

# TRAK<sup>TM</sup> 2<sup>OP</sup> M10 Mill

## Safety, Installation, Maintenance, Service and Parts List

---

Document: P/N 28004 Version: 111816
--



### Southwestern Industries, Inc.

2615 Homestead Place

Rancho Dominguez, CA 90220-5610 USA

T | 310-608-4422

F | 310-764-2668

Service Department: 800.367.3165

e-mail: [sales@southwesternindustries.com](mailto:sales@southwesternindustries.com) | [service@southwesternindustries.com](mailto:service@southwesternindustries.com) | web: [southwesternindustries.com](http://southwesternindustries.com)

Copyright © 2016, 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.

# Table of Contents

<b>1.0</b>	<b>Safety</b>			
1.1	Safety Publications	1		
1.2	Danger, Warning, Caution and Note Labels and Notices Used in this Manual			
1.3	Safety Precautions			
<b>2.0</b>	<b>System Description</b>			
2.1	Machine Specifications	8		
2.2	Maximum Spindle Torque & HP			
2.3	ProtoTRAK TMX Control Hardware			
2.4	Machine Major Subassemblies			
<b>3.0</b>	<b>Installation</b>			
3.1	Lifting the 2 OP mill	18		
3.2	Uncrating the 2 OP			
3.3	Shortages: Inventory Checklist			
3.4	Installation Checklist			
3.5	Electrical Connections			
3.6	Air Connections			
3.7	Cleaning the 2 OP			
3.8	Leveling Procedure			
3.9	Lubrication			
3.10	Moving the 2 OP Around the Shop			
3.11	Cutting the Euclid Test Block			
<b>4.0</b>	<b>Troubleshooting by Symptom</b>			
4.1	Machine Related Problems	30		
4.2	Motion Related Problems			
4.3	Control Related Problems			
4.4	Tool Changer (Carrier) Problems			
4.5	Control Input or Output Problem			
4.6	Measurement Problems			
4.7	Machine Tool Problems			
<b>5.0</b>	<b>Diagnostics</b>			
5.1	The Machine Tool & Setup	48		
5.2	The Mechanical Drive Train			
5.3	Computer Module			
5.4	Programming Panel			
5.5	Axis Motors/Servos			
5.6	Spindle Motor & AC Drive			
5.7	Electrical			
5.8	Tool Carrier Diagnostics			
5.9	Pneumatic Diagnostics			
5.10	Coolant Diagnostics			
5.11	Service Codes			
<b>6.0</b>	<b>Replacement Procedures</b>			
6.1	Axis Motor Replacement	97		
6.2	AC Spindle Drive Replacement			
6.3	Computer Module Replacement			
6.4	Linear Guide Replacement			
6.5	Ballscrew Replacement – X Axis			
6.6	Ballscrew Replacement – Y Axis			
6.7	Ballscrew Replacement – Z Axis			
6.8	Spindle Motor Replacement			
6.9	Spindle Motor Wiring			
6.10	Spindle Cartridge Replacement			
6.11	Spindle/Motor Coupling Alignment			
6.12	Automatic Tool Carrier (ATC) Replacement			
6.13	Setting ATC Locations			
6.14	Coolant Pump Replacement			
6.15	Bleeding Air from Tool Unclamp Cylinder Oil System			
6.16	Programming Panel Replacement			
6.17	Home Switch Replacement			
6.18	Spindle Motor Encoder Replacement			
6.19	X, Y & Z Home Switch Adjustments			
6.20	Setting Motor Index Angle			
6.21	Adjusting the Drawbar Bumpout			
<b>7.0</b>	<b>Maintenance</b>			
7.1	Calibration		123	
7.2	Backlash Compensation			
7.3	Periodic Maintenance			
	<b>Assembly Drawings (rear of manual)</b>			
	Machine Assembly – 27600 Rev D			
	System Diagram – 27648 Rev D			
	Enclosure Assembly – 27568 Rev C			
	Base Frame Assembly – 27542 Rev B			
	X Axis Drive Train – 27520 Rev B			
	Y Axis Drive Train – 27564 Rev E			
	Z Axis Drive Train – 27540 Rev F			
	Programming Panel Assembly – 27604 Rev D			
	ATC Assembly – 27587 Rev A			
	Spindle Head Assembly – 27500 Rev D			
	Spindle Cartridge Assembly – 27830 Rev D			
	Pneumatic System – 27563 Rev B			
	Coolant System – 27557 Rev B			
	Lubrication System – 27591 Rev A			
	Home Switch Assembly – 27658 Rev –			
	Enclosure-Elec – 28091 Rev A – 27621 Rev C			
	Electrical Schematic – 27650-SCH Rev A (D size)			
	440 Volt Option – 28091 Rev A			
	Cover Assembly – 27682 Rev A			

# 1.0 Safety

The safe operation of the 2 OP Mill depends on its proper use and the precautions taken by each operator.

- Read and study this manual and the 2 OP Programming, Operating, and Care Manual. Be certain every operator understands the operation and safety requirements of this machine *before* its use.
- Never run the machine with enclosure doors open
- 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 - Machining centers.

## 1.1 Safety Publications

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

**Safety Requirements for Machining Centers and Automatic, Numerically Controlled Milling, Drilling and Boring Machines** (ANSI B11.22-2002) (R2007) & (ANSI B11.23-2002) (R2007). 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 0210.

## 1.2 Danger, Warning, Caution, and 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, which *could* result in minor personal injury or equipment/product damage. Caution labels on the machine are yellow in color.

**NOTICE** - Call attention to specific issues requiring special attention or understanding.

# Safety & Information Labels Used On The TRAK 2<sup>OP</sup> Milling Machine

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

**SAFETY INSTRUCTIONS**

1. Read and understand the Operator's Manual and all warnings on this sign before operating machine.
2. Machine should only be operated by qualified personnel that have been trained in the operation and use of this machine.
3. Machine starts and moves automatically. Never place any part of your body near or on moving parts of this machine.
4. Stop spindle completely before touching the tool, work piece, or spindle.
5. Do not operate machine unless all guards, interlocks, and safety devices are installed and functioning.
6. Always clamp work piece and tool securely. Avoid excessive feeds and spindle speeds.
7. Wear safety glasses, shoes, and hearing protection when operating machine.
8. Remove rings, watches, jewelry and loose fitting clothes. Keep hair away from moving parts of the machine.
9. Installation and service must be performed by qualified personnel only, following instructions in the Maintenance Manual. Turn off and lock-out the power at the main electrical panel before servicing.
10. It is the responsibility of the user to be sure that this machine is in safe operating condition at all times, and that the operator follows the safe operating procedures described in the Operator and Maintenance Manuals.

**Do not remove or disfigure this sign.**

**SAFETY WARNING!**




1. Hazardous voltage present in the electrical equipment of this machine. Only qualified engineers are allowed to install, test, adjust or maintain it.
2. Isolate power before install, test, adjust or maintain the electrical equipment of this machine.
3. Do Not turn on the power before the protective grounding has been securely connected.
4. Do Not change any device of this machine without permission.

FAILURE TO COMPLY WITH THE ABOVE  
MAY RESULT IN A SERIOUS ACCIDENT

S-S1073

**WARNING**



1. Never open door during operation.
2. Do not operate with door removed.

Failure to observe the above may result in serious injury.

S-S3120



**WARNING**

Keep hands, clothing and body clear of rotating spindle. Machine starts and moves automatically. Can cause severe injury.

1. Set control in manual mode before working near spindle.
2. Isolate machine before servicing.

S-S3010

**WARNING:**  
**PRESSURIZED VESSEL**

THIS AIR TANK STAYS PRESSURIZED EVEN IF THE MAIN AIR IS DISCONNECTED. BEFORE DISCONNECTING THIS TANK, FIRST DISCONNECT THE MAIN AIR SUPPLY, LOWER THE FRONT DOOR ALL THE WAY DOWN, THEN RELEASE ALL AIR PRESSURE FROM THE TANK BY SLOWLY OPENING THE DRAIN VALVE LOCATED ON THE BOTTOM OF THE TANK.

**CAUTION!**  
IN ADDITION TO THE COMPRESSED AIR, THIS TANK MAY CONTAIN SOME OIL AND WATER. USE PROPER EYE PROTECTION AND EXERCISE CAUTION WHEN OPENING THE DRAIN VALVE.

**WARNING**

1. IMPROPER OPERATION OR IMPROPER MAINTENANCE OF THIS MACHINE MAY CAUSE SERIOUS BODILY INJURY OR DEATH.
2. DO NOT OPERATE THIS MACHINE UNTIL YOU HAVE RECEIVED OPERATING AND SAFETY INSTRUCTIONS FROM YOUR EMPLOYER.
3. FOLLOW ALL SAFETY PRACTICES PRESCRIBED BY YOUR EMPLOYER AND AS OUTLINED IN THE "PROGRAMMING, OPERATION AND CARE MANUAL."
4. IT IS THE RESPONSIBILITY OF THE EMPLOYER TO PROVIDE AND ENSURE POINT OF SAFEGUARDING PER ANSI: R11.23-2002 & R11.23-2003.
5. THE MANUFACTURER IS NOT LIABLE (RESPONSIBLE) FOR ANY DAMAGE 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 COMPONENTS, PARTS, OR THE USE OF THIS UNIT WITH ANY THIRD-PARTY ACCESSORIES OR PARTS.

DO NOT REMOVE THIS SIGN FROM MACHINE

**WARNING**

THIS COUNTERBALANCE CYLINDER STAYS PRESSURIZED EVEN IF THE MAIN AIR IS DISCONNECTED. BEFORE DISCONNECTING THIS CYLINDER, FIRST DISCONNECT THE MAIN AIR SUPPLY, LOWER THE FRONT DOOR ALL THE WAY DOWN, THEN RELEASE ALL AIR PRESSURE FROM THE AIR STORAGE TANK INSIDE THE MACHINE BY SLOWLY OPENING THE DRAIN VALVE LOCATED ON THE BOTTOM OF THE TANK.

**CAUTION!**  
IN ADDITION TO THE COMPRESSED AIR, THIS TANK MAY ALSO CONTAIN SOME OIL AND WATER. USE PROPER EYE PROTECTION AND EXERCISE CAUTION WHEN OPENING THE DRAIN VALVE.

**VICE & FIXTURE WARNING**

Vise or fixture must not protrude beyond the back edge of the worktable to avoid collision with the ATC. It may not protrude more than 1.5 inches beyond the front of the worktable to avoid collision with the front door. Use SWI modified Kurt vise P/N VISE-20PM10 or Kurt vise 3600V-INT or equivalent.

FRONT



# MAINTENANCE SCHEDULE

## DAILY

- Remove majority of chips from around the axis slide ways, work table and way covers, especially between table and ATC.
- Empty chip tray.
- Visually check lubrication pump oil level and make sure it is always above the minimum line.
- Visually check the coolant level and add if it is low.
- Visually check the air regulator filter.

## MONTHLY OR AS SPECIFIED

- Remove rear ATC and Y-axis motor compartment access covers and clean chips and other debris. Cleanup any oil or coolant accumulated on the bottom panel of the machine base.
- Visually inspect the condition of way and ball screw covers. Clean if showing chip build up.
- Check and if needed replace the air regulator filter element.
- Every two months drain and remove the coolant tank and clean inside, including pump screen. Fill with new coolant.
- Visually check the tool unclamp oil reservoir level.
- Remove all air filters in the electrical cabinet and transformer enclosure every two months and clean.

## YEARLY

- Remove all covers. Vacuum chips, debris, and wipe down machine from top to bottom.
- Check backlash on each axis and adjust if needed. Refer to the machine manual for more information.
- Inspect machine for any unusual wear and play.
- Check cables and pneumatic lines for any excessive abrasions or cuts.
- Inspect the ATC air cylinder and grease the ATC linear rail bearing blocks.
- Please contact SWI Service Dept. for help with any machine maintenance procedures. Service Dept. contact number is 1-800-367-3165.

I27694-20



## 1.3 Safety Precautions

1. Do not operate this machine before the **2 OP Installation, Maintenance, Service and Parts List Manual, Operating & Care Manual** have 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 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.
  - Do not use compressed air to clean the machine.
  - Before you make an adjustment to the part, fixture, coolant nozzle or take measurements.
  - Do not attempt to disable any safety interlock. Never reach around a safeguard.
11. Protect your eyes and the machine as well.
12. Disconnect power to the machine before you change belts, pulley, and gears.
13. Keep work areas 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 a 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 due to premature wear.

19. Use proper cutting tools for the job. Pay attention to the rotation of the spindle: As viewed from above, left hand tool for counterclockwise rotation of spindle, and right hand tool for clockwise rotation of spindle.
20. To 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 feature, clockwise rotation of the EHW moves the axis in the positive direction, counterclockwise in the negative direction.
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. Inspect the retention knobs for damage or excessive wear before each use.
24. Large overhang on cutting tools when not required result in accidents and damaged parts.
25. Prevent fires. When machining certain materials (magnesium, etc.) the chips and dust are highly flammable. Obtain special instruction from your supervisor before machining these materials.
26. Prevent fires. Keep flammable materials and fluids away from the machine and hot, flying chips.

**Warning**

Retention knobs come in a wide variety of designs, however they often look similar and appear to be interchangeable, but they are not. Use only the knob that the 2 OP mill is designed to use. The use of the incorrect knob, or the incorrect usage of a knob, may result in injury or property damage. To ensure the correct knob is chosen, please refer to section 2.4.4, System Description section of this manual

## 2.0 System Description

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

### 2.1 Machine Specifications

Please see the drawing on the next page for a layout of the 2 OP M10 machine.

#### Overall Machine Dimensions

Width of machine	30.5"
Depth of machine	52"
Height of mill with head all the way up	101"
Minimum height to fit mill through doorway (Z cable carrier collapsed)	90"

#### Machine Specifications

##### Table Dimensions

Table size	<b>18" x 15"</b>
Number of tee slots and pitch	4 @ 63 mm
Tee slot width	0.630" or 16 mm
Table maximum load	500 lbs.
Ball Lock ® hold down force	2250 lbs @ 35 in/lbs of torque
Machine Weight	~2400 lbs
Machine Shipping Weight	~2750 lbs

##### Travel

X-axis	14"
Y-axis	18" (12" of machining travel)
Z-axis	17"
Maximum distance from spindle nose table surface	20.25"
Minimum distance from spindle nose table surface	2.75"
Maximum swing clearance from spindle center to column	14"
Maximum Rapid speed X, Y & Z-axis, inches per minute	500

##### Spindle

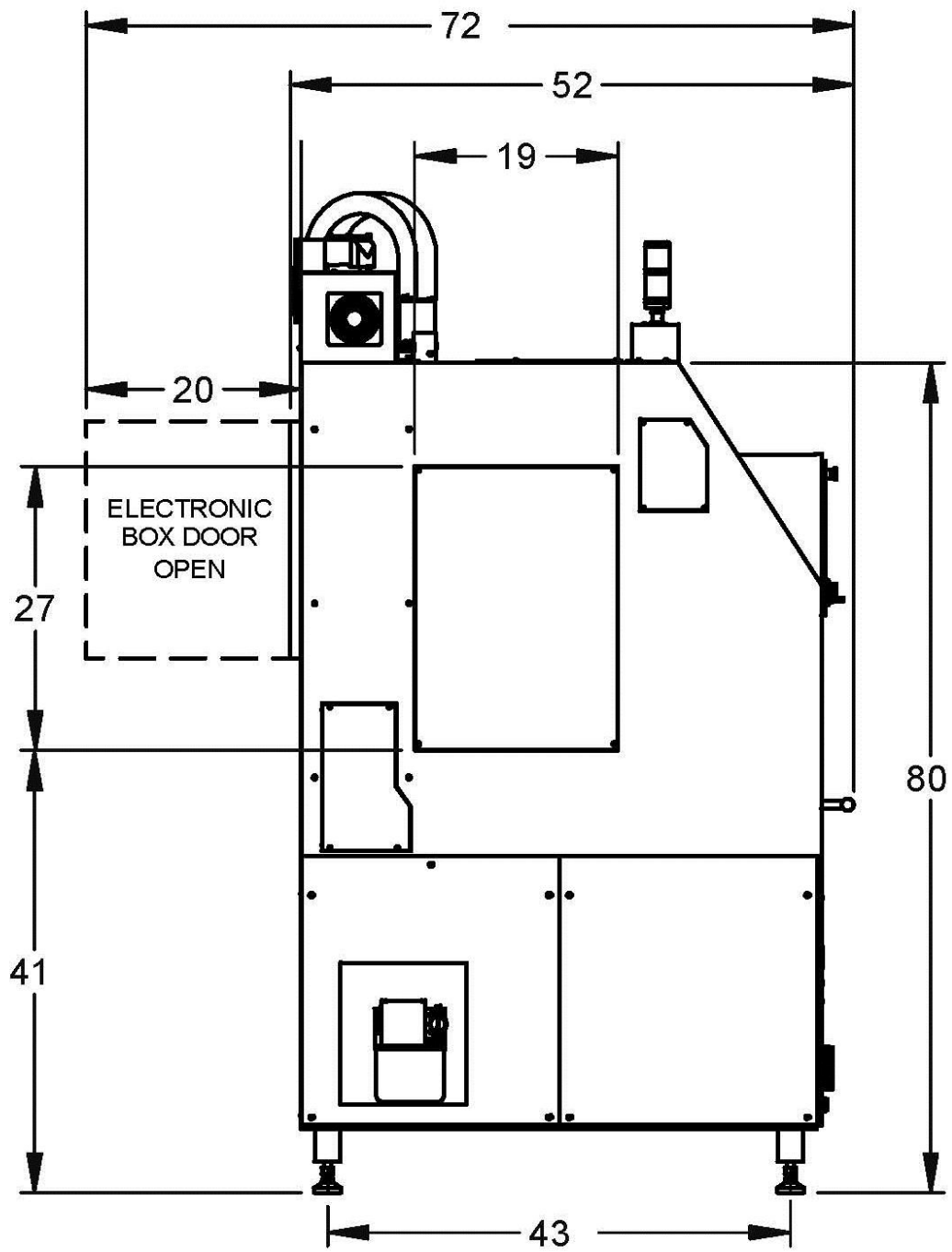
Tool holder type	BT30
Spindle nose diameter	2.2" or 56 mm
Maximum RPM	5000
Horsepower	3 HP

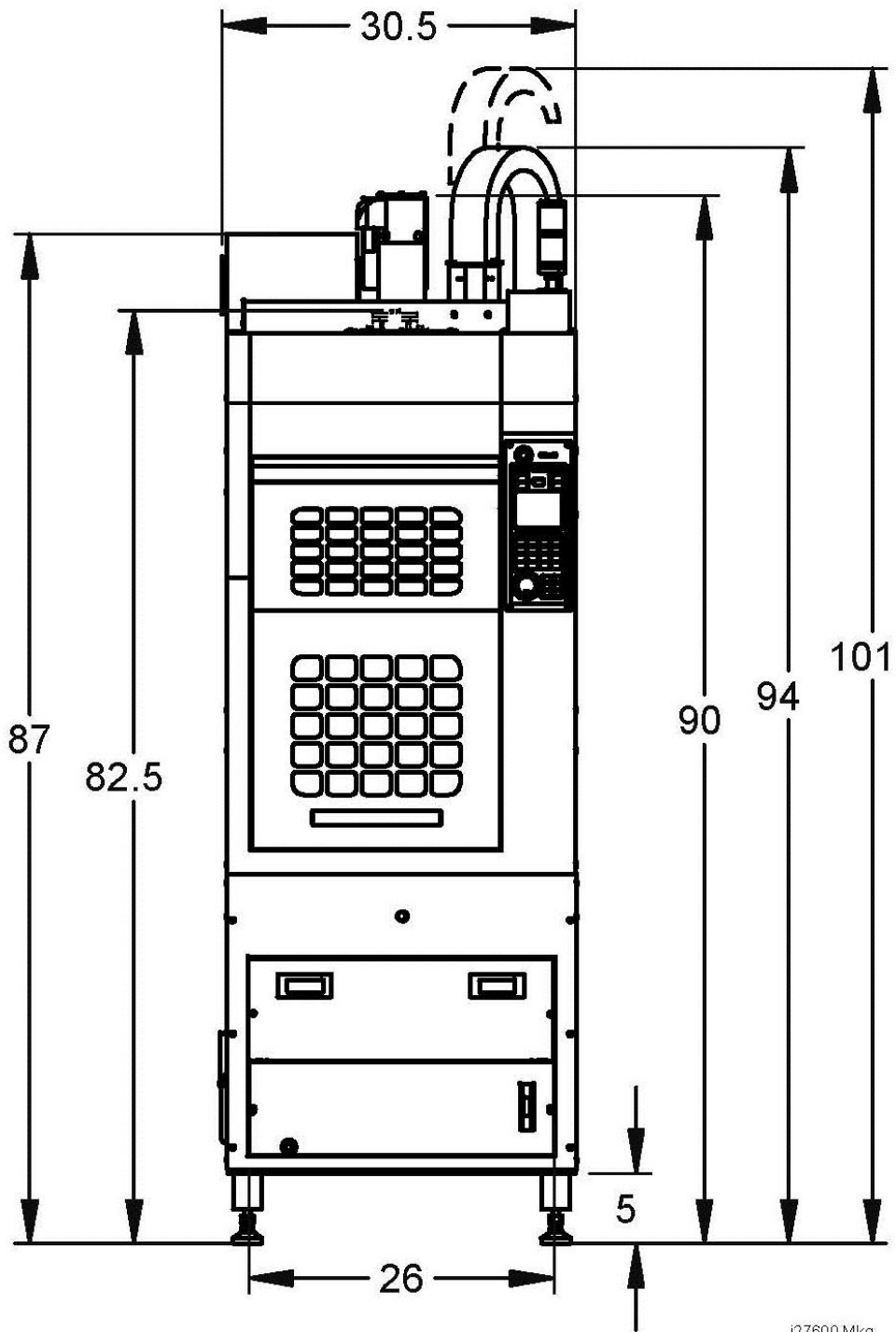
##### Automatic Tool Changer

Tool Capacity	8
Maximum tool diameter	2
Retention knob	See section 2.4.4

##### Air Requirements

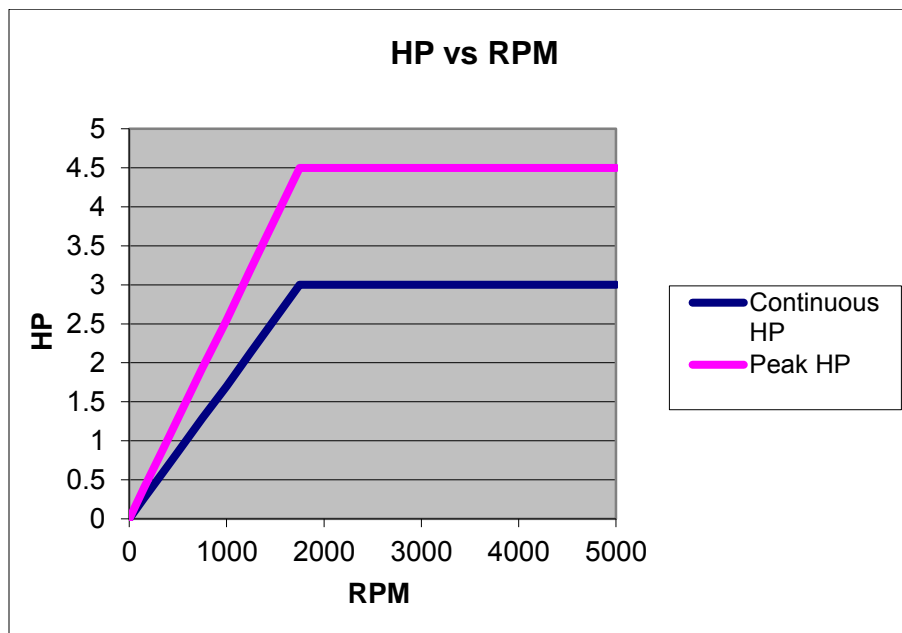
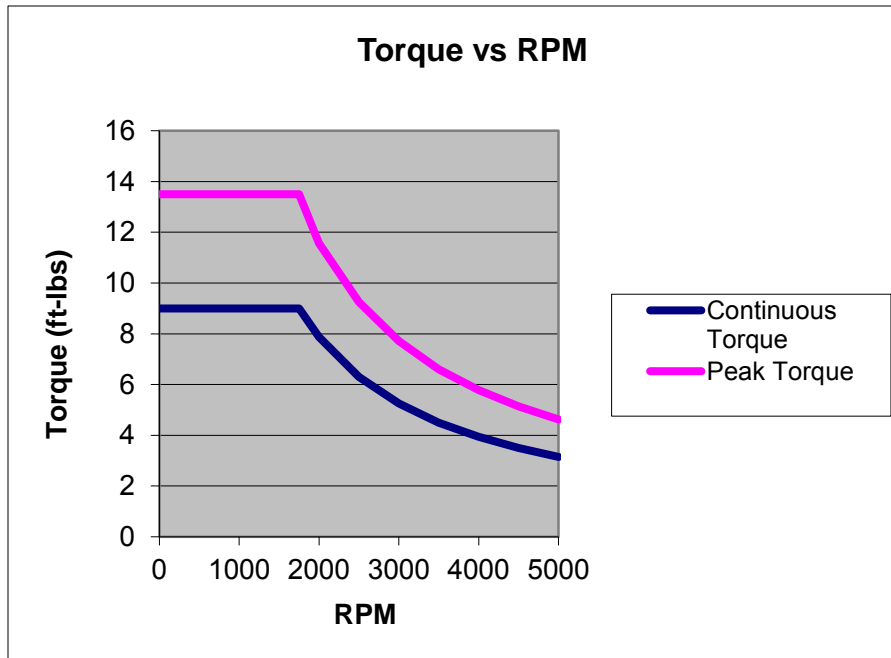
Pressure	90 psi
Quality	Air dried/filtered water separator upstream of the machine
CFM	2.5 at 90 psi
SCFM	18





## 2.2 Maximum Spindle Torque and Horsepower

The following graphs illustrate the continuous and peak torque vs RPM and horsepower vs RPM for the 2 OP M10 machine at the spindle. Peak torque and horsepower values can only be attained for a short period of time before the spindle drive will fault out to protect the motor.



Note - 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.

## **2.3 ProtoTRAK TMX Control Hardware**

### **2.3.1 Programming Panel Assembly**

The programming panel assembly on the 2 OP is mounted to the front right side of the machine. The panel consists of the program overlay, electronic handwheel (EHW), 5" LCD and a servo on button. There are 2 USB ports mounted on the right side of the machine next to the programming panel. They are used to save programs and/or plug in a keyboard and mouse.

There are 6 cables that route from the programming panel to the computer module. They are the VGA cable, 2 USB cables, COM port cable, overlay power cable and EHW cable. The VGA cable carries video signals from the computer module to LCD controller board. The LCD interface board gives the user the ability to modify the brightness, color and position of the image. The USB cables extend 2 of the USB ports on the computer module up to the right side of the machine, next to the programming panel. The COM port provides the communication between the computer and the Overlay Interface board. The Overlay power cable provides power to the LCD and Overlay Interface board, it also feeds back the critical keys (GO, STOP, etc) to the computer module. The EHW cable carries the signals from the EHW down to the computer module.

There are also 3 local cables that route between the LCD and associated boards. They are the LCD user interface, LCD power cable and VGA extension cable.

### **2.3.2 Electrical Cabinet**

The electrical cabinet is found at the rear of the machine. The electrical cabinet contains the main control hardware for the machine. The main components are the computer module and AC spindle drive. See drawing 27621 at the rear of the manual.

### **2.3.3 Computer Module**

The computer module is the heart and soul of the machine. All of the inputs and outputs are fed through this module. The computer module controls the programming panel assembly, AC spindle drive, servo drives, motor signals and feedback and all the inputs and outputs. Inside of the computer module is a motherboard, motion control board and an applications board along with a power supply.

The computer module also contains 2 USB ports. Both USB ports extend with 2 cables to the front of the machine to ease access from the front of the machine.

### **2.3.4 Servo Motors/Drives**

The 2 OP mill uses 3 servo motors with servo drives to run the X, Y and Z axis. The motors all produce 560 in-oz of torque and run off of 115 VAC. Each axis motor has a unique part number due to the cable lengths which are different between the 3. The Z axis motor also contains a braking circuit internal to the servo drive to help dissipate energy as the spindle head moves down. A braking resistor is used to dissipate energy when the Z axis moves down.

## 2.4 Machine Major Subassemblies

### 2.4.1 Spindle

The spindle is contained within a cartridge and BT30 tool holders must be used. The spindle bearings are permanently lubricated and require no additional attention by the user. The spindle has an air purge system that is automatically activated during the tool change sequence; it blows air down the spindle to prevent chips from being trapped between the holder and spindle taper.

**Warning!**  
**The spindle unit is not field serviceable. If the bearings go bad the entire spindle cartridge will be replaced.**

### 2.4.2 Spindle Motor & Drive

The spindle motor is 3 HP and directly drives the spindle via a coupling. The RPM range for this machine is 150 to 5000 RPM.

### 2.4.3 Automatic Draw Bar Assembly

The automatic drawbar is an assembly consisting of an air cylinder and an actuator that unclamps the tool. Tooling is changed by means of the Automatic Tool Changer (ATC), or can be **done manually by pressing and holding the "Unclamp" button. Tools are clamped when the button is released.** A clamping force of approximately 1000 lbs is generated to clamp the toolholder to the spindle. The Automatic Draw Bar Assembly uses full system air and hydraulic oil and requires no adjustment. There is an oil reservoir for the hydraulics that should be monitored on a regular basis. If there is a leak in the system the oil in this reservoir will go down. This leak will need to be fixed. This oil cup is found on top of the machine behind the spindle motor.

### 2.4.4 Retention Knobs

The TRAK 2<sup>OP</sup> Mill uses BT30 retention knobs as shown in Figure 2.4.4a. Tightening to the proper torque value is important for all retention knobs. Please see the retention knob manufacturer for the proper torque. You can order these retention knobs from Southwestern Industries under part number RETN KNOB-2OPM10. Our retention knobs should be torqued to 30 ft-lbs. It should be noted that lesser quality retention knobs will be torqued to something less than this.

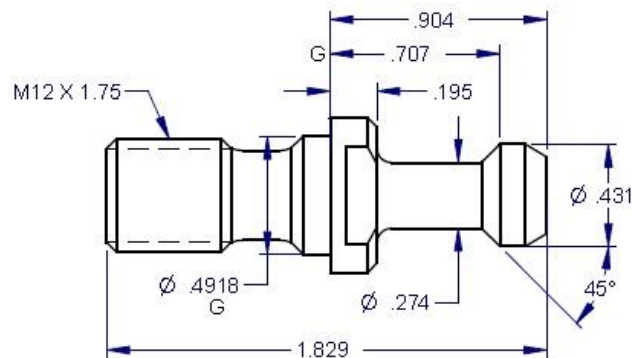


Figure 2.4.4a

**Warning!**

Retention knobs come in a wide variety of designs, however they often look similar and appear to be interchangeable, but they are not. Use only the knob that the 2 OP mill is designed to use. The use of the incorrect knob, or the incorrect use of a knob, may result in injury and/or damage to the mechanism.



### 2.4.5 Tool Changer (Carrier)

The tool changer is an 8 station mechanism that is actuated along the Y axis. It is hidden from view while the machine is cutting. The ATC mechanism slides forward on the Y axis linear guides and is actuated via an air cylinder.

### 2.4.6 Drive Train, Axes

Each axis (X, Y and Z) rides on precision linear guideways, with four preloaded recirculating ball carriages. Each axis is moved via a 6 mm pitch ballscrew. The axis motors drive each axis via a timing belt.

### 2.4.7 Worktable

The 2 OP table utilizes Ball Lock® technology as well as conventional T-bolt construction. Each Ball Lock mechanism has a hold-down force of 2250 lbs when 35 in/lbs of torque is applied to the screw. The software on the 2 OP mill allows the user to save the X and Y location of your program relative to the lower left hand corner ball lock. See the programming manual for more **information. There are 4 ball lock receivers mounted in the table and they are separated by 12"**. The front 2 ball lock receivers are to be used to locate your fixture and the rear two are for clamping purposes.

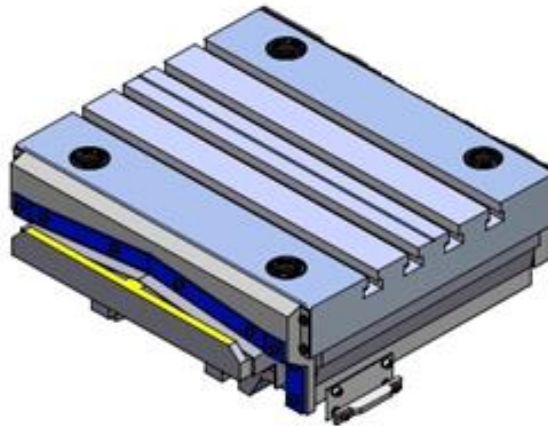


Figure 2.4.7a

### 2.4.8 Home switches

Each axis has a home switch which is used to home the mill. The machine must be homed each time the control is powered on.

#### **Warning**

It is not recommended that the position of the home switches be changed. They are preset at the factory and should require no additional adjustments. Should any major adjustments be done, service codes 500, 505, and 520 may need to be performed.

### 2.4.9 Lubrication System

The automatic lubricating system is a centralized system. It is located on the left side of the machine. While the system is automatic, it is recommended that after long idle periods, the machine be manually lubricated by using service code 300. Cycle the lube pump two to three times. The lubrication reservoir should be maintained on a daily basis, filling only with high quality lubricating oil. See section 3.9

#### **2.4.10 Coolant and Coolant Wash System**

The coolant and coolant wash system uses 1 pump to provide coolant to the work and also to wash chip away from the area where the ATC comes out. Wash areas can be controlled by the flexible coolant lines found at the base of the enclosure.

The coolant tank holds approximately 15 gallons of coolant.

See drawing 27557 at the rear of the manual for the coolant system.

#### **2.4.11 Pneumatic System**

The machine requires a supply of compressed air between 85-100 psi with a recommended air supply of  $\frac{1}{2}$ " I.D, minimum is  $\frac{3}{8}$ " ID. Air pressure to pneumatic components, the ATC slide mechanism, and air purge (internal spindle) can be controlled individually by means of the adjusting valves located at the back of the 2 OP mill. See drawing 27563 for an overview of the pneumatic system.

**CAUTION!**  
**Always Observe Low Air Pressure and Low Oil Level Warnings**

#### **2.4.12 Enclosure Doors**

The front door has an electro-mechanical safety interlock that must be engaged when running a CNC program. If the door is opened during a machining operation, the program will be shut down.

The enclosure is also equipped with left and right doors that are bolted in place.

**CAUTION!**  
**Do not Attempt to Disable or Override the Safety Interlock.**

#### **2.4.13 Status Light**

The machine has a status light attached to the top of the machine to give the user status of what is going on. The lights perform as follows:

- a. The green light is illuminated when the machine is running a program.
- b. The green light is flashing when operator input is required, like when a part change needs to be done.

#### **2.4.14 Chip Removal**

The chip pan is located in the front of the mill. To remove, lift up on the pan and pull forward.

#### **2.4.15 Work Lamp**

The 2 OP mill comes equipped with a fluorescent work lamp, which comes on automatically when the power is turned on.

#### **2.4.16 440 Volt Power Option**

The 2 OP mill comes standard for 220 volts. If you require a 440 volt input, then you must order this option with the machine. It is not field switchable. This option consists of replacing the AC spindle drive with a 440 volt unit, rewiring the transformer on the machine for 440 volts instead of 220 volts and rewiring the spindle motor for 440 volts.

#### **2.4.17 Transformer**

The 2 OP mill comes with a transformer that accepts either 200 to 240 or 400 to 480 volt input power and outputs 115 and 24 volts. During the installation of the machine, the wires to the transformer may need to be moved. From the factory the wires on the transformer will be placed on the 220 or 440 volt tap and 115 volt tap on the output side.

#### **Warning**

The input voltage to the machine must not exceed 240 or 480 volts. The spindle inverter is not rated for voltages higher than this. If the shop has voltages that exceed these numbers, it will need a step down transformer to lower the voltage. Voltages higher than this may void your warranty.

#### **DANGER**

You must turn the power off to the machine before adjusting the wires on the transformer. Failure to do so may cause death by electrocution.

The following are the general rules for moving the wires.

- If your input voltage to the machine is 215 volts or below, place the primary side wire on the 200 volt tap.
- If your input voltage to the machine is above 215 volts, place the primary side wire on the 220 volt tap.
- If your input voltage to the machine is between 400 and 430 volts, place the primary side wire on the 400 volt tap.
- If your input voltage to the machine is between 431 and 450 volts, place the primary side wire on the 440 volt tap.
- If your input voltage to the machine is between 451 and 480 volts, place the primary side wire on the 480 volt tap.

It is also important to make sure the 115 volt output voltage from the transformer is between 115 and 120 volts with 125 volts being the highest we would like to see. The 115 volt output voltage can be adjusted by moving wires on the transformer into different taps. The voltage can be placed on the 108, 115 or 124 volt tap. In general, if you set the primary voltage to the correct tap, then move the 115 volt wire to the higher voltage (like 124 volt) to raise the output secondary voltage or move the wire to the 108 volt tap to lower the output voltage. Check the voltage with a voltmeter. Putting the wire in the 124 volt tap does not mean you are going to get 124 volts. The input voltage to the machine will dictate your output voltage.

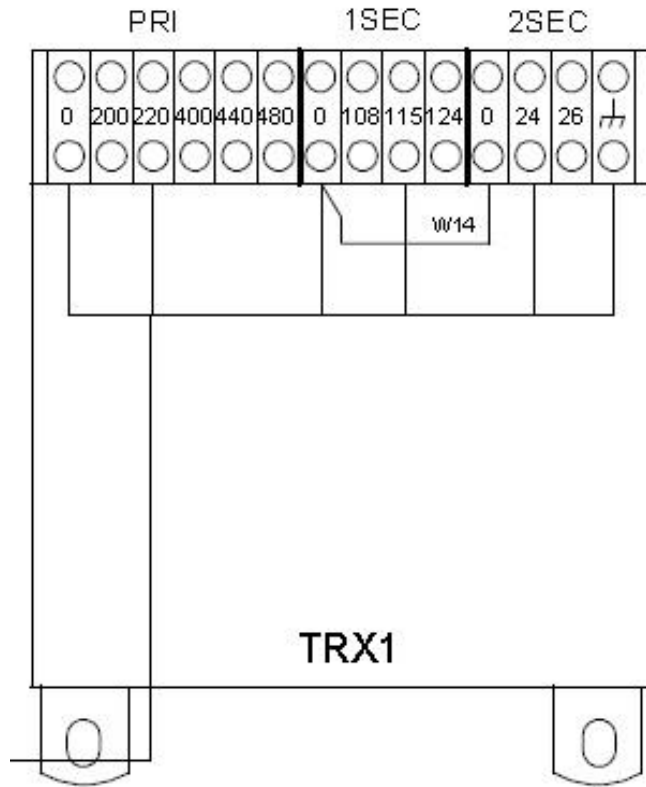


Figure 2.4.17a

Please see drawing 27648 at the rear of the manual for more information.

### 2.4.18 Single Phase Power Option

The TRAK 2<sup>OP</sup> mill has an optional single phase option for 220 volts. It needs to be noted that running the machine on single phase power reduces the spindle power by about 40% as compared to 3 phase 220 volt power. In other words, the spindle will not produce 3 HP. A different style electric cord plug is used with single phase power. As part of the single phase kit, we will provide an adaptor cable that allows the user to plug the machine into a 3 phase 220 volt power connector. Please note that the machine will still run on single phase power with this adaptor. In order to convert the machine back to 3 phase power, a number of changes need to be done to the machine. See section 3.5 for an illustration of what that plug looks like.

## 3.0 Installation

### 3.1 Lifting the 2 OP Mill

The 2 OP mill must be lifted and/or moved from the pallet with a forklift with a minimum capacity of 5,000 lbs. Make sure the forks extend all the way through the machine if lifted from the front, side or rear.



Figure 3.1a



Figure 3.1b



Figure 3.1c

**Important**

Before lowering the machine make certain that the 4 leveling feet have been re-attached to the machine. Remove the shipping plates and add the leveling feet. Thread in the leveling feet until the machine sits about 5 1/2" above the ground.



Figure 3.1d

## 3.2 Uncrating the 2 OP

1. Remove the loose articles from the pallet and check them against the loose Inventory Checklist (Section 3.3).
2. Unfasten the head support bracket as shown in figure 3.2.
3. Unstrap the ATC cylinder so it is free to move.
4. Undo the mechanism used to hold the ATC door in place during shipment.

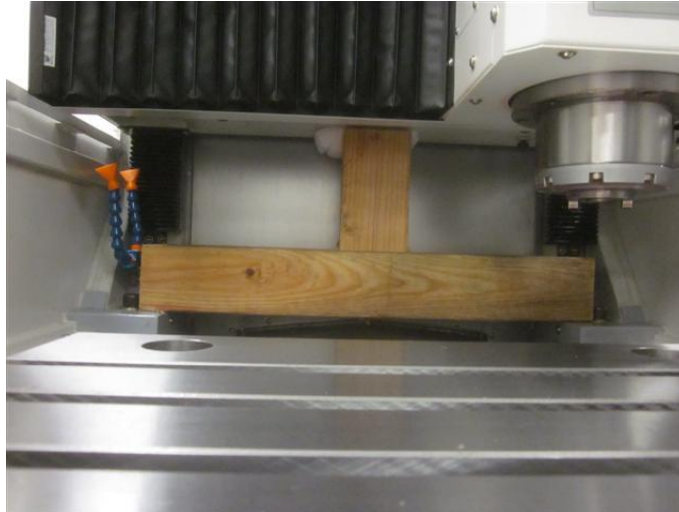


Figure 3.2

## 3.3 Shortages: Inventory Checklist

The following items will come with the 2 OP mill. Please note if the optional items that have been ordered are present.

### **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.

### **Loose Accessories Checklist**

Pallet Jack – see figure 3.1b above.

#### Box #1

- (1) Set of touch-up paint (1 can RAL 7035, 1 can RAL 7040 & 1 can of hardener)
- (4) leveling feet

#### Bracket fastened to machine and need removal

Head shipping bracket

#### Hardware Kit Box – P/N 27651

1. 27104-2 – CD containing 2 OP Programming and Service Manuals
2. 28005 – 2 OP Programming and Operating Manual

#### Potential Optional Items

1. Fixture Plate
2. Vise Fixture Plate Kit – includes aluminum fixture plate, fence and vise stop assembly

3. Vise Stop Assembly
4. Retention Knobs – a kit of 8 knobs
5. Primary Liner Kit – comes with 8 liners
6. Secondary Liner Kit – comes with 8 liners
7. Ball Lock Clamping Kit – comes with 4 clamping shanks
8. **6" Kurt Vise**
9. USB Memory
10. BT30 Tooling Kit
11. Tooling Cart

### 3.4 Installation Checklist

**Installer – Use this checklist to assure a complete setup on the 2 OP mill.**

<input type="checkbox"/>	1. Shut off power to the machine and disconnect the quick disconnect power cord from the machine.
<input type="checkbox"/>	2. Visually inspect the 220 volt cable (or 440 volt cable if option is installed) going into the electrical panel. Visually verify the wiring is correct per our wiring diagram and the voltage is between 208 and 240 volts or 400 and 480 volts. Have the customer resolve any voltage discrepancies. Do not turn on machine if voltage is outside of ranges listed above.
<input type="checkbox"/>	3. Measure the 115 volt power coming out of the transformer. The voltage can be adjusted by switching wires on the transformer taps. Ideally we would like between 115 and 120 volts coming out of the transformer. The wires to the primary side of the transformer may also need to be adjusted. See section 2.4.17 for more information.
<input type="checkbox"/>	4. Clean the machine if needed and remove any remaining protective grease.
<input type="checkbox"/>	5. Remove the head support bracket and parts used to hold the ATC in place. <b>WARNING! Refer to section 3.2 before proceeding.</b> Install the door handle on front door.
<input type="checkbox"/>	6. Re-attach the Z cable carrier if it has been disconnected for shipping purposes.
<input type="checkbox"/>	7. Turn on the power to the machine. Verify the lube pump cycles 1 time when machine is turned on. You can use service code 300 to manually lubricate the machine.
<input type="checkbox"/>	8. Press the servo on button to make sure the axis motors are activated. The screen should change from saying SERVO OFF to SERVO ON.
<input type="checkbox"/>	9. Check that the air pressure on the air regulator is set to 90 psi
<input type="checkbox"/>	10. Press SET HOME to home machine. Did the X axis home properly? Did the Y axis home properly? Did the Z axis home properly?
<input type="checkbox"/>	11. Adjust leveling feet as necessary to insure good spindle tram. We recommend the tram be checked each time the machine moves around the shop. Make sure the leveling feet are threading into the spacer blocks so the machine sits about 5 1/2" off the ground.
<input type="checkbox"/>	12. In DRO mode, turn the spindle on and then turn the coolant pump on by pressing the coolant AUX button.
<input type="checkbox"/>	13. Go to DRO mode and move each axis in a positive direction. Select the X axis, does the spindle head move to the right when turning EHW CW? Select the Y axis, does the saddle move toward the operator when turning the EHW CW? Select the Z axis, does the head move up when turning the EHW CW? Check that 1 click of the EHW in <b>0.020"</b> mode is <b>in fact 0.020"</b> .
<input type="checkbox"/>	14. Double check the motor index angle for each axis using service code 505. If this needs to be modified, then the ATC tool change locations and ball lock location may need to be reset in services codes 520 and 500 respectively.
<input type="checkbox"/>	15. Final test each axis by jogging (turning EHW) at 0.020" speed into the soft limits. Verify the machine does not hit the hard stop on the machine. Re-adjust limit switch cam if it does. Service Code 500 and 520 may need to be performed if major adjustments have been made



	to the X and Y axis limit/home locations. Service code 505 must also be run to reset the soft limits on all axes.
<input type="checkbox"/>	16. Check to make sure that the E-Stop button is functioning correctly. Turn spindle on and jog an axis using the EHW. Press the E-stop button during this operation and verify the spindle and axis stops. Make sure the Z axis does not move when the E-stop is pressed. The brake on the Z axis motor will hold the head.
<input type="checkbox"/>	17. Is the spindle motor fan running? Air should be blowing down over the spindle motor.
<input type="checkbox"/>	18. Close the door and make sure the control recognizes the door as being closed. When the door is open a DOOR OPEN message should be on the screen when in DRO mode. It goes away when the door is closed.
<input type="checkbox"/>	19. Press the manual tool change button on the head (GREEN button) and make sure air is coming down through the spindle. This can be adjusted, see pneumatic system drawing 27563.  Put a tool in the spindle and verify the tool clamps once the green button is released.
<input type="checkbox"/>	20. Go to SETUP mode and press LOAD TOOLS. Follow the message and press GO. The ATC should come forward. Remember the door must be shut. Hit RETURN once it comes out and it should prompt you to press GO again to move it back.
<input type="checkbox"/>	21. Physically load a tool in and out of the ATC to make sure the orientation angle and tool change height are correct. This can be done by pressing the TOOL IN ATC or TOOL OUT ATC buttons. Check all 8 stations to make sure tools load properly. If there is a problem with the X or Y location, adjust tool locations with service code 520. The Z tool change height can also be adjusted with code 520.
<input type="checkbox"/>	22. Turn off air to the machine and verify the control recognizes low air pressure. There should be a warning message on the screen that says low air pressure.
<input type="checkbox"/>	23. Run spindle in DRO at low speeds.
<input type="checkbox"/>	24. Spindle head test Run spindle at 1000 RPM for 5 minutes Run spindle at 5000 RPM for 5 minutes. Make sure the spindle brakes properly from 5000 RPM. It should stop in 6 seconds or less. Run spindle at 500 RPM increments for a few seconds per increment. Please note any of the following: Head noise, excessive heat on spindle, vibration, spindle fan noise.
<input type="checkbox"/>	25. Write a simple program with multiple tools called out and run program to make sure everything runs properly, including changing tools in the ATC. Try to use actual tools when running this program.
<input type="checkbox"/>	26. Double check the position of lower left hand corner ball lock location. Modify service 500 as necessary.
<input type="checkbox"/>	27. Make sure coolant wash down lines are adjusted properly. See section 5.10 for a picture of how they should be adjusted. One line should be directed toward the rear door and one toward the rear of the table to wash chips away so they do not interfere with the ATC.
<input type="checkbox"/>	27. Wipe down machine.

### 3.5 Electrical Connections

The 2 OP mill comes with a 220 or 440 volt power cord/plug so the machine can be easily moved around the shop. The female connector that needs to be provided by the end user should match the connector that we provide. Attached is a picture of the plugs we provide. From left to right they are as follows: 220 volt 3 phase 30 amp plug, 440 volt 3 phase 20 amp plug and single phase 220 volt 30 amp plug.



Figure 3.5

The user must provide a power circuit that provides 3 phase 220 voltage 20 amp capacity (208 – 240 V acceptable) or 3 phase 440 voltage 10 amp capacity (400 to 480 V acceptable).

## 3.6 Air Connections

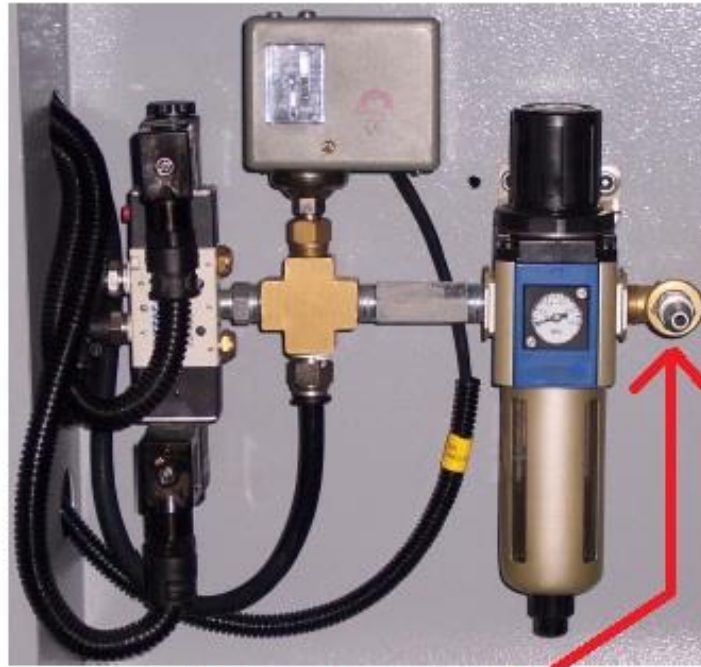
### 3.6.1 Air Connection

Connect the air supply to the quick disconnect coupling to the left of the pressure regulator. The air supply line should have a minimum of  $3/8$ " inside diameter. It is recommended that a water separator or air dryer be installed upstream of the 2 OP air supply. See the pneumatic drawing 27563 for where the air is connected to the machine and all other pneumatic information.

### 3.6.2 Air Regulators and Solenoids

The 2 OP consists of a main air regulator, air pressure switch, door pressure regulator, multiple air flow valves, 2 solenoid valves, check valve and an exhaust valve. They are all set at the factory but should be checked upon installation.

The main air regulator for the machine should be set at 90 psi. The regulator is adjusted by pulling the cap upward and rotating the cap clockwise to increase the air pressure and CCW to decrease the air pressure. The air regulator/filter will filter out debris and some water or oil. Once the regulator is filled with up to a point with water or oil, it will automatically drain this water or oil out through the black cap found at the bottom of the assembly.



**Incoming Air**

Figure 3.6

### 3.7 Cleaning the 2 OP

**Warning!**

Do not use water based cleaning agents for cleaning the machine.

1. Remove all the cardboard and protective plastic sheeting from the machine.
2. With a soft plastic scraper, remove all the protective grease from the machine. DO NOT USE ANY SHARP OBJECTS ON THE LINEAR GUIDEWAYS OR THE BALL SCREW. USE ONLY LINT FREE CLOTH IN THESE AREAS. It may be necessary to move the table, head left and right, up and down when cleaning.
3. When cleaning the front window, use a suitable cleaner that DOES NOT contain ammonia or solvents that could damage that polycarbonate windows.

### 3.8 Leveling Procedure

Leveling the 2 OP mill in the field consists of leveling the machine and then modifying the level, if necessary, to make sure the tram of the spindle is perpendicular to the table.

**Leveling the 2 OP**

1. Set the machine on its 4 leveling pads LF (left front), RF (right front), LR (left rear), & RR (right rear) on a solid, level floor prepared in accordance with the state and local rules for machine tool installation.
2. Clean the table thoroughly and place 1 or 2 precision Spirit levels or electronic levels in the center of the table in the positions illustrated in figure 3.8.

**Caution!**

If using 2 levels, make sure each level is measuring correctly. To check, place the level in one direction and note reading and then flip 180° and see if the reading is the same. If not, have the level recalibrated.

3. Leveling is achieved by using leveling screws LF, RF, LR and RR. Make sure each foot has weight on it.
4. With the precision levels placed on the worktable as shown in figure 3.8, level the 2 OP to within 0.0005"/10 in.
5. When machine is correctly leveled, lock the leveling feet in place with their hex nuts.

### **Modifying Level for Tram**

1. Mount the .0001" test indicator to the spindle nose and sweep the table with a 12" span (6" radius).
2. If the tram measurement is not .001 TIR, adjust the leveling feet according to the error you see. It is common to need to adjust the front left or right corner to adjust the tram along the X axis.
3. Once complete, lock all leveling screws in place with the lock nuts.

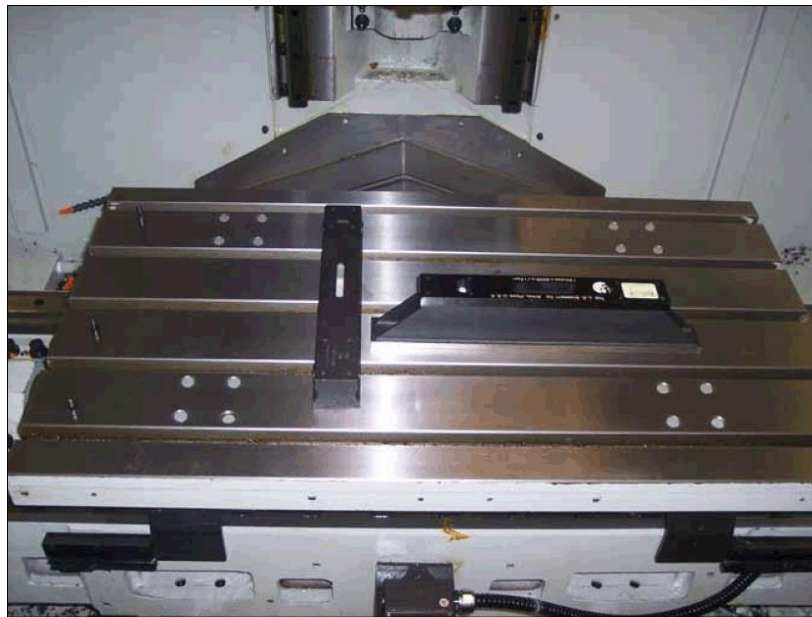


Figure 3.8

## 3.9 Lubrication

### 3.9.1 Way Lubrication

The auto lube system provides centralized automatic lubrication for the linear guides and ballscrews. The lube pump's 1-liter reservoir is serviced with Mobil Vactra Oil No. 1 or equivalent. The lube pump cycles automatically 1 time upon initial startup of the control and then 1 cycle for every 30 minutes of axis movement time. Each cycle of the lube pump lasts for 4 seconds or so and provides oil to the linear guides and ballscrews.

Discharge Pressure - Approximately 140 psi

To adjust the amount of Discharge Pressure displayed on the lube pump gauge, turn the adjustment screw clockwise to increase the pressure. 1 turn of this screw will raise the pressure about 100 psi.

At the beginning of each day, check the oil level in the Auto Lube system. If low, fill with an ISO32 oil (ex. Mobil Vactra Oil No. 1) or equivalent.

#### CAUTION!

Failure to manually activate the pump at the beginning of each day if the control was left on and the machine has been idle for a long period of time may cause severe damage to the linear guides and ballscrews.

To manually activate the lube pump, use service code 300. Repeat this process 2 or 3 times.

See lubrication system drawing 27591 for an overview of the system.

### 3.9.2 Other Lubrication Points

1. **Tool Change Air Cylinder Oil Cup supplies oil to the "Air Over Oil" cylinder and should not require replenishment. However, if required, fill the oil cup on the front of this cylinder with an ISO32 oil or equivalent.**
2. Grease fittings on ATC
3. Apply a good grade of general-purpose lithium based grease (#1.5 or 2) like Shell Gadus S5 V460 1.5 or equivalent through the grease fittings found at the rear of the machine that supply grease to the ATC linear guide blocks. The manufacturer of the linear guide blocks recommends 1 cm<sup>3</sup> of grease every 100 kilometers of travel. This equates to ~ 100000 tool changes. The frequency of adding grease should be based on how many tools changes you make per day. See figure 3.9.

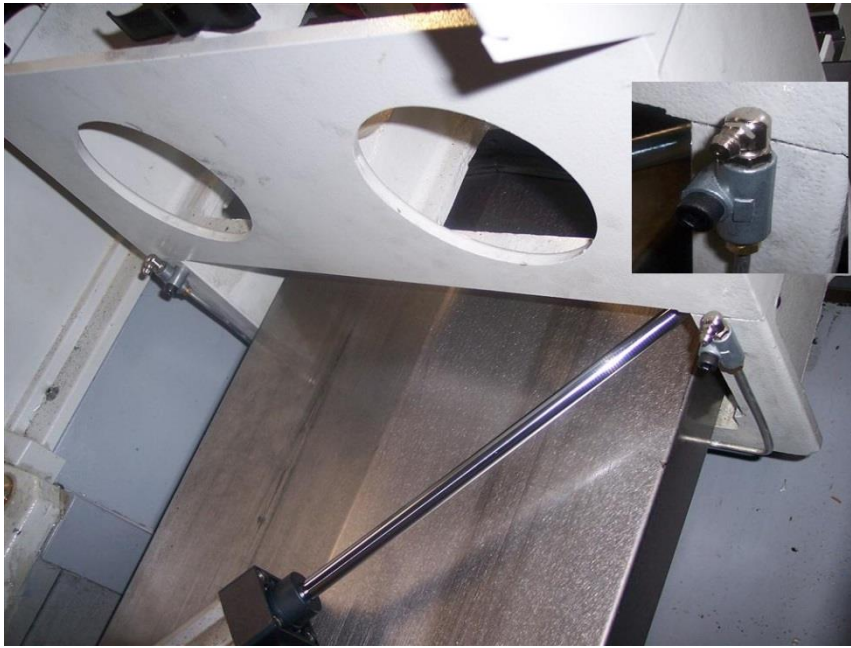


Figure 3.9

### 3.10 Moving the 2 OP Mill Around the Shop

The 2 OP mill was designed so it can be easily moved around the shop with the pallet jack that comes with the machine. Please follow the instructions below when moving the machine.

- I Machine relocation must be done by employees who are qualified and properly trained.
- II When moving machine using the SWI supplied pallet jack, following conditions must be satisfied:
  1. The floor must be structurally rated to support and transport this machine (total machine weight without any accessories is approximately 2500 lbs).
  2. The floor must be relatively flat and with a maximum slope not to exceed  $\frac{1}{4}$  inch /foot anywhere along the transportation path.
  3. Any steps, gaps or cracks in the floor that the pallet jack must go over, must be less than  $\frac{1}{2}$  inch high, wide, or deep.
  4. The minimum door opening for machine to go through is 32 x 94 inches.
  5. **For best results, clear a 4' wide path for transportation prior to actually moving the machine.**

TO MOVE THE MACHINE, PLEASE FOLLOW THE STEPS BELOW:

1. To prepare machine for relocation, move the X-axis to the approximate center, move the Y-axis all the way toward the door (front) until the (soft) limit is reached, move the Z-axis down until (soft) limit switch is reached.
2. **Power down, and disconnect the machine's** electrical power cord, and any other accessory cables connected to the machine.
3. **Disconnect the machine's compressed air supply hose, and any other accessory hoses or attachments** connected to the machine.
4. Close front door and check to make sure that nothing else is attached to the machine.
5. Check to make sure that the floor is free of any objects which may obstruct the movement of the pallet jack wheels or the machine along its transportation path.

6. Make sure that the door openings along the transportation path are adequate for the machine to go through.
7. For Front or Rear pickup; roll the pallet jack under the machine (roughly centered), as far as possible. Make sure that the pallet jack rails will positively support the front and rear structural cross-members of the base casting. From the Right or left side pickup, roll the pallet jack all the way as far as possible, where indicated on the side of the machine, to properly balance the machine load.
8. Lift the machine about 1/2-3/4 inches off the floor. **Note: never push or pull machine using the door handle.** While pulling, pushing and steering, monitor the movement of the machine to make sure that it does not run into or catch on anything during transportation. Carefully move the machine to the new location.
9. Once at the new location, **Slowly and Carefully** lower the machine down to the floor, and stow away the pallet jack.
10. Connect the electrical power cord, compressed air hose, and any other accessories disconnected before the move.
11. **Power up the machine and check machine's tram, if necessary, adjust the machine leveling feet to achieve the desired tram result.** All four legs must touch the floor.

### 3.11 Cutting the Euclid Test Block

The test part may be machined at the completion of the installation. (see figure 3.11)

Material Specification: Aluminum, 6061-T6 or T4

**Blank Size: (minimum dimensions) 3 x 3 x 1"**

Tool: 1/2" end mill, 2 flute, high speed steel, **sharp**

Coolant: Flood coolant

1. Mount vise and **indicate the back jaw parallel to the table within .0005"**. Use fixture vise plate if customer ordered this option.
2. **Clamp material in vice with a minimum of 0.800" above the vise jaws.**
3. Load in the Euclid block program into the ProtoTRAK TMX C drive, it is part number 99999998.PT4.
4. Use an edge finder to set your offsets for X, Y and Z. Absolute zero is the front left corner of the block as viewed from in front of the machine.
5. Go to the tool table and set the Z offset height for your tool.
6. Load this tool into the spindle.
7. Press the AUX button to turn the coolant on if you are going to use flood coolant.
8. Begin to run the program by pressing RUN, START and GO. The part will be machined in the following sequence:

Description	Depth of Cut
circle pocket – cuts middle circle	-0.250"
circle frame – cuts outer 1.830 diameter circle	-0.250"
circle frame – cuts material from corners remaining on Euclid block	-0.250"
roughs material in upper right-hand corner	-0.500"
cuts triangle on Euclid block	-0.500"
rectangular frame – cuts outer 2.750" rectangle	-0.750"
position to 1.318 on X and Y	+10.000"

9. After the program run, the program will locate to the following position.

X = 1.318

Y = 1.318

10. Mount a dial indicator in the quill and check the circles.

11. Check the runout of the sides of the square frame.

12. Inspect the machined surfaces for smoothness.

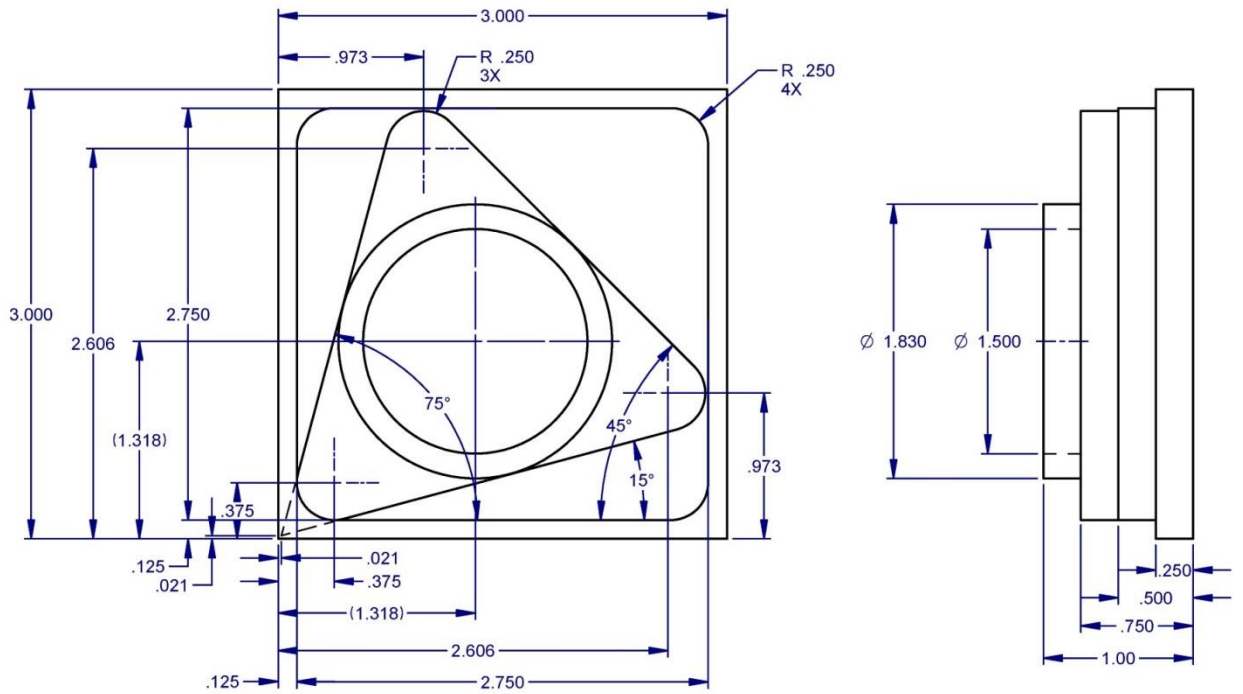


Figure 3.11



## 4.0 Troubleshooting by Symptom

Use this section to begin the process of resolving a service problem. Each symptom 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.

### 4.1 Machining Problems

#### 4.1.1 Poor Finish

The part finish is marred with scallops or is very rough.

Do the following Service Codes and document values:

- **Code 33** - Software Identification. This is needed if you call SWI Customer Service
- **Code 128** - Enter backlash compensation

Possible Cause	Check This
Too much backlash entered for code 128.	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 5.1
Inadequate or no Lubrication to Ballscrews and Linear Guide surfaces	Make sure all the Linear Guide 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 3.9
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 5.2
Linear Guide surfaces are scarred, exhibit noise or vibration, or are excessively worn	Visually check the condition of all the Linear Guide surfaces. For machines that may have excessively worn Linear Guide surfaces, a trained SWI Technician may need to inspect this area to determine if they need to be replaced. Check lubrication to affected areas.

#### 4.1.2 Circles Out of Round

Circles are not round within 0.002" TIR over a 1.830" dia. This is best measured by placing a dial indicator in the spindle and sweeping around circle on the euclid block part.

Do the following Service Codes and document values:

- **Code 33** Software Identification. This is needed if you call SWI Customer Service
- **Code 128** Enter backlash compensation

Possible Cause	Check This
Backlash values set too high or low	Check code 128. Typically values for backlash should be less than 0.002". <b>Reset values as necessary.</b>
Machine Tool and Setup problem	Check for any looseness in the setup (Tool, Tool holder, Part, Vise, or Fixture). See Machine Tool & Setup - Section 5.1

Machine not level	Verify that the machine is level to specification.
Head is not trammed	Verify that the Head is trammed to specification.
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.
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 5.2

### 4.1.3 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 a 1.830" DIA (assumes cutting euclid block)
- **Positional Accuracy:** 0.0005"
- **Repeatability:** 0.0005"

Do the following Service Code:

- **Code 33** Software Identification. This is needed if you call SWI Customer Service
- **Code 123** Calibration
- **Code 128** Enter backlash compensation

#### 4.1.3.1 Every Part Has the Same Error

Possible Cause	Check This
Machine Tool & Setup problem	See Machine Tool & Setup Section 5.1
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 that has been erased or corrupted.	Recalibrate the system.
Backlash problem	Unusual high backlash values are causing slight variations in your part dimensions. Values for backlash should be less than 0.002".

#### 4.1.3.2 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 5.1
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 5.2

## 4.2 Motion Related Problems

### 4.2.1 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 or following error building up on that axis. Following error is when the control sends a signal to the motor and the motor does not respond as it should. Once the error builds up to a certain point this will lead to a following error fault.

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 feed rate of an axis and if the encoders are counting and are they counting in the correct direction.
- **Code 131** turn the X or Y axis ballscrew manually to make sure the motor encoder counts. Each axis should count 6mm (0.236") per revolution of motor. Verify that all 6 LEDs for the encoder signals of each axis turn off and on as the motor is rotated slowly. When checking Z-axis remove belt and rotate motor.

Possible Cause	Check This
Poor cable connection	Check the cable connections at the computer module
Bad Motor Encoder	See Motor diagnostics section 5.5
Computer module	See computer module diagnostics section 5.3

### 4.2.2 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 feed rate of an axis and if the encoders are counting and are they counting in the correct direction.
- **Code 503** Sets the maximum rapid feedrates of the machine.

Possible Cause	Check This
The user has set the feedrate override to something less than 100% and hence the machine is moving slower	Check feedrate override.
Service code 503 set to a low value and now the machine is running that rapid speed	Check the setting of service code 503. See service code diagnostics section 5.11
The control is automatically slowing down the feedrate because the control is not capable of running at the programmed feedrates and minimizing the following error.	Use lower feedrates when programming or change the tool path so the change in direction is not as abrupt.
Inadequate or no Lubrication to Ballscrews and Linear guides	Make sure all the ballscrews and linear guides 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 3.9
Binding in the Drive Train	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 5.2

### 4.2.3 Axis Will Not Jog with Electronic Handwheel

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

Do the following Service Codes and procedures:

- **Code 33** Software Identification. This is needed if you call SWI Customer Service
- **Code 132** Each revolution of the EHW should display 100 counts on the screen
- Check the LED lights on the computer module as you turn the EHW. See section 5.3 for more information.

Possible Cause	Check This
Software may be in an indeterminate state	Press the MODE button and reenter the same screen and see if EHW works.
E-Stop is pressed in	Check E-Stop. Make sure the servo ON button has been pressed to energize the servo system.
EHW has failed	Verify the wiring of the EHW and replace as necessary. If only 1 axis will not jog, then it is not the EHW.
Poor cable or wiring connections	Remove programming panel and check cable connections
Servo Motor/Drive failure	Especially, if only one axis will not jog; See motor/servo diagnostics section 5.5
Computer module failed	See Computer module diagnostics Section 5.3

### 4.2.4 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 100** Axis open loop test. Used to check the maximum feed rate of an axis and if the encoders are counting and are they counting in the correct direction.
- **Code 128** Enter backlash compensation
- **Code 131** turn the X or Y axis ballscrew manually to make sure the motor encoder counts. **Each axis should count 6mm(0.236") per revolution of motor. Verify that all 6 LEDs for the encoder signals of each axis turn off and on as the motor is rotated slowly.** When checking Z-axis remove belt and rotate motor.

Possible Cause	Check This
Excessive backlash value entered	Go to service code 128 and note value of backlash for axis in question. Values should be less than 0.002"
Motor encoder Failure	Motor diagnostics section 5.5
Binding in the Drive Train	Check for excessive backlash in the drive train. 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 5.2

## 4.2.5 Vibration at Rest

While axis is holding position there is vibration or noise coming from the X, Y or Z-axis.

Do the following Service Codes and procedures:

- **Code 127** Measure's the backlash in the system.
- **Code 128** Enter backlash compensation
- Turn the EHW on the axis in question and see if the noise goes away.

Possible Cause	Check This
Too much backlash entered in Code 128	Recheck the machines backlash. Values should be less than <b>0.002"</b> .
Inadequate or no Lubrication to Ballscrews and linear guides	Make sure all the ballscrews and linear guides 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
Binding or looseness in the Drive Train	Check for excessive backlash on an axis. 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 5.2

## 4.2.6 Searching Axis

The DRO screen is flickering back and forth when the servos are engaged. Several ten thousandths of motion are observed and the frequency is one cycle every couple of seconds.

Do the following Service Code and procedures:

- **Code 127** Measure's the backlash in the system.
- **Code 128** Backlash compensation
- Check to see if the searching goes away when you turn the EHW and move the axis in question.

Possible Cause	Check This
Most often caused by excess backlash compensation	Check physical backlash in system and re-enter in code 128.
Looseness or excessive friction in the drive train	The drive train of the axis that is searching, especially the tightness of the drive assembly. See Mechanical Drive Train (X, Y) - Section 5.2

## 4.3 Control Related Problems

### 4.3.1 Blank Screen – Black or Blue

The display is a 5" LCD that connects to the computer module via the VGA port. The LCD is driven by 12VDC coming from the computer module through the Overlay Interface PCB.

The display is completely black with no text or video on the screen.

Please also read section 4.3.6, as this is a similar symptom.

Possible Cause	Check This
Power failure to the Computer Module.	Verify that 115VAC is supplied to the computer module and that the fuse is okay.
LCD Power is OFF.	Verify that the LCD power LED is on and green. Press the LCD power button on the LCD User Board inside the Panel Assy. See drawing 27604.
Connection problem with the Overlay Power cable.	Verify that the Overlay Power cable is connected properly from the computer module to the Overlay Interface Board inside the Pendant.
Connection problem with the LCD 12VDC Power cable.	Verify that the LCD 12VDC Power cable is connected properly between the Overlay Interface Board and the LCD Controller board inside the Pendant.
Connection problem with LCD Digital cable.	Verify that the LCD Digital cable is connected properly between the LCD Controller Board and the LCD.
LCD Power failure.	Verify that the LCD power LED on the LCD User Board is on and green. Verify that the 12VDC green LED (D26) on the Overlay Interface Board is on.
Computer Module failure.	See Computer Module diagnostics, Section 5.3
LCD Controller Board failure.	See Program Panel diagnostics, Section 5.4
Overlay Interface Board failure.	

The display shows a blue screen with a no signal (Primeview) or no syn text (Multi Inno) on the screen.

Possible Cause	Check This
VGA cable is not connected correctly	Verify connection at computer module and at programming panel.
Computer module failure	See computer module diagnostics, section 5.3
LCD controller board failure	See programming panel diagnostics, section 5.4

The display shows a blue screen with an AVI (Primeview) or AV (Multi Inno) error on the screen.

Possible Cause	Check This
User interface board selection problem	Press the source button until it displays RGB.
LCD controller board failure	See programming panel diagnostics, section 5.4

### 4.3.2 Distorted Video on Display

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

Possible Cause	Check This
Connection problem with the LCD Digital Cable.	Verify that the LCD Digital cable is connected properly between the LCD Controller Board and the LCD.
Connection problem with the VGA cable connection.	Verify that the VGA cable is connected properly between the Computer Module and the LCD Controller Board.
LCD Controller Board failure	See Program Panel diagnostics, Section 5.4
Computer Module failure	See Computer Module diagnostics, Section 5.3

### 4.3.3 Overlay Key Not Responding

The screen display is normal, but the system will not respond to an Overlay key press. Utilizing an external keyboard or mouse the system will respond.

