you should run a Code 12. When the heavy workpiece is removed, Code 12 should be run again.

Steps

1. Position the table and saddle in the center of travel. *Note: You will lose your DRO position reference.*
2. Go into the Service Codes and input the Code 12.
3. Press Auto
4. The system will run the routine automatically and then display values on the position readout.

Explanation

Typical values should be between 4.04 and 11.11 are considered normal for each axis. Higher values indicate excessive friction in the system. Lower values indicate a loose system and may mean a gib adjustment is necessary. Value 4.04 means the friction is a factor of 4 in one direction, and 4 in the other direction. The values should be within 3 or 4 of each other in both directions. A value of 6.08 would still be considered normal.

On S products, do not equate Code 12 values to torque on ball screw. Measure friction in system with an in-lb torque wrench.

The feed forward gain can be adjusted manually by pressing the manual button. Choose the axis you would like to change and then enter values in the positive and negative direction to adjust. Adjusting the gain can help solve circularity problems. Default values can be set by pressing the Reset button. The manual feature should only be used in extreme cases where the AUTO routine did not solve the problem. Manual adjusts above 12 may lead to servo related problems.

4.9.2.3 Code 100: Axis Open Loop Test

Code 100 procedure is used to diagnose problems with the configuration of the system, the encoders and incoming A/C voltage.

IMPORTANT -- SAFETY NOTICE

During this procedure the designated axis will be given a command to move at maximum speed for 1 second in the direction you choose. Avoid crashes by making sure the quill is out of the way and by starting with the table and saddle centered. MAKE SURE THAT NO ONE IS STANDING IN THE WAY OF THE TABLE OR SADDLE!

Note: You will lose the DRO reference position.

This procedure is to be run for each axis that is servo-driven, and for both the plus and minus direction for each axis.

1. Center the table and saddle and raise the head. Make sure the gib locks are released.
2. On the Pendant display, go into the Service Codes and input the Code 100.
3. **The conversation line will say: "SELECT AXIS". Input the axis. Either X, Y or Z.**
4. **In the conversation line it will say "WHICH DIRECTION? PLUS".**
 - If you want to run in the plus direction, press INC SET.
 - If you want to run in the minus direction, press +/-, then INC SET

5. In the conversation line it will say "PRESS GO". Press Go after you are sure that the machine will not crash in the direction and axis that you have specified.
6. Afterward the screen will display values next to the DRO position axes. The table below assumes machine has secondary feedback. Machines with motor encoders only will display the reading next to the axis in question.

Your input	Display	Data displayed.
X +	X	table encoder reading
	Y	nothing (should be 0)
	Z	Motor encoder reading
	Feedrate	the maximum feedrate attained

Your input X -	X	table encoder reading
	Y	nothing (should be 0)
	Z	Motor encoder reading
	Feedrate	the maximum feedrate attained

Your input Y +	X	nothing (should be 0)
	Y	table encoder reading
	Z	Motor encoder reading
	Feedrate	the maximum feedrate attained

Your input Y -	X	nothing (should be 0)
	Y	table encoder reading
	Z	Motor encoder reading
	Feedrate	the maximum feedrate attained

Your input Z +	X	nothing (should be 0)
	Y	nothing (should be 0)
	Z	motor encoder reading
	Feedrate	the maximum feedrate attained

Your input Z -	X	nothing (should be 0)
	Y	nothing (should be 0)
	Z	motor encoder reading
	Feedrate	the maximum feedrate attained

Interpretation of the resulting values displayed:

The values for the encoder displays should be in the range of 4.0000" to 6.5000".

- If the motor encoder and sensor or glass scale reading is not within this value, then the one that is out of specification may be the problem. If one of the encoders is not reading then it will need to be replaced.
- The feedrate should be a minimum of 300 ipm.
- If the feedrate is less than 300 ipm and inconsistent in both directions, check the incoming AC voltage and mechanics of the drive train.

4.9.2.4 Code 123: Calibration

See Section 5.2.2 for a further explanation of this code.

4.9.2.5 Code 127 - Set X or Y Backlash Constant

See Section 5.2.2 for a further explanation of this code.

4.9.2.6 Code 128: Input Backlash Constant

Code 128 allows you to enter the backlash values for each axis. It displays the value after it enters. This code is only used on machines with motor encoders only.

4.9.2.7 Code 304: Toggles X sensor or glass scale on/off

This service code toggles the X sensor or glass scale on or off. It is used to configure the machine and also is a useful tool for troubleshooting. Code 313 (configuration file) displays whether the sensors have been turned on or off. The line labeled secondary feedback explains which sensors or glass scales are turned on. This line can read any one of the following:

- 0 = sensors or glass scales turned off
- 1 = X sensor or glass scale turned on only
- 2 = Y sensor or glass scale turned on only
- 3 = both X and Y sensor or glass scale turned on

4.9.2.8 Code 305: Toggles Y sensor or glass scale on/off

This service code toggles the Y sensor or glass scale on or off. See Code 304 for further explanation

4.9.2.9 Code 312: Toggle Limit Switches On/Off

Use this service code to enable or disable the use of limit switches. Remember to check which type of limit switches are active in code 338. This code is default to off.

4.9.2.10 Code 308: Reverse X hand wheel direction

This service code reverses the direction of the X hand wheel.

4.9.2.11 Code 309: Reverse Y hand wheel direction

This service code reverses the direction of the Y hand wheel.

4.9.2.12 Code 310: Reverse Z hand wheel direction

This service code reverses the direction of the Z hand wheel.

4.9.2.13 Code 311: Set no move if spindle off – on/off

This service code toggles this function on or off. It defaults to on from the factory, which means the spindle must be on for a program to run. If it is on and you forget to turn the spindle on, the tool will move to Z rapid and wait for the spindle to come on. This function will be needed if you are running a repeatability program with an indicator in the spindle. Make sure this feature is on when cutting parts.

4.9.2.14 Code 312: Toggle limit switches on/off

This service code toggles the limit switches on or off. Code 313 also displays which state the limit switches are in.

4.9.2.15 Code 321: Reverse Y position sensor direction

This service code reverses the direction of the encoder. It may be needed if sensors or glass scales are mounted on different sides of the machine.

4.9.2.16 Code 322: Reverse X position sensor direction

This service code reverses the direction of the encoder. It may be needed if sensors or glass scales are mounted on different sides of the machine.

4.9.2.17 Code 337: Spindle RPM Calibration

This service code is for manually calibrating the spindle using a tachometer, simply follow the on-screen instructions. Please note that when installing a new machine, or replacing computer module, that if no configuration is present, spindle may not run properly. Press the F4 button to load spindle calibration defaults, if needed. This has no effect on other settings such as calibration, backlash, etc.

4.9.2.18 Code 338: Toggle Limit Switches 1 or 2 input

This is used to toggle the type of limit switch hardware installed on your machine. All newer style machines will have the 2-input style. Select 1 if you are using the older style single input limit switches. The default for this code is 2 input.

4.9.3 Diagnostic Codes

The following codes are used primarily when diagnosing a problem with the machine. To get to any of these codes go to Service Codes, press "C" and press the code you wish to view.

4.9.3.1 Code 54: Program Continuous Run

This Code runs a program continuously without stopping for SET Z or CHECK Z commands. It is helpful in running a long period to identify an intermittent problem.

1. Prepare a program as you normally would.
2. Press **MODE, SET UP, "C", Code 54, INC SET**. The program run will start automatically.
3. Press **STOP** to stop, and **GO** to continue.

4.9.3.2 Code 81: Keyboard Test

This code is used to check if the keyboard is functioning correctly. It allows you to test each key on the pendant individually. When you press the keys, the corresponding box for that key will highlight on the screen. The pendant will also beep, indicating that the key is working correctly. If one of the keys does not work the pendant assembly may need to be replaced. If none of the keys are working chances are that the computer module will need to be replaced.

4.9.3.3 Code 131: Manual DRO

A manual diagnostic routine to check the motor encoder and table encoders: Turn the X hand wheel to display the encoder readings. This code will display the actual DRO counts and the raw encoder counts before the calibration and backlash factors have been factors into the counts.

4.9.3.4 Code 132 - Electronic Hand wheel Test

Turn the X, Y or Z-axis electronic hand wheel. The display should show movement as the hand wheel is being turned. There should be no skipping and it should count smoothly

while the hand wheel is being turned. One revolution of hand wheel should read 0.2000”.

4.9.3.5 Code 314: Toggle test lights 'on' in status line

This code toggles on and off 2 test lights that appear in status line. The top light signifies if the master software is working. If functioning it should flash a green light. The bottom light signifies if the slave firmware is functioning. It will appear orange in run mode when it is processing information. Pressing the mode key will change this orange box to black. The orange box will also change to black when the program you are running reaches the 3rd event from the end of the program. If the firmware is locked up no keys will work. This code is useful for diagnosing intermittent problems with the control locking up.

4.9.3.6 Code 319: Error Log

This code when turned on captures the commands that were sent to the servo system. It includes items such as positioning commands, errors, stop and go commands, etc. It may be helpful for identifying problems between programmed commands and executed commands. To turn on the error log press the F6 softkey. The page forward and backward keys allow you to scroll through the file one page at a time. The data forward and data backward keys allow you to scroll through the file one line at a time. The data bottom key takes you to the bottom of the file and then changes to data top which will take you back to the top. The file will capture data until the file reaches a size of approximately 600 Kb. At this time the file is saved to a backup file and the original file is cleared and data is once again captured. Once again as the file reaches a size of 600 Kb it copies over the previous backup file. From here the user can save the file to the floppy drive by pressing the F8 softkey. Once this is done it prompts you for which file you want to save to disk. The F1 key saves the current file to disk and the F2 key saves the backup file to disk. To clear the files press the F7 softkey.

4.9.3.7 Code 324: Toggle Simulation Mode

Simulation Mode allows the control to run a program without actually moving the table. It is helpful in diagnosing Computer/display problems.

4.9.4 Operator Defaults/Options Codes

The following codes allow the user to set programming defaults or turn features on or off. To get to any of these codes go to Service Codes, press “D” and press the code you wish to view.

4.9.4.1 Code 66: Default Metric

This code causes the control to turn on in the metric mode.

4.9.4.2 Code 67: Default English

This code causes the control to turn on in the English mode.

4.9.4.3 Code 79: Beeper On

This turns on the beeper to the control keys.

4.9.4.4 Code 80: Beeper Off

This turns off the beeper to the control keys.

4.9.4.5 Code 129: Arc Accuracy

When the SMX control operates at high feedrates it may create small part machining errors as it goes around sharp corners. This exists on all CNC's and is commonly called a "following error." The control is factory preset to allow a maximum following error of 0.001 inch. The feedrate will automatically be adjusted around sharp corners so as to not violate this limit. This code only applies to arcs that are programmed and ones that are created in the tool path to generate the shape you want. This code will not make a difference on mill moves.

You may adjust the maximum following error to a value as small as .0001 inch. However, the smaller the value, the slower the feedrate around corners.

To input a new Following Error use the following procedure:

Follow the instructions on the screen and input the Following Error value (from .0001 to .0100) and press **INC SET**.

4.9.4.6 Code 335 Leave Spindle On During Pause

Toggles the spindle to stay on or to turn off at a programmed Pause event.

4.9.5 Lube Pump Codes

The following codes are used for programming and operating the lube pump. To get to any of these codes go to Service Codes, press "E" and press the code you wish to view.

4.9.5.1 Code 300: Lube Pump Switch

This code acts as a switch to turn the lube pump on for the programmed time set in Code 302.

4.9.5.2 Code 301: Set Lube Pump cycle time

This code sets the interval time between lube cycles.

4.9.5.3 Code 302: Set Lube Pump discharge time

This code sets the lube pumps discharge time.

5.0 Procedures for Replacements & Maintenance

5.1 Replacements

5.1.1 Servo Motor Replacement

WARNING!

Do not work with the Servo Motors unless the power is disconnected from the machine. The servomotors are run by 110 VAC. There is possibility of death by electrocution!

1. Turn off power to the machine.
2. Each motor is mounted by the use of (4) ¼-20 screws. Be careful not to over-tighten these bolts and strip the threads.

5.1.2 Servo Driver Replacement

WARNING!

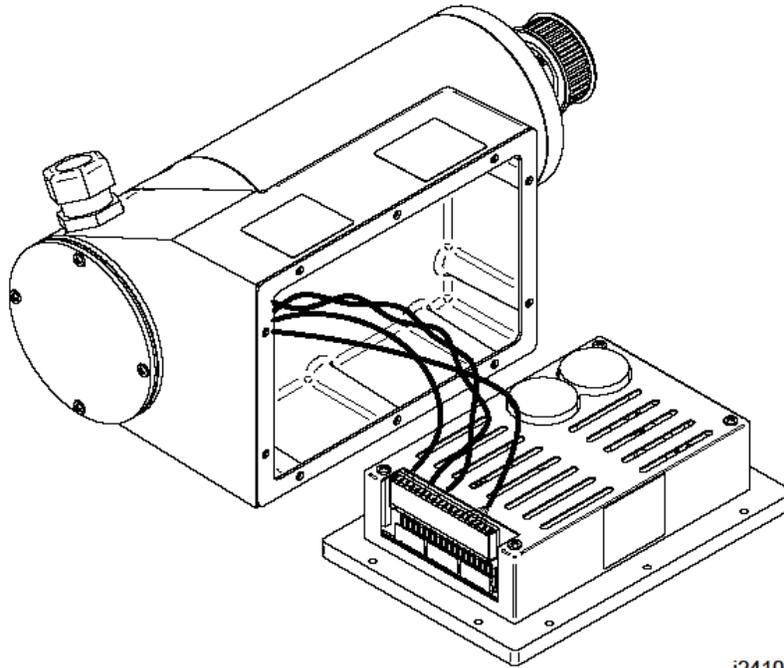
Do not work with the Servo Drivers unless the power is disconnected from the machine. The servo drivers are run by 110 VAC. There is possibility of death by electrocution!

The Servo Driver for each axis is integrated into the servo motor casting.

DANGER!

Always engage (push in) the Emergency Stop switch, turn the ProtoTRAK SM Control off, and disconnect the servo motor/driver cable at the cable breakout box.

1. Press in the Emergency Stop.
2. Remove the servo motor/driver assembly from its mounting bracket (the Y axis assembly is located inside the front of the bed).
3. Remove the 10 cap screws that hold the servo driver and its heat sink plate to the motor casting.
4. Disconnect the cable connector. Do not pull on the wires.
5. Reinstall the new servo driver with its heat sink plate. Be certain the gasket properly seals the assembly.
6. Reinstall the motor/driver assembly. Make certain the belt is tight so that there is little play if pinched in the middle.

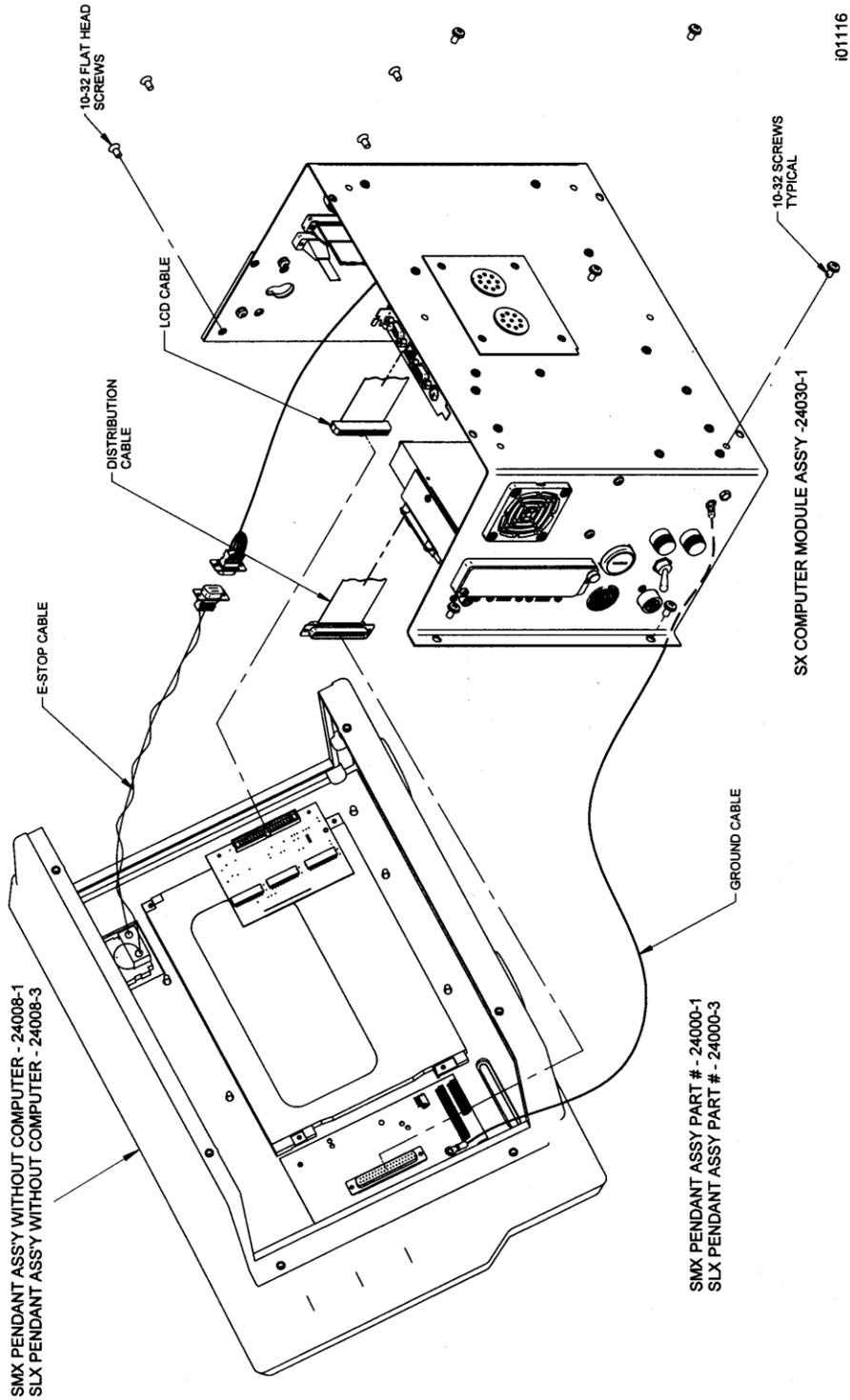


i24101-5

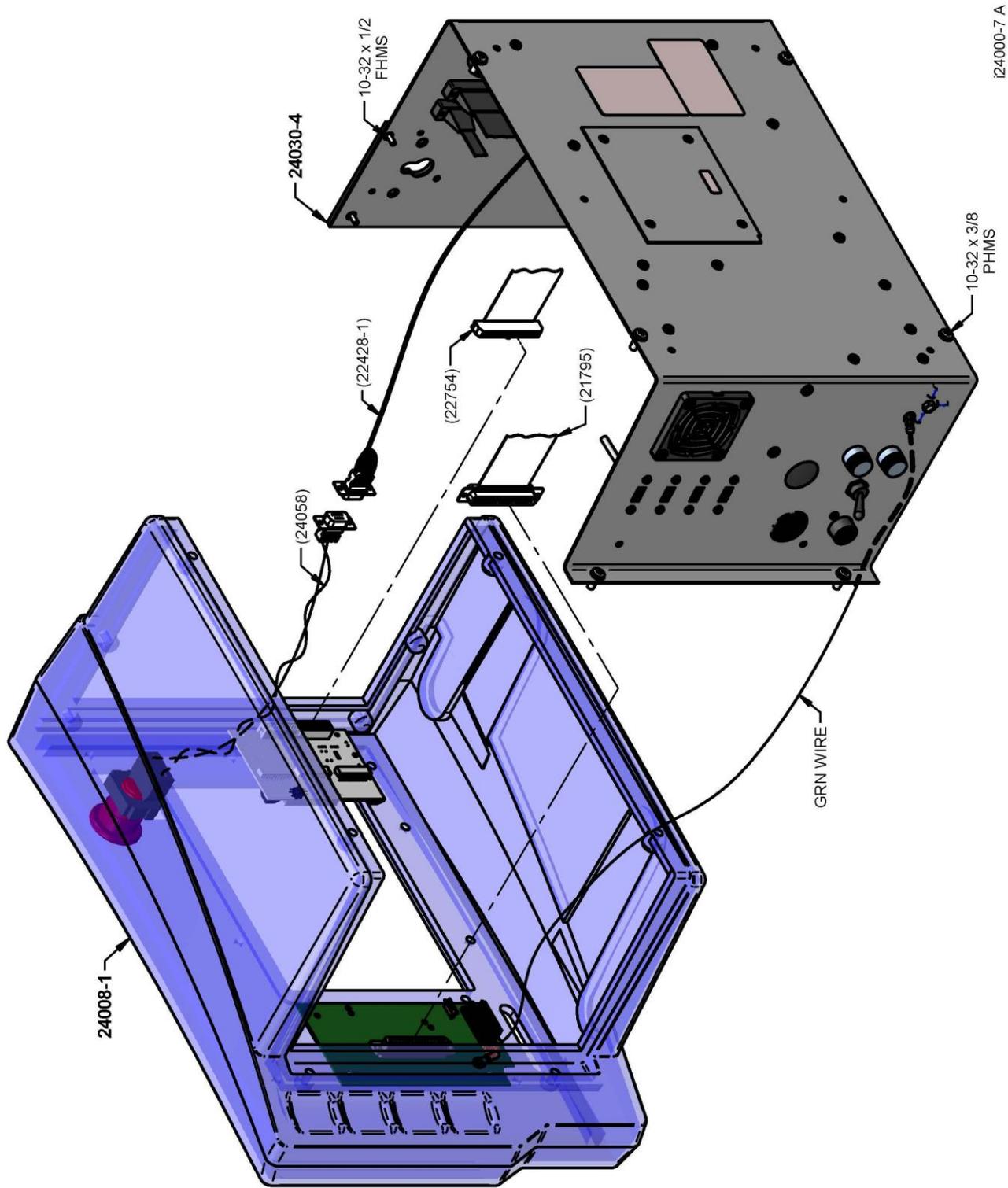
Figure 16 - FHM5 & FHM7 - Servo Drive Replacement - P/N: 24101-7R

5.1.3 Computer Module and LCD/Enclosure Replacement

1. Turn power off to the machine and control.
2. Unplug all the connectors on the pendant arm side of the pendant.
3. Remove the pendant from the pendant arm by removing the (4) ¼-20 x 3/4" SCHS that secure it in place.
4. Place the pendant assembly on a clean and secured table with the display pointing away from you.
5. Remove the (6) 10-32 x 3/8" Pan Phillips Head Screws and (4) 10-32 x 3/8" FHCS securing the computer module to the LCD/enclosure.
6. Pull the computer module a few inches and stop. Pulling the computer module too far will damage the ribbon cables.
7. Now reach from the top and remove the 37-pin LCD cable, 37-pin distribution cable and the 9-pin E/Stop cables. The cables are to stay with the computer module.
8. Now slide the module about ½ way out of the LCD/enclosure.
9. Remove the ground wire from the LCD/enclosure side.
10. Lastly, slide the unit completely out of the LCD/enclosure.
11. Replace computer module or LCD/enclosure.
12. Follow the instructions in reverse order when reinstalling the new computer module or LCD/enclosure.
13. Make sure that all connectors are properly seated before fastening the unit back in place.



**Figure 17a -
Computer Module &
LCD/Enclosure Replacement**



i24000-7 A

**Figure 17b -
Computer Module (USB) & LCD/Enclosure Replacement**

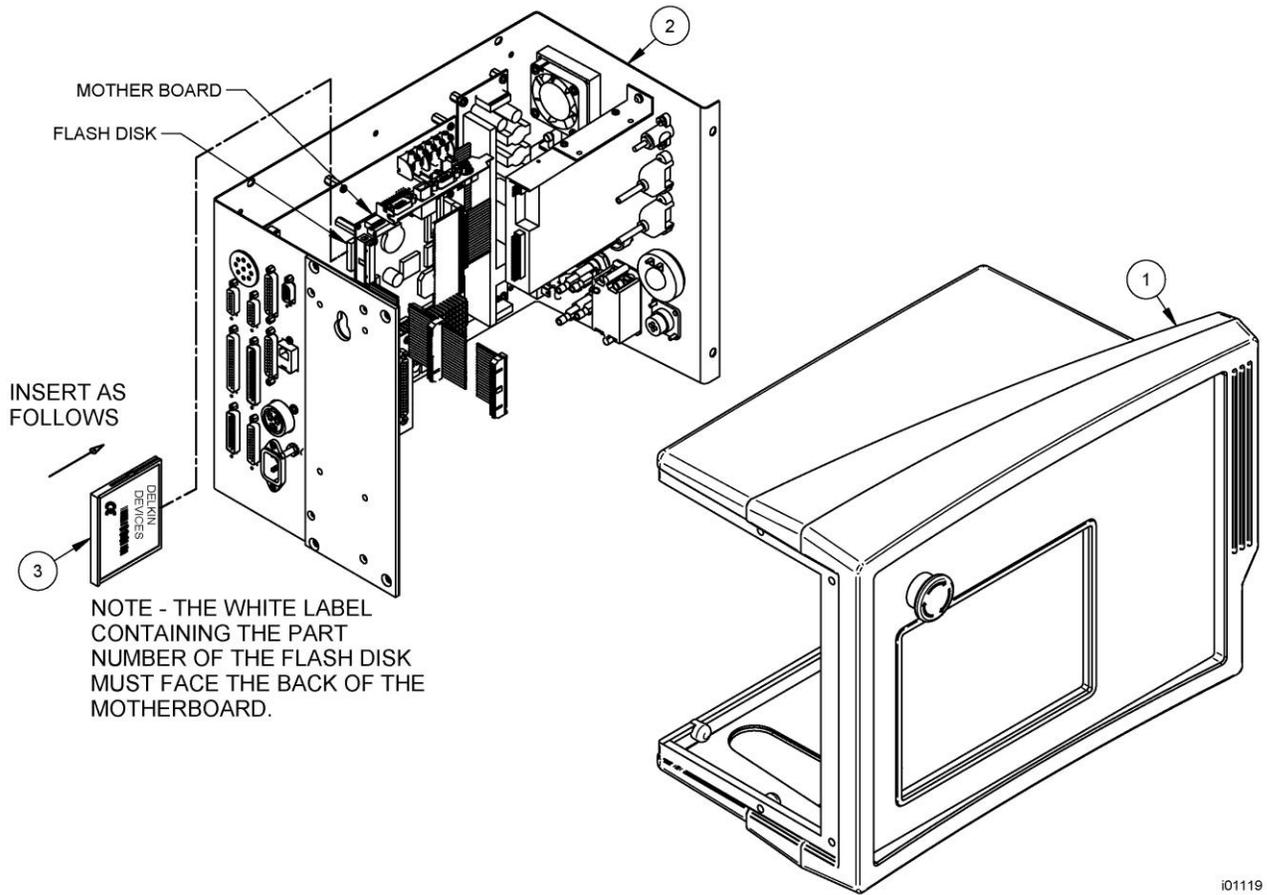


Figure 18 & Parts List Shown - Flash Disk Replacement

Item	P/N	Description
1	24008-1	PENDANT-SMX-WITHOUT COMPUTER MODULE
2	24000-1 or -7	PENDANT-SMX-USA
3	25078	FLASH DISK REPLACEMENT KIT FOR SX PENDANT REV D AND ABOVE
	25078-1	FLASH DISK REPLACEMENT KIT FOR SX PENDANT REV A, B OR C

i25078 & -1

5.1.4 System Flash Disk Replacement

1. From the control, go to SETUP, SERV CODES, SECTION A, and then code 142 and save your Configuration file (calibration values, etc.) on a floppy disk. There is a disk in the electric's cabinet for this purpose. Label this disk as "Backup Configuration" and store it for later use.
2. Turn power off to the machine and control.
3. Unplug all the connectors on the pendant arm side of the pendant.
4. Remove the pendant from the pendant arm by removing the (4) ¼-20 x 3/4" SCHS that secure it in place.
5. Place the pendant assembly on a clean and secured table with the display pointing away from you.
6. Remove the (6) 10-32 x 3/8" Pan Phillips Head Screws and (4) 10-32 x 3/8" FHCS securing the computer module to the LCD/enclosure.
7. Pull the computer module a few inches and stop. Pulling the computer module too far will damage the ribbon cables.
8. Remove the defective System Flash Disk (located on the back side of the mother board) by pushing the eject button on the flash drive.
9. Firmly insert the replacement System Flash Disk into the drive, making sure that the label with the serial number is pointing towards the motherboard.
10. Secure the computer module back to the LCD/enclosure by following the instructions in reverse order.
11. Make sure that all connectors are properly seated before fastening the unit back in place.
12. Turn power on to the machine and control.
13. When the system boots, you may get a message stating that the system cannot find your configuration file. Press NO if asked to load defaults.
14. Update the System Software by inserting the PT4 update disk into the floppy drive. Go to service codes 316 and 317 found in section A. Update the master and slave software.
15. Restore the Configuration file saved on your backup configuration disk with service code 141 found in section A of the service code section.
- 16.

CAUTION!

It is a good idea to back up your flash disk from time to time via a network or floppy disk. If your flash disk needs to be replaced you will loose all of your programs. See your programming manual for instruction on how to do this.

5.1.5 AC Drive Replacement

WARNING!

Do not work with the AC drive unless the power is disconnected from the machine. The AC drive is run by 220 VAC. There is possibility of death by electrocution!

1. Turn power off to the machine.
2. Before working on this unit make sure all lights on the display are off. These units have a capacitor internally that keep them powered up for a minute or so after the power is turned off.
3. Remove the display unit on the front face of the unit. Also remove the lower cover on the unit to gain access to the wires.
4. Disconnect the 3 wires on the lower left side of the unit. These wires bring power into the unit.
5. Remove the 2 wires labeled B1 and B2. These wires run up to the resistor.
6. Remove the 3 wires labeled T1, T2 and T3. These wires take power to the spindle motor. Make sure to put these wires in the same position on the new unit. T1 uses the red wire, T2 uses the white wire and T3 uses the black wire.
7. Remove the ground wires from the bottom of the unit.
8. The unit bolts in place with 4 screws.
9. Follow the instructions in reverse order when reinstalling.

Note – the replacement AC drive will have the AC drive cable (#22443) already wired to the drive.

5.1.6 Cable Routing on Machine

Whenever you replace a cable or reroute a cable it is very important to keep the power cables and logic cables separated from each other. The power cables consist of the (3) 110-volt motor cables and (2) 110-volt power cables for the pendant, and a coolant pump or solenoid power cable. The logic cables are used to carry encoder signals between the cable breakout box and computer module. Mixing of the power and logic cables may cause noise from the power cables to interrupt the signals in the logic cables. This can lead to intermittent axis faults or repeatability problems.

5.1.7 Electronic Handwheels

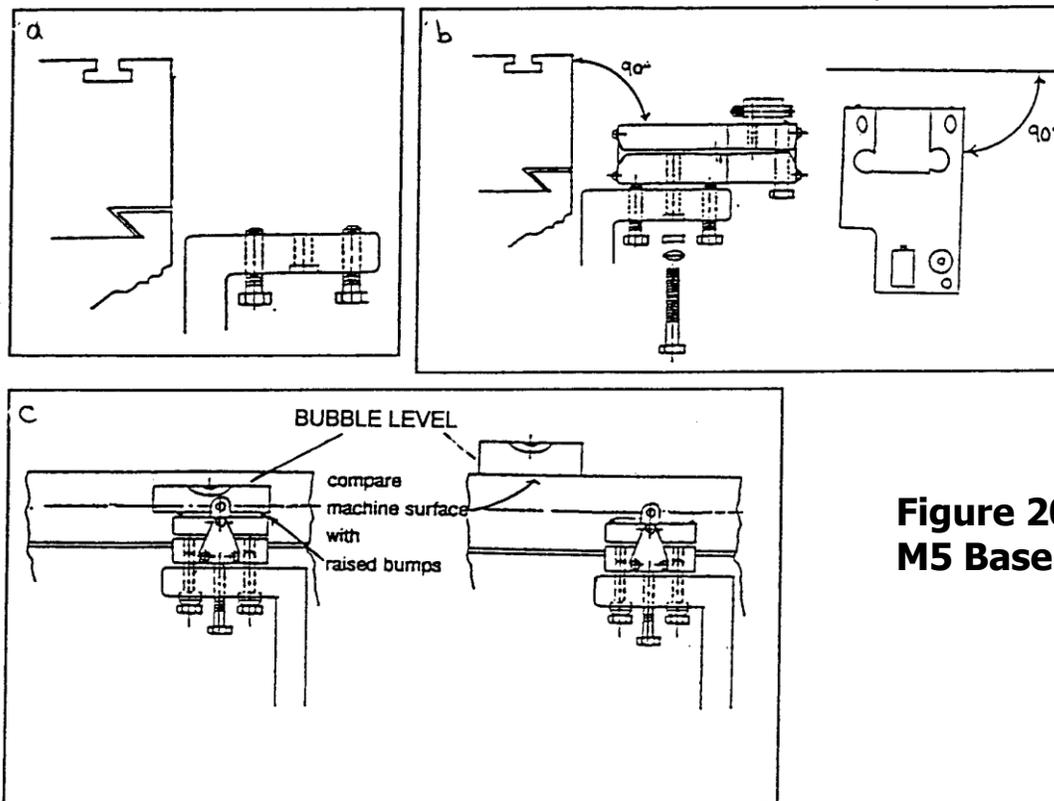
There are 3 electronic handwheels on the FHM machines. The X and Y hand wheel are interchangeable. All 3 handwheels are mounted on the machine by the use of 4 SHCS. The X and Y hand wheel have a hole in the hand wheel so the mounting bolts can be accessed easily with a 5 mm Allen wrench or ball end screwdriver. The handwheels are plugged into the encoder module located in the lower left side of the electrical cabinet. See the Section 6 for how to route the cables in the electrics box.

5.1.8 TRAK Sensor (FHM5 only)

5.1.8.1 Replacing the M5 Base

See Figures 20 and 21.

1. Remove the sensor by removing the clamp screw and then backing the load screw out a few turns. The sensor should lift off the base easily.
2. Remove the old M5 Base by removing the two 1/4-20 hex head screws that are threaded into the base.
3. Assemble the new base as per Figure 20 .
4. Use a bubble level to align the raised bumps on the base with the table for X axis or saddle ways for Y-axis.
5. A dial indicator may be used to align the bumps on the base instead of a bubble level.

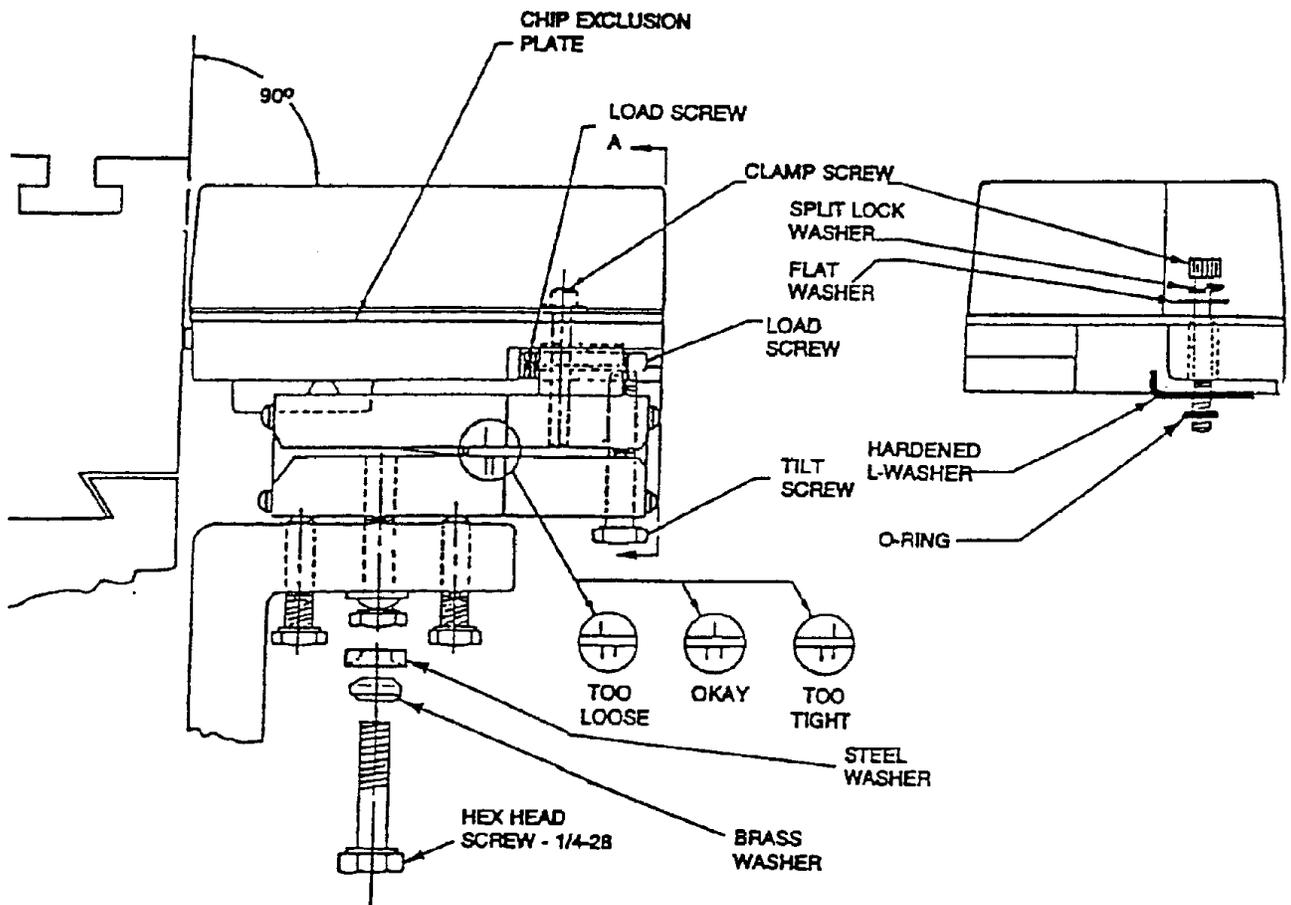


**Figure 20 -
M5 Base Mounting**

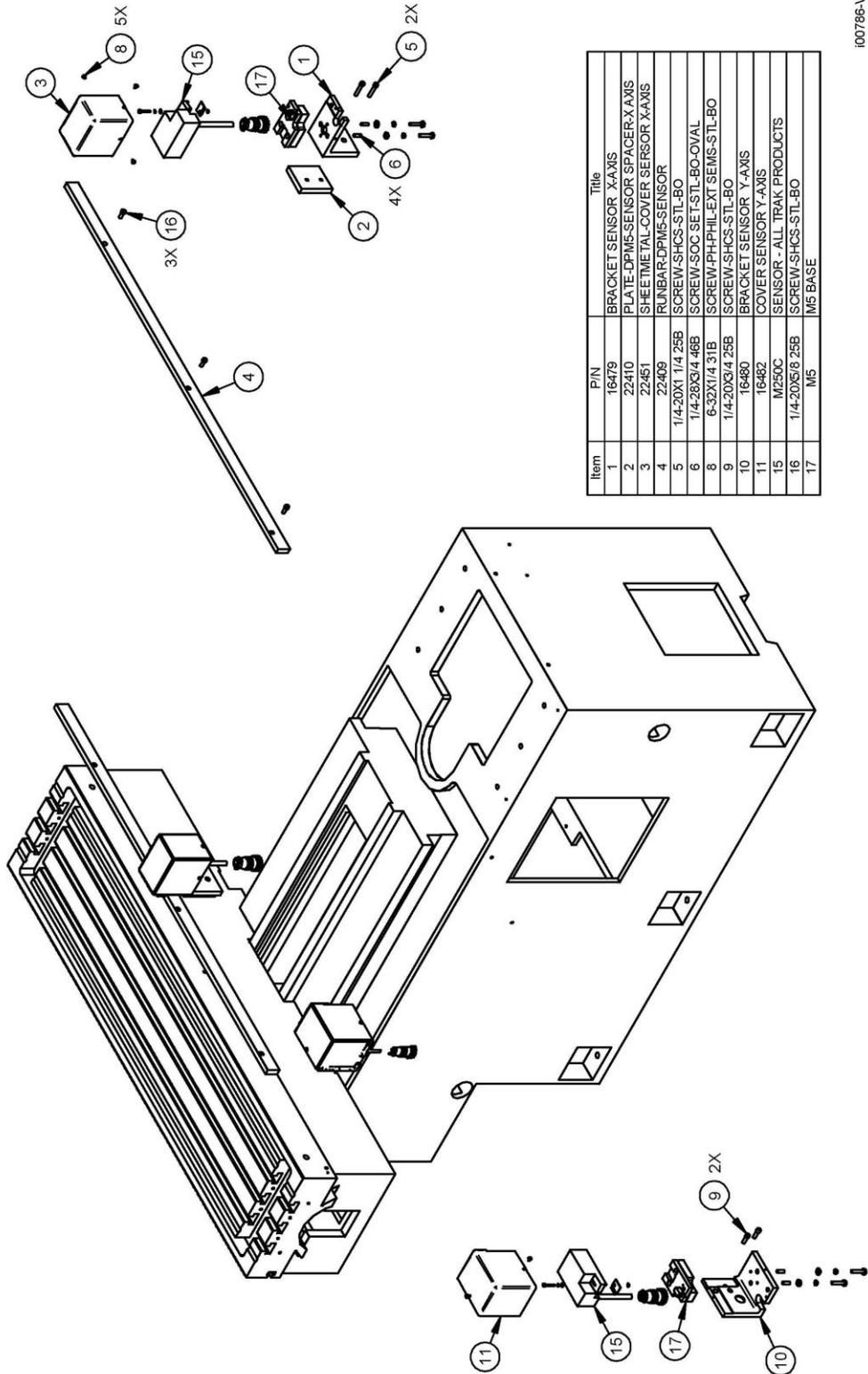
5.1.8.2 Replacing the TRAK Sensor

1. Remove the old sensor by removing the clamp screw and then backing the load screw out a few turns. The sensor should lift off the base easily.
2. Install the new sensor on the M5 base using the clamp screw.
3. Load the sensor against the running surface (table or run bar) using the load screw. The white lines on the side of the M5 base tell you when it is loaded correctly.

Note: You want to load the gage wheel against the running surface using the flat spring of the M5 base. Do not tighten the clamp screw fully until after loading the sensor.



**Figure 21 -
TRAK Sensor Mounting**



Item	P/N	Title
1	16479	BRACKET SENSOR X-AXIS
2	22410	PLATE-DFM5-SENSOR SPACER X-AXIS
3	22451	SHEETMETAL-COVER SENSORS X-AXIS
4	22409	RUNBAR-DFM5-SENSOR
5	1/4-20X1 1/4 25B	SCREW-SHCS-STL-BO
6	1/4-28X3/4 46B	SCREW-SOC SET-STL-BO-OVAL
8	6-32X1/4 31B	SCREW-PH-PHIL-EXT SEMS-STL-BO
9	1/4-20X3/4 25B	SCREW-SHCS-STL-BO
10	16480	BRACKET SENSOR Y-AXIS
11	16482	COVER SENSOR Y-AXIS
15	M250C	SENSOR - ALL TRAK PRODUCTS
16	1/4-20X5/8 25B	SCREW-SHCS-STL-BO
17	M5	M5 BASE

i00786.V5

**Figure 22 & Parts List Shown -
FHM5 Sensor Kit - P/N: 22564**

5.1.9 Glass Scale Replacement

5.1.9.1 Remove the Glass Scale

1. Unplug the glass scale connector from the encoder module inside the electric box.
2. Unbolt the reader head of the glass scale from its mounting surface.
3. Unbolt the glass scale enclosure from the table on X or the mounting spar on Y.
4. Install the head alignment bracket that came with the replacement scale to this scale to secure it for shipping back to SWI. Failure to do this may cause the glass scale to get damaged during shipment. The head alignment bracket secures the reader head so it cannot move and damage the glass in the scale.

Note: 1st align the reader head on the new scale before removing it to fasten the old scale.

CAUTION!
Once the head alignment bracket is installed, do not traverse the axis or the reader head will break.

5.1.9.2 Install the Replacement Scale

CAUTION!
If the scale is not long enough for the table, it will break when the machine is traversed past the scale travel.

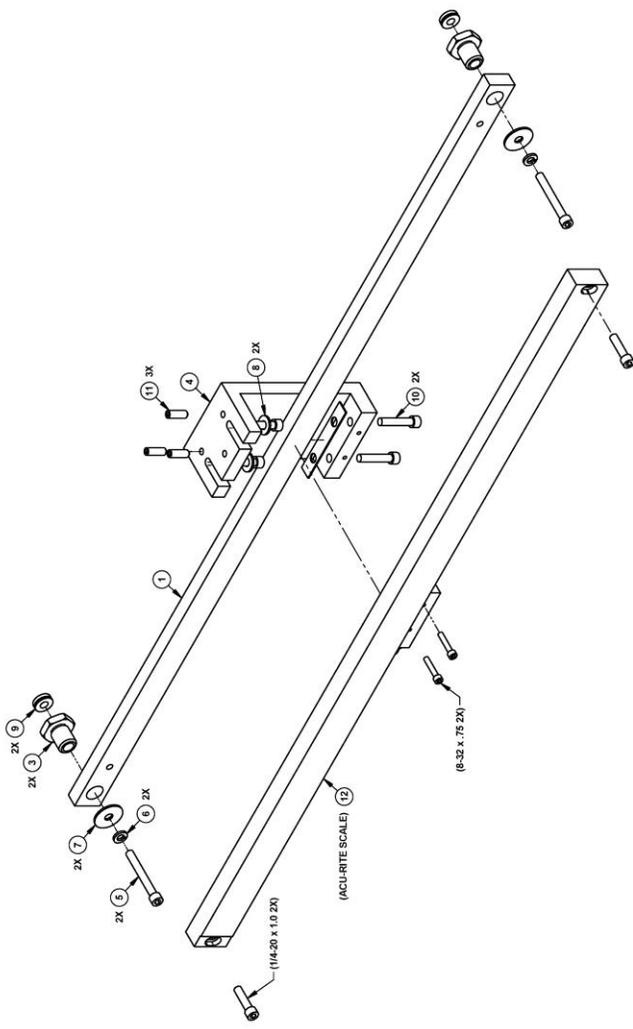
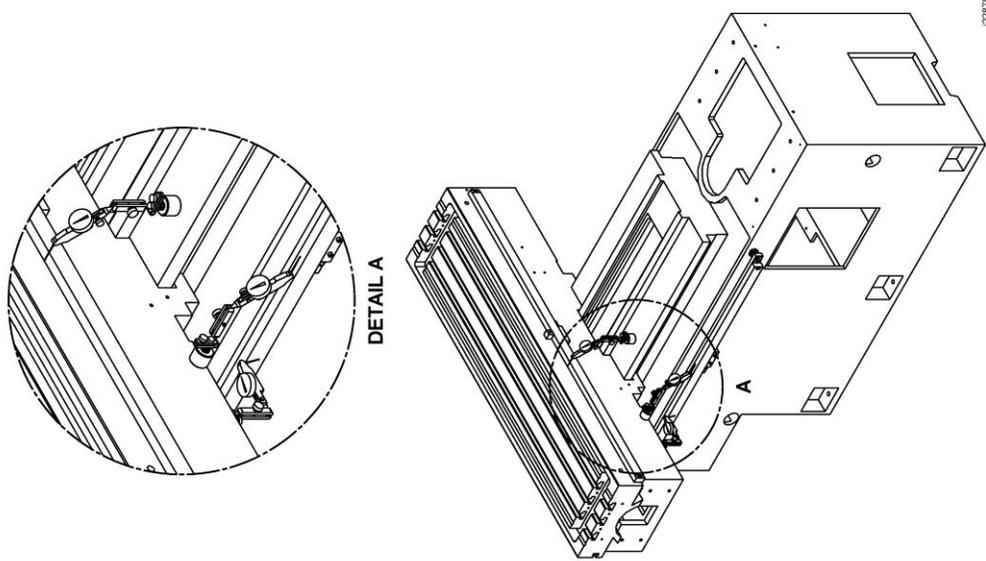
1. Mount the scale to the back of the table or Y-axis mounting spar.
2. Align the scale so that it is within +/- 0.005" end to end.

Notes: For the Y-axis, the mounting spar should already be aligned. It must be parallel to the Y-axis travel within +/- .005" end to end both horizontally and vertically. The mounting spar can be aligned in and out by the use of the adjustment screw.

3. Line the reader head up with the mounting holes on the back of the saddle for the X-axis or the bracket on the Y-axis.
4. Install the reader head bolts but leave them loose.
5. Use the jackscrews on the reader head to compensate for some gap between the reader head and the reader head mounting bracket. Leave the alignment brackets attached to the reader head. This bracket assures the reader head is aligned to the glass scale.
6. Tighten each jackscrew until it touches the bracket and then **back it off 0.001" or 0.002"**. Use a feeler gage to set the gap.
7. Tightening the reader head mounting screws. This ensures the reader head is aligned within a few thousandths.
8. Remove the shipping bracket that fixes the reader head to the scale for shipping.

WARNING!
After the reader head is attached to the reader head mounting bracket, do not move the machine axis until the shipping bracket is removed. This will break the reader head. This is not covered under warranty.

See Figure 23 for an illustration of how to align glass scales.



Item	P/N	Title	Qty
1	22879	MOUNTING PLATE-Y-AXIS GLASS SCALE	1
2	20546-2	SPACER - Y-AXIS GLASS SCALE	1
3	20545	ADJUSTMENT SCREW - Y-AXIS GLASS SCALE	2
4	22877	MOUNTING BRACKET MACHINING	1
5	1/4-20X2.25B	SCREW-SHCS-STL-BO	2
6	24009-3	WASHER - BELLEVILLE SPRING LOCK	2
7	1/4 79Z	WASHER-FENDER-0.25X1-STL-ZINC	2
8	1/4 71Z	WASHER-FLAT SAE-ZINC	2
9	1/4 72Z	WASHER-SPHERICAL-STL-ZINC	2
10	1/4-20X1.25B	SCREW-SHCS-STL-BO	4
11	1/4-28X3/4-40B	SCREW-SOC SET-STL-BO-CUP	3
12	22800-24	GLASS SCALE-ENC150-DIGITAL DIFFERENTIAL OUTPUT 24 IN	1
	22800-42	GLASS SCALE-ENC150-DIGITAL DIFFERENTIAL OUTPUT 42 IN	1
	22800-60	GLASS SCALE-ENC150-DIGITAL DIFFERENTIAL OUTPUT 60 IN	1

Figure 23 & Parts List Shown - Glass Scale Alignment

5.1.10 Power Drawbar

A power drawbar is an optional item on the FHM machine. It is bolted to the top of the head by the use of 3 SHCS. Some machines may require a washer to space the unit up to the proper height to allow the drawbar to engage properly.

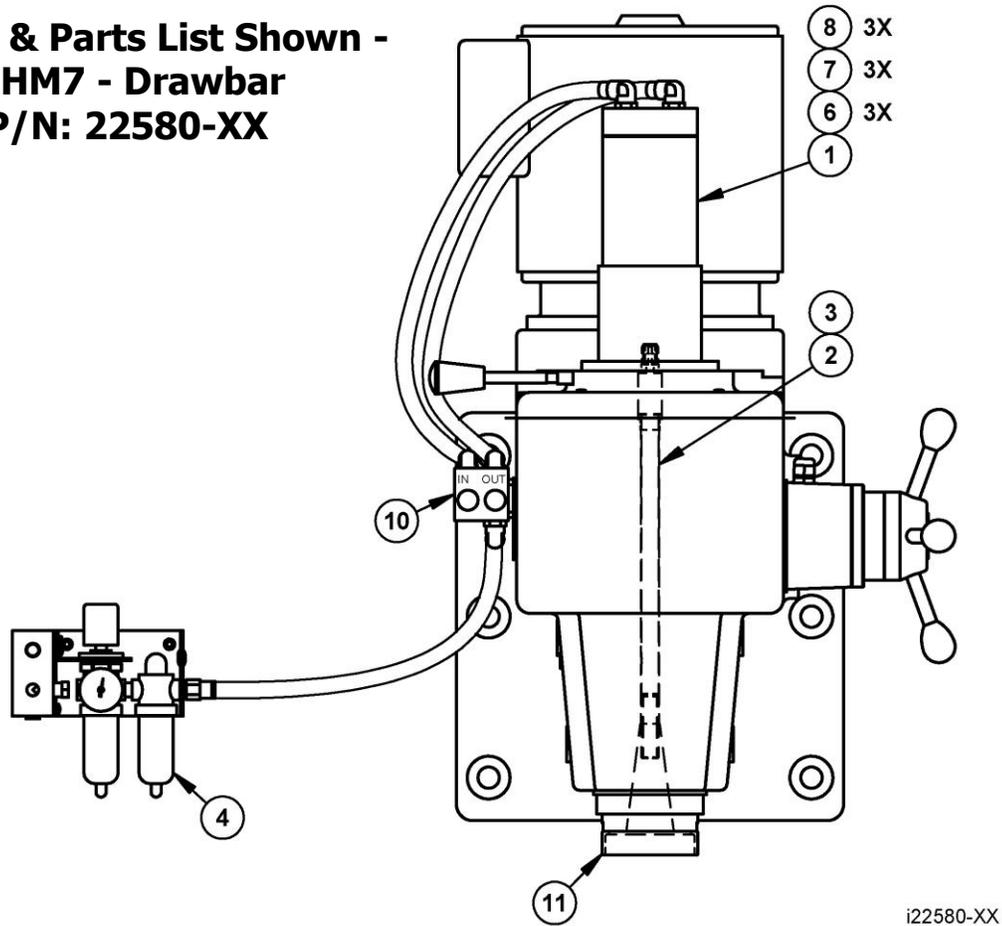
Air Regulator and Oiler - This unit requires between 80 and 100 psi to operate properly. Some units work fine at 80 psi while others may need 90 or 100 psi. It is also important to make sure the oiler for this unit is kept filled with oil. Fill the reservoir about 2/3 full using AIR TOOL OIL ONLY. Failure to do this will not allow oil to lubricate the internal components of the unit and it may wear out prematurely. It is also important to make sure the oiler is set properly. To set the oiler, first close the adjustment screw (CW) on top of the oiler completely making sure to not over tighten. Then open the screw (CCW) between 1/2 to 3/4 of a turn. Any more than this will cause too much oil to get into the unit and oil may come out of the exhaust port of the unit.