Do the following Service Codes and procedures:

- **Code 81 (Programming Panel Key)**

To check if the Programming Panel keys are working properly, press each key. If the key is working, the corresponding key on the screen will light up. The pendant will also beep.

Possible Cause	Check This
Software is in some indeterminate state.	Press the E stop, then servo on button and see if overlay not responds.
Overlay cables are loose or not seated	Check the 3 overlay cables to make sure they are seated properly to the overlay interface board.
Connection problem with the Overlay Power cable.	Verify that the Overlay Power cable is connected properly from the computer module to the Overlay Interface Board.
Connection problem with COM port cable.	Verify that the COM port cable is connected properly from the computer module to the Overlay Interface Board.
Computer Module failure	See Computer Module diagnostics, Section 5.3
Overlay Interface Board failure.	See Program Panel diagnostics, Section 5.4
Programming Panel Failure	See Programming Panel diagnostics, section 5.4

### 4.3.4 Axis Faulting

The program run or jogging operations are interrupted with an Axis 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 100** Axis open loop test. Used to check the maximum feed rate of an axis and if the encoders are counting and are they counting in the correct direction.

Possible Cause	Check This
Connection problem with Motor Encoder cable.	Verify that the Motor Encoder cable is connected properly to the computer module
115 Power Input too low.	Verify that the 115VAC voltage is between 115VAC and 125VAC. Move 115VAC tap on Transformer to obtain optimal voltage.
Connection problem with Motor Power cable.	Verify that the Motor Power cable is connected properly to the computer module
Excessive friction in the slide ways	See Machine Tool & Setup Section 5.1
Binding or looseness in the Drive Train	See Mechanical Drive Train (X, Y) Section 5.2
Motor/Servo Drive failure	See Axis Motors/Servos Section 5.5
Computer Module failure	See Computer diagnostics, Section 5.3

### 4.3.5 Problems Reading or Saving to the USB Drives

The USB port is USB 2.0 version. Only USB Drives formatted with FAT16 or higher should be used.

Do the following Service Codes and procedures:

- **Code 320** – if it takes 10 or so seconds to read your USB device when you plug it in, it most likely means that Windows is loading the proper driver. Use this service code to save this driver which will allow it to load automatically when you power up the ProtoTRAK each time thereafter.

Possible Cause	Check This
Make sure folder which programs are saved on the USB device is named properly.	The folder on the USB device should be called 2 OP PROGRAMS. This folder can be created automatically if you save a program.
USB Drive failure	See USB drive might not be compatible with system or has failed. Verify that the USB Drive supplied with the system is functional.
USB device is full	Check USB device for memory with service code 327
Connection problem with USB cable.	Verify that the USB cable is connected properly from the Computer Module to the programming panel
Computer Module failure	See Computer diagnostics, Section 5.3

### 4.3.6 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
Connection problem with the 115VAC cable.	Verify that the 115VAC cable is connected properly to the computer module.
Computer Module fuse is blown.	Remove fuses and check continuity.
Computer Module failure.	See Computer diagnostics, Section 5.3

### 4.3.7 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
Connection problem with the 115VAC cable.	Verify that the 115VAC cable is connected properly to the computer module.
Computer Module failed	See Computer diagnostics, Section 5.3



### 4.3.8 System Shuts Off

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

Possible Cause	Check This
Fuse blown in computer module or transformer fuses are blown.	Remove fuse and check continuity
Connection problem with the 115VAC cable.	Verify that the 115VAC cable is connected properly to the computer module.
Computer Module failure	See Computer diagnostics, Section 5.3

### 4.3.9 Coolant Pump Not Working

The coolant pump is controlled by the AUX button in run mode. When pressed it will show the status of the auxiliary function in the status line. To test, you can go to DRO and press the AUX button to turn the pump on.

Possible Cause	Check This
The output from the computer module is not working	Check the F1 fuse coming out of the computer module. Turn the coolant pump on and check for 115 VAC coming out of the computer module. If no voltage, then replace computer module
Pump has failed	Check voltage at pump and replace as required.

### 4.3.10 E-Stop Error

The E-stop stops the spindle and axis motors when pressed.

Possible Cause	Check This
Connection problem with the E-stop cable.	Verify that the E-stop cable is connected properly from the E-stop button to the Electrical cabinet. Verify the E stop input LED turns on at the computer module.
E-stop button failure	Check continuity with ohm meter across E stop terminals. It should be zero ohms when the E stop is in the out position.
Computer module failure	Verify the LED on the E-stop turns on.

### 4.3.11 Homing Error

The homing function is a very critical function that locates and identifies the absolute machine zero position. This function is to be performed every time the system has been turned on or reset. The homing function will cause each axis to move in the most positive direction that it can.

**WARNING407: HOMING ERROR**

Servo cannot home to machine zero.

Check machine and try again. If the problem persists, call for service

If a homing error occurs these are some of the possible causes.

Possible Cause	Check This
Door is open.	If the Door is open the homing routine will not run.
Home Switch failure.	The system will move the axis to the home switch when homing. If the switch is not seen by the system that axis will hit the hard stop and produce a servo fault error. This is noticeable because the axis will move only toward the end stop, it will not back up away from the stop. Check the 3 home switch input lights on the computer module when the switch is activated.
Motor encoder failure	See Motor diagnostics, Section 5.5. Check if software sees index angle on motor and reset once motors rotates 360 degrees.
Computer Module failure	See Computer diagnostics, Section 5.3.

## 4.4 Tool Changer Problems

### 4.4.1 Automatic Tool Changer (ATC) will not move

When a tool change is commanded, the ATC will not advance towards the front of the machine.

Possible Cause	Check This
Is the door open	Make sure the door is closed and there is no door open message on the screen.
The computer module is not outputting the command to move the ATC	Check the ATC front LED output on the computer module.
Compressed air not being supplied to the machine.	Is air connected to the machine? Has the air pressure been turned down at the pressure regulator? It should be set at 90 PSI
Low air pressure. A low air pressure warning should appear on the screen when the air pressure falls below 60 psi.	Make sure the machine is receiving 90 PSI. The tool carrier should still move if the air pressure is low.
Something is obstructing the movement of the ATC sliding assembly.	Switch off the air. Open the ATC cover and try to slide the tool carrier. Visually inspect for any foreign objects that may be preventing the movement of the ATC.
There is an air leak in one of the air lines feeding the ATC in/out pneumatic cylinder.	With the air switched on, inspect the air lines and fittings for a leak.
ATC in/out pneumatic cylinder is faulty	Check for air escaping from the ATC in/out pneumatic cylinder.
The solenoid labeled 2 on drawing 27563 has failed	If the solenoid is receiving a signal from the computer module, then press the red button to fire the solenoid to see if it works when commanded manually. Make sure the table and head are in the proper place prior to doing this.
The ATC door assist cylinder flow controls are closed too much, or the cylinder is jammed so it cannot move	Check if the cylinder is free to move and pivot. Check if the flow controls on the door lift are set per recommended settings as described in section 5.9 of this manual.

### 4.4.2 Spindle will not orientate properly

Each time a tool change is performed, the spindle must orientate the spindle so the dogs line up with the ATC fingers that hold the tool.

Do the following Service Codes and procedures:

- **Code 510 – Spindle Setup, set spindle orientation**

Possible Cause	Check This
The coupling that couples the motor to the spindle has come loose	This is only likely after a heavy crash on the machine. If this happens you will need to perform service code 510 - spindle orientation to resolve the issue.
The spindle encoder is not being read properly.	There is an index mark on the spindle encoder that we are reading to orientate the spindle. Check this by running service code 510. Make sure parameter 10-19 in the AC drive matches the value set in service code 510
Poor cable connection at spindle encoder, AC drive or computer module.	Check the cable connection at the spindle motor and AC drive. Also check the cable that runs from the AC drive to the computer module
Spindle Encoder Failure	Verify that all the encoder signals are being sent to the AC drive by verifying the LEDs for Channel A, B and Z are turning ON and OFF when the spindle is rotating.
Spindle drive failure	Replace drive
Computer module failure	Replace computer module. See section 5.3

### 4.4.3 Tool will not clamp or unclamp in the spindle

The automatic draw bar uses pull fingers that close down and pull up simultaneously on the retention knob to lock the tool holder into the spindle taper. These fingers act in the opposite fashion to release the tool holder. Tools can be clamped and unclamped manually by pressing the green button on the head. See section 4.5.5 as well.

Possible Cause	Check This
The control thinks the door is closed when pressing the green button on the head.	The door must be open for the green button to work
No or low air pressure	There is no air being supplied to the machine. Is the pressure regulator set at 90 PSI Is there a leak in the pneumatic system?
Are the tool holder(s) or the spindle taper bore dirty?	Examine the spindle taper bore and the tool holder for <b>embedded chips and "tackiness" from excessive coolant residue</b> . Sometimes tools that are worn or have defects on the taper will stick in the spindle.
The retention knob you are using is not correct for this machine	See section 2 for an illustration of the correct retention knob.
Loose tool holder retention knob	Check that the retention knob is tightened to the torque value of between 70 and 85 ft lbs
Belleville washers are damaged, worn or fatigued.	With a BT30 tension gage, check the pull strength of the draw bar, it should be approximately 1000 lbs.
The pull fingers inside the spindle have become loose	Check the fingers are tightened to the torque value of 20 ft lbs.
The pull fingers inside the spindle have been damaged	Remove the pull fingers and visually inspect for damage and replace as necessary

#### 4.4.4 Air is not blowing through the spindle during a tool change

Air should blow through the spindle when a tool holder is being removed, whether automatically or manually. The amount of air that flows down the spindle is controlled by a flow control valve at the rear of the machine. See drawing 27563. Press the green button on the head when the door is open to check this.

Possible Cause	Check This
No or low air pressure	There is no air being supplied to the machine. Is the pressure regulator set at 90 PSI Is there a leak in the pneumatic system?
The flow control valve is not adjusted properly	Check that the flow control valve is adjusted outward from the closed position.
There is a blockage	Check that there are no kinked lines.
The solenoid labeled 1 on drawing 27563 has failed or is not receiving an electrical signal.	If the solenoid is receiving a signal from the computer module, then press the red button to fire the solenoid to see if it works when commanded manually. Make sure the table and head are in the proper place prior to doing this.

### 4.5 Control Input or Output Problems

#### 4.5.1 Control reports low air pressure

The Control has the ability to display a number of different messages depending on the status of the machine. A low air message would be displayed as 'AIR PRESSURE LOW'. The following chart describes possible causes to this condition.

Possible Cause	Check This
Air line pinched	Check that air hose is not pinched or bent.
Air pressure not set	Check air regulator for the correct psi setting. Verify that it is set to 90psi.
Air pressure sensor not working	Check the air pressure sensor is set to 60 psi. Check that the computer module sees the air pressure input. A green LED should be on.
Computer module failed	See computer module diagnostics, section 5.3

#### 4.5.2 Status Light is not functioning correctly

The beacon light is used to identify the state of the program in RUN mode. The Green beacon light indicates that the program is running. A flashing green light indicates the machine is waiting for the operator to start the next program.

Do the following Service Code:

- **Code 521 – Input/Output Service Code**

Possible Cause	Check This
Beacon light failed	If the computer module output LED for the beacon light is on then the light or bulb may have failed.
Computer module failed	See computer module diagnostic, Section 5.3

### 4.5.3 Lube pump not working

The lube pump plays a key role in assuring the performance and durability of the 2 OP. Lack of lubrication can lead to problems with your machine motion due to increased friction on the sliding ways. This lube pump is set to lubricate the sliding ways and ball screws upon initial power up of the control and every 60 minutes of axial movement.

Do the following Service Codes and procedures:

- **Code 300** Manual turn on pump

Possible Cause	Check This
Lube pump fuse has blown	Check the fuse on the lube pump and manually turn on pump with service code 300
Computer module failed	See computer module diagnostic, section 5.3. You can remove the lube pump connector from the computer module and measure for 115 VAC when you turn pump on with service code 300.

### 4.5.4 Z Axis Motor Brake is not working

The 2 OP has no counterweight to support the head when the servos are off. The Z motor has a brake that comes on whenever the power to the servomotor is turned off. If this brake fails and does not engage, the head will move downward due to gravity. If the brake does not turn off, the motor will most likely fault since it is trying to move the head and has additional load due to brake being on. The brake also will come on if the machine is left idle for 20 minutes or more. The servo on button will need to be pressed to turn the motors back on.

When there is no power to the brake, the brake will be on (engaged).

Possible Cause	Check This
Computer module failure	Identify the status of the Z axis brake light on the computer module. When the brake is off, the light should be green. See computer module diagnostics, section 5.3
Motor brake has failed	Replace motor brake. A 24 volt signal should turn the brake off, which means the head is allowed to move.

### 4.5.5 Manual tool loading button is not working (green button on head)

The 2 OP has green button on the front of the head, which allows the user to manually load a tool into the spindle. Pressing this button activates an air cylinder, which pushes down on a drawbar in the spindle. This in turn opens up the fingers that grip the retention knob on your tool. When this button is released, the air cylinder moves up and the fingers grab the knob and hold the tool in the spindle.

**Warning** – Be careful when loading tools. The tool is held in the spindle with as much as 1000 lbs of force.

Possible Cause	Check This
No air or low air is supplied to the machine	The screen should have a flashing air pressure low message if this is true.

Switch has failed	Check the wiring to the switch and where it plugs into the computer module as an input. It is called unclamp BT.
Air solenoid that supplies air to the tool change air cylinder is not working	Check the solenoid in question. Check pneumatic diagnostics, section 5.9. See drawing 27563.
Computer module failure	See computer module diagnostics, section 5.3

## 4.6 Measurement Problems

### 4.6.1 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. This will test for uni directional repeatability. 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 the error abruptly changes by a large amount it may be caused by a bad motor encoder.

Expected repeatability numbers should be 0.0005" or less.

Bi directional repeatability tests moving up to the same point from different directions. If the machine does not repeat bi directionally, then you may need to adjust your backlash compensation for the given axis using service code 128.

In order to identify whether the problem is mechanical or electrical/software, make a mark on the motor and verify the motor shaft or coupling returns to the correct position. If it does, but your indicator does not, then the problem is mechanical in nature.

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 5.1
Thermal expansion of the ballscrew	If the machine is run very hard at high feedrates then this may come into play.
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 5.2. The coupling is the first place you should look. Make sure the coupling is not slipping on the motor or ballscrew end.
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.
Spindle may be loose	Use a Dial Indicator and check for side-to-side

	movement between the Spindle and the Head. There should be no more than 0.0003" of side-to-side movement.
--	---

### 4.6.2 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. Check for accuracy in 1 direction initially so as to not bring backlash compensation into play. If you reverse direction and have not set the backlash correctly, this could be the cause of your error.

Note: If your part has incorrect dimensions, see Parts Have Incorrect Dimensions, Section 4.1.3.

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 4.6.1)

Possible Cause	Do This
Part has been programmed wrong	Check the programming of your part to make sure no errors were made.
The tool diameter or tool length has not been entered correctly	Make sure you have measured the OD of the cutter and entered it correctly. Also check the tool length entered for your tool.
Machine Tool & Setup problem	This is the first place to start because if your setup is not sufficient it will affect the accuracy of your part. 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 5.1
Thermal expansion of the ballscrew	If the machine is run very hard at high feedrates then this may come into play.
Calibration has not been performed or is wrong	Go to service code 123 and recalibrate the machine
Incorrect backlash values	If the machine does not repeat bi-directionally check the backlash on the axis in question. See Section 7.2.

### 4.6.3 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 Faulting Axis Section 4.3.4

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 feed rate of an axis and if the encoders are counting and are they counting in the correct direction.
- **Code 131** Turn the X or Y ballscrew to check if the motor encoder is counting properly.

Possible Cause	Check This
The E-stop is pressed	Undo the E-stop and press the Servo on button

Servo amp failure	See Servo amp Section 5.5
Motor Encoder not counting	See Motor diagnostics, section 5.5
Computer module failure	See Computer module diagnostics, section 5.3

#### 4.6.4 Electronic Handwheel Moves Machine in Wrong Direction

The Electronic Handwheel moves the machine in the wrong direction on all 3 axis. When you move the EHW in a CW fashion on the machine, each axis will move in a positive direction.

Possible Cause	Check This
The EHW has been just replaced and wired wrong	Make sure the A and A' wires and B and B' wires are fastened to the proper terminals on the EHW.

### 4.7 Machine Tool Problems

#### 4.7.1 X, Y or Z-Axis Noisy

While jogging or cutting on a particular axis, the axis makes unusual noises.

Possible Cause	Check This
The way covers are not properly aligned on the Y or Z axis	Move the axis that the noise is coming from until the way cover is collapsed completely, slacken the SHCS that secure the way cover to the spindle bracket, allow the cover to center itself and then retighten.  Examine way cover for damage.
Inadequate or no Lubrication to the Ballscrew and linear guides	Make sure the ballscrew and linear guides 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.
Machine Tool and Setup problem	Check for any looseness in the setup (Tool, Tool holder, Part, Vise, or Fixture). See Machine Tool & Setup Section 5.1
A crash has damaged the angular contact bearings of the drive train.	Remove the bearings and check for damage, any damage felt by rotating the bearings in your hand may be very subtle.
Mechanical Drive Train	Misalign ballscrew, or top and lower bearing failure.
Z-axis motor failure	Replace Z-axis motor See Motor Diagnostics Section 5.5
Z axis brake malfunctioning	The Z axis brake may be rattling or it is turned on when it should not be.

#### 4.7.2 Spindle Stalls or Turns-Off During Machining

During machining, the spindle turns off and loses power.

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 5.1



Cut more than the machine is capable	Check width and depth of cut
Spindle Drive parameters are not correct	May need to re-download the Spindle Drive parameters. Contact Customer Service for assistance.
Spindle run command not reaching AC Drive	See diagnostic section 5.6.2 for how to check this signal.

### 4.7.3 Spindle Motor Hums or Will Not Run

The spindle motor makes a constant humming noise during operation or will not turn on. This machine can be wired for 220 or 440 volts. Make sure the voltage matches the AC spindle drive.

<b>DANGER!</b> Take extreme caution when working with high voltage. There is possibility of death by electrocution!
--

Possible Cause	Check This
Wrong voltage	Check the voltage to the machine before and after the Spindle Drive with a Voltmeter. Also, check the voltage to the Spindle Drive (L1, L2, and L3).
Poor wiring connections	Check all the wiring connections to the Spindle Drive and Spindle Motor. See section 6.9 for a wiring diagram for the spindle motor.
Spindle Drive may be in "Local Mode" and can not be run from the Pendant	On the Spindle Drive, push the "PU". If the PU letters under the display are red, then the drive is in local mode. Press the PU button once again to turn this feature off.
Spindle Motor is faulty	Check the resistance of the spindle motor windings on the spindle motor between L1 (U) and L2 (V), L2 (V) and L3 (W), then L1 (U) and L3 (W) using a digital ohmmeter. If the ohmmeter reads more than one (1) <b>ohm difference or "OL" (infinite) between any pair</b> , replace the motor. The next check is for resistance to ground using a digital ohmmeter. Check L1 (U) to ground, L2 (V) to ground, and L3 (W) to ground. The meter reading in the <b>display window should be "OL"</b> (infinite) with reference to ground. Any other reading indicates a problem, and the motor should be replaced.
Spindle Drive contains incorrect parameters and is not programmed correctly	Contact customer service.

### 4.7.4 Spindle Runs Backwards

The spindle motor runs in the opposite direction. The direction should be set at the factory and so this should not be the case in the field. Since the spindle motor is run with an AC drive, switching the power wires coming into the machine will have no effect on direction.

<b>DANGER!</b> Take extreme caution when working with high voltage. There is possibility of death by electrocution!
--

Possible Cause	Check This
3-Phase wires backwards	Switch any 2 of the 3 wires either coming out of the AC Drive (T1, T2 & T3) or going into the Spindle Motor (U, V & W). Caution: Be sure to shut off all power to the machine before attempting to switch any wires.
Wiring to AC drive incorrect.	Verify that the wiring to the AC Drive is correct and that the correct command is given. See section 5.6

### 4.7.5 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.
Spindle bearings are worn out	This is categorized by a high pitch sound and is most evident at high RPMs. It should also cause chatter under load. Replace the spindle cartridge if this is the case. See spindle replacement in Section 6.10.

## 5.0 Diagnostics

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

### 5.1 The Machine Tool & Set-Up

#### 5.1.1 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 cartridge replacement	Noisy head Parts incorrect Circles out of round	Older machines, machines that are pushed hard. Run spindle at high <b>RPM's for long periods of time.</b>
Lubrication system	Premature wear of ball screws and linear guides Poor part finish	New installations (may not be hooked up or line sheared)
Linear guides worn	Poor finish Out of round circles Faulting	Inadequate lubrication It should take many years for this to become a problem.
Machine not level Weight not distributed evenly on all 4 feet See Leveling procedures	Parts incorrect Machine geometry off, i.e. tram.	New installation, after moving machine or heavy crash.
Head out of tram	Leaves uneven surfaces on bottom of pockets. Circles are not round when circularity is checked.	Machine not level or after a heavy crash.
Water in your air lines	Faulty solenoid valves Rust Problems with the pneumatics on the tool carrier and tool change air cylinder	User does not drain air regular/water separator on a regular basis Users shop has a poorly designed air system with no air dryers to prevent water from entering lines
Performing periodic maintenance such as checking oil cup on tool unclamp cylinder and greasing fittings on ATC	Lack of lubrication to cylinder and premature failure Wear of sliding surfaces on ATC and premature failure	User does not perform recommended periodic maintenance on machine tool.

### 5.1.2 A Special Word About Linear Guides

The linear guides on your 2 OP are vital to the performance of the machine.

They should require very little maintenance over the life of the guides. It is recommended that these guides be inspected for any signs of excessive wear. Lubrication is the key to the longevity of the guides so it is important to verify oil is reaching the guides. It is also a good idea to make sure no cutting fluids or chips are reaching the guide surfaces. Periodic cleaning or inspection of the guides is recommended.

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 linear way surfaces and compromising the performance of the machine.

### 5.1.3 Lubrication

Lubrication is one of the single, most important maintenance issues and plays a key role in assuring the performance and durability of the machine. The ProtoTRAK will automatically lubricate the machine when it is turned on. At the beginning of the day, if the machine has been left on overnight, it is recommended to go to service code 300 to lubricate the guides and ballscrews.

Lack of lubrication using recommended type of lubricant 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 linear guides.

### 5.1.4 Machining Set-Up

The machining set-up can greatly influence the performance of your mill. Be aware of the following:

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.
Poor Tooling Using the wrong cutter for an application Entering the wrong size diameter.	Poor finish Tool chatter 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

### **5.1.4.1 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.*

### **5.1.4.2 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.

## **5.2 The Mechanical Drive Train**

The following sections talk about a key number of mechanical items that should be reviewed when a mechanical problem exists on the 2 OP machine.

### **5.2.1 Ballscrew Alignment**

Ballscrew alignment plays a critical role in making sure the machine performs at its highest level. It is very important to have consistent rolling torque values across the length of the X and Y-axis ballscrews. (Note – the Z axis has a mechanical brake so it is not possible to measure the torque) When values vary by more than a few inch-lbs across the length of the ballscrew, then this points to the ballscrew not being properly aligned.

To measure the rolling torque on the X and Y-axis you need to move the axis to the location you wish to check and then press the E-stop. This turns the axis motors off and allows you to manually turn the ballscrew with a torque wrench. The torque wrench is placed on the end opposite of the motor in the hex drive. We recommend each axis be checked in 3 places. Check the rolling torque in the center of travel and at both ends of travel.

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.

## **5.2.2 Protecting the Axis from a Crash**

The X, Y and Z axes servomotors are rated at 560 in-oz of continuous torque. Each motor is unique to each axis primarily due to the cable configuration that is used. For example, the X motor has short cables and uses an extension cable that routes through the cable carrier. This cable configuration makes it much easier to replace the motor. The other difference that must be noted is the X and Y servo wiring is different than the Z servo. The Z servo contains a braking circuit that helps dissipate energy when the Z axis is moving down. This is required since there is no counterbalance. A braking resistor is attached to this circuit to dissipate this energy.

## **5.2.3 Z Axis Mechanical Brake**

The Z axis contains an electro-mechanical safety brake that automatically engages when the electrical power is removed from the machine, or when the E-stop is pressed. This brake is required to support the head and keep it from falling when the servomotor is turned off or disabled. When 24 volts is applied to the brake, the brake disengages from the ballscrew, allowing the motor to move the Z axis up and down. When power is removed from the brake, the brake engages and stops the ballscrew from rotation. Note: if the machine is idle for more than 20 minutes, the brake engages automatically, in effort to prevent the Z axis motor from holding position for long periods of time. The Z motor pulls current when holding position because this machine does not have a counterweight. Once the servos are turned off, the user will need to press the SERVO ON button to enable the motors once again.

## **5.2.4 Linear Guides**

The linear guideways play a very important role in the drive system of the machine and with proper care and lubrication, they should last many years. They require no additional service nor are there any provisions for adjustment. Great care must be taken to protect the linear guideways. Never operate the 2 OP with the way covers removed (except when service requires it). NEVER ALLOW ANY OBJECT TO FALL ONTO THE LINEAR GUIDEWAYS!

## **5.2.5 Lubrication**

The automatic lubricating system is dedicated exclusively to the ballscrew and the linear guideways on this machine. The amount of oil and how often oil is applied is controlled by the service code. See section 5.11.4.7 for more information. Also see drawing 27591. The ATC linear guide blocks that the ATC moves on, needs to be manually lubricated with grease. There is 1 grease fitting for each of the 2 guide blocks. The lubrication pump reservoir oil level must be checked daily and maintained in the indicated Min/Max range.

## **5.2.6 Way Covers**

The Z ballscrew cover is telescoping in design, so alignment is important to avoid binding, way covers must be attached in the near fully collapsed state. This is the best way to align the covers to the axis. Do not move axes around with covers detached but still in the enclosure. The X axis and linear guides on the Z axis are protected with accordion style covers. The Y axis linear guideways are mostly unprotected, but are mounted upside-down underneath the Y-axis casting, therefore are not directly exposed to the normal hazards of the milling environment.

## 5.3 Computer Module Diagnostics

The computer module is the main component that controls the entire system. The computer module requires 115VAC input. The computer module 3 fuses is located just below the power input connection.

The F3 fuse is a 12-amp slow blow fuse that is used for the axis power and can be checked by looking at the light to the right of it. When the light is on, the fuse is good.

The F2 fuse is a 3 amps slow blow that is used to protect the power supply in the computer.

The F1 fuse is a 3 amps slow blow that is used to protect the coolant pump. These fuses will need to be checked with an ohmmeter.

The computer module consists of 6 main internal components.

1. The Motherboard, that runs the main software and the operating system and interfaces to the Motion Board.
2. The Motion Board, that actually controls each axis and every digital I/O function, it also interfaces between the Motherboard and the APPS Board.
3. The APPS Board, contains the circuitry that provides the interface for the motion board to control each axis and all the Digital I/O functions.
4. The Compact Flash, which contains the operating system and our software and is plugged into the motherboard.
5. The Power Supply, that provides 5, 12, -12 and 24 volts for all the boards inside the computer module.
6. Fan – the fan is used to cool the inside components.

The computer module contains a number of LED's that can be used for troubleshooting. The following summarizes the LED's and how they work. See figure 5.3b.

1. **Input LED's – these LED's are turned on when an input is triggered. A small green LED light will come on next to each of the inputs.** The inputs are E-stop, Door, X home, Y home, Z home, air pressure, tool clamp, tool unclamp, ATC front, ATC back, Unclamp button and Servo On. There are also spares.
2. **Output LED's – these LED's come on when the computer commands an output. The light is on for as long as the output is sent.** The outputs are Z axis brake, ATC front, ATC back, Tool Unclamp, Alarm or beacon light, door lock. There are also 3 spares. The door lock feature is not part of USA sold machines.
3. **LED's above the overlay power connector are used to monitor the pressing of the following 5 overlay buttons: AUX, STOP key, GO key, ON key, OFF key.** There is also one spare LED not used. See figure 5.3d for pin assignments.
4. **LED's below the overlay power connector of which there are 2 rows of 24 LED's. These LED's are used to monitor the signals for the axis motors. Each axis and the spindle have 6 LEDs.** The A+,A-,B+, and B- are used for encoder counts, as the motor rotates one direction a particular sequence of LEDs are turned ON and OFF. The other 2 LEDs, Z+ and Z- are the index pulse, they switch state once per revolution. The Z- LED light should be on most of the time and only goes off when the index mark on the encoder is triggered and then the Z+ comes on for a very brief second. The motor must be rotated slowly to see these lights update.
5. **LED's labeled 1 on figure 5.3b.**
  - a. Voltage Fault – this light will be on when the 5, 12 or -12 volt signal is not within specification. None of the outputs nor the axis or spindle will work if this is activated.
  - b. WDT – OK, WDT stands for watchdog timer. This light should be on when the computer is behaving normally. When this light goes off, it means the motion control board has lost communication from CPU to certain IC chips. The machine will most likely not be functional.

- c. CPU – OK, this refers to the CPU on the motion control board. If this light goes off, the CPU is not functioning correctly and the machine will not run.
  - d. Z AXIS EN – this light is on when the Z servo is holding position. So when the screen says SERVO ON, this light should be on.
6. **LED's labeled 2 on figure 5.3b. These LEDs flicker on and off when you turn the EHW on the programming panel.** The LEDs represent the counts from the handwheel if you turn the handwheel. Each LEDs represents a signal/wire for the handwheel.
  7. **LED's labeled 3 on figure 5.3b. Not used at this time.**

On the side of the computer module, there are 17 cable connections. The network and COM port are used internally and not applicable to users. The following is a summary of the connections.

1. AC Input – this is the 115VAC input required to run the computer module.
2. Green connectors – there are 5 green connectors that control 5 more outputs. X, Y and Z power is the power for the axis motors. Coolant and lube are outputs to turn the coolant and lube pump on respectively. These outputs are 115 volts.
3. X, Y and Z axis port – these connectors are the feedback from the axis motor encoders.
4. Handwheel port – this is the connection that feeds the electronic handwheel signals back to the computer. See below for more details.
5. Spindle Port – this is the connector that sends and receives the signals from the spindle drive. See below for more details.
6. VGA port – this sends the signal for the LCD.
7. COM port – this is a serial port used to communicate to the Overlay Interface board. If the Programming panel keys are not operating correctly this cable may be at fault.
8. Machine ID port – this port is used by our software to identify the type of machine.
9. USB port – we have 2 USB ports. We use 2 cables that run up to the right side of the machine where the USB ports reside. The USB ports are USB 2.0 compatible.



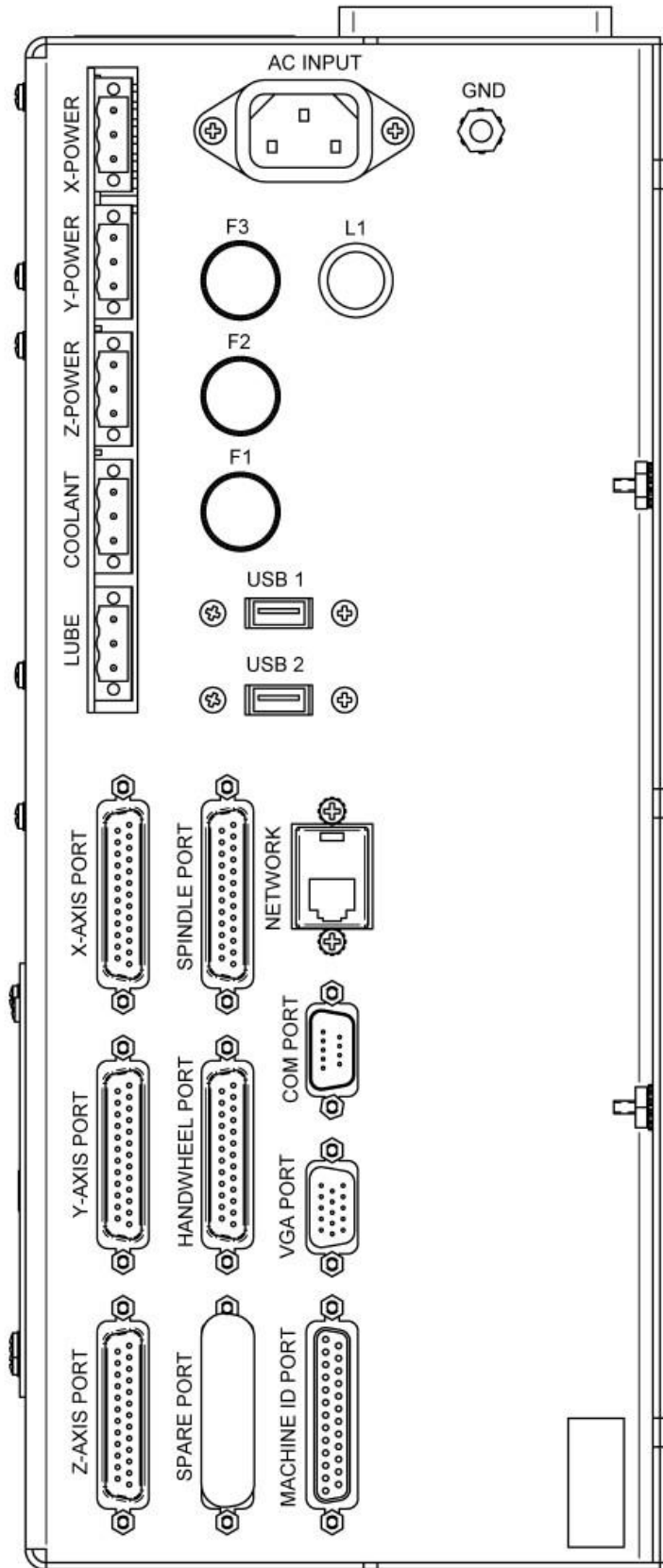


Figure 5.3a – Computer module Side View

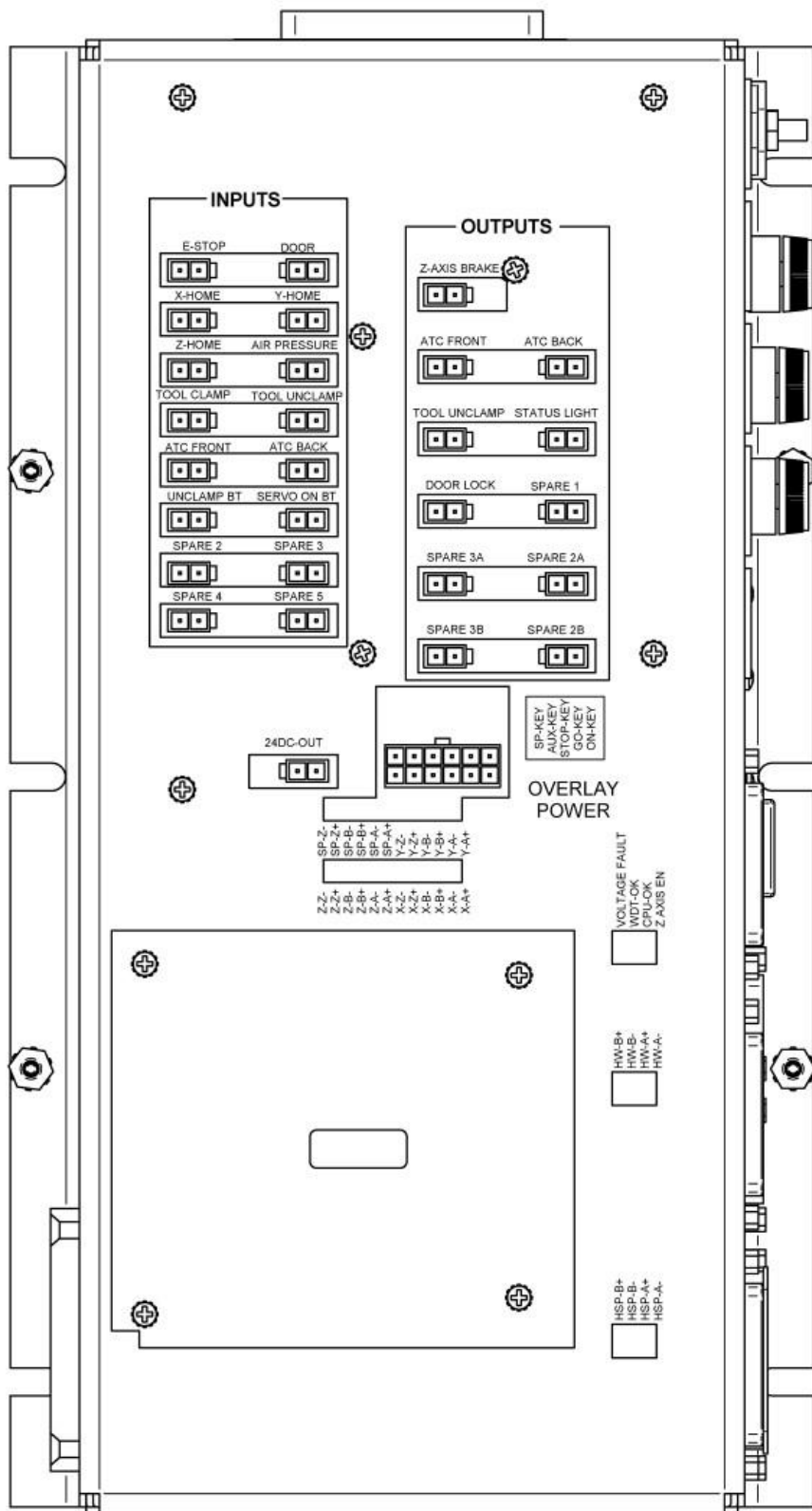


Figure 5.3a – Computer Module Front View

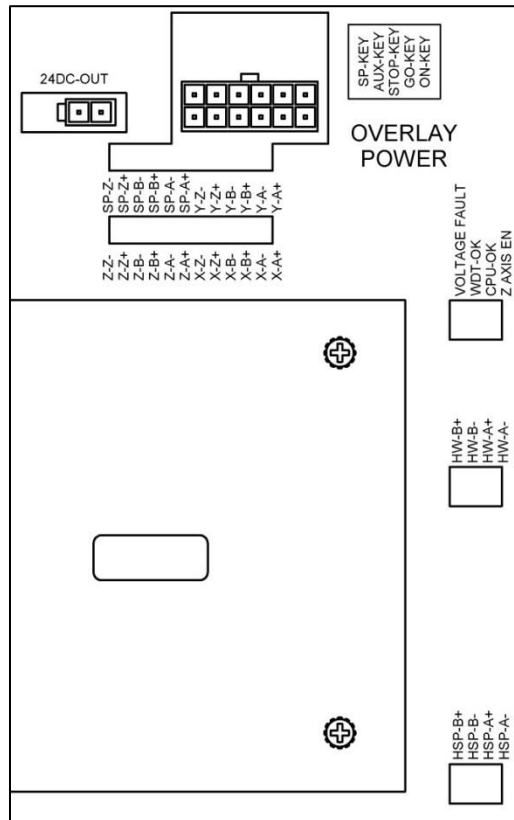
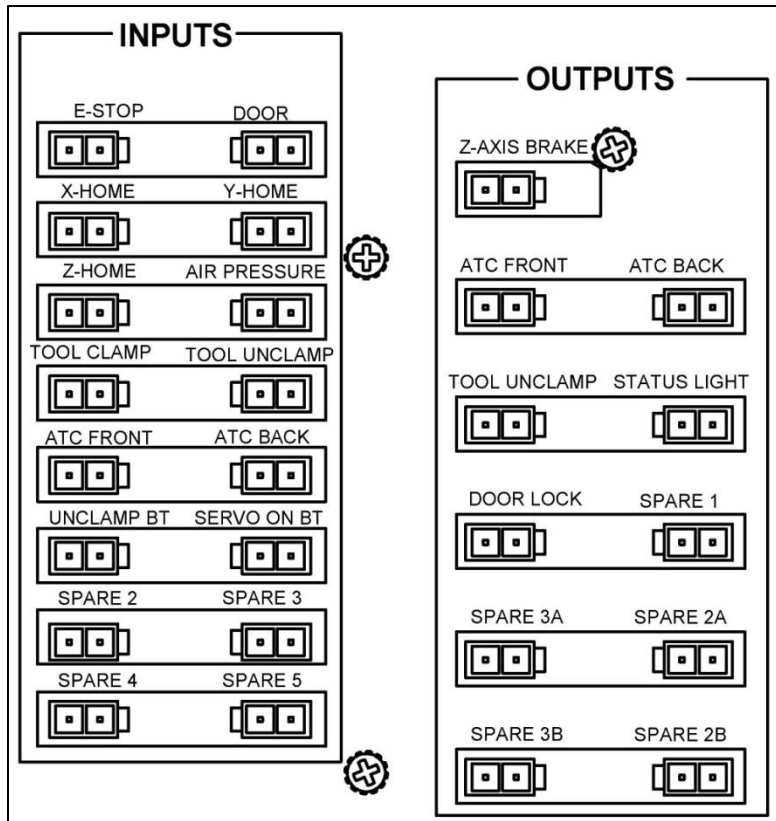
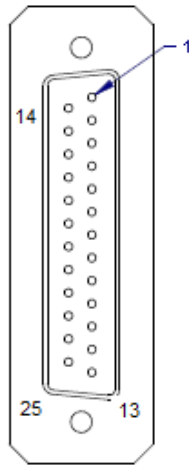


Figure 5.3b – Computer module Top View

The Spindle Port contains the following signals.

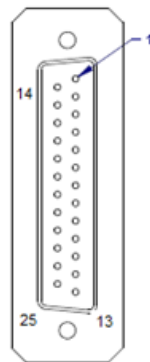
1. DAC (digital to analog) signal is an analog 0 to 8.5 Volt signal that is used to control the speed of the spindle motor. This is the AVI terminal on the AC Drive. When measuring AVI voltage use ACM terminal for reference.
2. SPD\_FWD signal is 24 DC Volt digital signal from the AC Drive that is used to command the spindle to spin in the forward direction. This is the FWD terminal on the AC Drive.
3. SPD\_REV signal is 24 DC Volt digital signal from the AC Drive that is used to command the spindle to spin in the reverse direction. This is the REV terminal on the AC Drive. The ON spindle button normally only runs in the FWD direction. The software may allow for reverse operation in certain circumstances.
4. SPD\_ORI signal is 24 DC Volt digital signal from the AC Drive that is used to command the spindle to go to the orientation angle for a tool change. This is the MI3 terminal on the AC Drive. To orientate the spindle, the FWD and Orientate command is sent at once.
5. SPD\_RESET signal is 24 DC Volt digital signal from the AC Drive that is used to command the spindle to reset the AC Drive when a fault has occurred. This is the MI2 terminal on the AC Drive.
6. E-SPD signal to the AC Drive. This is the MI1 terminal on the AC Drive.
7. CHA, CHB, CHZ are 5 volt DC digital signals that are used for the motor encoder input. The CHZ signal is the index pulse of the motor that is activated once per revolution.
8. SPD\_TAP signal is 24VDC volt digital signal from the AC Drive that is used to control the Acceleration and Deceleration time when tapping. This is the MI4 terminal on the AC Drive.



PIN #	WIRE COLOR	FUNCTION	AC DRIVE TERMINAL / LABEL TEXT
1	BLACK		-
2	BROWN	ODAC4+	AVI
3	RED		
4	ORANGE		-
5	YELLOW	E-SFD_COM	M1
6	GREEN	SFD_REV	REV
7	BLUE	SFD_RESET	M2
8	PURPLE	FAULT_4	RB
9	GRAY	IDC-20(RUN)	MRA
10	WHITE	CHA4+	AO
11	PINK	CHB4+	BO
12	LIGHT GREEN	CHZ4+	ZO
13	BLACK / WHITE	GND	GND
14	BROWN / WHITE	GND	ACM
15	RED / WHITE		-
16	ORANGE / WHITE		
17	GREEN / WHITE	SFD-TAP	M4
18	BLUE / WHITE	SFD_FWD	FWD
19	PURPLE / WHITE	SFD_ORT	MB
20	RED / BLACK	SFD_COM	DCM
21	ORANGE / BLACK	GND	RC
22	YELLOW / BLACK	GND	MRC
23	GREEN / BLACK	CHA4-	-AO
24	GRAY / BLACK	CHB4-	-BO
25	PINK / BLACK	CHZ4-	-ZO

Figure 5.3c – Spindle Port Pin Assignments

The computer module contains one Handwheel port that is used to move each axes, it is also used for spindle override, feedrate override, scrolling on certain screens and for TRAKing. The signals that are used on the Handwheel port are CHA and CHB signals for the encoder input. They are 5 Volt digital signals.



P2

WIRING CHART				
P1	COLOR	FUNCTION	LABEL	P2
1	RED	5VDC	VCC	1
6	BLACK	GND	GND	14
3	BLUE	CHA+	A	10
2	BLUE/BLACK	CHA-	-A	23
5	YELLOW	CHB+	B	11
4	YELLOW/BLACK	CHB-	-B	24
-	DRAIN	-	-	13

The Overlay Power Connector (see figure 5.3b) is used to provide power to the programming panel and it also carries some critical overlay key feedback to the computer module. The following are the signals that are carried inside the Overlay Power connector.

1. 5V is the 5 Volt DC power signal used to power up the Overlay Interface Board.
2. 12V is the 12 Volt DC power signal used to power up the LCD controller board.
3. KEY-COM is a 24 Volt DC power signal used for triggering the critical overlay keys.
4. ON-KEY is a 24 Volt DC digital signal that is used to command the spindle motor to turn on.
5. OFF-KEY is a 24 Volt DC digital signal that is used to command the spindle motor to stop spinning.
6. GO-KEY is a 24 Volt DC digital signal that is used to command the machine to start an automatic process like a Homing or run a program.
7. STOP-KEY is a 24 Volt DC digital signal that is used to command the machine to stop the axis while in an automatic process.
8. AUX is a 24 Volt DC digital signal that is used to turn the coolant pump on.

P2	FUNCTION
1	VCC IN +5V
2	GND
3	12 VDC
4	GND
5	24DC-1
6	AUX-KEY
7	SPD-ON
8	SPD-OFF
9	GO KEY
10	STOP KEY
11	SPARE KEY
12	GND




Figure 5.3d – Overlay Power Connector Pin Assignments

The 24 DC connector on the front of the computer module provides 24 volts to the EURO Relay Control system. This is not used on USA machines.

The compact flash is a 1GB compact flash. The compact flash stores the main operating system and software used to control the machine. The configurations for the machine are also stored on the compact flash. If a computer module is ever replaced then service codes 141 and 142 must be used to transfer the configuration from the old compact flash to the new compact flash on the new computer module.

In general, the computer module is best diagnosed by eliminating all other possible alternatives. The following table lists some symptoms and diagnostics that may be used in order to assure that the problem is due to the computer module, and thus should be replaced.

Symptoms	Diagnostics
As a general rule all symptoms should be checked for the following items.	<ul style="list-style-type: none"> <li>• Verify that the 5VDC is <math>\pm 0.25</math> volts DC.</li> <li>• Verify that the 12VDC is <math>\pm 1</math> volts DC.</li> <li>• Verify that the -12VDC is <math>\pm 1</math> volts DC.</li> <li>• Verify that the 24VDC is <math>\pm 2</math> volts DC.</li> <li>• Verify that the 115VAC is <math>\pm 5</math> volts AC.</li> <li>• Verify that loading defaults has no affect on the symptom.</li> <li>• Utilize service code 521 to test the I/O of each port.</li> </ul>
X, Y or Z-axis Faulting	<ul style="list-style-type: none"> <li>• Swap the axis port cable and power cable with a</li> </ul>

	<p>different axis to see if the problem follows the motor/servo or the computer module.</p> <ul style="list-style-type: none"> <li>Utilize service code 131 and LEDs on the computer module to test the encoder portion of the axis.</li> </ul>
Spindle Faulting	<ul style="list-style-type: none"> <li>Utilize service code 521 to test the digital I/O from the computer module to the AC Drive.</li> <li>Utilize service code 510 to test the encoder portion of the axis.</li> </ul>
Handwheel will not work	<ul style="list-style-type: none"> <li>Utilize service code 132 to test the encoder portion of the handwheel.</li> </ul>
Digital Input Errors	<ul style="list-style-type: none"> <li>Make sure that the LEDs to the corresponding digital input that is in question turn OFF and ON.</li> <li>Utilize service code 521 to test all the inputs to the computer module.</li> </ul>
Digital Output Errors	<ul style="list-style-type: none"> <li>Make sure that the LED corresponding to the output function in question turns OFF and ON utilizing service code 521.</li> </ul>
E-stop error cannot be cleared.	<ul style="list-style-type: none"> <li>Service code 521 should be performed and verified that the E-stop signal is not being seen by the computer module. Verify E-stop LED turns ON.</li> </ul>
Critical Keys (ON, OFF, GO, STOP & AUX) are not responding.	<ul style="list-style-type: none"> <li><b>Check LED's above overlay power connector when buttons are pressed.</b> Light should only be on when the button is being held down.</li> <li>Verify that the 24VDC is between 22-26 volts DC.</li> <li>Service code 521 should be performed to identify what critical keys are working.</li> </ul>
Blank Video or Distorted Video	<ul style="list-style-type: none"> <li>Verify that the 12VDC on the Overlay Power connector is between 11-13 volts DC.</li> <li>A standard desktop monitor with a VGA port may be connected to verify if any signal is being sent out from the computer module.</li> </ul>
Overlay Keys not responding	<ul style="list-style-type: none"> <li>Note that when an overlay key is not responding to a command but a beep is produced by the pendant this is an indication that the COM port on the computer module is functioning correctly.</li> <li>Verify that the Overlay software is running by using an <b>external USB keyboard and pressing "Cntrl-Alt-Delete"</b> this will bring up a window that will show the Overlay Key software running. If the Overlay Key software is not running this may be a Compact Flash problem.</li> </ul>
USB Device is not recognized by the system.	<ul style="list-style-type: none"> <li>Plug in the device to another port to see if the device is identify by a different port, if it is not then the device may not be supported as not all devices are compatible with this system.</li> <li>Verify that the USB does not have any obstructions in the port.</li> </ul>
System Software does not respond to any commands (Locks-up)	<ul style="list-style-type: none"> <li>When the system does not respond to an Overlay command, verify if the operating system is still operational by utilizing a USB keyboard. Press the cap lock button on the keyboard to see if the light comes on and off.</li> <li>Identify if the problem is resolved by restarting the system.</li> </ul>
System Will not boot up error	<ul style="list-style-type: none"> <li>Try disconnecting all cables one at a time until only the 115 Power Input, VGA, and Overlay Power cable are</li> </ul>

	connected to the computer module, if it still errors out then the computer module will need replacing.
WDT – OK or Watch Dog Timer LED is off.	<ul style="list-style-type: none"> <li>Verify that the computer module is at fault by removing all the cables connected to the computer module, except for the 115VAC input power cable, and seeing that the DC power LED is still off.</li> </ul>
Programming panel locks up	The system will not respond to key presses or operate. Shut down the system and wait 10 seconds before rebooting the system. Check the com port and overlay power cable connections. If the problem continues the computer module may have failed. See section 5.3 computer module diagnostics.
Disk boot failure message	Make sure there is no USB device inserted or a bootable device when booting. If problem continues refer to section 5.3 computer module diagnostics.
Machine will not home	Verify the index pulse is being recognized by the computer module by checking the LED's described above.

## 5.4 Programming Panel

The programming panel attaches to the front of the machine via 4 screws and also uses a gasket to prevent any coolant or debris from getting into the rear of the panel. The e-stop, EHW and servo on button is also part of this assembly. Please see figures 5.4a and 5.4b and drawing 27604 found in the rear of the manual.

In general, this is best diagnosed by eliminating all other possible alternatives. The following table lists some problems and what these problems can lead to. Make sure to first unplug any accessories such as external keyboard/mouse USB thumb drives etc. to eliminate any interference.





Fig. 5.4a – Programming Panel

The programming panel has 6 cables that run from this panel back to the computer module. See figure 5.4b. They are as follows:

1. E-stop cable – sends the signal for the E stop. If the E stop is not pressed, then the signal is able to travel back to the computer module. The signal is 24 VDC. The E stop is wired normally closed.
2. Servo On Cable – cable that run from an input port on the computer module to the servo on button. This button must be pressed upon boot up or after an e-stop condition is resolved. This switch is wired normally open.
3. VGA Cable – this cable carries the video signal from the computer module to the LCD controller board.

4. Com Port Cable – this cable is used to establish communication between the pendant and computer module. It carries the non-critical key signals on the overlay as well as the signal for the beeper. It connects to com port on the side of the computer module.
5. Overlay Power Cable – this cable provides power. The voltages are 12 VDC, 5 VDC and 24 VDC. This cable also carries the following critical keys: AUX, ON, OFF, GO and STOP.
6. EHW Cable - carries the encoder signals, which allows the axis to move in either direction. The 6 wires carry the following signals: power, ground, A, A not, B and B not. If one channel is not there it will not run right in one direction.

The Program Panel consists of the following components.

1. LCD Controller board –It controls the video output to the LCD screen, which comes from the computer module.
2. LCD User interface board - sets the video input signal and adjusts the screen image for brightness, contrast, etc. It also switches on/off the controller board and LCD screen. It has 1 LED light that shows the state of the controller. This light is green and indicates the board is on. If you see a red light, something is wrong and there most likely will be no video. This light should always be on when power is available. This is used on primary mfg of LCD only. On secondary mfg they integrate the LCD controller and user interface board into one. See figure 5.4c and 5.4d for a description of all the buttons for both units.
3. LCD User Interface Cable – used to communicate between the LCD controller board and LCD user interface board.
4. LCD Interface Cable - used to communicate between the LCD controller board and the LCD screen. It is found between LCD and board.
5. Overlay Interface Board - this board is responsible for sending and receiving signals to and from the programming panel and computer module. This board is responsible for the overlay buttons. The beeper is also found on this board. It also provides 12 VDC to the LCD module.
6. Internal VGA cable – the VGA cable that comes from the computer plugs into this port.
7. LCD Power Cable – It provides power to the LCD controller board, which is 12 VDC.
8. LED Lights – The overlay interface board has a few LED lights that can be used for troubleshooting. See figure 5.4e **for location of LED's on board.**
  - a. D22 – each key press on overlay will cause this light to flash, except critical keys.
  - b. D23 – LED should always be on and this means power is getting to critical keys
  - c. D26 – LED should always be on and it shows we have 12 volts.

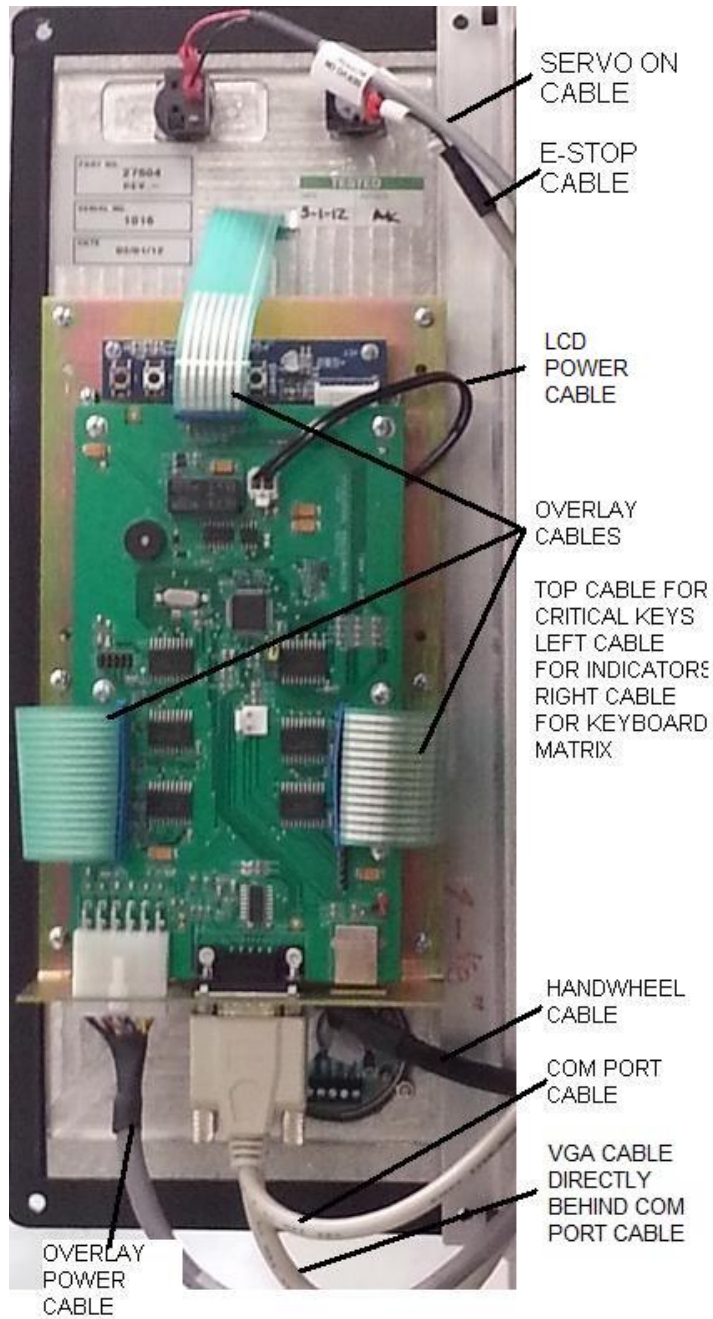


Figure 5.4b – Programming Panel Rear View

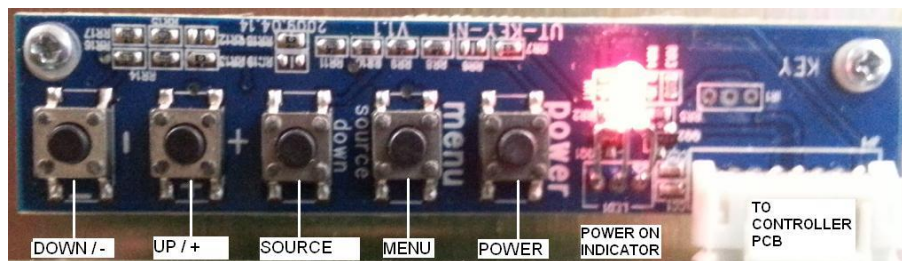


Figure 5.4c – LCD User Interface Board

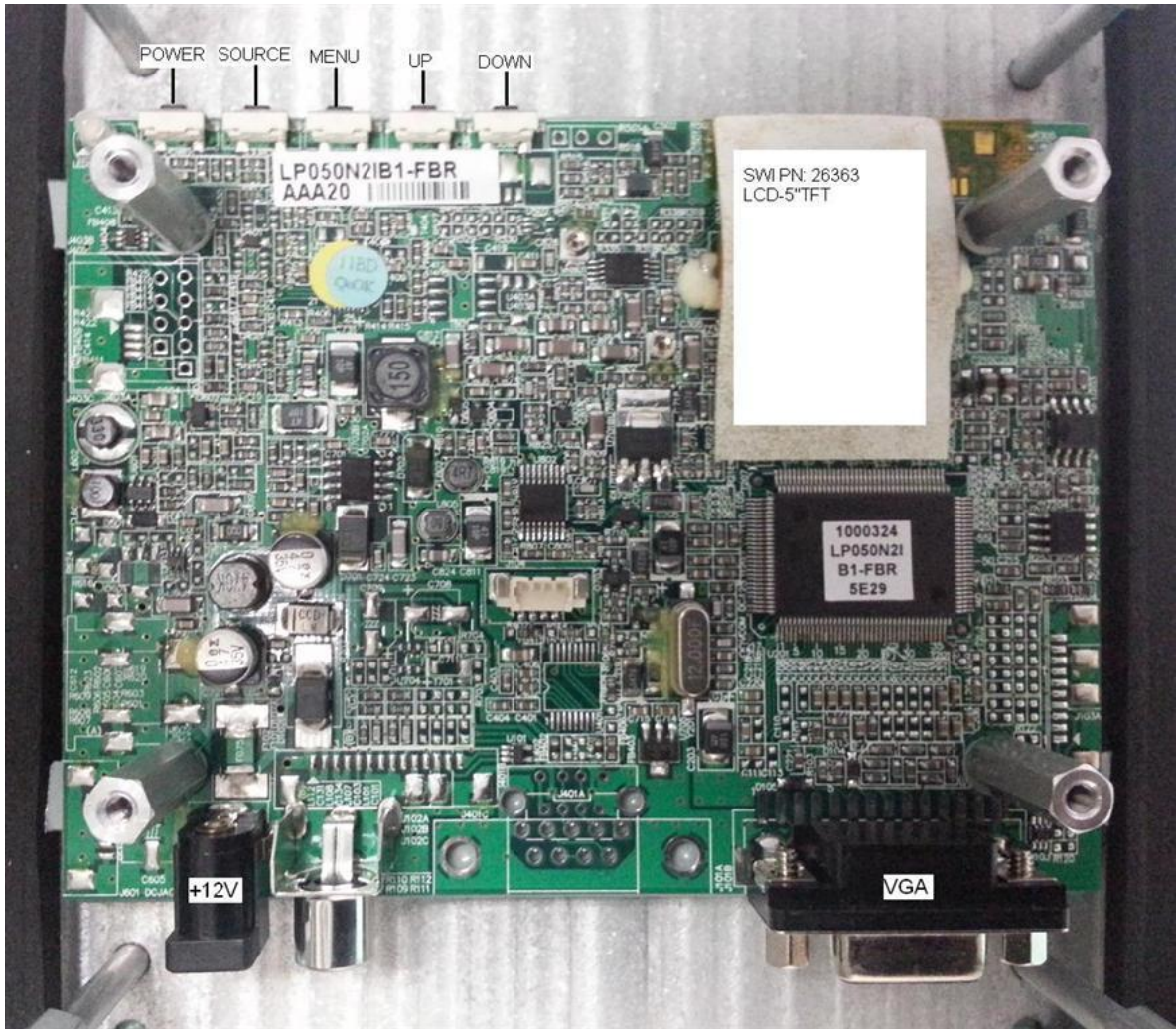


Figure 5.4d – LCD Controller Board (Secondary LCD Source)

Possible problems	Can lead to
Poor cable connections	Loss of backlight, video signal, overlay function, and/or LCD power. Check all cable connections.
Overlay Key failure	Keys on panel do not work. Check by using service code 81. The screen will display a picture of the overlay. Each key pressed on the overlay will light up on the screen and the pendant will beep which means it is working. If not check the connections between the Program panel overlay and the overlay interface board. Also check the overlay power cable for the critical keys and COM port cable for all other keys. Refer to Fig. 5.4b.
LCD has no display	You will not have the ability to see the video signal. Make sure the user interface board is not turned off (figure 5.4c). If the user interface board LED is on but the backlights remain off. Check all cable connections to LCD controller board and inverter board. See Fig. 5.4b.
Electronic Handwheel does not work	Unable to jog an axis. Make certain that the jog

	<p>speed key you want is pressed and you have selected the axis you wish to move. Check service code 132 to verify EHW is counting. One complete revolution of the EHW will display 100 counts on the screen. If not check EHW cable connection at the rear of panel to the computer module. You can also verify the computer module is reading the EHW signals but looking at the LED lights on the front of the computer module. See section 5.3 for more info.</p>
Faulty E-stop switch	<p>It can be stuck open or closed. If it is stuck closed the E-Stop switch will need to be replaced because the user will have no way to clear the E-Stop error message. If it is stuck open it will allow the machine to still operate but it will be unsafe for the user. The E-Stop switch will still need to be replaced. The replacement part number for E stop switch is 26039.</p>
USB port failure	<p>Will fail to recognize any external device. Check that the USB cable(s) are properly connected to the programming panel and computer module. Some USB devices may not be recognized by our computer module. We suggest you purchase the USB drive that SWI sells.</p>

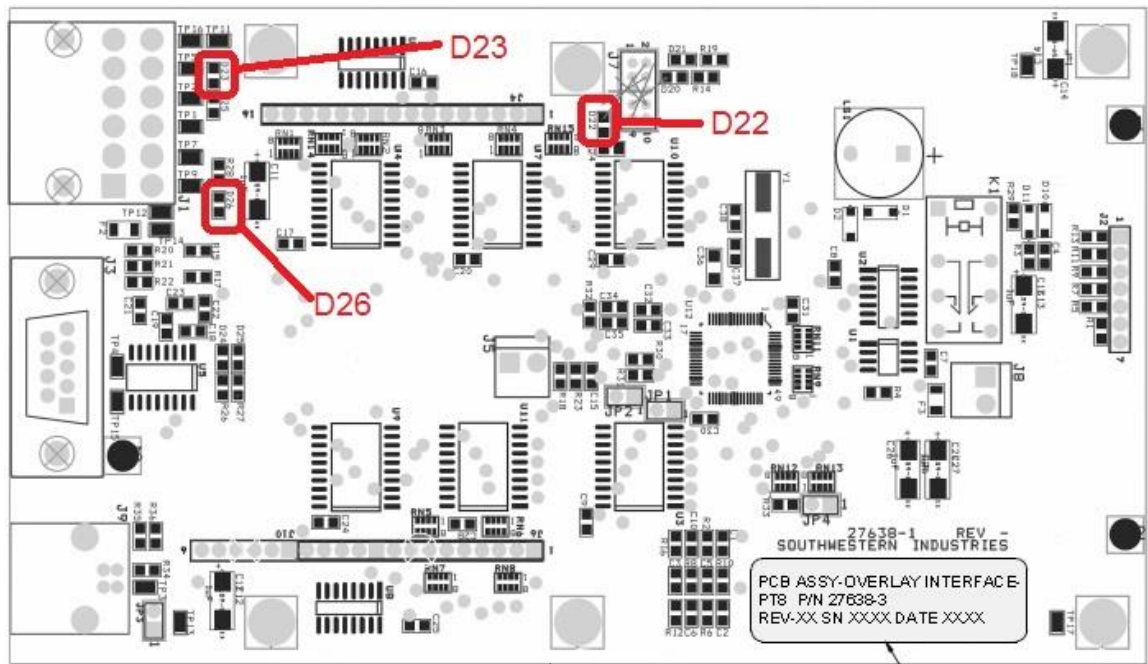


Figure 5.4e – Overlay Interface Board

## 5.5 Axis Motors/Servos

### 5.5.1 Axis Motors

#### **DANGER!**

Do not work with the motors unless the power is disconnected from the machine. The motors are run by 115 VAC. There is possibility of death by electrocution!

The Motor subsystem is comprised of 3 parts: The Motor Encoder, servo driver and the Motor. The motors are powered by 115 VAC voltage. The servo driver is also an integral part of servo system, which is discussed in detail in the next section.

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

The motors on the X, Y and Z-axis are the same type of motor but all 3 are different due to motor cable lengths which vary.

Check the motor cable connections on the computer module. There are 2 connections for each motor, one for power and one for the encoder signals.

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:

- Run Service Code 100 or 131. This will display on the DRO if the motor encoder is counting. If the axis does not count, 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. Service code 131 only works for the X and Y axis in both direction but works for Z only in the plus direction.

#### **Moving Problem from One Axis to Another**

#### **WARNING!**

Whenever troubleshooting the Z-axis it is best to disconnect the belt on the Z-axis and disconnect power from the brake so that the brake is always engaged. Then swap the axis encoder cables.

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 – Y Axis will not move and faults

This particular problem can happen because of any of following reasons: bad motor, servo driver, 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 Z-axis has no problems. Let's also assume it is not an obvious problem like a loose connection.**

Swap these components	Results
Physically swap the cable connections on the computer module. For example, the power and encoder cables for the Y and Z axis.	Has the problem moved to the Z axis? If so, then the computer module is bad.
Physically switch the Y and Z motors	Has problem moved to Z-axis? If yes, replace motor. If no, the motor is not the problem.

**WARNING!**

Whenever a motor is replaced or just removed it needs to be realigned so that the index pulse on the motor is 180 degrees from the home switch, service code 505 should be used to perform this alignment. Note that the ball lock locations under service code 500 must also be redone. The ATC tool positions may also need to be done with service code 520.

### 5.5.2 Servo Driver

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

**DANGER!**

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

**Indications:**

- Problems moving just one axis.

**Servo Types:**

- X and Y servos are identical. The Z axis servo has an additional circuit to help dissipate energy when the head moves down due to this machine not having a counterbalance. This energy is dumped to a braking resistor. The braking resistor is a 500 watt, 30 ohm resistor. To check this resistor, you will need to disconnect the cable connection that can be found under the transformer cover. Press the E-stop before checking this resistor with an ohmmeter.

**Objective:**

- Isolate the problem to the particular Servo Driver

**Steps:**

1. Turn off and unplug the system.
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.

If you temporarily swap the servo on the Z axis with one from the X or Y, do not run the Z axis at full feedrate. Lower the maximum feedrate in service code 503.

## 5.6 Spindle Motor & AC Drive

### Danger!

The spindle motor and AC Drive uses 220 or 415 AC volts to operate, utilize care when working with these components. There is possibility of death by electrocution!

### Warning!

The spindle inverter is able to store energy after power is removed. Please allow 20 seconds for the power to dissipate from these devices before servicing. The screen on the AC drive will go blank once power is dissipated from the unit.

### 5.6.1 Spindle Motor

The spindle motor is a 3HP induction motor rated for a max rpm of 5000 rpm. The spindle motor contains a 1024 window encoder that produces 4096 counts per revolution and is attached to the back of the motor. The spindle motor directly drives the spindle via a coupling. The spindle motor also contains a 110 VAC fan that is used to cool the motor. The fan blows air down over the motor. The motor can be wired for either 220 or 440 volts, make sure you wire the motor correctly if you replace the motor.

### WARNING!

Whenever the spindle motor is replaced or removed, service code 510 must be performed to reset the spindle orientation angle

Symptoms	Diagnostics
Spindle goes to the wrong orientation angle when doing a tool change.	<ul style="list-style-type: none"> <li>Verify that the spindle count on parameter 10-19 is set to the same value as the spindle orientation counter under service code 510.</li> <li>Check for spindle motor coupling being loose or slipping.</li> <li>Redo the spindle orientation setup.</li> </ul>
Spindle faults out immediately when trying to run the spindle.	<ul style="list-style-type: none"> <li>Verify that the spindle encoder is working properly. Use service code 510 to check.</li> <li>Verify that the AC drive parameters have the correct values.</li> <li>Verify that the spindle is able to turn freely.</li> <li>Verify that the spindle power wiring is correct and properly fasten.</li> </ul>
Spindle faults out when decelerating from high speed.	<ul style="list-style-type: none"> <li>Verify that the deceleration parameter on the AC Drive 01-13 is set correctly.</li> <li>Verify that the spindle braking resistors are connected properly to the AC drive.</li> <li>Verify that the braking resistance is equal to 100 ohms at the AC drive for a 220VAC system and 200 ohms for a 400 system</li> </ul>
Spindle will not turn when a command is given.	<ul style="list-style-type: none"> <li>Verify that the AC Drive has power.</li> <li>Verify that the Forward command is given to the AC Drive, by measuring 0 volts DC across the FWD terminal and the DCM terminal on the AC drive when the FWD command is given and 24 VDC when it is not.</li> <li>Verify that an RPM command greater than 100 rpm is entered on the spindle speed command.</li> <li>Verify that the voltage across terminal AVI and ACM is greater than 0 VDC.</li> </ul>



	<ul style="list-style-type: none"> <li>• Verify that the all the parameters on the AC drive are set correctly.</li> <li>• Verify that the E-stop command to AC Drive has not been activated (in other words, the button is not pressed). By measuring 0V from MI1 to DCM. When the E-stop message is present it will measure 24V (button is pressed).</li> <li>• Verify the parameters on the AC Drive are correct.</li> </ul>
--	--

## 5.6.2 Spindle AC Drive

The spindle AC Drive is a 3HP 3phase 220 VAC input drive or if the user orders the 400 volt option, it will be 440 VAC input. The AC drive is able to drive the spindle motor up to 5000 RPM, which is 167HZ on the AC Drive. The AC drive contains an encoder input PCB in order to perform the spindle orientation. Without the encoder input to the drive the AC drive will fault out. Once the AC drive receives the encoder input it then sends it out to the computer module. When the E-stop is pressed, the AC drive will automatically decelerate to a stop.

The spindle braking is done via a braking resistor that is found on the top of the machine. The resistor is rated at 500 watts and has 100 ohms of resistance for 220 volt power and 200 ohms for 440 volt power. If the spindle is not braking properly, check the resistance of the resistor with an ohmmeter.

All the digital inputs to the drive are 24 volts DC. There are 5 digital inputs to the AC drive and 2 outputs commands to the computer module.

The AC Drive operator, seen in Figure 5.6.2C may be used to display the frequency input, frequency output, output current, and the digital inputs. As a default whenever the AC Drive is initially turned on, it will be in the Frequency input mode. Every time the Mode button is press the AC drive will scroll through the following modes and in the following sequence.

1. Frequency Input Mode – In this mode the AC drive will display the frequency command **from the computer module. Note the letter "F" on the top left of the operator will turn red** when in this mode.
2. Frequency Output Mode – In this mode the AC drive will display the frequency command output to **the motor. Note the letter "H" on the top left of the operator will turn red when** in this mode.
3. Digital Input Mode (User Define) – In this mode the AC drive will display whatever digital input is triggered in Hexadecimal from the computer module. Note the **letter "U" on the top left of the operator will turn red when** in this mode. The following are the digital inputs codes.
  - a. 0000 – Means that no digital input is activated.
  - b. 0001 – Means that the FWD command input has been activated
  - c. 0002 – Means that the REV command has been activated.
  - d. 0004 – Means that the E-stop command has been activated.
  - e. 0008 – Means that Reset command has been activated
  - f. 0010 – Means that the Orientate command has been activated.
  - g. 0011 – Means that the Orientate and FWD command input has been activated. This is necessary when performing a tool change.
  - h. 0020 – means that the tap mode command has been activated.
4. Current Output Mode – In this mode the AC Drive will display the current being used by the motor. Note an "A" will be displayed in front of the current value. The following **RPM's should produce the noted current under a no load condition.**
  - a. 100 RPM – 6 amps
  - b. 1000 RPM – 6 amps
  - c. 1800 RPM – 5.4 amps

- d. 3000 RPM – 3.11 amps
  - e. 5000 RPM – 1.8 amps
5. Upload/Download Mode – In this mode the operator will have the ability to download or upload the parameters from the AC Drive. The operator will display a “read 0” in this mode. The following steps are used to download and upload the AC Drive parameters to and from the operator.
- a. To download the parameters from the Operator to the AC Drive follow the sequence in figure 5.6.2A below.