Tool Alignment Device - This unit also comes with a tool alignment device, which attaches to the bottom of the spindle. This device allows the tool to easily be aligned with the dogs when loading a tool.

CAUTION!

Some tools may not work with this device and the original spindle dogs will need to be used. The original spindle dogs are shipped with each machine in the toolbox. Some boring bar holders may not work with this device.

**Figure 25 & Parts List Shown -
FHM5 & FHM7 - Drawbar
Option - P/N: 22580-XX**



i22580-XX

Item	P/N	Title	Qty
1	22581	POWER DRAW BAR-TORQUE RITE	1
2	21660-NMTB	DRAWBAR-DPMV-NMTB - 2 PC HEAD (FHM5)	1
	21660-CAT	DRAWBAR-DPMV-CAT-2 PC HEAD (FHM5)	1
	23284	DRAWBAR-MANUAL (FHM5)	1
	24165-NMTB	DRAWBAR-DPMV7 (FHM7)	1
3	24165-CAT	DRAWBAR-DPMV7 (FHM7)	1
	23171-NMTB	DRAWBAR-NMTB-1 PC HEAD (FHM5)	1
	23171-CAT	DRAWBAR-CAT-1 PC HEAD (FHM5)	1
	21661	SPACER DRAWBAR - 3/5 HP (FHM5)	1
4	22116	SPACER-DRAWBAR-MANUAL (FHM5)	1
	24166	SPACER DRAWBAR - DPMV7 (FHM7)	1
6	1/4-20 X 1 25B	SCREW-SHCS-STL-BO	3
7	24009-3	WASHER - BELLEVILLE SPRING LOCK	3
8	1/4 71B	WASHER-FLAT SAE-STL-BO	3
10	22581-2	SWITCH - CONTROL HEAD - TORQUE RITE	1
11	22581-4	NOSEPIECE - TORQUE RITE	1

i22580-5

5.1.11 Ball Screw Replacement, X-Axis (Table) – FHM5

1. Remove table trays from each side of the table.
2. Remove bearing housing from right side of table.
3. Remove the sheet metal covers from the motor mounting brackets.
4. Remove the X-axis motor and belt from the left side of the table.
5. Remove the pulley and ferrule from the ball screw.
6. Remove the motor mounting bracket.
7. Loosen and remove the clamp nut. Loosen the setscrew on the clamp nut before loosening the clamp nut.
8. Push the table to the left so the bearing housing moves away from the saddle.
9. Remove the bearing housing. Note which way the bearings are in the bearing housing.
10. Slide the table to the right and remove the oil line and the 4 screws holding the ball nut to the yoke.
11. Pull the ball screw out.

Reassemble

12. Install the new ball screw into the yoke.
13. Slide table back to the left and assemble the left side of the X-axis.
14. Install rear bearing and seal into bearing housing and slide housing onto the ball screw. *(Note: Letters on bearings must face each other in the housing.)* Slide spacer onto ball screw. Slide top bearing onto ball screw and seat with clamp nut. Be sure to clamp nut to at least 50 ft-lbs. **Don't forget to tighten setscrew after clamp nut is tight.**
15. Install motor mounting bracket, motor spacer bracket, woodruff key, ferrule, pulley, star washer and nut. Before tightening down the motor mounting bracket move the table all the way to the left.
16. Move table to the right and assemble right side bearing housing.
17. Assemble motor to bracket. The servo should be facing toward the rear of the machine.
18. Install belt. Tighten lower 2 bolts followed by the top 2 bolts to properly tension belt.
19. Install electronic hand wheel.
20. Attach the sheet metal to the motor mounting bracket.
21. Install the table trays.

See the diagnostics section under Mechanical Drive Train for an explanation of how to align the ball screw.

See Figure 26 for an illustration of the X-axis drive train.

Parts List - FHM5 - X Drive Train (Figure 26)

Item	P/N	Title	Qty
3	15966	BRACKET-Y AXIS MOTOR MOUNT	1
47	22768-36	LABEL-TEXT	1
46	M6-1.0X75 25B	SCREW-SHCS-STL-BO	4
44	1/4-20X1/2 25B	SCREW-SHCS-STL-BO	4
45	21946	ELEC HANDWHEEL-X & Y AXIS	1
43	M6-1.0X30 25B	SCREW-SHCS-STL-BO	4
4	15967	COVER-UPPER	1
5	15968	COVER-LOWER	1
6	21585-1	COVER-BALLSCREW END	1
10	21584-1	END PLATE – COVER	1
11	6-32X3/8 10B	SCREW-PH-PHIL-STL-BO	5
25	M8-1.25X25 25B	SCREW-SHCS-STL-BO	4
13	98481A090	KEY WOODRUFF #404-1/8 X 1/2	1
15	16066	NUT CLAMP-X & Y AXIS	1
16	565-5M-15	BELT-TIMING	1
17	21662	BEARING HOUSING ASSY	1
18	20374	BEARING-ANGULAR CONTACT-7205	2
20	16078	BEARING SEAL	1
21	24009-2	WASHER – BELLEVILLE SPRING LOCK	5
24	M10-1.5X12 25B	SCREW-SHCS-STL-BO	1
26	24009-1	WASHER – BELLEVILLE LOCK	4
27	1/4-20X1 24B	SCREW-HEX HD-STL-BO	4
28	15759	WASHER-1/4 HARD BLK OX 1/8 THK	4
29	24009-3	WASHER – BELLEVILLE SPRING LOCK	4
33	10-32X3/4 25B	SCREW-SHCS-STL-BO	1
36	16983-1	PULLEY-SOLID 44 TEETH W/O GUIDES	1
37	16350	FERRULE-SPROCKET Z-AXIS DRIVE TRL-1440	1
38	1/2 71Z	WASHER-FLAT SAE-STL-ZINC	1
39	1/2-20 51Z	NUT-HEX JAM-STL-ZINC	1
40	1/2 75Z	WASHER-EXT TOOTH-STL-ZINC	1
41	M10-1.5X80 25B	SCREW-SHCS-STL-BO-FULLY THD	4
42	21985	SPACER ANGLED 30 DEGREE Y-AXIS	1

i24462

Ball Screw Replacement, X-Axis (Table) – FHM7

1. Remove table way covers from each side of the table.
2. Remove the left bearing housing cover by removing the (8) 10-24 truss head screw that secures it to the left bearing bracket.
3. Remove the motor cover/housing by removing the (4) 10-24 truss head screw secures it to the left bearing housing.
4. Remove the X-axis motor and belt from the left side of the table.

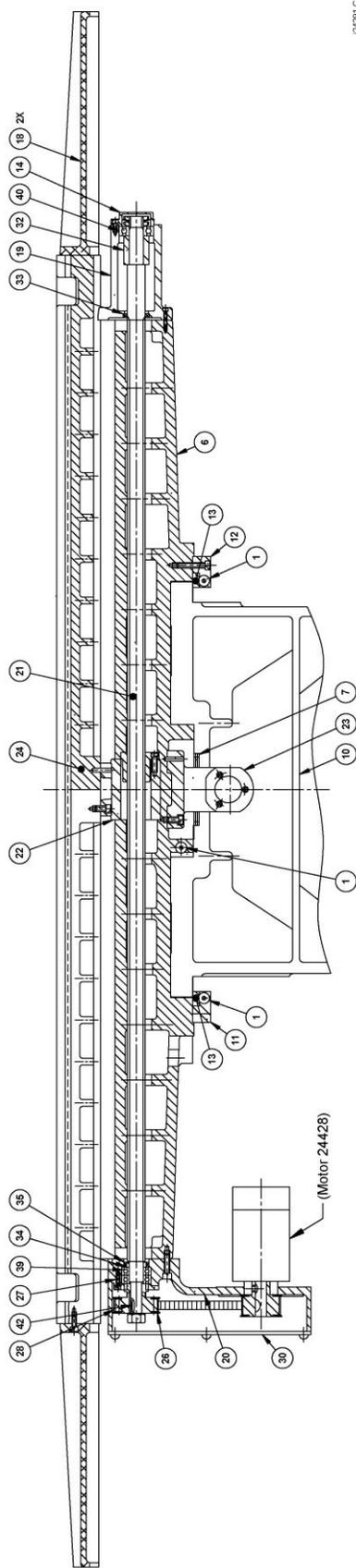
5. Using a #8 Allen hex key at the end of the ballscrew to hold it, remove the hex nut and lock washer securing the ballscrew pulley.
6. Remove pulley, key, and locking sleeve on the ballscrew.
7. **Remove the (4) 3/8"-16 SHCS** securing the left bearing housing to the saddle.
8. Remove left bearing housing and ballscrew bushing.
9. Remove the (3) 1/4"-20 SHCS securing the right bearing housing cover.
10. Remove the housing cover.
11. Disengage the lock washer tab from the two lock nuts.
12. Loosen and remove the (2) lock nut.
13. Remove the (4) 3/8"-16 SHCS securing the right bearing housing
14. Remove the right bearing housing and bushing.
15. Slide the table to the right, remove the oil line and the (3) 5/16"-18 SHCS that secures the ball nut to the yoke.
16. Pull the ball screw out.

Reassemble

17. Install the new ball screw into the yoke.
18. Reconnect oil line and fasten ball nut into yoke.
19. Slide table back to the center and assemble the left side of the X-axis.
20. Slide the left bearing housing bushing onto the ball screw.
21. Slide left bearing housing with bearing onto ball screw.
22. Mount bearing housing to saddle with the (4) 3/8"-16 SHCS.
23. Slide locking sleeve onto ball screw with the short side out.
24. Install key and slide pulley onto ball screw.
25. Secure pulley with the lock washer and hex nut. (Note: Use a #8 Allen hex key to hold ball screw.)
26. Install motor, mounting bracket, motor spacer bracket, woodruff key, ferrule, pulley, star washer and nut. Before tightening down the motor mounting bracket move the table all the way to the left.
27. Move table to the right and assemble right side bearing housing.
28. Assemble motor to bracket. The servo should be facing toward the rear of the machine.
29. Install belt. Tighten lower 2 bolts followed by the top 2 bolts to properly tension belt.
30. Attach the sheet metal to the motor mounting bracket.
31. Install the table trays.

See the diagnostics section under Mechanical Drive Train for an explanation of how to align the ball screw.

See Figure 27 for an illustration of the X-axis drive train.



124291 C

**Figure 27 - FHM7 -
X Drive Train -
P/N: 24291**

Parts List - FHM7 - X Drive Train - P/N: 24291 (Figure 27)

Item	P/N	Title	Qty
1	24518	SCREW - GIB ADJUSTING	3
2	24549	SCREW - GIB - X AXIS	2
3	24507-L	GIB-X AXIS-LEFT	1
4	24521	WIPER-WAY-Y AXIS-FHM7/V7	4
5	24507-R	GIB-X AXIS-RIGHT	1
6	H-034-14B	SADDLE	1
7	25209	COVER - BALLSCREW - CHIP GUARD - Y AXIS	1
10	H-067-9C	BASE-MACHINE	1
11	H-106-8	SEAT-GIB (LEFT)	1
12	H-107-8	SEAT-GIB (RIGHT)	1
13	24509	GIB - Y AXIS BOTTOM	2
14	H-120-6	COVER	1
15	H-122-6	STOP	2
16	24514	SWITCH - LIMIT	2
17	H-124-7A	COVER	1
18	24505	COVER - WAY - TABLE	2
19	HT-011-8B	BRACKET-RIGHT BEARING	1
20	HT-012-8B	BRACKET-LEFT BEARING	1
21	24500	BALLSCREW - X AXIS	1
22	HT-022-8	BRACKET-FEED NUT	1
23	HT-022-8B	BRACKET-CROSS SCREW	1
24	HT-029-14	TABLE	1
25	HT-032	PLUNGER-RUBBER	8
26	HT-040-7	COVER-BEARING	1
27	HT-041-6	SLEEVE-LOCKING	1
28	24545	PULLEY - X AXIS BALLSCREW	1
29	HT-090-8B	COVER	1
30	HT-098-8	COVER	1
31	HT-157-8	BRACKET-HANDWHEEL	1
32	HT-166-8	BUSHING	1
33	HT-167	SEAL-OIL	1
34	HT-181	SEAL-OIL	1
35	HX-002	BUSHING	1
39	23940	BEARING-ANGULAR CONTACT-U/SET (2)-7205	1
40	24512	BEARING-DEEP GROOVE-6305ZZ	1
42	24546	KEY - 5 x 5 x 20L	1

i24291

5.1.13 Ball Screw Replacement, Y-Axis (Saddle) – FHM5

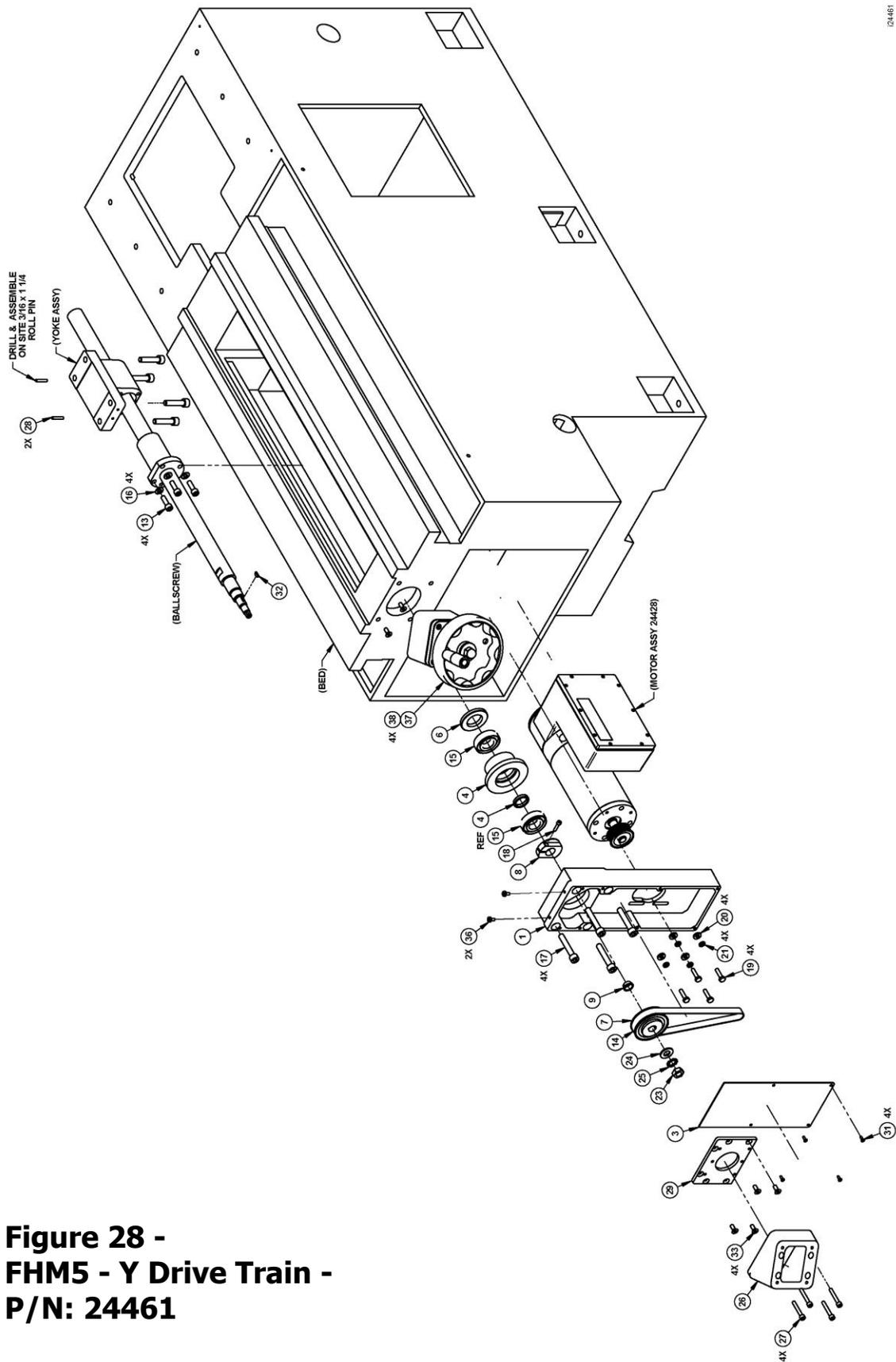
1. Remove the sheet metal from the front of the machine and from the motor mounting bracket.
2. Move the saddle toward the front of the machine and remove the electronic hand wheel.
3. Remove the Y-axis motor and belt.
4. Remove the pulley and ferrule from the ball screw.
5. Remove the motor mounting bracket.
6. Loosen and remove the clamp nut. Loosen the setscrew on the clamp nut before loosening the clamp nut.
7. Remove the bearing housing. Note which way the bearings are in the bearing housing.
8. Remove the oil line and the 4 screws holding the ball nut to the yoke.
9. Pull the ball screw out.

Reassemble

10. Install Y ball screw to yoke and install oil line to ball nut
11. Install rear bearing and seal into bearing housing and slide housing onto the ball screw. *(Note: Letters on bearings must face each other in the housing.)* Slide spacer onto ball screw. Slide top bearing onto ball screw and seat with clamp nut. Slide top bearing onto ball screw and seat with clamp nut. Be sure to clamp nut to at least 50 ft-lbs. Don't forget to tighten setscrew after clamp nut is tight.
12. Install motor mounting bracket, woodruff key, ferrule, pulley, star washer and nut. Before tightening down the motor mounting bracket move the saddle to the front of the machine.
13. Assemble motor to bracket. The servo should be facing the right of the machine.
14. Install belt. Tighten lower 2 bolts followed by the top 2 bolts to properly tension belt.
15. Install electronic hand wheel.
16. Install all sheet metal.

See the diagnostics section under Mechanical Drive Train for an explanation of how to align the ball screw.

See Figure 28 for an illustration of the Y-axis drive train.



**Figure 28 -
FHM5 - Y Drive Train -
P/N: 24461**

Parts List - FHM5 - Y Drive Train - P/N: 24461 (Figure 28)

Item	P/N	Title	Qty
1	15966	BRACKET-Y AXIS MOTOR MOUNT	1
3	21982	SHEET METAL-PT4-LOWER Y-AXIS DRIVE ASSY COVER	1
4	21662	BEARING HUSING ASSY	1
6	16078	SEAL-BEARING HOUSING	1
7	16983-1	PULLEY-SOLID 44 TEETH W/O GUIDES	1
8	16066	NUT CLAMP-X & Y AXIS	1
9	16350	FERRULE-SPROCKET	1
13	M8-1.25X25 25B	SCREW-SHCS-STL-BO	4
14	565-5M-15	BELT-TIMING	1
15	20374	BEARING-ANGULAR CONTACT	2
16	24009-1	WASHER - BELLEVILLE LOCK	4
17	M10-1.5X65 25B	SCREW-SHCS-STL-BO	4
18	10-32X3/4 25B	SCREW-SHCS-STL-BO	1
19	1/4-20X1 24B	SCREW-HEX HD-STL-BO	4
20	15759	WASHER-1/4 HARD BLK OX 1/8 THK	4
21	24009-3	WASHER - BELLEVILLE SPRING LOCK	4
23	1/2-20 51Z	NUT-HEX JAM-STL-ZINC	1
24	1/2 71Z	WASHER-FLAT SAE-STL-ZINC	1
25	1/2 75Z	WASHER-EXT TOOTH-STL-ZINC	1
26	21985	SPACER - 30 DEGREE Y-AXIS DRIVE ASSY	1
27	M6-1.0X25 25B	SCREW-SHCS-STL-BO	4
28	3/16X1 1/4 81P	PIN-ROLLED-STL-PLAIN	2
29	21984	BRACKET - WAY COVER FRONT Y-AXIS DRIVE	1
31	6-32X3/8 10B	SCREW-PH-PHIL-STL-BO	4
32	98481A090	KEY WOODRUFF #404-1/8 X 1/2	1
33	1/4-20X5/8 26B	SCREW-FHCS-STL-BO	4
36	M5-0.8X10 10B	SCREW-PH-PHIL-STL-BO	2
37	21946	ELECTRONIC HANDWHEEL-X & Y AXIS	1
38	M6-1.0X75 25B	SCREW-SHCS-STL-BO	4
39	22768-37	LABEL-TEXT	1

i24461

5.1.14 Ball Screw Replacement, Y-Axis – FHM7

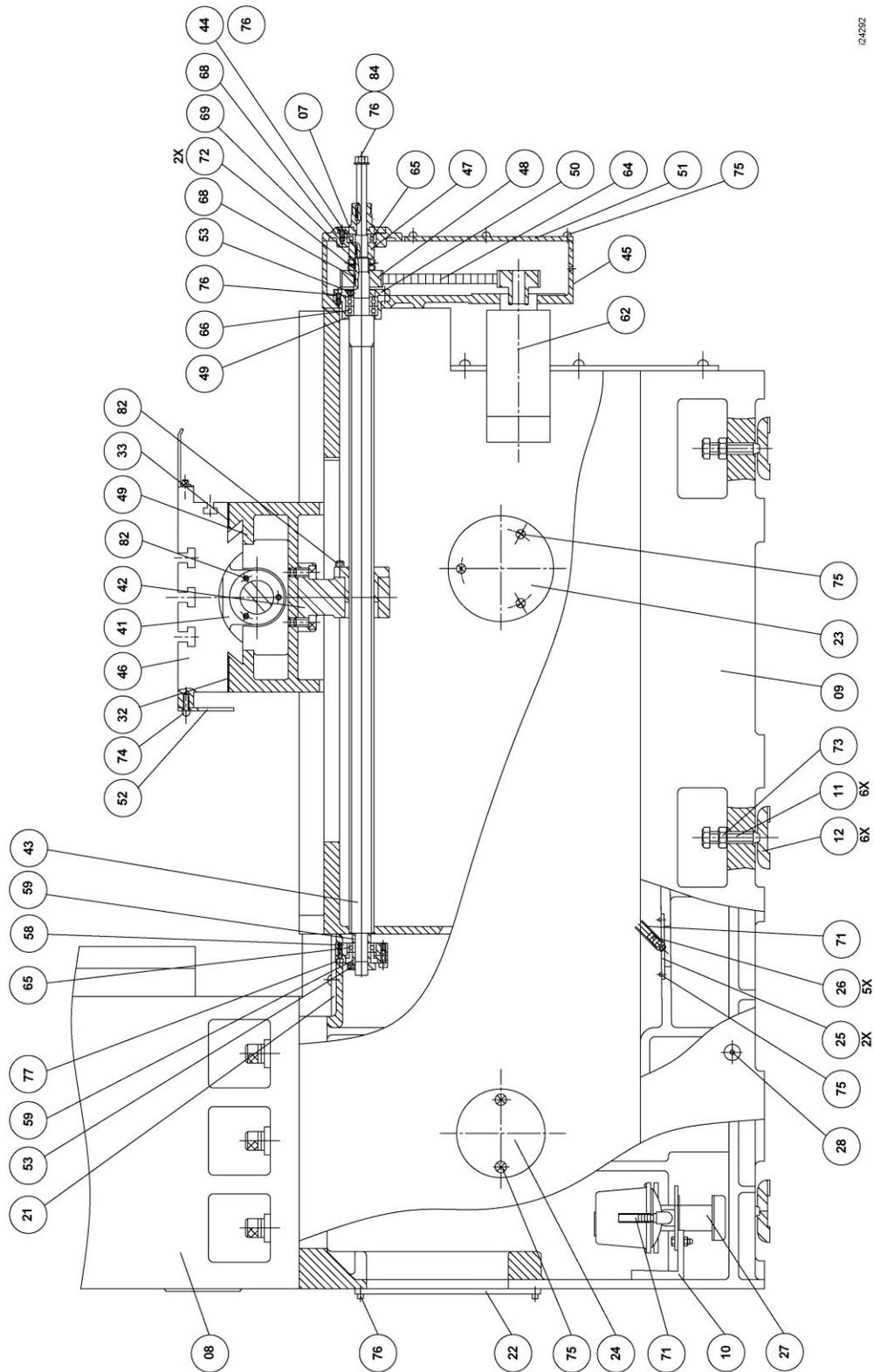
1. Move the y-axis to the front of the machine.
2. Remove the electronic handwheel and axis motor cover.
3. Remove the front ballscrew bearing and housing.
4. Remove the Y-axis motor and belt.
5. Remove the double nut that holds the pulley and slide the ballscrew pulley from the ballscrew along with the key.
6. Remove the bearing cover, locking nut, axis bearings and bearing housing (block). When removing the bearings, take note to how they are mounted.

7. Now go to the bottom of the column and rear of bed and remove the access cover to the rear bearing on the Y-axis.
8. Remove the nut, bearing and bushing that is found at the end of the ballscrew.
9. Now go the front of the machine and remove the ballnut from the yoke. Slide the ballscrew toward you to remove. Make sure to disconnect the oil line.

Reassemble

10. Install the Y ballscrew to the yoke and install the oil line.
11. Install the axis bearings in the housing and into the ballscrew in the same manner as you removed them. Tighten the lock nut and install the bearing cover.
12. Install the ballscrew pulley and key. Lock the pulley with the double nut.
13. Install the axis motor and belt.
14. Install the front bearing and housing.
15. Install the motor bracket cover and electronic handwheel.

Note: See the diagnostic section under mechanical drive train for an explanation on how to align the ballscrew.



124292

**Figure 29 - FHM7 - Y-Axis Drive Train -
P/N: 24292**

Parts List - FHM7 - Y Axis Drive Train - P/N: 24292 (Figure 29)

Item	P/N	Title	Qty
2	H-026-B	SCREW	3
3	H-029-8A	PLATE-ALUMINUM	4
5	H-034-14B	SADDLE	1
7	H-060	COVER-BEARING	1
8	H-067-8	BODY-MACHINE	1
9	H-067-9C	BASE-MACHINE	1
10	H-075	HOLDER-COOLANT NOZZLE	1
11	24524	SCREW - LEVELING	6
12	H-103	BLOCK-ADJUSTING	6
13	H-106-8	SEAT-GIB (LEFT)	1
14	H-107-8	SEAT-GIB (RIGHT)	1
15	24509	GIB - Y AXIS BOTTOM	2
16	H-124-7B	BOX-LIMIT SWITCH	1
17	H-165-8	PIPE CONNECTION	1
18	H-166-8C	COVER	2
19	H-166-14B	COVER-FRONT	1
20	H-170-8	WASHER	6
21	H-172-9	COVER	1
22	H-173-8B	COVER	1
23	H-237-8	COVER	1
24	H-237-9	COVER	1
25	H-239-10	NETWORK-OIL	2
26	H-254	NETWORK-OIL	5
27	23265	COOLANT PUMP 1/8 HP	1
28	H-259	PLUG-COOLANT	1
29	24506	COVER - WAY - Y AXIS REAR	1
30	H-263-10	BRACKET-UP/DOWN CHIP GUARD	1
31	22291-1	LUBRICATION PUMP	1
32	H-267-10	TEFLON (L)	1
33	H-268-10	TEFLON (R)	1
34	H-279-8	GUARD	1
35	H-280-8	PLATE-(L)-FIXED	1
36	H-281-8	PLATE-(R)-FIXED	1
41	HT-022-8	BRACKET-FEED NUT	1
42	HT-022-8B	BRACKET-CROSS SCREW	1
43	24501	BALLSCREW-Y AXIS	1
44	HT-028-7A	BRACKET-BEARING-CROSS FEED	1
45	HT-028-8B	BRACKET-BEARING-CROSS FEED	1
46	HT-029-14	TABLE	1
47	HT-041-8	BUSHING	1
48	24544	PULLEY - Y AXIS BALLSCREW	1

Parts List - FHM7 - Y Axis Drive Train - P/N: 24292 (Figure 29)

49	24372	HOUSING - BEARING	2
50	24373	COVER - BEARING	1
51	HT-096-8A	COVER	1
52	HT-142-8A	COVER	1
53	24519	NUT - LOCK	2
54	HX-046	STOP-LIMIT SWITCH	2
55	24504	COVER - WAY - Y AXIS FRONT	1
56	HY-066-8	REST-FOOT	1
57	HY-066-8A	REST-FOOT	1
58	HY-073-8	BRACKET-BEARING BALL SCREW	1
59	HY-083-9	BUSHING	2
60	24508	GIB - Y AXIS SIDE	1
61	24514	SWITCH - LIMIT	1
62	24428	MOTOR/ENCODER/SERVO ASSY-DRIVER-4055	1
64	670-5M-15	BELT-TIMING 5MM POWERGRIP	1
65	26198-1	BEARING-DEEP GROOVE-6204ZZ	2
66	23940	BEARING-ANGULAR CONTACT-U/SET (2)-7205	1
68	24546	KEY - 5 x 5 x 20L	2
69	AK0505022	KEY-5x5x22	1
70	AKP138	PIPE-3/8	2
71	AKP212	PIPE-1/2	2
72	24515	NUT-LOCK	2
73	24547	NUT - 3/4 - 10 NC	6
74	M5-0.8X10 25B	SCREW-SHCS-STL-BO	5
75	3/16-24X3/8 10B	SCREW-PAN HEAD PHILLIPS-STL-BO	26
76	1/4-20X5/8 25B	SCREW-SHCS-STL-BO	29
77	1/4-20X3/4 25B	SCREW-SHCS-STL-BO	10
78	1/4-20X1 5/8 25B	SCREW-SHCS-STL-BO	2
79	1/4-20X1 3/4 25B	SCREW-SHCS-STL-BO	2
80	5/16-18X1/2 25B	SCREW-SHCS-STL-BO	4
81	5/16-18X3/4 25B	SCREW-SHCS-STL-BO	14
82	5/16-18X1 25B	SCREW-SHCS-STL-BO	6
83	7/8-9X3 1/2 25B	SCREW-SHCS-STL-BO	6
84	1/4 70B	WASHER-FLAT USS-STL-BO	1
85	5/16 70B	FLAT WASHER 5/16	18

i24292

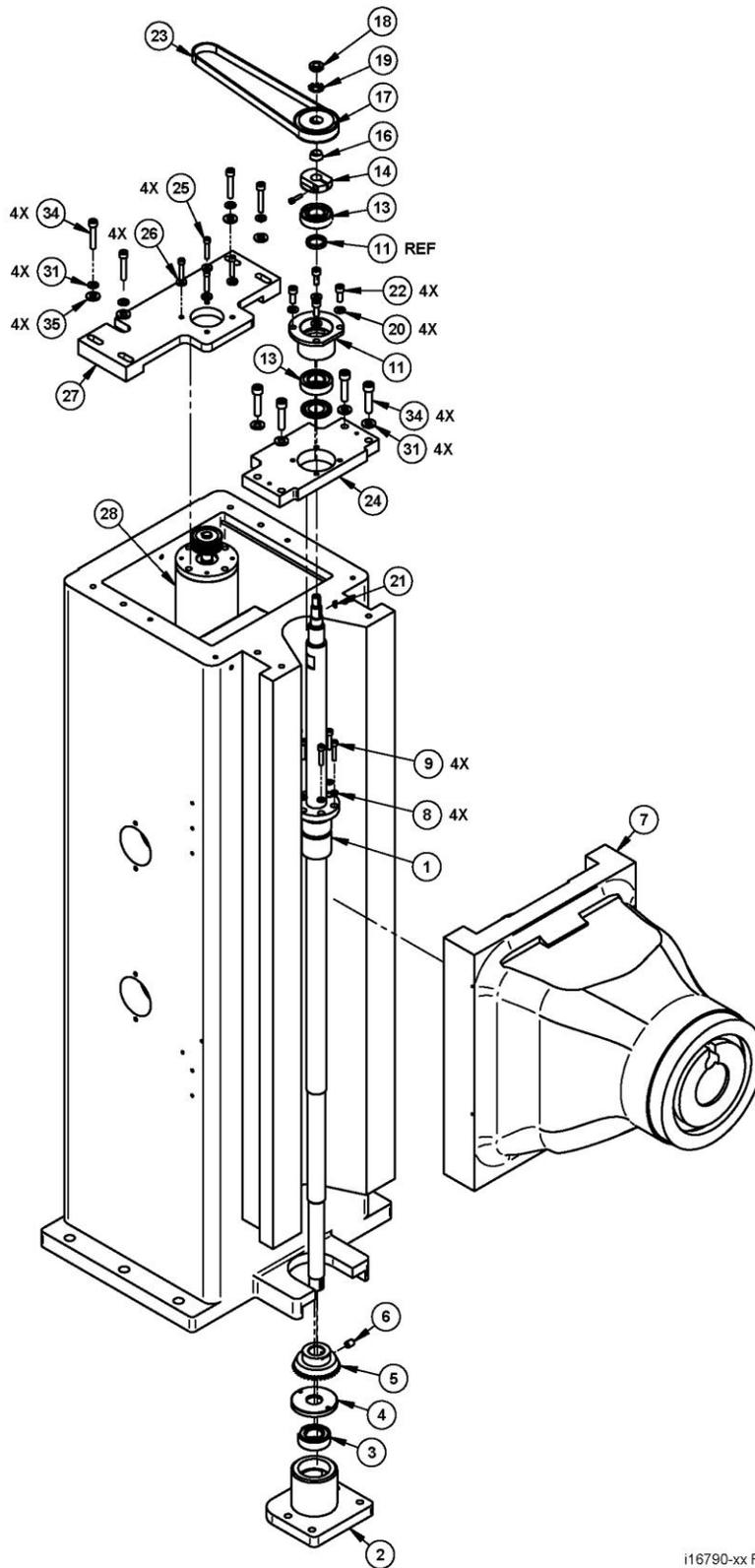
5.1.15 Z-Axis Ball Screw Removal & Replacement–FHM5 & FHM7

CAUTION!
Never screw a ball screw partially or totally out of its nut. They cannot be reassembled.

1. Ensure that there is sufficient vertical clearance above the top of the machine to remove the ball screw. Minimum clearance required is 32 inches.
2. Remove vertical column top cover.
3. Remove servomotor, belt and Z motor mounting bracket.
4. Remove upper and lower Z-axis way covers.
5. Lower head to table. Place 1 or 2 inch wood board between spindle nose and table to protect.
6. Lower head until weight of head is supported by the table.
7. Tighten both ram locks on the right side of ram.
8. Remove locknut and lock washer from the top of the Z ball screw.
9. Remove pulley and key.
10. For the FHM5, loosen #10-32 socket screw on clamp nut.
11. For the FHM5, using wrench flats on clamp nut and wrench flats on ball screw remove clamp nut.
12. Remove the four cap screws from bearing housing flange.
13. For the FHM5 remove the clamp nut, remove the locknut on the FHM7.
14. Remove bearing, nilos ring and bearing housing with matched spacer from ball screw.
15. Remove the cap screws and lock washers from ball nut flange.
16. Loosen setscrew from bevel gear. FHM5 only. Rotate ball screw by hand, if necessary, to access set screw. Extract ball screw assembly from machine until ball nut flange is above the top of the ram. Support ball screw & remove lubrication line from ball nut flange.
17. Raise the ball screw until the bottom end of the ball screw is above the ram. Be careful to remove bevel gear as the ball screw is raised. Angle the ball screw out and away from the head. Lower the ball screw on the right side of the machine until the top of the ball screw clears the support plate.
18. Reassemble all components in reverse order as shown above, except leave off the pulley, locknut and lock washer until ball screw is realigned. Torque clamp nut to 50 ft. lb. for the FHM5 and lock nut for the FHM7.
19. With the ball screw assembly installed, loosen four 5/16-18 cap screws from bearing housing, raise head to the uppermost position, and re-tighten 5/16-18 cap screws. Note that there is .060 clearance between the bearing housing outside diameter and the inside diameter of the support plate to allow for realignment. Traverse the head to the extreme of the up and down travel manually to check for freedom of movement. Use torque wrench to make sure torque is consistent along length of screw. Use torque wrench to make sure torque is consistent along length of screw.

See Figure 30 for the FHM5 and Figure 31 for the FHM7 for an illustration of the Z-axis drive train.

See Section 5.2.2 to properly measure & set the Z Backlash Compensation & calibration.



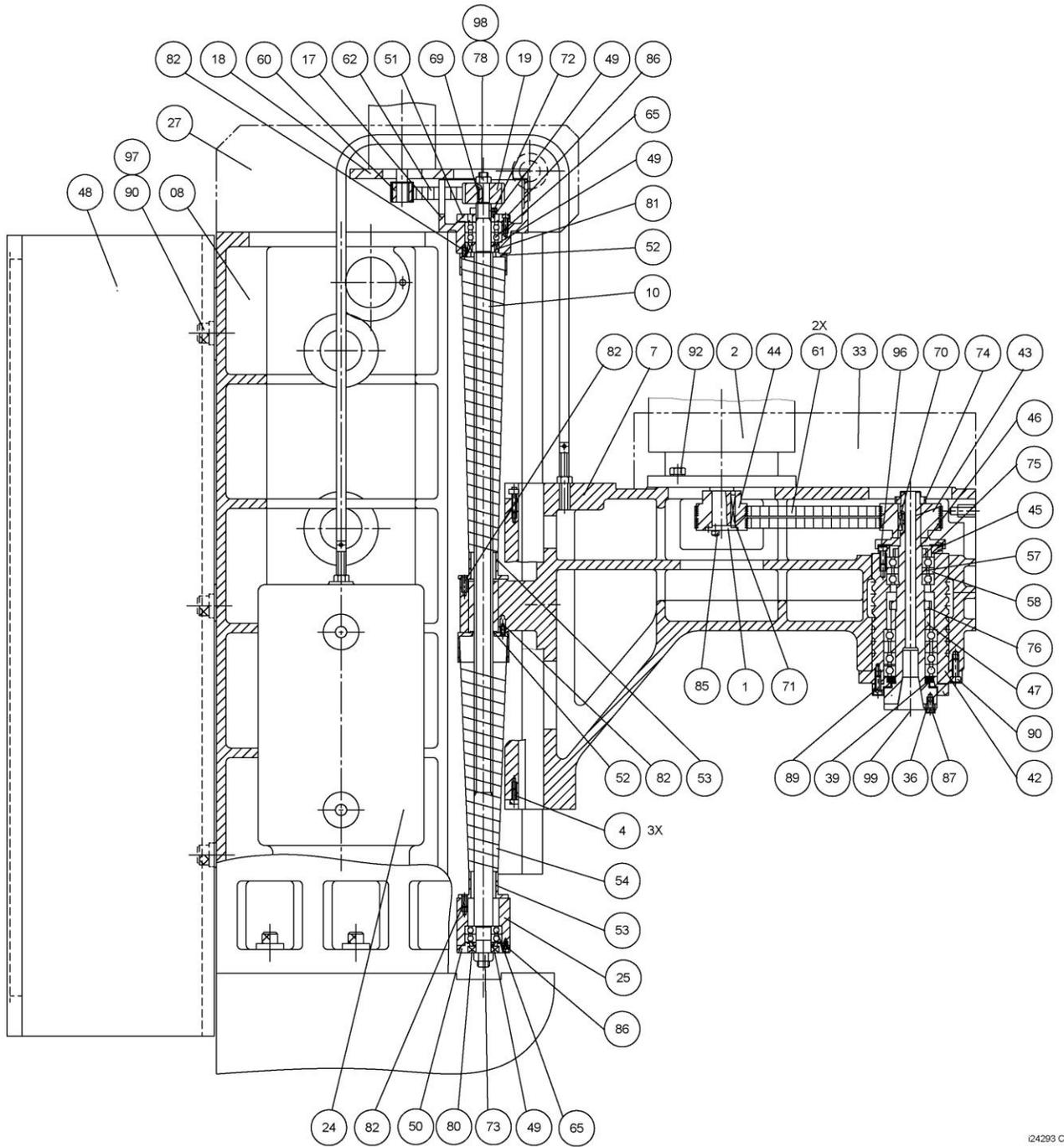
i16790-xx F

**Figure 30 -
FHM5 Z Axis Drive Train - P/N: 16790-1**

Part List - FHM5 - Z-Axis Drive Train - P/N: 16790-1 (Figure 30)

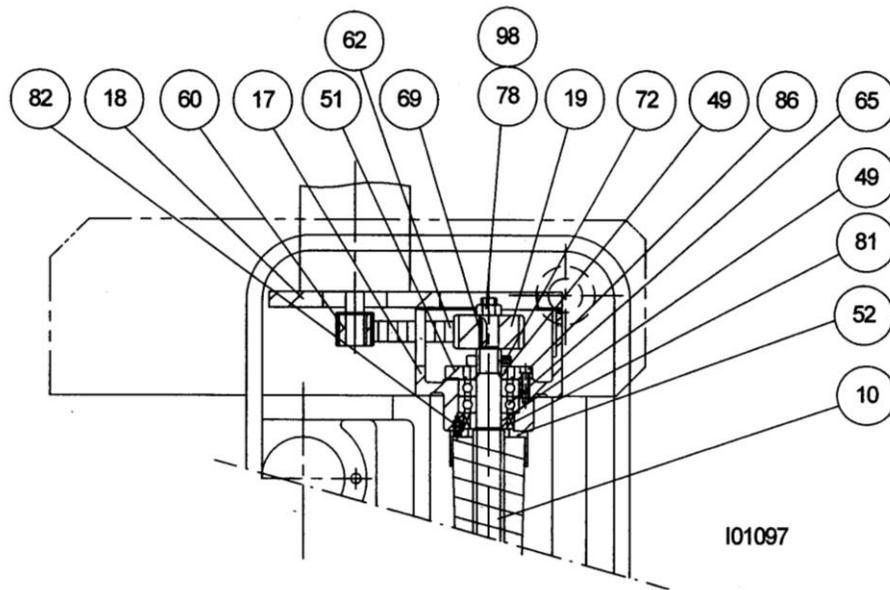
Item	P/N	Title	Qty
1	16806-M	BALLSCREW ASSY- Z-AXIS	1
2	PJ540015	BRACKET LOWER ELEVATING BALL SCREW	1
3	2205E-2RS1TN9	BEARING SELF ALIGNMENT SKF	1
4	16774	COVER - BEARING	1
5	16795	MODIFIED BEVEL GEAR BS1236-2A	1
6	M10-1.5X10 40B	SCREW-SOC SET-STL-BO-CUP	1
7	16770	MODIFICATION OF 3 HP RAM PING JENG PART	1
8	M6 73B	WASHER-SPLIT LOCK-STL-BO	6
9	M6-1.0X25 25B	SCREW-SHCS-STL-BO	6
10	7205-AVH	NILOS RING-7205	1
11	16295-1	BEARING HOUSING ASSY	1
13	20374	BEARING-ANGULAR CONTACT	2
14	16773	NUT CLAMP-Z AXIS	1
15	10-32X3/4 25B	SCREW-SHCS-STL-BO	1
16	16350	FERRULE-SPROCKET	1
17	16983	PULLEY-SOLID 44 TEETH Z-AXIS	1
18	N01	LOCKNUT	1
19	W01	LOCKWASHER	1
20	M8 73B	WASHER-SPLIT LOCK-STL-BO	4
21	98481A090	KEY WOODRUFF #404-1/8 X 1/2	1
22	M8-1.25X20 25B	SCREW-SHCS-STL-BO	4
23	710-5M-15	BELT - TIMING	1
24	21944	PLATE BALLSCREW SUPPORT - Z AXIS	1
25	1/4-20X1 1/4 25B	SCREW-SHCS-STL-BO	4
26	15759	WASHER-1/4 HARD BLK OX 1/8 THK	4
27	23197	BRACKET-Z AXIS MOTOR-DPMS	1
28	23198	MOTOR DRIVER ASSY - 4050	1
31	M10 73B	WASHER-SPLIT LOCK-STL-BO	8
32	17030	LOUVRE- SPACER	1
34	M10-1.5X45 25B	SCREW-SHCS-STL-BO	8
35	M10 71B	WASHER-FLAT SAE-STL-BO	4

i16790-XX



i24293 C

**Figure 31 -
FHM7 - Z-Axis Drive Train**



Parts List - FHM7 - Z-Axis Drive Train (Figure 31 & 32)

Item	P/N	Title	Qty
1	760-5A	COVER-FIXED	1
2	24525	MOTOR ASSY- SPINDLE - DPMV7	1
3	24518	SCREW - GIB ADJUSTING	3
4	H-026-B	SCREW	1
5	H-035-8	PLATE-ALUMINUM	4
6	24510	GIB - Z AXIS SIDE	1
7	H-045-14C	KNEE	1
8	H-067-8	BODY-MACHINE	1
9	H-077-3	SCREW	1
10	24502	BALLSCREW - Z AXIS	1
11	H-109-12	SEAT-GIB	1
12	H-110-12	SEAT-GIB	1
13	24511	GIB - Z AXIS REAR	2
14	H-124-5	HOLDER-MICRO SWITCH	1
15	H-139-8	BRACKET (R)-ROLLER'S	1
16	H-139-8A	BRACKET (R)-ROLLER'S	1
17	H-140-10	HOLDER FIXED MOTOR	1
18	H-140-10B	HOLDER FIXED	1
19	24542	PULLEY - Z AXIS BALLSCREW	1
20	H-145-8	ROLLER	4
21	H-146-8	SPACER	4
22	H-147-8	SHAFT-DRIVE	4
23	H-148-8	SCREW	4
24	H-149-8A	WEIGHT BALANCE	1
25	H-160-9	BRACKET-BEARING	1
26	H-165-8	PIPE CONNECTION	2
27	H-167-10B	COVER-TOP	1

Parts List - FHM7 - Z-Axis Drive Train (Figure 31 & 32)

28	H-168-8	HOLDER-BALANCE WEIGHT	1
29	H-170-8	WASHER	1
30	H-171-8	HOLDER-MICRO SWITCH	1
31	24550	VALVE	1
32	24551	NOZZLE - COOLANT	1
33	H-310-8	COVER	1
34	H-331-8	BRACKET-ARM	1
35	H-332-14	COVER-ARM	1
36	HB-127-B	BRACKET	1
39	HB-134-10	BRACKET BUSHING-BEARING	1
42	24532	CARTRIDGE HOUSING	1
43	24529	PULLEY - SPINDLE	1
44	24527	PULLEY - MOTOR	1
45	HB-199-10	CLAMPING RING	1
46	HB-200-10	DUST COVER	1
47	HB-201-13	SPACER	1
48	HT-067-14A	CABINET-ELECTRICAL CONTROL	1
49	HX-002-10	BUSHING-BEARING	3
50	HX-007	COVER-BEARING	1
51	HX-007-9	COVER-BEARING	1
52	HX-028-10	SUPPORT-DUST HELMET	2
53	HX-030-10	SUPPORT-DUST HELMET	2
54	24523	COVER - Z BALLSCREW	1
55	HX-046	STOP-LIMIT SWITCH	2
56	HY-043-14	ARM	1
57	24556	SPACER - BEARING - INNER	1
58	24557	SPACER - BEARING - OUTER	1
60	24427	SPROCKET ASSY - 26 TEETH - 40/55	1
61	24553	BELT SET - SPINDLE	2
62	425-5M-15	BELT-TIMING 5MM POWERGRIP	1
63	24558	ELBOW - 90	1
64	24555	BEARING - TA3025	4
65	24513	BEARING SET - ANGULAR CONTACT	1
67	24512	BEARING - BALL	1
69	24543	KEY - 5 x 5 x 25L	1
70	24530	KEY - 8 X 7 X 60L	1
71	24528	KEY - 10 X 8 X 35	1
72	24520	NUT - LOCK, M25X 1.5	1
73	24515	NUT - LOCK	1
74	24533	NUT - LOCK - M35 X 1.5	1
75	24534	NUT - LOCK - M40 X 1.5	1
77	1/4-20 50B	NUT-HEX-STL-BO	1
78	5/8-18 50B	NUT-HEX-STL-BO	1
79	3/4-10 50B	NUT-HEX-STL-BO	4
80	AOS255211	SEAL-OIL-25x52x11	1
81	AOS385216	SEAL-OIL-38x52x16	1
82	3/16-24X1/2 10B	SCREW-PAN HEAD PHILLIPS-STL-BO	24
83	3/16-24X5/8 10B	SCREW-PAN HEAD PHILLIPS-STL-BO	6

Parts List - FHM7 - Z-Axis Drive Train (Figure 31 & 32)

85	1/4-20X1/2 25B	SCREW-SHCS-STL-BO	4
85	1/4-20X5/8 25B	SCREW-SHCS-STL-BO	7
86	1/4-20X3/4 25B	SCREW-SHCS-STL-BO	6
87	1/4-20X1 25B	SCREW-SHCS-STL-BO	1
88	5/16-18X7/8 25B	SCREW-SHCS-STL-BO	4
89	5/16-18X1 25B	SCREW-SHCS-STL-BO	6
90	3/8-16X1 25B	SCREW-SHCS-STL-BO	20
91	3/8-16X1 1/2 25B	SCREW-SHCS-STL-BO	9
92	1/2-12X1 1/4 25B	SCREW-SHCS-STL-BO-FULL THREAD	4
93	3/4-10X5 24B	SCREW-HEX HD-STL-BO	1
94	M5-0.8X12 10B	SCREW-PH-PHIL-STL-BO	8
95	M6-1.0X12 25B	SCREW-SHCS-STL-BO	15
96	M6-1.0X20 25B	SCREW-SHCS-STL-BO	3
97	3/8 70P	WASHER-FLAT USS-STL-BO	6
98	5/8 70B	WASHER-FLAT USS-STL-BO	1
99	24566	SPINDLE CARTRIDGE ASSY	1

i24293

5.1.16 Air Solenoid Replacement

1. Unhook the air from the machine.
2. Unplug the power cable that connects to the right side of the air regulator bracket.
3. Remove the 2 screws that hold the connector to the bracket.
4. Undo the airline that runs from the oiler to the power drawbar if that option is installed on the machine.
5. Remove the 2 screws on the left side of the bracket that holds the air manifold to the U-shaped bracket.
6. With the assembly in hand unthread the solenoid from the rear of the air regulator. The solenoid and cable will be replaced as a unit.

See Figure 11 in Section 2 for an illustration of this assembly.

5.1.17 Spindle Motor Replacement-FHM5

1. Turn machine off. Disconnect power to machine from the shop feeder box.
2. Open the motor junction box to gain access to the wiring.
3. Disconnect all the wires and conduit going to the motor. Take note of how the motor is wired. The spindle motors must be wired for low voltage in the Y configuration.
4. Remove the (4) screws that fasten the ventilation plate on the right side of the spindle head and remove vent plate.
5. Release the belt tension by adjusting the belt tension mechanism, which is integrated to the upper spindle plate cover.
6. Disengage the (2) belts from the motor pulley thru the vent/access hole.

7. Remove the (4) M10 hex-head screws that hold the motor. Remove the motor. Be careful the motor weighs approximately 70 lbs. for the FHM5 and over 100 lbs. for the FHM7.
8. Install new motor/pulley assembly and secure loosely with the (4) M10 hex-head screw.
9. Engage the belt to motor and spindle pulley. Make sure that the belt is 100% engaged to both pulleys.
10. Adjust belt tension mechanism until proper belt tension is reach. Belt is visible thru the vent hole.
11. Tighten the (4) M10 hex-head screws that secure the motor to the casting.
12. Connect all the wires that go to the motor. See the motor wiring section for further explanation.
13. Install remaining components in reverse order.
14. Turn on all the power to the machine. Run the head at low and high rpm. Listen for any obvious unusual noises.