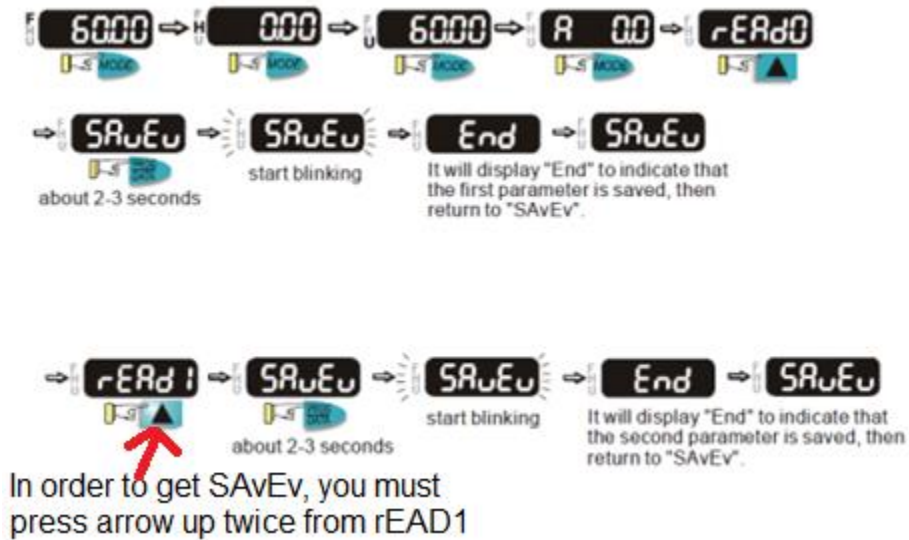


Figure 5.6.2A

- b. To upload the parameters from the AC drive to the Operator follow the sequence in Figure 5.6.2B

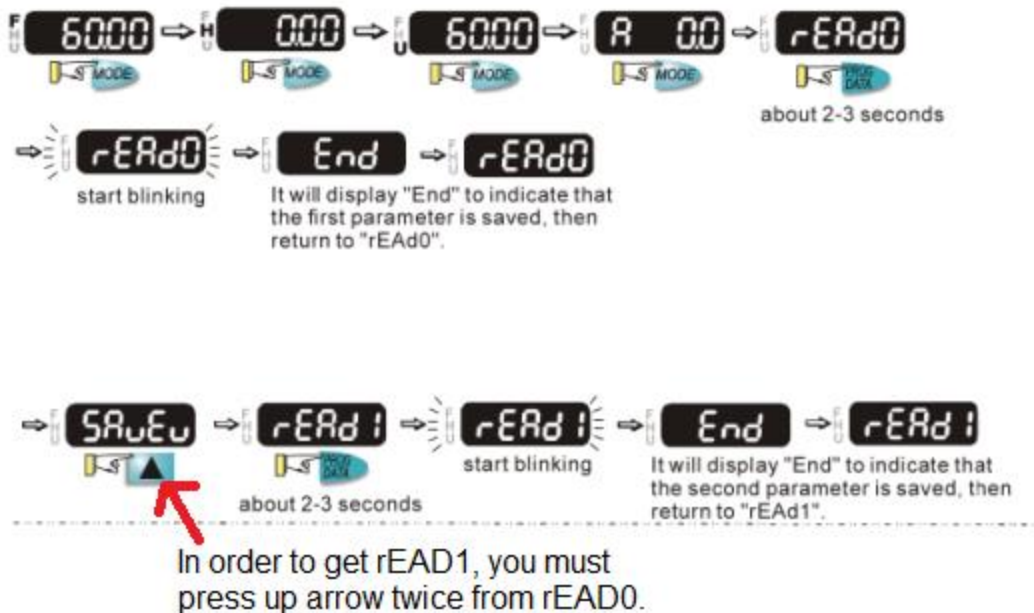


Figure 5.6.2B

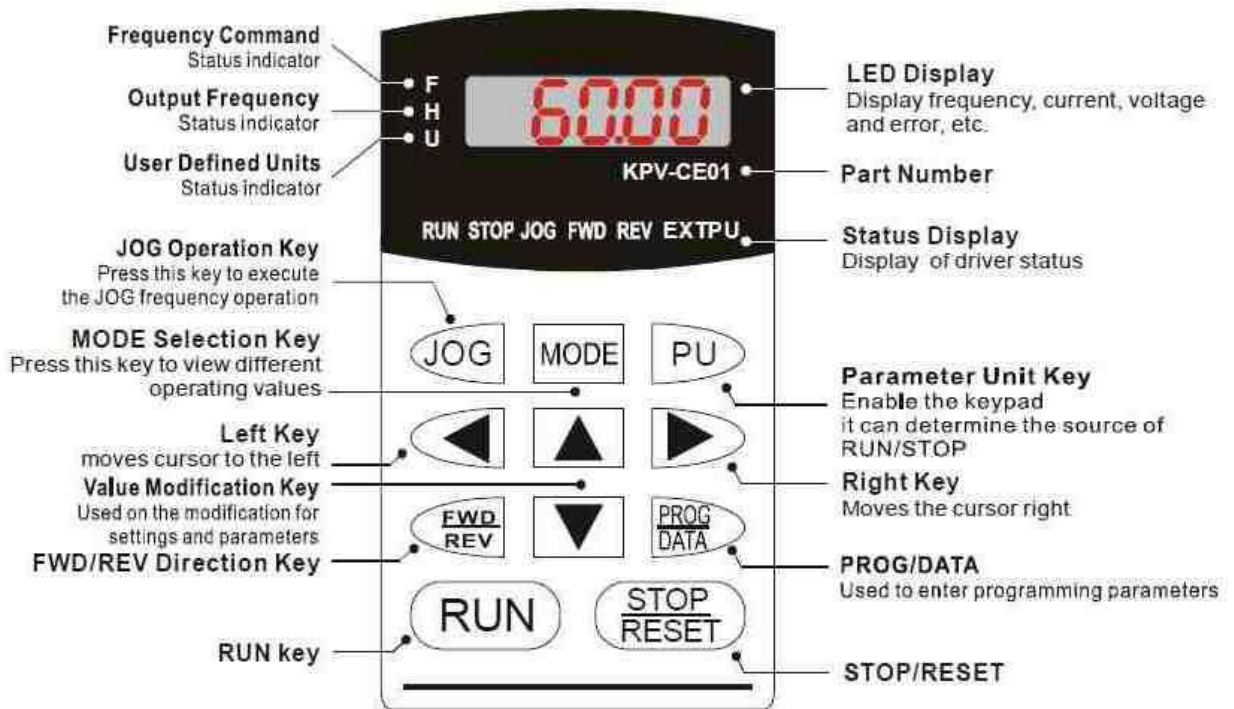


Figure 5.6.2C

## Inputs

1. FWD (FWD terminal) input command, is used to tell the AC drive to rotate the spindle in the forward direction, that is CW when viewing the motor from the top looking down. The command is said to be activated when the voltage between the DCM and the FWD terminals is 0 volts and deactivate when it is 24 volts DC.
2. REV (REV terminal) input command, is used to tell the AC drive to rotate the spindle in the reverse direction, that is CCW when viewing the motor from the top looking down. The command is said to be activated when the voltage between the DCM and the REV terminals is 0 volts and deactivate when it is 24 volts DC. Please note that the user can only run the spindle forward when pressing the ON button on the overlay. The ON button usually only runs in FWD. The software may allow for reverse commands to be sent to drive.
3. Orientate (MI3 terminal) input command, is used to tell the AC drive to go a specific angle that is specified on parameter 10-19. Note in order for the AC drive to accept an orientation command a FWD and Orientation command must be given at the same time. The command is said to be activated when the voltage between the DCM and the MI3 terminals is 0 volts and deactivate when it is 24 volts DC.
4. Reset (MI2 terminal) input command, is used to reset the AC Drive after a fault condition has occurred. The command is said to be activated when the voltage between the DCM and the RESET terminals is 0 volts and deactivate when it is 24 volts DC.
5. E-stop (MI1 terminal) input command, is used to inform the drive that an E-stop condition has be activated and to stop rotation immediately. The E-stop command takes precedence over any other command. The command is said to be activated when the voltage between the DCM and the MI1 terminals is 24 volts and deactivate when it is 0 volts DC. When the E stop button is pressed and the message is on the screen you should see 24 volts.

6. DAC (digital to analog) signal is an analog 0 to 8.5 Volt signal that is used to control the speed of the spindle motor. This is the AVI terminal on the AC Drive. When measuring AVI voltage use ACM terminal for reference.

### Outputs

1. Fault (RB and RC terminals) output, is used to indicate a fault has occurred on the AC drive to the computer module. When a fault occurs the voltage between terminals RB and RC will be 5 volts DC and when it is okay it will be 0 volts.
2. Speed Agree (MRA and MRC terminals) output, is used to indicate when the actual spindle speed is equal to the commanded speed. When the spindle speed is equal to the commanded speed the voltage between the MRA and MRC terminals will be 0 volts and when it is not it will be 5 volts.

Symptoms	Diagnostics
Spindle will not perform a spindle orientate command.	<ul style="list-style-type: none"> <li>• Verify that the orientation command is being sent to the AC drive by measuring 0 VDC from MI3 to DCM terminals and from the FWD to DCM terminals of the AC drive when the orientation command is triggered.</li> <li>• Verify that the all the parameters are set correctly on the AC Drive.</li> <li>• Verify that the E-stop command to AC Drive has not been activated. By measuring 0V from MI1 to DCM. When the E-stop command is present it will measure 24V.</li> </ul>
The AC Drive will fault out immediately when starting the spindle.	<ul style="list-style-type: none"> <li>• Verify that the spindle AC drive encoder PCB is properly seated.</li> <li>• Verify the spindle encoder on the motor works.</li> <li>• Verify that the wiring on the AC drive is correct.</li> <li>• Verify that the parameters on the AC drive are correct.</li> </ul>
The AC drive has a Fault and it is unable to clear the fault.	<ul style="list-style-type: none"> <li>• Verify that the spindle Reset signal is being sent to the AC drive by measuring the voltage between MI3 and DCM on the AC drive. When the reset command is given, it should be 0 VDC and 24 VDC when no reset command is given.</li> </ul>

## 5.7 Electrical

### 5.7.1 Checking Voltages

**DANGER!**

Take extreme caution when working with high voltage. There is possibility of death by electrocution!

There are 8 different voltages that need to be checked when troubleshooting a system. A digital multi meter will be necessary in order to measure the voltages. An auto adjustable digital multi meter is preferred that goes from 0 to 600 DC/AC.

1. 220VAC (208 to 240VAC), 3 phase – This is the main power to the entire machine. When measuring this voltage measure between each phase, as seen in figure 5.7.1a.
2. 415VAC (400 to 440 VAC), 3 phase – this is an optional voltage that can be ordered with this machine and replaces the standard 220 volts.
3. 115VAC (115 to 125VAC), 1 phase – This voltage is produced by the transformer. It is used for power to the computer module, which then powers the axis motors, lube and coolant Pumps. If the voltage coming out of the transformer is not exactly 115VAC, it can be adjusted by moving the wire coming out of the transformer to a different terminal. For example if the 115VAC is actually 130VAC and the wire is currently on the 115VAC terminal, then move the wire to the 104 terminal so that the actual voltage drops to around 120VAC. When measuring this voltage it is best to measure at the Transformer as shown in figure 5.7.1a.
4. 24VDC (22 to 26VDC) – This voltage is produced by the internal power supply of the computer module and is used for most of the inputs and outputs. The voltage can be measured between pin 1 of the 24VDC Port and the chassis ground on the computer module, as seen on figure 5.7.1b
5. +12VDC (11 to 13VDC) – This voltage is produced by the internal power supply of the computer module, it is used to power some internal functions of the computer module and to power the LCD controller board. The voltage can be measured between pin 3 of the Overlay Power Port and the chassis ground on the computer module, as seen on figure 5.7.1b. If this voltage is not correct the computer module will produce a DC Power Fault that will be identified by the Voltage Fault LED being turn ON, on the computer module.
6. -12VDC ( -11 to -13VDC) – This voltage is produced by the internal power supply of the computer module, it is used to power the internal circuits for the  $\pm 10$  volts used for the axis motors. If this voltage is not correct the computer module will produce a DC Power Fault that will be identified by the Voltage Fault LED being turn ON, on the computer module.
7. 10VDC – This voltage is produced by the computer module, it is used for control of the spindle motor (0 to 10 VDC). This voltage varies depending on rpm of the motor.
8. 5VDC (4.75 to 5.25VDC) – This voltage is produced by the internal power supply of the computer module, it is used to power the internal functions of the

computer module, servo drives, motor encoders, and the Overlay Interface board on the pendant. The voltage can be measured between pin 1 of the Overlay Power Port and the chassis ground on the computer module, as seen on figure 5.7.1b. If this voltage is not correct the computer module will produce a DC Power Fault that will be identified by the Voltage Fault LED being turn ON, on the computer module.

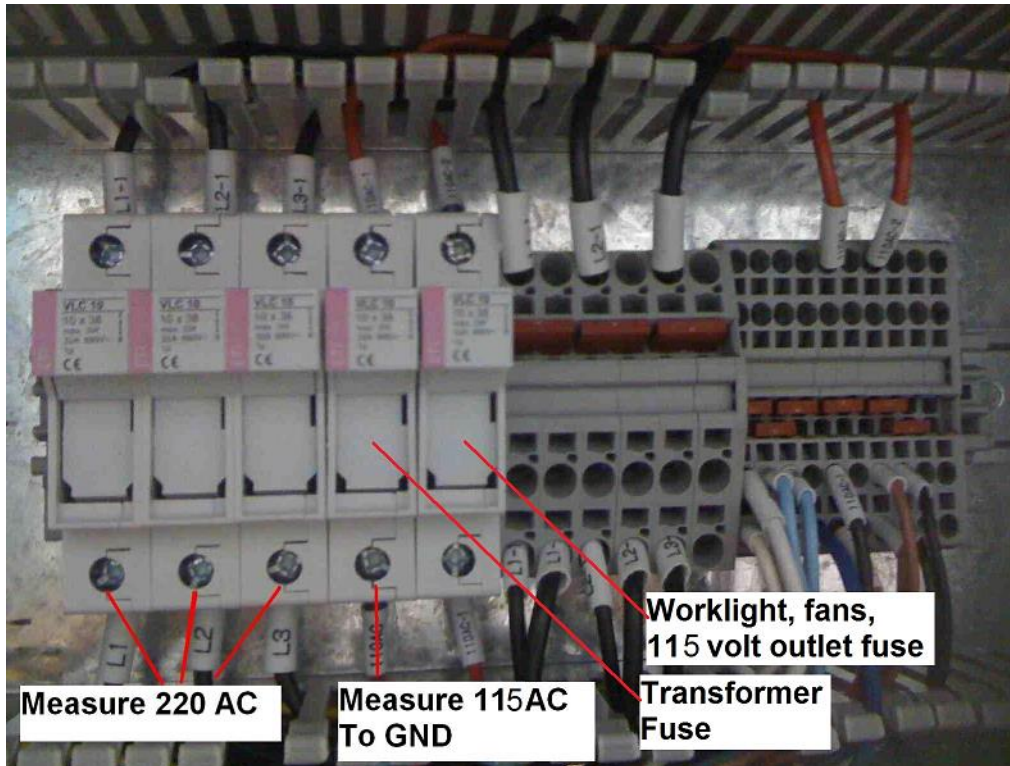


Figure 5.7.1a

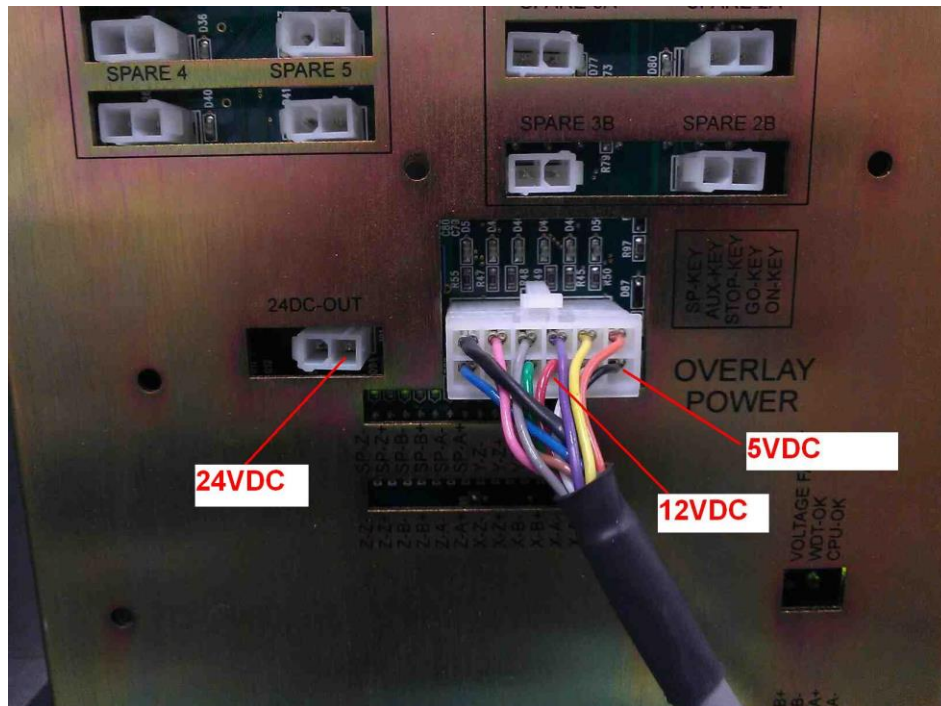


Figure 5.7.1b

## 5.7.2 Checking Fuses

There are 9 field replaceable fuses in the system.

- 3 on the computer module (see section 5.3).
  - F1 – coolant pump – 3 amp
  - F2 – computer module power supply – 3 amp
  - F3 – axis motors – 12 amp
- 3 next to the on/off switch are for the 3 phase 220 volt power in (20 amp) and if you have the 440 volt option these fuses are 10 amp.
- 1 fuse (16 amp) that controls power out of the transformer for the control system
- 1 fuse (4 amp) that controls power of the worklight, electrical cabinet fans, spindle fan and auxiliary 115 volt port. This 115 volt auxiliary port should only be used to run low current devices like a light or laptop.
- 1 on the lube pump (5 amp). There is no fuse on the computer module for the lube pump.

To check fuses:

- **Use a Volt/Ohmmeter; select "OHM".**
- Remove the fuse completely from its holder.
- 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.

## 5.8 Tool Carrier Diagnostics

The Automatic Tool Carrier or the ATC, as it is referred to throughout this manual, consists of 8 tool spots that correspond to tools 1 through 8 in your program. See drawing 27587 at the rear of the manual.

### 5.8.1 Spindle Orientation

An automatic tool change requires that many components of the 2 OP work in concert with one another. These components include the ATC positions (Position relative to the centerline of the spindle), the spindle (Orientation of the spindle drive dogs relative to angle of the tool holder held in the ATC), the Z-axis (tool change height) and the Automatic Draw Bar (being in state of clamped or unclamped).

**Let's start with spindle orientation. Spindle orientation is like any other setting regarding the ATC.** It is a critical one because the machine will crash as a result of an improper setting. Spindle orientation aligns the spindle drive dogs for proper engagement with the 30 taper tool holders held in the ATC tool magazine. Service code 510 will safely walk you through this procedure. Make sure to follow the procedure precisely.

### 5.8.2 Tool Change Height

Service code 520 will take you through the procedure for setting the tool change height. It will set the position where the Z-axis will clamp or unclamp the tool. Like the spindle orientation, this setting is also very critical.

During this procedure you **will hear the "air through spindle" hissing sound, this sound is actually a valuable tool for this procedure.** As you near the proper tool change height while performing service code 520, you will hear the sound of the air slowly being blocked off, simply creep down **at .002" jog feed rate until the sound of the air hissing just disappears, then back it off one click** and a slight sound of air will once again be heard. That is the proper tool change height.

It should be noted, that the tool clamping mechanism will give the 30 taper tool holder a slight **bump of ~0.020" during the "Unclamp" cycle, to help dislodge the tool holder from the spindle.** Likewise, it will give the tool holder a slight tug at the **"Clamp" cycle. This action is both normal and proper.**

Any improper setting of the tool change height would result in unnecessary stresses on the gripper assemblies and the tool magazine.

### 5.8.3 Tool Change Positions

The ATC has 8 tool (X,Y) locations that need to be set correctly. Service code 520 is used to set these locations. See section 6.13 for a procedure.

All 8 locations should be set by using a dial indicator to sweep in the taper on a tool. The X and Y coordinate should be within **0.005" or so on your indicator. In other words, there is some room for error, but these tool locations cannot be set by eyesight.** Once you have all tools set properly, press the **"SAVE TABLE" button to save all tool locations.**

### 5.8.4 Tool Clamping Mechanism

There are two forces that are used in the tool clamping mechanism. The first being the force applied by a stack of Belleville spring washers that are set to apply ~1000 lbs of pull force on the



30 taper retention knob which clamps the tool holder into the spindle. The second being the force of the air/oil cylinder that compresses the Belleville washers and releases the tool holder from the spindle. See section 6.15 for how to bleed this hydraulic system if air gets into it.

The spindle pull force is set at the factory and should not be modified for any reason. Modifying this setting will change the effectiveness of the tool clamping mechanism, and/or shorten its life expectancy.

### 5.8.5 Tool Carrier Front and Back Cylinder Switches

An air cylinder is used to move the ATC to the front and back. There are two sensors mounted on the cylinder, one near each end. Each sensor has an LED light which illuminates to indicate when the air cylinder has reached the fully retracted or extended position. When the ATC is back, the rear LED light should be on. When the ATC moves all the way forward, the front LED comes on for a brief second and then turns off, as soon as the ATC is pushed back by the worktable to the proper Y location.

There are also 2 switches to monitor if the spindle is clamped or unclamped.

**ATC "FRONT"** is a limit switch that turns ON when the ATC has advanced all the way forward toward the operator.

**ATC "BACK"** is a limit switch that turns ON when the ATC has retracted all the way back behind the access door.

**Tool "Unclamp"** is a limit switch that turns ON when the tool unclamp mechanism is in the unclamped state. If this limit switch is not set or functioning improperly, there is the potential that the drawbar gripper or the mechanism may become damaged. This switch is triggered only when the machine or the operator is loading a tool in and out of the spindle. Pressing the green push button on the head puts the machine in the unclamped state.

**Tool "Clamp"** is a limit switch that turns ON when the tool clamp mechanism is in the clamped state.

### 5.8.6 ATC Flow Control Valves

The speed at which the ATC can move front or back can be controlled by 2 flow control valves, identified on drawings 27563 and 27540 found in this manual. See section 5.9 for more information on these flow control valves and guidelines on how to adjust them.

One flow control valve controls the speed at which the ATC travels out toward the operator and other how fast it travels back to its retracted position. In the case of either valve, an adjustment in the clockwise direction reduces the speed of the ATC sliding assembly, and an adjustment in the counter clockwise direction increases the speed of the ATC sliding assembly.

### 5.8.7 Error Messages Relating to the ATC

The following is the list of error messages that the ATC might generate.

**Error 105 - Check the Spindle Drive Module and related electronics. Repair as needed.** The spindle drive may have faulted.

**Error 124 - The spindle did not orient correctly.** The orientation angle in the spindle drive does not match the angle in the control.

**Error 125 - The current position of the Z Axis is BELOW the tool change position.** The Z-axis is not high enough to execute a tool change.

**Error 126 - The spindle is in the unclamped position and needs to be clamped to proceed.** The unclamp limit switch is detecting that the tool clamping mechanism is still in the unclamped state, this might occur when the spindle has grabbed a tool in the ATC, but it is not clamped in the spindle for the tool change routine to complete.

**Error 127 - The spindle is in the clamped position and needs to be unclamped to proceed.** The clamp limit switch is detecting that the tool clamping mechanism is still in the clamped state, this might occur when a tool has been returned to the tool carrier, but is still clamped in the spindle. In this state if the Z axis was to move, the tool gripper in the ATC could be damaged.

**Error 129 - The ATC carrier is out of position or is between its limit switches.** This occurs if the ATC "FRONT" or "BACK" limit switch fails to be recognized.

**Error 131 - The ATC was unable to move to the front position.** This message appears when the ATC fails to reach the front limit switch within five seconds of being commanded to do so.

**Error 132 - The ATC was unable to move to the back position.** This message appears when the ATC fails to reach the back limit switch within five seconds of being commanded to do so.

**Error 133 - The Z-axis was unable to move to the unclamped position.** This means the Z-axis was unable to move to just above the retention knob of a tool in the ATC within five seconds of being commanded to do so.

**Error 134 - The Z-axis was unable to move to the tool change position.** The Z-axis was unable to reach the tool change height within five seconds of being commanded to do so.

**Error 138 - The ATC is trying to unclamp the spindle but the spindle is still in motion.**  
This message appears when the system detects any amount of velocity from the spindle. The system will not allow the spindle to unclamp under this condition.

**Error 139 - The ATC carrier is trying to move but the air pressure is too low.**  
This message will occur if a tool change is requested from a program.

**Error 150 - The current ATC function has timed out.** This happens when the control expects another action to occur but it doesn't.

### 5.8.8 Diagnostics Table

The following is a list of symptoms for the ATC and possible causes and remedies.

Symptom	Possible Cause	Remedy
ATC will not move to the front or back positions	<ul style="list-style-type: none"><li>• The door is open</li><li>• Compressed air is not being supplied to the machine.</li><li>• Low air pressure</li></ul>	<ul style="list-style-type: none"><li>• Close the door.</li><li>• Supply 90 psi air to the machine</li><li>• Find the cause of the low air pressure. Pressure should be 90 psi at the</li></ul>

	<ul style="list-style-type: none"> <li>• The solenoid is not receiving an electrical signal.</li> <li>• The tube supplying air to advance the sliding mechanism toward the spindle became pinched or obstructed.</li> <li>• A mechanical obstruction is preventing movement.</li> <li>• The ATC door lift assist cylinder is jammed, or its flow controls are closed too much and do not allow sufficient amount of air flow to lift the door up and assist the ATC cylinder. This causes too much resistance for the ATC cylinder and will prevent the ATC cylinder from moving forward.</li> </ul>	<p>machines regulator.</p> <ul style="list-style-type: none"> <li>• Check the LED light on the computer module to see if the output has been triggered to move ATC move out or in.</li> <li>• Replace and re-route pinched tubing.</li> <li>• Remove the obstruction</li> <li>• Adjust the ATC door assist lift cylinder flow controls as specified in section 5.9.</li> </ul>
<b>The tool holder “pops” when being removed from the spindle</b>	Tool holder or the spindle bore taper is contaminated with dry coolant causing it to be tacky	Clean all mating surfaces
Tool holder falls from the spindle during a tool change	<ul style="list-style-type: none"> <li>• An incorrect retention knob is being used.</li> <li>• The pull fingers inside the spindle are damaged, jammed open or missing</li> </ul>	<ul style="list-style-type: none"> <li>• Locate and use the proper retention knob.</li> <li>• Visually inspect the pull fingers.</li> </ul>

## 5.9 Pneumatic Diagnostics

Air is a vital component to the operation of the 2 OP machine and is used to run many key components on the machine. Air is used to run the tool change carriage cylinder, clamp and unclamp tools in the spindle, and to clean the spindle taper during a tool change.

The following is a brief description of the pneumatic components used on the 2 OP machine. Please refer to drawing 27563 at the rear of the manual for a schematic of the pneumatic system.

1. Supply Air Line to Machine – in order to provide the proper pressure and volume of air necessary to run the 2 OP you must use an air supply line with a minimum ID diameter of **3/8"**, we recommend a **1/2"** supply line. The main air line is connected to the machine on the right side of the machine.
2. Air regulator (main) – the air regulator allows you to adjust the air pressure supplied to all the major components of the pneumatic system. It is set to 90 psi from the factory and should not need to be adjusted. The air pressure can be adjusted by lifting up on the cap at the top and rotated clockwise to increase the air pressure and counterclockwise to decrease the air pressure. The air pressure gage reads from 0 to 160 psi. Liquid impurities, for instance water and compressor oils, and other solid particles in the compressed air that are above 40 microns in size, are filtered out and collected in the filter below the regulator. Solid particles are captured in the filter element, and the liquid impurities collect on the bottom of the filter bowl. The liquid impurities will be released automatically once they reach a certain level.
3. Air regulator (door) – a 2<sup>nd</sup> air regulator is used to control the air pressure to the door open cylinder. This air regulator is to be set so the door requires around 8 to 10 lbs of force to lift. This regulator should be set to around 70 to 75 psi to accomplish this task.
4. Air Pressure Switch – the 2 OP is equipped with an air pressure switch that monitors the air pressured supplied to the machine. It is set to trigger an alarm when the air pressure falls below 60 psi. When this happens, a low air pressure flashing message will appear on the screen. This message will go away automatically when the air pressure rises above this value. This switch is set at the factory to 60 psi. The low pressure setting on **this switch is set on the "RANGE" scale at the factory to 60 psi (4 kg/cm<sup>2</sup>), and the differential pressure setting is set on the "DIFF" scale to ~22 psi (1.5 kg/cm<sup>2</sup>). These values should not need to be adjusted in the field. If necessary, the low pressure setting "Range" can be adjusted by turning the right screw on the top of the switch. The CW adjustment will reduce this setting and CCW will increase it. The differential pressure setting "DIFF" is adjusted by turning the left screw on the top of the switch. The CW adjustment will increase the value and CCW will reduce it.**

Note - The "Range" is total pressure range that this switch can be adjusted or set to trip at. The "Diff" setting is for setting the maximum pressure difference between the input and output. If this difference is exceeded the switch will also trip.

5. Solenoids Valves – the 2 OP Mill has 2 solenoid valves as seen on the schematic drawing 27563. These valves are designed to control various functions of the pneumatic system.
  - a) **Valve labeled "1" (controls the flow of air to the clamp/unclamp air cylinder)** – this valve allows air to flow to the air cylinder found on top of the spindle which allows tools to be clamped and unclamped from the spindle. It also provides air

to blow down the center of the spindle when changing tools. This helps blow chips or debris off of the spindle taper and tool holder during a tool change.

- b) **Valve labeled "2"** – this is a dual solenoid, 4 Way valve and designed to control the direction of flow of air to the ATC carriage cylinder and the ATC door lift cylinder. It moves the ATC front and back depending on which solenoid is energized. This valve also supplies air to the door lift cylinder, which assists in opening and closing the ATC door.
- c) Valve Manual Override – each valve has a  $\frac{1}{4}$ " red button **that protrudes 1/8" out** of the valve near each solenoid that can be pushed in to manually shift/operate the valve. This feature is particularly useful during the initial pneumatic system adjustment procedure, and later during pneumatic system troubleshooting. The electrical power does not have to be connected to use this feature.

**Warning!**

These override buttons should never be pressed during the normal machine operation, or even if **the machine's electrical power is on and the computer still has control of the solenoids**. The locking feature should be only used if absolutely necessary, usually in a case when one person is setting up or troubleshooting the machine.

Pressing the manual override button basically shifts the valve in the same direction as if it was operated via the adjacent solenoid during the normal machine operation. These buttons are normally spring loaded OUT. They have two basic functions:

1. Push button - when pushed in they shift the valve, and when released the valve shifts back.
2. Push and Twist to Lock - when pushed down and twisted clockwise, the **button will stay down and stick out only about 1/16" in this state. The valve will shift and will stay shifted until the button is twisted counterclockwise to unlock it.** Once unlocked, the button will return to its OUT position (**stick out 1/8"**), and act as a spring loaded push button.

The locked down button is often forgotten after the machine troubleshooting/diagnostics are completed. It is often hard to notice that the button is down, and if left in the locked position, the machine will not function properly, which may lead to confusion and cause a more serious and complicated machine problem or malfunction.

**Warning!**

Do not activate the valve #2 manually if the Y-axis is not completely forward, (0.40 inches past the actual soft limit) or if the Z axis is not in its upper most position. Failure to do so may lead to a crash of the ATC into the table or head. Also, never activate the air tool change cylinder valve 1 when there is a tool still in the spindle.

- 6. Flow Control Valves – the 2 OP has 6 air flow control valves and are labeled 1 through 6 on drawing 27563. The tool carrier carriage cylinder has 2 of them (labeled 1 and 2), which control the speed at which the ATC moves front and back. The flow control labeled 2 controls the speed at which the ATC will move out. The flow control labeled 1 controls how fast it moves back. They are adjusted at the factory by opening them to make the ATC move as fast as possible but smooth and without a noticeable bounce at the end of the stroke. Note: The ATC flow controls must be adjusted in conjunction with **the ATC cylinder's internal cushions for the optimum operation** – see below for adjustment procedure. It should take approximately 1 second to move out and 1 second to move back in. Flow control valve labeled 3 is used to control the amount of air that

comes down through the spindle during a tool change. This has been adjusted from the factory by closing the valve and then opening it approximately 8 full turns. Flow controls 4 through 6 are used to control the speed of the tool change door lift assist cylinder (see procedure on the next page). These flow controls should also be adjusted to obtain a fast but smooth door operation. Flow control #6 controls how fast the door can open by regulating how fast the air can exhaust from the cylinder. Flow control #5 controls how fast the door is permitted to close. Flow control #4 works in conjunction with #5 when closing the door. See below for a guideline on how to adjust the flow controls.

**Note** – it is important to route the air lines properly when replacing a flow control valve. Failure to do so will cause the system to not behave properly when adjustments are made. Figure 5.9 explains how a flow control valve works.

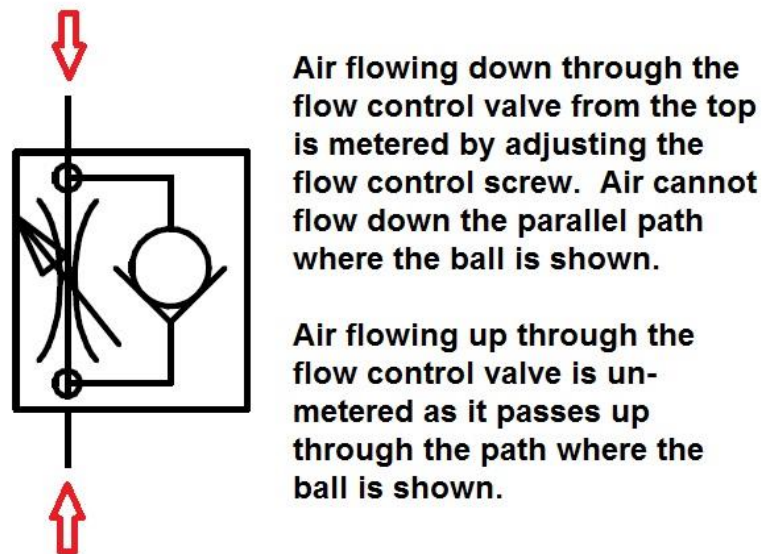


Figure 5.9

### **ATC Cylinder initial Adjustments**

**Front Flow Control adjustment** (labeled 2 on drawing 27563) – commonly known as “meter-out” type, it controls the air exhausting from the cylinder, it is used to adjust the speed of the ATC cylinder as it extends toward the work table.

**Initial adjustment** - close the flow control all the way\*\*, mark the knob with a black marker to establish a reference starting point, and then open it 10 full turns.

**Front Internal Cushion adjustment** – this air cushion controls the deceleration of the cylinder when it is within the last 1.5 inches of its full extension. It causes the cylinder to slow down gradually near the end of the extend stroke. See figure 5.9a.

**Initial adjustment** – using a 3mm allen wrench close the cushion all the way down, and open it 1/2 of a turn.

**Rear Flow Control** (mounted on the exhaust port of the quick exhaust valve, labeled 1 on drawing 27563) - this “metering-out” type flow control is used to control the speed of the ATC cylinder as it retracts back to its home position.

**Initial adjustment** - close the flow control all the way, mark the knob with a black marker to establish a reference starting point, and then open it 1 1/2 turns.

**Rear Internal Cushion adjustment** – this air cushion controls the deceleration of the cylinder when it is within the last 1.5 inches of the full retraction. It causes the cylinder to slow down gradually near the end of the retract stroke.

**Initial adjustment** – close the cushion all the way down, and open it 1/4 turn. Figure 5.9a shows both cushions on the ATC cylinder.

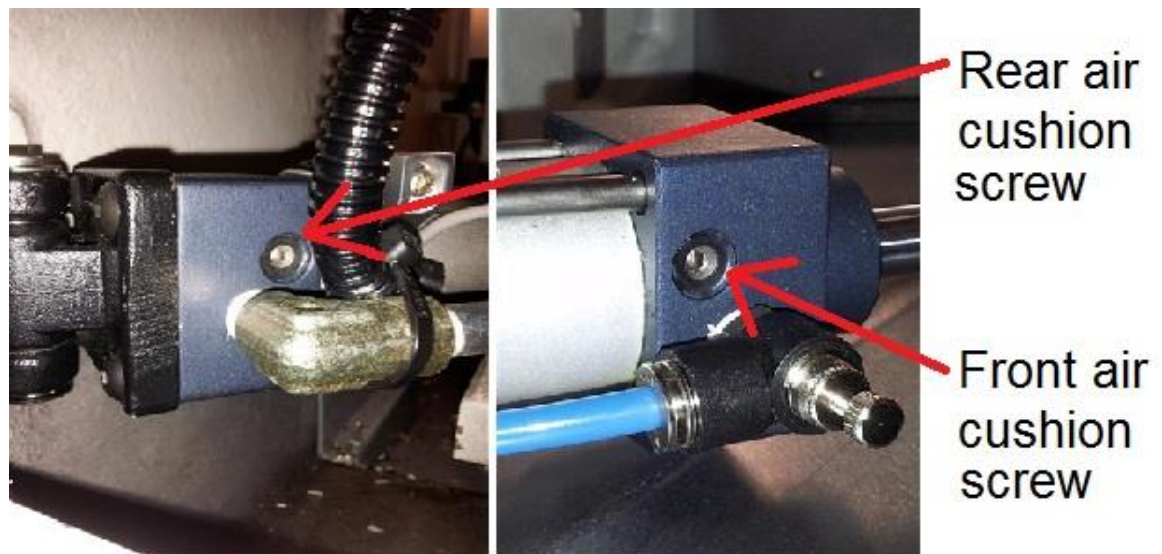


Figure 5.9a

### **ATC Door Assist Cylinder initial adjustments**

#### **Door opening**

**Front Flow Control** - this flow control is a “metering-out” type (labeled 6 on drawing 27563), it controls the air exhausting from the front of the cylinder, it is used to adjust the speed of the door cylinder as it extends and lifts the door up.

**Initial adjustment** - close the flow control all the way\*\*, mark the knob with a black marker to establish a reference starting point, and then open it 1 3/4 turns.

#### **Door closing**

**Rear Flow Control**- this flow control is a “metering-out” type (labeled 4 on Sheet 2 of drawing 27563), it controls the air exhausting from the back of the cylinder, it is used to adjust the speed of the door cylinder as it retracts and closes the door.\*

**Initial adjustment** – close the flow control all the way\*\*, mark the knob with a black marker to establish a reference starting point, and then open it 1 1/2 turns.

\* In order to close the door in a relatively controlled manner, a second flow control for controlling the air going into the cylinder is used; this flow control is commonly known as a “metering -in” type (labeled 5 on drawing 27563).

**Initial adjustment** - close the flow control all the way\*\*, mark the knob with a black marker to establish a reference starting point, then open it 1 1/2 turns.

\*\*Note: When closing flow controls used on this machine you will not feel a hard stop when the flow control is completely closed, but you will feel a noticeable change in tightening resistance as you approach the closed position, please use reasonable care and do not over tighten them.

7. Air/Oil Tool Change Cylinder – this is air-over-oil cylinder that is mounted near the top, behind the spindle. Its output line carries high-pressure oil to the hydraulic cylinder built into the spindle, for clamping and unclamping tools in the spindle. Please make sure to monitor a small oil reservoir cup that is mounted near this cylinder, just above the head sheet metal enclosure for easy visibility. The oil level inside this reservoir will only drop if there is a leak in the system. Please note that the solenoid valve #1 described in item 5a provides air to this cylinder and a 2<sup>nd</sup> air line provides the air that is directed down through the center of the spindle. See section 6.15 for how to bleed this hydraulic system if air gets into it.
8. ATC Air Cylinder – this is the cylinder that moves the ATC to the front and back when changing tools. This cylinder has two adjustable internal cushions designed to decelerate the carriage motion as smoothly as possible, as it approaches each end of its stroke. These adjustment screws are located in the front and back end cap of the cylinder next to the air line connections. They are factory set, and should not be tempered with. The cushions must be properly adjusted to take advantage of this feature. The basic adjustment of the cushion requires that the screw be turned almost all the way in at first, and as the cylinder is moved back and forth with full load, the screw is slowly unscrewed until the deceleration of the carriage is smooth and soft – see the initial setting procedure above.
9. Quick Exhaust – the 2 OP has a quick exhaust valve that helps to exhaust air quickly. On the tool carrier carriage cylinder, the quick exhaust prevents the air cylinder from seeing too high of a pressure during the ATC shift from the first to the second row of tools. Once again, if you need to replace a quick exhaust valve, you must make sure to mount it properly, as shown on the pneumatic schematic, drawing 27563.
10. Reservoir Tank – this tank is used to store extra volume of compressed air for the front door assist cylinder in the event the 90 psi compressed air supply line is disconnected from the machine. It also acts as an air pressure accumulator to help maintain the air pressure relatively constant during opening and closing of the front door. This tank will keep the door feeling light even if the air supply is suddenly disconnected or removed. **Due to the check valve installed before the tank's pressure regulator, the pressure will stay in the front door reservoir tank overnight assuming you do not open and close the door many times with the air disconnected.**
11. Check Valve – there is one check valve found prior to the inlet of the door pressure regulator. It prevents air from exhausting from this line when air is removed from the machine.
12. Tank Bleed Off Valve – this is used to remove air and drain any water or oil from the reservoir tank. This valve must remain closed during normal operation.

## Air Quality

Air quality is very important in the pneumatic system of the 2 OP Mill. The most common problem with the compressed air quality is the presence of water. Water contamination has a negative impact on the longevity and performance of various pneumatic components. It is not uncommon for many shops to have a lot of moisture in their air lines. For this reason, we strongly recommend installing an air dryer or a water separator upstream of the 2 OP Mill.

The 2 OP does have a filter with water separation ability but it can only handle a small amount of water per day, and if a larger amount of water was to enter the air line at one time, water may move downstream of this device and cause problems with the pneumatic components.



**Note: Valves and cylinders on this machine are internally pre-lubricated with grease from the manufacturer; therefore no external lubrication is needed nor recommended.**

The following table is a quick reference guide for troubleshooting problems related to the pneumatic system.

Problems with	Can contribute to
Air Pressure Switch or low air pressure	<ul style="list-style-type: none"> <li>• Flashing air pressure warning message on screen</li> <li>• Inability to change tools or load tools in the spindle. An error message can occur when trying to perform these activities</li> <li>• You can check if the control is seeing this air pressure switch by performing service code 521.</li> </ul>
Air Flow Control Valves	<ul style="list-style-type: none"> <li>• ATC will move in and out either too fast or too slow</li> <li>• Too little air is coming down through the spindle which can lead to chips sticking inside of the spindle taper</li> <li>• Make sure they are installed properly and air flows in the correct direction.</li> </ul>

## 5.10 Coolant Diagnostics

The coolant system consists of a 115 volt coolant pump, coolant tank and various hoses that supply coolant to various aspects of the machine. For an illustration of the coolant system, see drawing 27557 located in the rear of the manual.

The following summarizes various aspects of the coolant system.

1. Coolant pump – the coolant pump serves 2 purposes. It supplies coolant to the cutting tool and also washes chips away from the rear of the table so the ATC can move forward and backward smoothly. If the coolant wash is not working properly to clean chips away, it could lead to the ATC not moving forward enough which may lead to error messages or a possible machine crash when changing tools.
2. Coolant Wash Nozzles – the coolant wash supplies coolant to the rear of the table via 2 nozzles. The nozzles are flexible and should be directed as shown in the picture below. It is very important to make sure the lines are routed as shown so chips are washed away from the path that the ATC travels.



Figure 5.10

3. Chip Coolant Screen – the coolant tank contains a screen to filter out any chips or debris from the coolant pumps. Please see drawing 27557, item 7 for an illustration of this item. Depending on the machine usage, and the material being machined, this screen may need to be cleaned at various intervals. If the coolant is not draining fast enough and causes low coolant flow, the screen needs to be cleaned.
4. Coolant Hoses – there are 2 coolant hoses attached to the coolant pump. One hose delivers coolant to the nozzle on the head, and the second one to the nozzle used for washing chips from the back of the worktable.
5. Coolant Drain Plug – there is a drain plug near the bottom left corner on front of the machine intended for coolant draining from the tank.
6. Coolant level Sight Gauge - An external coolant level sight gauge is mounted on the front of the coolant tank. It gives the operator an easy way to visually check how much coolant is in the tank.
7. Coolant tank capacity – the capacity of the coolant tank on the 2 OP Mill is approximately 15 gal.
8. Rear Drain Plug – at the rear of the machine is a drain plug that can be removed to drain any coolant that collects in the rear compartment of the machine. Over time as coolant splashes around, some coolant may accumulate in this area.

## 5.11 Service Codes

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

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 CODE #, enter the number you want, then press SET.

**Warning!**

Certain service codes must be performed when servicing certain items on the 2 OP. Failure to do so can lead to machine crashes and expensive repair work. Do not work on the TRAK 2 OP unless you have been trained on these service codes.

Please see a table at the end of the service code section for the list of service codes that must be run when certain machine components are worked on.

The Service Codes are divided into logical categories. The table below is a quick summary of the service codes. More detailed information can be found below.

### Software

Code	Description	Comment
33	Software, Firmware and PLC versions	Displays current software versions and system settings.
141	Load configuration file from USB thumb drive	To load configuration files from a USB thumb drive to the TMX control.
142	Save configuration file to USB thumb drive	To save the configuration files for reloading later. When a computer replacement is necessary, saving the settings to a thumb drive for reloading them later is highly desirable.
316	Update Software	Runs the routine that copies new software from a USB thumb drive device to the ProtoTRAK system. Use this routine to install new ProtoTRAK software.

### Machine Set-Up

100	Open Loop Test	Caution! Machine will move. Check for crash conditions before running. Run under the direction of service personnel.
123	Calibration Mode	Use to calibrate the TMX control
128	Backlash Calibration Constant	Use to load backlash compensation for each axis.
400	Load foreign language MLS files	Used to download language tables that have been translated into a foreign language.
500	X, Y Ball Lock Offsets	Used to enter the offsets for ball lock
505	Over-travel Limits	Used to setup and troubleshoot software limits.
510	Spindle Setup	Used to calibrate spindle, orient the spindle in relation to the ATC, and troubleshoot any spindle encoder related issues.
520	Set Tool Carrier Locations	Use to set the 8 ATC tool locations as well as the tool change height.

### Diagnostic Codes

1	Program, File, Log Backup	Backs up all logs, program, tool info, calibration, and settings into a zip file. Used for the sake of troubleshooting.
54	Continuous Run Mode	Cycles through the program in current memory.
81	Program Panel Keyboard Test	Gives a tone feedback to a button push and highlights the button.
131	Manual DRO	Turns off servos so you can check encoders

132	Electronic Handwheel Test	Test the EHW signals
314	Toggle Test Lights in Status Line	Used to troubleshoot control issues
319	Error Logging	Logs the machine as it runs
326	Error Message Display	Displays error messages on screen
327	Display Memory Check	Displays memory availability of various devices
521	Check Control IO (input/output)	Application used to check all machine input and outputs.

### Operator Defaults/Options

66	Metric Boot Up Default	To have the ProtoTRAK open up in mm measurement.
67	English Boot Up Default	To have the ProtoTRAK open up in inch measurement.
79	Turn On Beeper	Turn the beeper on when pressing keys on either of the front panels
80	Turn Off Beeper	Turns the beeper off when pressing keys
203	Initiate Homing Sequence	Homes machine when entered
503	Set Maximum Feedrate	Sets the rapid speed for the machine. Default is 500 ipm
300	Set Lube Pump	Allows user to manual run lube pump and adjust frequency and discharge times.
320	Commit Image to Compact Flash	This service code may be used to save a device driver from a USB device to the compact flash so it is loaded upon boot up of the control. This ensures your USB device is recognized upon boot up and will eliminate delays each time you plug in your device.

## 5.11.1 Section A - 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. These values will be valuable for troubleshooting.

### 5.11.1.1 CODE 33: Software ID

The Code 33 is the software identification procedure. This will most likely be used when a customer service representative asks to identify what version(s) of software is being run on your machine.

- **Software Version** - the version of the system you have installed.
- **Firmware Version** - the version of firmware software that is installed on the motion control board.
- **PLC Versions** – lists the versions of various PLC's that are loaded on the system.
- **Operating System Version** – shows the version of the XP operating system.

### 5.11.1.2 CODE 141: Load Configuration File from USB flash drive

This code allows you to load your configuration file from a USB flash drive to your machine's compact flash drive. The configuration file consists of items such as calibration, backlash constants, ball lock locations, etc. This code is useful when a computer module or compact flash card has been replaced, and you want to restore a machine to its previous state.

In order to load the files correctly on the 2 OP, you must have the following file structure. On your thumb drive you need to have a folder called PT8, with a subfolder called CONFIG.

### 5.11.1.3 CODE 142: Save Configuration File to USB flash drive

This code allows you to save your configuration file to a USB flash drive. The configuration file consists of items such as calibration, backlash constants, ball lock locations, etc. This code is

used when a computer module or compact flash card needs to be replaced. This stores the **configuration file from the machine's compact flash drive to a portable USB flash drive. 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 compact flash card 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 compact flash drive is replaced.**

When you save the configuration file to a thumb drive, the file structure mentioned above in service code 141 will be created.

#### **5.11.1.4 CODE 316: Update Software**

Insert the USB flash drive that contains the software update and press this service code. New software will automatically download and the control may need to be shut down if prompted. Follow the instructions on the screen.

### **5.11.2 Section B - 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.

#### **5.11.2.1 CODE 100: Axis Open Loop Test (Note – this service code may not work upon product release)**

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

#### **Warning - 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 Z axis is at a safe height and no fixture or vise will interfere with the travel of the axis.

This procedure is to be run for either the X or Y axis, and for both the plus and minus direction for each axis. Make sure the Z axis is out of the way, and that there is no tool in the spindle or fixture mounted on the table.

1. On the programming panel display, go into the Service Codes and input the Code 100.
2. **The conversation line will say: "SELECT AXIS". Input the axis. Either X or Y.**
3. **In the conversation line it will say "WHICH DIRECTION? PLUS".**
4. If you want to run in the plus direction, press INC SET.
5. If you want to run in the minus direction, press +/-, then INC SET
6. **In the conversation line it will say "PRESS GO". Pressing GO will slowly move the axis back towards the opposite soft limit of the axis you chose. From this position it will prompt you to press GO again.**
7. Press GO a second time to initiate the open loop test. The axis you chose will rapid in the direction you specified earlier and eventually come to a halt.
8. Afterward the screen will display values next to the DRO position axes.
9. The values for the encoder displays should be around 8 to 12".
10. If the motor 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.
11. The max feedrate should be somewhere in the range of 600.
12. If the feedrate is less than 600 ipm and inconsistent in both directions, check the incoming AC voltage and mechanics of the drive train.

#### **5.11.2.2 CODE 123: Calibration**

See Section 7.1 for a further explanation of this code.

#### **5.11.2.3 CODE 128: Input Backlash Constant**

Code 128 allows you to enter the backlash values for each axis. It displays the value after it is entered. See section 7.2 for more information on this service code.

#### **5.11.2.4 Code 400: Update Foreign Language MLS Files**

If you have received a foreign language update for your machine, you can put it on a USB flash drive, and enter this service code to update your control. Please contact your distributor for more information and availability.

#### **5.11.2.5 Code 500: XY Ball Lock Offsets**

This code defines the locations of the **ball lock located on the machine's table, relative to the machine's home position**. These values are set at the factory, but if the X or Y axis motors or ballscrews are ever replaced or moved, the machine must be re-homed and the ball lock locations **MUST** be re-located using a .0001" **dial indicator and sweeping in the ball lock receiver**. Major changes to the home switches or cams may also require this service code to be redone.

#### **5.11.2.6 Code 505: Over Travel Limits**

When entering this service code, the soft limits will be disabled so as to allow for setup or troubleshooting.

In addition to the DRO, the motor angle for each axis relative to the limit switch can be seen. This is to ensure that the index pulse for the motor is close to 180 degrees when it hits the home switch. This is done to obtain maximum reliability when the machine performs its homing routine. The angle should be 180 degrees +/- 45 degrees. Values from 135 to 225 degrees are acceptable. Failure to set this correctly may cause the machine to not home properly which can lead to problems. See section 6.20 for a procedure.

1. **SOFT LIMIT ON / OFF** – You can choose to toggle the soft limits on or off. They will default to off when entering this service code, but will always turn back on after exiting.
2. **SET SOFT LIMITS** – This will run an automatic routine that moves all three axis to the positive and negative limit switches in order to find and set the software limits accordingly. Make sure that there is no tool loaded in the spindle, and that no fixture or vice is mounted on the table before proceeding. The Z axis moves first so clear out anything that is on the table that the head may interfere with. Once the Z is done it moves back up to its highest point before X and Y move.
3. **MOVE TO INDEX** – This will move the selected axis to the home position and then to the first index pulse of the motor of that axis.

#### **5.11.2.7 Code 510: Spindle Setup**

Use these service codes to setup or troubleshoot the electronic spindle.

1. **CAL RPM** – Running this routine will automatically calibrate the spindle over several increments from its minimum to maximum rated speed. The process should take between 5-10 minutes to complete.
2. **ORIENT SPINDLE** – This sets the orientation of the spindle in relation to the ATC when the machine performs a tool change. Follow the instructions on screen to set or verify the orientation of the spindle.
  - a) **ATC FRONT** – brings the ATC in towards the user. Make sure the Z axis is high enough to clear the ATC before using.

- b) ATC BACK – moves the ATC back out and away from the user.
  - c) ORIENT ON / OFF – pressing this button will make the spindle turn to the orientation offset that is currently saved, and hold position. Pressing it again will release the spindle so that it can be turned manually if necessary.
3. **ENC CHECK** – Use to verify the spindle encoder is functioning properly. For every revolution of the spindle, you should see 4096 counts on the screen. The counts should also reset to 0 once the encoder reaches the index pulse. You can turn the spindle manually, or use **SPIN SPEED** to enter an rpm, and press FWD to power on the spindle.

### 5.11.2.8 Code 520: Set Tool Change Locations

Use this service code to set the 8 ATC locations. The locations are relative to the machines home position.

Follow the directions on the screen. All 8 locations should be set by using a dial indicator to **sweep in the taper on a tool. The X and Y coordinate should be within 0.005" or so on your indicator.** In other words, there is some room for error, but these tool locations cannot be set by eyesight.

The Z tool change height is defined as the location that Z axis must go to load a tool into the ATC. See section 5.8.2 above for more instructions.

Once you have all tools set properly and the Z height, **press the "SAVE TABLE" button to save all tool locations.**

## 5.11.3 Section C - 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.

### 5.11.3.0 Code 1: Program, File, Log Backup

This service code is meant for trying to backup everything currently in memory, for the sake of troubleshooting. Along with the logs from code 319, and the config files from code 142, this will also save the current program in memory, tool table, and various other files that may be useful for pinpointing a problem that may have occurred.

All the above files will be put saved into a ZIP file onto the destination USB flash drive, and will be named SWI\_Service\_Code\_1.zip.

### 5.11.3.1 Code 54: Program Continuous Run

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

Prepare a program as you normally would.

Press **MODE, SET UP, "C", Code 54, INC SET**. The program run will start automatically.

Press **STOP** to stop, and **GO** to continue.

### 5.11.3.2 Code 81: Program Panel Test

This code is used to check if the buttons located on the program panel are functioning correctly. It allows you to test each key 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 program panel assembly may need to be replaced. If none of the keys are working, you may want to check the connections from the back of the program panel to the overlay interface board.

### **5.11.3.3 Code 131: Manual DRO**

A manual diagnostic routine used to check the motors' encoders. Manually turn the X or Y axis ballscrew to display the actual DRO counts and the raw encoder counts. The DRO will display counts unaffected from calibration compensation. The Z axis cannot be checked with this service code.

### **5.11.3.4 CODE 132: Electronic Handwheel Test**

This service code can be used to troubleshoot any issues seen with the electronic handwheel. Simply turn the handwheel in either direction while in this screen, and the display should increment 1 count per click, 100 counts per revolution.

### **5.11.3.5 Code 314: Toggle Test Lights 'On' in Status Line**

This code toggles a group of test lights up on the top of the display when turned ON. The lights are used to help determine if there are any communication problems between the computer and the motion control hardware. They would ideally be used for issues where the control appears to be slow to respond, or not responding at all, especially when trying to run a program. An SWI service rep may ask you to turn these lights on and see describe their status while troubleshooting.

### **5.11.3.6 Code 319: Error Log**

This service code captures data as the machine runs. It captures key presses, error messages, commands sent to the motion control system amongst other things. This is the key piece of information we request when dealing with a potential software problem. This file can be saved via service code 319 or when running service code 1. The preference is to run service code 1 as this captures these files along with others that we may want to review.

You can navigate the log via the PAGE FWD and PAGE BACK soft keys on the screen. Use the EHW 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. If you press MORE, you can turn the log on and off, the default is on. The log should not be turned off. The message log file will capture data up to a point and then the file is saved to a backup file and the original file is cleared and data is once again captured. There is also a clear log file, which is useful if you have a problem that you can duplicate. It is nice to clear the file and then run your program to capture just the information that pertains to the problem. From here the user can save the 2 files to a USB flash drive. Once this is done it prompts you to save the files individually. Again, it is better to run service code 1 to capture the logs.

Lastly, there is another MORE button on the 2<sup>nd</sup> page of the message log. This allows the user to change the logging capabilities. The log leaves the factory with the following settings. These should not be changes unless specifically requested by a SWI representative. Turning on the logging features that are off may have a negative impact on the motion control system.

### **5.11.3.7 Code 326: Error Message Display**

Useful for checking error messages if the error number is already known.

### **5.11.3.8 Code 327: Display Memory Check**

This service code is used to check the amount of free memory available from system RAM or a USB device. This can be useful for troubleshooting any issues where memory may be a factor, such as system slowing down, or intermittently not responding. Press the **DRIVE SPACE** button to check the amount of free space on the system drive as well as removable devices such as USB flash drives. A service technician may ask you to take note of these screens while troubleshooting certain computer related issues.

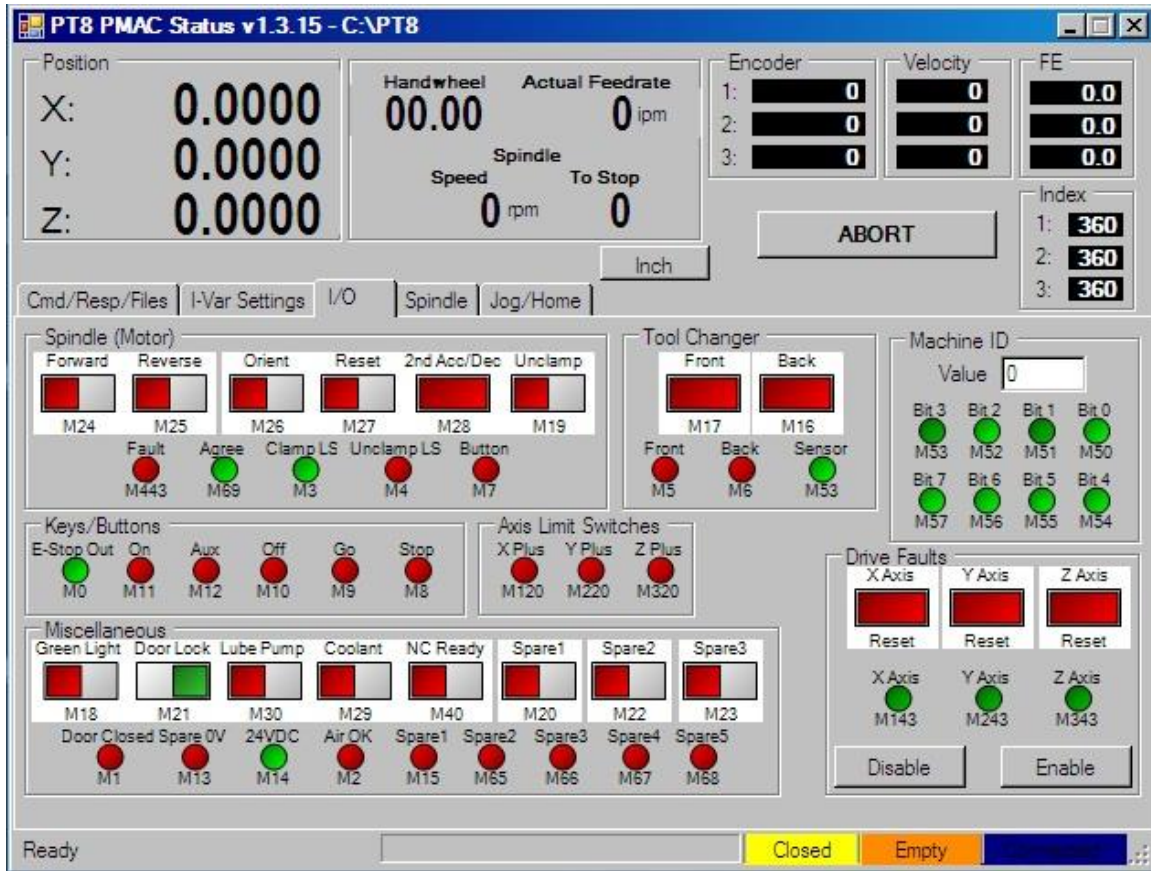
### **5.11.3.9 Code 521: Check Control I/O**



This service launches a separate application which allows the user to check the various inputs and outputs on the machine. It is mainly used for troubleshooting purposes. The figure below depicts what the screen looks like.

### Warning

Be careful when commanding the ATC to move in this service code as it may cause the ATC to slam into the back of the table. There is a good chance the table is not in the correct position when in this mode.



## 5.11.4 Section D - 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.

### 5.11.4.1 Code 66: Default Metric

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

### 5.11.4.2 Code 67: Default English

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

### 5.11.4.3 Code 79: Beeper On

This turns on the beeper to the control keys.

### 5.11.4.4 Code 80: Beeper Off

This turns off the beeper to the control keys.

#### 5.11.4.5 Code 203: Initiate Homing Sequence

This service code allows the user to home the machine. Normally this is done on the first screen when the control boots up, but if you exit this screen before homing the machine, you will need to home the machine via service code 203. You cannot run the machine until the machine is homed.

#### 5.11.4.6 Code 503: Set Maximum Feedrate

Sets the maximum feedrate limit that the machine will run at. This affects programmed feedrates and rapid feedrates. Can be set in inches per minute or millimeters per minute.

#### 5.11.4.7 Code 300: Set Lube Pump

Allows user to manual run lube pump and adjust frequency and discharge times.

#### 5.11.4.8 Code 320: Commit Image to Compact Flash

This service code will allow the user to permanently save a change to the compact flash. In most cases, this service code will be used to save a device driver from a USB device to the compact flash so it is loaded upon boot up of the control. This ensures your USB device is recognized upon boot up and will eliminate delays each time you plug in your device.

### 5.11.5 Section E - Critical Service Codes that Must Be Performed

The following table summarizes the critical service codes that must be performed after working on certain aspects of the machine.

#	Service Code	When	Consequence
1	500 – setting ball lock locations for X and Y	<ol style="list-style-type: none"><li>1. Motor removed or replaced</li><li>2. Motor belt slips</li><li>3. Home switch replaced or a major mounting adjustment is made.</li><li>4. Home switch cam replaced or a major adjusted is made</li><li>5. Ballscrew replaced</li><li>6. Angular contact bearings on motor end replaced</li><li>7. Table removed from machine and hence separated from linear guides</li><li>8. Computer module or compact flash has been replaced and the configuration file was not loaded into the new computer.</li></ol>	<ul style="list-style-type: none"><li>• The X and/or Y offsets saved with the users programs could now be off as much as 6 mm or 0.236”.</li><li>• These items only apply when working on the X or Y axis</li></ul>
4	505 – checking the motor index angle. Must be set to 180° +/- 45°	<ol style="list-style-type: none"><li>1. Motor removed or replaced</li><li>2. Motor belt slips</li><li>3. Home switch replaced or a major mounting adjustment is made.</li><li>4. Home switch cam replaced or a major adjusted is made</li><li>5. Ballscrew replaced</li><li>6. Angular contact bearings on motor end replaced</li></ol>	<ul style="list-style-type: none"><li>• This code applies to any work done to the X, Y and Z axis</li><li>• As a secondary item, you should rerun this same code and reset the soft limits</li></ul>
5	510 – setting the spindle orientation angle	<ol style="list-style-type: none"><li>1. Spindle motor has been removed, replaced or motor coupling has slipped during operation</li><li>2. AC spindle drive has been replaced (need to reset parameter 10-19, each machine has a unique value)</li><li>3. Computer module or compact flash has been</li></ol>	<ul style="list-style-type: none"><li>• The user will most likely break a finger on the ATC. More severe damage could also occur which could be</li></ul>

		replaced and the configuration file was not loaded into the new computer.	costly to the user
6	141 – Load configuration file	<ol style="list-style-type: none"> <li>1. Replace compact flash</li> <li>2. Replace entire computer module along with compact flash</li> </ol>	<ul style="list-style-type: none"> <li>• Machine will crash if 1 or more service codes are not set correctly.</li> <li>• The following service code settings will be wrong: 123, 128, 134, 500, 505 and 510</li> </ul>
7	520 – setting the ATC locations	<ol style="list-style-type: none"> <li>1. ATC replaced</li> <li>2. ATC finger replaced</li> <li>3. Motor removed or replaced</li> <li>4. Motor belt slips</li> <li>5. Home switch replaced or a major mounting adjustment is made.</li> <li>6. Home switch cam replaced or a major adjusted is made</li> <li>7. Ballscrew replaced</li> <li>8. Angular contact bearings on motor end replaced</li> </ol>	<ul style="list-style-type: none"> <li>• This code applies to any work done to the X, Y and Z axis</li> </ul>

# 6.0 Replacement Procedures

## 6.1 Axis Motor Replacements

### 6.1.1 X Axis Motor replacement

Please refer to assembly drawing 27520 found at the back of this manual.

**Warning!**

Whenever the X or Y axes motors are removed, service code 520 must be performed **AFTER** index angles are set and machine has been homed. This re-establishes the precise location of the tool pockets of the ATC. Service code 500 must also be reset.

1. Remove the sheet metal
  - a. Jog the Z-axis to its full upward position.
  - b. Refer to figure 6.1.1a.
  - c. Remove the ATC door by removing the four BHCS that secure the door flange to the column. Disconnect the door from the air cylinder at the pivot bolt. See figure 6.1.1b.
  - d. Remove the side enclosure covers A & B from the machine enclosure.
  - e. Remove the Z-axis ballscrew cover C.
    - i. Remove the four SHCS that the top bracket to the underside of the head, they can be found between the column and the back of the bridge.
    - ii. Remove the two SHCS that secure the bottom most segment to the Z-axis lower bearing housing.
    - iii. Lower the head, remove the upper sheet metal cover to access the upper (2) screws that secure the Z-axis ballscrew cover (frame) to the column.
    - iii. Raise the head and remove the four SHCS that secure the Z-axis ballscrew cover (frame) to the column and remove the cover.
    - iv. Slide the way cover out as an assembly

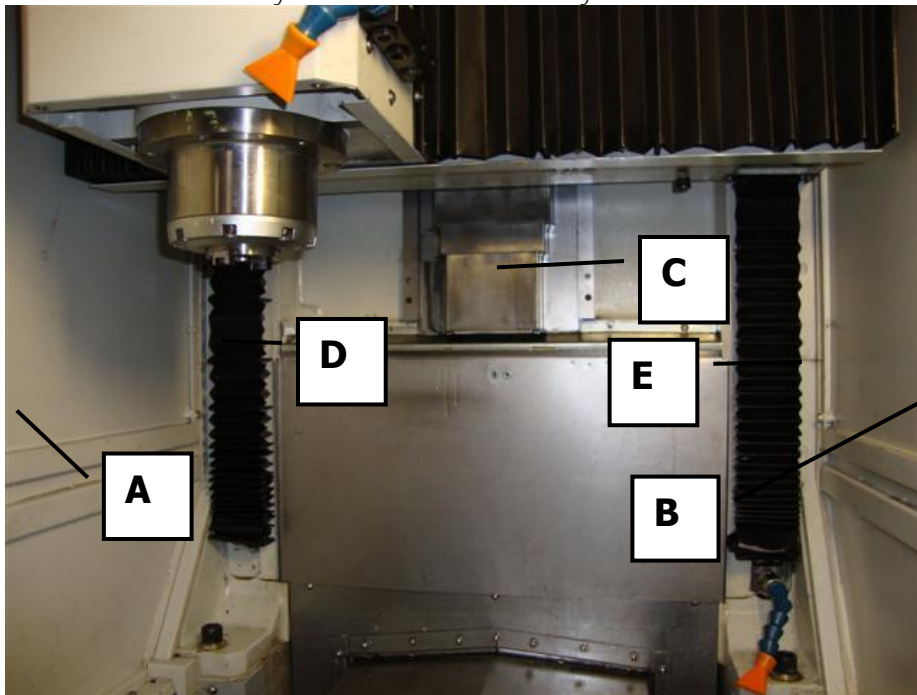


Figure 6.1.1a

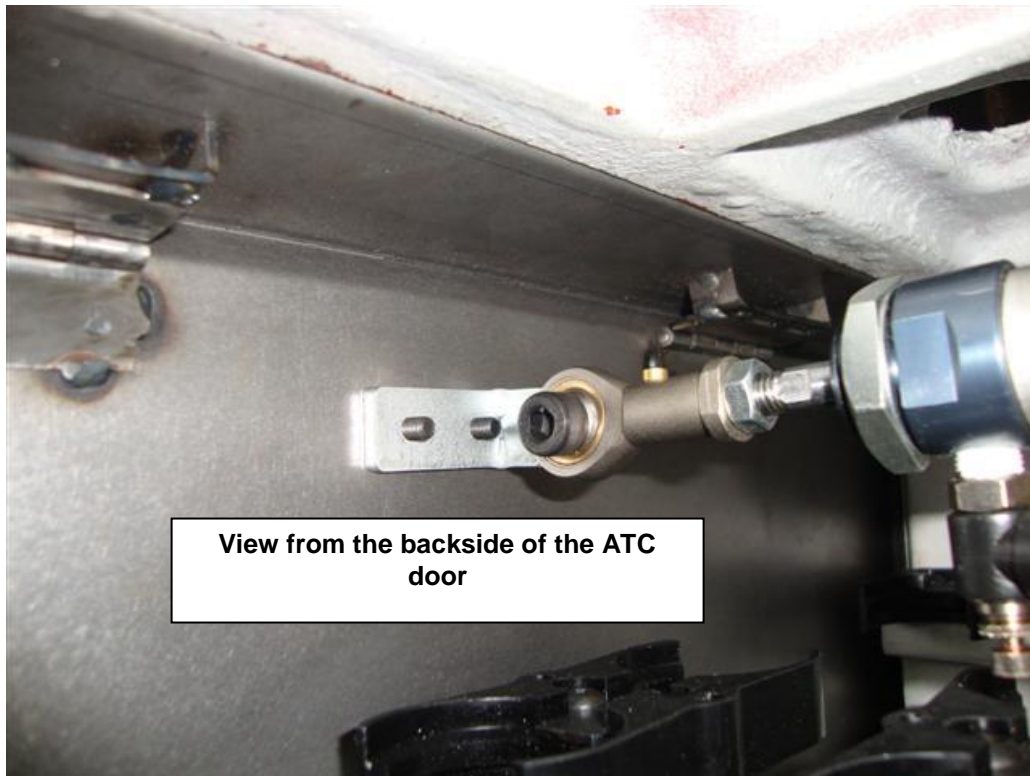


Figure 6.1.1b

2. Remove the Z-axis cushion from the lower bearing housing.
3. Remove the Z-axis way covers left and right D & E, see figure 6.1.1a..
4. Remove tool rack from the ATC
  - a. Disconnect the air supply from the 2 Op mill
  - b. Manually pull the rack forward to a position where the four SHCS that secure the tool rack to the tool rack carriages are accessible.
  - c. Remove the three BHCS that secure the ATC door lower wiper
  - d. Remove the tool magazine.
5. Enter service code 505 to disable the soft limits.
6. Jog the **Z-axis downward until the face of the spindle is approximately 2 ¼" from the table.** Make sure not to bring the head down too low and let the ball nut hit the lower bearing housing.
7. Press the E-stop before proceeding.
8. Remove the cover that allows entrance to the motor cavity.
9. Before removing the motor, please note the relative location of the key on the motor shaft that holds the pulley in place. It is important to place the new motor in the same orientation when mounting the motor. This will insure that the index angle is correct. This is discussed further below. Service code 505 is used to check the index angle.
10. **Loosen the four ¼" -20 SHCS** that secure the X-axis servo motor to the X-axis bridge. See figure 6.1.1c.
11. Lower the X-axis servo motor adjusting screw located on the underside of the bridge, until the motor is resting on the inside bottom of the bridge. See figure 6.1.1d.
12. Remove the drive belt. See figure 6.1.1c.
13. From the back of the machine, disconnect the encoder and power cables at the connectors. Pull the motor outward while rotating it in the forward direction.