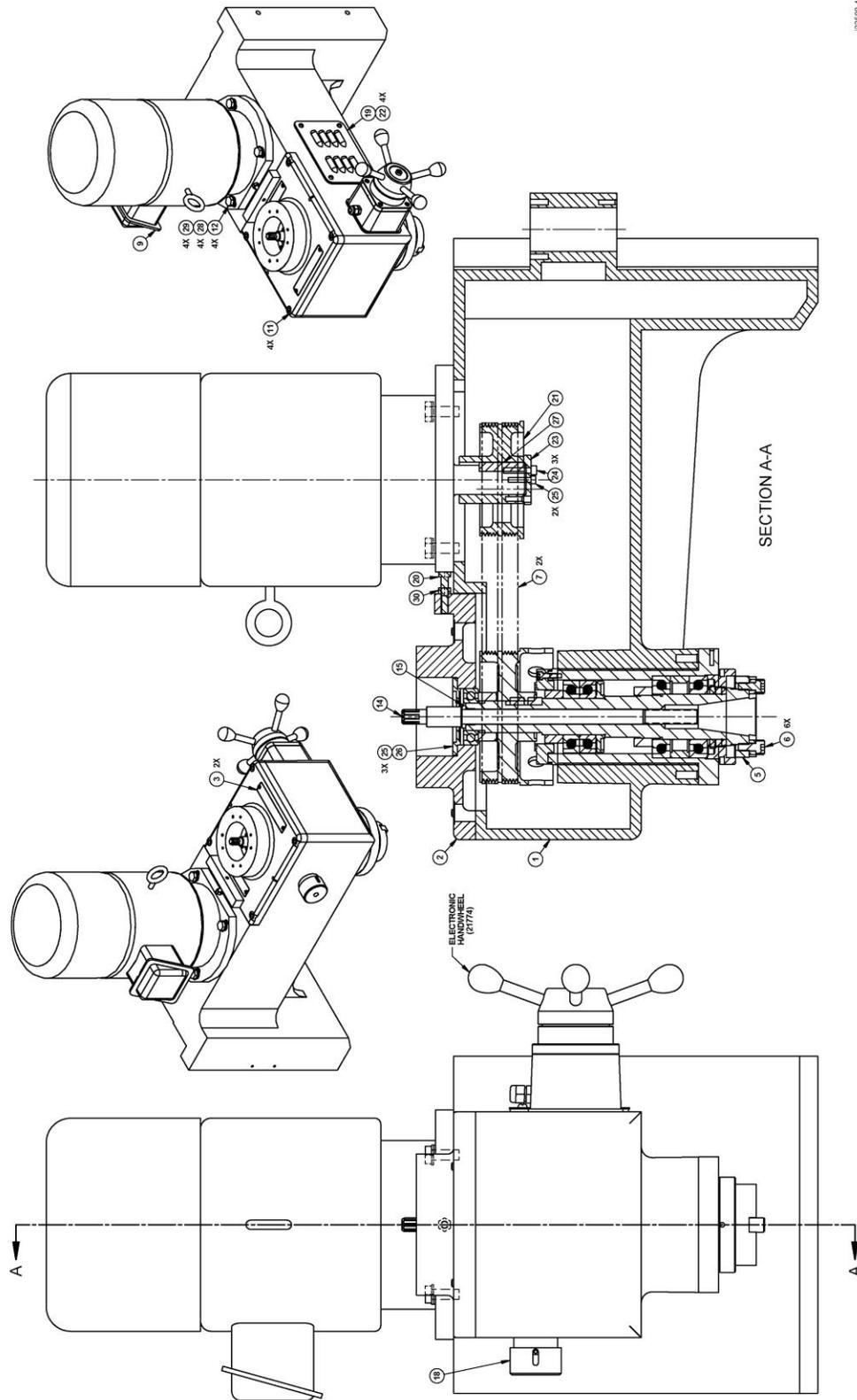


Figure 31.1 - FHM5 Head

Parts List - FHM5 Head (Figure 31-1)

Item	P/N	Title	Qty
1	21552-3	SPINDLE HEAD - 5 H.P.	1
2	21553-4	COVER SPINDLE, ALUMINUM CASTING	1
3	22279	COVER - SPINDLE HEAD- AIR VENT	2
4	M4-0.7X6 10B	SCREW-PH-PHIL-STL-BO	4
5	23320	SPINDLE-FLANGE QUILL ASSY	1
6	5/16-18X3/4 25B	SCREW-SHCS-STL-BO	6
7	K050360	BELT POLY-V (MICRO-V "K" PROFILE 5 RIBS GATES CORP)	2
8	1/4-20X1/4 40B	SCREW-SOC SET-STL-BO-CUP	2
9	23326	MOTOR-GFVF-SPINDLE INVERTER DUTY-FUKUTA 4P-5 HP	1
11	M10-1.5X40 25B	SCREW-SHCS-STL-BO	4
12	M10 70P	WASHER-FLAT USS-STL-PLAIN	4
14	23171-NMTB	DRAWBAR-DPMV 3/5 HP	1
15	21661	SPACER DRAWBAR - 3/5 HP	1
16	23284	DRAWBAR - MANUAL - 1 PIECE HEAD	1
17	22116	SPACER- DRAWBAR - 1 PIECE HEAD	1
18	23121	LOCK ASSY	1
19	22679	COVER -	1
20	M8-1.25X40 24Z	SCREW-HEX HEAD-ZINC	1
21	23310	PULLEY-MOTOR SHAFT-DPMV5	1
22	M6-1.0X15 20Z	SCREW-RH-PHIL-STL-ZINC	4
23	23327	RETAINER-PULLEY MOTOR	1
24	M6-1.0X25 25B	SCREW-SHCS-STL-BO	3
25	M5-0.8X25 25B	SCREW-SHCS-STL-BO	5
26	23324	COVER-UPPER SPINDLE	1
27	21729-3	KEY-MOTOR SHAFT 8x10x50mm	1
28	M10 73B	WASHER-SPLIT LOCK-STL-BO	4
29	M10-1.5X45 24B	SCREW-HEX HD-STL-BO	4
30	M8-1.25 50Z	NUT-HEX-ZINC	1

i22500-1

5.1.18 Spindle Motor Replacement – FHM7 (see Figure 31)

1. Turn machine off. Disconnect power from machine.
2. Remove the spindle head cover to gain access to the spindle motor.
3. Open motor junction box and disconnect all wires and conduit from motor. Take note how the motor is wired and re-wire in the low voltage configuration.
4. Release the belt tensioning device that is used to tight the belt.
5. Remove the 4 screws that hold the motor down in place.
6. Slide the motor forward to remove the belt from the motor pulley.
7. Remove the motor. Be careful, the motor weights over 100 lbs. Use a lift to remove the motor and to put the new motor in place.
8. Slid the belt over the motor pulley and snug the 4 bolts that fastens the motor down.

9. Tension the belt by use the belt tensioning device in front of the motor. Be careful not **to over tighten the belt. The belt should deflect about ¼" in the center of the belt when** applying force in this spot.
10. Tighten the 4 bolts that hold the motor down.
11. Connect all wires and the conduit back to the motor junction box.
12. Install the head cover plate and turn power back on to the machine.

5.1.19 Spindle Assembly Replacement – FHM5

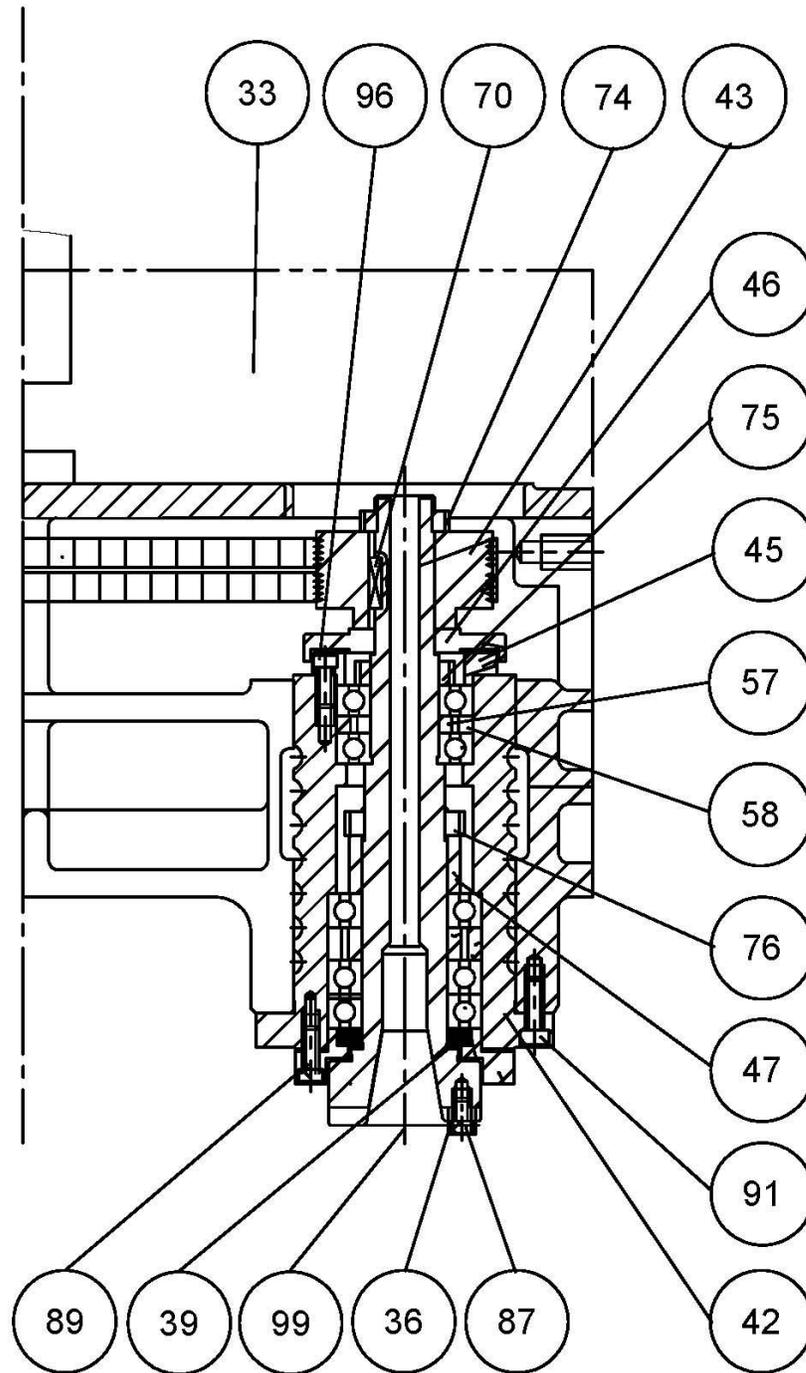
Note: The quill should never have to be disassembled from the spindle head. The spindle will be replaced as an assembly.

1. Turn off and unplug all the power to the machine.
2. Loosen the (4) M8 hex-nut securing the spindle motor.
3. Release the belt tension by adjusting the belt tension mechanism, which is integrated to the upper spindle plate cover.
4. For machine fitted with the optional Power Drawbar unit, remove power drawbar unit, rod and spacer.
5. Remove the (4) SHCS securing the upper spindle plate cover.
6. Use (2) M8 x 30 SHCS to jack the upper spindle plate cover off from the spindle shaft.
7. Using a bearing-puller, remove the upper bearing from the spindle shaft.
8. Remove the (2) spindle belt.
9. Loosen the (3) setscrew securing the upper lock nut on the spindle shaft.
10. Remove the lock nut using a spanner wrench.
11. Remove pulley and key from the spindle shaft
12. Loosen the setscrew that holds the nosepiece to the quill.
13. Tap the spindle quill assembly down with a rubber mallet.
14. **Using an adjustable spanner wrench, loosen the nosepiece by turning it "counter clockwise".**
15. The spindle collar will start to tighten up as you continue to loosen it. Use a dead blow hammer to hit the top of the spindle shaft little by little while simultaneously loosening the spindle collar. Eventually the spindle shaft and bearings will drop out through the bottom of the spindle quill.
16. Replace components in reverse order.

See Figure 32 for an illustration.

5.1.20 Spindle Assembly Replacement – FHM7

1. Turn off power to the machine.
2. Remove the spindle head cover to gain access to the spindle.
3. Remove the power drawbar if one is installed.
4. Loosen the 4 screws that fasten the spindle motor down.
5. Release the belt tension by sliding the motor forward.
6. Remove the spindle motor belt.
7. Remove the locknut that fastens the upper spindle pulley and key.
8. Remove the dust cover that covers the top of the upper spindle bearings.
9. Remove the upper bearing cap.
10. Remove the locknut that fastens the upper spindle bearings. NOTE – the upper bearings will not come out with the spindle assembly. They are removed from the top of the quill.
11. Remove the screws that hold the lower spindle collar to the bottom of the quill housing.
12. To remove the spindle assembly, tap the top of the spindle shaft to push the spindle down.
13. Install the new upper spindle bearings and the bearing cap. Make sure to put the upper spindle bearings on correctly. The thicker outer race of each bearing should be facing each other. The spacers should be in between the bearings.
14. Now go ahead and install the new spindle assembly back up into the quill. The upper shaft of the spindle must go through the upper spindle bearings.
15. Once the spindle assembly is all the way up, tighten the spindle collar back to the quill.
16. Now remove the upper bearing cap and fasten the locknut back down to load the upper bearings.
17. Re-install the bearing cap and dust shield.
18. Install the spindle pulley and key and locknut.
19. Install the spindle belt and re-tension the belt.
20. Install the power drawbar and head cover.



I24293-1

Figure 32 - FHM7 Head - Z-Axis Spindle
(Refer to Figure 31 Parts List in Section 5.1.15)

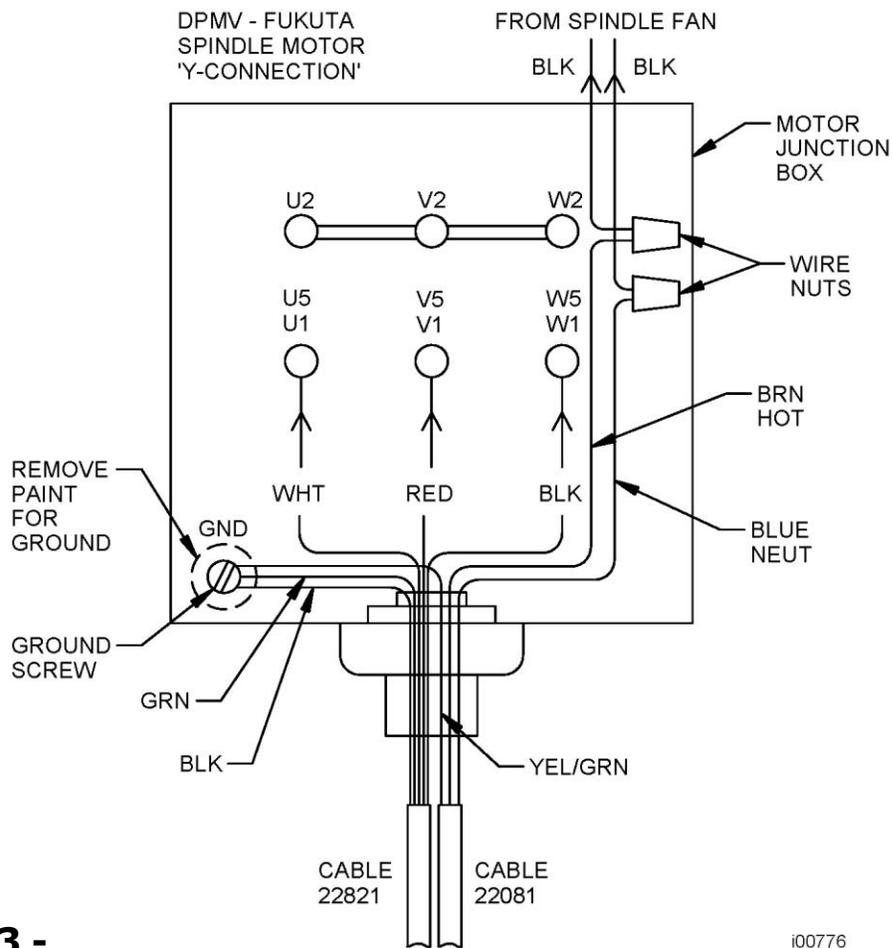
5.1.21 Spindle Motor Wiring

The FHM5 spindle motors are wired for 220 volts (low voltage) in the Y configuration. The FHM7 spindle motors are wired in low voltage in the Δ configuration.

Each junction box contains 6 terminals. The 3 upper terminals should be jumpered together and have wires labeled U2, V2 and W2 as shown in the figure. The bottom 3 terminals should have 3 wires on each terminal as shown. It is important to hook up the incoming 3-phase wires in the same order as what is shown in the figure. Failure to do this will run the spindle motor backwards on the control.

The spindle motor fan wires are also found in the junction box. There is 1 hot wire, 1 neutral wire and 1 ground wire. The hot and neutral wires are connected to 2 wires coming out of the spindle fan by the use of wire nuts. It does not matter which wires are connected to the hot and neutral wires. There are also 3 ground wires inside the junction box: 2 ground wires from the incoming 3-phase cable and 1 ground wire from the spindle motor fan cable.

Please refer to Figure 33 for an illustration of how to wire the spindle motor for the FHM5 Y configuration. See motor junction box diagram for FHM7 Δ configuration.



**Figure 33 -
Spindle Motor Wiring**

i00776

5.2 Maintenance

5.2.1 Gib Adjustments

The objective of adjusting the gibs is to eliminate as much play in the table, saddle and ram sliding surfaces as possible without having the tightness of the gib interfere with their free movement and cause a decrease in the accuracy and/or performance of the machine due to excessive friction.

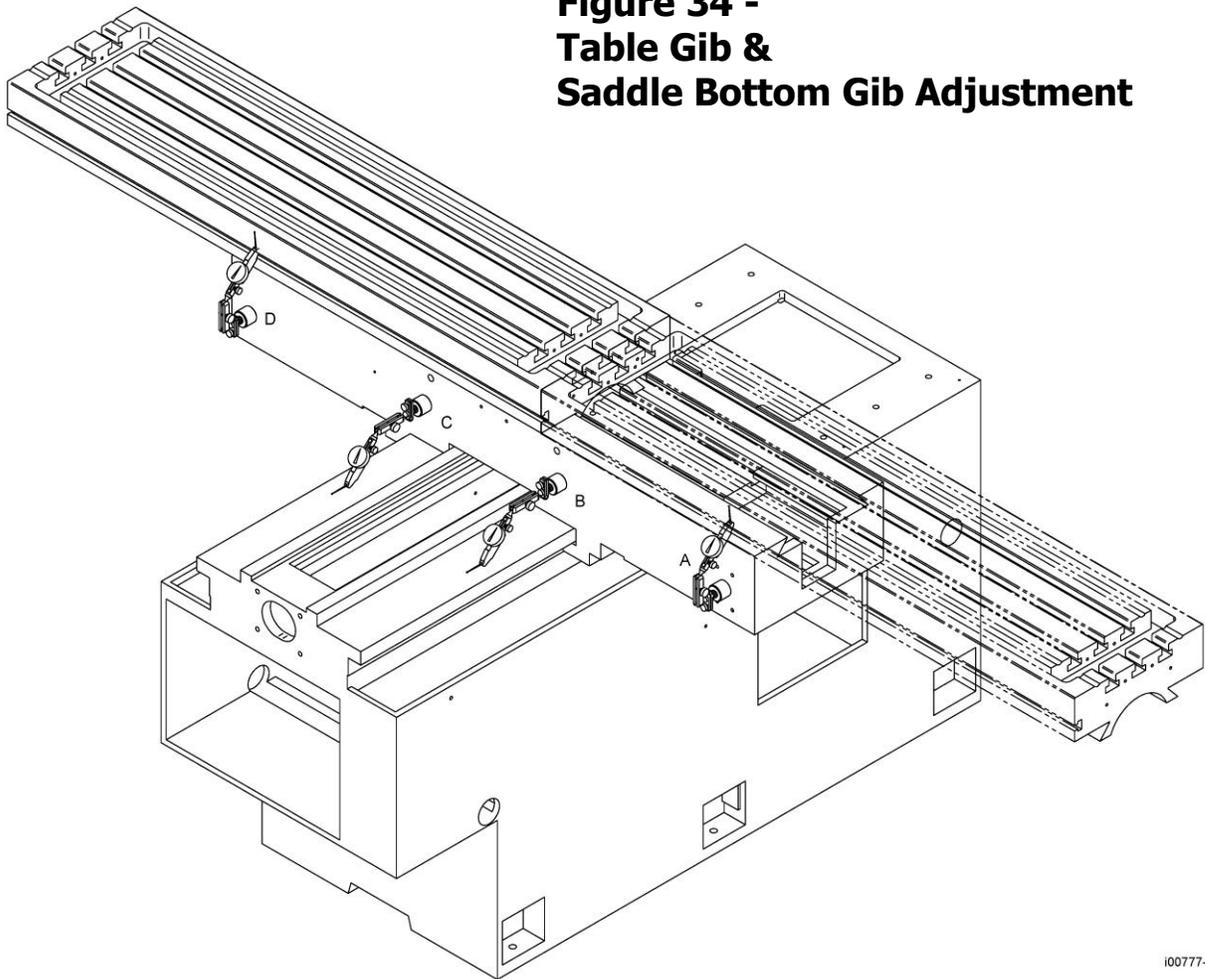
5.2.1.2 Gib Adjustment, X-Axis

The X-axis has 2 gibs for the table because of the length of the saddle. Each gib is adjusted from each end of the table. There are not 2 adjustment screws at either end of the gib like the Y-axis and Z-axis.

1. Clean all chips, dirt and excess oil from the table.
2. Remove the table trays.
3. Move the table to the left and mount the indicator at Point D and move the table back and forth perpendicular to the length of the table. Note the amount of movement of the dial indicator. Adjust gib until the movement is between .0005-.001.
4. Move the table to the right and mount the indicator at Point A and move the table back and forth perpendicular to the length of the table. Note the amount of movement of the dial indicator. Adjust gib until the movement is between .0005-.001.
 - To adjust the gib for excess clearance: Loosen the nut closest to the table and tighten the nut furthest from the table. Once the clearance has been taken up tighten each nut against the gib bracket. Do this for each end of the table.
 - To adjust the gib for too small of a clearance: Loosen the nut furthest from the table and tighten the inside nut up against the bracket to pull the gib away from the machine. Once the clearance has been taken up tighten each nut against the gib bracket. Do this for each end of the table.
5. Replace table trays.

See Figure 34.

**Figure 34 -
Table Gib &
Saddle Bottom Gib Adjustment**

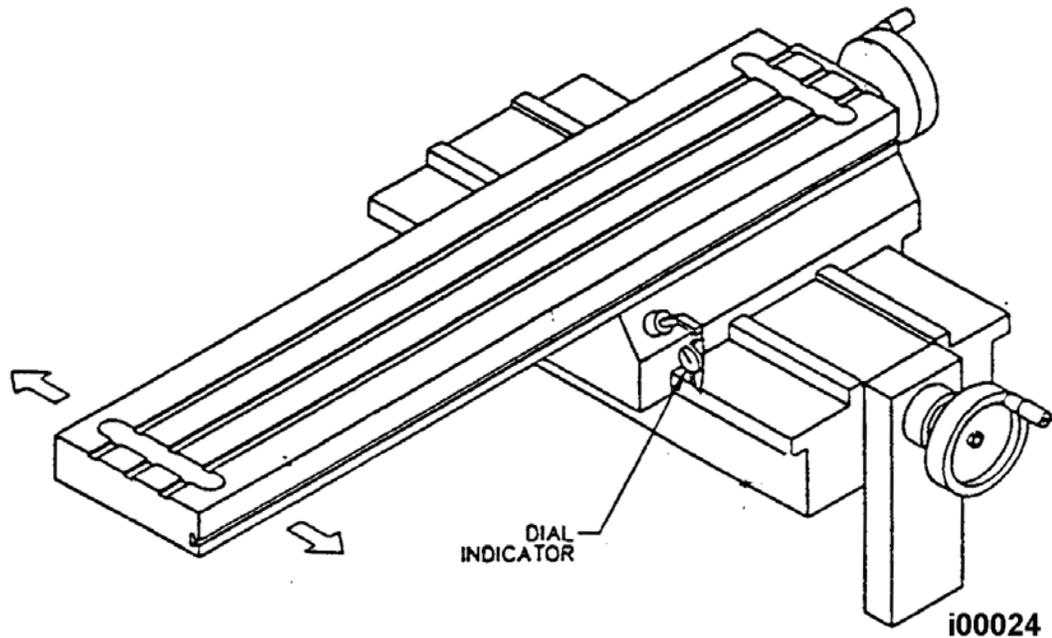


i00777-V5

5.2.1.3 Saddle Side Gib Adjustment, Y-Axis – FHM5

See Figure 35

1. Clean all chips, dirt and excess oil from the table and saddle.
2. Center the saddle on the bed ways.
3. Move the table fully to the left side of the saddle.
4. Remove the chip wiper guard and chip wiper from the front and rear of the left side box way.



**Figure 35 -
Saddle Side Gib Adjustment**

5. Attach a .0001 dial indicator with a magnetic base to the left front of the saddle. Place the indicator stylus on the edge of the large box way.
6. Move the left end of the table back and forth and note the amount of movement on the dial indicator. Adjust the Y-axis side gib until the registered movement is .0010-.0015.
 - **To adjust the gib for excessive clearance:**
Loosen the gib lock screw on the back of the saddle. Estimate the amount of gib lock screw adjustment required, and tighten the gib lock screw on the front of the saddle. Tighten the gib lock screw on the back end of the saddle to lock the gib in place, and recheck. Repeat as necessary
 - **To adjust the gib for too small of a clearance:**
Loosen the gib lock screw on the front of the saddle. Estimate the amount of gib lock screw adjustment required, and tighten the gib lock screw on the back of the saddle. Tighten the gib lock screw on the front of the saddle to lock the gib in place, and recheck. Repeat as necessary.
7. Replace the front and rear chip wiper, and chip wiper guard.

5.2.1.4 Saddle Side Gib Adjustment, Y-Axis – FHM7

1. Clean all chips, dirt and excess oil from the table and saddle.
2. Center the saddle on the bed ways.
3. Move the table fully to the right side of the saddle.
4. Remove the chip wiper guard and chip wiper from the front and rear of the left side box way.

5. Attach a .0001 dial indicator with a magnetic base to the right front of the saddle. Place the indicator stylus on the edge of the large box way.
6. Move the right end of the table back and forth and note the amount of movement on the dial indicator. Adjust the Y-axis gib until the registered movement is .0010-.0015.
 - **To adjust the gib for excessive clearance:**
Loosen the gib lock screw on the right backside of the saddle. Estimate the amount of gib lock screw adjustment required, and tighten the gib lock screw on the right front side of the saddle. Tighten the gib lock screw on the back end of the saddle to lock the gib in place, and recheck. Repeat as necessary
 - **To adjust the gib for too small of a clearance:**
Loosen the gib lock screw on the front right side of the saddle. Estimate the amount of gib lock screw adjustment required, and tighten the gib lock screw on the right backside of the saddle. Tighten the gib lock screw on the front right side of the saddle to lock the gib in place, and recheck. Repeat as necessary.
7. Replace the front and rear chip wiper and wiper guard.

5.2.1.5 Saddle Bottom Gib Adjustment, Y-Axis (see Figure 34)

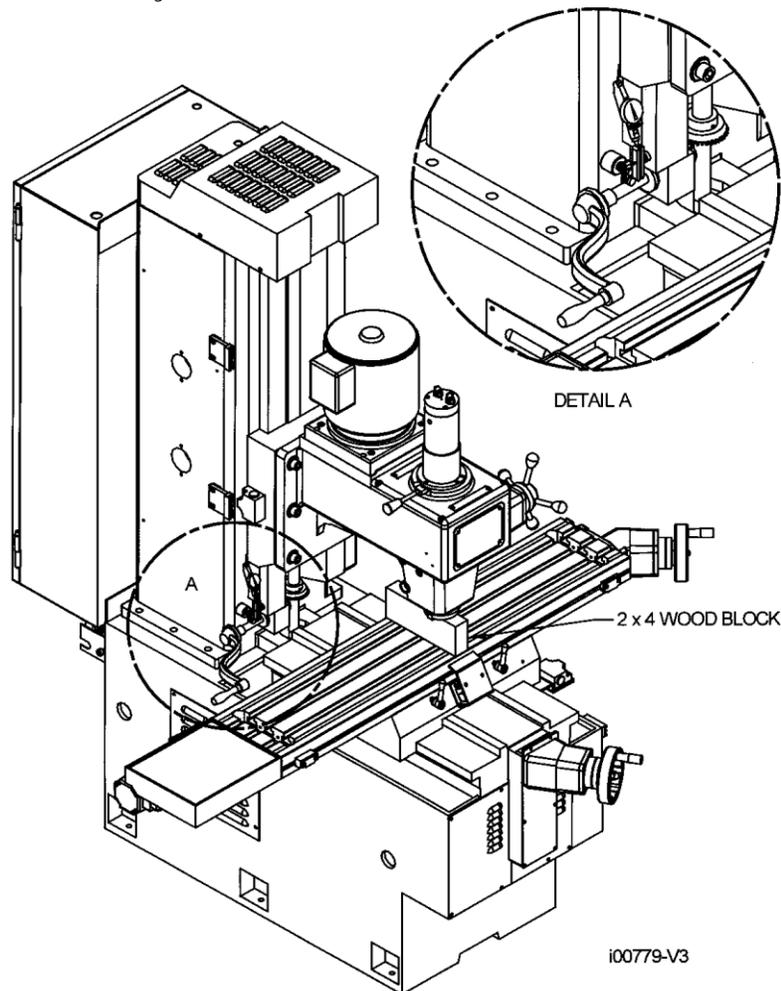
1. Clean all chips, dirt and excess oil from the table and saddle.
2. Center the saddle on the bed ways.
3. Mount your indicator on the left side of the saddle (Point C) with the table in the center of its travel and zero out your indicator.
4. Then move the table all the way to the right side. When the gibs are adjusted properly you should see no more than 0.0003" movement on the indicator.
5. Do the same thing on the right side of the saddle (Point B) this time moving the table all the way to the left. The reading should be positive on the indicator because the saddle should rise where you are indicating.

Note: You can get better readings than 0.0003" but the torque on the Y ball screw may exceed our recommended levels. Remove the ball screw cover and check the torque with an in-lb torque wrench. Normally, the torque should be around 15 in-lbs. Do not exceed 20 in-lbs. Values higher than this may cause circularity problems.

- **To adjust the gib for excessive clearance:**
Loosen the gib lock screw on the back of the saddle. Estimate the amount of gib lock screw adjustment required, and tighten the gib lock screw on the front of the saddle. Tighten the gib lock screw on the back end of the saddle to lock the gib in place, and recheck. Repeat as necessary.
- **To adjust the gib for too small of a clearance:**
Loosen the gib lock screw on the front of the saddle. Estimate the amount of gib lock screw adjustment required and tighten the gib lock screw on the back of the saddle. Tighten the gib lock screw on the front of the saddle to lock the gib in place, and recheck. Repeat as necessary.

5.2.1.6 Ram Back Gib Adjustment, Z-Axis (see Figure 36)

1. Clean all chips, dirt and excess oil from the table and saddle.
2. Remove the lower way cover on the ram to gain access to Z crank.
3. Disconnect the upper way cover to expose the back ram gibs.
4. Remove drawbar nosepiece if present.
5. Place a piece of wood on the table underneath the quill.
6. Position the milling head so that the table can be reached by cranking the Z-axis down with the hand crank.
7. Attach a .0001 dial indicator with a magnetic base to the column near the base of the ram on the left side of the machine. Place the indicator stylus on the rear surface of the ram near the bottom.



**Figure 36 -
Ram Back Gib Adjustment**

6. Crank the Z-axis until it touches the wood block. Place a moderate amount of force on the crank (FHM5 only) and note the indicator reading. For the FHM7, use the Z electronic handwheel to move the head down on the wood block. Adjust the left side gib until the registered movement is .001-.0015.

- **To adjust the gib for excessive clearance:** Loosen the gib lock screw on the bottom of the ram. Estimate the amount of gib lock screw adjustment required and tighten the gib lock screw on the top of the ram. Tighten the gib lock screw on the bottom of the ram to lock the gib in place, and recheck. Repeat as necessary.
 - **To adjust the gib for too small of a clearance:** Loosen the gib lock screw on the top of the ram. Estimate the amount of gib lock screw adjustment required and tighten the gib lock screw on the bottom of the ram. Tighten the gib lock screw on the bottom of the ram. Tighten the gib lock screw on the top of the ram to lock the gib in place, and recheck. Repeat as necessary.
7. Repeat the procedure for the back gib on the right side of the machine.

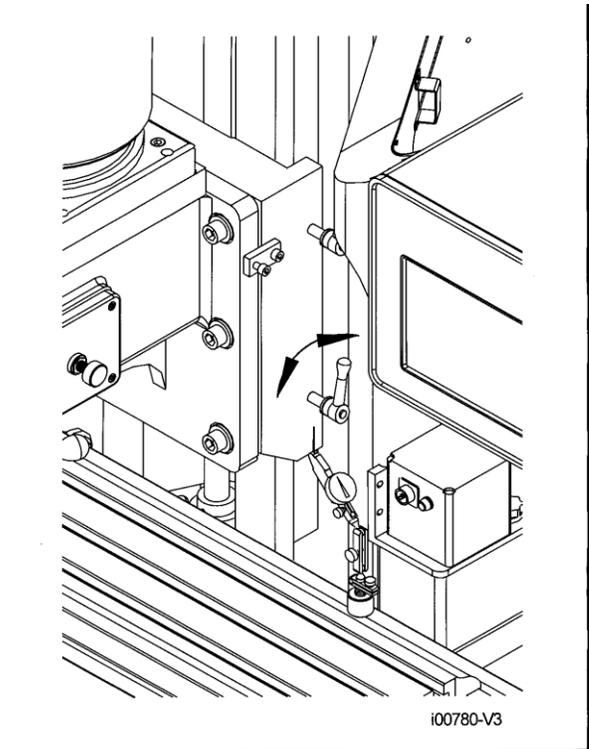
CAUTION!

Be careful not to over tighten the ram gibs. Over tightening may lead to faulting and repeatability problems. Double-check the gib adjustment by checking the torque on the Z-axis. Use an in-lb torque wrench on top of the ball screw and typical readings should be from 12 to 17 in-lbs and consistent across the Z travel.

5.2.1.7 Ram Side Gib Adjustment, Z-Axis (see Figure 37)

1. Clean all chips, dirt and excess oil from the column ways.
2. Attach a .0001 dial indicator with a magnetic base towards the rear of the table on the right side of the ram. Place the indicator stylus on the ram in line and below the lower mounting bolt for the coolant hose connector block.
3. Lock and unlock the lower ram side gib lock and note the amount of movement on the dial indicator. Adjust the ram side gib until the registered movement is .0005-.0010.
 - **To adjust the gib for excessive clearance:** Loosen the gib lock screw on the bottom of the ram. Estimate the amount of gib lock screw adjustment required, and tighten the gib lock screw on the top of the ram. Tighten the gib lock screw on the bottom of the ram to lock the gib in place, and recheck. Repeat as necessary.
 - **To adjust the gib for too small of a clearance:** Loosen the gib lock screw on the top of the ram. Estimate the amount of gib lock screw adjustment required and tighten the gib lock screw on the bottom of the ram. Tighten the gib lock screw on the top of the ram to lock the gib in place, and recheck. Repeat as necessary.
4. Reattach the upper and lower way cover to the ram.

**Figure 37 -
Ram Side Gib Adjustment**



5.2.2 Calibration & Backlash Constants

Calibration and backlash constants were set as part of the installation and set-up of your system. They should be re-set when indicated in the Troubleshooting section or after the replacement of the Computer module, or any parts of the drive train.

5.2.2.1 X, Y and Z Calibration

Calibration is used to teach the machine a known distance. We typically calibrate our machines over a 150 mm distance. There is no limit to how far you can calibrate the machine.

1. If you have installed TRAK Sensors, move each axis through its travel 4-6 times in order to allow the gage wheel to establish its track.
2. Set-up a gauge block or standard and indicate it parallel to the axis you are calibrating.

Note: Put the display in Inch or mm to match your gage block. Recommended gage blocks are:

- X and Y -- 150mm or 6"
 - Z -- 75 mm or 3"
3. Set a 0.0001" indicator in the spindle and move it up to one side of the gage block or standard.
 4. Go to setup mode, select "Service Codes", go to section "B" and press CODE 123.
 5. Select the axis you want to calibrate.
 6. Follow the instructions on the screen to complete calibration.

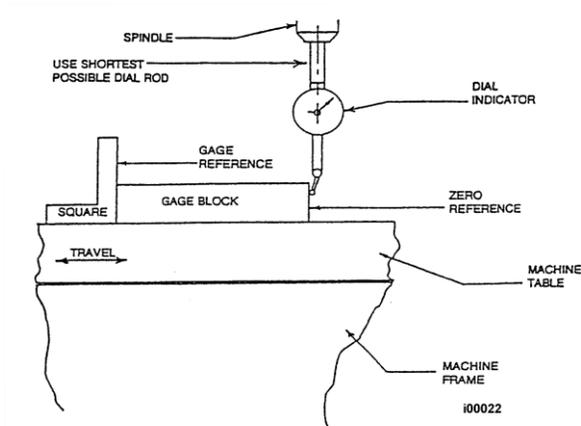


Figure 38 - Calibration Set-up

5.2.2.2 Backlash Compensation

Code 11: Set X or Y backlash constant

Note: this procedure is on systems with TRAK Sensors or Glass Scales only.

Go to setup mode, go to section "B" and press CODE 11. Refer to service code section for further explanation.

Code 127: Set X or Y Backlash Constant

Note: this procedure is only for systems without TRAK Sensors or Glass Scales.

Every mechanical system has at least a little backlash or lost motion. It is produced by the small amount of play between the gibs and ways, and mostly by the accumulative bending or elasticity of all the parts of the drive train under load. The backlash constant is factory set, but may need to be adjusted periodically.

1. Set a .0001-inch dial indicator in the spindle, and touch off on a block or the vise along the direction (X, Y or Z) you wish to check, or set the backlash constant.
2. Turn on the ProtoTRAK and at the Main Menu, follow the procedure below precisely:

Conversation Says	You Do
a. ---	a. Press MODE
b. Select Mode	b. Press SET UP
c. Select	c. Press SERV CODES
d. Select	d. Press "B"
e. Select Code 127	e. Press X or Y or Z
f. Backlash Value = _ _ _ _	f. What is shown is the current value. Follow the instruction on the screen and press the appropriate soft keys. Wait a few seconds between each INCR VALUE or DECR VALUE press.
g. The following is an example of what you might see when running this code.	For example, if the up and down "Oscillation Value" shown in the conversation line is .00278 inch, and the dial indicator is moving back and forth .0012, then the true backlash value is $.00278 - .0012 = .00158$ inch. Input this by pressing MODE, SET UP, SERV CODE, 128, SET and then .00158, SET, RETURN.

3. The X backlash identified and stored in Step 2 should **be less than 0.003” on a new machine**. If it is appreciably larger, inspect the drive train for loose bolts, brackets, bearings, etc.

The backlash can also be found manually with a 0.0001” indicator with the following method.

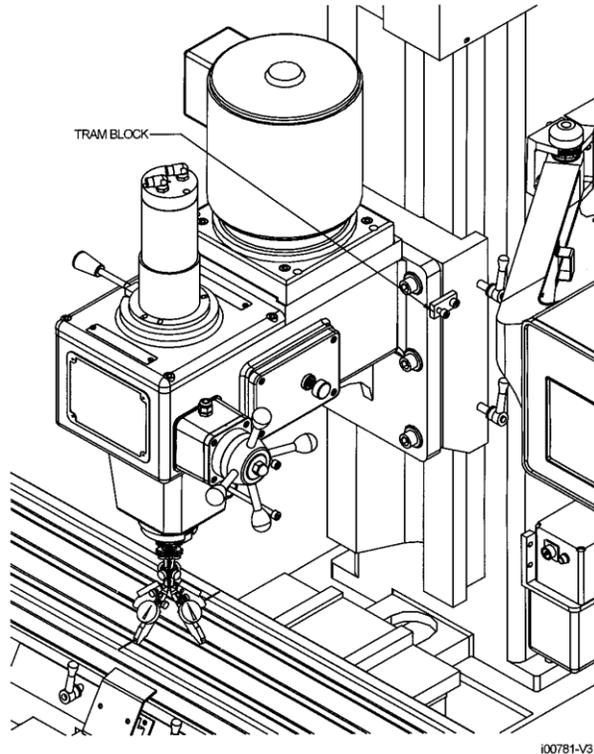
- Load the indicator to zero from one direction and zero out the DRO.
- **Move the indicator to 0.002” and then back to zero. Do not over shoot 0,** otherwise start over.
- Whatever number appears on the screen is the backlash value.
- Enter this value into service code 128.
- After entering this number redo the process. The DRO and indicator should now both read 0.

CODE 128: Input Backlash Constant

Code 128 allows you to enter the backlash values for each axis. It displays the value after it enters. This code is only used on machines with motor encoders only.

5.2.3 Trimming the Head

The purpose of trimming the head is make sure the head is perpendicular to the top of the table from both side to side and back to front.



**Figure 39 -
Tramming of Head**

5.2.3.2 Back to Front & Side to Side Adjustment

Note: The head of the FHM machine is adjusted at the factory. This procedure should only be needed for a head replacement. It is placed in this section for continuity with the tramming discussion.

With the dial indicator sweep the table from 6 o'clock to 12 o'clock. The head should be trammed within $\pm 0.0008''$ from front to back and side to side and overall tram TIR should be $0.0008''$ or less.

Note: Minor adjustments can be made with the back ram gibs. Tightening the gibs will tend to tilt the head up from the table. Loosening the gibs tends to allow the head to droop down toward the table. Over tightening or loosening can lead to other problems with the machine. Typical adjustments with the gibs is $0.0005''$ or less.

5.2.4 X, Y and Z Limit Switch Adjustments

5.2.4.1 Limit Switch Assembly Configurations

There are two different types of limit switch assembly configurations. One type has the cable exiting from the right and the other type has the cable exiting from the left. The following table lists which machines get what type of limit switch assembly configurations for each axis.

5.2.4.2 X-axis Limit Switch-Stop Installation and Adjustment

The limit switch-stops for the X-axis are mounted to the front side of the table. The limit switch-stop consists of a cam and spacer, which is fastened to the T-slot on the front side of the table. Each limit switch-stop must be set to a specific distance from the end of the table in order to maximize travel and simultaneously prevent serious damage to the machine in the event of a crash. Also, the cam must be set to a specific distance from

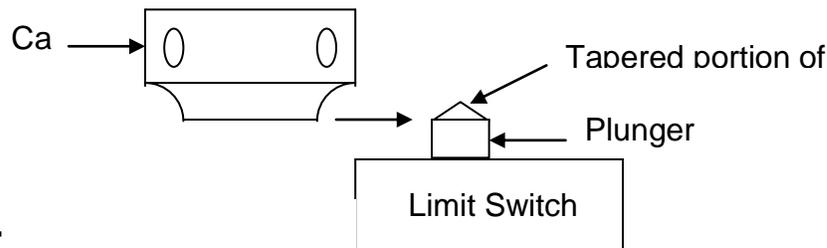
the limit switch assembly in order for the limit switch to trigger properly. The cam contains slotted holes, which allows for up and down adjustment. All limit switches are set at the factory for maximum travel.

5.2.4.2.1 Procedure for setting X limit switch

1. Loosen the X-axis cams and spacers on each side of the table.
2. Slide each X-axis cam and spacer within the T-slot to the end of the table.
3. Slowly move the table to one side by hand until the end of the travel is reached.
4. In DRO mode set X = 0 ABS.

CAUTION!
The limit switch must be triggered a minimum of 1/2" before the machine reaches its travel limits in both directions. This allows sufficient room for the servomotors to stop when the limit switch is hit at 250 ipm.

5. Using the DRO display, back the table off 1/2".
6. Loosely mount the cam and the spacer on the same side of the table that the end of travel was reached.
7. Slide the cam and the spacer up next to the plunger, which is located on the limit switch assembly.
8. Set the height of the cam such that the cam initially makes contact near the bottom, but not past, the tapered portion of the plunger as shown below in Figure 44.
9. Slide the cam along with the spacer up against the plunger until the limit switch is triggered. *Note: The moment when the limit switch is triggered can be seen on the DRO display.*
10. Mount the cam and the spacer in this position.
11. Repeat Steps 2-6 for setting the position of the cam and the spacer for the other side of the table.
12. Jog the table at 250ipm to each side and verify that the limit switches are working properly. Also, make sure that the table does not exceed its travel and crash.



**Figure 40 -
Limit Switch Installation**

5.2.4.3 Y-axis Limit Switch-Stop Installation and Adjustment

The limit switch-stops for the Y-axis are mounted on the side of the bed. The limit switch-stop consists of a cam attached to a cam holder. Each limit switch-stop cam must be set to a specific distance from the end of the bed in order to maximize travel and simultaneously prevent serious damage to the machine in the event of a crash. Also, the

limit switch assembly must be set to a specific distance from the cam in order for the limit switch to trigger properly. The limit switch bracket contains slotted holes, which allow for in and out positioning adjustments of the limit switch assembly.

5.2.4.3.1 Cam and cam holder

The cam holder is mounted to the side of the bed by use of a couple of screws. However, the cam is mounted to the cam holder by a special means. Each of the two set-screws on the cam itself push against the top side of two ball bearings (located inside the cam) forcing them out of the side of the cam and up against the inner walls of the cam holder. This action clamps the cam to the cam holder. Also, the cam holder is longer than the cam, which allows for side-to-side positional adjustment of the cam within the cam holder.

5.2.4.3.2 Procedure for setting Y limit switch

1. Remove the limit switch assembly from its bracket to prevent any interference between the limit switch assembly and the cam assembly in Step 2.
2. Slowly move the saddle to the front of the bed by hand until the end of the travel is reached. In DRO mode set X = 0 ABS.
3. Using the DRO display, back the saddle off 1/2".

CAUTION!

The limit switch must be triggered a minimum of 1/2" before the machine reaches its travel limits in both directions. This allows sufficient room for the servomotors to stop when the limit switch is hit at 250 ipm.

4. Loosen the (2) setscrews on the cam so that the cam can slide back and forth freely within its cam holder.
5. Loosely mount the limit switch assembly.
6. Slide the cam up next to the plunger located on the limit switch assembly.
7. Mount the limit switch assembly to its bracket such that the cam will initially make contact near the bottom, but not past, the tapered portion of the plunger.
13. Slide the cam up against the plunger until the limit switch is triggered. *Note: The moment when the limit switch is triggered can be seen on the DRO display.*
14. Mount the cam in this position.
15. Loosen the (2) set screws on the other cam located near the back of the bed so that the cam can slide back and forth freely within its cam holder.
16. Slowly move the saddle to the rear of the bed by hand until the end of the travel is reached. In DRO mode set X = 0 ABS.
17. Using the DRO display, back the saddle off 1/2".
18. Slide the cam up against the plunger until the limit switch is triggered. *Note: The moment when the limit switch is triggered can be seen on the DRO display.*
19. Mount the cam in this position.
20. Jog the saddle at 250ipm to the front and then to the back to verify that the limit switches are working properly. Also, make sure that the table does not exceed its travel and crash.

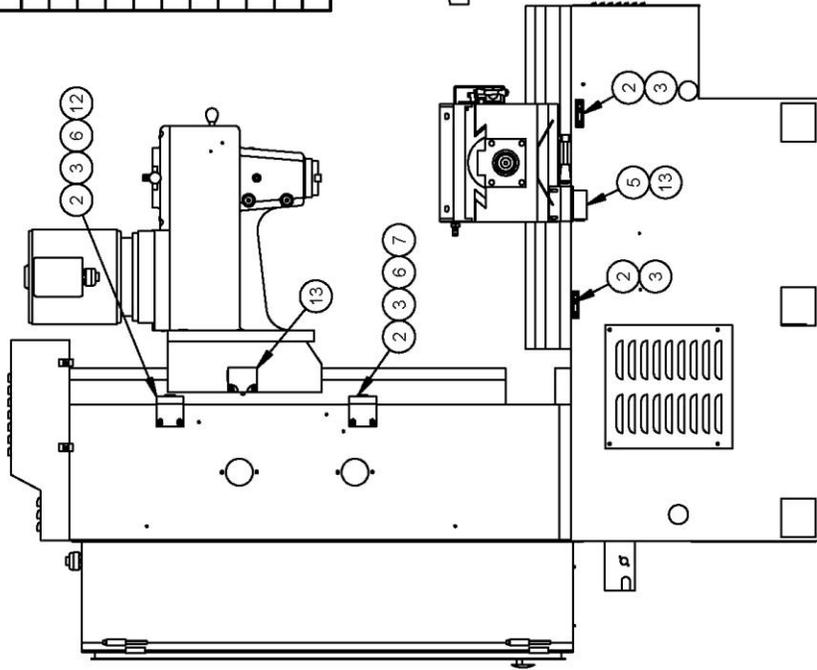
5.2.4.4 Z-axis Limit Switch-Stop Installation and Adjustment

The limit switch-stops for the Z-axis are mounted on the side of the column. The limit switch-stop consists of a cam, cam holder, bracket, and spacer. Each limit switch-stop cam must be set to a specific distance from each end of the column in order to maximize travel and simultaneously prevent serious damage to the machine in the event of a crash. Also, the cam assembly must be set to a specific distance from the limit switch assembly in order for the limit switch to trigger properly. The cam bracket assembly contains slotted holes, which allow for in and out positioning adjustments of the cam assembly.

5.2.4.4.1 Procedure for setting Z limit switch

1. On the lower cam assembly, loosen the (2) setscrews on the cam.
2. Slide the cam to the bottom of its cam holder.
3. Tighten the (2) setscrews on the cam to hold it in place.
4. Loosen the two screws that mount the cam bracket assembly to the column of the machine.
5. The cam bracket assembly contains slotted holes to allow for in and out positioning adjustments of the cam assembly. Move the cam bracket assembly away from the limit switch assembly and then tighten the cam bracket screws to hold in place.
6. By hand, slowly move the head down to approximately 1 1/2" above the top of the table. *Note: Use a tape measure to measure the distance between the spindle and the table.*
7. Slide the cam up next to the plunger located on the limit switch assembly.
8. Mount the cam bracket assembly to the column such that the cam will initially make contact near the bottom, but not past, the tapered portion of the plunger.
9. Slide the cam up against the plunger until the limit switch is triggered. *Note: The moment when the limit switch is triggered can be seen on the DRO display.*
10. Mount the cam in this position.
11. On the upper cam assembly, loosen the (2) setscrews on the cam.
12. Slide the cam to the top of its cam holder.
13. Tighten the (2) setscrews on the cam to hold it in place.
14. Loosen the two screws that mount the cam bracket assembly to the column of the machine.
15. The cam bracket assembly contains slotted holes to allow for in and out positioning adjustments of the cam assembly. Move the cam bracket assembly away from the limit switch assembly and then tighten the cam bracket screws to hold in place.
16. By hand, slowly move the head up toward the top of the column until just before the Z-axis upper way cover begins to squish together.
17. Back the head off 1/2" in the downward direction.
18. Slide the cam up next to the plunger located on the limit switch assembly.
19. Mount the cam bracket assembly to the column such that the cam will initially make contact near the bottom, but not past, the tapered portion of the plunger.
20. Slide the cam up against the plunger until the limit switch is triggered. *Note: The moment when the limit switch is triggered can be seen on the DRO display.*
21. Mount the cam in this position.

Item	P/N	Title	Qty
1	22471	SHEETMETAL-DPMV3-SUPPORT LIMIT SWITCH X-AXIS	1
2	22547	CAM HOLDER-PT4-Y & Z AXIS	4
3	22108	CAM-LIMIT SWITCH	4
4	22113	NUT TEE- X AXIS	4
5	22093	SUPPORT-Y AXIS SWITCH	1
6	22109	BRACKET- CAM HOLDER	2
7	22110-2	SPACER-Z AXIS	1
8			
9	22469	CAM	2
10	22470	CAM SEAT	2
11			
12	22110-1	SPACER-Z AXIS	1
13	22551-1	LIMIT SWITCH ASSY-PT4-RIGHT	2
14	22551-2	LIMIT SWITCH ASSY-PT4-LEFT	1



Y & Z LIMIT SWITCHES

X LIMIT SWITCHES

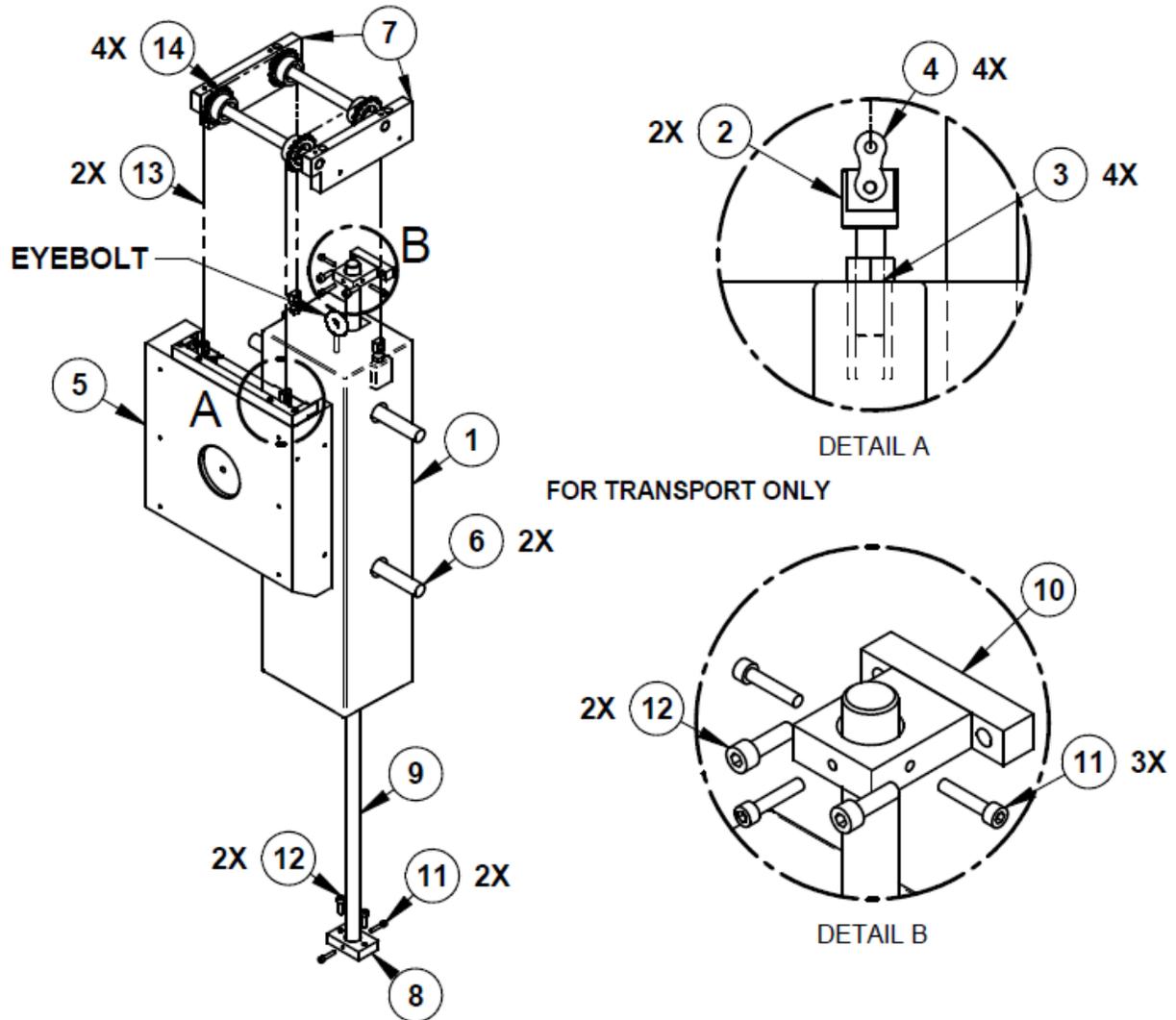
i00782-V5

**Figure 41 -
Limit Switches**

6.0 Parts Lists & Drawings

6.1 Counter Balance System Drawing

Figure 42 & Parts List Shown - FHM - Counter Balance System

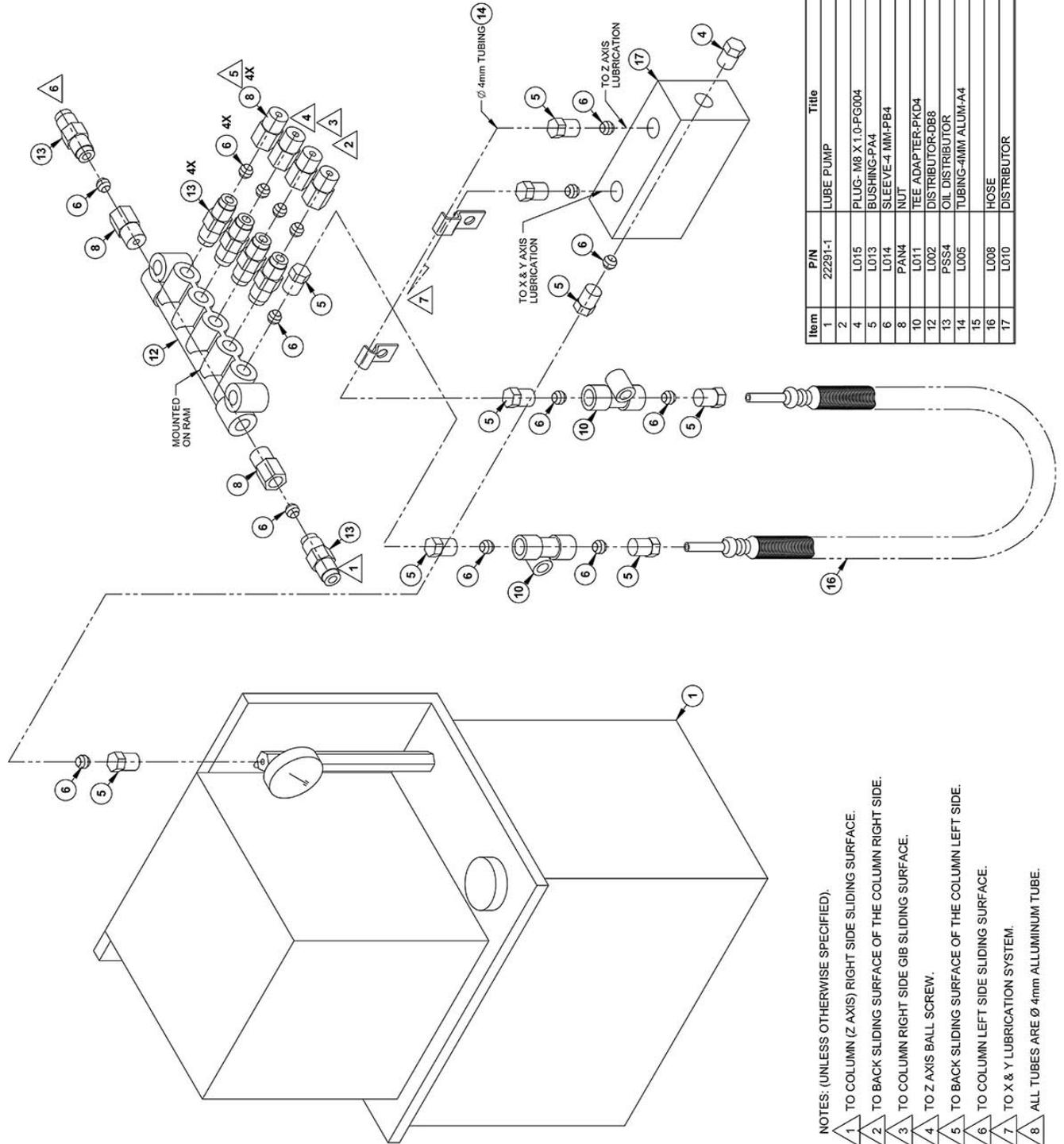


Item	P/N	Title	Qty
1		CASTING-COUNTERWEIGHT	1
2	21766	SCREW CHAIN (PJ 500030)	4
3	M10-1.5 50B	NUT-HEX-STL-BO	4
4	6261K194	MASTERLINK	4
5	21717	RAM	1
6		BAR - C'WEIGHT (TRANSPORT)	2
7	21937-1,-2	SUPPORT BAR	1
8		GUIDE - LOWER C'WEIGHT (PJ - SW0011)	1
9		CENTERING BAR (PJ - SW0009-1)	1
10		GUIDE ASSY. UPPER - C'WEIGHT ASSY.	1
11	M6-1.0X30 25B	SCREW-SHCS-STL-BO	5
12	M8-1.25X30 25B	SCREW-SHCS-STL-BO	2
13	500068-3	CHAIN	1
14	21765	SPROCKET-13 TEEETH	4