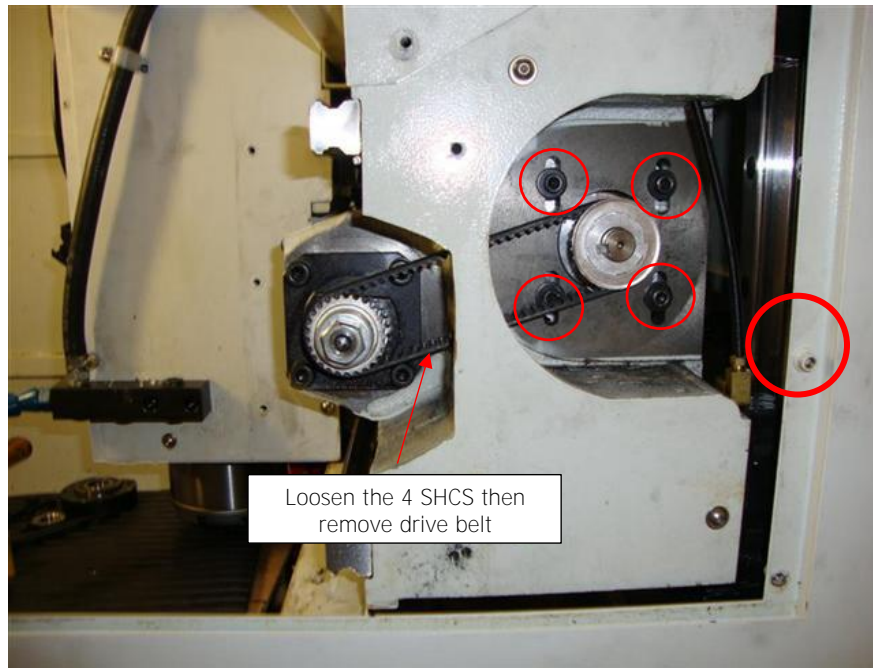


Figure 6.1.1c

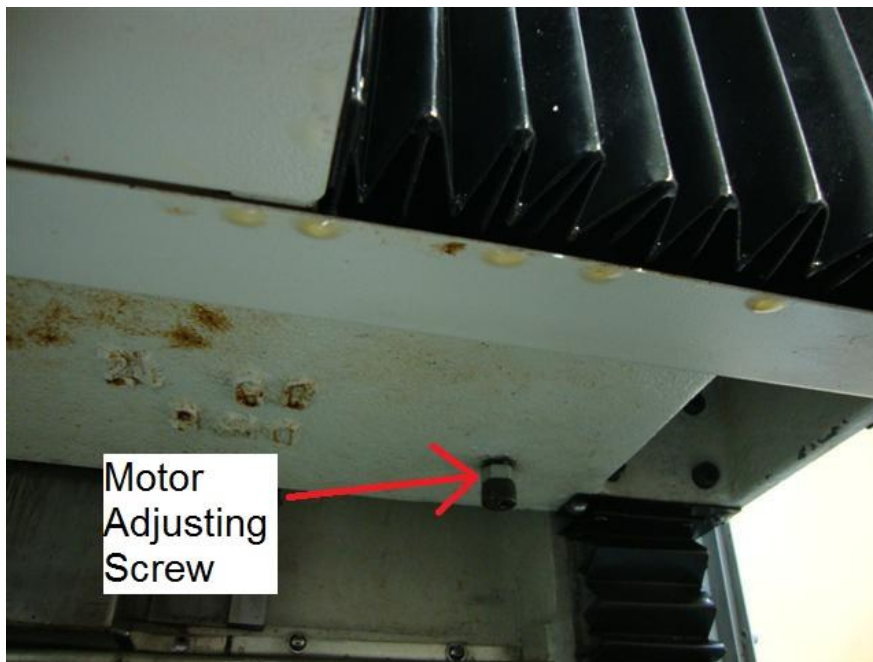


Figure 6.1.1d

### Installing the X-axis motor

1. With the servo drive housing facing the rear of the machine, slide the motor while rotating the servo housing downward into the X-axis motor cavity at the rear of the machine. The servo housing faces down when the motor is installed.
2. Connect the encoder and power cables.
3. Release the E-stop and jog the Z-axis upward to gain access to the X-axis motor adjusting slots on the right hand side of the bridge.

4. **Raise the motor upward and lightly secure with the four ¼" –20 SHCS** to the side of the X-axis bridge.
5. Install the ballscrew drive belt and raise the motor with the adjusting screw until the belt is sufficiently tight. The belt should twist approximately 45°. Tighten the jam nut on the adjusting screw
6. Tighten the (4) ¼-20 SHCS that hold the motor to 7 ft-lbs
7. At this point it is very important to make sure the index angle on the motor is set correctly. The index angle should be set to 180° +/- 45°. This can be checked in service code 505. See section 6.20.
8. Lower the head to install the cover for the X-axis motor cavity
9. Raise the head to the full upright position
10. Install the tool magazine. See ATC installation procedure
11. Install the Z- axis cushion.
12. Install the Z- axis way covers.
13. Install the Z-axis ballscrew cover.
14. Service codes 500 and 520 must be redone after a motor is replaced.

### 6.1.2 Y-axis servo motor replacement

Please refer to assembly drawing 27564 found at the back of this manual.

1. Shut down the 2 Op mill and shut off the power at the disconnect switch.
2. Locate the Y-axis servo motor at the lower rear section of the 2 Op mill and remove. **NOTE –** before removing the motor, note the position of the keyway in the motor shaft. It is important to put the replacement motor in the same position so the index angle will stay the same.
  - a. Unplug both the Y-axis power and encoder cables that are located on the right hand side of the computer module.
  - b. Gently feed the power and encoder cables through the casting channels and into the Y-axis motor cavity.
  - c. Loosen the lower two SHCS that secure the Y-axis motor mounting plate, then remove the two upper SHCS, raise the motor upward and off of the belt.

#### **Warning!**

Whenever the X or Y axes motors are removed, service code 520 must be performed **AFTER** index angles are set and machine has been homed. This re-establishes the precise location of the tool pockets of the ATC. Service code 500 must also be reset.

### **Installing the Y-axis motor**

1. Mount the motor to the motor mounting plate and tighten the ¼-20 SHCS to 7 ft-lbs
2. Install the Y-axis motor by sliding the motor pulley into the looped belt and onto the two lower SHCS. Install the two upper SHCS and tighten all four SHCS. The weight of the motor should be sufficient to set the proper tension of the belt. When the tension is correct, the belt should twist 90°.
3. Fish the power and encoder cables through the casting channels and out to the computer module and connect.
4. Set motor index angle, see section 6.20.
5. Start and home the machine. The machine **must** be homed before proceeding.
6. In DRO mode, set spindle speed for 100 RPM.
7. Enter service code 520 and follow the on-screen instructions.
8. Perform service code 500.

### 6.1.3 Z-axis servo motor replacement

Please refer to assembly drawing 27540 found at the back of this manual.

1. Shut down the 2 Op mill and shut off the power at the disconnect switch.
2. Locate the Z-axis servo motor at the top of the column of the 2 Op mill and remove. NOTE – before removing the motor, note the position of the keyway in the motor shaft. It is important to put the replacement motor in the same position so the index angle will stay the same.
  - a. Unplug both the Z-axis power and encoder cables that are located on the right hand side of the computer module.
  - b. Gently feed the power and encoder cables through the casting channels.
  - c. Disconnect the Z-Axis brake cable
  - d. Remove the four SHCS from the Z-axis motor mounting plate. Slide the motor forward and remove the belt.

#### **Warning!**

Whenever the Z-axis motor is removed, service code 520 must be performed to re-establish the precise tool change height

#### **Installing the Z-axis motor**

3. Mount the motor to the motor mounting plate and tighten the ¼-20 SHCS to 7 ft-lbs
4. Install the Z-axis motor by placing the motor and motor mounting bracket on top of the column. Tighten the belt adjusting screw until the belt is sufficiently tight. When the belt tension is correct, the belt should twist approximately 90°.
5. Fish the power and encoder cables through the casting channels and out to the computer module and connect.
6. Connect the Z-Axis brake cable
7. Start and home the machine. The machine **must** be homed before proceeding.
8. **Enter service code 520 and press the "Input Table" tab to set Z tool change height.**
  - a. Place a tool holder in any pocket. Jog the X and Y axes to that pocket's coordinates that are displayed in the table.
  - b. Press the orient spindle tab.
  - c. Press the tool unclamp tab.
  - d. Using the EHW, highlight the Z Tool Change dialogue box.
  - e. Jog the Z-axis **towards the tool holder, change to .002" feedrate as you get close to the tool holder.** As the spindle goes over the tool holder, listen for the air to stop escaping from around the tool holder, then back up one click. Enter the Z tool change offset that is displayed in the lower right hand gray box.

## 6.2 AC Spindle Drive Replacement

#### **DANGER!**

The AC Drive uses 220 or 440 AC volts to operate, utilize care when working with these components. There is possibility of death by electrocution!

The following service code **must** be performed when an AC drive is replaced. Failure to do so will cause the spindle to orientate improperly and may lead to a crash.

- **Service Code 510** – reset orientation angle of the spindle



1. Press the E-stop to disconnect power from the drive.
2. Turn the power off to the machine.
3. Open the electrical cabinet door.
4. Disconnect the cable that runs from the spindle drive to the computer module. It is plugged into a port called spindle port. A new cable will come on the replacement AC drive, so do not disconnect this from the drive you are removing.
5. Remove the front cover of the AC drive. It is held in place with a couple of screws.
6. Remove the wires that are used to hook up the spindle encoder. Please see drawing 27648 for which wires go where. You will need to hook up these wires on the new AC drive.
7. Remove the remaining 10 large wires. They are used to provide power to the drive, provide power from the drive to the spindle motor, dump the energy during braking to the braking resistors and provide grounds for the components.
8. Remove the AC drive from the machine, it is held in place with 4 screws.
9. Follow these steps in reverse order install the replacement drive.

It should be noted that the replacement drive has already been programmed, but 1 parameter will need to be reset since it is unique for each machine. The parameter in question controls the orientation of the spindle.

1. Go to service code 510 and press the orientate spindle button. The offset should be displayed in the lower left hand corner and must be added to the new AC drive which will allow tool changes to work correctly.

**WARNING!**

Failure to perform this step will cause the tool changer to crash and damage may occur.

2. Now go to the Delta AC drive and enter this value under parameter 10-19. To do so, follow these steps.
  - a. Press the Program/Data button on the drive
  - b. Use the up and down arrows to scroll to 10 and press Program/Data
  - c. Now use the up and down arrows to scroll to 19 and press Program/Data
  - d. Enter the offset found in service code 510 and press Program/Data
  - e. Press Mode button to return to frequency reading.
3. Lastly, go back to service code 510 and re-calibrate the spindle. Press the CAL RPM button and following the instructions on the screen.

### 6.3 Computer Module Replacement

**Caution!**

Make sure you have a back up copy of the machines configuration file when replacing the computer. Failure to do so will require you to reset all the important machine parameters such as ball lock locations, tool change height, ATC locations, etc.

The following service code **must** be performed when a computer is replaced. Failure to do so will cause many parameters to be incorrect and will lead to the machine crashing.

- **Service Code 141** – Load the configuration file back into the new computer that contains all important machine parameters.

Refer to section 5.3 for a drawing of the computer module and cable connections.

1. If you do not have a copy of your configuration file and the computer module is still functional, perform service code 142 and save your machines configuration file to a thumb drive. If you are not able to run this service code, then contact Southwestern Industries. We should be able to email you a backup copy of this file.
2. Turn power off to the control and machine.

**Note** – steps 1 and 7 can be avoided if you are able to reuse the compact flash card, which contains the operating system and your machines configuration.

3. Remove all cables from the computer module.
4. Remove the 4 SHCS that hold the computer module in place.
5. Fasten the new computer module in place and connect all cables.
6. Turn power on to the machine.
7. Go to service code 141 to load in the saved configuration file.

## **6.4 Linear Guide Replacement**

The linear guides that have come with the 2 OP should be trouble free for many years as long as they are properly lubricated per the specifications stated in this manual. Should the time come when a linear guide will need to be replaced, a machine tool builder will need to be hired to do this work. In order to replace the linear guides, major castings will need to be removed. For example, if the Z linear guides needed replacing, the head of the machine would need to be removed. All linear guide spare parts would be purchased through Southwestern Industries and we would also organize finding a machine tool rebuilder to do the work.

## **6.5 Ballscrew Replacement, X Axis**

Please refer to assembly drawing 27520 at the back of this manual.

1. Remove the sheet metal and covers
  - a. Remove the side enclosure covers, left and right.
  - b. Remove the X-axis accordion covers, left and right.
  - c. Remove the sheet metal covers that are adjacent to the accordion covers.
2. Remove the X-axis drive belt.
  - a. Loosen the four SHCS shown in figure 6.5a. Lower the belt adjusting screw found on the underside of the X-axis casting until the belt can be freely removed.

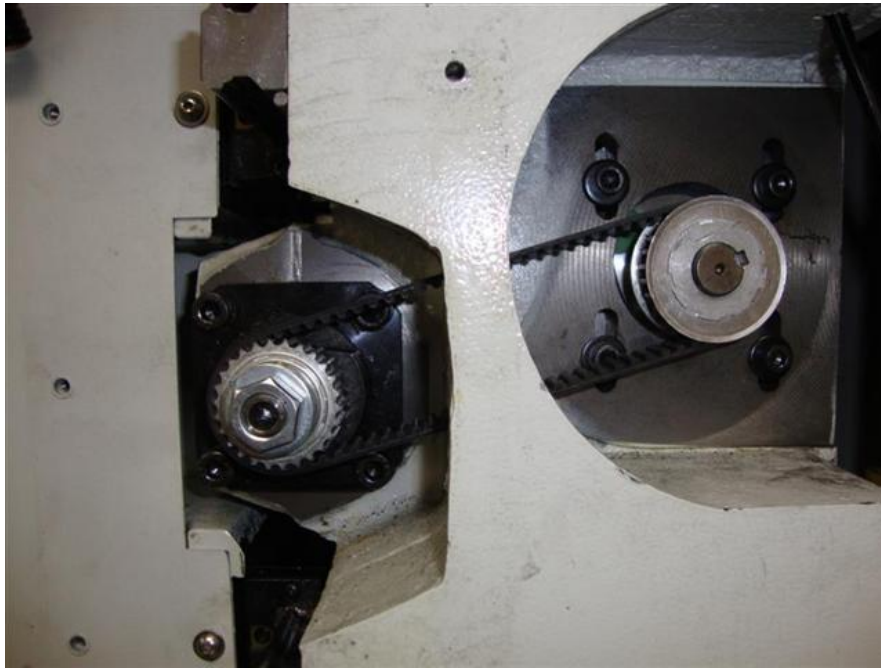


Figure 6.5a

3. While using a 6mm hex key to prevent the ballscrew from rotating, remove the hex nut, star washer, flat washer, pulley, ferrule and the clamp nut. See figures 6.5b and 6.5c.

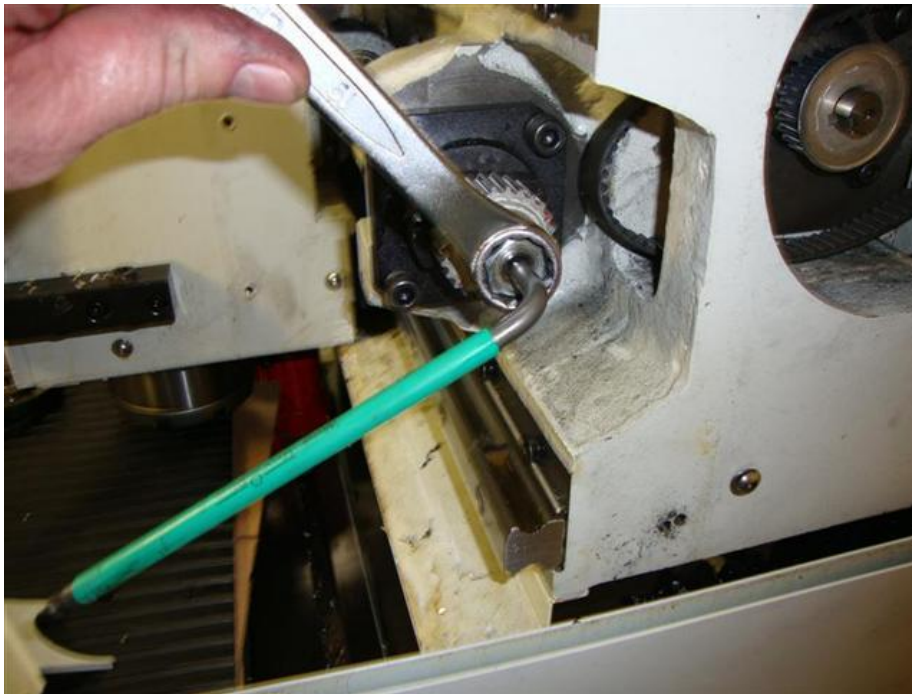


Figure 6.5b

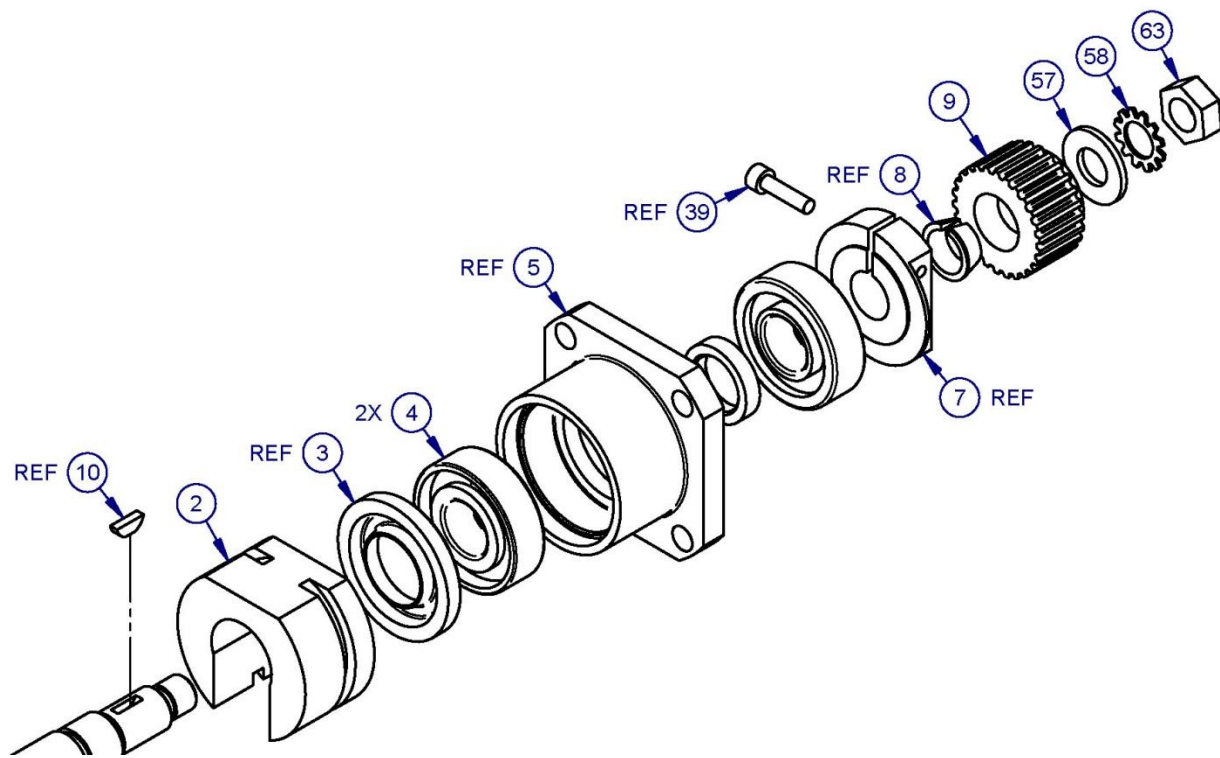


Figure 6.5c  
See 27520 for Reference

Remove the oil line that is connected to the ball nut located on the left side of the head, as well as the cushion shown in figure 6.5d.

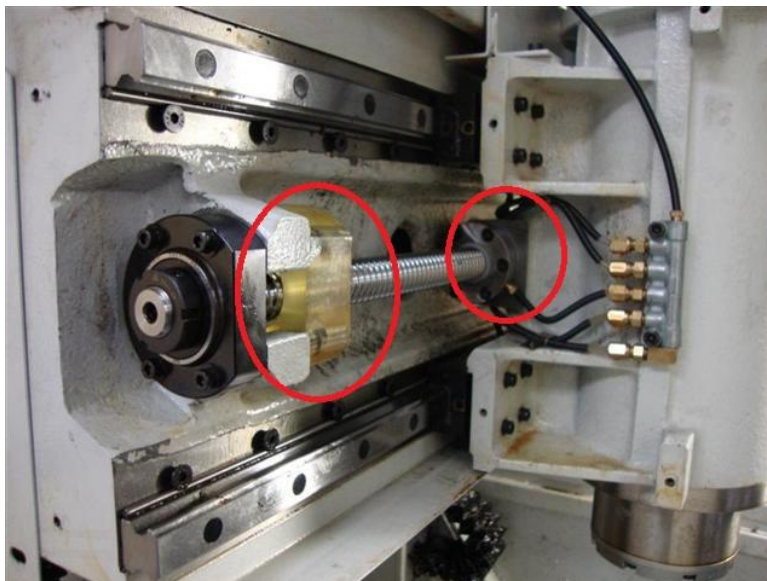


Figure 6.5d

4. Remove the five SHCS that secure the ballnut to the X-axis yoke.

5. Remove the four SHCS that secure the bearing cap found opposite to where the cushion seats, also shown in Figure 6.5c.
6. Slide the ballscrew out the left hand side window.
7. Remove the bearing housing from the right side of the X-axis casting, refer Figure 6.5c disassemble the seal, bearings and the inner spacer.

### **X Axis Ballscrew Installation**

Note: Apply a thin film of oil on all screws to be torqued prior to installation

1. Thoroughly clean all parts before beginning the assembly process.
2. Install the angular contact bearings into the housing and seal. The bearings should be installed in the Back-to-Back arrangement as shown in figure 6.5e. Make sure that the inner spacer is between the two bearings. Install the housing assembly loosely into the right side of the X-axis casting.

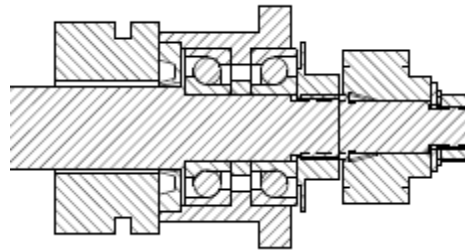


Figure 6.5e

3. Install bearing onto the left end of the ballscrew, lightly fasten with the bearing locknut.
4. Slide ballscrew assembly through the yoke at a slight angle, straighten it out as the ends of the ballscrew get closer to the ends.
5. Carefully guide end of the ballscrew into the set of angular contact bearings. Note: the inner spacer may not be lined up, so wiggle the shaft a bit until it does, but do not force it.
6. Slide the head back until the ballnut is inside of the yoke, and lightly secure it to the yoke with five SHCS.
7. Slide the bearing cap over the bearing, on the left side of the ballscrew, slide the ballscrew forward from the left hand side, and lightly secure the cap to the X-axis casting
8. Install the right side cushion and secure
9. Drive the head to near the full length of travel to the right, but not against the cushion. This will align the ballnut to the angular contact bearings.
10. Tighten the four SHCS that secure the bearing housing to the X-axis casting. Torque 11 ft-lbs
11. Tighten the five SHCS that secure the ballnut to the yoke. Torque to 7 ft-lbs and torque stripe
12. Install the cushion to the left side of the X-axis casting, and the lubrication line to the ball nut.
13. Drive the head to the full length of travel to the left, but not against the cushion.
14. Tighten the SHCS that secure the bearing cap to the X-axis casting. Torque to 11 ft-lbs
15. Install and tighten clamp nut and torque to 50 ft-lbs and lock in place with the SHCS. Tighten lock screw and torque to 5 ft-lbs
16. Install the key into the key seat of the shaft.
17. Slide ferrule against the face of the clamp nut.
18. Fit pulley over the ferrule and key. Place the flat washer, the star washer and tighten down with the nut.
19. Loop the belt over both pulleys, then adjust the belt adjusting screw until the belt can be only twisted 45°
20. Tighten the four SHCS that secure the motor, tighten the jam nut of the belt adjusting screw.
21. Check X-Axis torque in 3 positions. Torque should be 10 in-lbs or less and within 3 in-lbs at all 3 locations

### Service Codes to be Performed

1. Service code 505 to check that the index angle is at  $180^{\circ} \pm 45^{\circ}$
2. Service code 520 to reset ATC tool positions.
3. Service code 500 to reset the ball lock location.

## 6.6 Ballscrew Replacement, Y Axis

Please refer to assembly drawing 27564 found at the back of this manual.

1. Remove the sheet metal and covers
  - a. Remove the rear cover for the Y-axis compartment.
  - b. Remove the drip pan that is secured to the motor mounting bracket.
  - c. Remove the front and rear sheet metal covers from the table.
  - d. Disconnect the ATC door from the door assist cylinder and remove the ATC door
  - e. Remove the ATC wiper cover.
  - f. Remove the six countersink screws that secure the Y-axis sheet metal cover to the Y-axis casting.
2. Remove the Y-axis motor, motor bracket and belt.
3. Remove the Y-axis motor plate bracket
4. Remove the hex nut, star washer, pulley, ferrule, key and clamp nut from the back end of the ballscrew.
5. Remove the four SHCS that secure the ATC magazine to the ATC slide, and remove the magazine.
6. Remove the eight SHCS that secure the table to the support brackets and remove the table.
7. Remove the Y-axis sheet metal cover
8. Drive out the two roll pins of the Y-axis casting, located in between the casting mounting holes at both ends.
9. Remove the seven SHCS that secure the Y-axis casting to the base.
10. Place a block of wood at the back of the Y-axis casting to prevent it from moving while hoisting, see figure 6.6a.
11. Place a sling around the Y-axis casting and the head as shown in figures 6.6b and 6.6c.

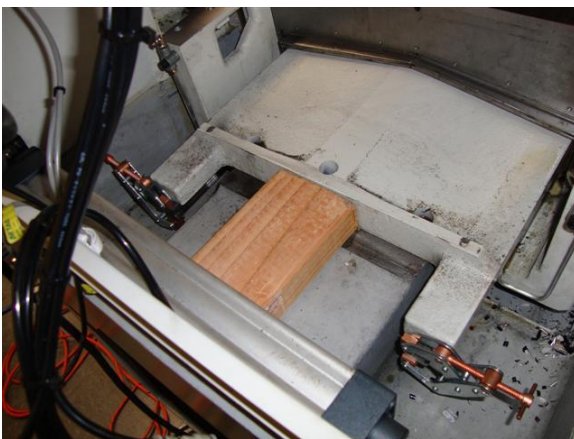


Figure 6.6a



Figure 6.6b

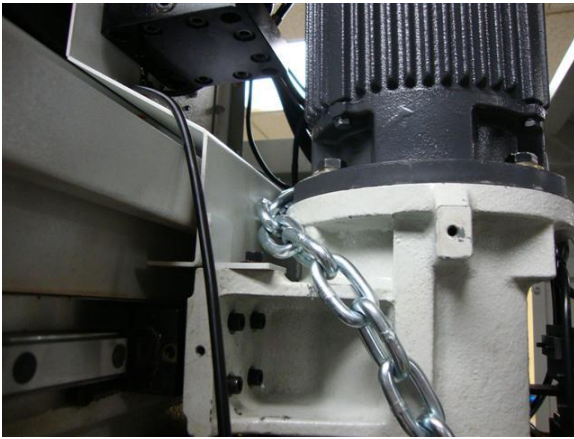


Figure 6.6c



Figure 6.6d

12. Using the electronic hand wheel, carefully jog the Z-axis upward to raise the Y-axis casting to expose the Y-axis ballscrew.
13. From the front of the machine, remove the five SHCS that secure the ball nut to the yoke and disconnect the oil line feeding the ball nut. (See figure 6.6d)
14. Remove the four SHCS that secure the bearing cap to the Y-axis casting on the front of the machine.
15. Slide the ballscrew out the front of the machine.
16. Remove the bearing housing from the bearing block.
17. Remove locknut and bearing from the forward end of the ballscrew.

### Y Axis Ballscrew Installation

1. When installing the ballscrew, it is recommended that new bearings be installed at both ends
2. Thoroughly clean all parts before beginning the assembly process.
3. Install the angular contact bearings into the housing and seal. The bearings should be installed in the Back-to-Back arrangement as shown in figure 6.5e. Make sure that the inner spacer is between the two bearings. Install the housing assembly loosely into the bearing block on the Y-axis casting.

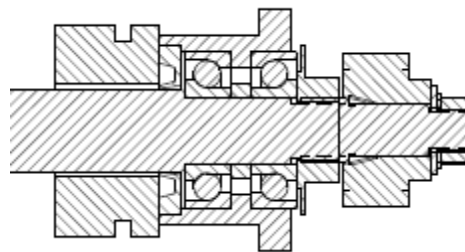


Figure 6.6e

4. Install bearing onto the front end of the ballscrew, lightly fasten with the bearing locknut.
5. Slide ballscrew assembly through the yoke at a slight angle, straighten it out as the ends of the ballscrew get closer to the ends.
6. Carefully guide end of the ballscrew into the set of angular contact bearings mounted in the rear bearing cap and block. Note: the inner spacer may not be lined up, so wiggle the shaft a bit until it does, but do not force it.
7. Rotate the ballscrew until the ballnut is even with the yoke, and lightly secure it to the yoke with five SHCS. Install the lubrication line to the ballnut.

8. Slide the bearing cap over the bearing, on the front of the ballscrew, and lightly secure the cap to the Y-axis casting
9. Install the front cushion and secure
10. Using the EHW carefully lower the Z-axis to lower the Y-Axis casting back into place.
11. Align the Y-Axis casting and install roll pins
12. Secure the Y-Axis casting to the bed of the machine.
13. Drive the saddle to near the full length of travel to the rear, but not against the cushion. This will align the ballnut to the angular contact bearings.
14. Tighten the four SHCS that secure the bearing housing to the Y-axis bearing block. Torque 11 ft-lbs
15. Tighten the five SHCS that secure the ballnut to the yoke. Torque to 7 ft-lbs and torque stripe
16. Drive the saddle the full length of travel to the front, but not against the cushion.
17. Tighten the SHCS that secure the bearing cap to the Y-axis casting. Torque to 11 ft-lbs.
18. Install and tighten clamp nut and torque to 50 ft-lbs and lock in place with the SHCS. Tighten lock screw and torque to 5 ft-lbs
19. Install the key into the key seat of the shaft.
20. Slide ferrule against the face of the clamp nut.
21. Fit pulley over the ferrule and key. Place the flat washer, the star washer and tighten down with the nut.
22. Install Y-axis motor plate bracket
23. Install Y-Axis motor, motor bracket and belt.
24. Loop the belt over both pulleys, then adjust the belt adjusting screw until the belt can be only twisted 45°
25. Tighten the four SHCS that secure the motor, tighten the jam nut of the belt adjusting screw.
26. Check Y-Axis rolling torque in 3 positions. Torque should be 10 in-lbs or less and within 3 in-lbs at all 3 locations.
27. Install Y-Axis sheetmetal cover
28. Secure the table to the support bracket
29. Secure the ATC magazine to the ATC slide
30. Re-attach sheetmetal covers and ATC door assist cylinder.

The following service codes **must** be performed in the following order, after the Y-axis motor is installed.

- **Service Code 505** – Reset the index angle.
- **Service Code 505** – Set soft limits
- **Service Code 500** – Set ball lock location
- **Service Code 520** – Set ATC pocket location

## 6.7 Ballscrew Replacement, Z Axis

Please refer to assembly drawing 27540 found at the back of this manual.

1. Remove the sheet metal
  - a. Jog the Z-axis to its full upward position.
  - b. Refer to figure 6.1.1a.
  - c. Remove the ATC door by removing the four BHCS that secure the door flange to the column. Disconnect the door from the air cylinder at the pivot bolt. See figure 6.1.1b.
  - d. Remove the side enclosure covers A & B from the machine enclosure.
  - e. Remove the Z-axis ballscrew cover C.
    - i. Remove the four SHCS that the top bracket to the underside of the head, they can be found between the column and the back of the bridge.
    - ii. Remove the two SHCS that secure the bottom most segment to the Z-axis lower bearing housing.



- iii. Lower the head, remove the upper sheet metal cover to access the upper (2) screws that secure the Z-axis ballscrew cover (frame) to the column.
  - iv. Raise the head and remove the four SHCS that secure the Z-axis ballscrew cover (frame) to the column and remove the cover.
  - v. Slide the way cover out as an assembly
2. Disconnect the oil line that feeds lubrication to the Z-axis ballnut.
  3. Rotate the Z-axis ballscrew and loosen the three set screws that secure the lower bearing locknut. Remove the bearing locknut.
  4. Remove the four SHCS that secure the lower bearing housing to the column, remove the housing and set aside.
  5. Jog the Z-axis downward and rest the bridge on a suitable and stable brace.
  6. Shut down the 2 Op mill and shut off the power at the disconnect switch
  7. Disconnect the electrical connection to the Z-axis brake.
  8. Loosen the Z-axis motor and remove the belt
  9. Remove the two SHCS that secure the brake to the brake standoffs and remove the brake.

### **Warning!**

Make certain that the bridge is resting securely before removing the brake!

10. Remove the two screws that secure the cushion to the ballnut, and remove the cushion.
11. **With a 36" extension and a hex bit socket, remove** the five SHCS that secure the ballnut to the yoke.
12. Remove the four SHCS that fasten the bearing housing to the top of the column.
13. Remove the ballscrew by sliding it upward and towards the bridge allowing the ballnut to clear.

### **Disassembling the Z-axis Ballscrew**

1. Remove the M10 hex nut and lock washer
2. Slide the brake hub from the ballscrew
3. Remove the key.
4. Remove the spacer
5. Loosen the three set screws that lock the timing pulley and remove.
6. Remove the sprocket ferrule and woodruff key.
7. Loosen the bearing locknut jam screw and remove the locknut.
8. Remove the bearing housing.
9. Remove the bearings.

### **Installing the Z-axis ballscrew**

Note: Apply a thin film of oil on all screws to be torqued prior to installation

1. When installing the ballscrew, it is recommended that new bearings be installed at both ends.
2. Reassemble the upper end of the ballscrew.
  - a. Install the bearings in the bearing housing and seal.
  - b. Place the bearing housing on the ballscrew
  - c. Install the bearing locknut torque to 50 ft-lbs and tighten the clamp screw torque to 5 ft-lbs
  - d. Install the woodruff key.
  - e. Slide the sprocket ferrule against the shoulder of the ballscrew.
  - f. Install the 26 tooth sprocket. Put a drop of Loctite on each of the three set screws and lock them down.
  - g. Install the spacer flange side against the sprocket.
  - h. Insert the key into the keyseat, slide the brake hub against the spacer.
  - i. Install the lockwasher and hex nut and lock in place.

3. Install a new bearing into the lower bearing housing and install the housing onto the column.
4. Slide the ballscrew into the machine from the top of the column.
5. Wind the ball nut up or down until the bearing cap is flush with the mating boss of the column, **and ballnut flange is slightly (.100" or less) above the yoke of the bridge.**
6. Install the four SHCS that secure the bearing cap to the column, torque to 40 ft lbs 25 ft-lbs
7. Install the five SHCS that secure the ballnut to the bridge and tighten 75%. The bridge will pull upward as the screws are tightened. Do not tighten the screws completely at this time.
8. Install the brake and connect to power.
9. Reinstall the motor belt
10. Jog the Z-axis upward to near the end of travel, this will align the ballnut with the bearing housing.
11. Attach the oil line to the ballnut.
12. Torque the five SHCS that secure the ballnut to the yoke to 20 ft lbs. (m5 torque to 7 ft-lbs)
13. Install the lower bearing locknut and tighten the three locking set screws.
14. Check Z-Axis torque. Move head down and place a support under head and press the E stop. Go to electrical cabinet and move Z axis brake connector to the 24 VDC out port to turn brake off. **DANGER – HEAD WILL FALL IF NOT SUPPORTED.** Check torque in upward direction and record. Values should be 25 in-lbs or less
15. Install the Z-axis ballscrew cover. Perform step 1 in this procedure in reverse order.
  - a. Place the cover against the column and secure with the two SHCS at the center of the frame.
  - b. Secure the underside of the frame to the lower bearing housing with two BHCS
  - c. Secure the top segment of the telescoping cover to the sheet metal bracket at the back of the bridge.
16. Make sure the motor index angle is set correctly. Check in service code 505. Adjust motor as required.
17. Enter service code 520 to set the tool change height.
  - a. Place a tool holder in any pocket. Jog the X and Y axes to that pocket's coordinates that are displayed in the table.
  - b. Press the orient spindle tab.
  - c. Press the tool unclamp tab.
  - d. Using the EHW, highlight the Z Tool Change dialogue box.
  - e. Jog the **Z-axis towards the tool holder, change to .002" federate as you get** close to the tool holder. As the spindle goes over the tool holder, listen for the air to stop escaping from around the tool holder, then back up one click. Enter the Z tool change offset that is displayed in the lower right hand gray box.

## 6.8 Spindle Motor Replacement

Please refer to assembly drawing 27500 found at the back of this manual.

1. Remove the sheet metal covers
  - a. Remove the right and left side enclosure panels, the unclamp button panel, the vented top cover, the front cover, and the left side cover.
2. Jog the Z-axis downward to the end of travel.
3. Shut down the 2 Op mill and turn off the power.
4. Remove the junction box covers from the motor and disconnect the incoming power, spindle fan and encoder cables.
5. Secure a cable to the eye-hooks attached to the motor if you are using a hoist. The motor weighs approximately 65 lbs.
6. Remove the clamp/ unclamp bracket assembly
7. Loosen the 2 clamp screws on the driven side of the coupler
8. Remove the four hex head bolts that secure the motor the head.

9. Hoist the motor upward until the motor shaft is clear of the head.
10. Using an extended hex socket, manually drive the X-axis to the right hand side of the bridge, allowing the motor to be lowered to the table.
11. Place a couple blocks of wood or other suitable support onto the table and lower the motor down.
12. Remove the hoisting cable
13. Manually drive the Y-axis toward the front of machine to ease lifting from the machine.
14. Install the new motor in reverse order.
15. Tighten the two clamp screws on the motor coupler.
16. Enter service code 510 to set spindle orientation and follow the on-screen instructions.

## 6.9 Spindle Motor Wiring

The following 3 pictures show the wiring of the spindle motor. It should be noted that the spindle motor can be wired for 220 volts or 440 volts. Make sure you wire the motor correctly depending the voltage supplied to the machine and the inverter voltage.

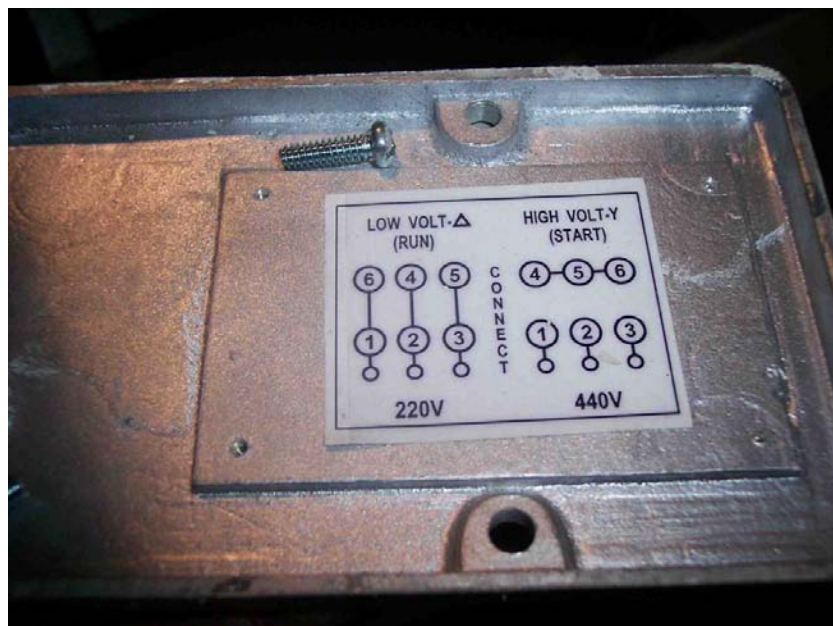


Figure 6.9a – Wiring Diagram for 220 and 440 volts



Figure 6.9b – Wiring into spindle motor – 220 volt wiring shown



Figure 6.9c – Wiring of motor fan and encoder

## 6.10 Spindle Cartridge Replacement

Please refer to assembly drawing 27500 found at the back of this manual.

1. Remove the left and right side sheet metal covers
2. Remove the unclamp button panel.
3. Jog the Z-axis downward toward the table so you have access to the unclamp panel and the 6 bolts that hold the spindle cartridge in place.
4. Press the E stop on the control.
5. Remove the clamp/unclamp bracket assembly (A), air line (B), oil line (C) and the actuator plate (D). Reference figure 6.10

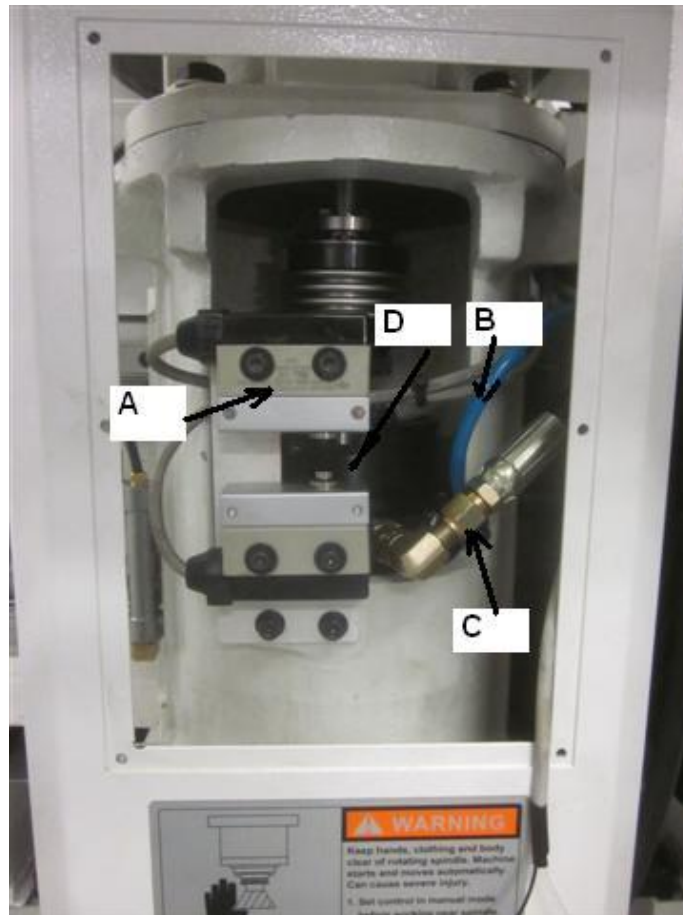


Figure 6.10

6. Loosen the 2 clamp screws on the motor coupler.
7. Remove 5 of the 6 bolts that holds the spindle cartridge up inside of the head. Loosen the 6 bolt as well.
8. Jog the Z-axis downward toward the table and place the spindle nose on top of a block of wood.
9. Remove the last bolt and now move the head up with the handwheel to expose the spindle cartridge.
10. Install the new spindle cartridge in reverse order. It is recommended to perform tightening of the screws crosswise in order to prevent any distortion of the hub. These bolts are to be tightened to 8 ft-lbs.
11. It is very important to set the clamp and unclamp switches correctly upon installation.
12. Enter service code 510 to set spindle orientation and follow the on-screen instructions.

## 6.11 Spindle/Motor Coupling Alignment

When a motor or spindle is replaced on the 2 OP mill, it is important that the coupling that attaches between the top of the spindle and the motor shaft is aligned and there is minimal runout axially and radially. The procedure below explains how to align and install the coupling.

1. Remove the front cover on the head to gain access to the spindle coupling.
2. Remove the bracket that holds the clamp and unclamp switches.
3. Slide one half of the coupling on the spindle motor shaft as far up as it will go and still be able to lightly tighten the clamp screw so it does not slide down on its own.
4. Slide the other half of the coupling with the urethane middle piece onto the spindle shaft and lightly tighten the clamp screw, like on the motor shaft.
5. Install the spindle in the spindle housing and snug the spindle mtg. screws slightly and then just break them loose.
6. Loosen the coupling half on the motor shaft and lower it down to engage with the half installed on the spindle shaft, and loosen the spindle half of the coupling so the coupling can be moved up and down as an assembly.
7. Align the spindle in the housing so the coupling assembly easily slides up the motor shaft and down the spindle shaft without noticeable resistance during the transition from shaft to shaft. Loosen the motor bolts if required to get more adjustment.
8. Once the coupling moves freely from shaft to shaft, the spindle is adequately aligned with the motor. Center the coupling so each half is roughly clamped on the same length of the corresponding shaft and tighten the clamp screws to the recommended torque setting of 18.5 ft-lbs.
9. Make sure the tighten the motor and spindle bolts.

## 6.12 Automatic Tool Changer (ATC) Replacement

Please see drawings 27600 and 27587 in the back of this manual.

1. Go to tool loading and bring the ATC out.
2. Press E stop once the ATC is out.
3. Remove the three BHCS that secure the ATC door lower wiper
4. Remove the 4 bolts that hold the ATC in place. It is also keyed to ensure you can remove it and place it back in the same place.
5. Remove the ATC casting from the machine and replace with the new one.
6. To replace a finger, loosen the 2 screws that hold the finger in place. The fingers are pinned so you can place the new finger in the same exact spot.
7. After replacing the ATC or a finger, go to service code 520 and double check the ATC locations.

## 6.13 Setting ATC Tool Locations

1. Go to service code 520, bring tool magazine out and select Input Table
2. Place a .0005" test indicator in the spindle.
3. Place a BT30 tool into the tool change spot or the locating tool shown below in figure 6.13.
4. Jog both X and Y axes until the spindle is in line with the bore of the locating tool as shown in figure 6.13.
5. Using the .0002" feed rate, jog both X and Y while rotating the spindle until the indicator reads less than .0050". The spindle centerline is now positioned over the center of the pocket.
6. Enter the X and Y values displayed in the DRO shown in the lower right into the input table.
7. Repeat this procedure for pockets 2 through 8. Press save table after each position is found.
8. For setting the Z height on the ATC, see section 5.8.2.



Figure 6.13

## 6.14 Coolant Pump Replacement

Please see drawings 27557 and 27542 in the back of this manual.

1. Remove the chip pan from the machine.
2. Drain the coolant from the coolant tank.
3. Slide the coolant tank out of the machine.
4. Remove the 4 screws that hold the pump in place.
5. Remove the power cable from the coolant pump.
6. Follow these instructions in reverse to install the new pump.

## 6.15 Bleeding Air from Tool Unclamp Cylinder Oil System

As described in section 5.8.4, oil is compressed by the tool unclamp cylinder which then presses down on the drawbar that holds the tools. If air gets into this system, the tool unclamping process will not work correctly. This is usually identified by seeing oil on some of the fittings or seeing air bubbles in the oil reservoir. Figure 6.15 shows this oil reservoir.



Figure 6.15

Please also refer to drawing 27500 for a reference drawing.

To bleed air from the system, follow this procedure.

1. Make sure all connection points are tight and no air can get into the system. If the connection points are tight and not leaking but you notice oil leaking from the tool clamp cylinder, the cylinder will need to be replaced.
2. Make sure to fill the oil reservoir cap to the fill line. If the system has been leaking the oil level will have dropped.
3. Press the unclamp button on the front of the head a number of times over and over until you do not see any more oil bubbles in the oil reservoir. The air should escape from the top of the oil reservoir tank.

## 6.16 Programming Panel Replacement

See reference drawing 27648 for cable connections.

1. Turn power off to the machine.
2. Remove the 4 bolts that hold the programming panel in place.
3. Remove the following 4 connectors: E-stop cable, com port cable, VGA cable and overlay power cable. See section 5.4 for a diagram of these connections.
4. Reconnect cables to new panel.
5. Fasten panel with the 4 bolts you removed.



## 6.17 Home Switch Replacement

The 2 OP machine has 3 home switches which are used to home the machine.

1. Depending on which switch you need to replace or adjust, you may need to move the machine to gain clearance. For the X axis, it is best to move the head all the way to the left. For the Y axis, move the table towards the rear of the machine. For the Z axis, it may be easiest to move the head down toward the table.
2. Turn power off to the machine.
3. See drawing 27658 for an illustration of where each home switch is mounted.
4. Remove all sheet metal covers necessary to gain access to the switches.
5. The switches are held in place with a few screws.
6. It is very important to place the new switch in the same location as the old one so the home of the machine will stay the same.
7. Replace all covers and sheet metal as necessary.

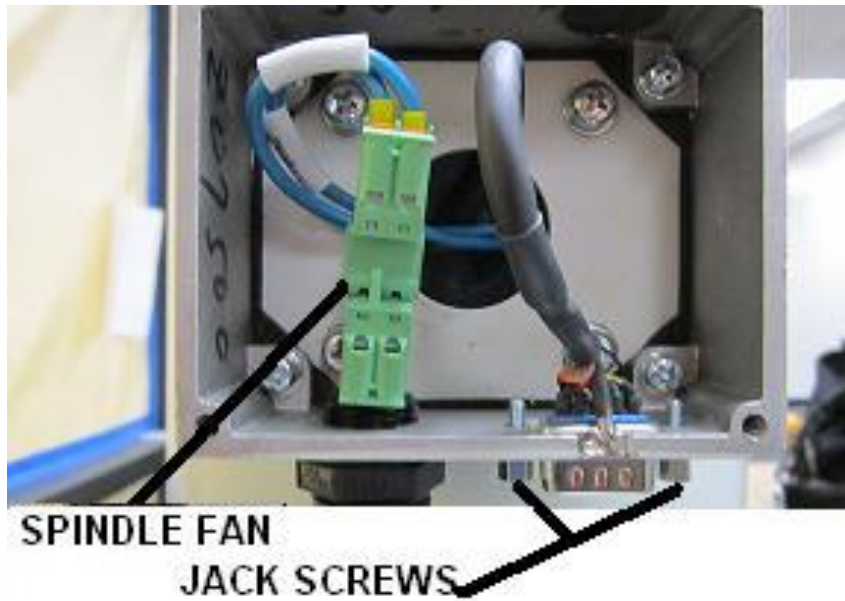
### Caution!

If the home of the machine changes, various parameters will need to be reset. Important machine parameters such as ball lock locations, tool change height, ATC locations will need to be reset if the home has changed.

## 6.18 Spindle Motor Encoder Replacement



1. Remove Encoder housing cover to gain access to internal connections.



2. Disconnect Spindle fan and remove jackscrews.



3. Push Spindle Fan cable through Encoder housing opening.



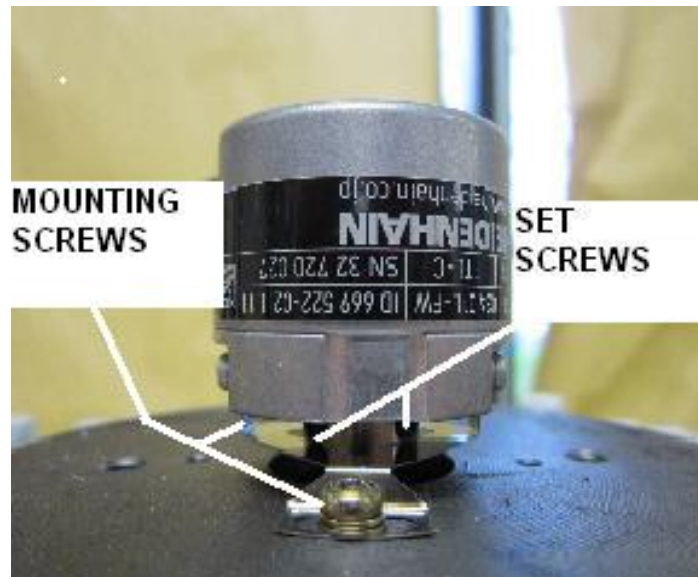
4. Push Encoder cable through Encoder housing opening.



5. Remove Spindle Fan shroud.



6. Remove Spindle Fan. Loosen and remove the 3 screws that secure it in place.



7. Remove the 2 screws on top and loosen the setscrews underneath to remove encoder.

**INSTALL NEW ENCODER IN REVERSE ORDER**

## 6.19 X, Y, Z Home Switch Adjustments

The following service codes may need to be performed when a major adjustment is made to a home switches. Failure to do may cause the ball lock locations to be off for the X and Y axis and the tool change X and Y locations as well as height may be off in the Z axis. The machine may crash if these items are not set correctly.

- Service Code 505 – reset the motor index angle (machine may not home properly) and resets soft limits. Must be redone after any home switch is adjusted.
- Service Code 500 – reset the X and Y ball lock locations. May need to be performed after X or Y axis home switch work
- Service Code 520 – reset the X and Y tool position locations and tool change height.

The home switches that come on the 2 OP should not need to be adjusted unless a component that is part of the drive train is changed, such as an axis motor or ballscrew.

The home switches are set from the factory to be approximately 1 revolution of the ballscrew (6 mm) from the hard stop on the machine. From there **the soft limits are set approximately 0.215" on the home switch side and 0.400", 0.250" and 0.500" on the non switch side for the X, Y and Z respectively.** When setting this 6 mm distance at the factory, we turn power off to the machine and manually move the ballscrew until the given access hits the hard stop. We then turn the ballscrew in the opposite direction approximately 1 turn (since the ballscrew has a 6 mm pitch) and then set the cam.

The home switch cams should never have to be adjusted unless a motor or ballscrew is replaced or if the motor is removed for any reason. Once the motor is removed, we need to make sure the motor index pulse on the motor encoder is approximately 180 degrees (+/- 45 degrees) from the home switch cam, this will ensure the homing algorithm works very reliability. Service code 505 is used to check the angle of the motor encoder versus the home switch cam. When replacing a motor, the index mark on the encoder is set relative to the keyway on the motor shaft. This means if you pay attention to how the motor was mounted on the machine, you can put the replacement motor in the same position and the index angle should not require change. See drawing 27658.

## 6.20 Setting the Axis Motor Index Angle

1. Enter service code 505
2. Bring the axis near to the end of travel, press the E stop.
3. Using the small end of a hex key, rotate the ballscrew until it just touches the cushion.
4. Now rotate the ballscrew one complete revolution in the opposite direction.
5. Adjust the limit switch cam until the limit switch is just recognized, and lock in place.
6. Check the index angle displayed on the screen, it should be 180° +/- 45°. If it is not, loosen the belt until the pulley can be turned without rotating the ballscrew, rotate the pulley until the index angle reads 180°, then tighten the belt.
7. Mode out of service code 505. Press RSTR and then press SET HOME.
8. Return to service code 505. Before proceeding, make sure there are no obstructions on the table as all axes are going to go to their full length of travel. Press SET SOFT LIMIT.
9. Perform service code 500 on the X or Y axis depending on which motor you replaced.
10. Perform service code 520 for the ATC tool locations on X and Y or for the tool change height for the Z motor.

Note – when replacing a motor in the field, the index mark on the encoder should match the location of the keyway on the motor shaft. This means that you can replace the motor and if you orientate it back in the same position as the motor you removed the index angle should be correct.

## 6.21 Adjusting the Drawbar Bump Out

To prevent tools from sticking in the spindle taper, the tool is bumped out by the drawbar assembly when the green button is pressed or when an automatic tool change is done. The bump out amount should be approximately **0.015" to 0.02"**. **You can check this** amount by loading a tool manually and taking note how much the tool is sucked up into the spindle once you release the green button. This amount would be what we consider the bump out amount. To adjust bump out, you will need a 4 and 5 mm allen wrench.

1. Turn off the air that flows down the spindle when you press the green button. To do so, you can close the air flow control valve found on top of the tool clamp/unclamp cylinder. See drawing 27563 (item 35) for this valve.
2. Loosen the set screw up inside the spindle with a 4 mm wrench. Figure 6.21 shows the drawbar assembly when removed from the machine so you can see how it is assembled.
3. Now use a 5 mm wrench to move the spanner down so it will bump the top of the retention knob on the tool holder. Please note, only very small adjustments are necessary to adjust the bump out.
4. Fasten the 4 mm set screw back down.
5. Load a tool manual in and out of the spindle to verify the bump is now within spec.
6. Turn the air flow valve that allows air down through the spindle.



Figure 6.21

## 7.0 Maintenance

### 7.1 Calibration

#### 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.

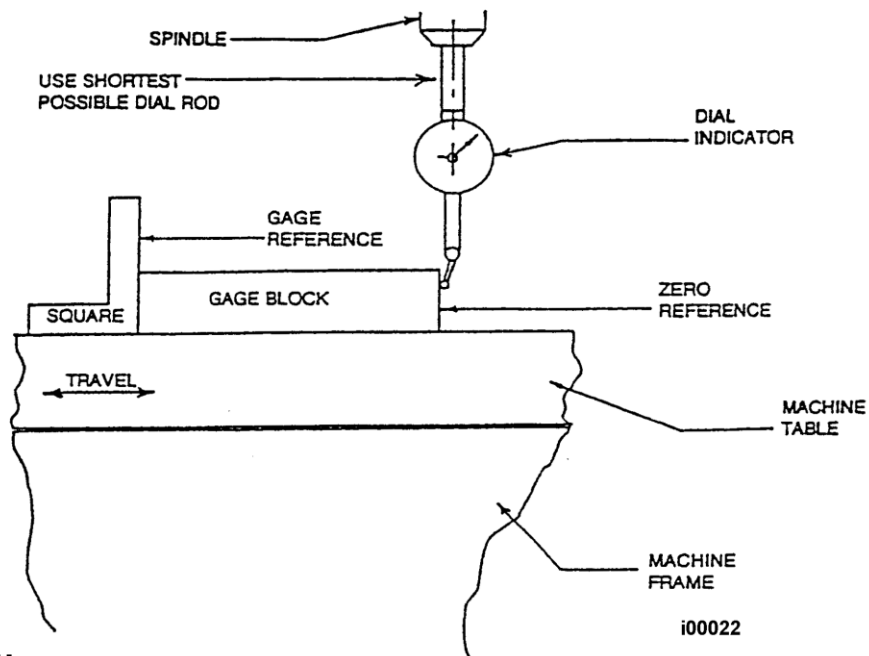
#### X, Y, Z Calibration

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. 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, Y and Z -- 150mm or 6"
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, go to section "B" and press CODE 123.
  5. Select the axis you want to calibrate X, Y or Z.
  6. Follow the instructions on the screen to complete calibration.



**Figure 7.1**  
**Calibration Set-Up**

## 7.2 Backlash Compensation

Every mechanical system has at least a little backlash or lost motion. It is produced by the small amount of play between the mechanical components, and mostly by the accumulative bending or elasticity of all the parts of the drive train under load. The backlash constants are factory set, but may need to be adjusted periodically. These are set at the factory by running a ballbar test using a Reinshaw probe. If a ballbar is not available, then the following procedure will work.

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.
2. **The backlash can also be found manually with a 0.0001" indicator with the following method.**
3. Load the indicator to zero from one direction and zero out the DRO.
4. **Move the indicator to 0.002" and then back to zero. Do not over shoot 0, otherwise start over.**
5. Whatever number appears on the screen is the backlash value.
6. Enter this value into service code 128.
7. After entering this number, redo the process. The DRO and indicator should now both read 0.

Typical values for backlash should be 0.002" or less. **Most** new machines will exhibit a **0.001" or less**. Larger values could mean the machine has a mechanical problem.

## 7.3 Periodic Maintenance

The following table lists the periodic maintenance that must be done on a daily, month(s) and yearly basis.

Maintenance Time Period	Items
Daily	<ol style="list-style-type: none"> <li>1. Remove majority of chips from around the axis slide ways, work table and ways covers, especially between table and ATC.</li> <li>2. Empty chip tray.</li> <li>3. Visually check lubrication pump oil level, make sure it is always above the minimum line.</li> <li>4. Visual check the coolant level, add if needed.</li> <li>5. Visually check the air supply filter.</li> </ol>
Month(s)	<ol style="list-style-type: none"> <li>1. Remove back ATC and Y axis motor compartment access covers and clean chips and any other debris. Cleanup any oil or coolant accumulated on the bottom panel of the machine base. There is a drain plug at the rear of the machine to drain any fluids.</li> <li>2. Visually inspect the condition of way and ballscrew covers, clean if showing chip build up.</li> <li>3. Check and if needed replace the air regulator filter element.</li> <li>4. Remove all air filters in the electrical cabinet and transformer enclosure every 2 months and clean.</li> <li>5. Every 2 months, drain and remove the coolant tank and clean inside, including the pump screen. Fill with new coolant.</li> <li>6. Visually check the tool unclamp oil reservoir level.</li> </ol>
Yearly	<ol style="list-style-type: none"> <li>1. Check backlash on each axis and adjust as necessary.</li> <li>2. Remove all covers and clean chips and debris that may have built up.</li> <li>3. Inspect the tool change air cylinder and grease the ATC linear rail bearing blocks.</li> <li>4. Inspect machine for any unusual wear and play, check cables and pneumatic lines for any excessive abrasions or cuts.</li> </ol>

TRAK Machine Tools  
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/ProtoTRAK	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 product, subsystem or component proves to be defective in workmanship and fails within the warranty period, 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.

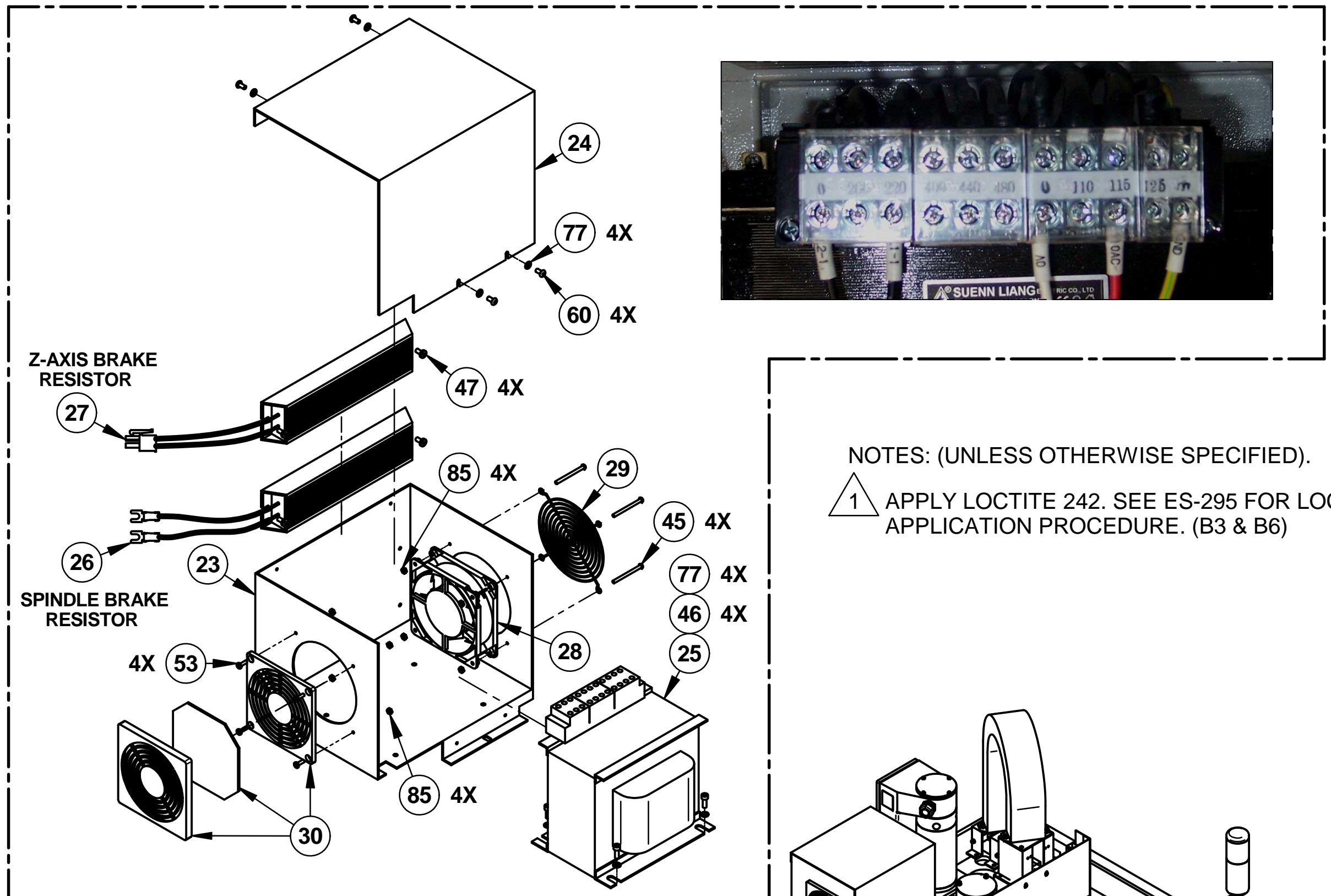
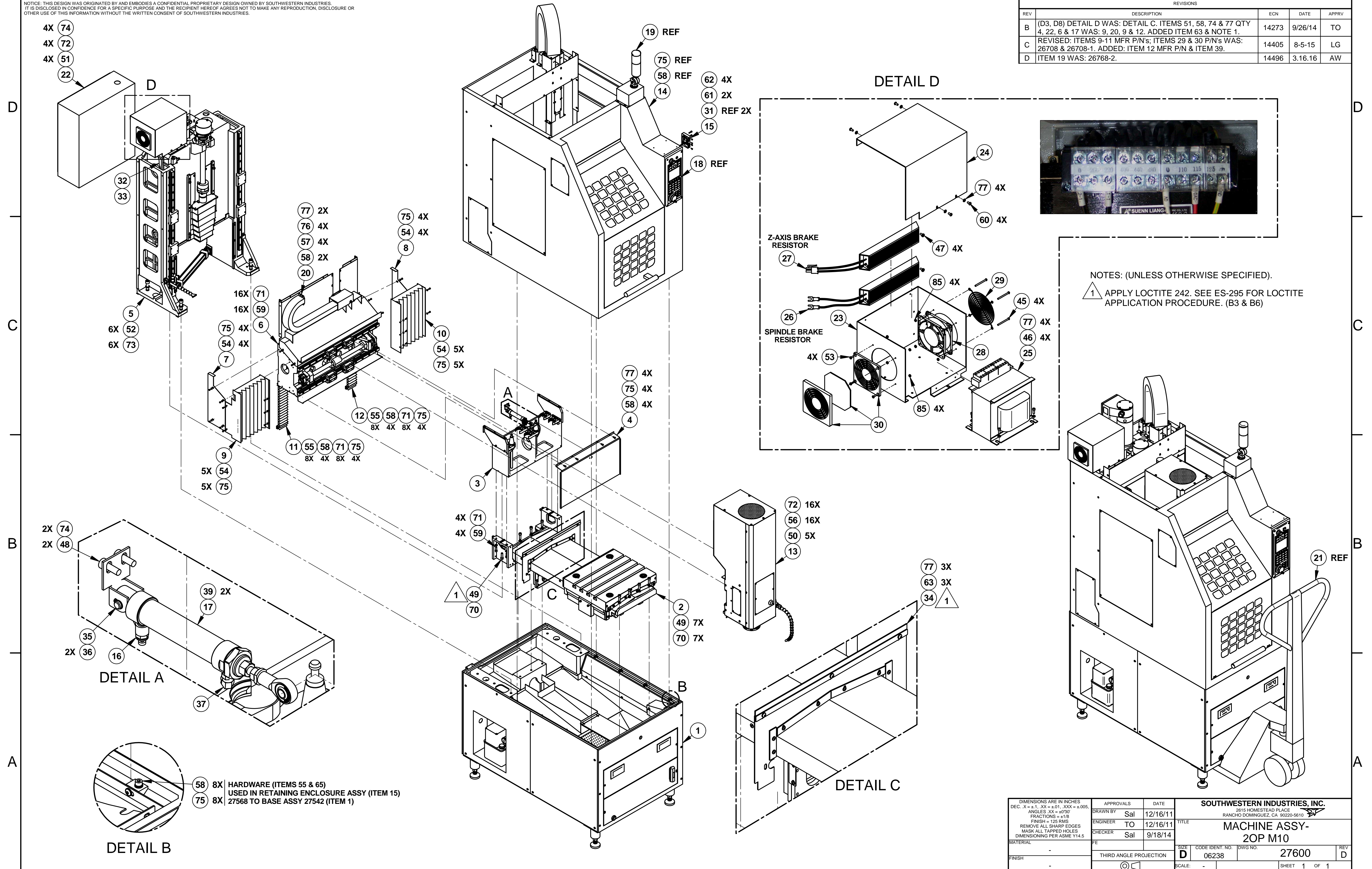
## Disclaimers of Warranties

- 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/electronic systems and must be given the reasonable care that these types of products require. Evidence that the product does not receive adequate Preventative Maintenance may invalidate the warranty. Excessive chips built up around ballscrews and way surfaces is an example of this evidence.
- Accidental damage, beyond the control of SWI, is not covered by the warranty. Thus, the warranty does not apply if a product has been abused, dropped, hit or disassembled.
- 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.
- Warranty does not cover wear items that are consumed under normal use of the product. These items include, but are not limited to: windows, bellows, wipers, filters, drawbars and belts.



NOTICE: THIS DESIGN WAS ORIGINATED BY AND EMBODIES A CONFIDENTIAL PROPRIETARY DESIGN OWNED BY SOUTHWESTERN INDUSTRIES. IT IS DISCLOSED IN CONFIDENCE FOR A SPECIFIC PURPOSE AND THE RECIPIENT HEREOF AGREES NOT TO MAKE ANY REPRODUCTION, DISCLOSURE OR OTHER USE OF THIS INFORMATION WITHOUT THE WRITTEN CONSENT OF SOUTHWESTERN INDUSTRIES.

REVISIONS		ECN	DATE	APPRV
B	(D3, D8) DETAIL D WAS: DETAIL C. ITEMS 51, 58, 74 & 77 QTY 4, 22, 6 & 17 WAS: 9, 20, 9 & 12. ADDED ITEM 63 & NOTE 1.	14273	9/26/14	TO
C	REVISED: ITEMS 9-11 MFR P/N's; ITEMS 29 & 30 P/N's WAS: 26708 & 26708-1. ADDED: ITEM 12 MFR P/N & ITEM 39.	14405	8-5-15	LG
D	ITEM 19 WAS: 26768-2.	14496	3.16.16	AW



NOTES: (UNLESS OTHERWISE SPECIFIED).  
 1 APPLY LOCTITE 242. SEE ES-295 FOR LOCTITE APPLICATION PROCEDURE. (B3 & B6)

58 8X HARDWARE (ITEMS 55 & 65)  
 USED IN RETAINING ENCLOSURE ASSY (ITEM 15)

75 8X 27568 TO BASE ASSY 27542 (ITEM 1)

DIMENSIONS ARE IN INCHES DEC. X = ±.1, XX = ±.01, XXX = ±.005 ANGLES: XX = ±0°30' FRACTIONS = ±1/8 FINISH = 125 RMS REMOVE ALL SHARP EDGES MASK ALL TAPPED HOLES DIMENSIONING PER ASME Y14.5		APPROVALS	DATE	SOUTHWESTERN INDUSTRIES, INC. 2615 HOMESTEAD PLACE RANCHO DOMINGUEZ, CA 90220-5610	
DRAWN BY	Sal	12/16/11	TITLE		
ENGINEER	TO	12/16/11	MACHINE ASSY- 2OP M10		
CHECKER	Sal	9/18/14	SIZE	CODE IDENT. NO.	REV
MATERIAL	FE		D	06238	D
FINISH			THIRD ANGLE PROJECTION	DWG NO.	27600
			SCALE: -	SHEET	1 OF 1

Parts List for Assembly P/N: 27600

Printed 3/17/2016

27600  
MACHINE ASSY-2OP M10

Type	PL	Dwg Size	D
Revision	D	Product	2OP
Status	R	Engineer	TO
Date	5/26/2009	Planner Code	
By	Sal	Comm Code	

Item	P/N	Title	Detail	Reference(t)	Qty	UseAs	Rev	Stat	Type	Mfr	Mfr P/N
1	27542	BASE FRAME ASSY-2OP M10			1	EA	A	R	PL		
2	27564	DRIVE TRAIN ASSY-Y AXIS-M10			1	EA	E	R	PL		
3	27587	ATC ASSY-2 OP MILL			1	EA	A	R	PL		
4	27686	DOOR ASSY-ATC CARRIAGE			1	EA	A	R	PL		
5	27540	COLUMN ASSY-Z AXIS-M10			1	EA	E	R	PL		
6	27520	DRIVE TRAIN ASSY-X AXIS			1	EA	B	R	PL		
7	27603-19	COVER-LEFT-X AXIS ASSY			1	EA	-	R	PS	KING RICH	
8	27603-20	COVER-RIGHT-X AXIS ASSY			1	EA	-	R	PS	KING RICH	
9	27689-1	BELLOW-LEFT-300mm H			1	EA	A	R	DWG	KING RICH	OP441010
10	27689-2	BELLOW-RIGHT-300mm H			1	EA	A	R	DWG	KING RICH	OP441020
11	27689-3	BELLOW-LEFT-70mm H			1	EA	A	R	DWG	KING RICH	OP443011
12	27689-4	BELLOW-RIGHT-70mm H			1	EA	A	R	DWG	KING RICH	OP443021
13	27500	SPINDLE HEAD ASSY-2OP M10			1	EA	D	R	PL		
14	27568	ENCLOSURE ASSY-2OP M10 MILL			1	EA	C	R	PL		
15	28031	COVER-USB CONNECTOR-2 OP MILL & LATHE			1	EA	-	R	DWG		
16	28071	VALVE-FLOW CONTROL-AIR			1	EA	-	R	PS	KING RICH	A-572-001
17	27583-5	CYLINDER-AIR-20mm BORE X 60mm S			1	EA	-	R	DWG		
18	27604	PANEL ASSY-2OP M10 MILL			(1)	EA	D	R	PL		

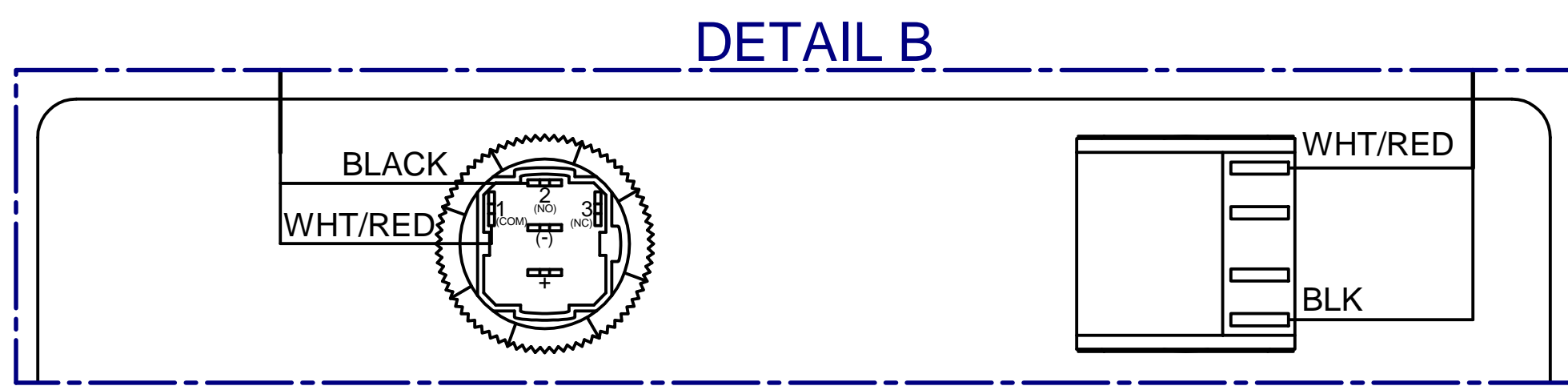
Item	P/N	Title	Detail	Reference(t)	Qty	UseAs	Rev	Stat	Type	Mfr	Mfr P/N
19	26768-3	STATUS LIGHT LED ASSY-2OP	THERE ARE NO REPLACEME NT PARTS IN CASE OF FAILURE REPL ENTIRE ASSY		(1)	EA	A	R	PL	KING RICH	A-141-082
20	26891-4	CARRIER-CABLE-X AXIS			1	EA	-	R	PS	KING RICH	A-85-183
21	27724	PALLET JACK-2 OP MILL			(1)	EA	A	R	DWG		
22	27621	ENCLOSURE-ELEC ASSY-2OP M10 MILL			1	EA	C	R	PL		
23	27554	SHEET METAL-TRANSFORMER			1	EA	-	R	DWG		
24	27554-1	SHEET METAL-COVER-TRANSFORMER			1	EA	-	R	DWG		
25	21258-6	TRANSFORMER-SINGLE PHASE-1.9 KVA			1	EA	-	R	DWG		
26	27175-1	RESISTOR ASSY-SPINDLE BRAKE-100 OHMS			1	EA	-	R	PL		
27	27175	RESISTOR ASSY-BRAKE-Z AXIS			1	EA	-	R	PL		
28	26564-1	FAN-115 VAC			1	EA	-	R	DWG		
29	26708-1	FAN GUARD-120 mm			1	EA	-	R	DWG		
30	26708-2	FILTER GUARD-PLASTIC-120mm			1	EA	A	R	DWG		
31	27657-1	CABLE ASSY-USB-MALE-A TO FEMALE-A-PANEL MT	3 METER LENGTH		(2)	EA	A	R	PS		
32	27176-3	CABLE ASSY-TRANSFORMER FAN	DC300-119		1	EA	A	R	PL		
33	27547	WIRE HARNESS ASSY-TRANSFORMER			1	EA	-	R	PL		
34	27682	COVER ASSY-TOOL -2OP			1	EA	A	R	PL		
35	28087	PIN-PIVOT-ATC DOOR ASSIST CYLINDER			1	EA	-	R	DWG		
36	24768-1	RETAINING RING-EXTERNAL-7mm	NON STOCKABLE		2	EA	-	R	PS	MCMASTER	98541A115
37	24673-2	ELBOW-1/8 BSPT TO 6mm QUICK CONNECT			1	EA	-	R	PS		

Item	P/N	Title	Detail	Reference(t)	Qty	UseAs	Rev	Stat	Type	Mfr	Mfr P/N
39	27745-1	COUPLING-Y-6mm PUSH TO CONNECT	SEE 27563		2	EA	-	R	PS	KING RICH	
45	M4-0.7X50 10Z	SCREW-PH-PHIL-STL-ZINC	NON STOCKABLE		4	EA	-	R	PS		
46	M5-0.8X15 25B	SCREW-SHCS-STL-BO	NON STOCKABLE		4	EA	-	R	PS		
47	M5-0.8X8 10Z	SCREW-PH-PHIL-STL-ZINC			4	EA		R	PS		
48	M6-1.0X16 25B	SCREW-SHCS-STL-BO			2	EA	-	R	PS		
49	M10-1.5X35 25B	SCREW-SHCS-STL-BO			8	EA		R	PS		
50	M5-0.8X16 25B	SCREW-SHCS-STL-BO			5	EA	A	R	PS		
51	M6-1.0X12 27B	SCREW-BHCS-STL-BO			4	EA		R	PS		
52	M16-2.0 X 50 25B	SCREW-SHCS-STL-BO	NON STOCKABLE		6	EA	-	R	PS		
53	M4-0.7X12 10Z	SCREW-PH-PHIL-STL-ZINC			4	EA	-	R	PS		
54	M5-0.8X8 27B	SCREW-BHCS-STL-BO			18	EA	-	R	PS		
55	M8-1.25X35 25B	SCREW-SHCS-STL-BO			16	EA		R	PS		
56	M6-1.0X25 25B	SCREW-SHCS-STL-BO			16	EA		R	PS		
57	M8-1.25X10 25B	SCREW-SHCS-STL-BO			4	EA		R	PS		
58	M5-0.8X12 25B	SCREW-SHCS-STL-BO			22	EA	-	R	PS		
59	M8-1.25X25 25B	SCREW-SHCS-STL-BO			20	EA		R	PS		
60	M5-0.8X10 27Z	SCREW-BHCS-STL-ZINC	NON STOCKABLE		4	EA	-	R	PS		
61	M4-0.7X20 25B	SCREW-SHCS-STL-BO			2	EA		R	PS		
62	4-40X3/8 31B	SCREW-PH-PHIL-EXT SEMS-STL-BO			4	EA		R	PS		
63	M5-0.8X12 27Z	SCREW-BHCS-STL-ZINC			3	EA		R	PS		
70	M10 73B	WASHER-SPLIT LOCK-STL-BO			8	EA	-	R	PS		
71	M8 73B	WASHER-SPLIT LOCK-STL-BO			36	EA		R	PS		
72	M6 73B	WASHER-SPLIT LOCK-STL-BO			20	EA	-	R	PS		

Item	P/N	Title	Detail	Reference(t)	Qty	UseAs	Rev	Stat	Type	Mfr	Mfr P/N
73	M16 WASHER FINISH	WASHER-FINISH-Ø35 OD x Ø17 ID x 6mm H	NON STOCKABLE		6	EA	-	R	PS		
74	M6 70B	WASHER-FLAT USS-STL-BO			6	EA	-	R	PS		
75	M5 73B	WASHER-SPLIT LOCK-STL-BO			38	EA	-	R	PS		
76	M8 71B	WASHER-FLAT SAE-STL-BO			4	EA		R	PS		
77	M5 70B	WASHER-FLAT USS-STL-BO			17	EA		R	PS		
85	M4-0.7 50Z	NUT-HEX-STL-ZINC			8	EA	-	R	PS		

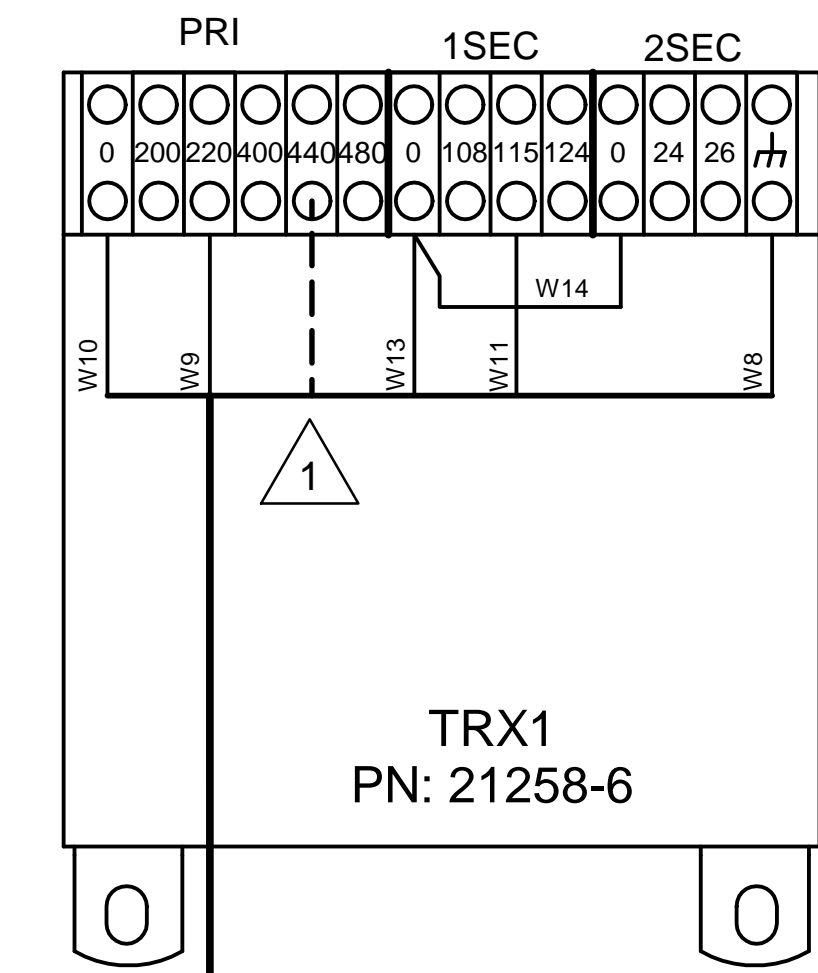
REVISIONS				
REV	DESCRIPTION	ECN	DATE	APPRV
C	ADDED: SH1: NOTE 1, DETAIL B, INPUT PWR CHART; (2C3) 440 OPTION; SH3 X, Y, Z SW REF DES 'HOME'. SH 4 REVISED WIRE CHART.	14076	5/11/13	RO
D	ADDED CURRENT CONFIGURATIONS: SH3 SENSORS; SH4 STATUS & WORK LIGHTS.	14491	03/09/16	AW

INPUT POWER WIRING			
SW1	220 OPTION CABLE 21490-1	440 OPTION CABLE 21490-2	220 SINGLE PHASE OPTION CABLE 21490-3
L1	RED	RED	WHITE
L2	WHITE	WHITE	BLACK
L3	BLACK	BLACK	----
GS1	GREEN	GREEN	GREEN

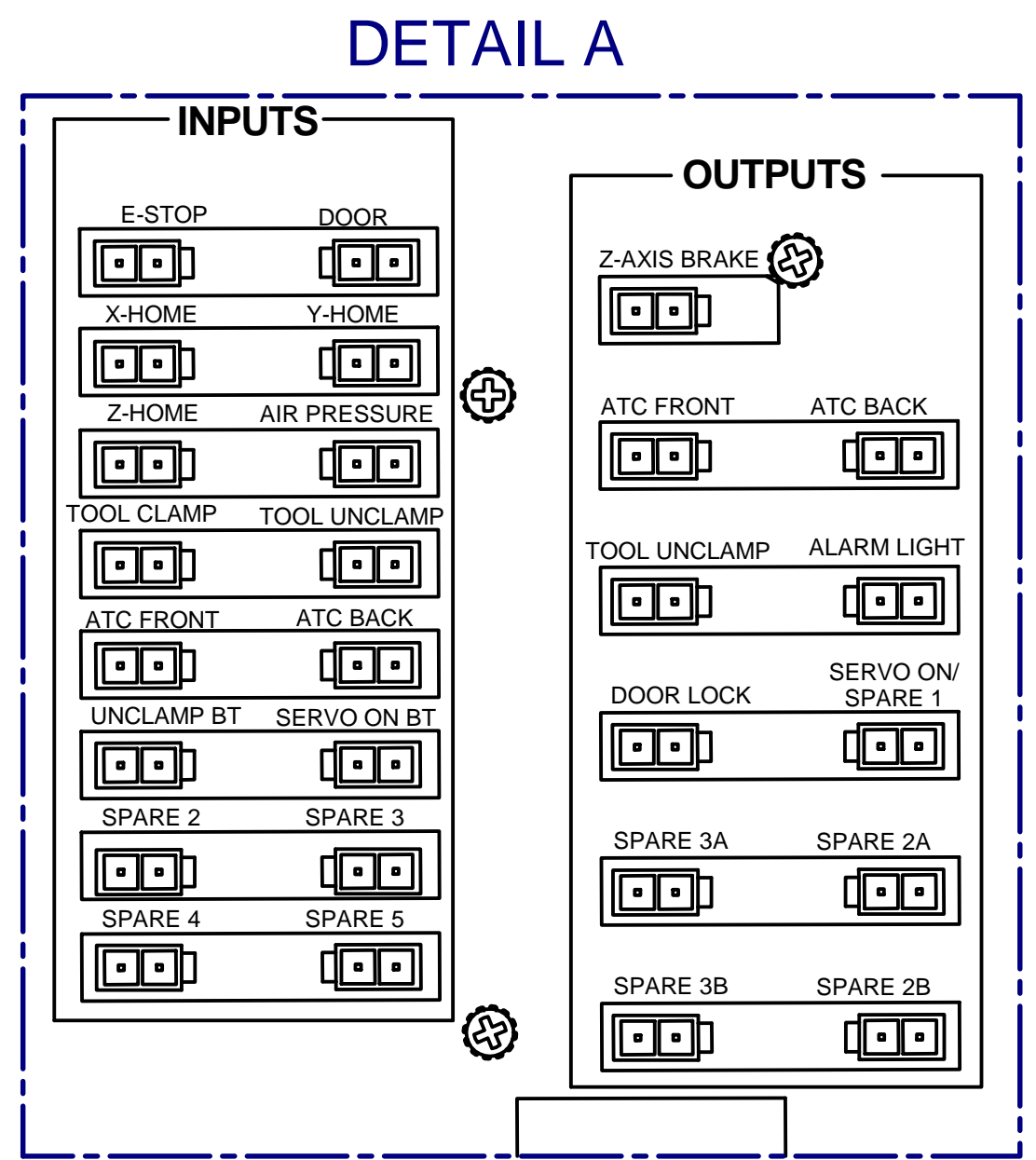


220/440 VAC INPUT  
SEE INPUT POWER WIRING CHART

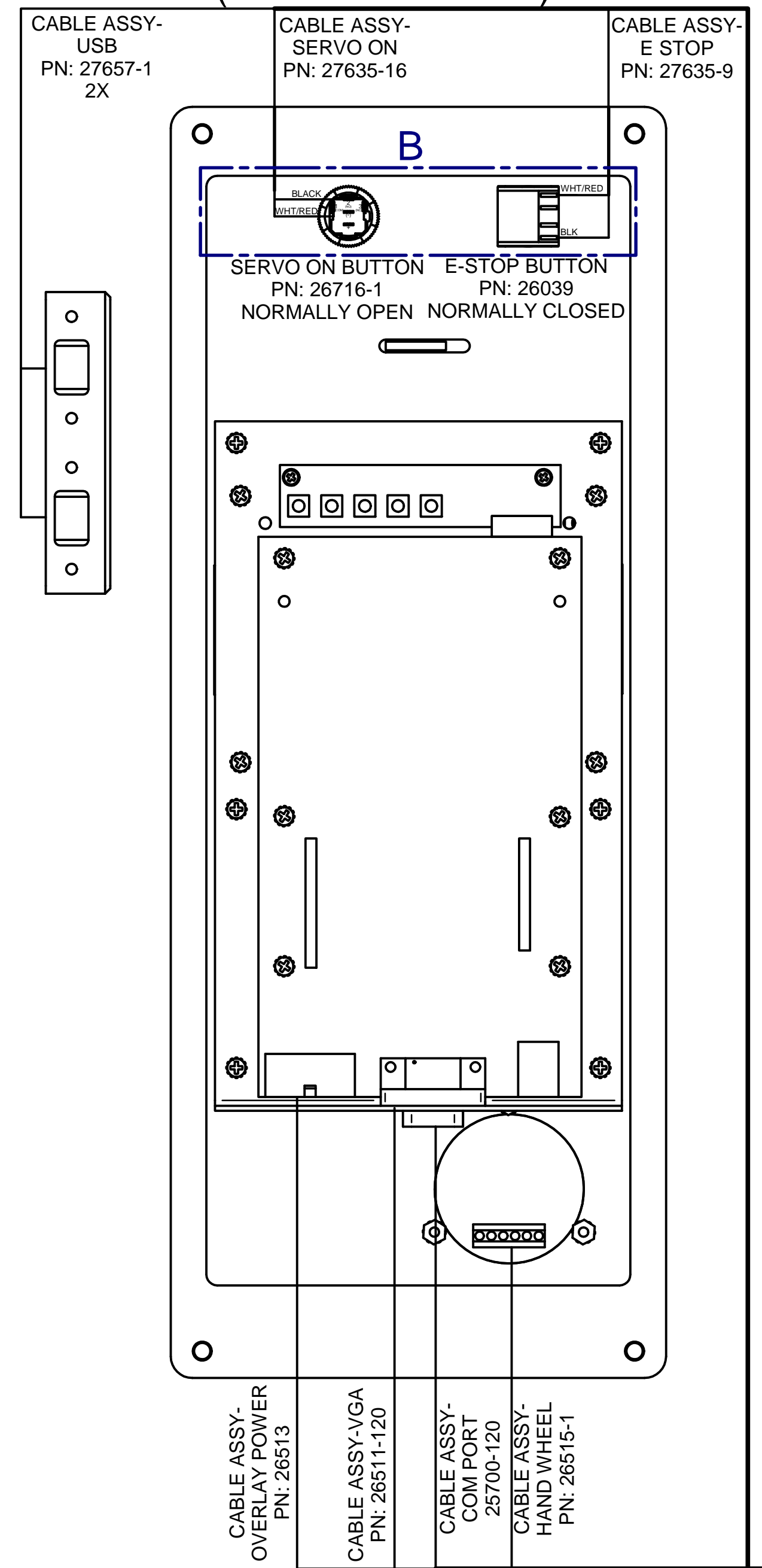
WIRE HARNESS ASSY-27547					
WIRE/ CABLE	WIRE FROM	WIRE LABEL	WIRE GAGE	COLOR	WIRE TO
W8	GS7	GND	2mm <sup>2</sup>	GREEN	TRX1-2SEC-GND
W9	TB1-3	L1-1	2mm <sup>2</sup>	BLACK	TRX1-PRI-220
W10	TB3-3	L2-1	2mm <sup>2</sup>	BLACK	TRX1-PRI-0
W11	F1-2	115AC	2mm <sup>2</sup>	RED	TRX1-1SEC-115
W13	TB7-3	0V	2mm <sup>2</sup>	WHITE	TRX1-1SEC-0
W14	TRX1-1SEC-0	0V	2mm <sup>2</sup>	WHITE	TRX1-2SEC-0



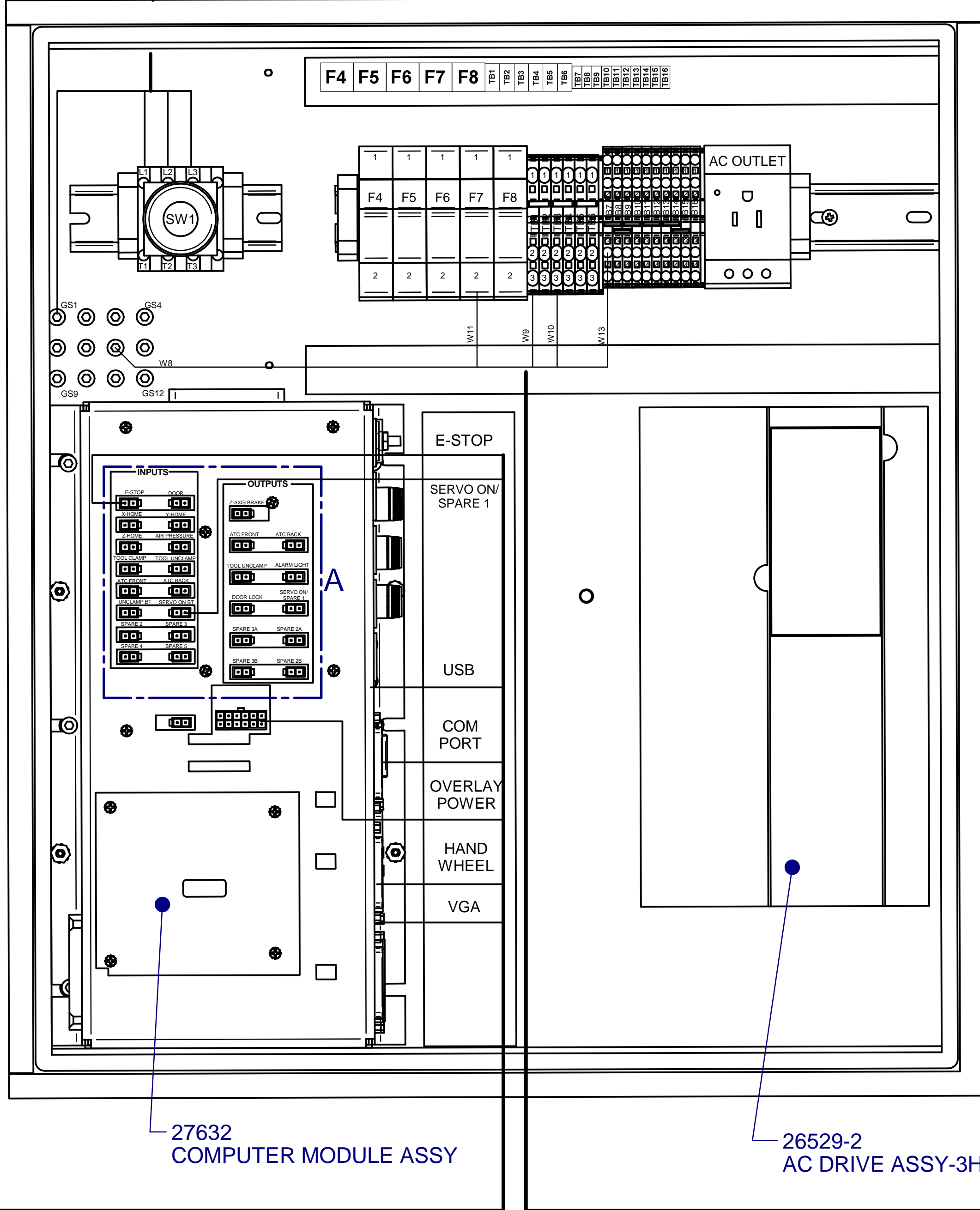
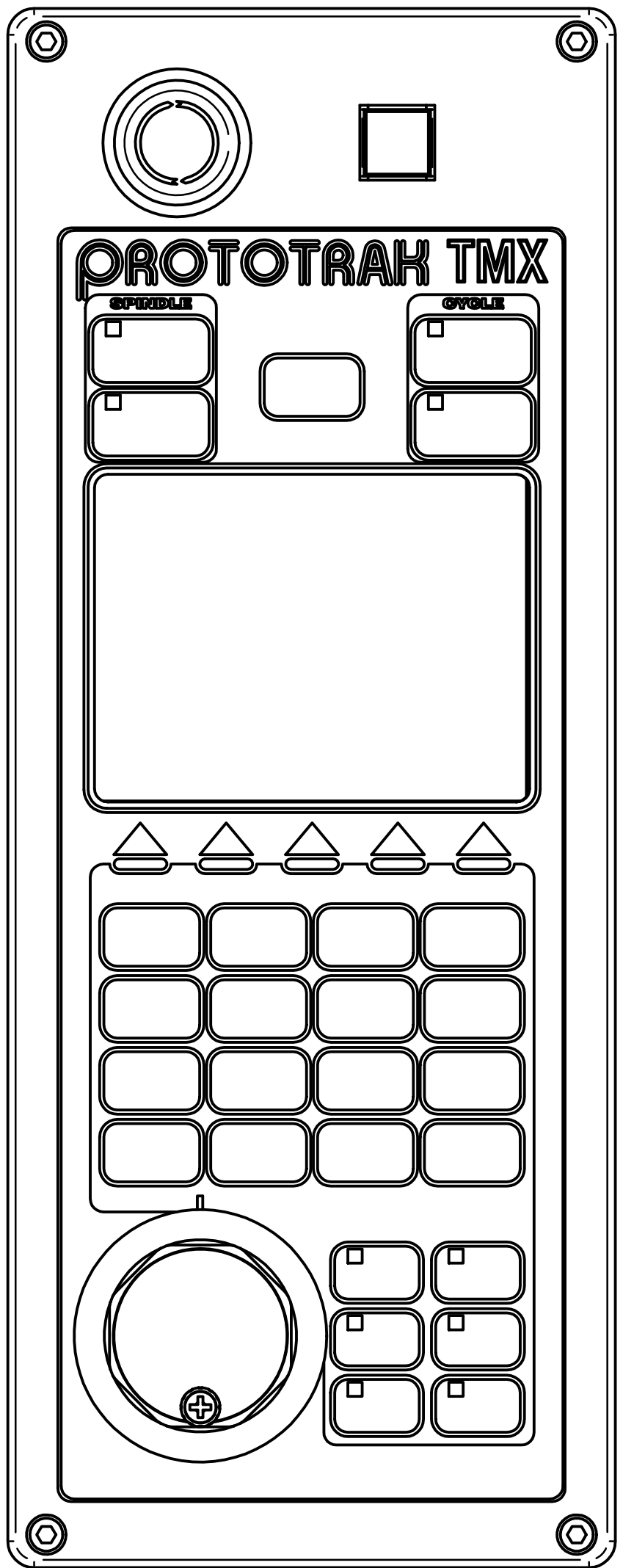
27547  
WIREWAY ASSY



PANEL ASSY-REAR  
(PROGRAMMING)



PANEL ASSY  
(PROGRAMMING)  
P/N: 27604



SEE SEPARATE "A" SIZE SHEET FOR PARTS LIST

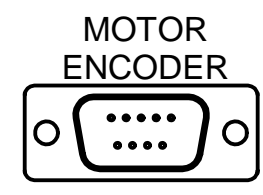
DIMENSIONS ARE IN INCHES DEC. X = ±.1, XX = ±.01, XXX = ±.005 ANGLES: XX = ±0°30' FRACTIONS = ±1/8 FINISH = 125 RMS REMOVE ALL SHARP EDGES MASK ALL TAPPED HOLES DIMENSIONING PER ASME Y14.5		APPROVALS DRAWN BY RC 10/11/11 ENGINEER RO 9/18/12 ENGINEER		DATE 10/11/11 9/18/12		SOUTHWESTERN INDUSTRIES, INC. 2615 HOMESTEAD PLACE RANCHO DOMINGUEZ, CA 90220-5610	
MATERIAL FE				TITLE SYSTEM DIAGRAM- 2OP M10		CODE IDENT. NO. 06238	
FINISH -				THIRD ANGLE PROJECTION		DWG NO. 27648	
SCALE: -				SHEET 1 OF 4		REV D	

NOTES: (UNLESS OTHERWISE SPECIFIED).

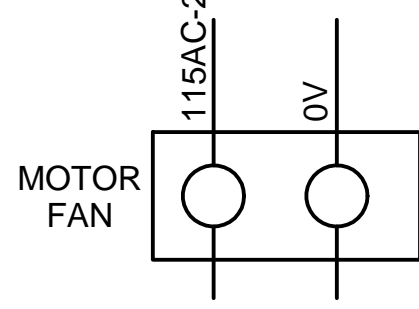
1 FOR 440 OPTION MOVE W9 WIRE TO 400-480 TAP IN ORDER TO GET 115 VAC OUT OF TRX1.  
FOR 440 OPTION DETAILS SEE PN 28091 DRAWING. (1C2)

NOTICE: THIS DESIGN WAS ORIGINATED BY AND EMBODIES A CONFIDENTIAL PROPRIETARY DESIGN OWNED BY SOUTHWESTERN INDUSTRIES. IT IS DISCLOSED IN CONFIDENCE FOR A SPECIFIC PURPOSE AND THE RECIPIENT HEREOF AGREES NOT TO MAKE ANY REPRODUCTION, DISCLOSURE OR OTHER USE OF THIS INFORMATION WITHOUT THE WRITTEN CONSENT OF SOUTHWESTERN INDUSTRIES.

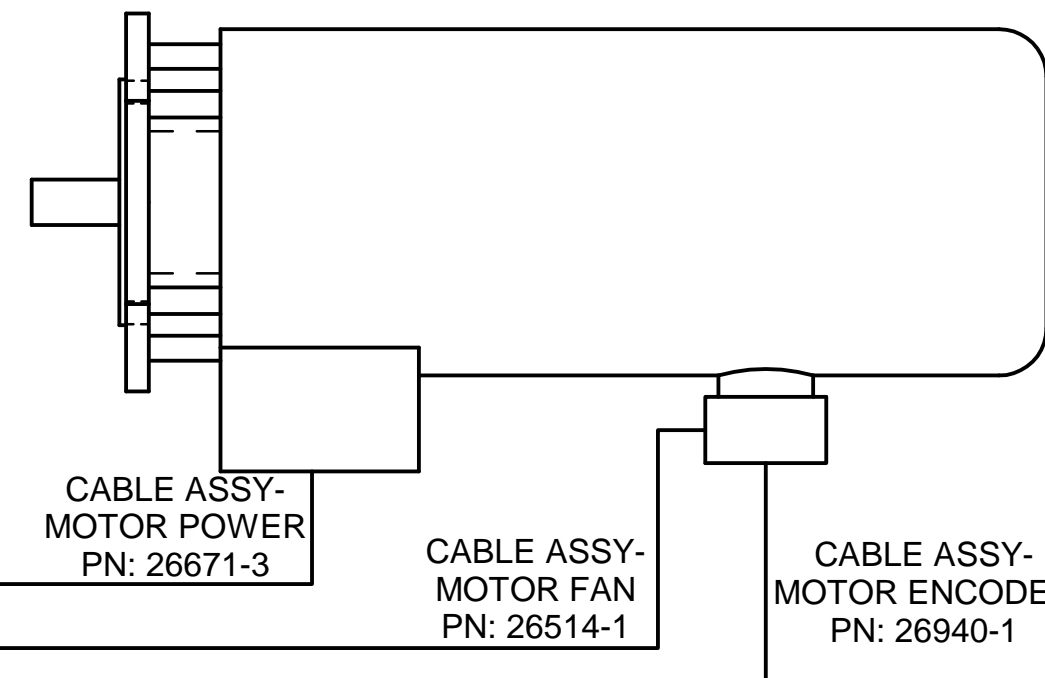
WIRE CHART				
CABLE	PIN	FUNCTION	COLOR	WIRE TO
MOTOR ENCODER CABLE	1	A1	BLUE	A1
	2	-A1	ORANGE	-A1
	3	B1	GREEN	B1
	4	-B1	VIOLET	-B1
	5	Z1	YELLOW	Z1
	6	-Z1	WHITE	-Z1
	8	5V/VP	RED	VP
	9	GND	BLACK	GND (J7)
MOTOR FAN	1	115AC-2		TB13-4
	2	0V		TB10-4



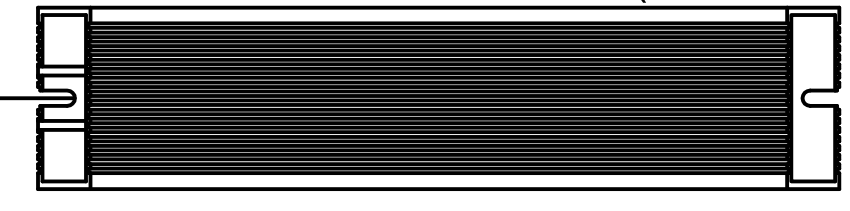
MOTOR POWER



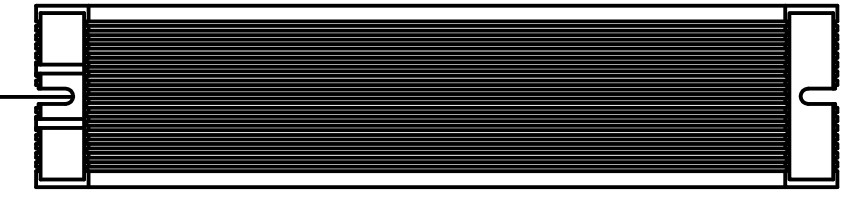
SPINDLE MOTOR  
PN: 26849-1



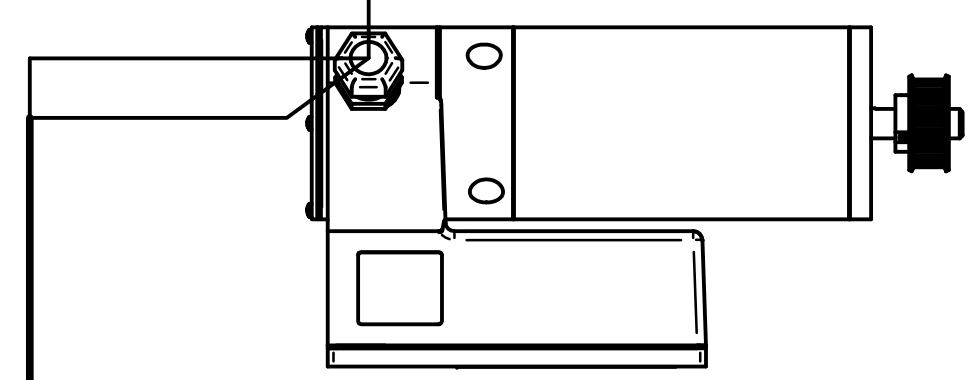
SPINDLE BRAKE RESISTOR  
PN: 27175-1 (100 OHMS)  
440 VAC OPT: PN: 27175-2 (200 OHMS)



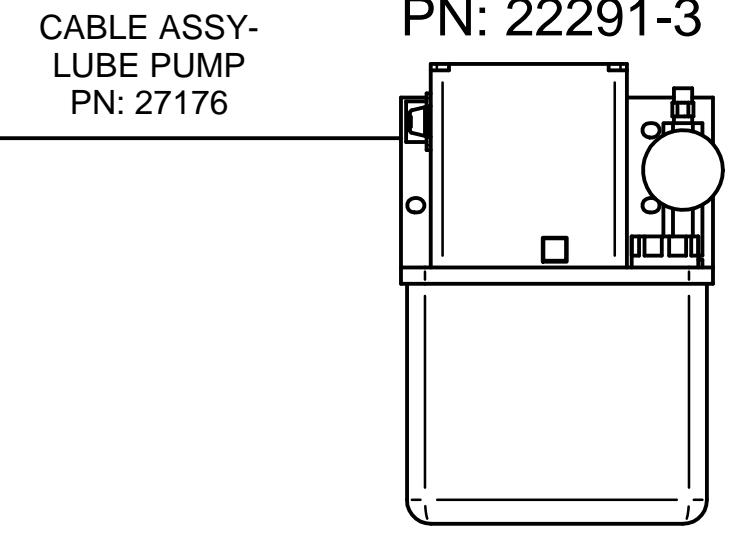
Z AXIS BRAKE RESISTOR  
PN: 27175 (30 OHMS)



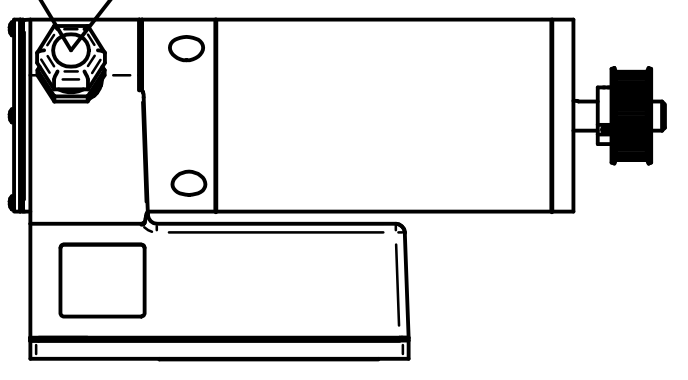
Z AXIS MOTOR  
PN: 24428-4



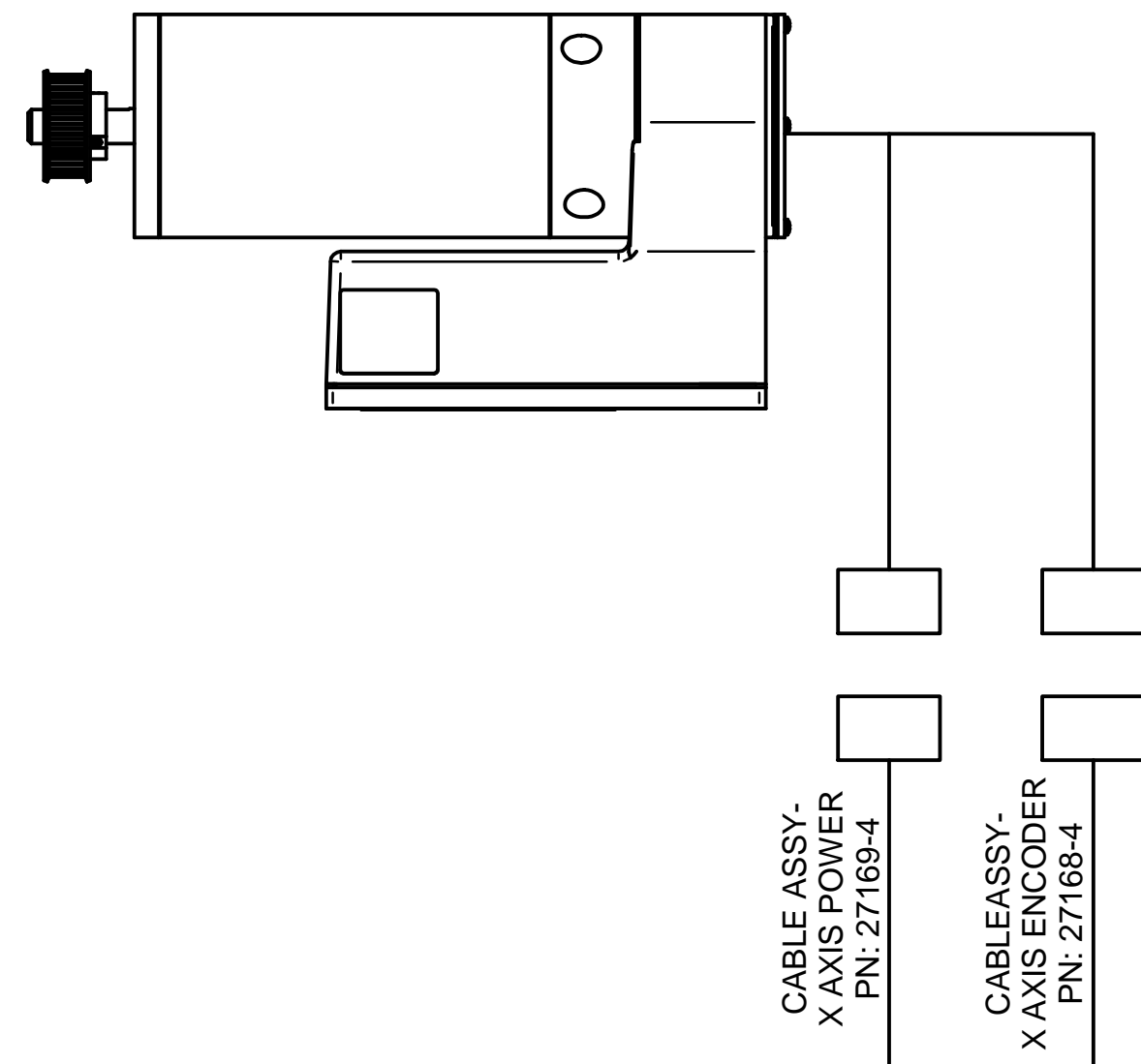
LUBE PUMP  
PN: 22291-3



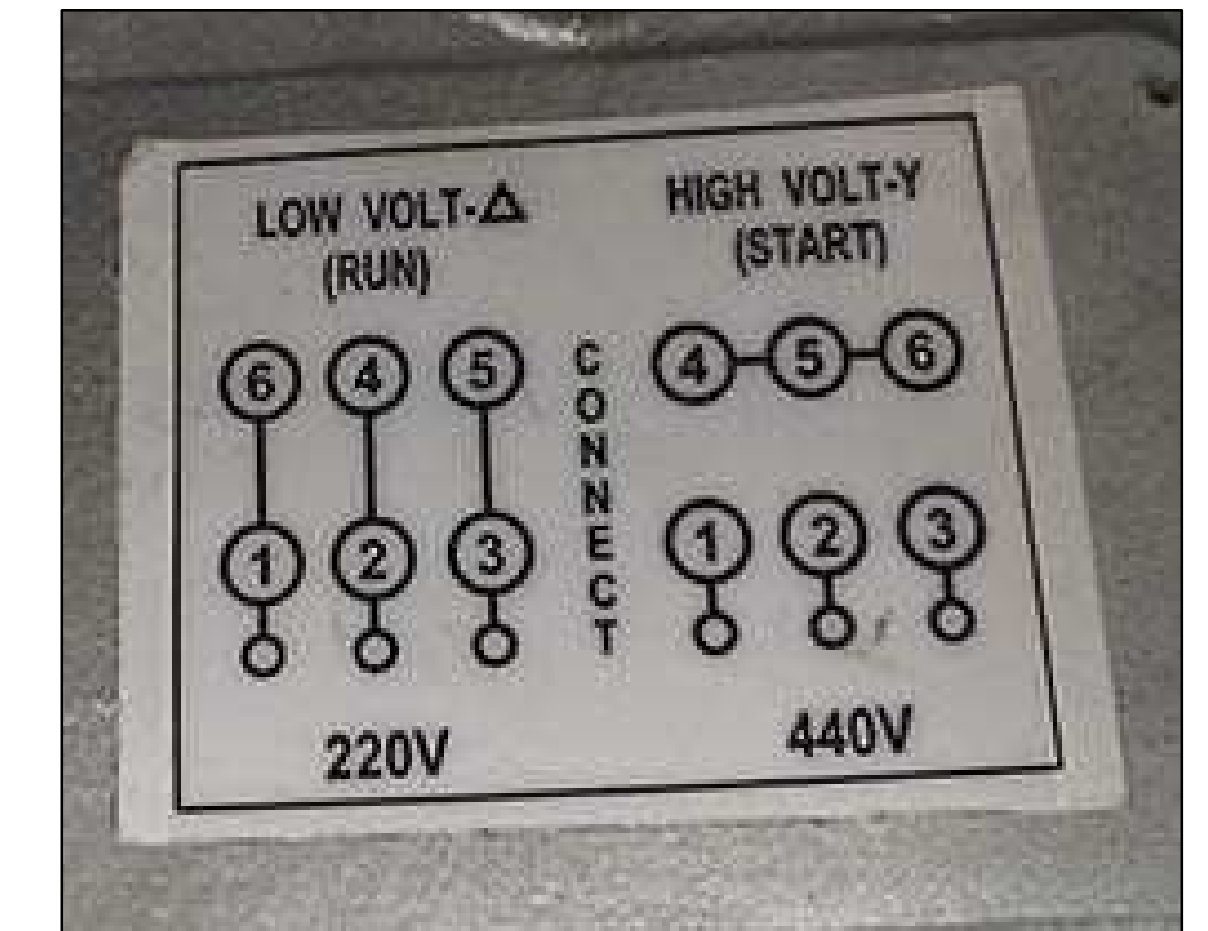
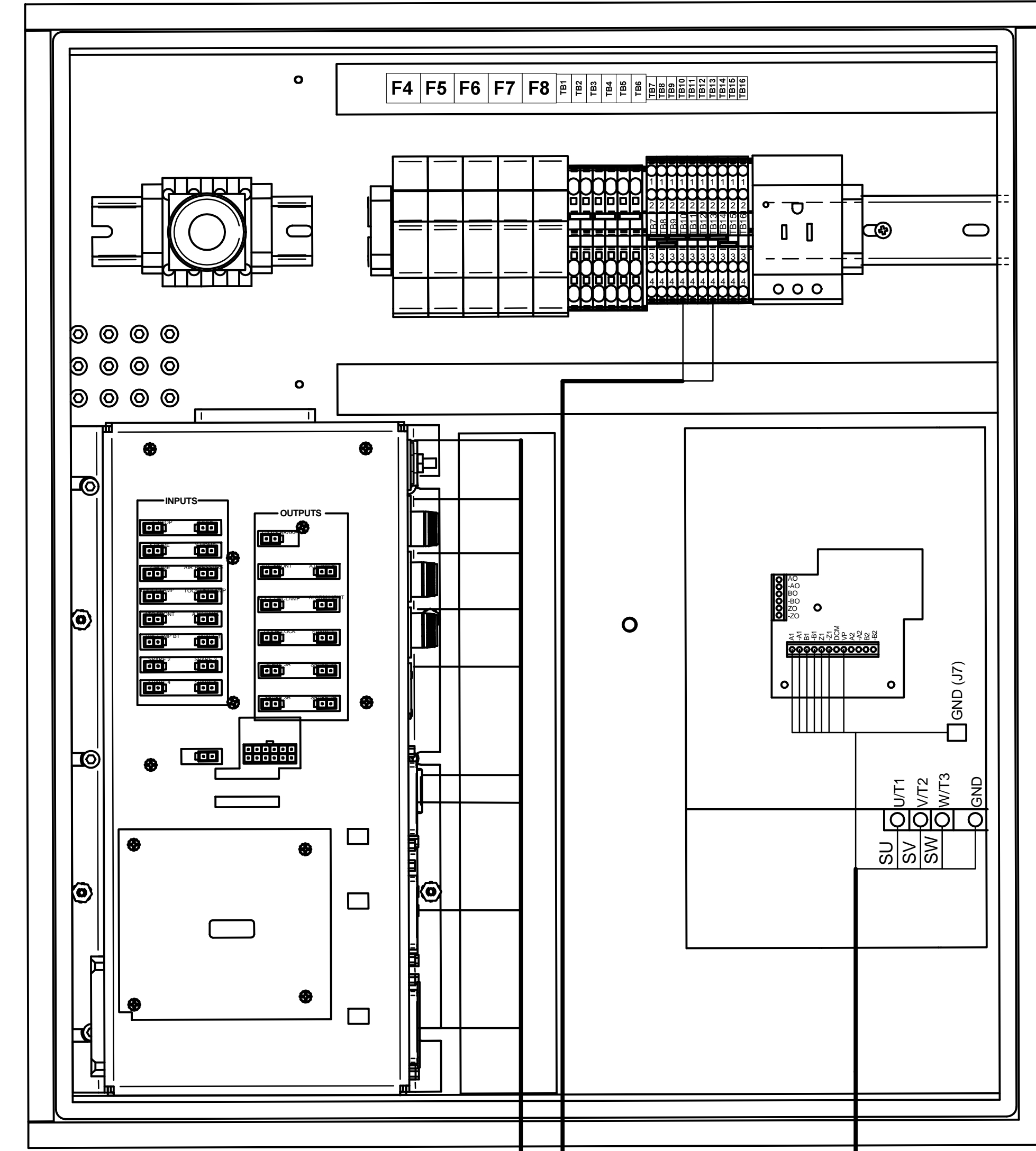
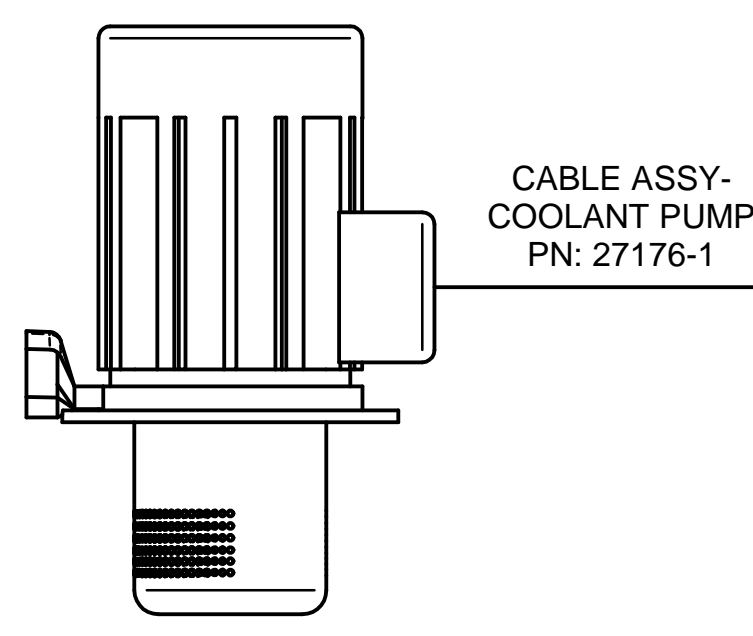
Y AXIS MOTOR  
PN: 24428-3



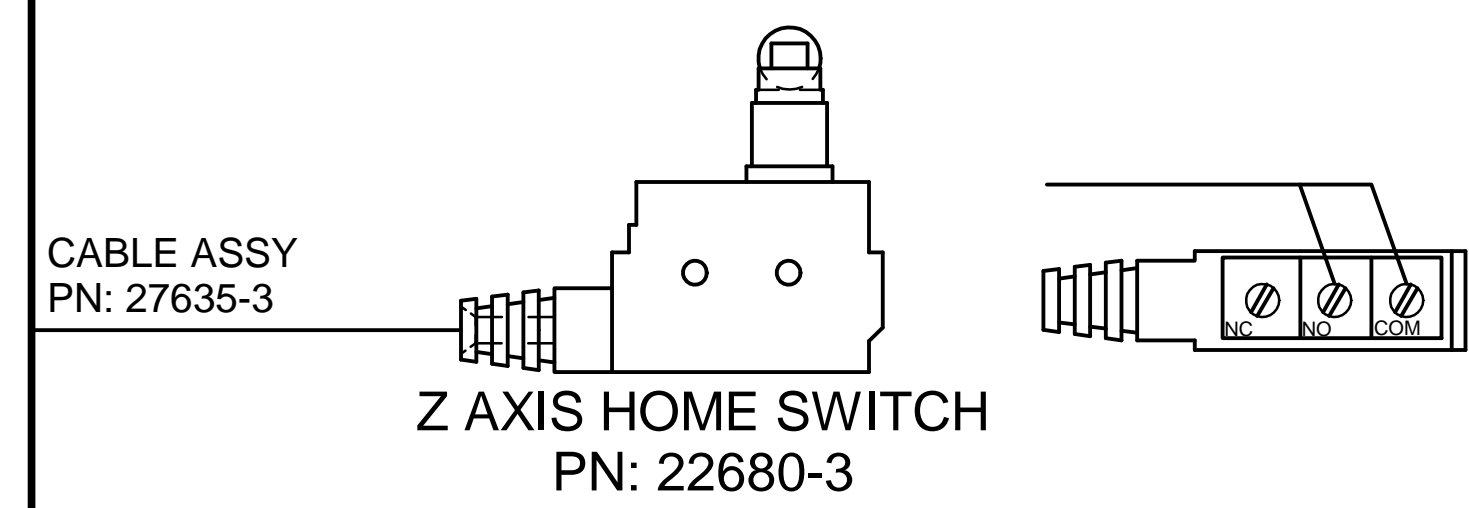
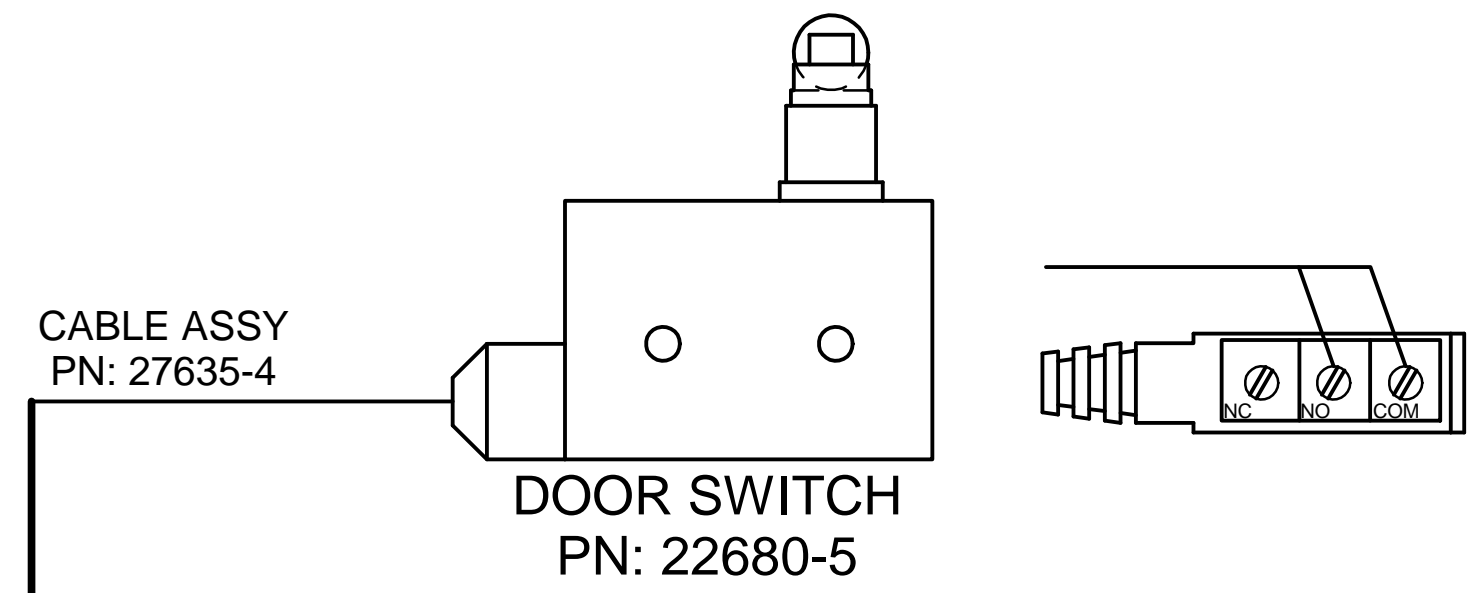
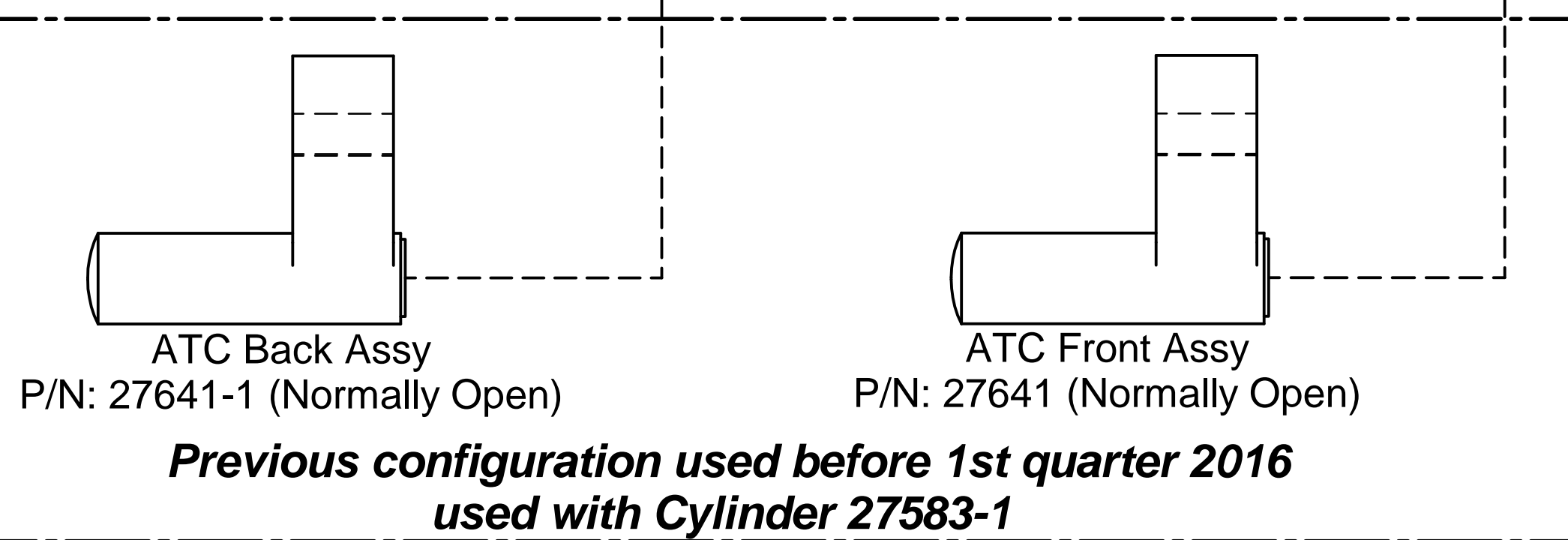
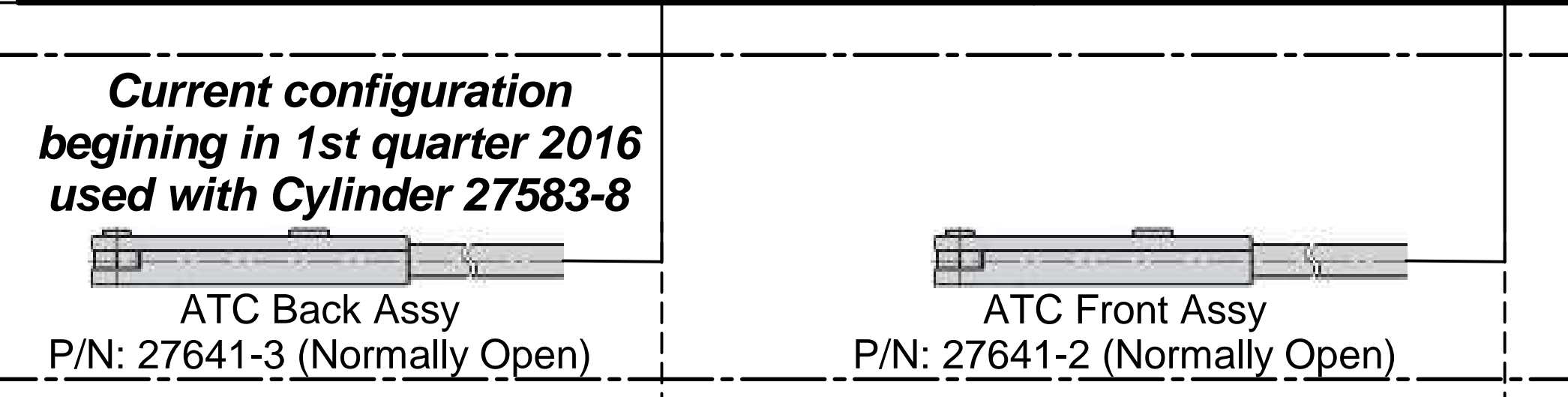
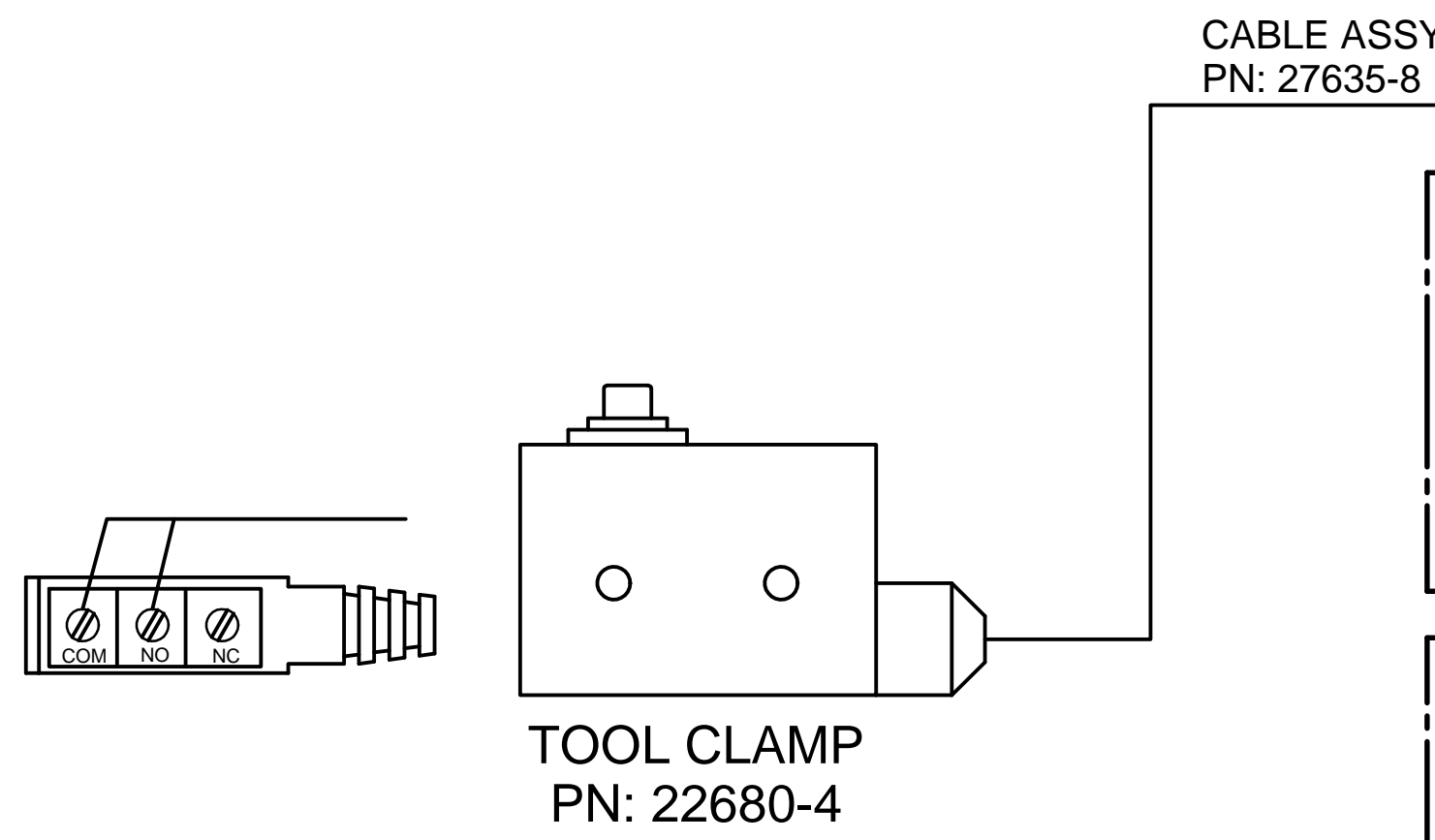
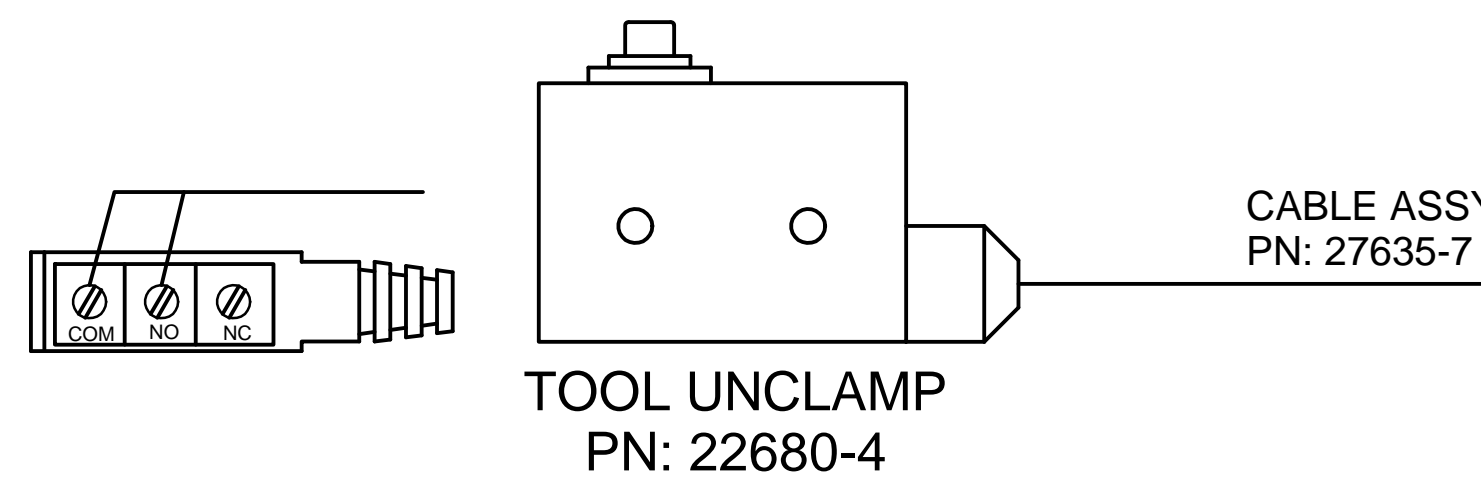
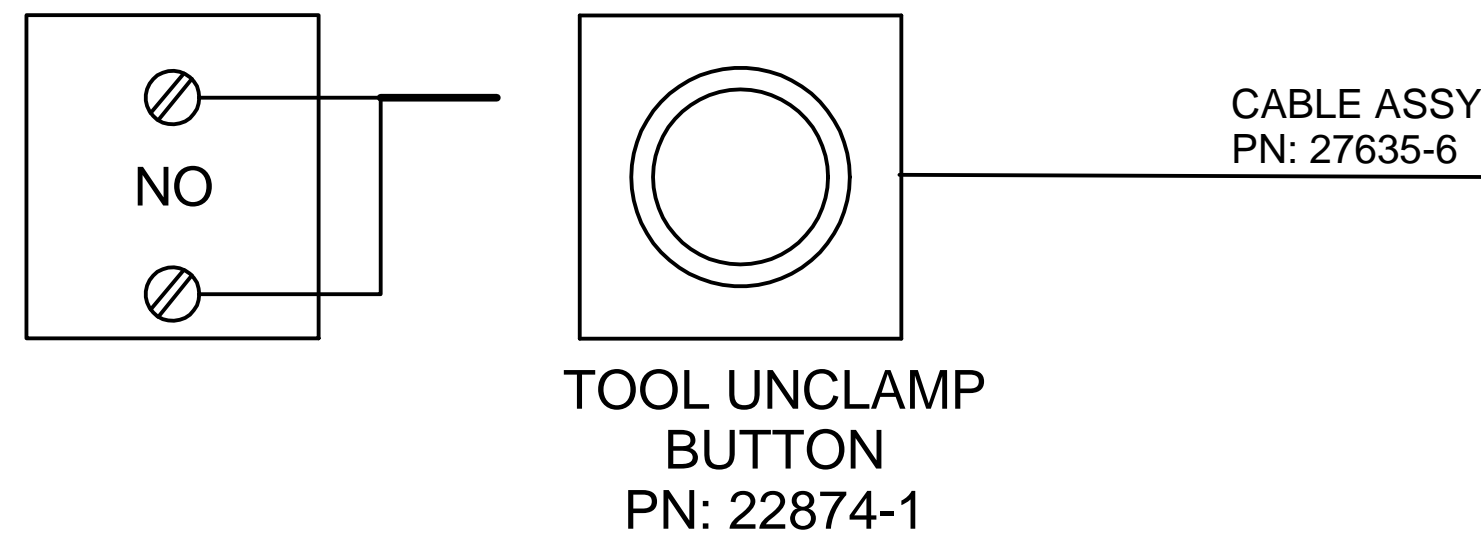
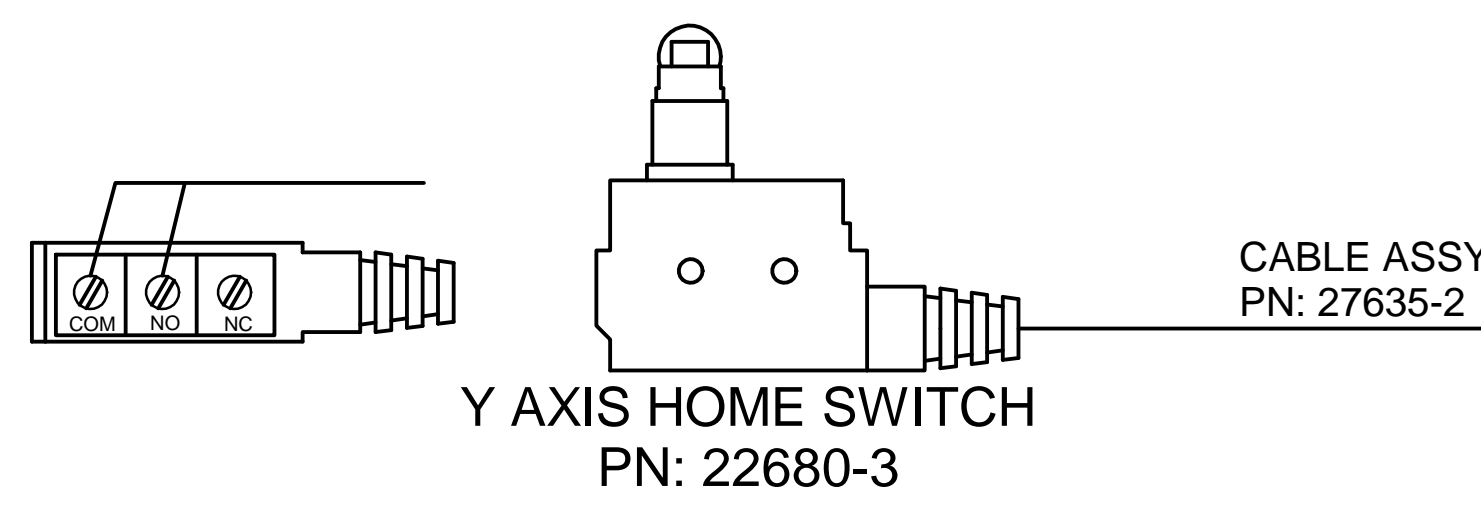
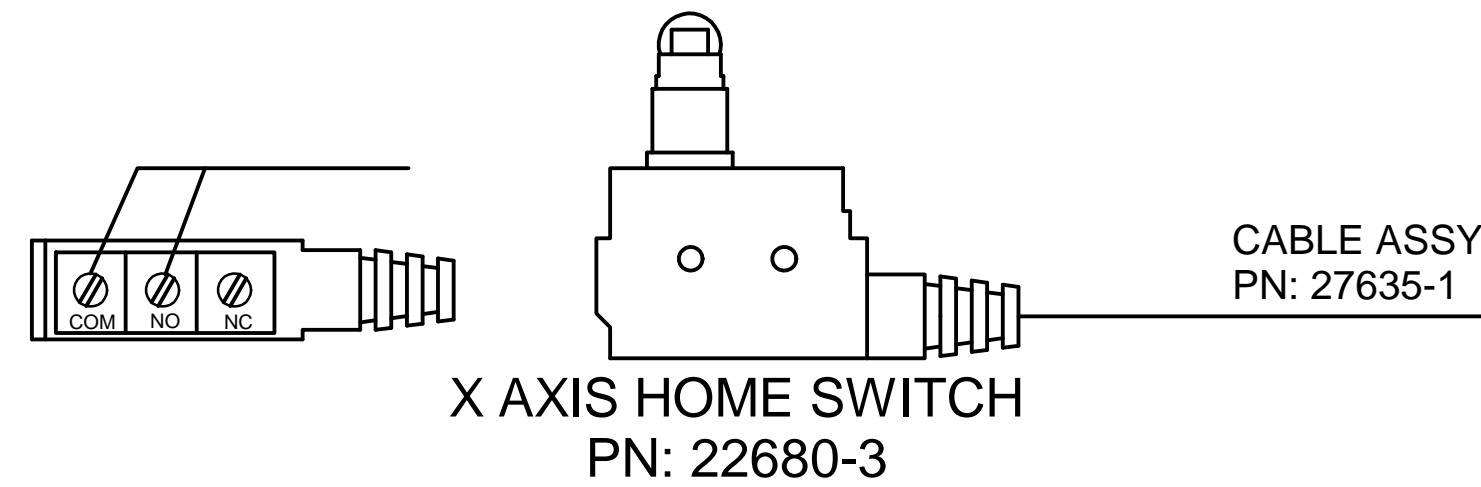
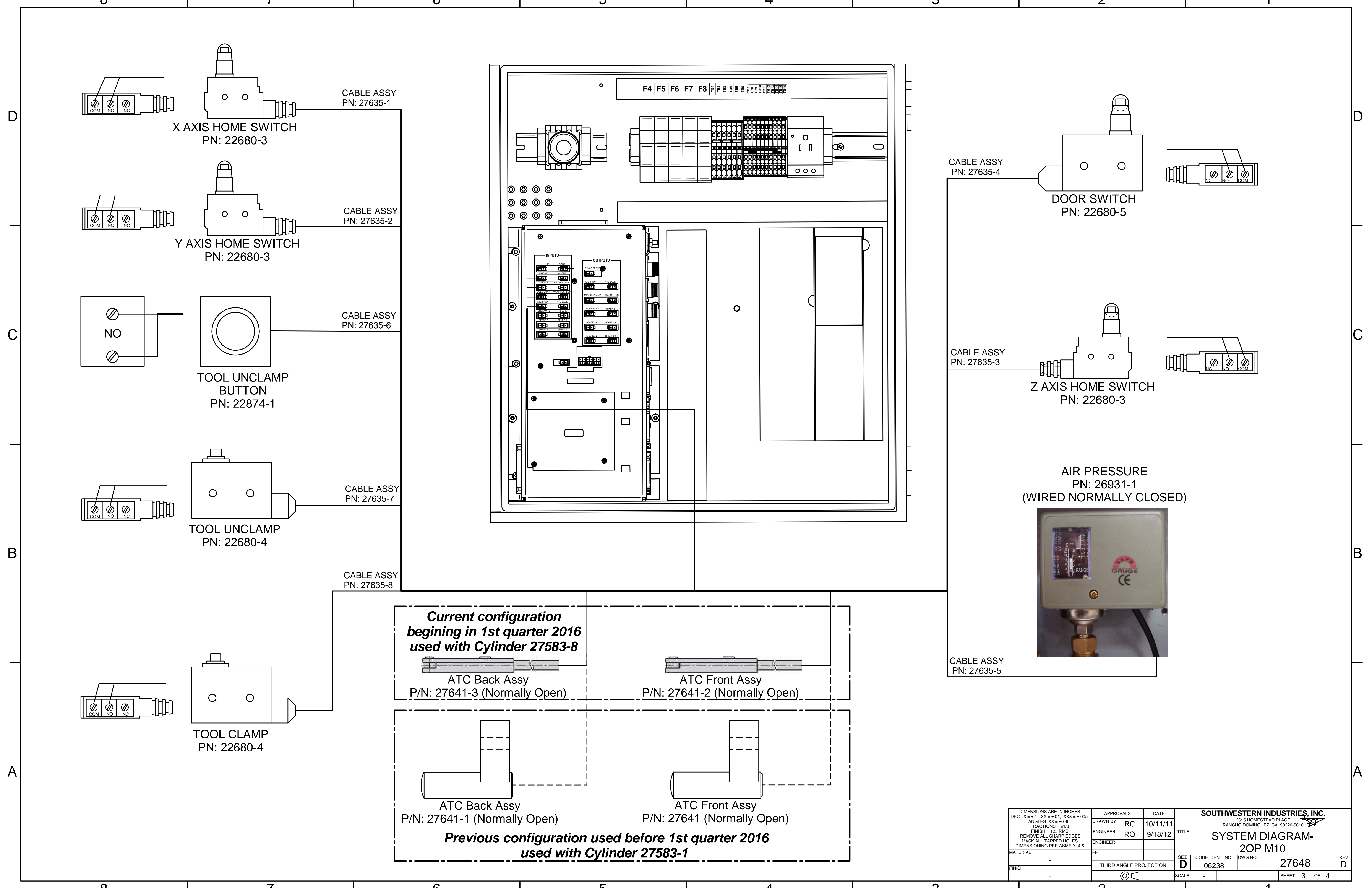
X AXIS MOTOR  
PN: 24428-2