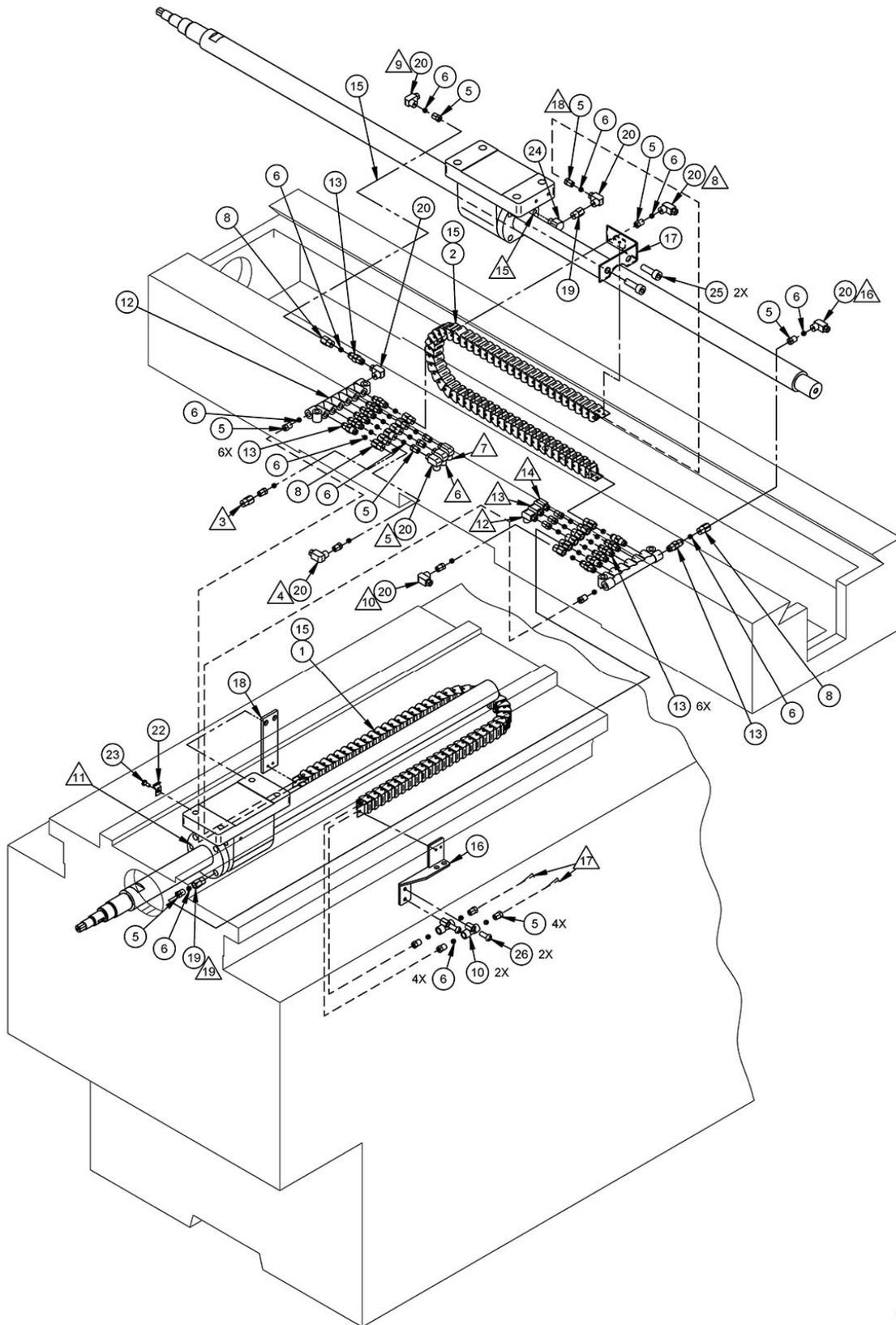
i00789

6.2 Lubrication System Drawings

Figure 43 & Parts List Shown - FHM - Lubrication System



000783



i21688-2

**Figure 44 - FHM5 & 7 - Lubrication Kit -
P/N: 21688-2**

Parts List - FHM 5 & 7 - Lubrication Kit - P/N: 21688 (Figure 44)

Item	P/N	Title	Qty
1	P8011010	CHAIN 10MMX10MMX34 UNITS	1
2	P8621010	CABLE CARRIER-10MMX10MMX42 UNITS	1
5	PA4	NUT-COMPRESSION 4mm	22
6	PB4	SLEEVE-COMPRESSION 4mm	36
8	PAN4	NUT	14
10	JD-4	2-WAY JUNCTION	2
12	DB8	DISTRIBUTOR	2
13	PSS4	OIL DISTRIBUTOR	14
14	A4	TUBING-4MM ALUM	144
15	P04	TUBING-4MM PLASTIC	108
16	23254	BRACKET-X & Y AXIS LUBRICATION	1
17	22346	BRACKET- LUBE X-AXIS BALLSCREW	1
18	21737	BRACKET- X & Y AXIS LUBRICATION	1
19	PD408	ADAPTER	2
20	PH408	ADAPTER- RIGHT ANGLE	13
22	PZ0104	CLAMP	1
23	M5-0.8X10 10B	SCREW-PH-PHIL-STL-BO	1
24	PH4-8	CONNECTOR-	1
25	M8-1.25X25 25B	SCREW-SHCS-STL-BO	2
26	M6-1.0X16 20B	SCREW-RH-PHIL-STL-BO	2

i21688-2 G

NOTES: (UNLESS OTHERWISE SPECIFIED).

1. ALL TUBES ——— ARE Ø 4mm ALUMINUM TUBE.
2. ALL TUBES - - - - - ARE Ø 4mm NYLON.
3. TO X AXIS LEFT GIB.
4. TO X AXIS FRONT WAY SURFACE.
5. TO Y AXIS LEFT BOTTOM GIB.
6. TO Y AXIS LEFT WAY SURFACE.
7. TO Y AXIS LEFT SIDE GIB.
8. TO X AXIS REAR WAY SURFACE.
9. TO X AXIS LEFT REAR DOVE TAIL CONTACT SURFACE.
10. TO X AXIS RIGHT GIB.
11. TO Y AXIS BALLSCREW.
12. TO Y AXIS RIGHT BOTTOM GIB.
13. TO Y AXIS RIGHT WAY SURFACE.
14. TO Y AXIS RIGHT SIDE CONTACT SURFACE.
15. TO X AXIS BALLSCREW.
16. TO X AXIS RIGHT REAR DOVE TAIL CONTACT SURFACE.
17. TO Z AXIS LUBRICATION SYSTEM.
18. PLACE ITEMS 5, 6, 20, 19, & 24 IN PLASTIC BAG, THEN PLACE IN SADDLE.
19. PULL EXCESS Y-AXIS OIL LINE UP THROUGH SADDLE BEFORE TIGHTING COMPRESSION NUT. DO NOT KINK OR ALLOW LINE TO RUB BALLSCREW. TWIST TIE EXCESS OIL LINE TO SADDLE RIBS.

6.3 Bed Parts List

B230	VENT-LEFT SLIDE
B246	VENT-LEFT FRONT
B231	VENT-RIGHT SLIDE
22051	VENT-RIGHT FRONT
B238	COOLANT SCREEN
B239	FOOT PADS
B240	FOOT PAD BOLT/NUT

6.4 Table/Saddle Spare Parts List (FHM5)

B260	TABLE GIB LOCK HANDLE & PLUNGER
	SADDLE GIB LOCK HANDLE & PLUNGER
B262	TABLE GIB
B263	SADDLE BOTTOM GIB
B264	SADDLE SIDE GIB
B265	TABLE GIB ADJUSTMENT SCREW
B266	SADDLE GIB ADJUSTMENT SCREW
B267-1	WAY COVER-BACK BED
B268	WAY COVER-FRONT BED
B269	TABLE STOP DOG
B270	TABLE ADJUSTMENT STOPS
B271	SADDLE GIB CHIP GUARDS & GASKETS
21571	CHIP GUARD PLATE COVERING Y BALL SCREW

6.4.1 Table/Saddle Spare Parts List (FHM7)

	TABLE GIB LOCK HANDLE & PLUNGER
	SADDLE GIB LOCK HANDLE & PLUNGER
24507	X-AXIS GIB
24509	SADDLE BOTTOM GIB
24508	SADDLE SIDE GIB
24549	TABLE GIB ADJUSTMENT SCREW
24518	SADDLE GIB ADJUSTMENT SCREW
24505	TABLE WAY COVER
24504	WAY COVER-FRONT BED
24506	WAY COVER-Y-AXIS (REAR)
24522	WAY COVER-Z-AXIS (TOP)
24523	Z-AXIS BALLSCREW COVER

6.5 Manual Ram Elevation Drawing

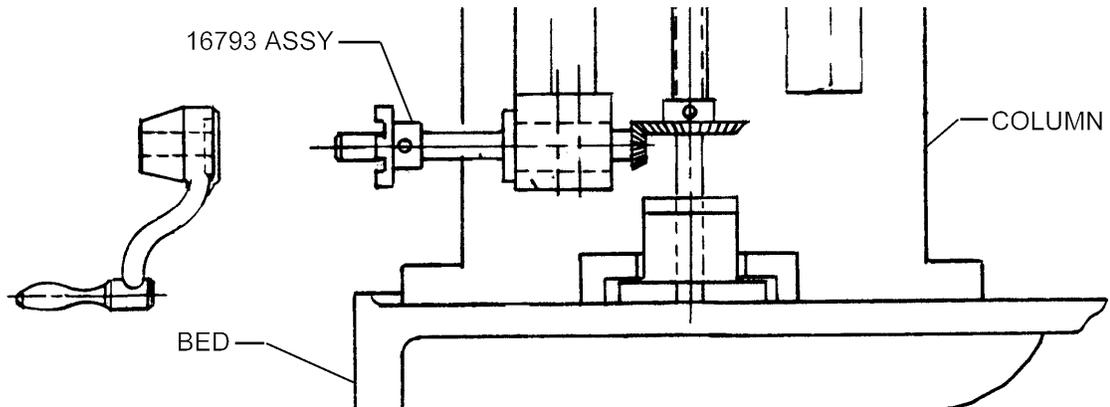
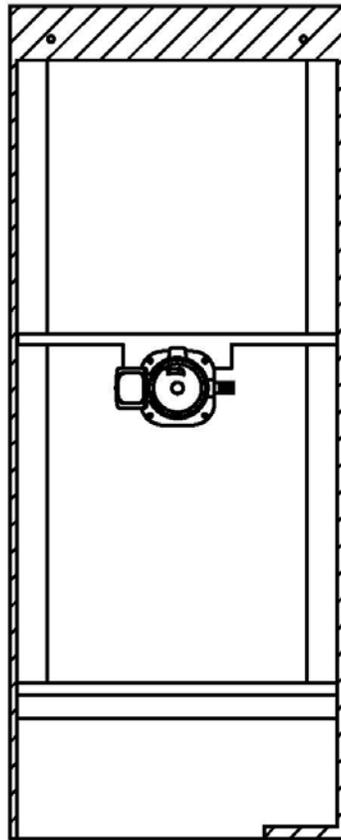
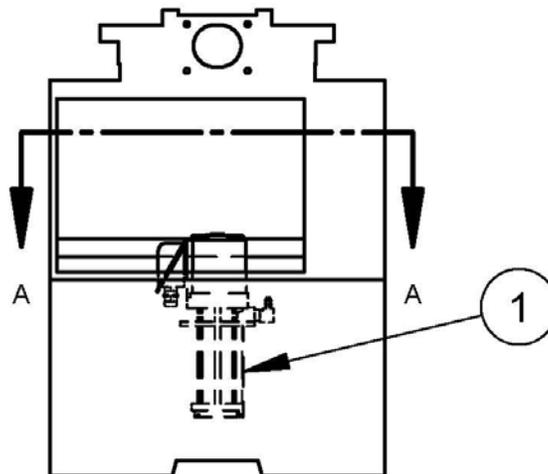


Figure 45 - FHM5 - Manual Ram Elevation

6.6 Coolant Pump Mounting



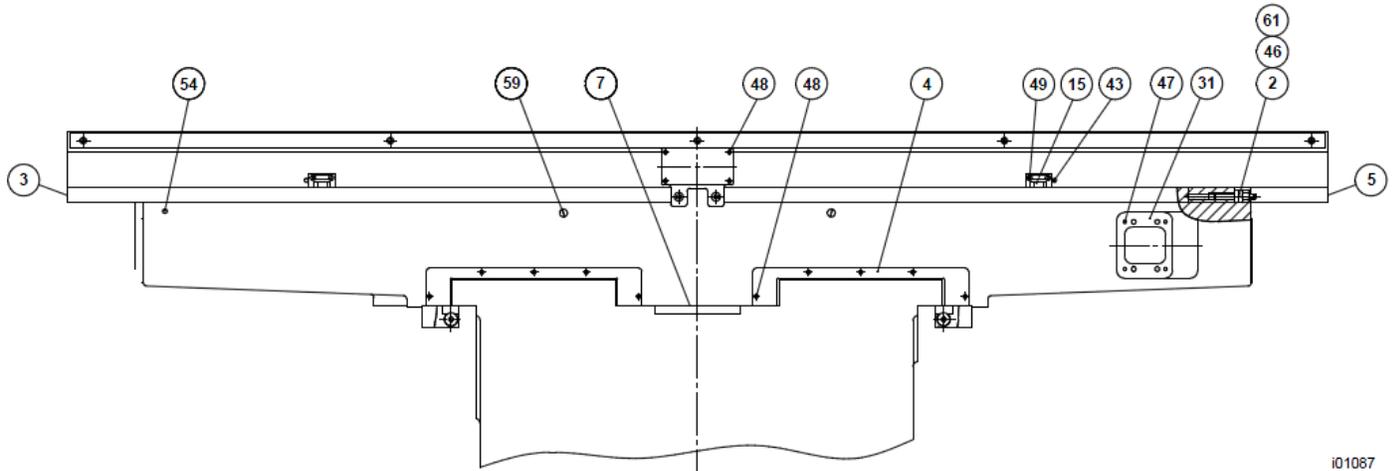
SECTION A-A



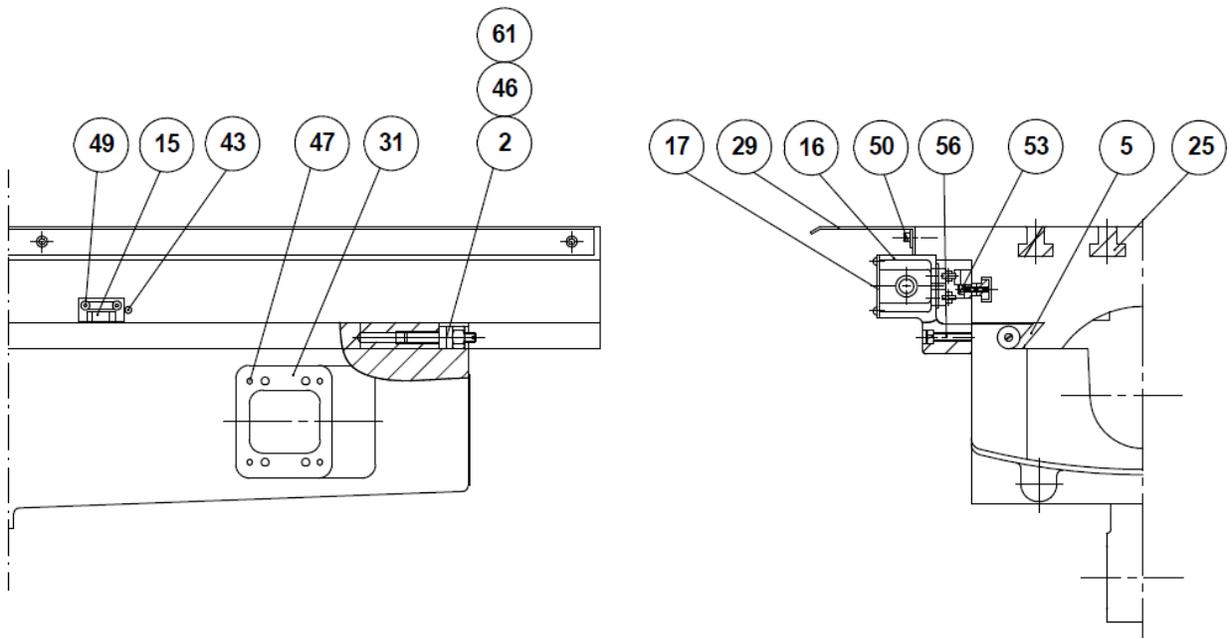
i00788

**Figure 46 -
Coolant Pump Mounting**

**Figure 47 -
FHM7 Table & Saddle**



i01087



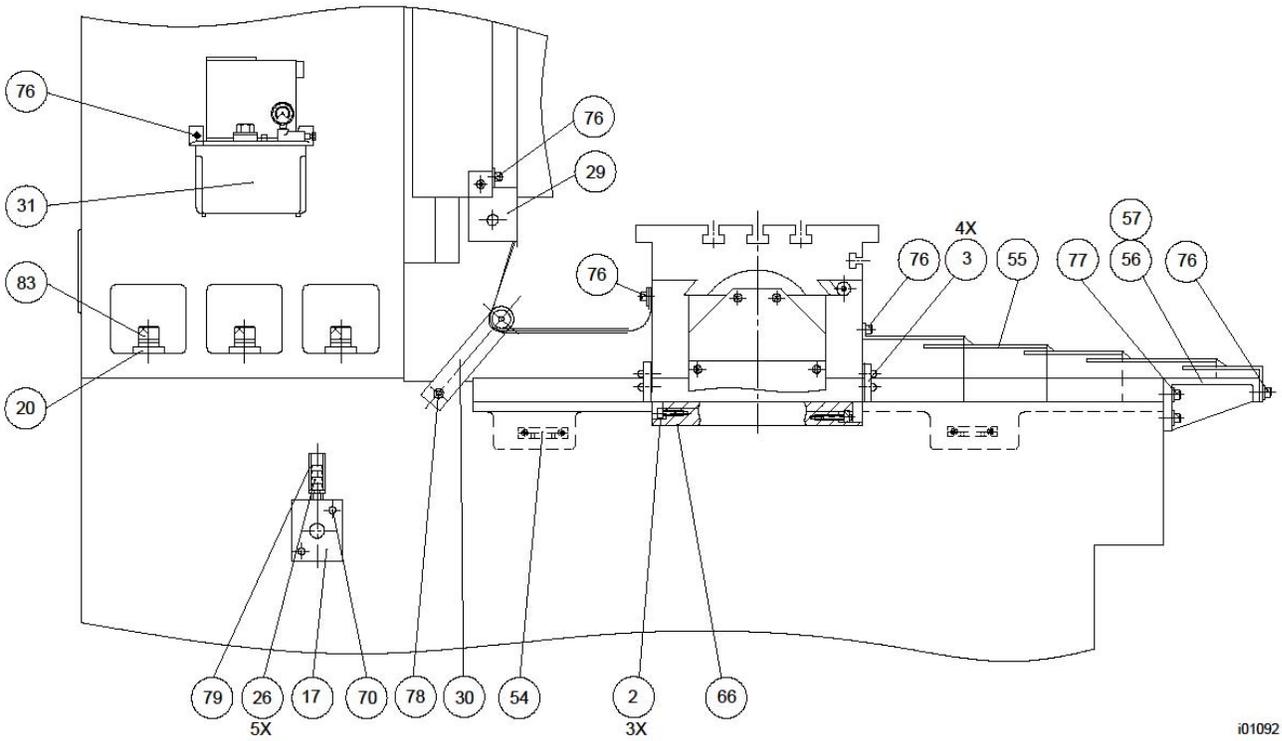
i01088

Parts List - FHM7 - Table & Saddle (Figure 47)

Item	P/N	Title	Qty
1	24518	SCREW - GIB ADJUSTING	3
2	24549	SCREW - GIB - X AXIS	2
3	24507-L	GIB-X AXIS-LEFT	1
4	24521	WIPER-WAY-Y AXIS-FHM7/V7	4
5	24507-R	GIB-X AXIS-RIGHT	1
6	H-034-14B	SADDLE	1
7	25209	COVER - BALLSCREW - CHIP GUARD - Y AXIS	1
10	H-067-9C	BASE-MACHINE	1
11	H-106-8	SEAT-GIB (LEFT)	1
12	H-107-8	SEAT-GIB (RIGHT)	1
13	24509	GIB - Y AXIS BOTTOM	2
14	H-120-6	COVER	1
15	H-122-6	STOP	2
16	24514	SWITCH - LIMIT	2
17	H-124-7A	COVER	1
18	24505	COVER - WAY - TABLE	2
19	HT-011-8B	BRACKET-RIGHT BEARING	1
20	HT-012-8B	BRACKET-LEFT BEARING	1
21	24500	BALLSCREW - X AXIS	1
22	HT-022-8	BRACKET-FEED NUT	1
23	HT-022-8B	BRACKET-CROSS SCREW	1
24	HT-029-14	TABLE	1
25	HT-032	PLUNGER-RUBBER	8
26	HT-040-7	COVER-BEARING	1
27	HT-041-6	SLEEVE-LOCKING	1
28	24545	PULLEY - X AXIS BALLSCREW	1
29	HT-090-8B	COVER	1
30	HT-098-8	COVER	1
31	HT-157-8	BRACKET-HANDWHEEL	1
32	HT-166-8	BUSHING	1
33	HT-167	SEAL-OIL	1
34	HT-181	SEAL-OIL	1
35	HX-002	BUSHING	1
39	23940	BEARING-ANGULAR CONTACT-U/SET (2)-7205	1
40	24512	BEARING-DEEP GROOVE-6305ZZ	1
42	24546	KEY - 5 x 5 x 20L	1

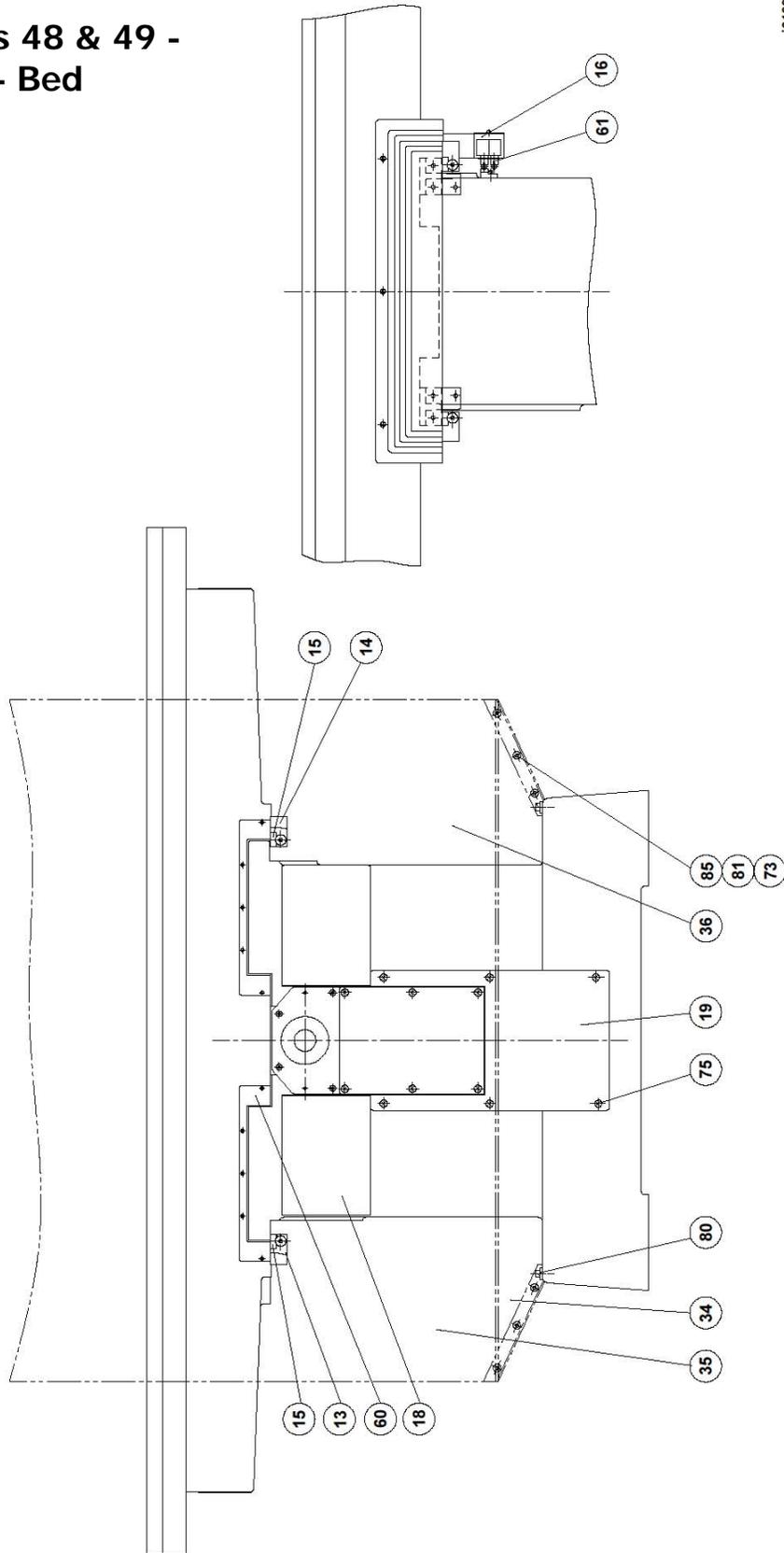
i24291

**Figure 48 -
FHM7 - Bed**



i01092

**Figures 48 & 49 -
FHM7 - Bed**



i01093

Parts List - FHM7 - Bed (Figures 48 & 49)

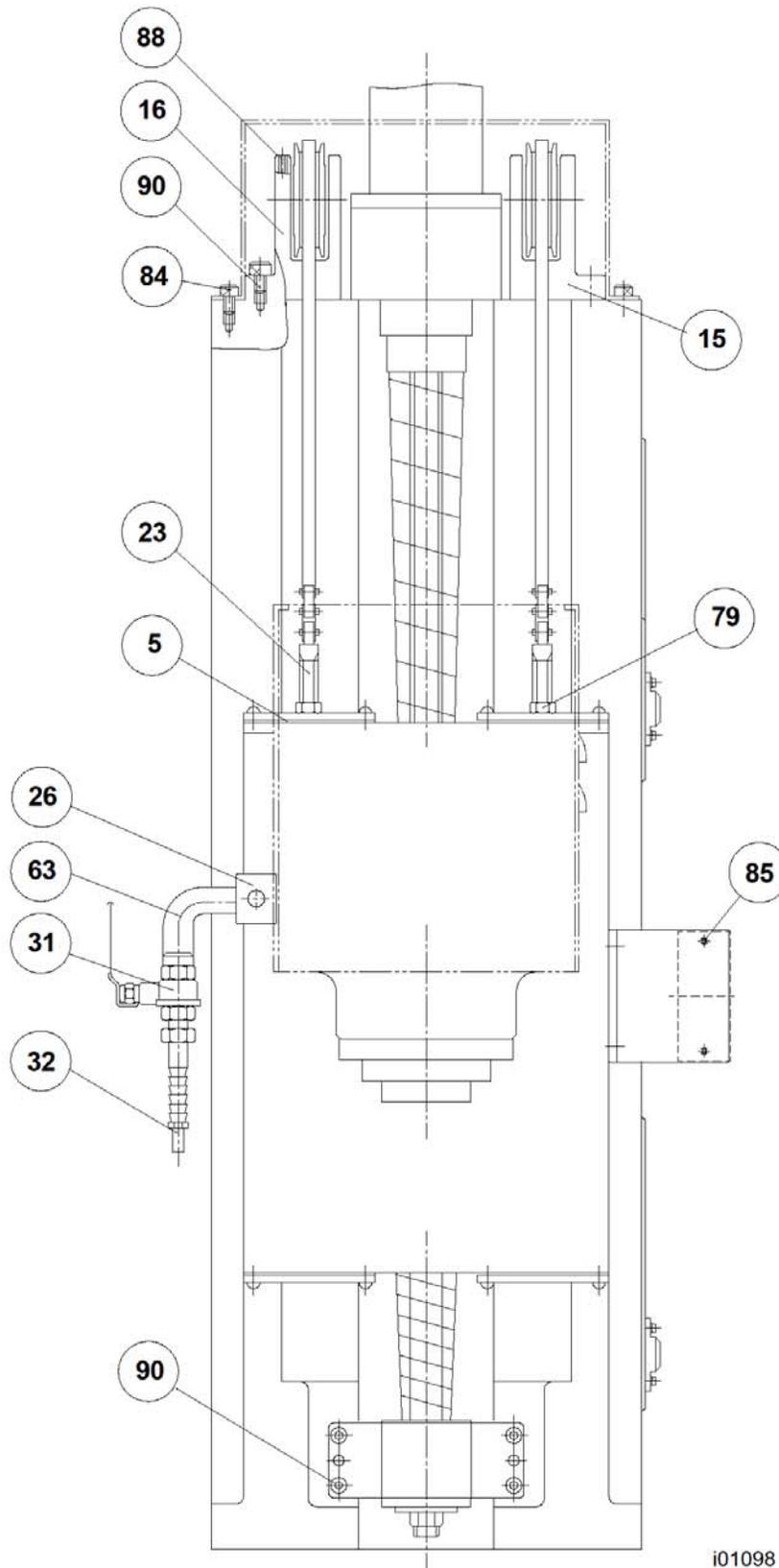
Item	P/N	Title	Qty
2	H-026-B	SCREW	3
3	H-029-8A	PLATE-ALUMINUM	4
5	H-034-14B	SADDLE	1
7	H-060	COVER-BEARING	1
8	H-067-8	BODY-MACHINE	1
9	H-067-9C	BASE-MACHINE	1
10	H-075	HOLDER-COOLANT NOZZLE	1
11	24524	SCREW - LEVELING	6
12	H-103	BLOCK-ADJUSTING	6
13	H-106-8	SEAT-GIB (LEFT)	1
14	H-107-8	SEAT-GIB (RIGHT)	1
15	24509	GIB - Y AXIS BOTTOM	2
16	H-124-7B	BOX-LIMIT SWITCH	1
17	H-165-8	PIPE CONNECTION	1
18	H-166-8C	COVER	2
19	H-166-14B	COVER-FRONT	1
20	H-170-8	WASHER	6
21	H-172-9	COVER	1
22	H-173-8B	COVER	1
23	H-237-8	COVER	1
24	H-237-9	COVER	1
25	H-239-10	NETWORK-OIL	2
26	H-254	NETWORK-OIL	5
27	23265	PUMP COOLANT 1/8 HP	1
28	H-259	PLUG-COOLANT	1
29	24506	COVER - WAY - Y AXIS REAR	1
30	H-263-10	BRACKET-UP/DOWN CHIP GUARD	1
31	22291-1	LUBRICATION PUMP	1
32	H-267-10	TEFLON (L)	1
33	H-268-10	TEFLON (R)	1
34	H-279-8	GUARD	1
35	H-280-8	PLATE-(L)-FIXED	1
36	H-281-8	PLATE-(R)-FIXED	1
41	HT-022-8	BRACKET-FEED NUT	1
42	HT-022-8B	BRACKET-CROSS SCREW	1
43	24501	BALLSCREW - Y AXIS	1
44	HT-028-7A	BRACKET-BEARING-CROSS FEED	1
45	HT-028-8B	BRACKET-BEARING-CROSS FEED	1
46	HT-029-14	TABLE	1
47	HT-041-8	BUSHING	1
48	24544	PULLEY - Y AXIS BALLSCREW	1
49	24372	HOUSING - BEARING	2
50	24373	COVER - BEARING	1
51	HT-096-8A	COVER	1

Parts List - FHM7 - Bed (Figures 48 & 49)

52	HT-142-8A	COVER	1
53	24519	NUT - LOCK	2
54	HX-046	STOP-LIMIT SWITCH	2
55	24504	COVER - WAY - Y AXIS FRONT	1
56	HY-066-8	REST-FOOT	1
57	HY-066-8A	REST-FOOT	1
58	HY-073-8	BRACKET-BEARING BALL SCREW	1
59	HY-083-9	BUSHING	2
60	24508	GIB - Y AXIS SIDE	1
61	24514	SWITCH - LIMIT	1
62	24428	MOTOR DRIVER ASSY - 40/55	1
64	670-5M-15	BELT-TIMING 5MM POWERGRIP	1
65	6204ZZ	BEARING-	3
66	24513	BEARING SET - ANGULAR CONTACT	1
68	24546	KEY - 5 x 5 x 20L	2
69	AK0505022	KEY-5x5x22	1
70	AKP138	PIPE-3/8	2
71	AKP212	PIPE-1/2	2
72	24515	NUT - LOCK	2
73	24547	NUT - 3/4 - 10 NC	6
74	M5-0.8X10 25B	SCREW-SHCS-STL-BO	5
75	3/16-24X3/8 10B	SCREW-PAN HEAD PHILLIPS-STL-BO	26
76	1/4-20X5/8 25B	SCREW-SHCS-STL-BO	29
77	1/4-20X3/4 25B	SCREW-SHCS-STL-BO	10
78	1/4-20X1 5/8 25B	SCREW-SHCS-STL-BO	2
79	1/4-20X1 3/4 25B	SCREW-SHCS-STL-BO	2
80	5/16-18X1/2 25B	SCREW-SHCS-STL-BO	4
81	5/16-18X3/4 25B	SCREW-SHCS-STL-BO	14
82	5/16-18X1 25B	SCREW-SHCS-STL-BO	6
83	7/8-9X3 1/2 25B	SCREW-SHCS-STL-BO	6
84	1/4 70B	WASHER-FLAT USS-STL-BO	1
85	5/16 70B	FLAT WASHER 5/16	18

i24292

Figure 50 - FHM7 - Column Parts (Refer to Figure 53 Parts List)



i01098

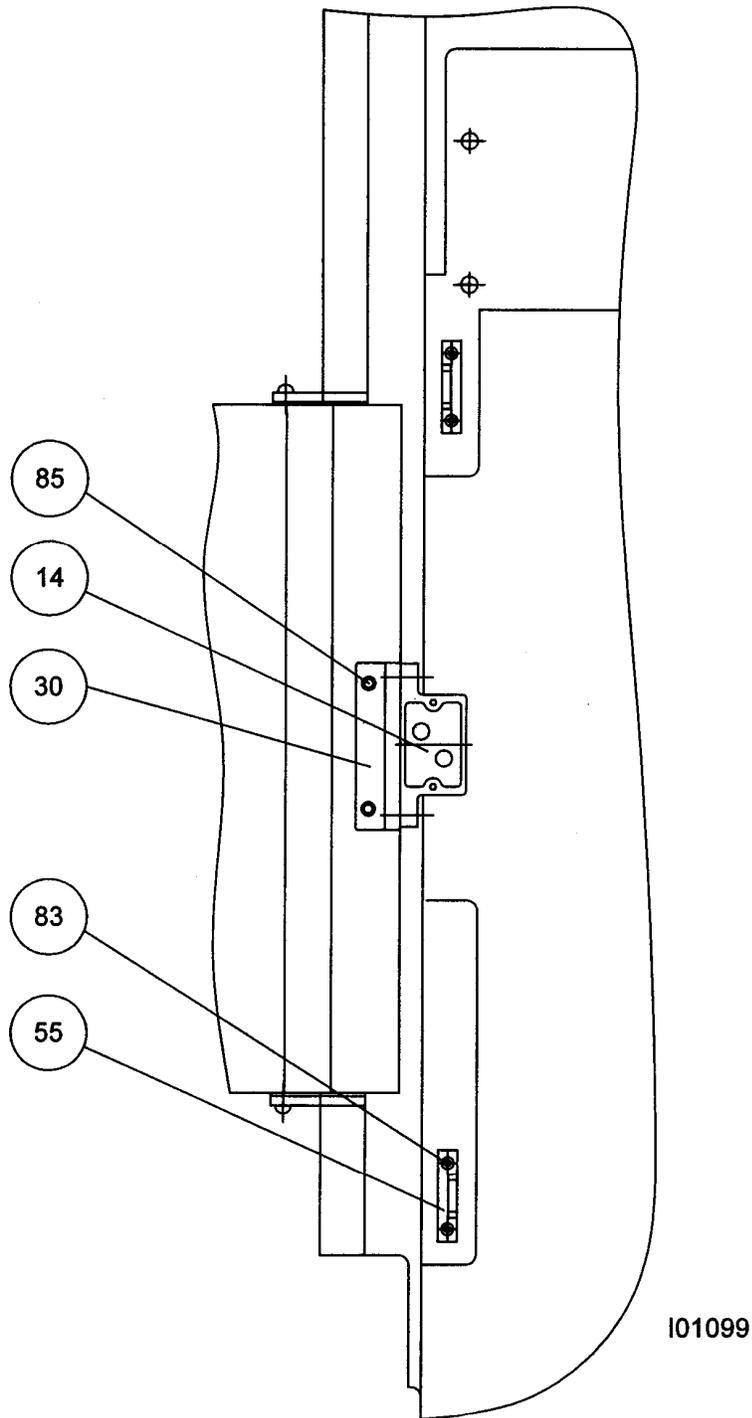


Figure 51 - FHM7 - Column Parts

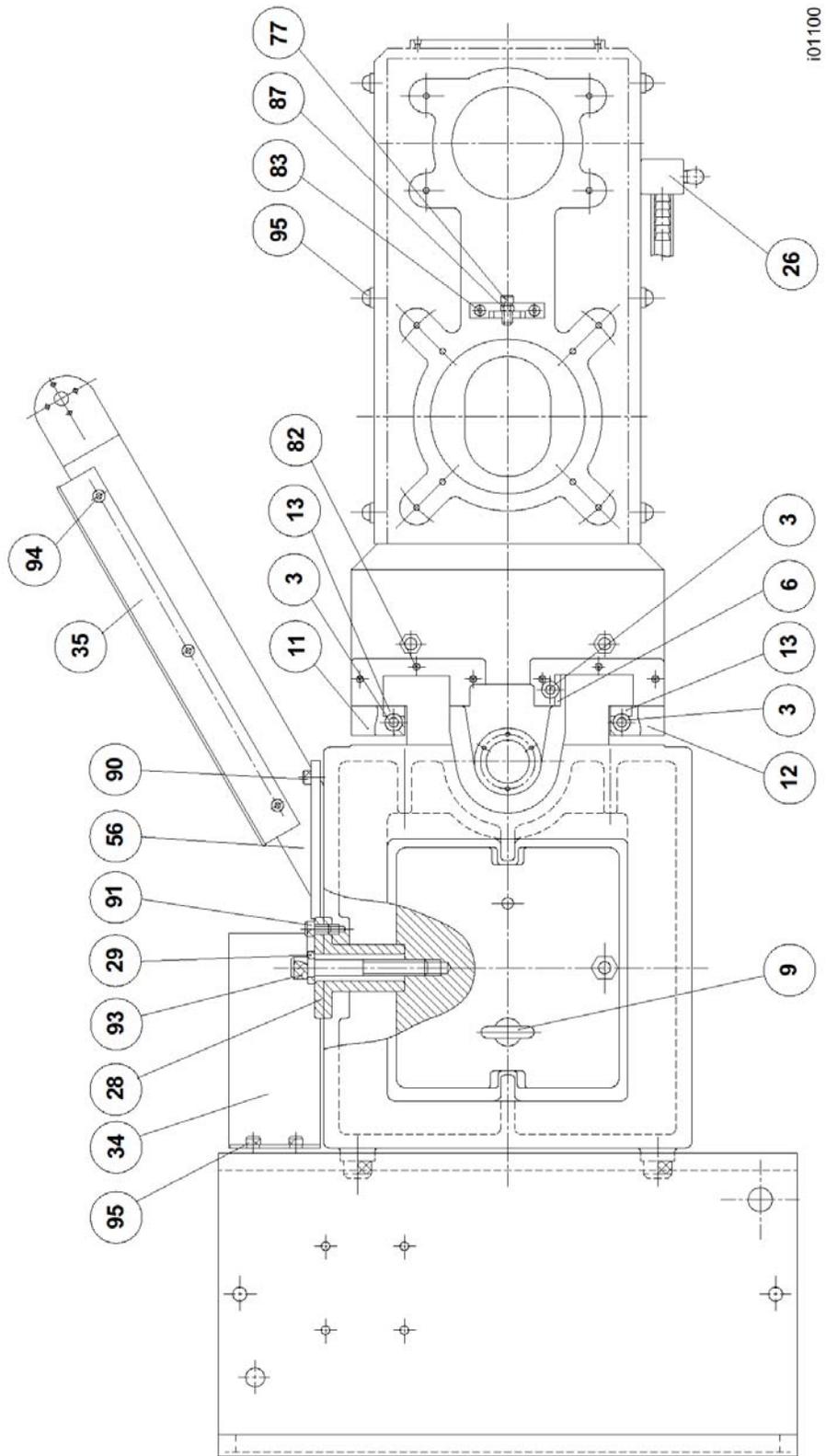


Figure 52

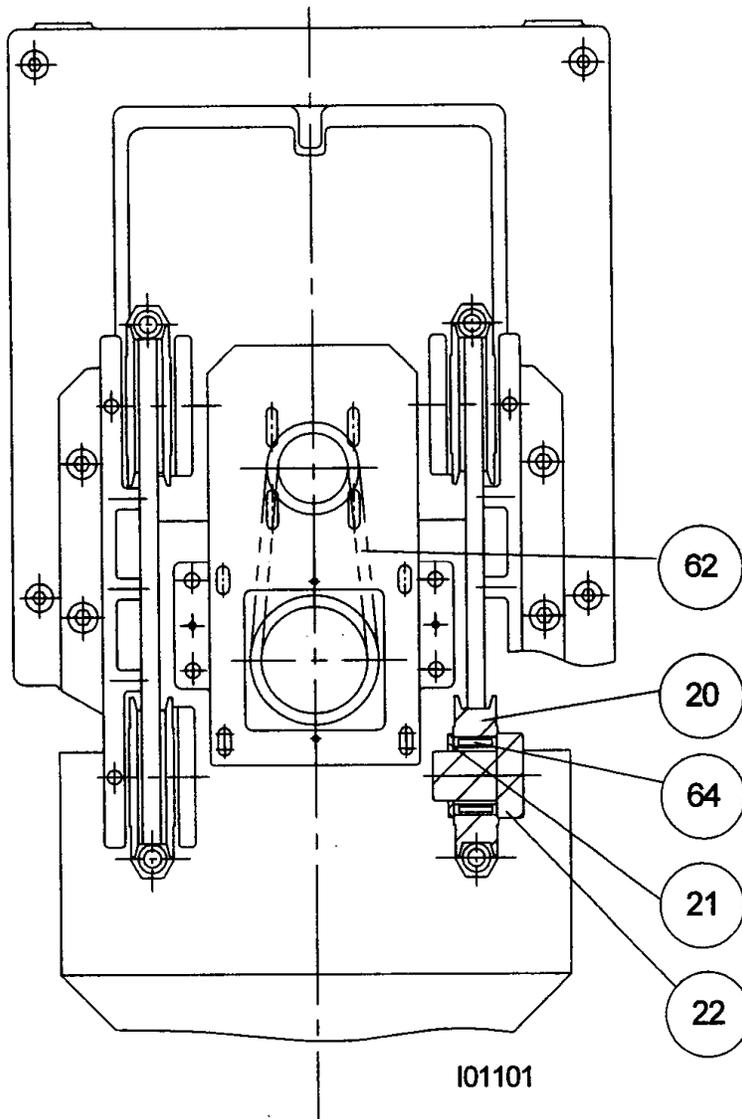


Figure 53 - FHM7

**Parts List - FHM7 - Column & Z Axis Drive Train -
(Figure 50, 51, 52 53)**

Item	P/N	Title	Qty
1	760-5A	COVER-FIXED	1
2	24525	MOTOR ASSY- SPINDLE - DPMV7	1
3	24518	SCREW - GIB ADJUSTING	3
4	H-026-B	SCREW	1
5	H-035-8	PLATE-ALUMINUM	4
6	24510	GIB - Z AXIS SIDE	1
7	H-045-14C	KNEE	1
8	H-067-8	BODY-MACHINE	1
9	H-077-3	SCREW	1
10	24502	BALLSCREW - Z AXIS	1
11	H-109-12	SEAT-GIB	1
12	H-110-12	SEAT-GIB	1
13	24511	GIB - Z AXIS REAR	2
14	H-124-5	HOLDER-MICRO SWITCH	1
15	H-139-8	BRACKET (R)-ROLLER'S	1
16	H-139-8A	BRACKET (R)-ROLLER'S	1
17	H-140-10	HOLDER FIXED MOTOR	1
18	H-140-10B	HOLDER FIXED	1
19	24542	PULLEY - Z AXIS BALLSCREW	1
20	H-145-8	ROLLER	4
21	H-146-8	SPACER	4
22	H-147-8	SHAFT-DRIVE	4
23	H-148-8	SCREW	4
24	H-149-8A	WEIGHT BALANCE	1
25	H-160-9	BRACKET-BEARING	1
26	H-165-8	PIPE CONNECTION	2
27	H-167-10B	COVER-TOP	1
28	H-168-8	HOLDER-BALANCE WEIGHT	1
29	H-170-8	WASHER	1
30	H-171-8	HOLDER-MICRO SWITCH	1
31	24550	VALVE	1
32	24551	NOZZLE - COOLANT	1
33	H-310-8	COVER	1
34	H-331-8	BRACKET-ARM	1
35	H-332-14	COVER-ARM	1
36	HB-127-B	BRACKET	1
39	HB-134-10	BRACKET BUSHING-BEARING	1
42	24532	CARTRIDGE HOUSING	1
43	24529	PULLEY - SPINDLE	1
44	24527	PULLEY - MOTOR	1
45	HB-199-10	CLAMPING RING	1
46	HB-200-10	DUST COVER	1
47	HB-201-13	SPACER	1
48	HT-067-14A	CABINET-ELECTRICAL CONTROL	1
49	HX-002-10	BUSHING-BEARING	3
50	HX-007	COVER-BEARING	1

Parts List - FHM7 - Column & Z Axis Drive Train - (Figure 50, 51, 52 53)

52	HX-028-10	SUPPORT-DUST HELMET	2
53	HX-030-10	SUPPORT-DUST HELMET	2
54	24523	COVER - Z BALLSCREW	1
55	HX-046	STOP-LIMIT SWITCH	2
56	HY-043-14	ARM	1
57	24556	SPACER - BEARING - INNER	1
58	24557	SPACER - BEARING - OUTER	1
60	24427	SPROCKET ASSY - 26 TEETH - 40/55	1
61	24553	BELT SET - SPINDLE	2
62	425-5M-15	BELT-TIMING 5MM POWERGRIP	1
63	24558	ELBOW - 90	1
64	24555	BEARING - TA3025	4
65	24513	BEARING SET - ANGULAR CONTACT	1
67	24512	BEARING - BALL	1
69	24543	KEY - 5 x 5 x 25L	1
70	24530	KEY - 8 X 7 X 60L	1
71	24528	KEY - 10 X 8 X 35	1
72	24520	NUT - LOCK, M25X 1.5	1
73	24515	NUT - LOCK	1
74	24533	NUT - LOCK - M35 X 1.5	1
75	24534	NUT - LOCK - M40 X 1.5	1
77	1/4-20 50B	NUT-HEX-STL-BO	1
78	5/8-18 50B	NUT-HEX-STL-BO	1
79	3/4-10 50B	NUT-HEX-STL-BO	4
80	AOS255211	SEAL-OIL-25x52x11	1
81	AOS385216	SEAL-OIL-38x52x16	1
82	3/16-24X1/2 10B	SCREW-PAN HEAD PHILLIPS-STL-BO	24
83	3/16-24X5/8 10B	SCREW-PAN HEAD PHILLIPS-STL-BO	6
85	1/4-20X1/2 25B	SCREW-SHCS-STL-BO	4
85	1/4-20X5/8 25B	SCREW-SHCS-STL-BO	7
86	1/4-20X3/4 25B	SCREW-SHCS-STL-BO	6
87	1/4-20X1 25B	SCREW-SHCS-STL-BO	1
88	5/16-18X7/8 25B	SCREW-SHCS-STL-BO	4
89	5/16-18X1 25B	SCREW-SHCS-STL-BO	6
90	3/8-16X1 25B	SCREW-SHCS-STL-BO	20
91	3/8-16X1 1/2 25B	SCREW-SHCS-STL-BO	9
92	1/2-12X1 1/4 25B	SCREW-SHCS-STL-BO-FULL THREAD	4
93	3/4-10X5 24B	SCREW-HEX HD-STL-BO	1
94	M5-0.8X12 10B	SCREW-PH-PHIL-STL-BO	8
95	M6-1.0X12 25B	SCREW-SHCS-STL-BO	15
96	M6-1.0X20 25B	SCREW-SHCS-STL-BO	3
97	3/8 70P	WASHER-FLAT USS-STL-BO	6
98	5/8 70B	WASHER-FLAT USS-STL-BO	1
99	24537	SPINDLE ASSEMBLY	1

i24293

Southwestern Industries, Inc

TRAK Warranty Policy

Warranty

TRAK products are warranted to the original purchaser to be free from defects in workmanship and materials for the following periods:

Product	Warranty Period	
	Materials	Factory Labor
New TRAK	1 Year	1 Year
Any EXCHANGE Unit	90 Days	90 Days

The warranty period starts on the date of the invoice to the original purchaser from Southwestern Industries, Inc. (SWI) or their authorized distributor.

If a unit under warranty fails, it will be repaired or exchanged at our option for a properly functioning unit in similar or better condition. Such repairs or exchanges will be made FOB Factory/Los Angeles or the location of our nearest factory representative or authorized distributor.

Disclaimers of Warranties

- This warranty is expressly in lieu of any other warranties, express or implied, including any implied warranty of merchantability or fitness for a particular purpose, and of any other obligations or liability on the part of SWI (or any producing entity, if different).
- Warranty repairs/exchanges do not cover incidental costs such as installation, labor, freight, etc.
- SWI is not responsible for consequential damages from use or misuse of any of its products.
- TRAK products are precision mechanical/electromechanical measurement systems and must be given the reasonable care that these types of instruments require:
- Replacement of chip scrapers and wipers is the responsibility of the customer. Consequently, the warranty does not apply if chips have been allowed to enter the mechanism.
- Accidental damage, beyond the control of SWI, is not covered by the warranty. Thus, the warranty does not apply if an instrument has been abused, dropped, hit, disassembled or opened.
- Improper installation by or at the direction of the customer in such a way that the product consequently fails, is considered to be beyond the control of the manufacturer and outside the scope of the warranty.