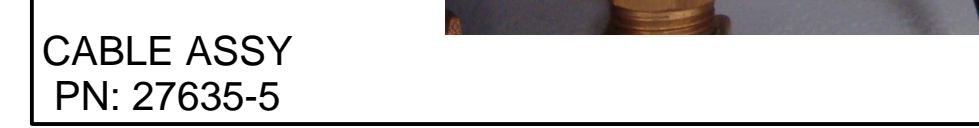
COOLANT PUMP  
PN: 27713



DIMENSIONS ARE IN INCHES DEC. X = ±.1, XX = ±.01, XXX = ±.005 ANGLES: XX = ±0°30' FRACTIONS = ±1/8 FINISH = 125 RMS REMOVE ALL SHARP EDGES MASK ALL TAPPED HOLES DIMENSIONING PER ASME Y14.5		APPROVALS	DATE	SOUTHWESTERN INDUSTRIES, INC. 2615 HOMESTEAD PLACE RANCHO DOMINGUEZ, CA 90220-5610	
DRAWN BY	RC	10/11/11	TITLE		
ENGINEER	RO	9/18/12	SYSTEM DIAGRAM- 2OP M10		
MATERIAL	FE		SIZE	CODE IDENT. NO.	DWG NO.
FINISH			D	06238	27648
THIRD ANGLE PROJECTION			SCALE:		SHEET 2 OF 4



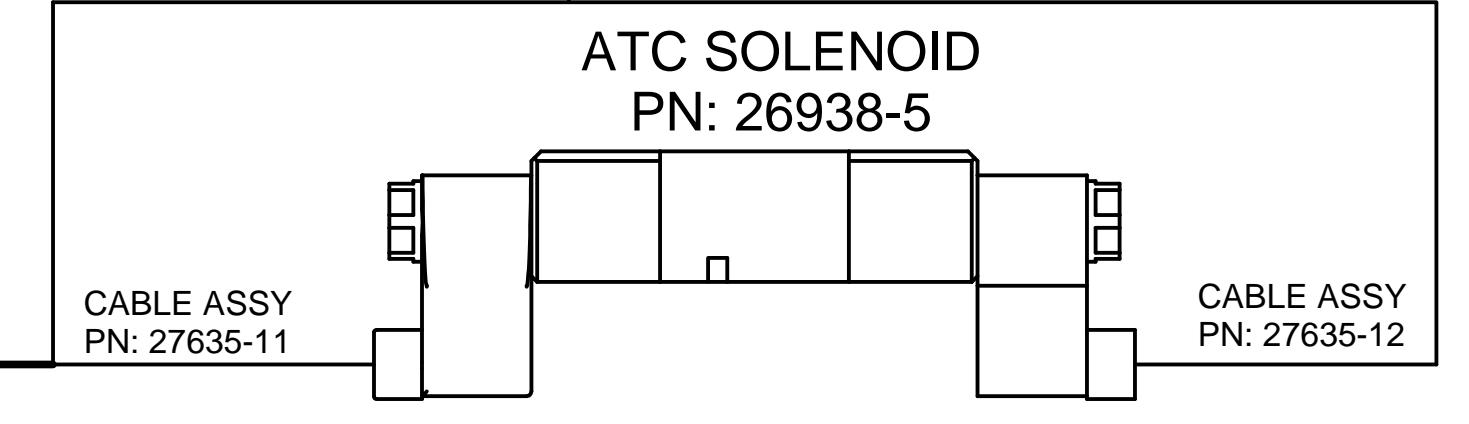
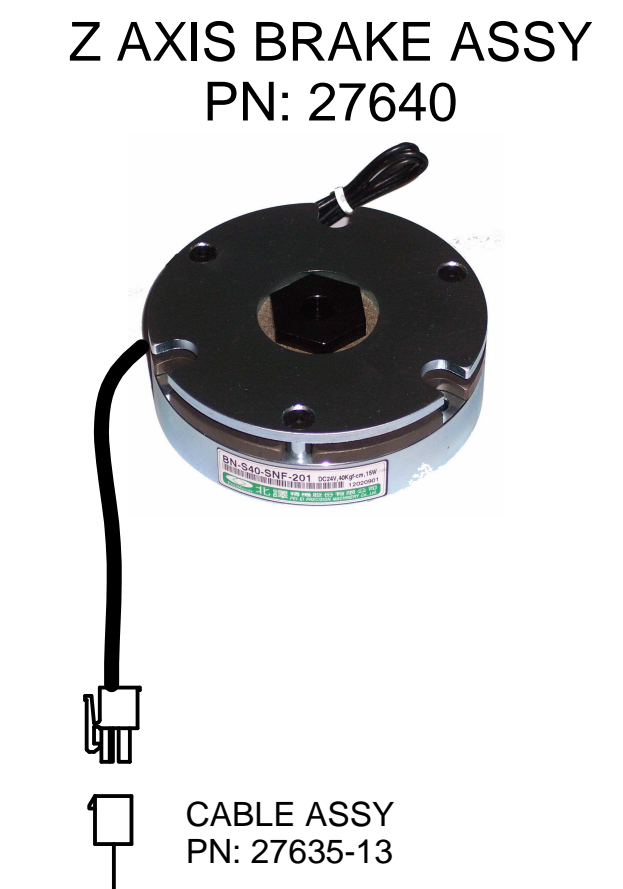
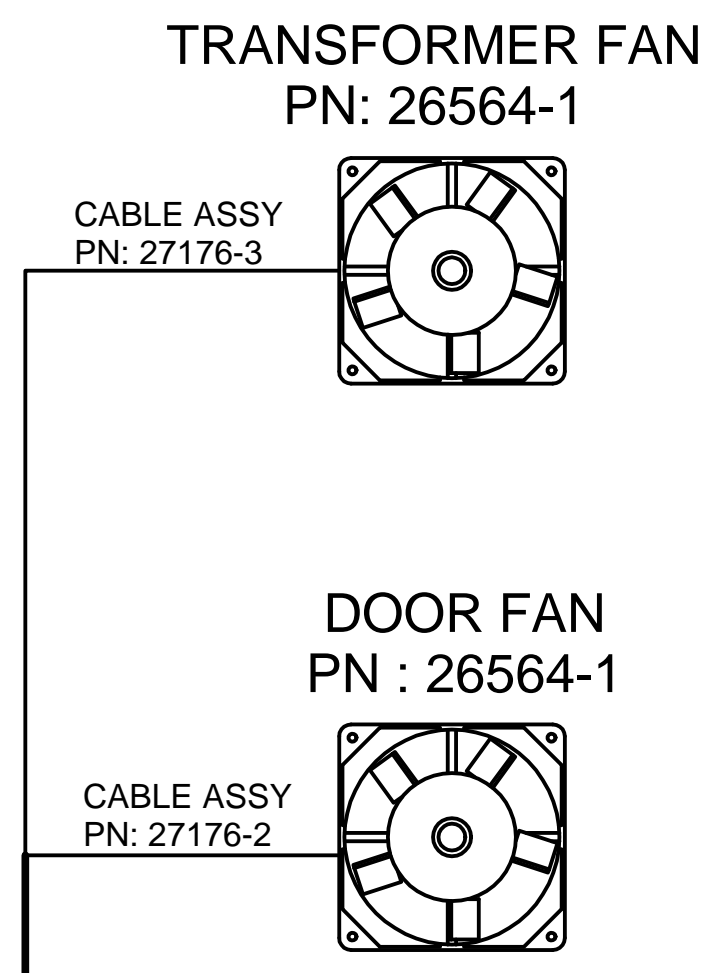
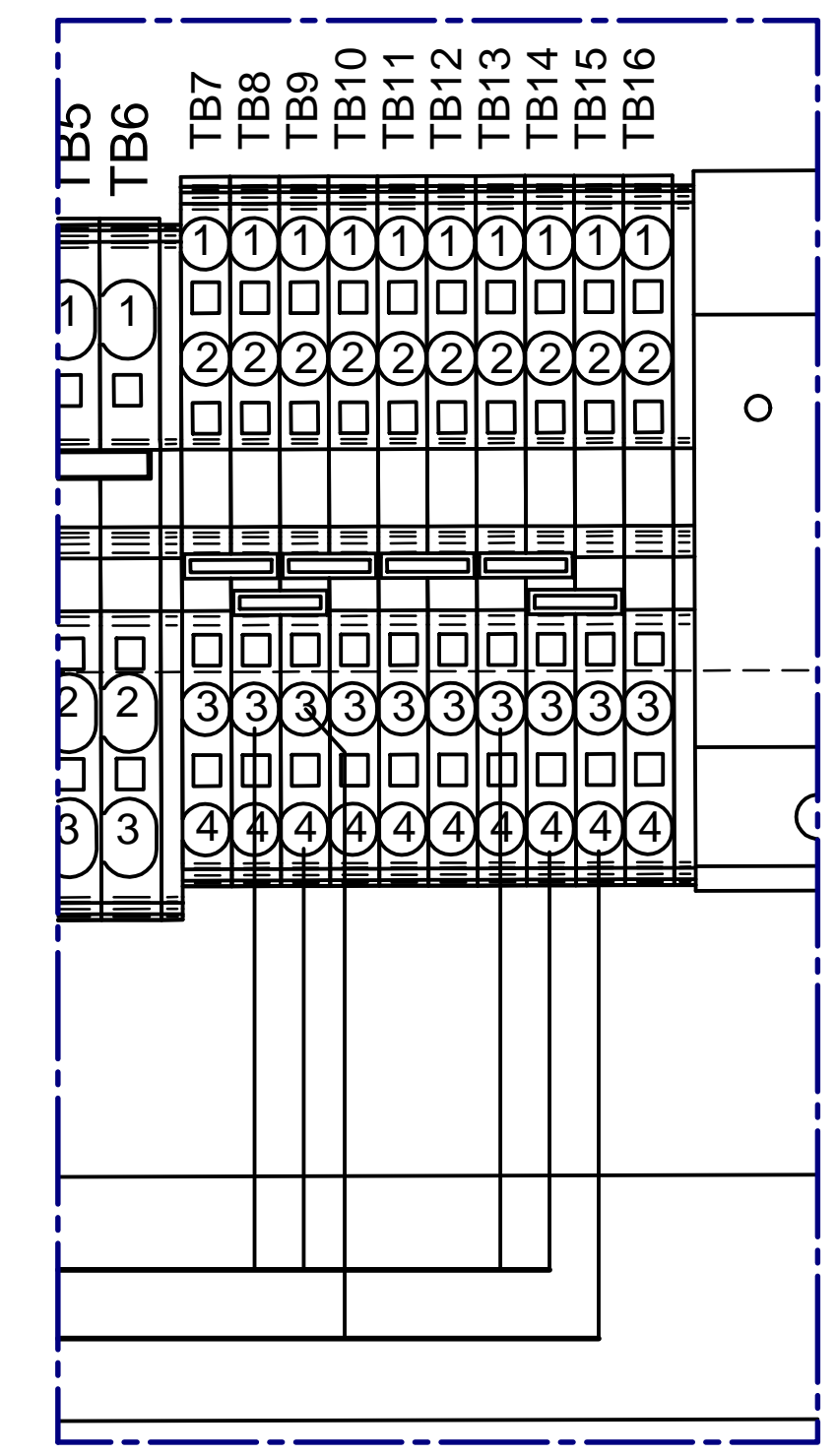
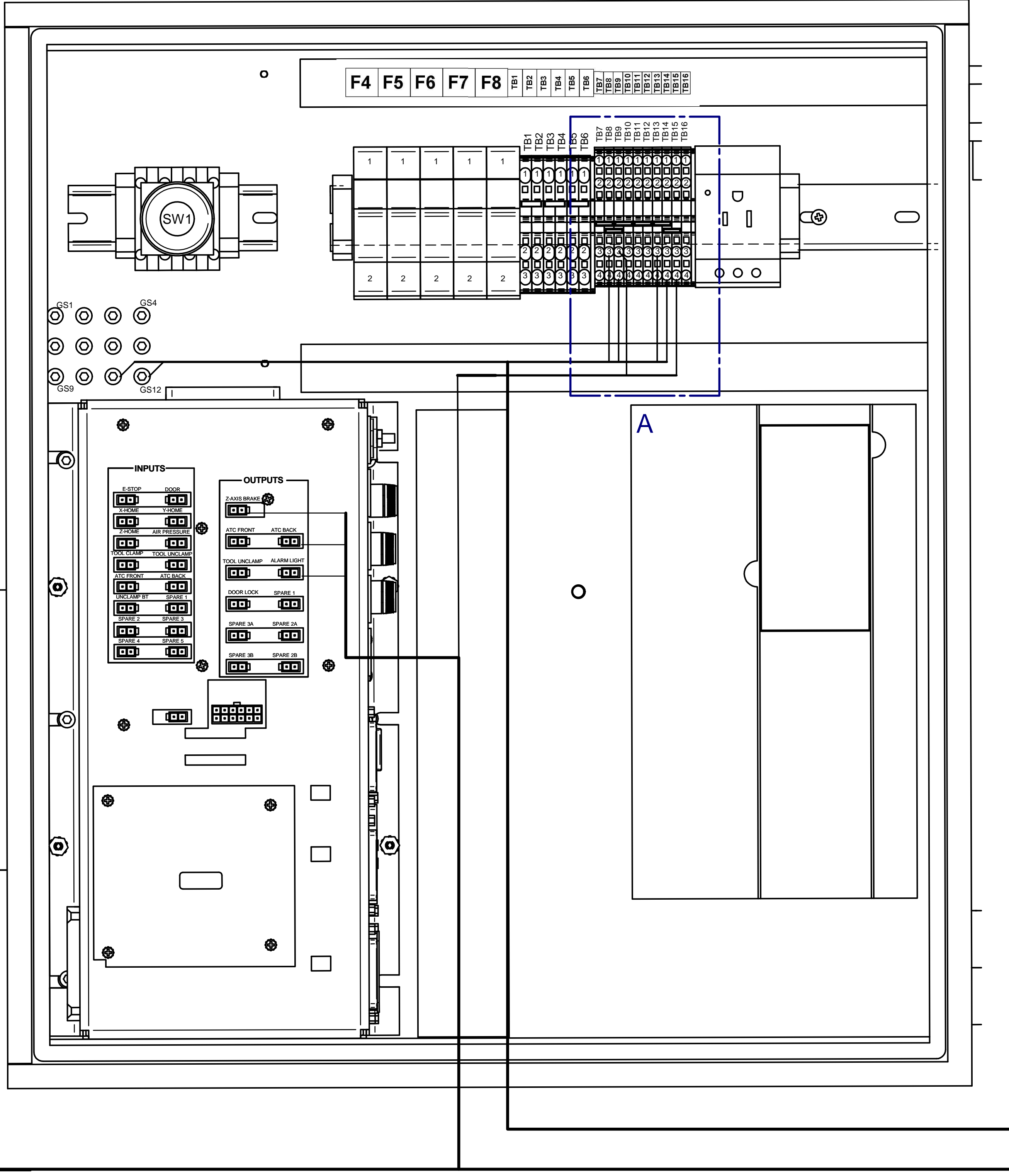
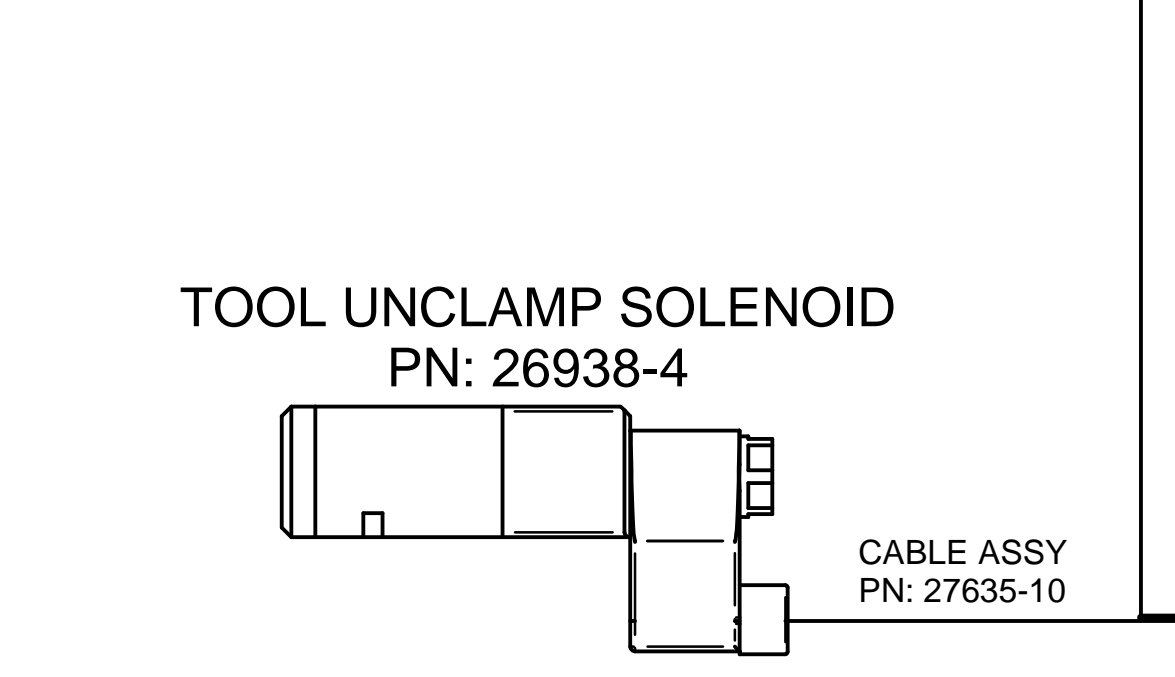
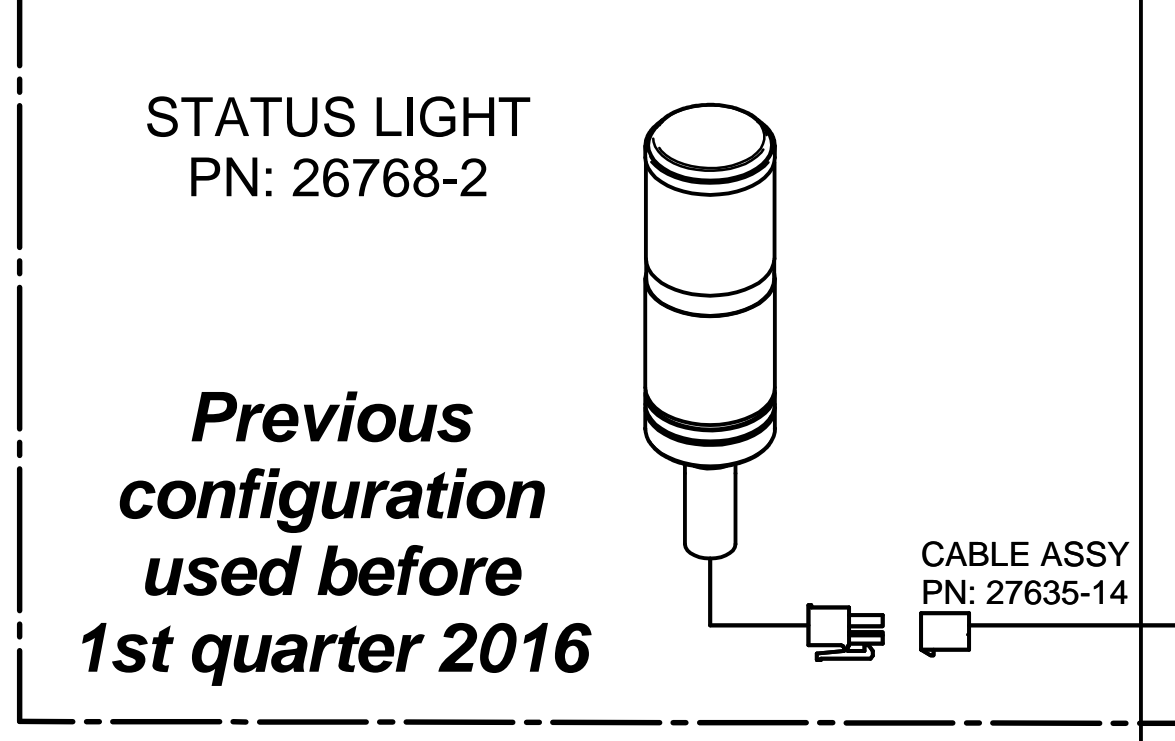
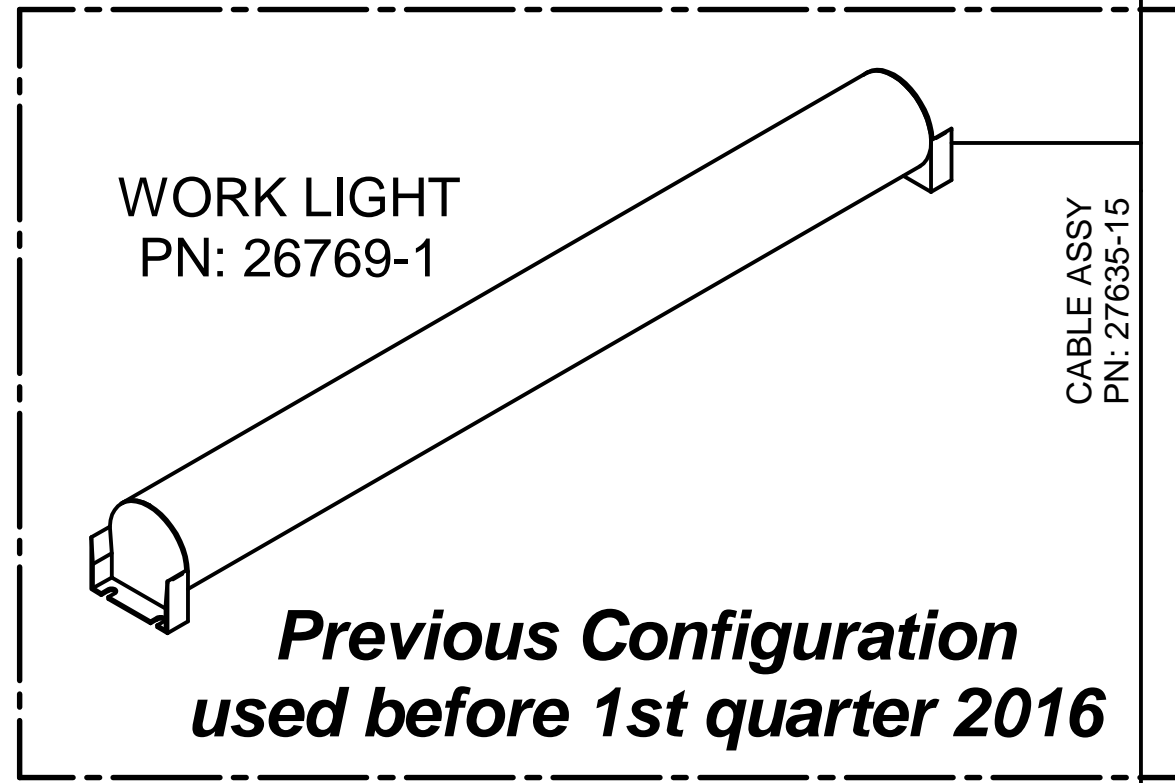
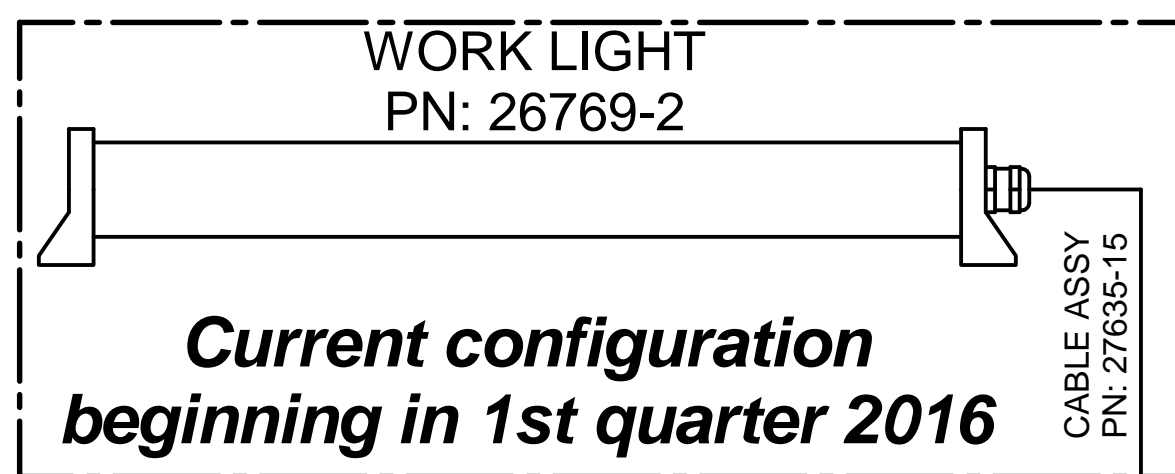
AIR PRESSURE  
PN: 26931-1  
(WIRED NORMALLY CLOSED)



DIMENSIONS ARE IN INCHES DEC. .X = ±.1, .XX = ±.01, .XXX = ±.005 ANGLES: .XX = ±0°30' FRACTIONS = ±1/8 FINISH = 125 RMS REMOVE ALL SHARP EDGES MASK ALL TAPPED HOLES DIMENSIONING PER ASME Y14.5		APPROVALS	DATE	SOUTHWESTERN INDUSTRIES, INC. 2615 HOMESTEAD PLACE RANCHO DOMINGUEZ, CA 90220-5610	
DRAWN BY	RC	10/11/11	TITLE		
ENGINEER	RO	9/18/12	SYSTEM DIAGRAM- 2OP M10		
MATERIAL	FE		SIZE	CODE IDENT. NO.	REV
FINISH			THIRD ANGLE PROJECTION	D 06238	DWG NO. 27648
			SCALE: -		SHEET 3 OF 4

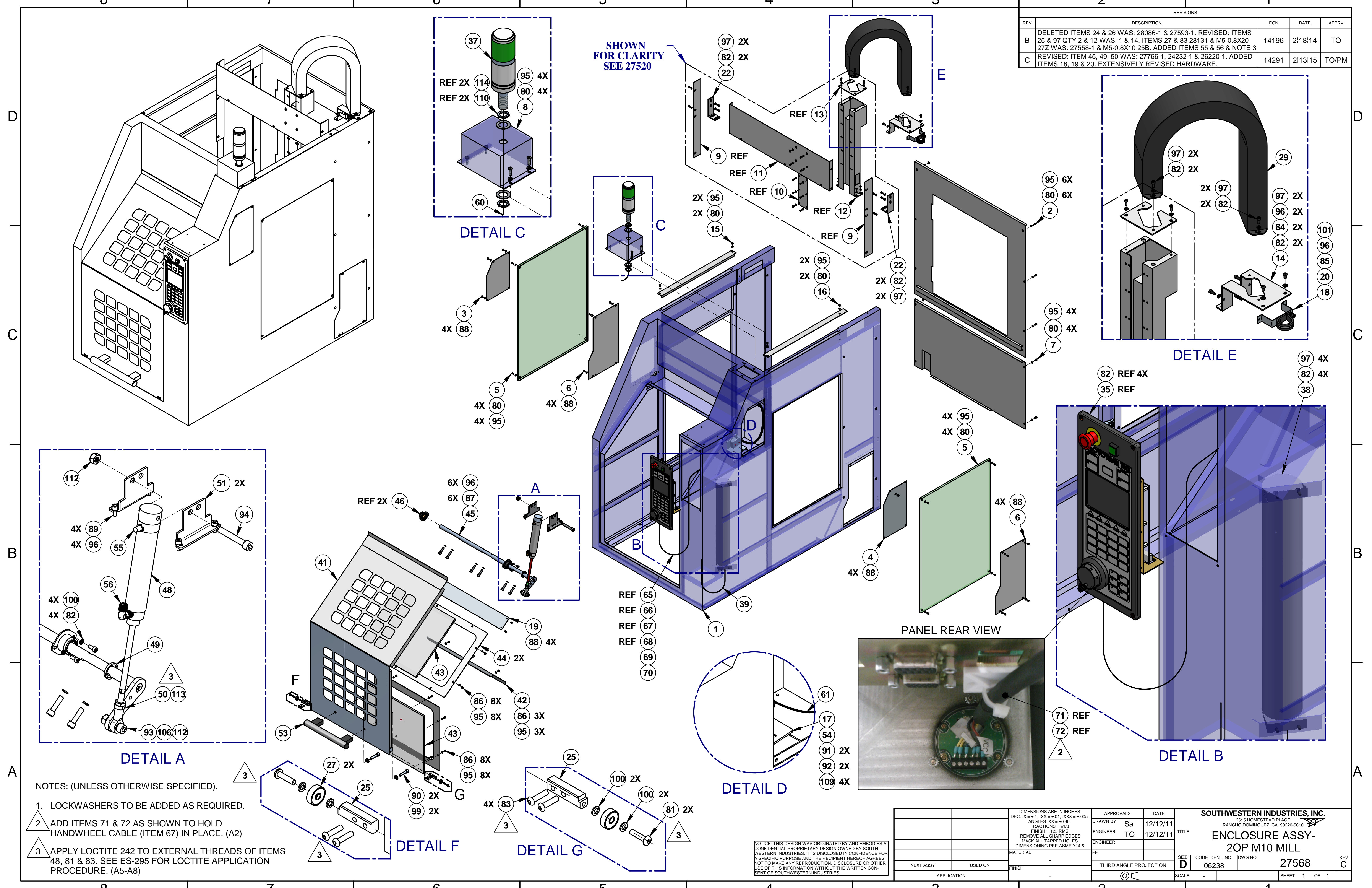


WIRE CHART					
WIRE/ CABLE	WIRE FROM	WIRE LABEL	WIRE GAGE	COLOR	WIRE TO
TRANSFORMER FAN	TB8-3	0V	0.75mm <sup>2</sup>	WHITE	FAN 1-0V
	TB13-3	115AC-2	0.75mm <sup>2</sup>	BLACK	FAN 1-115AC
	GS11	GND	0.75mm <sup>2</sup>	GREEN	GND
DOOR FAN	TB9-4	0V	0.75mm <sup>2</sup>	WHITE	FAN 2-0V
	TB14-4	115AC-2	0.75mm <sup>2</sup>	BLACK	FAN 2-115AC
	GS12	GND	0.75mm <sup>2</sup>	GREEN	GND
WORK LIGHT CABLE (WL1)	TB9-3	0V	0.75mm <sup>2</sup>	WHITE	LIGHT-0V
	TB15-4	115AC-2	0.75mm <sup>2</sup>	BLACK	LIGHT-115AC



DIMENSIONS ARE IN INCHES DEC. X = ±.1, XX = ±.01, XXX = ±.005 ANGLES: XX = ±0°30' FRACTIONS = ±1/8 FINISH = 125 RMS REMOVE ALL SHARP EDGES MASK ALL TAPPED HOLES DIMENSIONING PER ASME Y14.5		APPROVALS DRAWN BY RC ENGINEER RO ENGINEER	DATE 10/11/11 9/18/12	SOUTHWESTERN INDUSTRIES, INC. 2615 HOMESTEAD PLACE RANCHO DOMINGUEZ, CA 90220-5610
MATERIAL FINISH		TITLE SYSTEM DIAGRAM- 2OP M10		CODE IDENT. NO. 06238
THIRD ANGLE PROJECTION		SIZE D	DWG NO. 27648	REV D
SCALE: -		SHEET 4 OF 4		

REVISIONS				
REV	DESCRIPTION	ECN	DATE	APPRV
B	DELETED ITEMS 24 & 26 WAS: 28086-1 & 27593-1. REVISED: ITEMS 25 & 97 QTY 2 & 12 WAS: 1 & 14. ITEMS 27 & 83 28131 & M5-0.8X20 27Z WAS: 27558-1 & M5-0.8X10 25B. ADDED ITEMS 55 & 56 & NOTE 3	14196	2/18/14	TO
C	REVISED: ITEM 45, 49, 50 WAS: 27766-1, 24232-1 & 26220-1. ADDED ITEMS 18, 19 & 20. EXTENSIVELY REVISED HARDWARE.	14291	2/13/15	TO/PM



- NOTES: (UNLESS OTHERWISE SPECIFIED).
- 1. LOCKWASHERS TO BE ADDED AS REQUIRED.
  - 2. ADD ITEMS 71 & 72 AS SHOWN TO HOLD HANDWHEEL CABLE (ITEM 67) IN PLACE. (A2)
  - 3. APPLY LOCTITE 242 TO EXTERNAL THREADS OF ITEMS 48, 81 & 83. SEE ES-295 FOR LOCTITE APPLICATION PROCEDURE. (A5-A8)

NOTICE: THIS DESIGN WAS ORIGINATED BY AND EMBODIES A CONFIDENTIAL PROPRIETARY DESIGN OWNED BY SOUTHWESTERN INDUSTRIES. IT IS DISCLOSED IN CONFIDENCE FOR A SPECIFIC PURPOSE AND THE RECIPIENT HEREOF AGREES NOT TO MAKE ANY REPRODUCTION, DISCLOSURE OR OTHER USE OF THIS INFORMATION WITHOUT THE WRITTEN CONSENT OF SOUTHWESTERN INDUSTRIES.

DIMENSIONS ARE IN INCHES DEC. X = ±.1, .XX = ±.01, .XXX = ±.005 ANGLES: XX° = ±0.01° FRACTIONS = ±1/8 FINISH = 125 RMS REMOVE ALL SHARP EDGES MASK ALL TAPPED HOLES DIMENSIONING PER ASME Y14.5		APPROVALS	DATE	SOUTHWESTERN INDUSTRIES, INC. 2615 HOMESTEAD PLACE RANCHO DOMINGUEZ, CA 90220-5610	
DRIVEN BY	Sal	12/12/11	TITLE		
ENGINEER	TO	12/12/11	ENCLOSURE ASSY- 20P M10 MILL		
ENGINEER			SIZE	CODE IDENT. NO.	DWG NO.
FE			D	06238	27568
THIRD ANGLE PROJECTION			SCALE:	SHEET 1 OF 1	
NEXT ASSY	USED ON	FINISH	REV C		
APPLICATION					

## Parts List for Assembly P/N: 27568

Printed 2/13/2015

**27568**  
ENCLOSURE ASSY-2OP M10 MILL

Type	PL	Dwg Size	D
Revision	C	Product	2OP
Status	R	Engineer	TO
Date	5/26/2009	Planner Code	
By	Sal	Comm Code	

Item	P/N	Title	Detail	Reference(t)	Qty	UseAs	Rev	Stat	Type	Mfr	Mfr P/N
1	27603-1	ENCLOSURE-UPPER STRUCTURE	SEE 27568		1	EA	-	R	PS	KING RICH	OP420010
2	27603-2	PANEL-REAR/TOP-UPPER STRUCTURE	SEE 27568		1	EA	-	R	PS	KING RICH	OP420180
3	27603-3	PANEL-TOP/LEFT-UPPER STRUCTURE	SEE 27568		1	EA	-	R	PS	KING RICH	OP420860
4	27603-4	PANEL-TOP/RIGHT-UPPER STRUCTURE	SEE 27568		1	EA	-	R	PS	KING RICH	OP420940
5	27603-5	PANEL-CENTER-UPPER STRUCTURE	SEE 27568		2	EA	-	R	PS	KING RICH	OP420070
6	27603-6	PANEL-BOTTOM-UPPER STRUCTURE	SEE 27568		2	EA	-	R	PS	KING RICH	OP420870
7	27603-7	PANEL-REAR/BOTTOM-UPPER STRUCTURE	SEE 27568		1	EA	-	R	PS	KING RICH	OP420190
8	27603-8	COVER-CYLINDER-UPPER STRUCTURE	SEE 27568		1	EA	-	R	PS	KING RICH	OP420841
9	27603-9	SUPPORT-LEFT & RIGHT-UPPER STRUCTURE	SEE 27520		(2)	EA	-	R	PS	KING RICH	OP420500
10	27603-10	COVER-CONDUIT-MINOR-UPPER STRUCTURE	SEE 27520		(1)	EA	-	R	PS	KING RICH	OP420420
11	27603-11	COVER-CONDUIT-MAJOR-UPPER STRUCTURE	SEE 27520		(1)	EA	-	R	PS	KING RICH	OP420410
12	27603-12	CONDUIT-UPPER STRUCTURE	SEE 27520		(1)	EA	-	R	PS	KING RICH	OP420430
13	27603-13	COVER-CONDUIT-UPPER STRUCTURE	SEE 27520		(1)	EA	-	R	PS	KING RICH	OP420460
14	27603-14	BRACKET-MTG-CABLE CARRIER-UPR STRUCT	SEE 27520		1	EA	-	R	PS	KING RICH	OP420520
15	27603-15	COVER-TOP-LEFT-UPPER STRUCTURE	SEE 27568		1	EA	-	R	PS	KING RICH	OP420141
16	27603-16	COVER-TOP-RIGHT-UPPER STRUCTURE	SEE 27568		1	EA	-	R	PS	KING RICH	OP420131
17	27603-24	BRACKET-L-DOOR SWITCH	SEE 27568		1	EA	-	R	PS	KING RICH	OP420700

Item	P/N	Title	Detail	Reference(t)	Qty	UseAs	Rev	Stat	Type	Mfr	Mfr P/N
18	27603-30	BRACKET-MTG-SERVO CABLES-UPR STRUCT	SEE 27568-1		1	EA	A	R	PS	KING RICH	OP420520-A
19	27603-22	BRACE-DOOR ASSY-UPPER REAR	SEE 27568-1		1	EA	A	R	PS	KING RICH	
20	22636-3	CLAMP-CABLE-1 1/4-RUBBER STEEL LOOP			1	EA	A	R	DWG		
22	27682-8	BRACKET-L-LEFT & RIGHT			2	EA	-	R	PS	KING RICH	OP420161
25	28086	BLOCK-MOUNTING-DOOR-2OP			2	EA	A	R	DWG		
27	28131	BEARING-DEEP GROOVE-635-2RS1			2	EA	-	R	DWG		
29	26891-5	CARRIER-CABLE-Z AXIS			1	EA	-	R	PS	KING RICH	A-85-184
35	27604	PANEL ASSY-2OP M10 MILL			(1)	EA	D	R	PL		
37	26768-2	STATUS LIGHT ASSY-2OP	REPL BULB W/ 26768-BULB		1	EA	A	R	PL	KING RICH	A-81-035-1
38	26769-1	WORK LIGHT 115VAC	REPL LIGHT W/ 26769-1-BULB		1	EA	A	R	DWG		
39	27635-15	CABLE ASSY-WORK LIGHT EXTENSION	DC300-116		1	EA	-	R	PL		
41	27606	DOOR-UPPER & LOWER	SEE 27568		1	EA	-	R	PS	KING RICH	OP420050 & OP420060
42	27603-26	COVER-SHEET METAL-DOOR-2OP	SEE 27568		1	EA	-	R	PS	KING RICH	OP420990
43	24404-3	LEXAN WINDOW-DOOR-2OP			2	EA	-	R	PS	KING RICH	A-82-019
44	27560	FRAME-LEXAN-WINDOW			2	EA	-	R	PS	KING RICH	OP420120
45	27897	WELDMENT-DOOR SHAFT AND LEVER ARM			1	EA	A	R	PL		
46	27688	BEARING-BRONZE-SELF ALIGNING-18mm	FLANGE-MOUNT		(2)	EA	-	R	PS	SPYRAFLO	BFM-18M-B
48	27583-6	CYLINDER-AIR-40mm BORE 125mm STROKE			1	EA	-	R	DWG		
49	27897-1	SPACER-DOOR SHAFT WELDMENT			1	EA	A	R	DWG		
50	27583-2	ROD END-BALL JOINT-10MM ID	SEE 27540 OR 27540-1		1	EA	-	R	PS		
51	27682-9	BRACKET-L-CYLINDER ASSY			2	EA	-	R	PS	KING RICH	OP420010
53	27937-1	HANDLE-DOOR-2OP			1	EA	-	R	PS	KING RICH	A-141-018

Item	P/N	Title	Detail	Reference(t)	Qty	UseAs	Rev	Stat	Type	Mfr	Mfr P/N
54	22680-5	SWITCH-LIMIT-ROLLER PLUNGER			1	EA	-	R	PS	KING RICH	A-432-013
55	27574	MUFFLER-1/4 BSPT			1	EA	-	R	PS	KING RICH	A-316-136
56	26952-3	FITTING-AIR-90°-1/4 BSPTx1/4 HYDR M/M	SEE 27563		1	EA	-	R	PS	KING RICH	A-316-012
60	27635-14	CABLE ASSY-STATUS LIGHT	DC300-115		1	EA	-	R	PL		
61	27635-4	CABLE ASSY-DOOR SWITCH	DC300-117		1	EA	-	R	PL		
65	26511-120	CABLE ASSY- VGA-10FT			(1)	EA	-	R	DWG		
66	26513	CABLE ASSY-OVERLAY POWER			(1)	EA	B	R	PL		
67	26515-1	CABLE ASSY-HANDWHEEL			(1)	EA	A	R	PL		
68	25700-120	CABLE ASSY-DB9 SHIELDED MALE/FEMALE 120"			(1)	EA	-	R	DWG		
69	27635-9	CABLE ASSY-E STOP	DC300-114		1	EA	-	R	PL		
70	27635-16	CABLE ASSY-SERVO ON BUTTON	DC300-124		1	EA	A	R	PL		
71	23262-2	CABLE TIE HOLDER	0.75 x 0.75 x 0.188		(1)	EA	A	R	DWG		
72	22475	TIE WRAP-4 IN-PLASTIC			(1)	EA	-	R	DWG		
80	M5-0.8X10 27Z	SCREW-BHCS-STL-ZINC	NON STOCKABLE		26	EA	-	R	PS		
81	M5-0.8X20 27B	SCREW-BHCS-STL-BO	NON STOCKABLE		2	EA	-	R	PS		
82	M5-0.8X12 25B	SCREW-SHCS-STL-BO			22	EA	-	R	PS		
83	M6-1.0X20 27Z	SCREW-BHCS-STL-ZINC	NON-STOCKABLE		4	EA	-	R	PS		
84	M6-1.0X10 27B	SCREW-BHCS-STL-BO			2	EA	-	R	PS		
85	M6-1.0X10 25B	SCREW-SHCS-STL-BO			1	EA		R	PS		
86	M5-0.8X8 27B	SCREW-BHCS-STL-BO			19	EA	-	R	PS		
87	M6-1.0X20 25B	SCREW-SHCS-STL-BO			6	EA		R	PS		

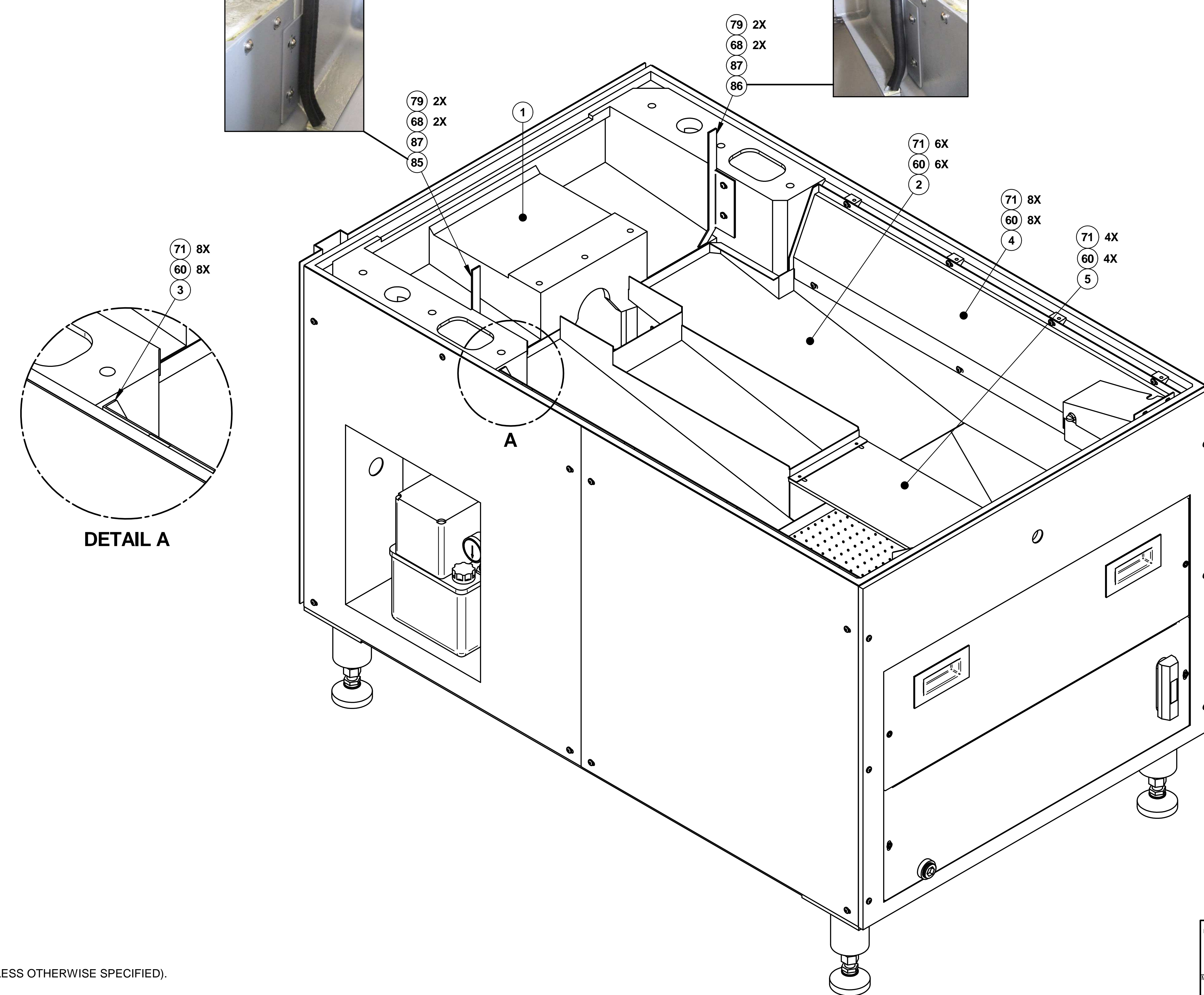
Item	P/N	Title	Detail	Reference(t)	Qty	UseAs	Rev	Stat	Type	Mfr	Mfr P/N
88	M4-0.7X8 27Z	SCREW-BHCS-STL-ZINC	NON-STOCKABLE		20	EA	-	R	PS		
89	M6-1.0X15 25B	SCREW-SHCS-STL-BO			4	EA		R	PS		
90	M10-1.5X45 25B	SCREW-SHCS-STL-BO			2	EA		R	PS		
91	M3-0.5X10 25B	SCREW-SHCS-STL-BO			2	EA	-	R	PS		
92	M3-0.5X20 25B	SCREW-SHCS-STL-BO			2	EA	-	R	PS		
93	M10-1.5X40 25B	SCREW-SHCS-STL-BO			1	EA		R	PS		
94	M10-1.5X65 25B	SCREW-SHCS-STL-BO			1	EA		R	PS		
95	M5 78Z	WASHER-FLAT-DIN 125-ZINC	NON-STOCKABLE		45	EA	-	R	PS		
96	M6 78B	WASHER-FLAT-DIN 125-BO	NON-STOCKABLE		13	EA		R	PS		
97	M5 78B	WASHER-FLAT-DIN 125-BO	NON-STOCKABLE		14	EA		R	PS		
99	M10 78B	WASHER-FLAT-DIN 125-BO	NON-STOCKABLE		2	EA		R	PS		
100	M5 73B	WASHER-SPLIT LOCK-STL-BO			8	EA	-	R	PS		
101	M6 73B	WASHER-SPLIT LOCK-STL-BO			1	EA	-	R	PS		
106	M10 73B	WASHER-SPLIT LOCK-STL-BO			1	EA	-	R	PS		
109	M3 73B	WASHER-SPLIT LOCK-STL-BO	NON STOCKABLE		4	EA	-	R	PS		
110	M22 73Z	WASHER-SPLIT LOCK-STL-ZINC	NON STOCKABLE		(2)	EA	-	R	PS		
112	M10 56Z	NUT-NYLON LOCK-STL-ZINC	NON STOCKABLE		2	EA	-	R	PS		
113	M10-1.5 51Z	NUT-HEX JAM-STL-ZINC	NON STOCKABLE		1	EA	-	R	PS		
114	M22-2.5 51Z	NUT-HEX-STL-ZINC	NON STOCKABLE		(2)	EA	-	R	PS		

NOTICE: THIS DESIGN WAS ORIGINATED BY AND EMBODIES A CONFIDENTIAL PROPRIETARY DESIGN OWNED BY SOUTHWESTERN INDUSTRIES. IT IS DISCLOSED IN CONFIDENCE FOR A SPECIFIC PURPOSE AND THE RECIPIENT HEREOF AGREES NOT TO MAKE ANY REPRODUCTION, DISCLOSURE OR OTHER USE OF THIS INFORMATION WITHOUT THE WRITTEN CONSENT OF SOUTHWESTERN INDUSTRIES.

REVISIONS				
REV	DESCRIPTION	ECN	DATE	APPRV
-	ORIGINAL RELEASE	13915	04/27/12	TO
A	ADDED ITEMS: 22, 27, 30, 34-36, 55-59. ITEM 47 QTY 2 WAS: 1	14196	2/18/14	TO
B	ADDED ITEMS: 68, 79, 85, 86, 87.	14523	6.3.16	TO

D  
C  
B  
A

D  
C  
B  
A



DETAIL A

NOTES: (UNLESS OTHERWISE SPECIFIED).

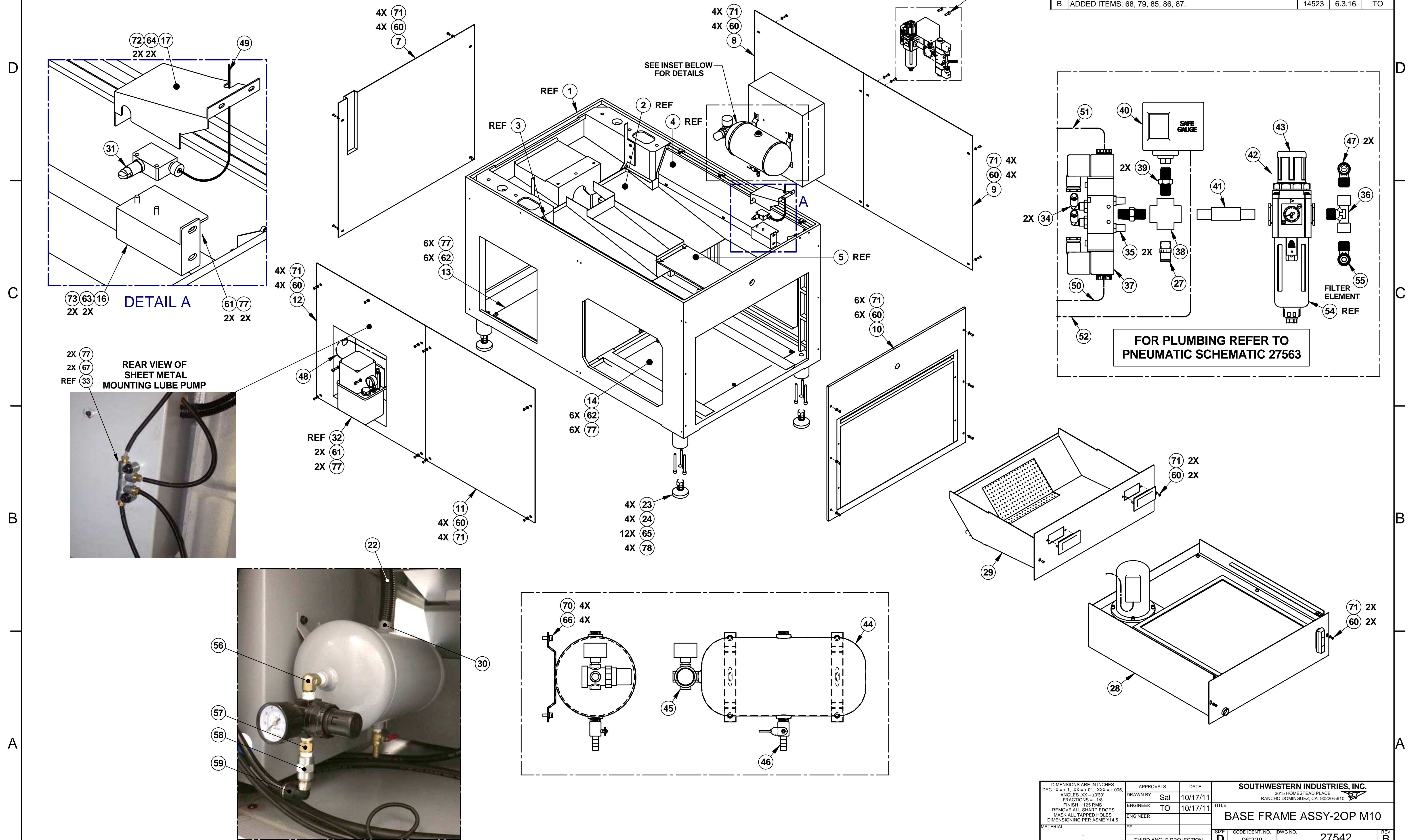
SEE SEPARATE 'A' SIZED SHEET FOR PARTS LIST

<small>DIMENSIONS ARE IN INCHES DEC. .X = ±.1, .XX = ±.01, .XXX = ±.005 ANGLES .XX = ±0°00' FRACTIONS = ±1/8 FINISH = 125 RMS REMOVE ALL SHARP EDGES MASK ALL TAPPED HOLES DIMENSIONING PER ASME Y14.5</small>		<small>APPROVALS</small> DRAWN BY: Sal ENGINEER: TO ENGINEER:		<small>DATE</small> 10/17/11 10/17/11		<b>SOUTHWESTERN INDUSTRIES, INC.</b> <small>2615 HOMESTEAD PLACE RANCHO DOMINGUEZ, CA 90220-5610</small>									
<small>MATERIAL</small> -			<small>FINISH</small> -			<small>THIRD ANGLE PROJECTION</small> 		<small>SIZE</small> D		<small>CODE IDENT. NO.</small> 06238		<small>DWG NO.</small> 27542		<small>REV</small> B	
<small>SCALE: -</small>						<small>SHEET 1 OF 2</small>									

8 7 6 5 4 3 2 1

NOTICE: THIS DESIGN WAS ORIGINATED BY AND EMBODIES A CONFIDENTIAL PROPRIETARY DESIGN OWNED BY SOUTHWESTERN INDUSTRIES. IT IS DISCLOSED IN CONFIDENCE FOR A SPECIFIC PURPOSE AND THE RECIPIENT HEREOF AGREES NOT TO MAKE ANY REPRODUCTION, DISCLOSURE OR OTHER USE OF THIS INFORMATION WITHOUT THE WRITTEN CONSENT OF SOUTHWESTERN INDUSTRIES.

REVISIONS				
REV	DESCRIPTION	ECN	DATE	APPRV
-	ORIGINAL RELEASE	13915	04/27/12	TO
A	ADDED ITEMS: 22, 27, 30, 34-36, 55-59. ITEM 47 QTY 2 WAS: 1	14196	2/18/14	TO
B	ADDED ITEMS: 68, 79, 85, 86, 87.	14523	6.3.16	TO



DIMENSIONS ARE IN INCHES DEC. X = ±.1, XX = ±.01, XXX = ±.005 ANGLES: XX = ±0°01' FRACTIONS = ±1/8 FINISH = 125 RMS REMOVE ALL SHARP EDGES MASK ALL TAPPED HOLES DIMENSIONING PER ASME Y14.5		APPROVALS	DATE	SOUTHWESTERN INDUSTRIES, INC. 2615 HOMESTEAD PLACE RANCHO DOMINGUEZ, CA 90220-5610	
DRAWN BY	Sal	10/17/11	TITLE		
ENGINEER	TO	10/17/11	BASE FRAME ASSY-2OP M10		
MATERIAL	FE		SIZE	CODE IDENT. NO.	DWG NO.
FINISH			THIRD ANGLE PROJECTION	D	06238
			SCALE:		27542
					REV B
					SHEET 2 OF 2



Parts List for Assembly P/N: 27542

Printed 6/7/2016

**27542**  
 BASE FRAME ASSY-2OP M10

Type	PL	Dwg Size	D
Revision	B	Product	2 OP MILL
Status	R	Engineer	TO
Date	5/1/2009	Planner Code	
By	Sal	Comm Code	

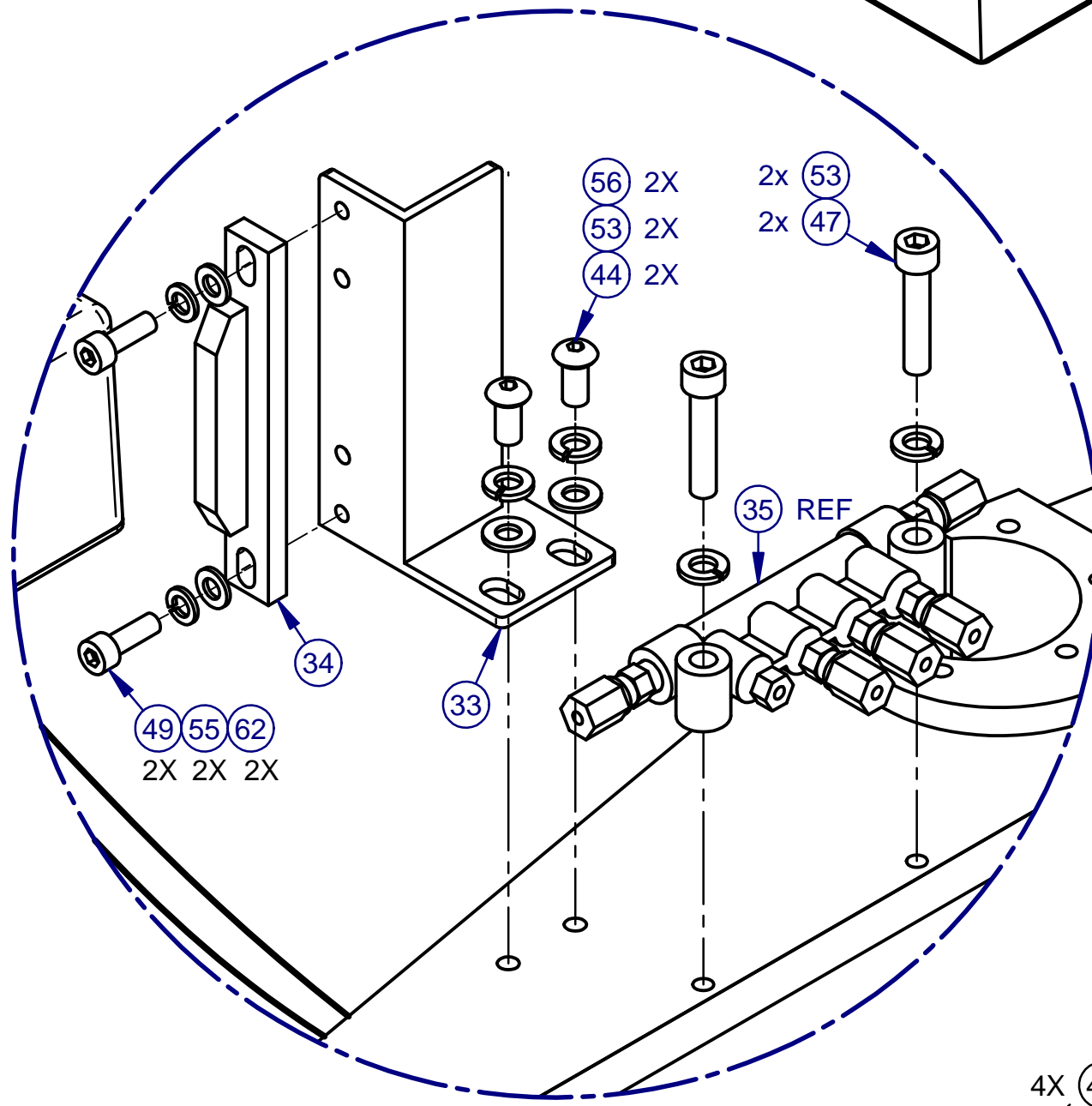
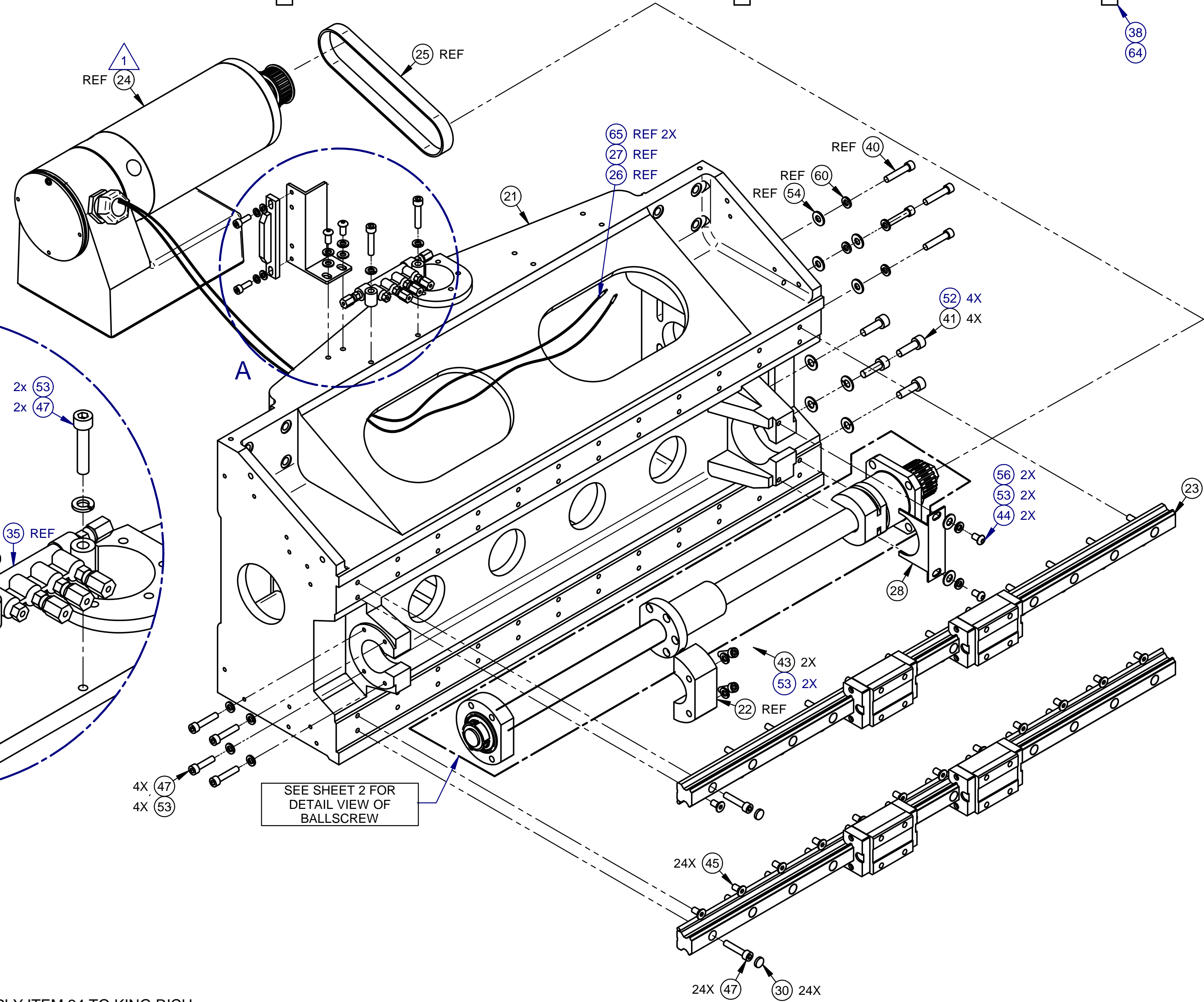
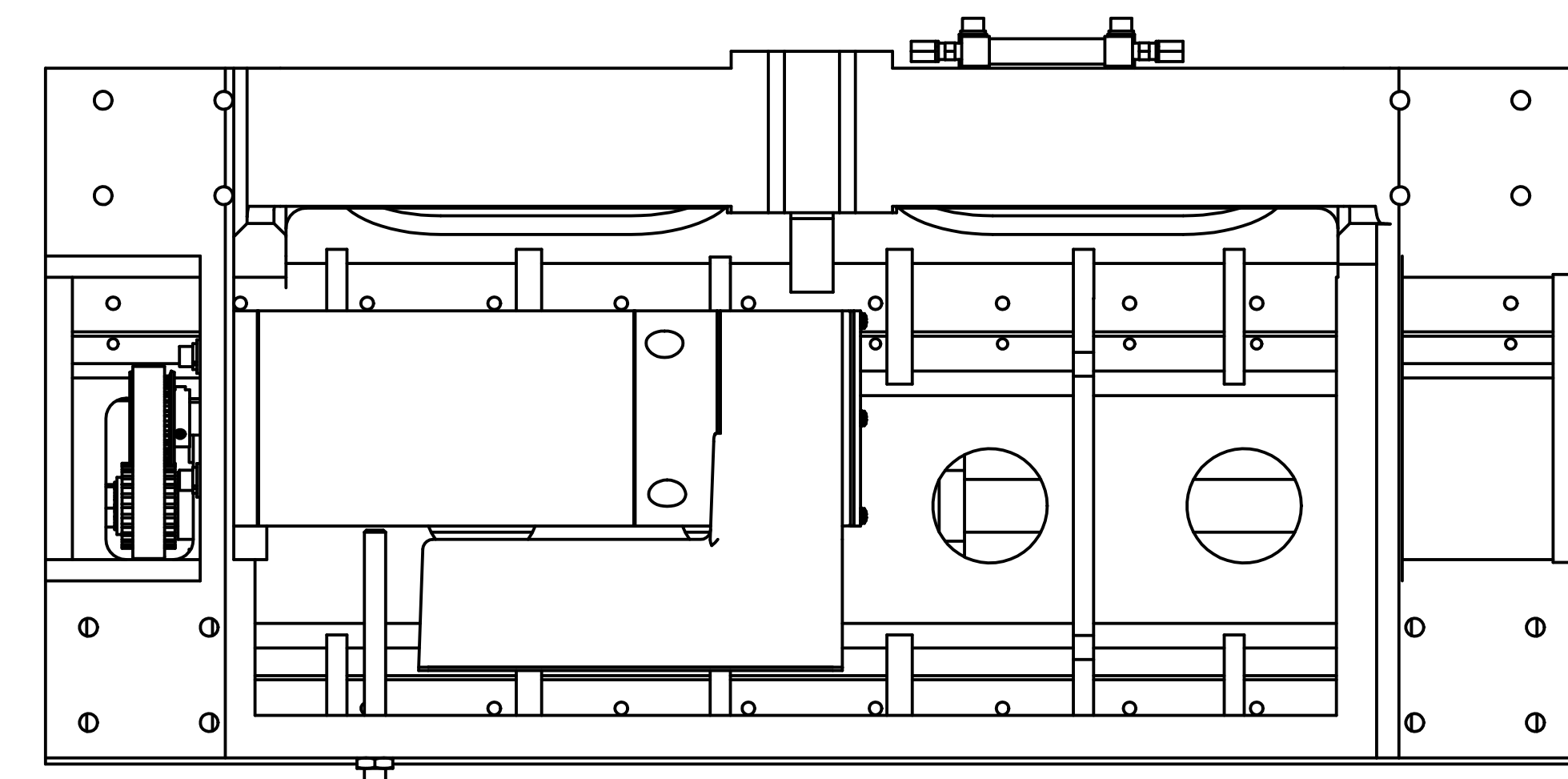
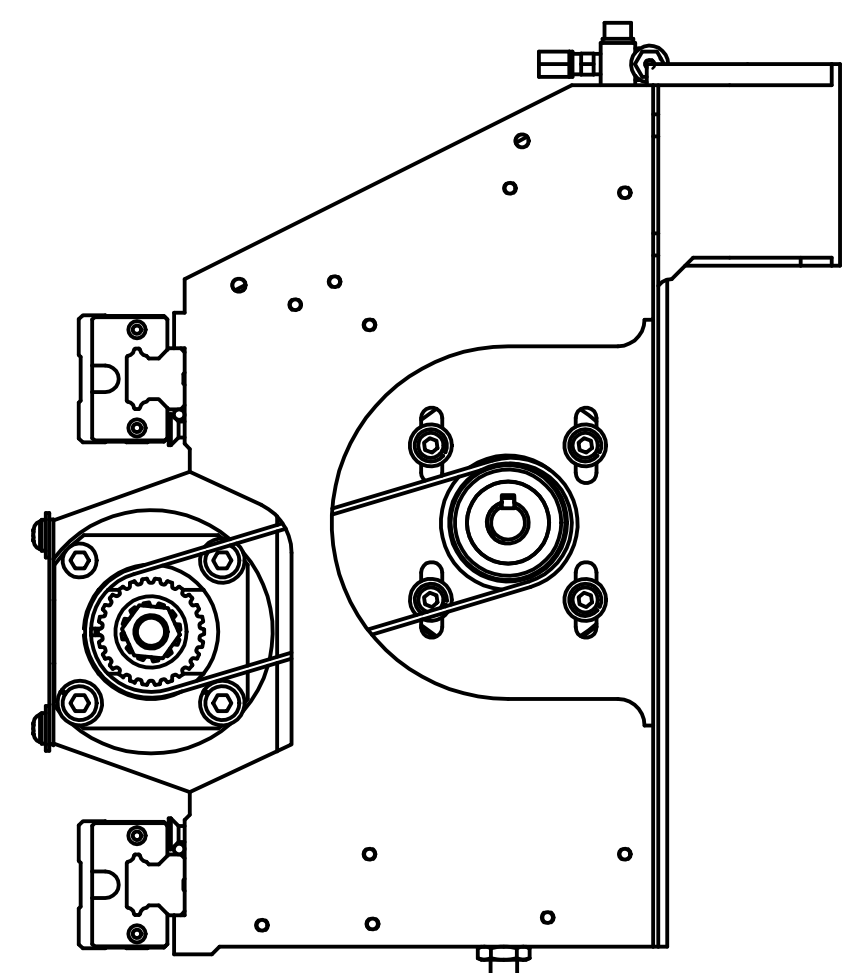
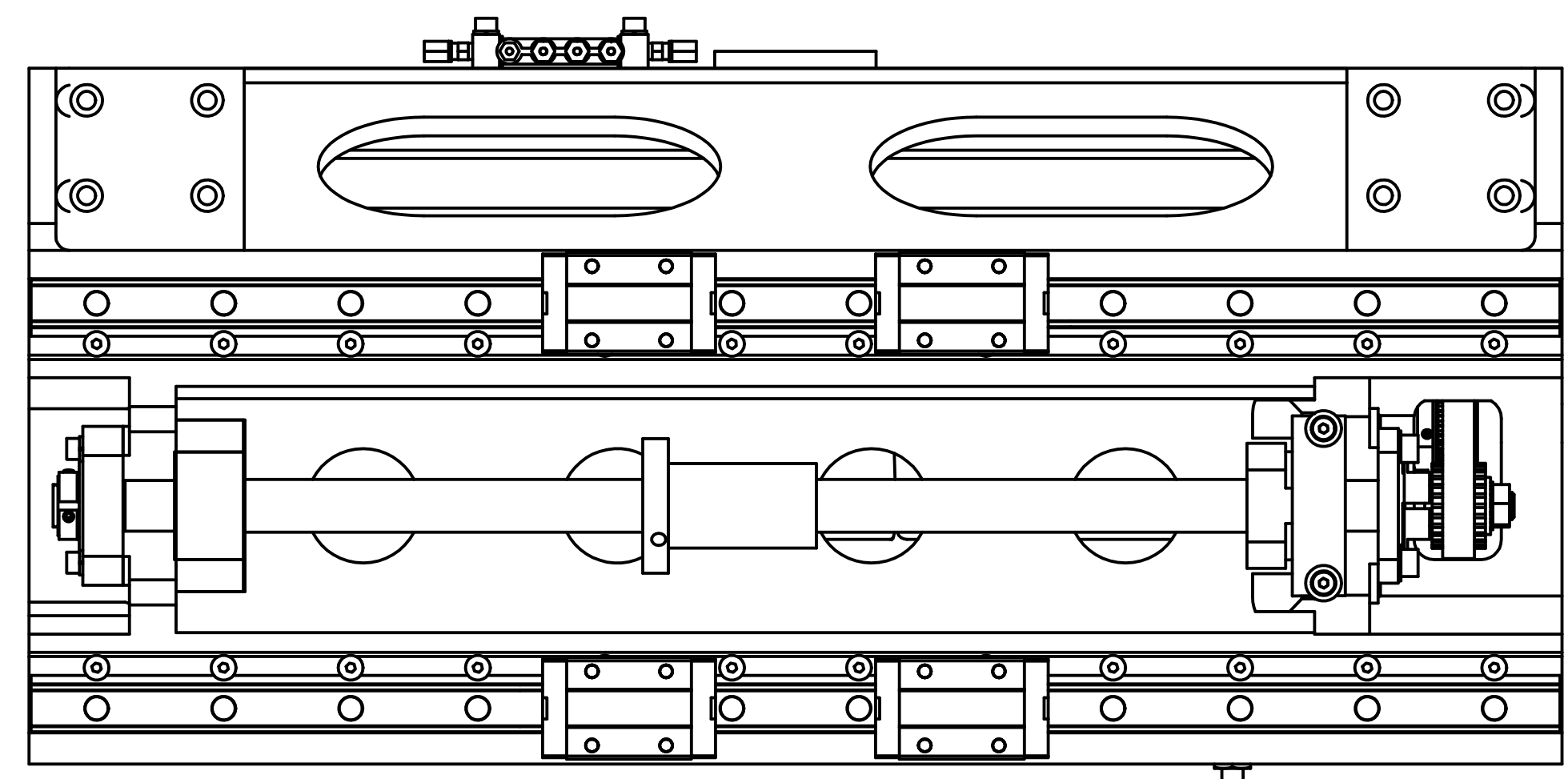
Item	P/N	Title	Detail	Qty	UseAs	Rev	Stat	Type	Mfr	Mfr P/N
1	27529	BASE CASTING		1	EA	-	R	DWG		
2	27530-1	DRAIN PAN	SEE 27542	1	EA	-	R	PS	KING RICH	OP420220
3	27530-2	BRACE-DRAIN PAN-LEFT	SEE 27542	1	EA	-	R	PS	KING RICH	OP420200
4	27530-3	BRACE-DRAIN PAN-RIGHT	SEE 27542	1	EA	-	R	PS	KING RICH	OP420210
5	27530-4	COVER-Y AXIS BALLSCREW	SEE 27542	1	EA	-	R	PS	KING RICH	OP420680
7	27530-5	COVER-REAR-FRAME ASSY	SEE 27542	1	EA	-	R	PS	KING RICH	OP420270
8	27530-6	COVER-REAR/RIGHT-SOLENOID	SEE 27542	1	EA	-	R	PS	KING RICH	OP420250
9	27530-7	COVER-FRONT/RIGHT-FRAME ASSY	SEE 27542	1	EA	-	R	PS	KING RICH	OP420260
10	27530-8	COVER-CHIP & COOLANT TANK-FRAME ASSY	SEE 27542	1	EA	-	R	PS	KING RICH	OP420290
11	27530-9	COVER-FRONT/LEFT-FRAME ASSY	SEE 27542	1	EA	-	R	PS	KING RICH	OP420260
12	27530-10	COVER-REAR/LEFT-LUBE PUMP	SEE 27542	1	EA	-	R	PS	KING RICH	OP420240
13	27530-11	COVER-BOTTOM/REAR-FRAME ASSY	SEE 27542	1	EA	-	R	PS	KING RICH	OP420631
14	27530-12	COVER-BOTTOM/FRONT-FRAME ASSY	SEE 27542	1	EA	-	R	PS	KING RICH	OP420621
16	27546-1	BRACKET-LOWER-SWITCH-Y AXIS	SEE 27542	1	EA	-	R	PS	KING RICH	OP420700
17	27546-2	BRACKET-UPPER-SWITCH-Y AXIS	SEE 27542	1	EA	-	R	PS	KING RICH	OP420711
22	28127-2	LINE-HYDRAULIC-1/8 X 2350mm		1	EA	A	R	DWG		
23	27555-1	LEVELING MOUNT-FRAME ASSY		4	EA	-	R	DWG		
24	27555-2	LEVELING PAD-FRAME ASSY	SEE 27542	4	EA	-	R	PS	KING RICH	A-446-003
27	27091-2	FITTING-AIR-STRAIGHT-10mm-PUSH TO CONNECT	1/4 BSPT MALE THD	1	EA	-	R	PS	KING RICH	
28	27557	COOLANT SYSTEM ASSY-2OP MILL		1	EA	B	R	PL		
29	27562	CHIP TRAY ASSY		1	EA	-	R	PL		

Item	P/N	Title	Detail	Qty	UseAs	Rev	Stat	Type	Mfr	Mfr P/N
30	27091-3	FITTING-STRAIGHT-1/4 BSPT X 1/4 HYDR M/M	SEE 27563	1	EA	-	R	PS	KING RICH	
31	22680-3	SWITCH-LIMIT-ROLLER PLUNGER		1	EA	-	R	DWG		
32	22291-3	LUBRICATION PUMP-WITH CABLE-110 VAC-M10		(1)	EA	A	R	PL		
33	28042-1	MANIFOLD-TUBE FITTING-4 OUTLETS	SEE 27591	(1)	EA	-	R	PS	KING RICH	
34	27085-1	FITTING-AIR-90°-6mm-PUSH TO CONNECT	1/4 BSPT MALE THD	2	EA	-	R	PS	KING RICH	
35	27574	MUFFLER-1/4 BSPT		2	EA	-	R	PS	KING RICH	A-316-136
36	22169-4	FITTING-PIPE-TEE-F/M/F-1/4 BSPT	SEE 27542 OR 27563	1	EA	-	R	PS	KING RICH	
37	26938-5	VALVE-AIR-SOLENOID-DOUBLE-4WAY -3POS-NO-24VDC		1	EA	-	R	DWG		
38	22169-2	FITTING-PIPE-CROSS-1/4-BSPT BRASS	SEE 27542	1	EA	-	R	PS		
39	24151-1	HEX NIPPLE BSPT 1/4 M		2	EA	-	R	PS	KING RICH	
40	26931-1	SWITCH-AIR PRESSURE		1	EA	-	R	PS	KING RICH	
41	22647-6	NIPPLE-1/4 BSPT x 3.0" LG		1	EA	-	R	PS	KING RICH	
42	22607-3	BRACKET-MOUNTING KIT	MATE W/ 22607-2	1	EA	-	R	PS		
43	22607-2	FILTER/REGULATOR-W/ 40µm FILTER, 0-160 PSI	FOR FILTER REPL SEE 24607-4	1	EA	B	R	DWG		
44	28033	AIR TANK		1	EA	-	R	DWG		
45	28034	AIR REGULATOR	SEE 27563	1	EA	-	R	PS		
46	28035	DRAIN VALVE - AIR TANK	SEE 27563	1	EA	-	R	PS	KING RICH	
47	26952-2	ELBOW-STREET-1/4 BSPT	SEE 27563	2	EA	-	R	PS	KING RICH	
48	27176	CABLE ASSY-LUBE PUMP	DC300-120	1	EA	A	R	PL		
49	27635-2	CABLE ASSY-Y AXIS HOME SW	DC300-112C	1	EA	A	R	PL		
50	27635-11	CABLE ASSY-SOLENOID ATC BACK	DC300-108	1	EA	A	R	PL		
51	27635-12	CABLE ASSY-SOLENOID ATC FRONT	DC300-109	1	EA	A	R	PL		
52	27635-5	CABLE ASSY-LIMIT SW-AIR PRESSURE	DC300-110	1	EA	-	R	PL		
54	22607-4	FILTER ELEMENT-REPLACEMENT	SEE 22607-2	(1)	EA	-	R	PS	KING RICH	A-260-051

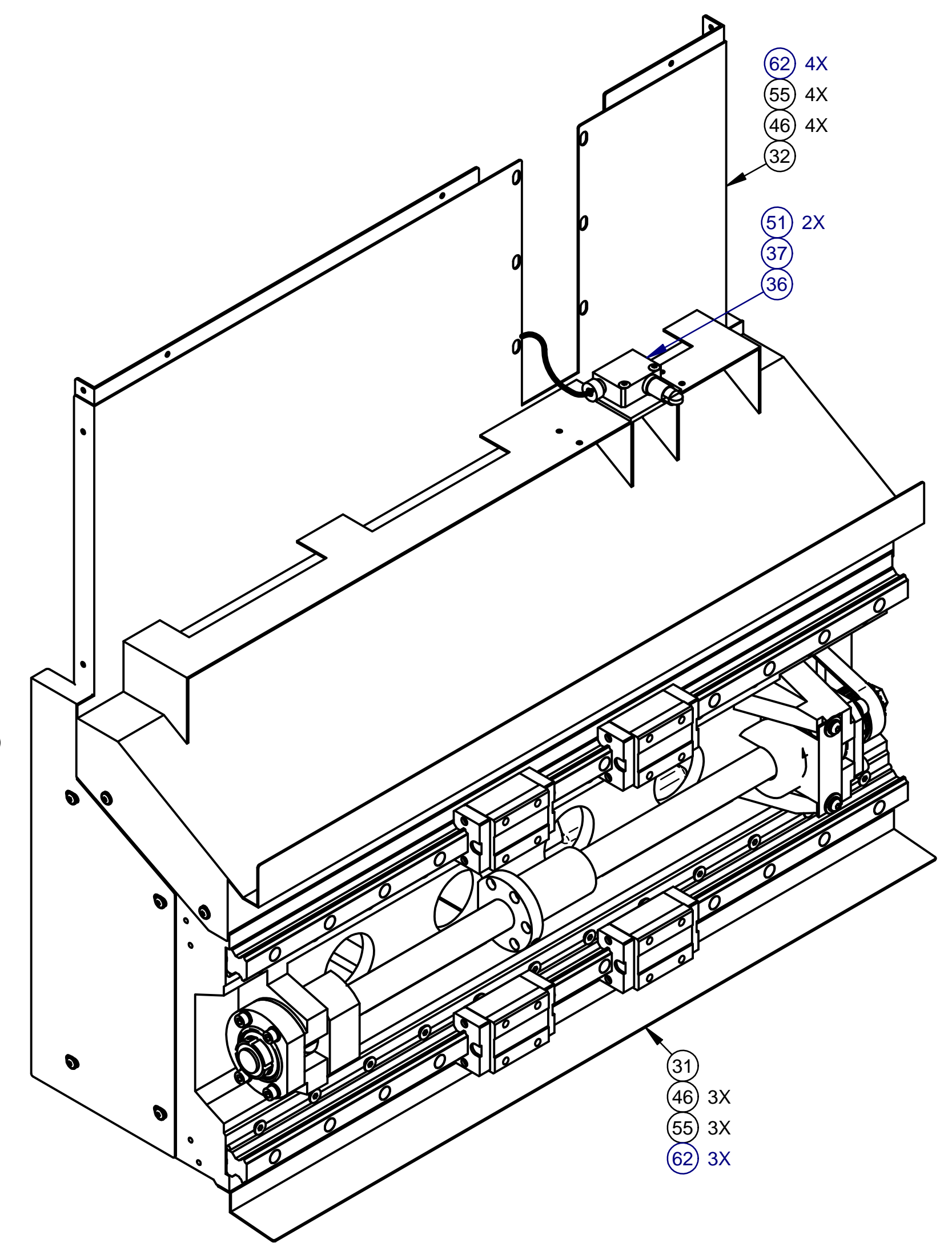
Item	P/N	Title	Detail	Qty	UseAs	Rev	Stat	Type	Mfr	Mfr P/N
55	28042-3	PLUG-1/4 BSPT	SEE 27563	1	EA	-	R	PS	KING RICH	
56	26952-4	FITTING-AIR-90°-1/4 BSPT M/M	SEE 27542 OR 27563	1	EA	-	R	PS	KING RICH	
57	27725	CHECK VALVE-STRAIGHT-1/4 BSPT	SEE 27563	1	EA	-	R	PS	KING RICH	
58	27745	COUPLING-1/4 BSPT	SEE 27563	1	EA	-	R	PS	KING RICH	
59	27085-2	FITTING-AIR-90°-10mm-PUSH TO CONN-1/4 BSPT M	SEE 27542 OR 27563	1	EA	-	R	PS	KING RICH	A-316-381
60	M5-0.8X12 27J	SCREW-BHCS-SS	NON-STOCKABLE	56	EA	-	R	PS		
61	M6-1.0X16 25B	SCREW-SHCS-STL-BO		6	EA	-	R	PS		
62	M6-1.0X12 25B	SCREW-SHCS-STL-BO		12	EA		R	PS		
63	M5-0.8X10 25B	SCREW-SHCS-STL-BO		2	EA	-	R	PS		
64	M4-0.7X10 25B	SCREW-SHCS-STL-BO		2	EA		R	PS		
65	M8-1.25X80 25B	SCREW-SHCS-STL-BO		12	EA	-	R	PS		
66	M5-0.8X12 25B	SCREW-SHCS-STL-BO		4	EA	-	R	PS		
67	M6-1.0X35 25B	SCREW-SHCS-STL-BO		2	EA	-	R	PS		
68	M5-0.8X8 27Z	SCREW-BHCS-STL-ZINC		4	EA	-	R	PS		
70	M5 70B	WASHER-FLAT USS-STL-BO		4	EA	-	R	PS		
71	M5 70J	WASHER-FLAT-SS	NON-STOCKABLE	56	EA	-	R	PS		
72	M4 73B	WASHER-SPLIT LOCK-STL-BO		2	EA		R	PS		
73	M5 73B	WASHER-SPLIT LOCK-STL-BO		2	EA	-	R	PS		
77	M6 73B	WASHER-SPLIT LOCK-STL-BO		20	EA	-	R	PS		
78	M8 73B	WASHER-SPLIT LOCK-STL-BO		4	EA		R	PS		
79	M5 71Z	WASHER-FLAT-STL-ZINC	NON STOCKABLE	4	EA	-	R	PS		
85	27262-1	BRACKET-L-LEFT SIDE-ATC		1	EA	A	R	DWG		
86	27262-2	BRACKET-L-RIGHT SIDE-ATC		1	EA	A	R	DWG		
87	27263	SEAL-RUBBER		2	EA	A	R	PS		

NOTICE: THIS DESIGN WAS ORIGINATED BY AND EMBODIES A CONFIDENTIAL PROPRIETARY DESIGN OWNED BY SOUTHWESTERN INDUSTRIES. IT IS DISCLOSED IN CONFIDENCE FOR A SPECIFIC PURPOSE AND THE RECIPIENT HEREOF AGREES NOT TO MAKE ANY REPRODUCTION, DISCLOSURE OR OTHER USE OF THIS INFORMATION WITHOUT THE WRITTEN CONSENT OF SOUTHWESTERN INDUSTRIES.

REVISIONS				
REV	DESCRIPTION	ECN	DATE	APPRV
-	ORIGINAL RELEASE	13915	05/01/12	TO
A	REVISED: ITEMS 24 PICTORIAL & 25 WAS: 410-5M-15.	14120	10/2/13	TO
B	ITEM 58 1/2 66Z WAS: 1/2 71Z	14335	12/5/14	LG



SEE SHEET 2 FOR  
DETAIL VIEW OF  
BALLSCREW



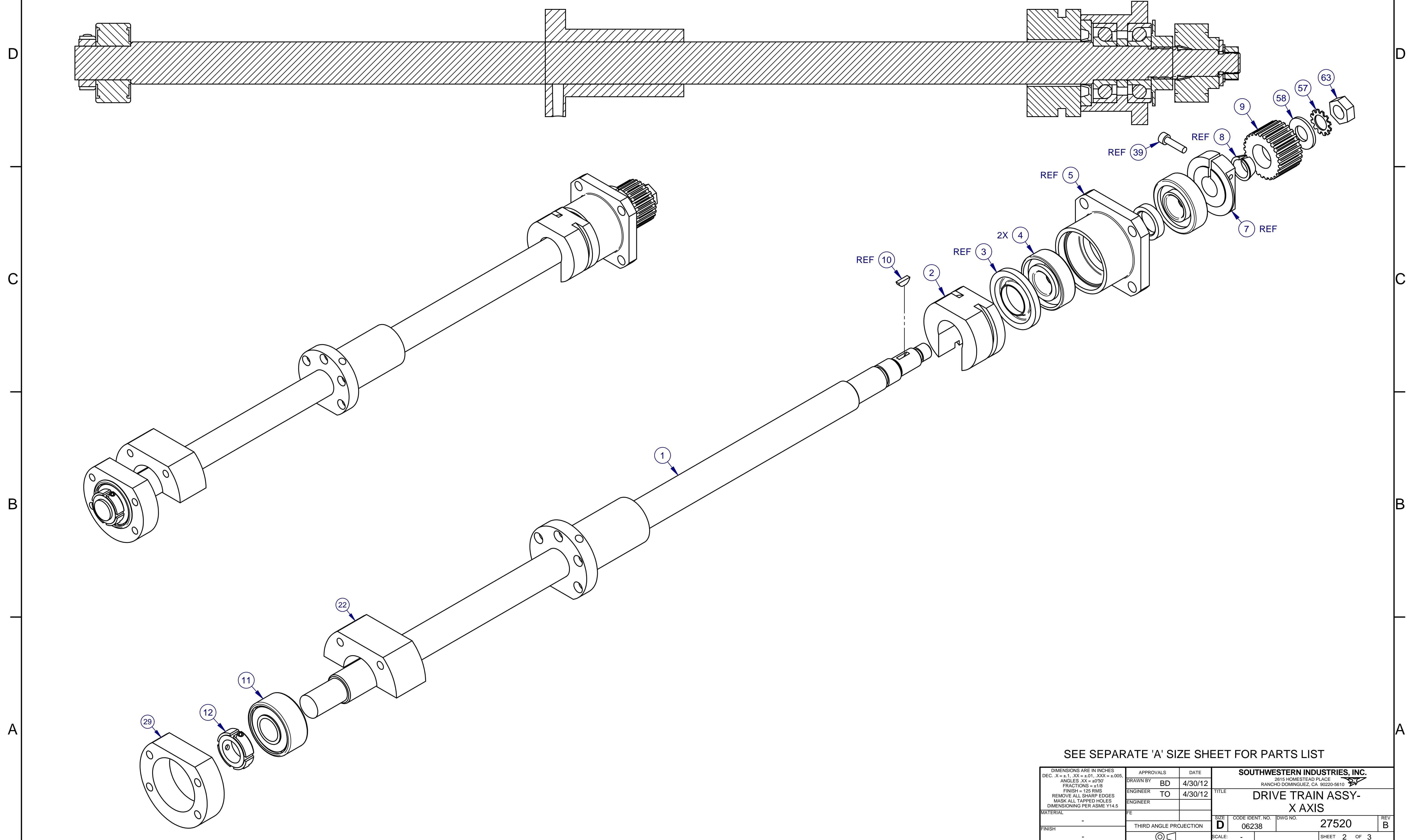
SEE SEPARATE 'A' SIZE SHEET FOR PARTS LIST

NOTES: (UNLESS OTHERWISE SPECIFIED).  
1 SOUTHWESTERN INDUSTRIES TO SUPPLY ITEM 24 TO KING RICH.

DIMENSIONS ARE IN INCHES DEC. X = ±.1, XX = ±.01, XXX = ±.005 ANGLES: XX = ±0°01' FRACTIONS = ±1/8 FINISH = 125 RMS REMOVE ALL SHARP EDGES MASK ALL TAPPED HOLES DIMENSIONING PER ASME Y14.5		APPROVALS	DATE	SOUTHWESTERN INDUSTRIES, INC. 2615 HOMESTEAD PLACE RANCHO DOMINGUEZ, CA 90220-5610	
DRAWN BY	BD	4/30/12	TITLE		
ENGINEER	TO	4/30/12	DRIVE TRAIN ASSY- X AXIS		
ENGINEER			SIZE	CODE IDENT. NO.	DWG. NO.
MATERIAL			D	06238	27520
FINISH			THIRD ANGLE PROJECTION	SCALE: -	SHEET 1 OF 3
					REV B

NOTICE: THIS DESIGN WAS ORIGINATED BY AND EMBODIES A CONFIDENTIAL PROPRIETARY DESIGN OWNED BY SOUTHWESTERN INDUSTRIES. IT IS DISCLOSED IN CONFIDENCE FOR A SPECIFIC PURPOSE AND THE RECIPIENT HEREOF AGREES NOT TO MAKE ANY REPRODUCTION, DISCLOSURE OR OTHER USE OF THIS INFORMATION WITHOUT THE WRITTEN CONSENT OF SOUTHWESTERN INDUSTRIES.

REVISIONS				
REV	DESCRIPTION	ECN	DATE	APPRV
-	ORIGINAL RELEASE	13915	05/01/12	TO
A	REVISED: ITEMS 24 PICTORIAL & 25 WAS: 410-5M-15.	14120	10/2/13	TO
B	ITEM 58 1/2 66Z WAS: 1/2 71Z	14335	12/5/14	LG

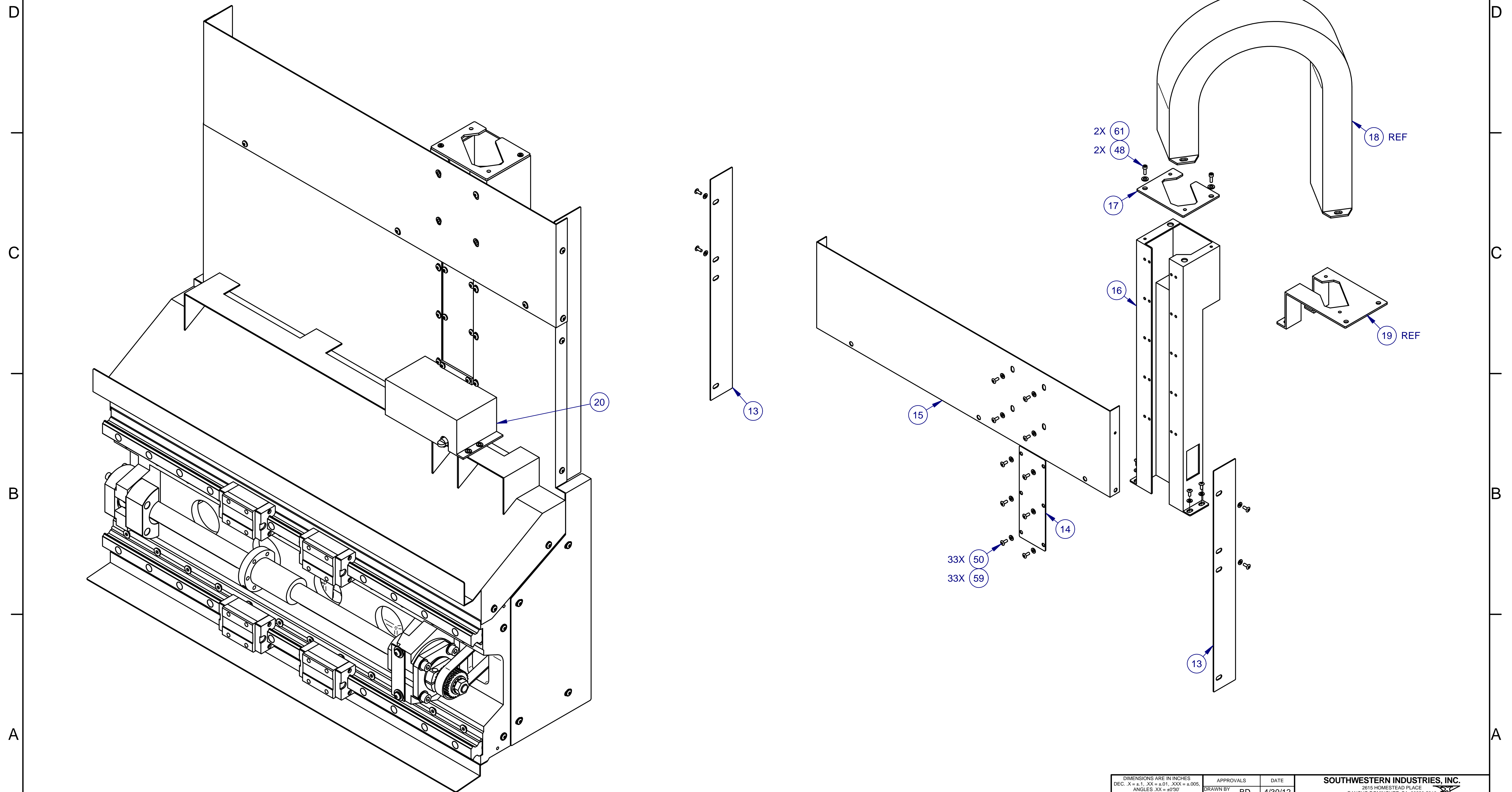


SEE SEPARATE 'A' SIZE SHEET FOR PARTS LIST

DIMENSIONS ARE IN INCHES DEC. .X = ±.1, .XX = ±.01, .XXX = ±.005 ANGLES: XX = ±0°30' FRACTIONS = ±1/8 FINISH = 125 RMS REMOVE ALL SHARP EDGES MASK ALL TAPPED HOLES DIMENSIONING PER ASME Y14.5	APPROVALS	DATE	<b>SOUTHWESTERN INDUSTRIES, INC.</b> 2615 HOMESTEAD PLACE RANCHO DOMINGUEZ, CA 90220-5610			
	DRAWN BY	BD	4/30/12	TITLE		
	ENGINEER	TO	4/30/12	<b>DRIVE TRAIN ASSY- X AXIS</b>		
	ENGINEER			SIZE	CODE IDENT. NO.	DWG NO.
MATERIAL	FE		<b>D</b>	06238	27520	
FINISH			THIRD ANGLE PROJECTION	SCALE: -	SHEET 2 OF 3	

NOTICE: THIS DESIGN WAS ORIGINATED BY AND EMBODIES A CONFIDENTIAL PROPRIETARY DESIGN OWNED BY SOUTHWESTERN INDUSTRIES. IT IS DISCLOSED IN CONFIDENCE FOR A SPECIFIC PURPOSE AND THE RECIPIENT HEREOF AGREES NOT TO MAKE ANY REPRODUCTION, DISCLOSURE OR OTHER USE OF THIS INFORMATION WITHOUT THE WRITTEN CONSENT OF SOUTHWESTERN INDUSTRIES.

REVISIONS				
REV	DESCRIPTION	ECN	DATE	APPRV
-	ORIGINAL RELEASE	13915	05/01/12	TO
A	REVISED: ITEMS 24 PICTORIAL & 25 WAS: 410-5M-15.	14120	10/2/13	TO
B	ITEM 58 1/2 66Z WAS: 1/2 71Z	14335	12/5/14	LG



DIMENSIONS ARE IN INCHES DEC. X = ±.1, XX = ±.01, XXX = ±.005 ANGLES: XX = ±0°30' FRACTIONS = ±1/8 FINISH = 125 RMS REMOVE ALL SHARP EDGES MASK ALL TAPPED HOLES DIMENSIONING PER ASME Y14.5		APPROVALS DRAWN BY <b>BD</b> ENGINEER <b>TO</b> ENGINEER	DATE <b>4/30/12</b> <b>4/30/12</b>	<b>SOUTHWESTERN INDUSTRIES, INC.</b> 2615 HOMESTEAD PLACE RANCHO DOMINGUEZ, CA 90220-5610	TITLE <b>DRIVE TRAIN ASSY- X AXIS</b>
MATERIAL	FE	THIRD ANGLE PROJECTION		SIZE <b>D</b> CODE IDENT. NO. <b>06238</b> SCALE: -	DWG NO. <b>27520</b> REV <b>B</b>
				SHEET 3 OF 3	

Parts List for Assembly P/N: 27520

Printed 12/5/2014

**27520**  
DRIVE TRAIN ASSY-X AXIS

Type	PL	Dwg Size	D
Revision	B	Product	2 OP MILL
Status	R	Engineer	TO
Date	4/23/2009	Planner Code	
By	BD	Comm Code	

Item	P/N	Title	Detail	Qty	UseAs	Rev	Stat	Type	Mfr	Mfr P/N
1	27522	BALLSCREW-X AXIS		1	EA	-	R	DWG		
2	27521	BUMPER-X AXIS-RIGHT SIDE		1	EA	-	R	DWG		
3	15626	SEAL-BEARING HOUSING		(1)	EA	A	R	DWG		
4	20373	BEARING-ANGULAR CONTACT-7204		2	EA	D	R	DWG		
5	27515	BEARING HOUSING ASSY		(1)	EA	-	R	PL		
7	16452	NUT CLAMP-X, Y, Z AXIS		(1)	EA	D	R	DWG		
8	16350	FERRULE-SPROCKET-DRIVE		(1)	EA	-	R	DWG		
9	27513	SPROCKET-26 TEETH W/O GUIDES		1	EA	A	R	DWG		
10	98481A090	KEY WOODRUFF #404-1/8 X 1/2		(1)	EA		R	PS		
11	22008	BEARING-204KTT		1	EA	C	R	DWG		
12	27951-4	LOCKNUT-M20 X 1.0		1	EA	-	R	PS	KING RICH	
13	27603-9	SUPPORT-LEFT & RIGHT-UPPER STRUCTURE	SEE 27520	2	EA	-	R	PS	KING RICH	
14	27603-10	COVER-CONDUIT-MINOR-UPPER STRUCTURE	SEE 27520	1	EA	-	R	PS	KING RICH	OP420420
15	27603-11	COVER-CONDUIT-MAJOR-UPPER STRUCTURE	SEE 27520	1	EA	-	R	PS	KING RICH	OP420410
16	27603-12	CONDUIT-UPPER STRUCTURE	SEE 27520	1	EA	-	R	PS	KING RICH	OP420430
17	27603-13	COVER-CONDUIT-UPPER STRUCTURE	SEE 27520	1	EA	-	R	PS	KING RICH	OP420460
18	26891-5	CARRIER-CABLE-Z AXIS		(1)	EA	-	R	PS	KING RICH	A-85-184
19	27603-14	BRACKET-MTG-CABLE CARRIER-UPR STRUCT	SEE 27520	(1)	EA	-	R	PS	KING RICH	OP420520
20	27690-1	COVER-HOME SWITCH-X AXIS	SEE 27520	1	EA	-	R	PS		
21	27523	CASTING-X AXIS		1	EA	-	R	DWG		
22	27572	BUMPER-X AXIS-LEFT SIDE		1	EA	-	R	DWG		

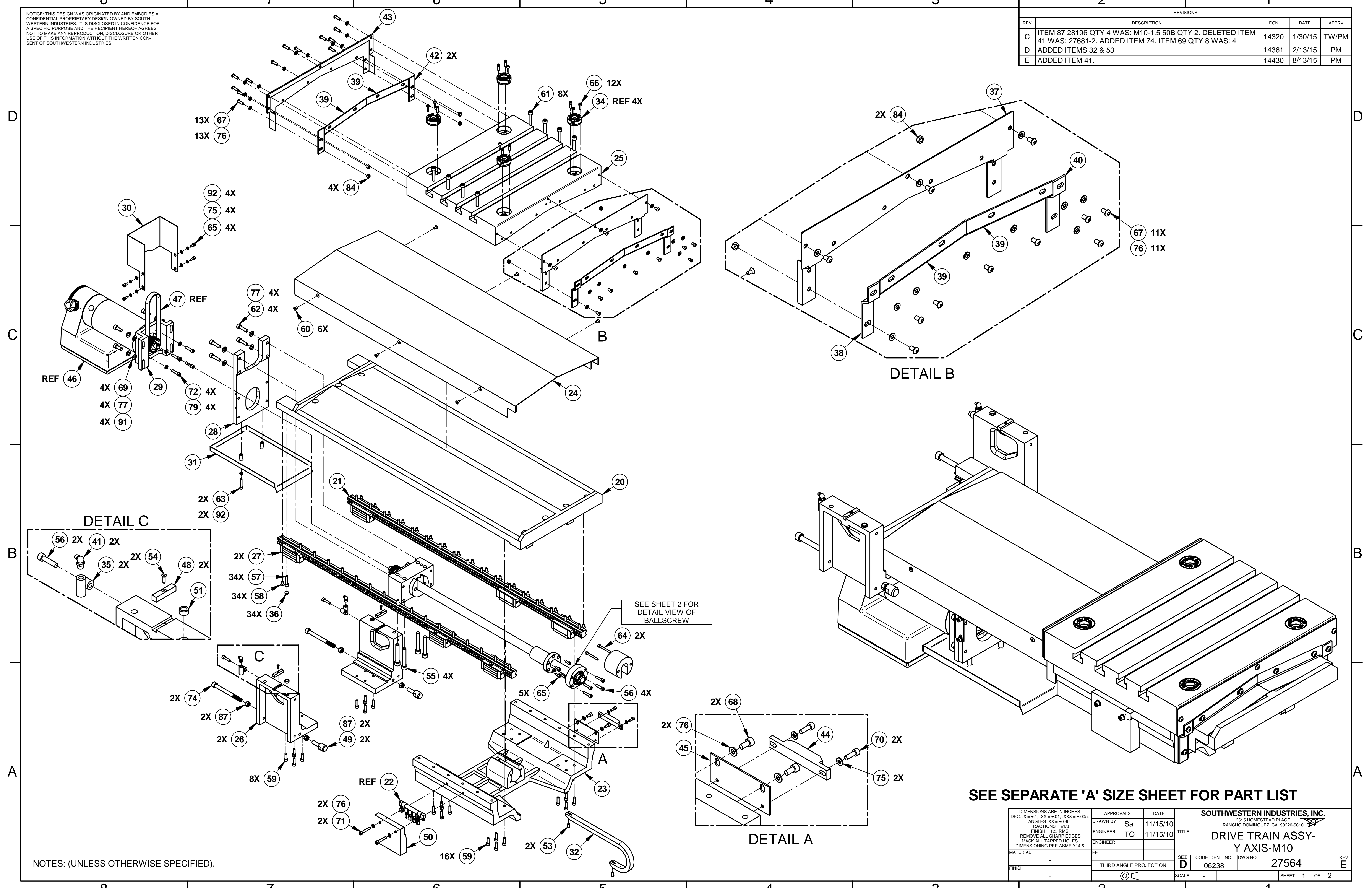
Item	P/N	Title	Detail	Qty	UseAs	Rev	Stat	Type	Mfr	Mfr P/N
23	26740-3	GUIDE-LINEAR-SET (2) -X AXIS	720mm	1	EA	-	R	DWG		
24	24428-2	MOTOR DRIVER ASSY-40/55-W/ INDEX - 2FT CABLE		(1)	EA	E	R	PL		
25	410-5MR-15	BELT-TIMING 5MM POWERGRIP-GT2		(1)	EA	A	R	PS		
26	27168-4	CABLE ASSY-MOTOR ENCODER-12'		(1)	EA	A	R	PL		
27	27169-4	CABLE ASSY-MOTOR POWER-12'		(1)	EA	A	R	PL		
28	27683	CLIP-BUMPER RETAINING		1	EA	-	R	DWG		
29	27517	BEARING HOUSING		1	EA	-	R	DWG		
30	27541-1	CAP-GUIDE-LINEAR	SEE X, Y, Z DRV TRAIN	24	EA	-	R	PS		
31	27603-17	COVER-LOWER-X AXIS	SEE 27520	1	EA	-	R	PS		
32	27603-18	COVER-X AXIS ASSY	SEE 27520	1	EA	-	R	PS		
33	27603-21	BRACE-RIGHT-X AXIS ASSY	SEE 27520	1	EA	-	R	PS		
34	27634	TRIGGER-HOME SWITCH-2 OP		1	EA	-	R	PS	KING RICH	OP360011
35	28042-2	MANIFOLD-TUBE FITTING-6 OUTLETS		(1)	EA	-	R	PS	KING RICH	
36	22680-3	SWITCH-LIMIT-ROLLER PLUNGER		1	EA	-	R	DWG		
37	27635-1	CABLE ASSY-X AXIS HOME SW	DC300-111	1	EA	-	R	PL		
38	M10-1.5X120 25B-FULL THRD	SCREW-SHCS-STL-BO-FULL THRD	NON STOCKABLE	1	EA	-	R	PS		
39	10-32X3/4 25B	SCREW-SHCS-STL-BO		(1)	EA		R	PS		
40	1/4-20X1 1/4 25B	SCREW-SHCS-STL-BO		(4)	EA		R	PS		
41	M8-1.25X25 25B	SCREW-SHCS-STL-BO		4	EA		R	PS		
43	M6-1.0X20 25B	SCREW-SHCS-STL-BO		2	EA		R	PS		
44	M6-1.0X10 27B	SCREW-BHCS-STL-BO		4	EA	-	R	PS		
45	M6-1.0X12 26B	SCREW-FHCS-STL-BO	NON STOCKABLE	24	EA	-	R	PS		
46	M5-0.8X8 27B	SCREW-BHCS-STL-BO		7	EA	-	R	PS		
47	M6-1.0X30 25B	SCREW-SHCS-STL-BO		30	EA		R	PS		



Item	P/N	Title	Detail	Qty	UseAs	Rev	Stat	Type	Mfr	Mfr P/N
48	M4-0.7X12 25B	SCREW-SHCS-STL-BO		2	EA		R	PS		
49	M5-0.8X15 25B	SCREW-SHCS-STL-BO	NON STOCKABLE	2	EA	-	R	PS		
50	M4-0.7X10 27B	SCREW-BHCS-STL-BO		33	EA	-	R	PS		
51	M4-0.7X25 27B	SCREW-BHCS-STL-BO	NON STOCKABLE	2	EA	-	R	PS		
52	M8 73B	WASHER-SPLIT LOCK-STL-BO		4	EA		R	PS		
53	M6 73B	WASHER-SPLIT LOCK-STL-BO		12	EA	-	R	PS		
54	1/4 70B	WASHER-FLAT USS-STL-BO		(4)	EA		R	PS		
55	M5 70B	WASHER-FLAT USS-STL-BO		9	EA		R	PS		
56	M6 70B	WASHER-FLAT USS-STL-BO		4	EA	-	R	PS		
57	1/2 75Z	WASHER-EXT TOOTH-STL-ZINC		1	EA		R	PS		
58	1/2 66Z	WASHER-FLAT-NARROW-ANSI TYPE B		1	EA	-	R	PS		
59	M4 70Z	WASHER-FLAT-STL-ZINC		33	EA	-	R	PS		
60	1/4 73B	WASHER-SPLIT LOCK-STL-BO		(4)	EA		R	PS		
61	M4 70B	WASHER-FLAT-STL-BO		2	EA	-	R	PS		
62	M5 73B	WASHER-SPLIT LOCK-STL-BO		9	EA	-	R	PS		
63	1/2-20 51Z	NUT-HEX JAM-STL-ZINC		1	EA		R	PS		
64	M10-1.5 51P	NUT-HEX-JAM-STL-PLAIN	NON STOCKABLE	1	EA	-	R	PS		
65	22768-32	LABEL-TEXT-WHITE-1.00W x 1.437H	X MOTOR	(2)	EA	AC	R	DWG		

NOTICE: THIS DESIGN WAS ORIGINATED BY AND EMBODIES A CONFIDENTIAL PROPRIETARY DESIGN OWNED BY SOUTH-WESTERN INDUSTRIES. IT IS DISCLOSED IN CONFIDENCE FOR A SPECIFIC PURPOSE AND THE RECIPIENT HEREOF AGREES NOT TO MAKE ANY REPRODUCTION, DISCLOSURE OR OTHER USE OF THIS INFORMATION WITHOUT THE WRITTEN CONSENT OF SOUTHWESTERN INDUSTRIES.

REVISIONS				
REV	DESCRIPTION	ECN	DATE	APPRV
C	ITEM 87 28196 QTY 4 WAS: M10-1.5 50B QTY 2. DELETED ITEM 41 WAS: 27681-2. ADDED ITEM 74. ITEM 69 QTY 8 WAS: 4	14320	1/30/15	TW/PM
D	ADDED ITEMS 32 & 53	14361	2/13/15	PM
E	ADDED ITEM 41.	14430	8/13/15	PM



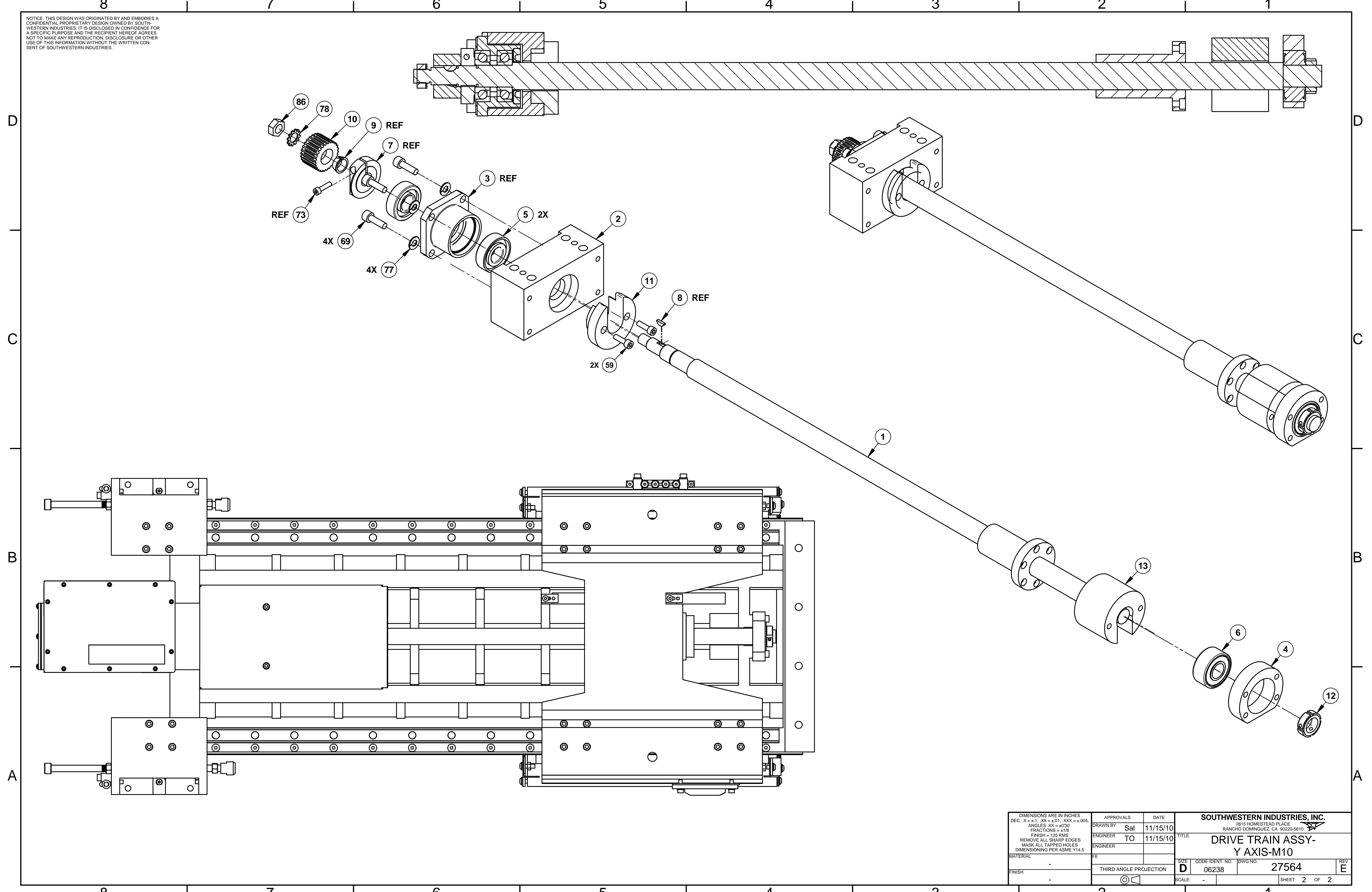
NOTES: (UNLESS OTHERWISE SPECIFIED).

SEE SHEET 2 FOR  
DETAIL VIEW OF  
BALLSCREW

**SEE SEPARATE 'A' SIZE SHEET FOR PART LIST**

DIMENSIONS ARE IN INCHES DEC. X = ±.1, XX = ±.01, XXX = ±.005 ANGLES: XX = ±0°30' FRACTIONS = ±1/8 FINISH = 125 RMS REMOVE ALL SHARP EDGES MASK ALL TAPPED HOLES DIMENSIONING PER ASME Y14.5		APPROVALS	DATE	SOUTHWESTERN INDUSTRIES, INC. 2615 HOMESTEAD PLACE RANCHO DOMINGUEZ, CA 90220-5610	
DRAWN BY	Sal	11/15/10	TITLE		
ENGINEER	TO	11/15/10	DRIVE TRAIN ASSY- Y AXIS-M10		
ENGINEER			SIZE	CODE IDENT. NO.	DWG NO.
MATERIAL			D	06238	27564
FINISH			THIRD ANGLE PROJECTION	SCALE: -	SHEET 1 OF 2

NOTICE: THIS DESIGN WAS ORIGINATED BY AND EMBODIES A CONFIDENTIAL PROPRIETARY DESIGN OWNED BY SOUTHWESTERN INDUSTRIES. IT IS DISCLOSED IN CONFIDENCE FOR A SPECIFIC PURPOSE AND THE RECIPIENT HEREOF AGREES NOT TO MAKE ANY REPRODUCTION, DISCLOSURE OR OTHER USE OF THIS INFORMATION WITHOUT THE WRITTEN CONSENT OF SOUTHWESTERN INDUSTRIES.



DIMENSIONS ARE IN INCHES DEC. .X = ±.1, .XX = ±.01, .XXX = ±.005 ANGLES .XX = ±0°30' FRACTIONS = 1/8 FINISH = 125 RMS REMOVE ALL SHARP EDGES MASK ALL TAPPED HOLES DIMENSIONING PER ASME Y14.5		APPROVALS	DATE	SOUTHWESTERN INDUSTRIES, INC. 2615 HOMESTEAD PLACE RANCHO DOMINGUEZ, CA 90220-5610	
DRAWN BY	Sal	11/15/10	ENGINEER	TO	11/15/10
MATERIAL	-		ENGINEER		
FINISH	-		THIRD ANGLE PROJECTION	SIZE	D
			SCALE	CODE IDENT. NO.	06238
				DWG NO.	27564
				REV	E
				SHEET	2 OF 2

Parts List for Assembly P/N: 27564

Printed 8/13/2015

**27564**  
DRIVE TRAIN ASSY-Y AXIS-M10

Type	PL	Dwg Size	D
Revision	E	Product	2 OP M10 MILL
Status	R	Engineer	TO
Date	5/19/2009	Planner Code	
By	Sal	Comm Code	

Item	P/N	Title	Qty	Detail	Rev	UseAs	Stat	Type	Mfr	Mfr P/N
1	27579	BALLSCREW-Y AXIS	1		-	EA	R	DWG		
2	27516	BEARING BLOCK-FIXED END	1		-	EA	R	DWG		
3	27515	BEARING HOUSING ASSY	(1)		-	EA	R	PL		
4	27517	BEARING HOUSING	1		-	EA	R	DWG		
5	20373	BEARING-ANGULAR CONTACT-7204	2		D	EA	R	DWG		
6	22008	BEARING-204KTT	1		C	EA	R	DWG		
7	16452	NUT CLAMP-X, Y, & Z AXIS	(1)		E	EA	R	DWG		
8	98481A090	KEY WOODRUFF #404-1/8 X 1/2	(1)		-	EA	R	PS		
9	16350	FERRULE-SPROCKET-DRIVE KIT	(1)		-	EA	R	DWG		
10	27513	SPROCKET-26 TEETH W/O GUIDES	1		A	EA	R	DWG		
11	27526	BUMPER-Y AXIS FIXED END	1		-	EA	R	DWG		
12	27951-4	LOCKNUT-M20 X 1.0	1		-	EA	R	PS	KING RICH	
13	27527	BUMPER-Y AXIS FLOATING END	1		-	EA	R	DWG		
20	27559	CASTING-Y AXIS DRIVE TRAIN	1		A	EA	R	DWG		
21	26740-4	GUIDE-LINEAR-SET (2) -Y AXIS	1	1010mm	-	EA	R	DWG		
22	28042-2	MANIFOLD-TUBE FITTING-6 OUTLETS	(1)		-	EA	R	PS	KING RICH	
23	27566	CASTING-WORKTABLE SUPPORT	1		-	EA	R	DWG		
24	27584	COVER-Y AXIS CASTING	1	SEE 27564	-	EA	R	PS	KING RICH	OP442010
25	27582	WORKTABLE-MODIFIED-2OP M10 MILL	1		A	EA	R	DWG		
26	27577-1	CASTING-TOOL CHANGER	2		-	EA	R	DWG	KING RICH	
27	27518	BEARING BLOCK-25mm RAIL EXTENDED	2		-	EA	R	DWG		

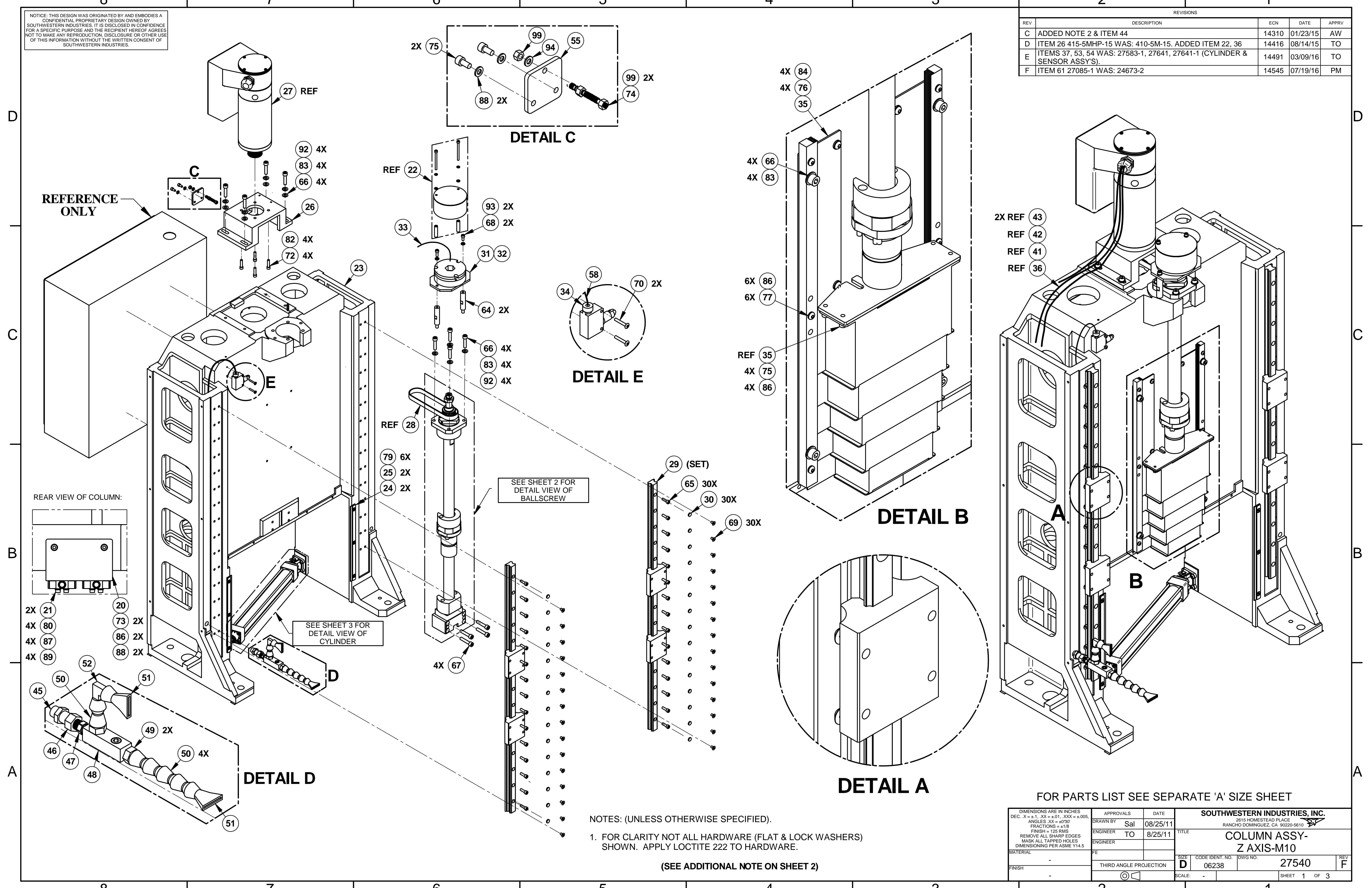
Item	P/N	Title	Qty	Detail	Rev	UseAs	Stat	Type	Mfr	Mfr P/N
28	27675	PLATE-CASTING-MTR BRK	1		-	EA	R	DWG		
29	27675-1	BRACKET-MOUNTING-MOTOR	1		-	EA	R	DWG		
30	27603-23	COVER-MOTOR-Y AXIS	1	SEE 27564	-	EA	R	PS	KING RICH	OP420540
31	27675-2	DRAIN PAN-MOTOR-Y AXIS	1	SEE 27564	-	EA	R	PS	KING RICH	
32	26891-6	CARRIER-LUBE LINE-Y AXIS-2OP	1		A	EA	R	DWG		
34	26711	RECEIVER-BALL LOCK-FACE MOUNT	(4)		-	EA	R	DWG		
35	27676	FITTING-LUBRICATION	2	SEE 27564	-	EA	R	PS	KING RICH	
36	27541-1	CAP-GUIDE-LINEAR	34	SEE X, Y, Z DRV TRAIN	-	EA	R	PS		
37	27679-1	COVER-WIPER-FRONT-WORKTABLE	1	SEE 27564	-	EA	R	PL		
38	27998-1	WIPER-FRONT/LEFT	1	SEE 27564	-	EA	R	PS		
39	27998-2	WIPER-CENTER-FRONT & REAR	4		A	EA	R	DWG		
40	27998-3	WIPER-FRONT/RIGHT	1	SEE 27564	-	EA	R	PS		
41	26969-1	FITTING-GREASE-90°-M8-1 x MALE-18mm H-SS	2		A	EA	R	DWG		
42	27998-4	WIPER-REAR-LEFT & RIGHT	2		A	EA	R	DWG		
43	27679-2	COVER-WIPER-REAR-WORKTABLE	1	SEE 27564	-	EA	R	PS		
44	27634	TRIGGER-HOME SWITCH-2 OP	1		-	EA	R	PS	KING RICH	OP360011
45	27691-1	BRACKET-HOME SWITCH-Y AXIS	1	SEE 27564	-	EA	R	PS		
46	24428-3	MOTOR DRIVER ASSY-40/55-W/ INDEX-6FT CABLE	(1)		D	EA	R	PL		
47	450-5M-15	BELT-TIMING 5MM POWERGRIP	(1)		-	EA	R	PS		
48	26220-2	KEY-8mm x 8mm x 38.1L	2	SEE 27564	-	EA	R	PS		
49	22719-1	STOP-ATC HOUSING	2		-	EA	R	DWG		
50	27584-1	COVER-Y AXIS MANIFOLD	1	SEE 27564	-	EA	R	PS		
51	28043	PIN-LOCATING-ØM13 x 6mm L	1	WITH M6 C' BORE	-	EA	R	DWG		

Item	P/N	Title	Qty	Detail	Rev	UseAs	Stat	Type	Mfr	Mfr P/N
53	M5-0.8X12 27B	SCREW-BHCS-STL-BO	2			EA	R	PS		
54	M3-0.5X10 26B	SCREW-FHCS-STL-BO	2	NON-STOCKABLE	-	EA	R	PL		
55	M10-1.5X45 25B	SCREW-SHCS-STL-BO	4			EA	R	PS		
56	M5-0.8X20 27Z	SCREW-BHCS-STL-ZINC	6		-	EA	R	PS		
57	M6-1.0X30 25B	SCREW-SHCS-STL-BO	34			EA	R	PS		
58	M6-1.0X12 26B	SCREW-FHCS-STL-BO	34	NON STOCKABLE	-	EA	R	PS		
59	M6-1.0X20 25B	SCREW-SHCS-STL-BO	26			EA	R	PS		
60	M5-0.8X10 26B	SCREW-FHCS-STL-BO	6	NON STOCKABLE		EA	R	PS		
61	M8-1.25X40 25B	SCREW-SHCS-STL-BO	8			EA	R	PS		
62	M8-1.25X30 25B	SCREW-SHCS-STL-BO	4			EA	R	PS		
63	M5-0.8X30 25B	SCREW-SHCS-STL-BO	2	NON STOCKABLE	-	EA	R	PS		
64	M5-0.8X45 25B	SCREW-SHCS-STL-BO	2		-	EA	R	PS		
65	M5-0.8X12 25B	SCREW-SHCS-STL-BO	9		-	EA	R	PS		
66	10-32X5/8 25B	SCREW-SHCS-STL-BO	12			EA	R	PS		
67	M6-1.0X20 27B	SCREW-BHCS-STL-BO	24			EA	R	PS		
68	M6-1.0X12 25B	SCREW-SHCS-STL-BO	2			EA	R	PS		
69	M8-1.25X25 25B	SCREW-SHCS-STL-BO	8			EA	R	PS		
70	M5-0.8X15 25B	SCREW-SHCS-STL-BO	2	NON STOCKABLE	-	EA	R	PS		
71	M6-1.0X35 25B	SCREW-SHCS-STL-BO	2		-	EA	R	PS		
72	1/4-20X1 25B	SCREW-SHCS-STL-BO	4			EA	R	PS		
73	10-32X3/4 25B	SCREW-SHCS-STL-BO	(1)			EA	R	PS		
74	M10-1.5X110 25B	SCREW-SHCS-STL-BO	2	NON STOCKABLE	A	EA	R	PS		
75	M5 73B	WASHER-SPLIT LOCK-STL-BO	6		-	EA	R	PS		
76	M6 73B	WASHER-SPLIT LOCK-STL-BO	28		-	EA	R	PS		

Item	P/N	Title	Qty	Detail	Rev	UseAs	Stat	Type	Mfr	Mfr P/N
77	M8 73B	WASHER-SPLIT LOCK-STL-BO	12			EA	R	PS		
78	1/2 75Z	WASHER-EXT TOOTH-STL-ZINC	1			EA	R	PS		
79	1/4 73B	WASHER-SPLIT LOCK-STL-BO	4			EA	R	PS		
84	M6-1.0 50B	NUT-HEX-STL-BO	6			EA	R	PS		
86	1/2-20 51Z	NUT-HEX JAM-STL-ZINC	1			EA	R	PS		
87	28196	HEX JAM NUT	4		A	EA	R	DWG		
91	M8 70B	WASHER-FLAT USS-STL-BO	4			EA	R	PS		
92	M5 70B	WASHER-FLAT USS-STL-BO	6			EA	R	PS		

NOTICE: THIS DESIGN WAS ORIGINATED BY AND EMBODIES A CONFIDENTIAL PROPRIETARY DESIGN OWNED BY SOUTHWESTERN INDUSTRIES. IT IS DISCLOSED IN CONFIDENCE FOR A SPECIFIC PURPOSE AND THE RECIPIENT HEREOF AGREES NOT TO MAKE ANY REPRODUCTION, DISCLOSURE OR OTHER USE OF THIS INFORMATION WITHOUT THE WRITTEN CONSENT OF SOUTHWESTERN INDUSTRIES.

REVISIONS				
REV	DESCRIPTION	ECN	DATE	APPRV
C	ADDED NOTE 2 & ITEM 44	14310	01/23/15	AW
D	ITEM 26 415-5MHP-15 WAS: 410-5M-15. ADDED ITEM 22, 36	14416	08/14/15	TO
E	ITEMS 37, 53, 54 WAS: 27583-1, 27641, 27641-1 (CYLINDER & SENSOR ASSY'S)	14491	03/09/16	TO
F	ITEM 61 27085-1 WAS: 24673-2	14545	07/19/16	PM



SEE SHEET 2 FOR  
DETAIL VIEW OF  
BALLSCREW

SEE SHEET 3 FOR  
DETAIL VIEW OF  
CYLINDER

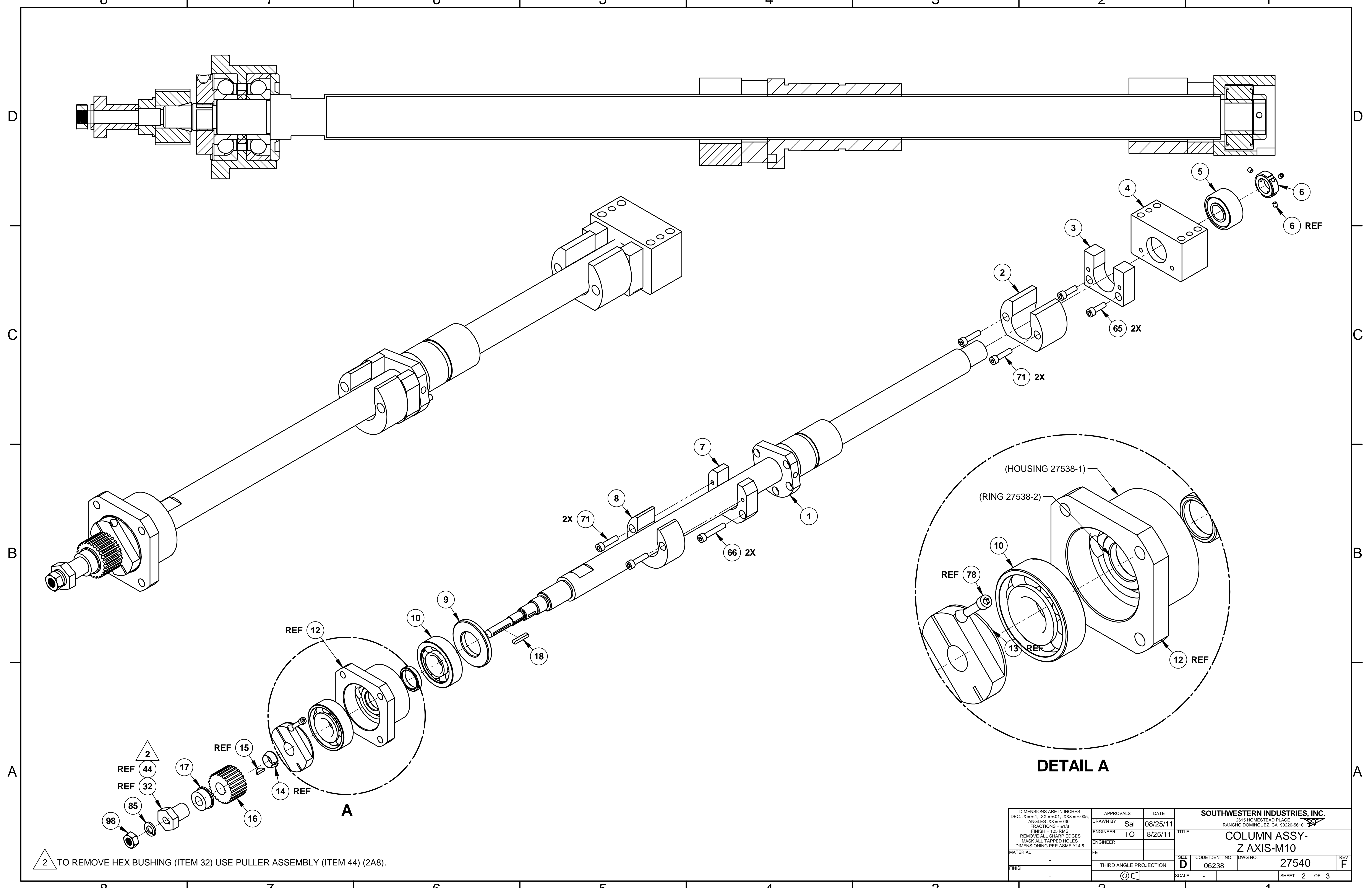
NOTES: (UNLESS OTHERWISE SPECIFIED).  
1. FOR CLARITY NOT ALL HARDWARE (FLAT & LOCK WASHERS) SHOWN. APPLY LOCTITE 222 TO HARDWARE.

(SEE ADDITIONAL NOTE ON SHEET 2)

FOR PARTS LIST SEE SEPARATE 'A' SIZE SHEET

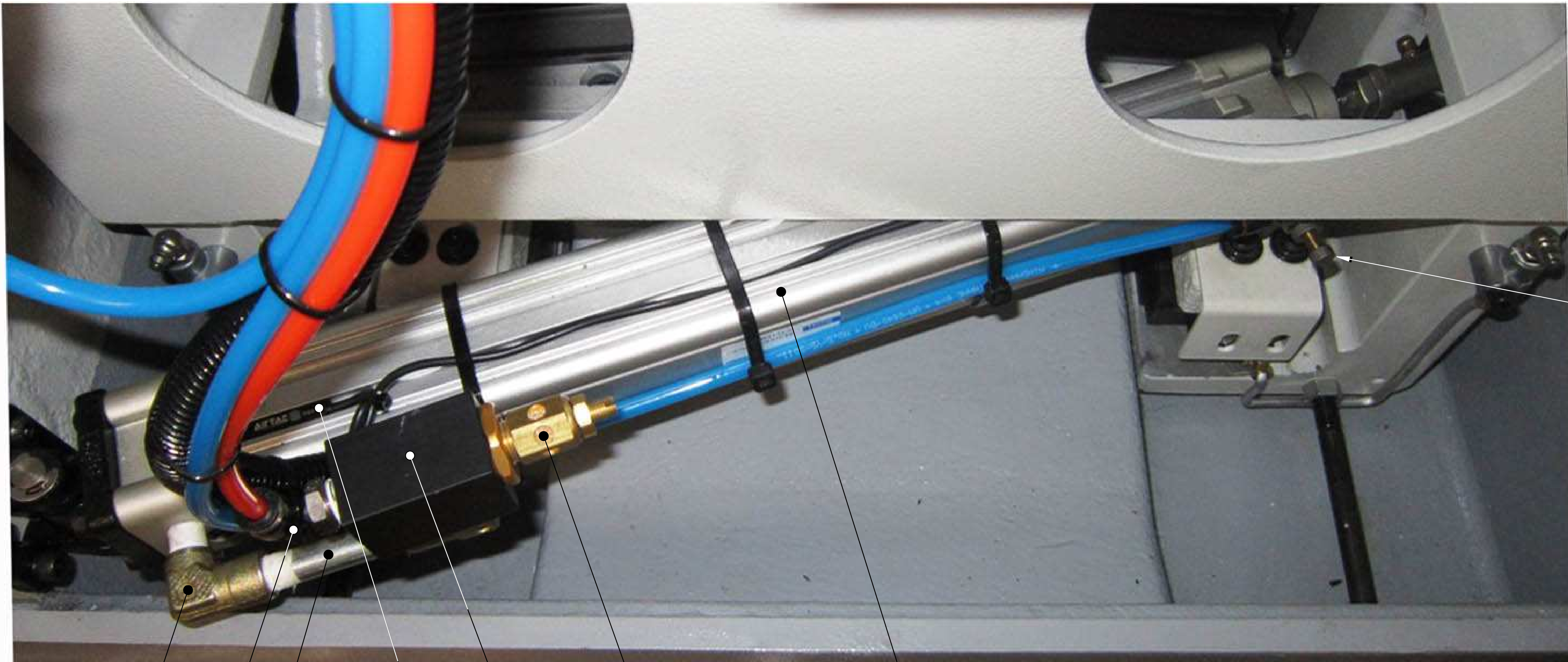
DIMENSIONS ARE IN INCHES DEC. X = ±.1, XX = ±.01, XXX = ±.005 ANGLES: XX = ±0°30' FRACTIONS = ±1/8 FINISH = 125 RMS REMOVE ALL SHARP EDGES MASK ALL TAPPED HOLES DIMENSIONING PER ASME Y14.5		APPROVALS	DATE	SOUTHWESTERN INDUSTRIES, INC. 2615 HOMESTEAD PLACE RANCHO DOMINGUEZ, CA 90220-5610	
DRAWN BY	Sal	08/25/11	TITLE		
ENGINEER	TO	8/25/11	COLUMN ASSY- Z AXIS-M10		
MATERIAL	FE		SIZE	CODE IDENT. NO.	DWG. NO.
FINISH			THIRD ANGLE PROJECTION	D	06238
			SCALE: -		27540
					REV F
					SHEET 1 OF 3





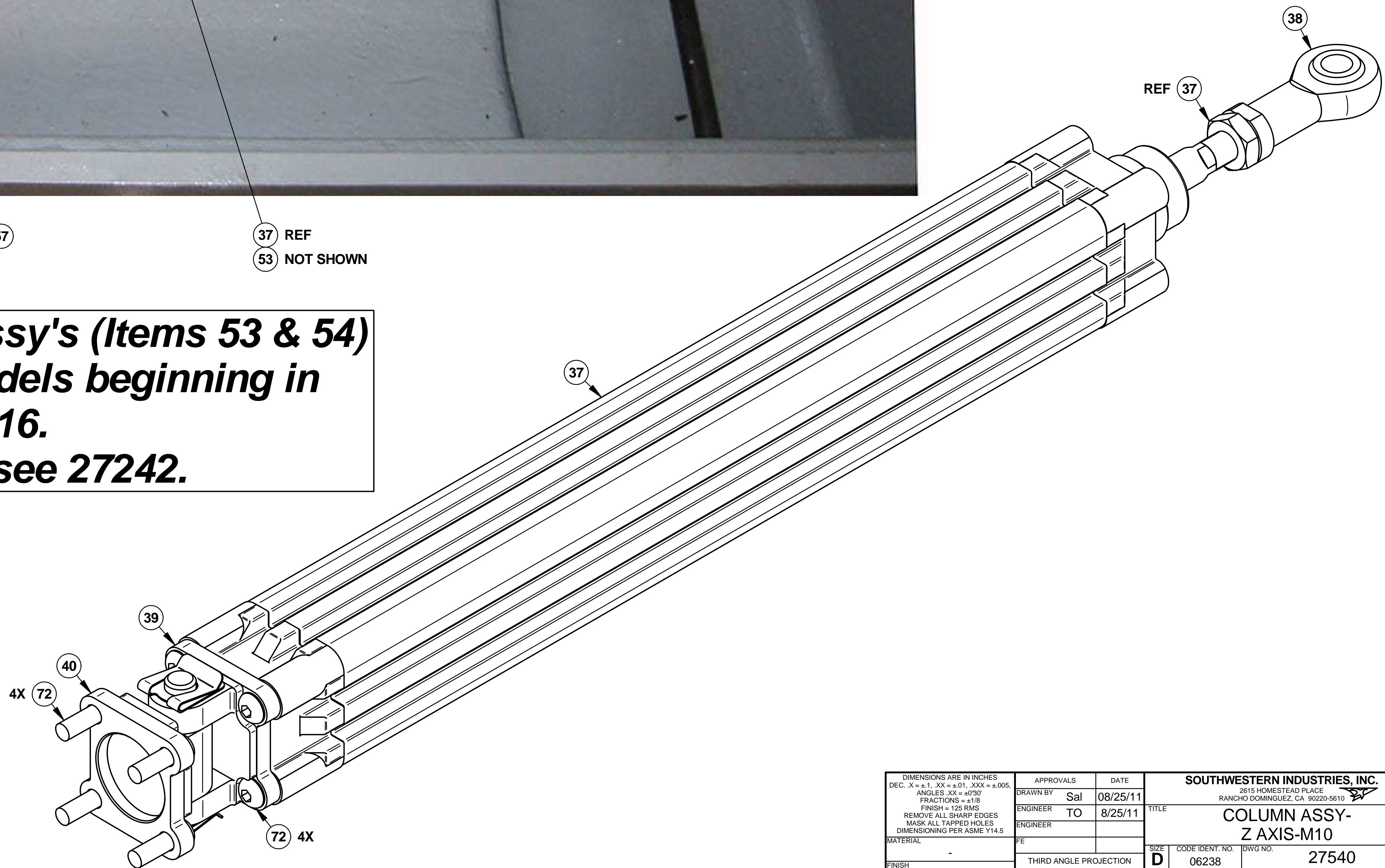
2 TO REMOVE HEX BUSHING (ITEM 32) USE PULLER ASSEMBLY (ITEM 44) (2A8).

DIMENSIONS ARE IN INCHES DEC. X = ±.1, XX = ±.01, XXX = ±.005 ANGLES: XX = ±0°30' FRACTIONS = ±1/8 FINISH = 125 RMS REMOVE ALL SHARP EDGES MASK ALL TAPPED HOLES DIMENSIONING PER ASME Y14.5		APPROVALS DRAWN BY Sal ENGINEER TO ENGINEER	DATE 08/25/11 8/25/11	SOUTHWESTERN INDUSTRIES, INC. 2615 HOMESTEAD PLACE RANCHO DOMINGUEZ, CA 90220-5610
MATERIAL FE		THIRD ANGLE PROJECTION		TITLE <b>COLUMN ASSY- Z AXIS-M10</b>
FINISH -		SIZE <b>D</b>	CODE IDENT. NO. 06238	DWG. NO. 27540
		SCALE: -	SHEET 2 OF 3	REV <b>F</b>



2X (60) (61) (62) (54) (59) (57) (37) REF (53) NOT SHOWN

**Cylinder (Item 37) & Sensor Assy's (Items 53 & 54) were changed to current models beginning in 1st quarter 2016. For Replacement Kit see 27242.**



<small>DIMENSIONS ARE IN INCHES          DEC. X = ±.1, XX = ±.01, XXX = ±.005          ANGLES: XX = ±0°30'          FRACTIONS = ±1/8          FINISH = 125 RMS          REMOVE ALL SHARP EDGES          MASK ALL TAPPED HOLES          DIMENSIONING PER ASME Y14.5</small>	APPROVALS	DATE	<b>SOUTHWESTERN INDUSTRIES, INC.</b> <small>2615 HOMESTEAD PLACE          RANCHO DOMINGUEZ, CA 90220-5610</small>		
	DRAWN BY	Sal	08/25/11	TITLE	
	ENGINEER	TO	8/25/11	<b>COLUMN ASSY-          Z AXIS-M10</b>	
	ENGINEER			SIZE	CODE IDENT. NO.
MATERIAL	THIRD ANGLE PROJECTION		D	06238	27540
FINISH	SCALE: -				REV F
			SHEET 3 OF 3		

**27540**  
COLUMN ASSY-Z AXIS-M10

Type	PL	Dwg Size	D
Revision	F	Product	2 OP Mill
Status	R	Engineer	TO
Date	4/24/2009	Planner Code	
By	Sal	Comm Code	

Item	P/N	Title	Detail	Qty	UseA	Rev	Stat	Type	Mfr	Mfr P/N
1	27533	BALLSCREW-Z AXIS		1	EA	-	R	DWG		
2	27537-1	BUMPER-Z AXIS-BOTTOM		1	EA	-	R	DWG		
3	27536-1	SPACER-BUMPER-Z AXIS-BOTTOM	SEE 27540 OR 27540-1	1	EA	-	R	PS	KING RICH	
4	27535	BEARING BLOCK-FLOATING END Z AXIS		1	EA	-	R	DWG		
5	22008	BEARING-204KTT		1	EA	C	R	DWG		
6	27951-4	LOCKNUT-M20 X 1.0		1	EA	-	R	PS	KING RICH	
7	27536-2	SPACER-BUMPER-Z AXIS-TOP		1	EA	A	R	DWG		
8	27537-2	BUMPER-Z AXIS-TOP		1	EA	-	R	DWG		
9	27674	SEAL-NILOS RING-7305-AVH		1	EA	-	R	DWG		
10	20373-1	BEARING-ANGULAR CONTACT-7305 BECBP		2	EA	-	R	DWG		
12	27538	BEARING HOUSING ASSY- Z AXIS DRIVE		(1)	EA	-	R	PL		
13	27756	NUT-CLAMP-Z AXIS		(1)	EA	C	R	DWG		
14	16350	FERRULE-SPROCKET-DRIVE KIT		(1)	EA	-	R	DWG		
15	98481A090	KEY WOODRUFF #404-1/8 X 1/2		(1)	EA	-	R	PS		
16	27513	SPROCKET-26 TEETH W/O GUIDES		1	EA	A	R	DWG		
17	27536	SPACER-SHOULDER M10	SEE 27540	1	EA	-	R	PS	KING RICH	
18	27501	KEY-4x4x25	SEE 27540	1	EA	-	R	PS	KING RICH	
20	27603-25	BRACKET-MTG-FLOW CONTROLS-ATC DOOR CYL		1	EA	-	R	DWG	KING RICH	
21	28071-3	VALVE-FLOW CONTROL-INLINE-AIR	Ø6mm PUSH TO CONNECT	2	EA	-	R	PS	KING RICH	A-260-070
22	27206	COVER ASSY-BRAKE-M10		(1)	EA	A	R	PL		
23	27528	COLUMN-Z AXIS		1	EA	-	R	DWG		
24	27682-12	RETAINER-SEAL-TOOL-Z AXIS	SEE 27540 OR 27540-1	2	EA	-	R	PS	KING RICH	

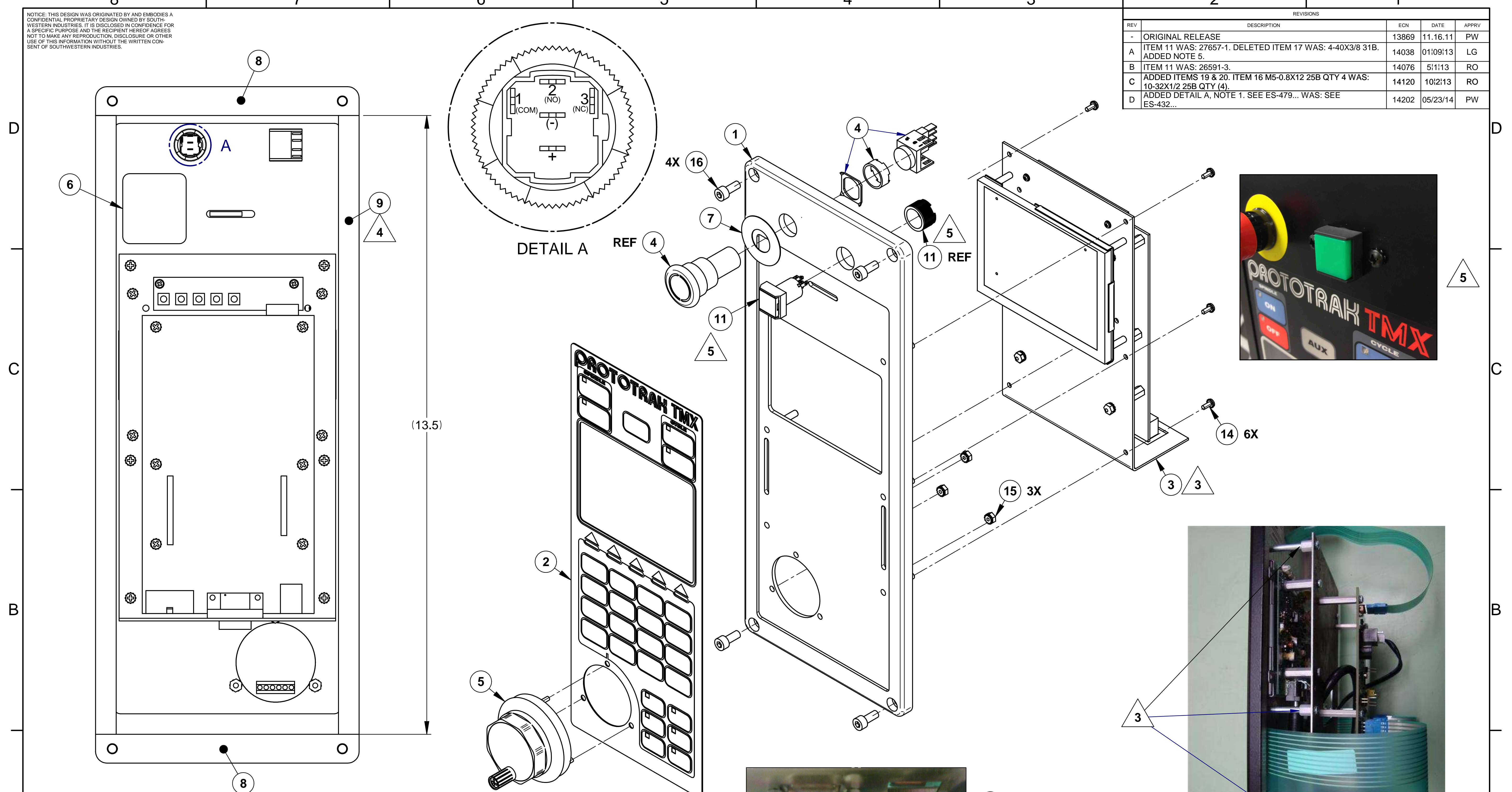
Item	P/N	Title	Detail	Qty	UseA	Rev	Stat	Type	Mfr	Mfr P/N
25	27682-13	SEAL-TOOL-Z AXIS	SEE 27540 OR 27540-1	2	EA	-	R	PS	KING RICH	
26	27539	BRACKET-MOTOR-Z AXIS		1	EA	-	R	DWG		
27	24428-4	MOTOR DRIVER ASSY-40/55-W/BRAKE-Z AXIS		(1)	EA	E	R	PL		
28	415-5MHP-15	BELT-TIMMING 5MM OMEGA HP OPTIBELT		(1)	EA	A	R	PS	OPTIBELT	415-5MHP-15
29	26740-5	GUIDE-LINEAR-SET (2) -Z AXIS	920mm	1	EA	-	R	DWG		
30	27541-1	CAP-GUIDE-LINEAR	SEE X, Y, Z DRV TRAIN	30	EA	-	R	PS		
31	24642	MOUNTING PLATE-BRAKE-Z AXIS		1	EA	-	R	DWG		
32	27640	BRAKE ASSY-Z AXIS-24VDC		1	EA	B	R	PL		
33	27635-13	CABLE ASSY-Z AXIS BRAKE	DC300-118	1	EA	-	R	PL		
34	22680-3	SWITCH-LIMIT-ROLLER PLUNGER		1	EA	-	R	DWG		
35	27545	TELESCOPIC COVER ASSY-LF & RT	SEE 27540 OR 27540-1	1	EA	-	R	PL		
36	27170	CABLE ASSY-MOTOR BREAKING-3'		(1)	EA	A	R	PL		
37	27583-8	CYLINDER-AIR-32 BORE 300 STROKE	USED WITH SENSORS ASSY 27641-2 & 27641-3	1	EA	A	R	DWG		
38	27583-2	ROD END-BALL JOINT-10MM ID	SEE 27540 OR 27540-1	1	EA	-	R	PS		
39	27583-3	SWIVEL FLANGE-REAR PIVOT	SEE 27540 OR 27540-1	1	EA	-	R	PS	AIR TAC	CA-174404 SNCL 32 L
40	27583-4	SWIVEL FLANGE-MTG BRKT	SEE 27540 OR 27540-1	1	EA	-	R	PS	AIR TAC	CB-174390 SNCB 32 SF 0
41	27169	CABLE ASSY-MOTOR POWER-7.5'		(1)	EA	A	R	PL		
42	27168	CABLE ASSY-MOTOR ENCODER-75"-3 HOLE FITTING		(1)	EA	-	R	PL		
43	22768-33	LABEL-TEXT-WHITE-1.00W x 1.437H	Y MOTOR	(2)	EA	AD	R	DWG		
44	28203	PULLER ASSY-HEX BUSHING-BRAKE-M10		(1)	EA	A	R	PL		
45	28020-1	FITTING-HOSE- HYDRAULIC	SEE 27540 OR 27540-1	1	EA	-	R	PS	KING RICH	
46	28020-2	FITTING-COLUMN/MANIFOLD	SEE 27540 OR 27540-1	1	EA	-	R	PS	KING RICH	

Item	P/N	Title	Detail	Qty	UseA	Rev	Stat	Type	Mfr	Mfr P/N
47	28020-3	FITTING-COLUMN	SEE 27540 OR 27540-1	1	EA	-	R	PS	KING RICH	
48	26893-1	MANIFOLD-AIR/COOLANT	SEE 27540 OR 27540-1	1	EA	-	R	PS	KING RICH	
49	27177-3	NUT-FLARE-ADAPTER	SEE 27540 OR 27540-1	2	EA	-	R	PS	KING RICH	
50	27177-1	ADAPTER-LINK-COOLANT		5	EA	-	R	PS	KING RICH	A-084-25
51	27177-2	NOZZLE-COOLANT WASH-1" FLARE	SHORT	2	EA	-	R	PS	KING RICH	
52	27177-4	CONNECTOR-LOC LINE-COOLANT NPT	SEE 27540 OR 27540-1	1	EA	-	R	PS	LOC LINE	
53	27641-2	SENSOR ASSY-ATC FRONT INPUT		1	EA	A	R	PL		
54	27641-3	SENSOR ASSY-ATC BACK INPUT		1	EA	A	R	PL		
55	28018	PLATE-MOTOR/BELT ADJUSTMENT		1	EA	-	R	PS		
56	28071	VALVE-FLOW CONTROL-AIR		1	EA	-	R	PS	KING RICH	A-572-001
57	28071-1	VALVE-FLOW CONTROL W MUFFLER-AIR	SEE 27563	1	EA	-	R	PS	KING RICH	A-260-007-3
58	27635-3	CABLE ASSY-Z AXIS HOME SW	DC300-113	1	EA	-	R	PL		
59	28074	VALVE-QUICK EXHAUST	SEE 27563	1	EA	-	R	PS	KING RICH	A-201-001
60	24673-1	ELBOW-STREET - 1/8 BSPT	SEE 27540 OR 27540-1	2	EA	-	R	PS		
61	27085-1	FITTING-AIR-90°-6mm-PUSH TO CONNECT	1/4 BSPT MALE THD	1	EA	-	R	PS	KING RICH	A-316-408
62	28076	NIPPLE-ROUND- 1/8 BSPT X 2 LG	SEE 27540 OR 27540-1	1	EA	-	R	PS		
64	M6XM8X62	STANDOFF-M/F-62mm L	NON STOCKABLE	2	EA	-	R	PS		
65	M6-1.0X20 25B	SCREW-SHCS-STL-BO		36	EA		R	PS		
66	M8-1.25X35 25B	SCREW-SHCS-STL-BO		14	EA		R	PS		
67	M8-1.25X40 25B	SCREW-SHCS-STL-BO		4	EA		R	PS		
68	M6-1.0X12 25B	SCREW-SHCS-STL-BO		2	EA		R	PS		
69	M6-1.0X10 26B	SCREW-FHCS-STL-BO	NON STOCKABLE	30	EA	-	R	PS		
70	M4-0.7X25 27B	SCREW-BHCS-STL-BO	NON STOCKABLE	2	EA	-	R	PS		
71	M6-1.0X25 25B	SCREW-SHCS-STL-BO		4	EA		R	PS		

Item	P/N	Title	Detail	Qty	UseA	Rev	Stat	Type	Mfr	Mfr P/N
72	1/4-20X1 25B	SCREW-SHCS-STL-BO		4	EA		R	PS		
73	M5-0.8X20 25B	SCREW-SHCS-STL-BO	NON STOCKABLE	2	EA	-	R	PS		
74	M5-0.8X0.05M	THREADED ROD-50mm L	SEE 27540	1	EA	-	R	PS		
75	M5-0.8X10 25B	SCREW-SHCS-STL-BO		6	EA	-	R	PS		
76	M6-1.0X10 27B	SCREW-BHCS-STL-BO		8	EA	-	R	PS		
77	M5-0.8X10 27B	SCREW-BHCS-STL-BO		6	EA	-	R	PS		
78	10-32X3/4 25B	SCREW-SHCS-STL-BO		(1)	EA		R	PS		
79	M5-0.7X10 26Z	SCREW-FHCS-STL-ZINC	NON STOCKABLE	6	EA	-	R	PS		
80	M4-0.7X25 25B	SCREW-BHCS-STL-BO	NON STOCKABLE	4	EA	-	R	PS		
82	1/4 73B	WASHER-SPLIT LOCK-STL-BO		4	EA		R	PS		
83	M8 73B	WASHER-SPLIT LOCK-STL-BO		12	EA		R	PS		
84	M6 73B	WASHER-SPLIT LOCK-STL-BO		4	EA	-	R	PS		
85	M10 73B	WASHER-SPLIT LOCK-STL-BO		1	EA	-	R	PS		
86	M5 73B	WASHER-SPLIT LOCK-STL-BO		12	EA	-	R	PS		
87	M4 73B	WASHER-SPLIT LOCK-STL-BO		4	EA		R	PS		
88	M5 70B	WASHER-FLAT USS-STL-BO		4	EA	-	R	PS		
89	M4 70B	WASHER-FLAT-STL-BO		4	EA	-	R	PS		
92	M8 70B	WASHER-FLAT USS-STL-BO		8	EA		R	PS		
93	M6 71B	WASHER-FLAT SAE-STL-BO		2	EA	-	R	PS		
94	M5 71B	WASHER-FLAT SAE-STL-BO	NON STOCKABLE	1	EA	-	R	PS		
98	M10 56Z	NUT-NYLON LOCK-STL-ZINC	NON STOCKABLE	1	EA	-	R	PS		
99	M5-0.8 50B	NUT-HEX-BLK OX		3	EA	-	R	PS		

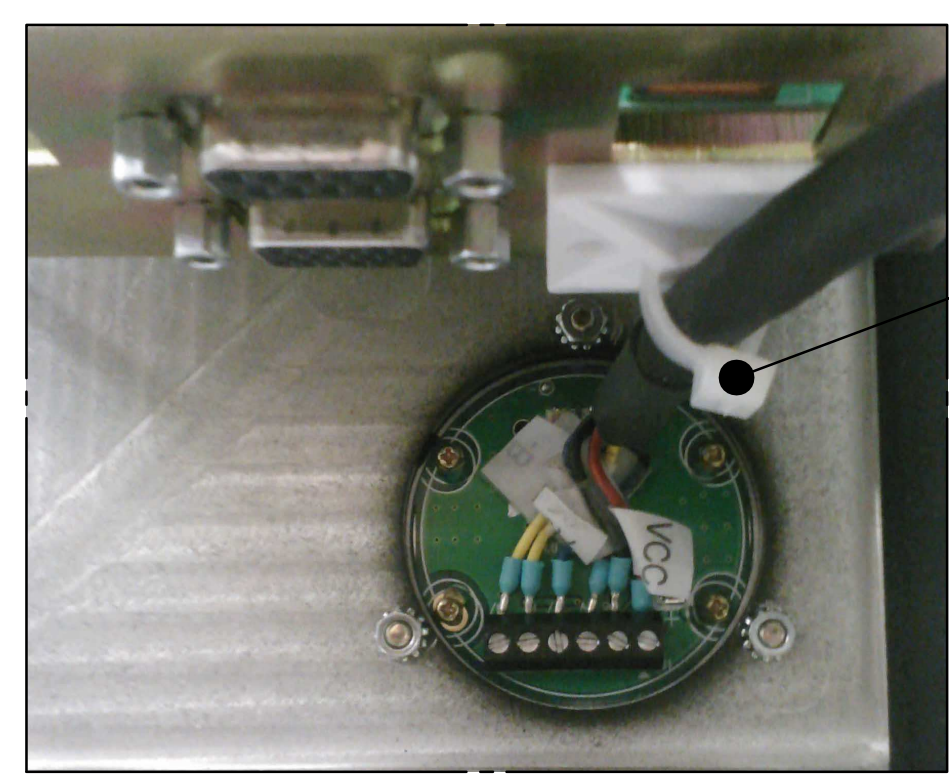
NOTICE: THIS DESIGN WAS ORIGINATED BY AND EMBODIES A CONFIDENTIAL PROPRIETARY DESIGN OWNED BY SOUTHWESTERN INDUSTRIES. IT IS DISCLOSED IN CONFIDENCE FOR A SPECIFIC PURPOSE AND THE RECIPIENT HEREOF AGREES NOT TO MAKE ANY REPRODUCTION, DISCLOSURE OR OTHER USE OF THIS INFORMATION WITHOUT THE WRITTEN CONSENT OF SOUTHWESTERN INDUSTRIES.

REVISIONS				
REV	DESCRIPTION	ECN	DATE	APPRV
-	ORIGINAL RELEASE	13869	11.16.11	PW
A	ITEM 11 WAS: 27657-1. DELETED ITEM 17 WAS: 4-40X3/8 31B. ADDED NOTE 5.	14038	01/09/13	LG
B	ITEM 11 WAS: 26591-3.	14076	5/11/13	RO
C	ADDED ITEMS 19 & 20. ITEM 16 M5-0.8X12 25B QTY 4 WAS: 10-32X1/2 25B QTY (4).	14120	10/2/13	RO
D	ADDED DETAIL A, NOTE 1. SEE ES-479... WAS: SEE ES-432...	14202	05/23/14	PW



NOTES: (UNLESS OTHERWISE SPECIFIED).

1. SEE ES-479 FOR TEST PROCEDURE.
2. SOCKET HEAD CAP SCREW (ITEM 16) USED TO MOUNT PENDANT TO MACHINE ON NEXT ASSEMBLY.
3. MULTI-INNO IS PRIMARY LCD ASSY USED AND SHOWN IN ASSY DRAWING. WHEN USING SECONDARY LCD MODULE ASSY (PRIME VIEW) USE 27652-1 FOR ITEM 3. PLACE 6 STANDOFFS (4-40x1/4x5/16 93A) THAT COME WITH 27652-1 ASSY ON BEZEL STANDOFFS AS SHOWN IN PICTURE.
4. ADD 13.5 OF ITEM 9 GASKET TO EACH SIDE AS SHOWN ON DRAWING FLUSH TO ITEM 8 GASKET ON E-STOP SIDE.
5. ORIENTATE SERVO ON BUTTON (ITEM 11) AS SHOWN (C1,3,5).



DIMENSIONS ARE IN INCHES DEC. X = ±.1, XX = ±.01, XXX = ±.005 ANGLES XX = ±0°30' FRACTIONS = ±1/8 FINISH = 125 RMS REMOVE ALL SHARP EDGES MASK ALL TAPPED HOLES DIMENSIONING PER ASME Y14.5		APPROVALS	DATE	SOUTHWESTERN INDUSTRIES, INC. 2615 HOMESTEAD PLACE RANCHO DOMINGUEZ, CA 90220-5610	
MATERIAL		DRAWN BY	RC	5/10/11	TITLE
NEXT ASSY		ENGINEER	PW	11/16/11	PANEL ASSY- 2 OP MILL
USED ON		CHECKER	SAL	05/23/14	
APPLICATION		THIRD ANGLE PROJECTION		SIZE	CODE IDENT. NO.
		SCALE: -		D	06238
				REV	D
				27604	
				SHEET 1 OF 1	

Parts List for Assembly P/N: 27604

Printed 5/23/2014

**27604**  
 PANEL ASSY-2OP M10 MILL

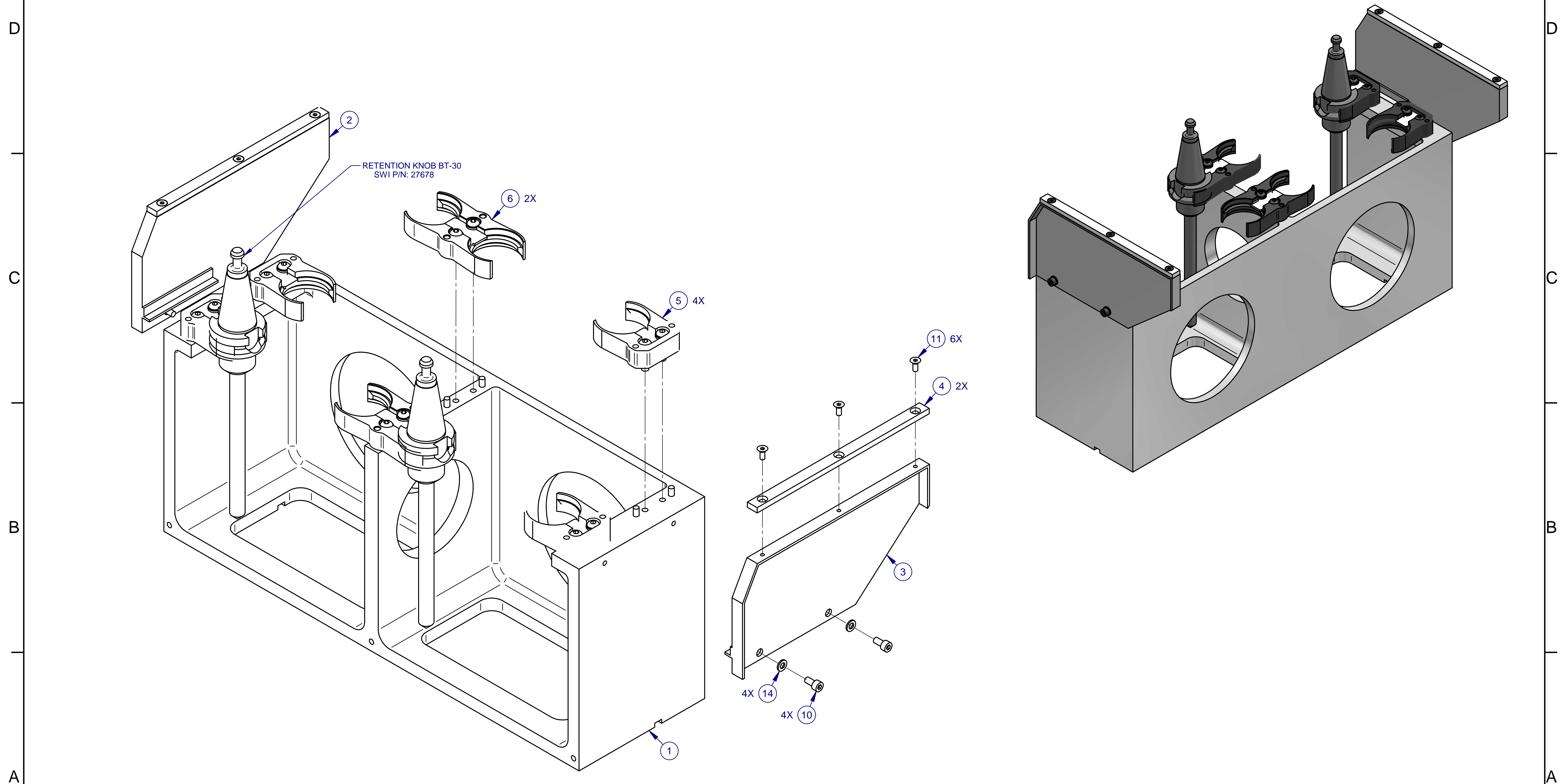
Type	PL	Dwg Size	D
Revision	D	Product	2 OP
Status	R	Engineer	PW
Date	5/10/2011	Planner Code	
By	RC	Comm Code	

Item	P/N	Title	Detail	Stat	Qty	Rev	Type	UseAs	Mfr	Mfr P/N
1	26364	BEZEL-PENDANT-5" LCD		R	1	B	DWG	EA		
2	27647	OVERLAY-TMX		R	1	A	PS	EA		
3	27652	LCD MODULE ASSY-5"		R	1	A	PL	EA		
4	26039	SWITCH - E-STOP - PUSH BUTTON		R	1	-	PS	EA		
5	26538-1	HANDWHEEL-ELECTRONIC		R	1	A	PS	EA		
6	27604-LB1	LABEL-TEXT-PANEL ASSY		R	1	-	PS	EA		
7	22302-1	LABEL-YELLOW E-STOP		R	1	-	DWG	EA		
8	27669	GASKET-BEZEL		R	2	-	PS	EA		
9	27669-1	GASKET-BEZEL-ROLL		R	27	-	DWG	MM		
10	27672	PACKAGING-TX PENDANT		R	(1)	A	PL	EA		
11	26716-1	SWITCH-ASSY-PUSHBUTTON-SERVO ON		R	1	-	PL	EA		
14	4-40X1/2 31Z	SCREW-PH-PHIL-EXT SEMS-STL-ZINC		R	6	-	PS	EA		
15	M3 61Z	NUT-KEP-STL-ZINC		R	3	-	PS	EA		
16	M5-0.8X12 25B	SCREW-SHCS-STL-BO		R	4	-	PS	EA		
19	23262-2	CABLE TIE HOLDER-1.125"X1.125"		R	1	-	DWG	EA		
20	22475	TIE WRAP-4 IN-PLASTIC		R	1	-	DWG	EA		



NOTICE: THIS DESIGN WAS ORIGINATED BY AND EMBODIES A CONFIDENTIAL PROPRIETARY DESIGN OWNED BY SOUTHWESTERN INDUSTRIES. IT IS DISCLOSED IN CONFIDENCE FOR A SPECIFIC PURPOSE AND THE RECIPIENT HEREOF AGREES NOT TO MAKE ANY REPRODUCTION, DISCLOSURE OR OTHER USE OF THIS INFORMATION WITHOUT THE WRITTEN CONSENT OF SOUTHWESTERN INDUSTRIES.

		REVISIONS		
REV	DESCRIPTION	ECN	DATE	APPRV
-	ORIGINAL RELEASE	13911	12.19.11	TO
A	F/D ITEMS 2 & 3 WAS: 3 & 2	14273	9/26/14	LG



NOTES: (UNLESS OTHERWISE SPECIFIED).

DIMENSIONS ARE IN INCHES DEC. .X = ±.1, .XX = ±.01, .XXX = ±.005 ANGLES: .XX = ±0°30' FRACTIONS = ±1/8 FINISH = 125 RMS REMOVE ALL SHARP EDGES MASK ALL TAPPED HOLES DIMENSIONING PER ASME Y14.5		APPROVALS DRAWN BY RC ENGINEER TO CHECKER Sal DATE 9/15/11 DATE 12/19/11 DATE 9/18/14	SOUTHWESTERN INDUSTRIES, INC. 2615 HOMESTEAD PLACE RANCHO DOMINGUEZ, CA 90220-5610
MATERIAL - FINISH -		THIRD ANGLE PROJECTION 	TITLE <b>ATC ASSY- 2 OP MILL</b> SIZE <b>D</b> CODE IDENT. NO. 06238 DWG NO. 27587 REV A SCALE: - SHEET 1 OF 1

Parts List for Assembly P/N: 27587

Printed 9/26/2014

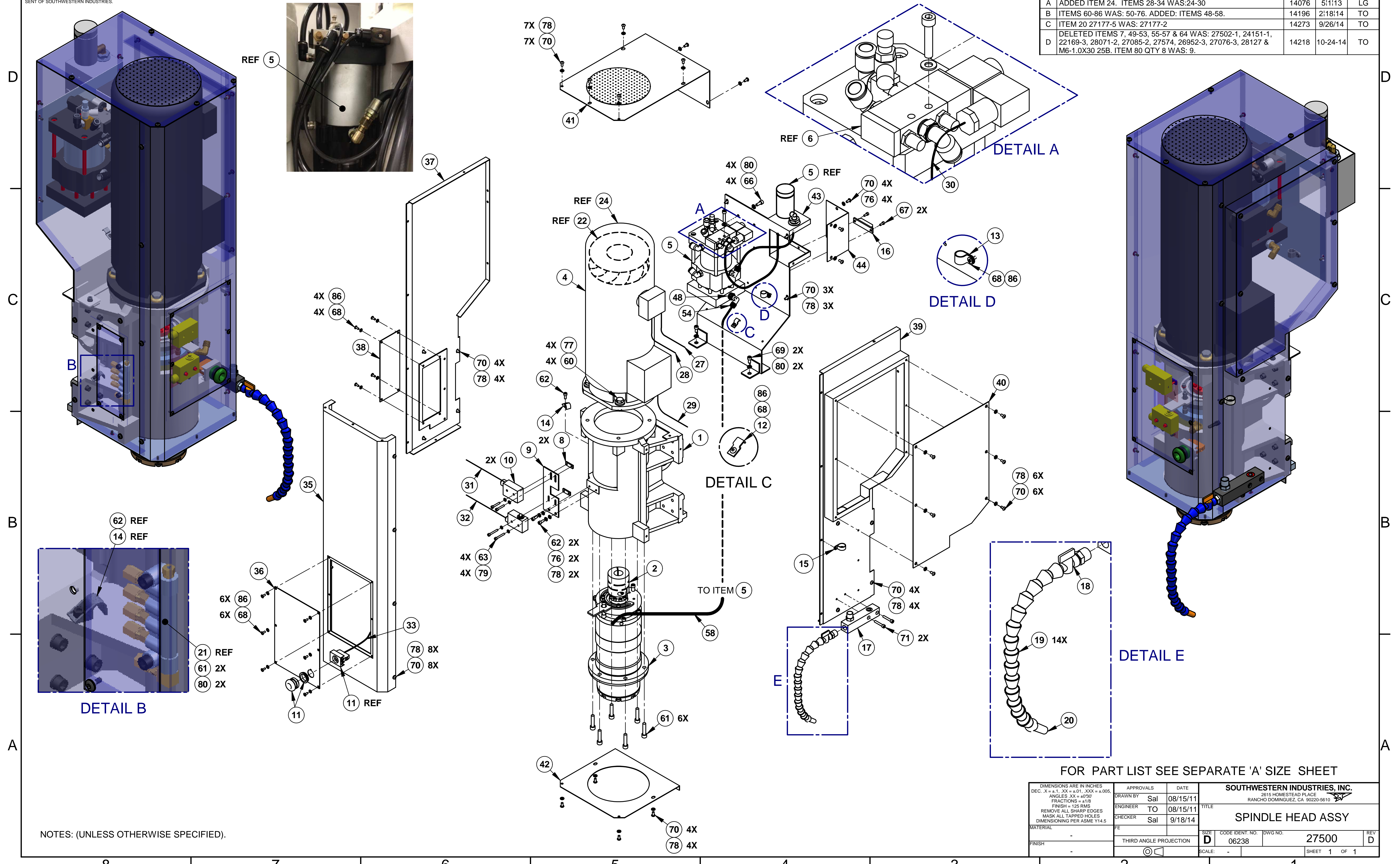
**27587**  
 ATC ASSY-2 OP MILL

Type	PL	Dwg Size	D
Revision	A	Product	2 OP
Status	R	Engineer	TO
Date	9/15/2011	Planner Code	
By	RC	Comm Code	

Item	P/N	Title	Detail	Qty	UseAs	Rev	Stat	Type	Mfr	Mfr P/N
1	27576-1	HOUSING-TOOL HOLDERS ASSY		1	EA	-	R	PL		
2	27575	BRACKET-DOOR ASSIST-LEFT		1	EA	-	R	PS	KING RICH	OP520100
3	27575-1	BRACKET-DOOR ASSIST-RIGHT		1	EA	-	R	PS	KING RICH	OP520110
4	27615	WEAR STRIP-DOOR ASSIST		2	EA	-	R	PS	KING RICH	OP520210
5	27493	GRIPPER ASSY-TOOL CHANGER		4	EA	-	R	PL		
6	27494	GRIPPER ASSY-DUAL-TOOL CHANGER		2	EA	-	R	PL		
10	M5-0.8X10 25B	SCREW-SHCS-STL-BO		4	EA	-	R	PS		
11	M4-0.7X10 26B	SCREW-FHCS-STL-BO	NON STOCKABLE	6	EA	-	R	PS		
14	M5 71B	WASHER-FLAT SAE-STL-BO	NON STOCKABLE	4	EA	-	R	PS		

NOTICE: THIS DESIGN WAS ORIGINATED BY AND EMBODIES A CONFIDENTIAL PROPRIETARY DESIGN OWNED BY SOUTHWESTERN INDUSTRIES. IT IS DISCLOSED IN CONFIDENCE FOR A SPECIFIC PURPOSE AND THE RECIPIENT HEREOF AGREES NOT TO MAKE ANY REPRODUCTION, DISCLOSURE OR OTHER USE OF THIS INFORMATION WITHOUT THE WRITTEN CONSENT OF SOUTHWESTERN INDUSTRIES.

REVISIONS				
REV	DESCRIPTION	ECN	DATE	APPRV
-	ORIGINAL RELEASE	13915	04/26/12	TO
A	ADDED ITEM 24. ITEMS 28-34 WAS:24-30	14076	5/11/13	LG
B	ITEMS 60-86 WAS: 50-76. ADDED: ITEMS 48-58.	14196	2/18/14	TO
C	ITEM 20 27177-5 WAS: 27177-2	14273	9/26/14	TO
D	DELETED ITEMS 7, 49-53, 55-57 & 64 WAS: 27502-1, 24151-1, 22169-3, 28071-2, 27085-2, 27574, 26952-3, 27076-3, 28127 & M6-1.0X30 25B. ITEM 80 QTY 8 WAS: 9.	14218	10-24-14	TO



NOTES: (UNLESS OTHERWISE SPECIFIED).

FOR PART LIST SEE SEPARATE 'A' SIZE SHEET

DIMENSIONS ARE IN INCHES DEC. X = ±.1, XX = ±.01, XXX = ±.005 ANGLES: XX = ±0°30' FRACTIONS = ±1/8 FINISH = 125 RMS REMOVE ALL SHARP EDGES MASK ALL TAPPED HOLES DIMENSIONING PER ASME Y14.5		APPROVALS DRAWN BY: Sal ENGINEER: TO CHECKER: Sal		DATE 08/15/11 08/15/11 9/18/14		SOUTHWESTERN INDUSTRIES, INC. 2615 HOMESTEAD PLACE RANCHO DOMINGUEZ, CA 90220-5610	
MATERIAL		FINISH		THIRD ANGLE PROJECTION		TITLE <b>SPINDLE HEAD ASSY</b>	
SIZE		CODE IDENT. NO.		DWG NO.		REV	
-		D		06238		27500	
SCALE: -		SHEET 1 OF 1					

Parts List for Assembly P/N: 27500

Printed 10/27/2014

27500  
SPINDLE HEAD ASSY

Type	PL	Dwg Size	D
Revision	D	Product	2OP
Status	R	Engineer	TO
Date	4/14/2009	Planner Code	
By	Sal	Comm Code	

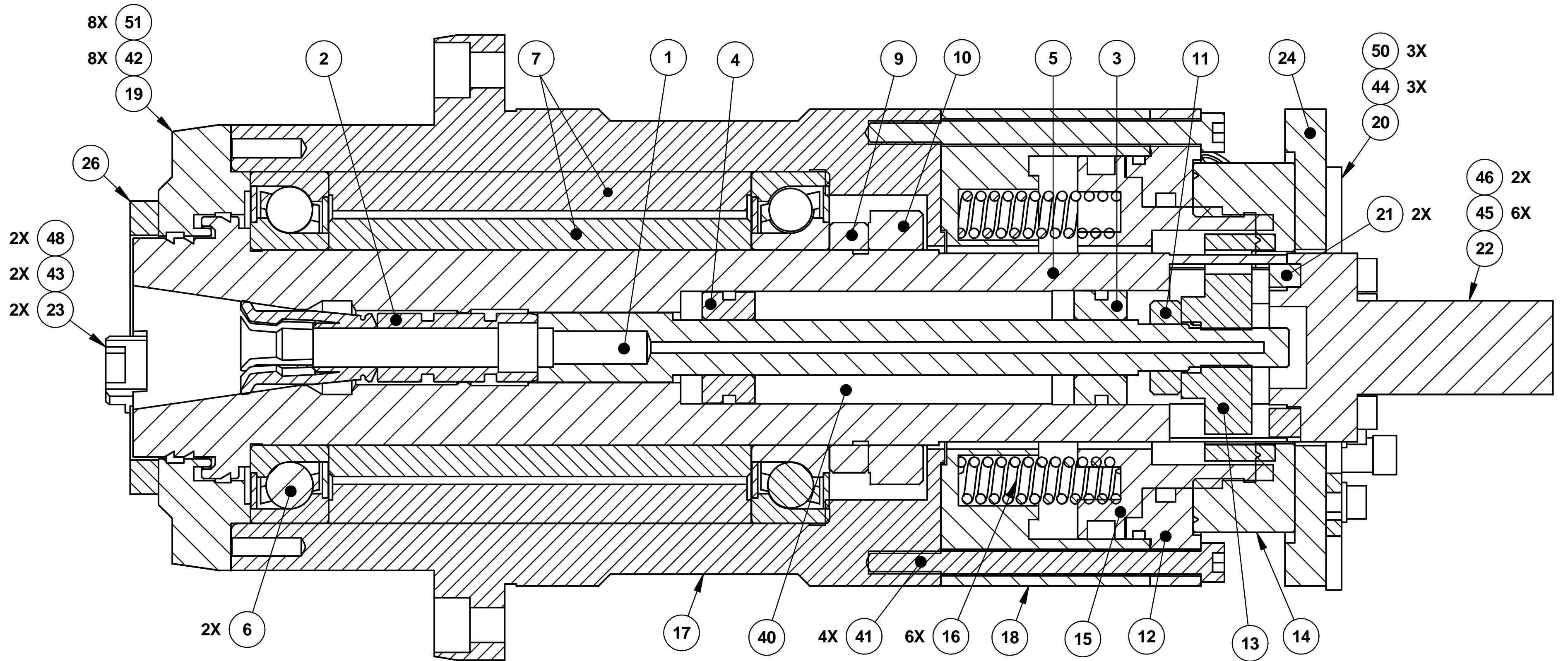
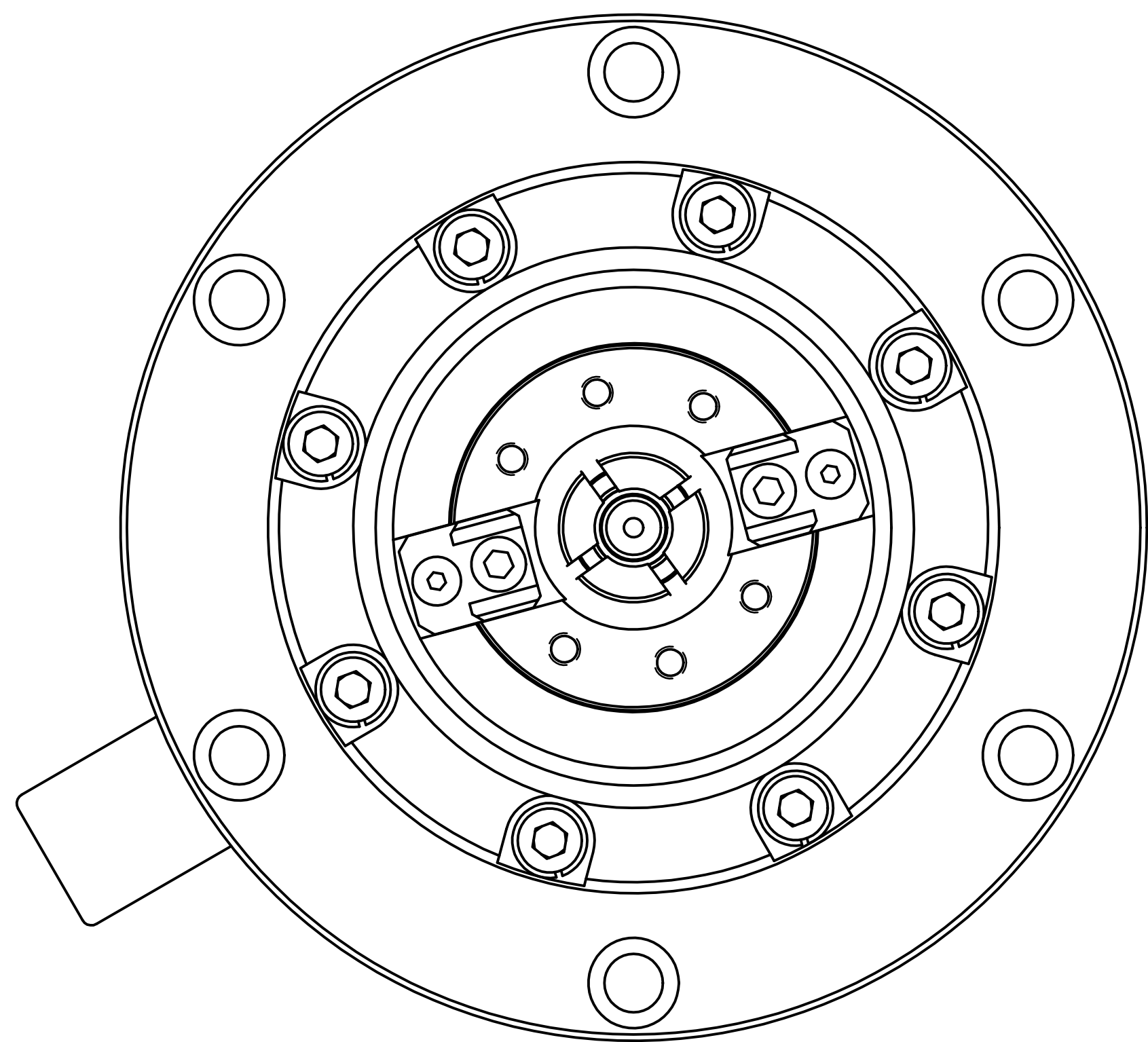
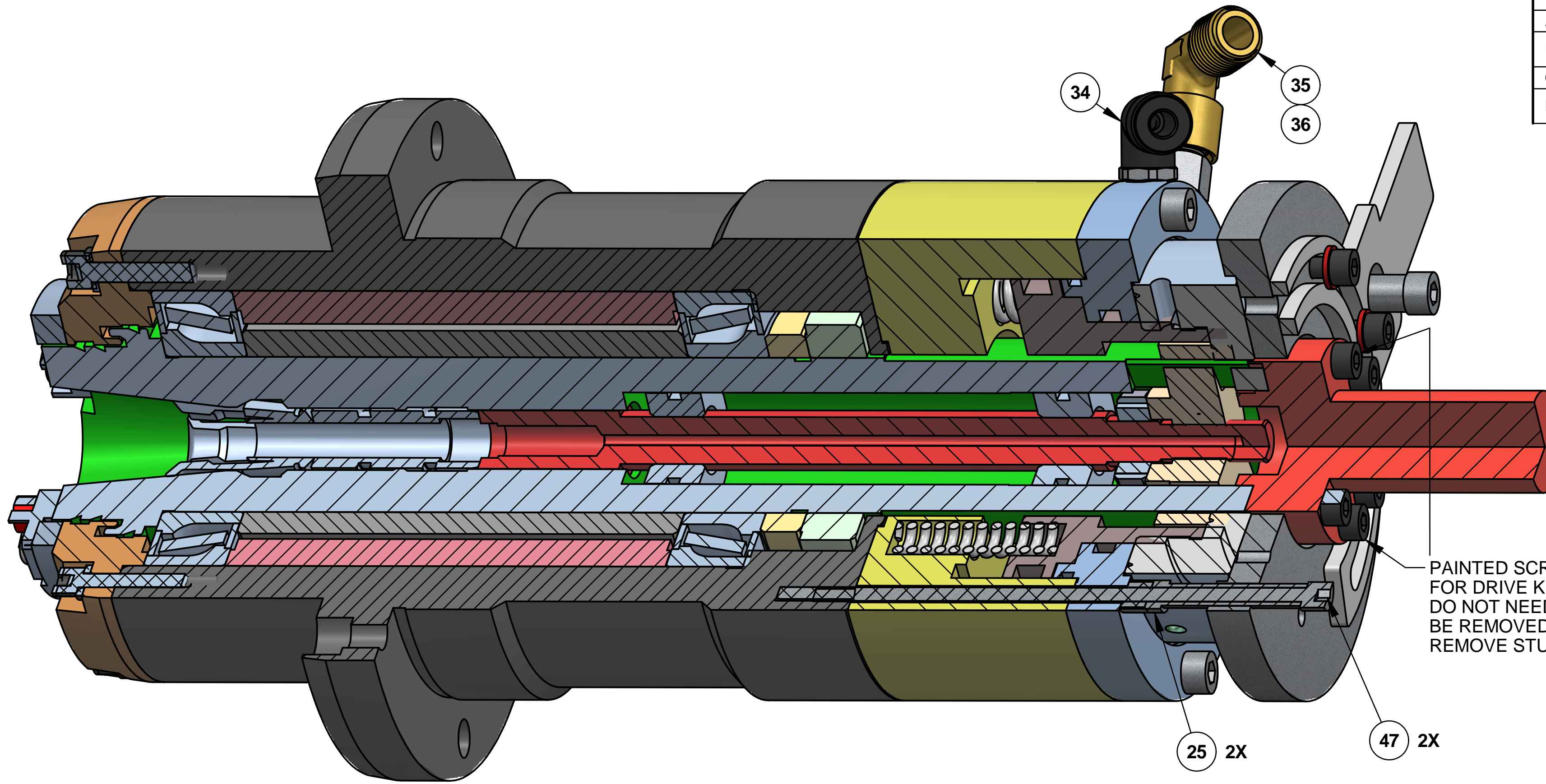
Item	P/N	Title	Detail	Qty	UseAs	Rev	Stat	Type	Mfr	Mfr P/N
1	27505	HOUSING-SPINDLE-30 TAPER		1	EA	-	R	DWG		
2	27857	COUPLING-SPINDLE-2OP	SEE 27500 OR 27500-1	1	EA	-	R	PS	KING RICH	
3	27830	SPINDLE ASSY-2OP MILL		1	EA	A	R	PL		
4	26849-1	MOTOR-SPINDLE-INDUCTION-3HP-WITH ENCODER		1	EA	-	R	DWG		
5	27502	CYLINDER ASSY-TOOL UNCLAMP		1	EA	A	R	PL		
6	26938-4	VALVE-AIR-SOLENOID-SINGLE-4WAY-2POS- 24VDC		(1)	EA	-	R	DWG		
8	27506	PLATE-NUT-LIM SW	SEE 27500 OR 27500-1	2	EA	-	R	PS	KING RICH	
9	27507	PLATE-MOUNTING-LIM SW		1	EA	-	R	DWG		
10	22680-4	SWITCH-LIMIT-PLUNGER	SEE 27500 OR 27500-1	2	EA	-	R	PS		
11	22874-1	PUSH BUTTON-RESET-N.O. CONTACT	TOOL UNCLAMP	1	EA	B	R	DWG		
12	22637-2	CLAMP-CABLE-HALF	SEE 27500 OR 27500-1	1	EA	-	R	PS		
13	22599	CLAMP-CABLE-NYLON-1/2"		1	EA	-	R	DWG		
14	22637	CLAMP-HALF		1	EA	-	R	DWG		
15	22636-2	CLAMP-CABLE- Ø 7mm	0.8125 L x 0.375 W x 0.0469 THK	1	EA	-	R	PS		
16	27634	TRIGGER-HOME SWITCH-2 OP		1	EA	-	R	PS	KING RICH	
17	22378-1	MANIFOLD-COOLANT	SEE 27500 OR 27500-1	1	EA	-	R	PS		
18	27177	VALVE-MALE-COOLANT WASH		1	EA	-	R	PS	LOC LINE	21192
19	27177-1	ADAPTER-LINK-COOLANT		14	EA	-	R	PS	KING RICH	
20	27177-5	NOZZLE-COOLANT-1/4" ROUND		1	EA	A	R	PS	KING RICH	
21	28042-2	MANIFOLD-TUBE FITTING-6 OUTLETS		(1)	EA	-	R	PS	KING RICH	
22	26348-1	FAN-SPINDLE MOTOR	SEE 27500 OR 27500-1	(1)	EA	-	R	PS		

Item	P/N	Title	Detail	Qty	UseAs	Rev	Stat	Type	Mfr	Mfr P/N
24	27553	ENCODER ASSY-MOTOR-SPINDLE-2OP	ENCODER REPLACEMENT KIT 27581	(1)	EA	-	R	PL		
27	26514-1	CABLE ASSY-SPINDLE MOTOR FAN	DC300-103	1	EA	-	R	PL		
28	26940-1	CABLE ASSY-SPINDLE MOTOR ENCODER	DC300-102	1	EA	A	R	PL		
29	26671-3	CABLE ASSY-SPINDLE MOTOR POWER	DC300-101	1	EA	A	R	PL		
30	27635-10	CABLE ASSY-SOLENOID-TOOL UNCLAMP	DC300-104	1	EA	-	R	PL		
31	27635-8	CABLE ASSY-LIMIT SW-TOOL CLAMP	DC300-105	1	EA	-	R	PL		
32	27635-7	CABLE ASSY-LIMIT SW-TOOL UNCLAMP	DC300-106	1	EA	-	R	PL		
33	27635-6	CABLE ASSY-BUTTON-TOOL UNCLAMP	DC300-107	1	EA	-	R	PL		
35	27495-1	SHEET METAL-FRONT COVER-SPINDLE ASSY	SEE 27500 OR 27500-1	1	EA	-	R	PS		
36	27495-2	SHEET METAL-FRONT PANEL-SPINDLE ASSY	SEE 27500 OR 27500-1	1	EA	-	R	PS		
37	27495-3	SHEET METAL-LEFT COVER-SPINDLE ASSY	SEE 27500 OR 27500-1	1	EA	-	R	PS		
38	27495-4	SHEET METAL-LEFT PANEL-SPINDLE ASSY	SEE 27500 OR 27500-1	1	EA	-	R	PS		
39	27495-5	SHEET METAL-RIGHT COVER-SPINDLE ASSY	SEE 27500 OR 27500-1	1	EA	-	R	PS		
40	27495-6	SHEET METAL-RIGHT PANEL-SPINDLE ASSY	SEE 27500 OR 27500-1	1	EA	-	R	PS		
41	27495-7	SHEET METAL-TOP COVER-SPINDLE ASSY	SEE 27500 OR 27500-1	1	EA	-	R	PS		
42	27495-8	SHEET METAL-BOTTOM COVER-SPINDLE ASSY	SEE 27500 OR 27500-1	1	EA	-	R	PS		
43	27495-9	SHEET METAL-CYLINDER BRACKET-SPINDLE ASSY	SEE 27500 OR 27500-1	1	EA	-	R	PS		
44	27495-10	SHEET METAL-CYLINDER COVER-SPINDLE ASSY	SEE 27500 OR 27500-1	1	EA	-	R	PS		
48	27091-4	FITTING-STRAIGHT-3/8 BSPT X 1/4 HYDR M/M	SEE 27563	1	EA	-	R	PS		KING RICH
54	27076-2	FITTING-90°-1/4 HYDR SWVL TO 1/4 HYDR F/M		1	EA	-	R	PS		KING RICH
58	28127-1	LINE-HYDRAULIC-1/4 X 450mm		1	EA	A	R	DWG		
60	M10-1.5X30 24B	SCREW-HEX HD-STL-BO	NON STOCKABLE	4	EA	-	R	PS		
61	M6-1.0X35 25B	SCREW-SHCS-STL-BO		8	EA	-	R	PS		
62	M5-0.8X12 25B	SCREW-SHCS-STL-BO		3	EA	-	R	PS		

Item	P/N	Title	Detail	Qty	UseAs	Rev	Stat	Type	Mfr	Mfr P/N
63	M4-0.7X20 25B	SCREW-SHCS-STL-BO		4	EA		R	PS		
66	M6-1.0X15 25B	SCREW-SHCS-STL-BO		4	EA		R	PS		
67	M4-0.7X10 25B	SCREW-SHCS-STL-BO		2	EA		R	PS		
68	M4-0.7X10 27B	SCREW-BHCS-STL-BO		12	EA	-	R	PS		
69	M6-1.0X12 25B	SCREW-SHCS-STL-BO		2	EA		R	PS		
70	M5-0.8X12 27B	SCREW-BHCS-STL-BO		40	EA		R	PS		
71	M5-0.8X30 25B	SCREW-SHCS-STL-BO	NON STOCKABLE	2	EA	-	R	PS		
76	M5 70B	WASHER-FLAT USS-STL-BO		6	EA		R	PS		
77	M10 WASHER	WASHER-FINISH-BRASS	NON STOCKABLE	4	EA	-	R	PS		
78	M5 73B	WASHER-SPLIT LOCK-STL-BO		38	EA	-	R	PS		
79	M4 70Z	WASHER-FLAT-STL-ZINC		4	EA	-	R	PS		
80	M6 73B	WASHER-SPLIT LOCK-STL-BO		8	EA	-	R	PS		
86	M4 73B	WASHER-SPLIT LOCK-STL-BO		12	EA		R	PS		

NOTICE: THIS DESIGN WAS ORIGINATED BY AND EMBODIES A CONFIDENTIAL PROPRIETARY DESIGN OWNED BY SOUTHWESTERN INDUSTRIES. IT IS DISCLOSED IN CONFIDENCE FOR A SPECIFIC PURPOSE AND THE RECIPIENT HEREOF AGREES NOT TO MAKE ANY REPRODUCTION, DISCLOSURE OR OTHER USE OF THIS INFORMATION WITHOUT THE WRITTEN CONSENT OF SOUTHWESTERN INDUSTRIES.

REVISIONS				
REV	DESCRIPTION	ECN	DATE	APPRV
-	ORIGINAL RELEASE	13915	12/07/12	TO
A	REVISED ITEM 34 PICT. ADDED: ITEMS 35 & 36.	14196	2/18/14	TO
B	ITEM 6 QTY 1 WAS: 2. ITEM 7 28488 WAS: 27833. DELETED ITEM 8	14333	12/4/14	TO
C	ADDED ITEMS 26 & 48. REVISED: ITEM 23 27838-1 WAS: 27838	14375	2/13/15	TO
D	ITEM 44 M5-0.8X12 25B QTY 3 WAS: M5-0.8X25 25B QTY 2. ITEM 50 QTY 3 WAS: QTY 2.	14528	6.29.16	PB



NOTES: (UNLESS OTHERWISE SPECIFIED).

DIMENSIONS ARE IN INCHES DEC. X = ±.1, .XX = ±.01, .XXX = ±.005 ANGLES: XX = ±0°30' FRACTIONS = ±1/8 FINISH = 125 RMS REMOVE ALL SHARP EDGES MASK ALL TAPPED HOLES DIMENSIONING PER ASME Y14.5		APPROVALS DRAWN BY: Sal ENGINEER: TO ENGINEER:	DATE 11/11/10 11/11/10	SOUTHWESTERN INDUSTRIES, INC. 2615 HOMESTEAD PLACE RANCHO DOMINGUEZ, CA 90220-5610
MATERIAL: - FINISH: -		TITLE: SPINDLE ASSY- 2 OP M10 MILL THIRD ANGLE PROJECTION		SIZE: D CODE IDENT. NO.: 06238 DWG NO.: 27830 SHEET 1 OF 1

Parts List for Assembly P/N: 27830

Printed 6/29/2016

**27830**  
SPINDLE ASSY-2OP M10 MILL

Type	PL	Dwg Size	D
Revision	D	Product	2 OP MILL
Status	R	Engineer	TO
Date	8/19/2010	Planner Code	
By	Sal	Comm Code	

Item	P/N	Title	Qty	Detail	UseAs	Rev	Stat	Type	Mfr	Mfr P/N
1	27832	DRAWBAR-SPINDLE 2 OP MILL	1		EA	-	R	DWG		
2	27852	GRIPPER-TOOL CLAMPING	1	SEE 27830	EA	-	R	PS	KING RICH	A-197-003
3	27835	GUIDE-DRAWBAR-UPPER	1		EA	-	R	DWG		
4	27835-1	GUIDE-DRAWBAR-LOWER	1		EA	-	R	DWG		
5	27831	SPINDLE	1		EA	-	R	DWG		
6	27844	BEARING-ANGULAR CONTACT-7210 P4-SET (2)	1	7210A5TYNSUMP4	SET	B	R	DWG		
7	28488	SPACER KIT-INNER & OUTER SPINDLE BEARING (1 SET)	1		EA	A	R	PL		
9	27836	SPACER-TOP BEARING-SPINDLE	1		EA	-	R	DWG		
10	27837	NUT-SPANNER-M50	1		EA	-	R	DWG		
11	27839	NUT-SPANNER M12	1		EA	-	R	DWG		
12	27848	HOUSING-TOP-SPINDLE	1		EA	-	R	DWG		
13	27841	COLLAR-INNER	1		EA	-	R	DWG		
14	27849	ADJUSTMENT RING-PISTON STROKE-TOOL UNCLAMP	1		EA	-	R	DWG		
15	27840	PISTON-CYLINDER-TOOL RELEASE	1		EA	-	R	DWG		
16	27843	SPRING-CYLINDER RETURN-TOOL RELEASE	6	SEE 27830	EA	-	R	PS	KING RICH	
17	27846	HOUSING-PRIMARY-SPINDLE	1		EA	-	R	DWG		
18	27847	BODY CYLINDER-TOOL RELEASE	1		EA	-	R	DWG		
19	27845	END CAP-SPINDLE	1		EA	-	R	DWG		
20	27853	ACTUATOR PLATE-TOOL UNCLAMP-SWITCHES	1		EA	-	R	DWG		
21	27842	DRIVE DOG-ADAPTOR SPINDLE	2		EA	-	R	DWG		

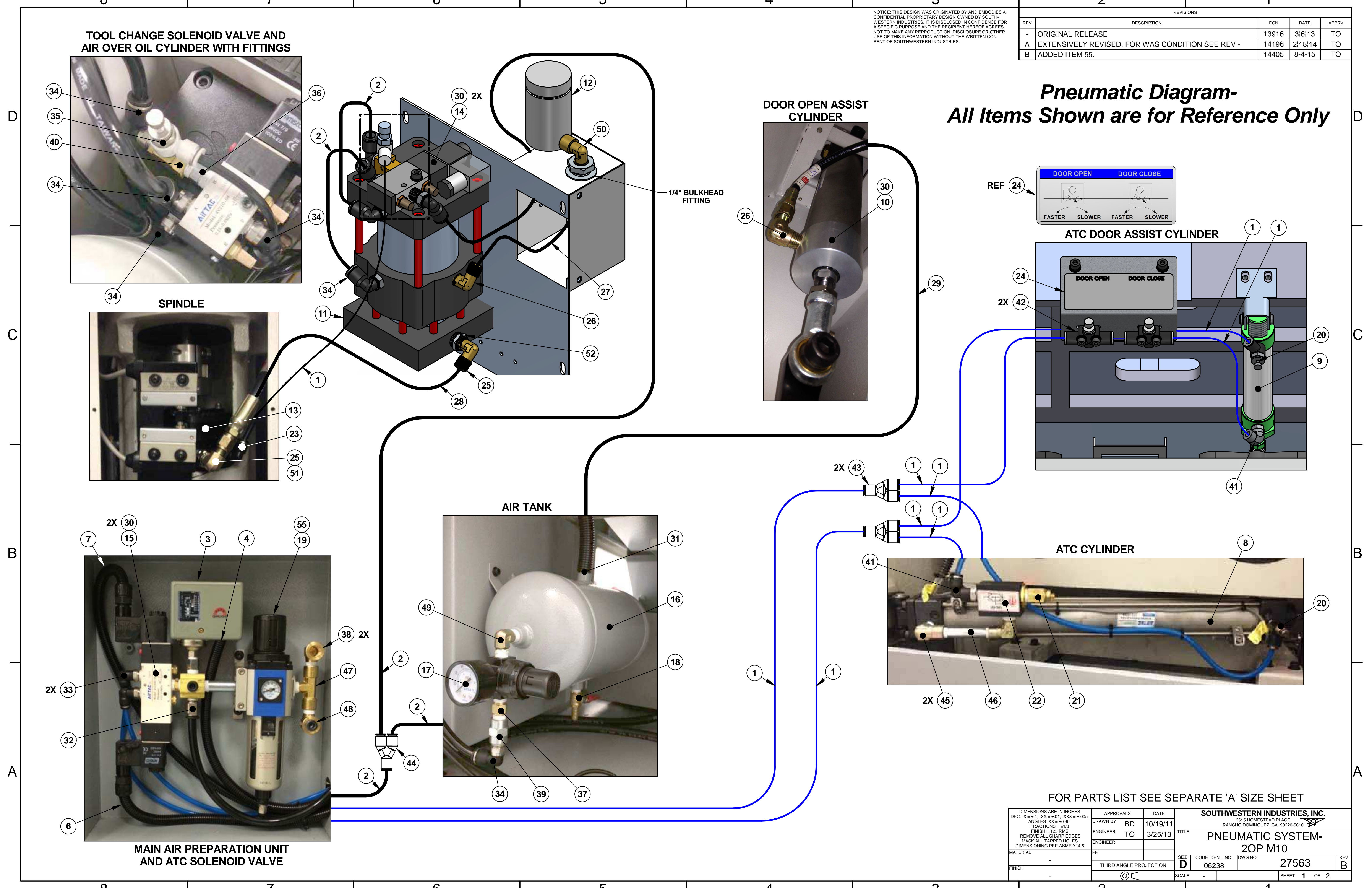


Item	P/N	Title	Qty	Detail	UseAs	Rev	Stat	Type	Mfr	Mfr P/N
22	27850	SHAFT-STUB COUPLING	1		EA	-	R	DWG		
23	27838-1	DRIVE DOG-FLANGED-SPINDLE	2		EA	A	R	DWG		
24	28084	PLATE-GUIDE-SPINDLE-TOOL UNCLAMP CYLINDER	1		EA	-	R	DWG		
25	28085	PIN-GUIDE-SPINDLE-TOOL UNCLAMP CYLINDER	2		EA	-	R	DWG		
26	27904	SEAL-SPINDLE	1		EA	A	R	DWG		
34	27016-1	FITTING-QUICK CONNECT 6MM TO 1/8 BSPT	1		EA	A	R	DWG		
35	27076-1	FITTING-STRAIGHT-1/8 BSPT TO 1/4 HYDR M/M	1	SEE 27563	EA	-	R	PS	KING RICH	
36	27076-2	FITTING-90°-1/4 HYDR SWVL TO 1/4 HYDR F/M	1		EA	-	R	PS	KING RICH	A-316-012
40	27851	WASHER-BELLEVILLE-SPINDLE	28	SEE 27830	EA	-	R	PS	KING RICH	
41	M6-1.0X85 25B	SCREW-SHCS-STL-BO	4	NON STOCKABLE	EA	-	R	PS		
42	M6-1.0X25 25B	SCREW-SHCS-STL-BO	8		EA		R	PS		
43	M5-0.8X14 25B	SCREW-SHCS-STL-BO	2	NON STOCKABLE	EA	-	R	PS		
44	M5-0.8X12 25B	SCREW-SHCS-STL-BO	3		EA	-	R	PS		
45	M5-0.8X30 25B	SCREW-SHCS-STL-BO	6	NON STOCKABLE	EA	-	R	PS		
46	M5-0.8X20 25B	SCREW-SHCS-STL-BO	2	NON STOCKABLE	EA	-	R	PS		
47	M6-1.0X120 25B	SCREW-SHCS-STL-BO	2	NON STOCKABLE	EA	-	R	PS		
48	M4-0.7X8 27Z	SCREW-BHCS-STL-ZINC	2	NON-STOCKABLE	EA	-	R	PS		
50	M5 70B	WASHER-FLAT USS-STL-BO	3		EA	-	R	PS		
51	M6 73B	WASHER-SPLIT LOCK-STL-BO	8		EA	-	R	PS		

NOTICE: THIS DESIGN WAS ORIGINATED BY AND EMBODIES A CONFIDENTIAL PROPRIETARY DESIGN OWNED BY SOUTHWESTERN INDUSTRIES. IT IS DISCLOSED IN CONFIDENCE FOR A SPECIFIC PURPOSE AND THE RECIPIENT HEREOF AGREES NOT TO MAKE ANY REPRODUCTION, DISCLOSURE OR OTHER USE OF THIS INFORMATION WITHOUT THE WRITTEN CONSENT OF SOUTHWESTERN INDUSTRIES.

REVISIONS				
REV	DESCRIPTION	ECN	DATE	APPRV
-	ORIGINAL RELEASE	13916	3/6/13	TO
A	EXTENSIVELY REVISED. FOR WAS CONDITION SEE REV -	14196	2/18/14	TO
B	ADDED ITEM 55.	14405	8-4-15	TO

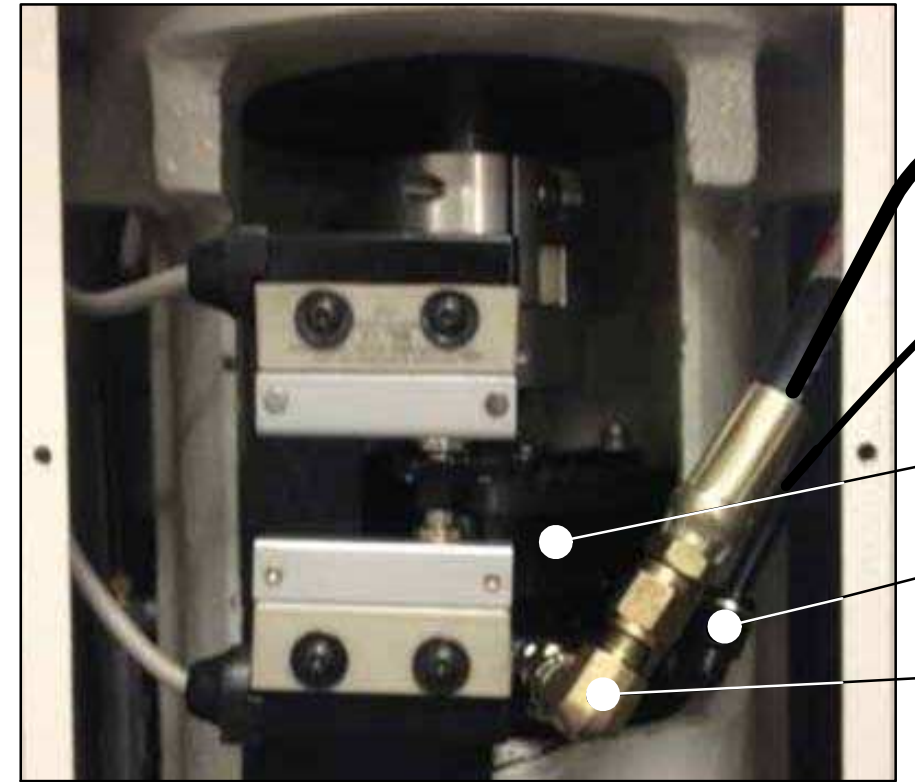
### Pneumatic Diagram- All Items Shown are for Reference Only



**TOOL CHANGE SOLENOID VALVE AND AIR OVER OIL CYLINDER WITH FITTINGS**



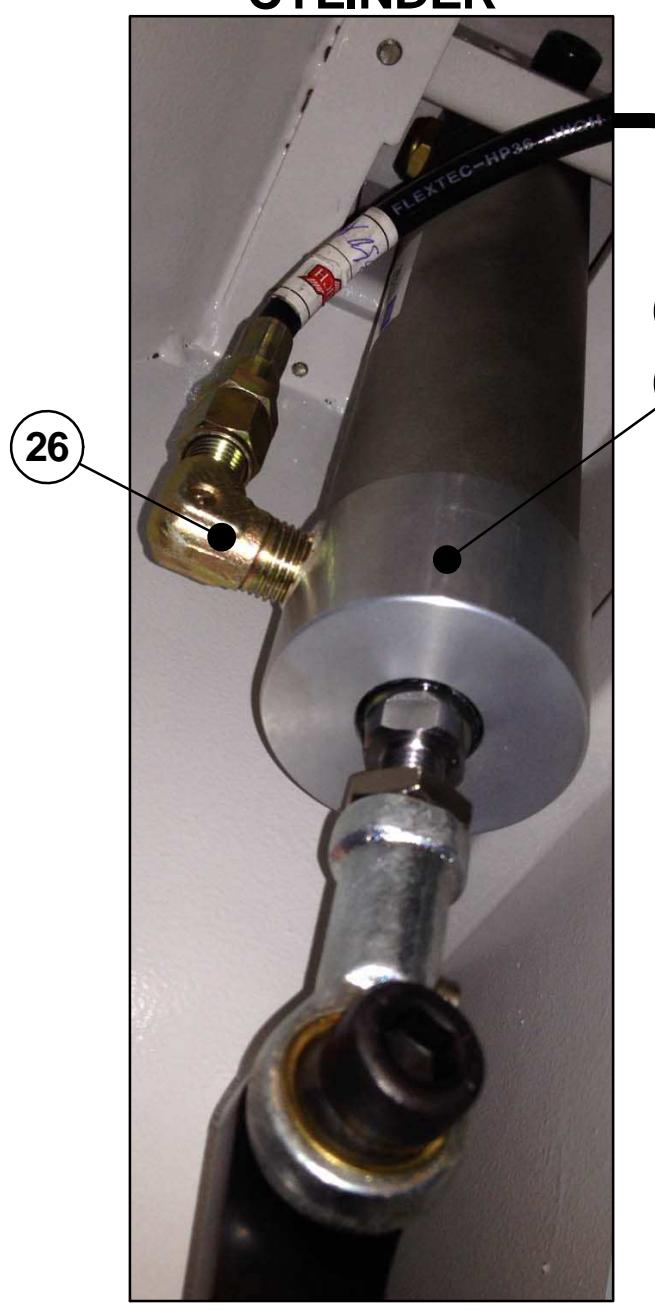
**SPINDLE**



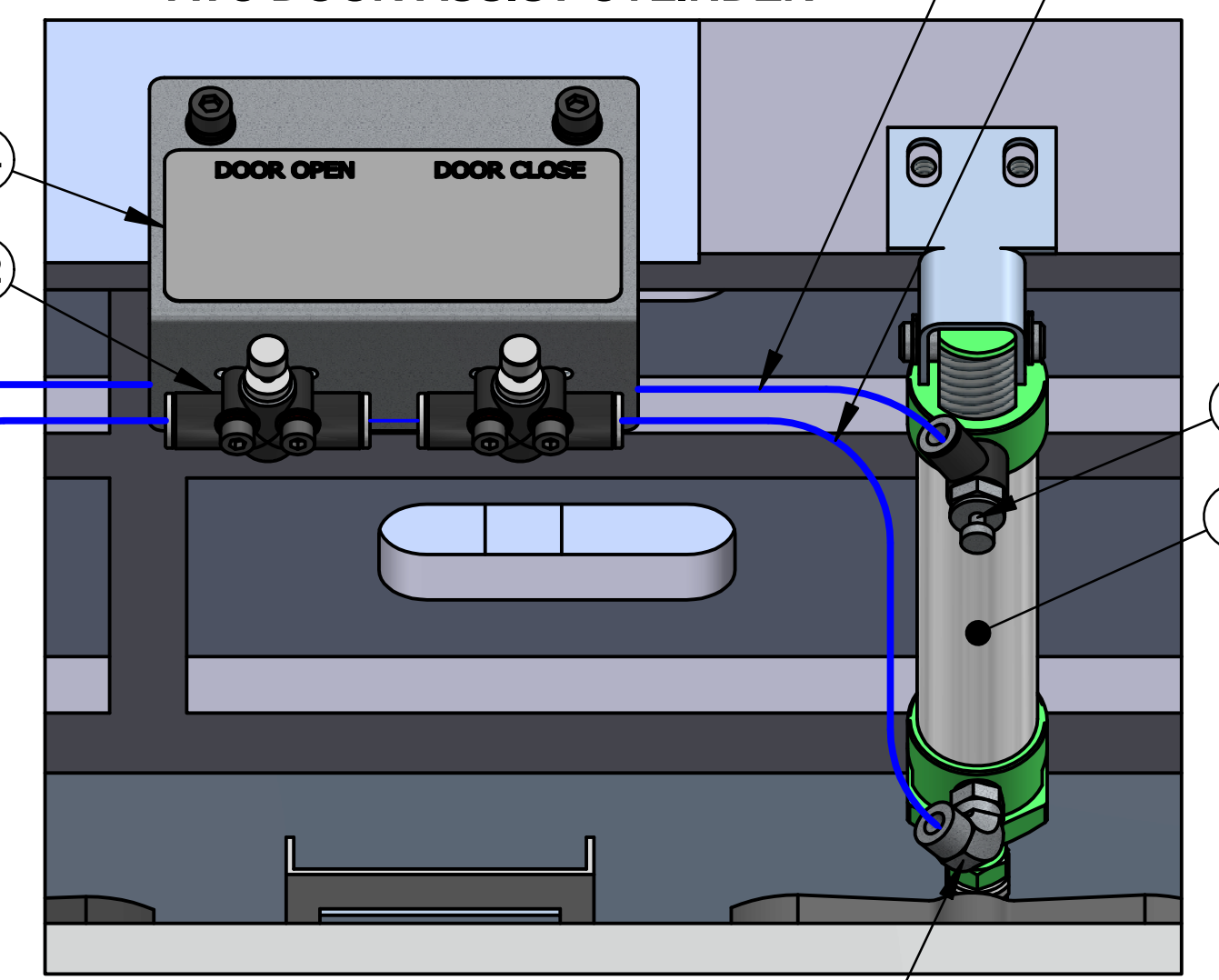
**AIR TANK**



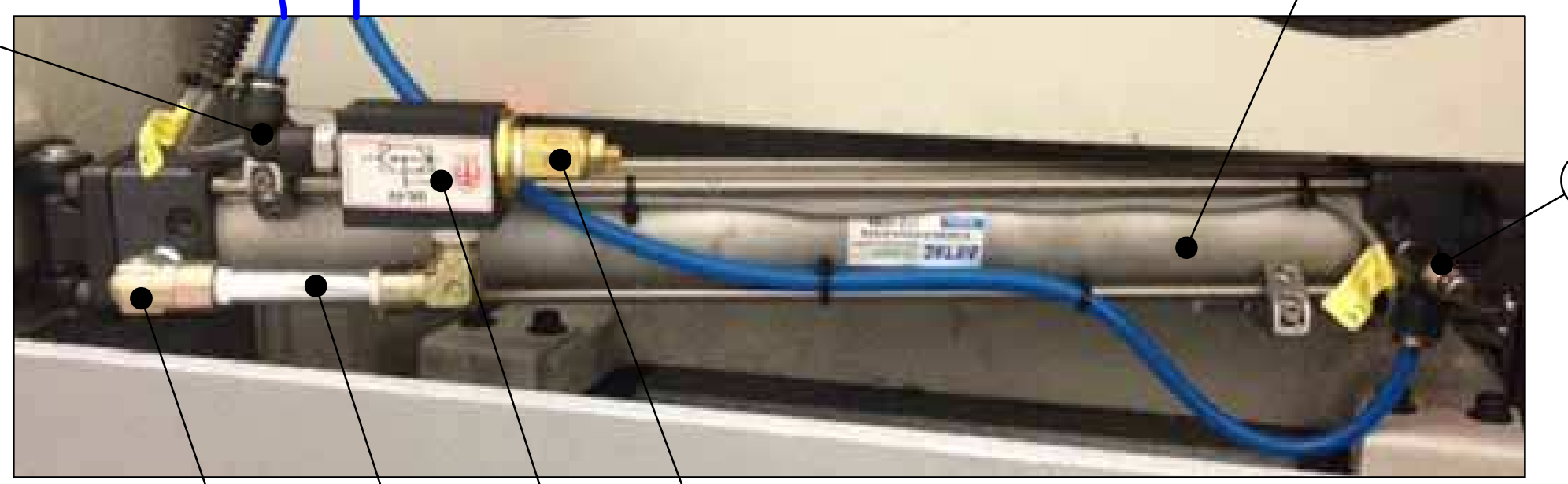
**DOOR OPEN ASSIST CYLINDER**



**ATC DOOR ASSIST CYLINDER**



**ATC CYLINDER**



**MAIN AIR PREPARATION UNIT AND ATC SOLENOID VALVE**

FOR PARTS LIST SEE SEPARATE 'A' SIZE SHEET

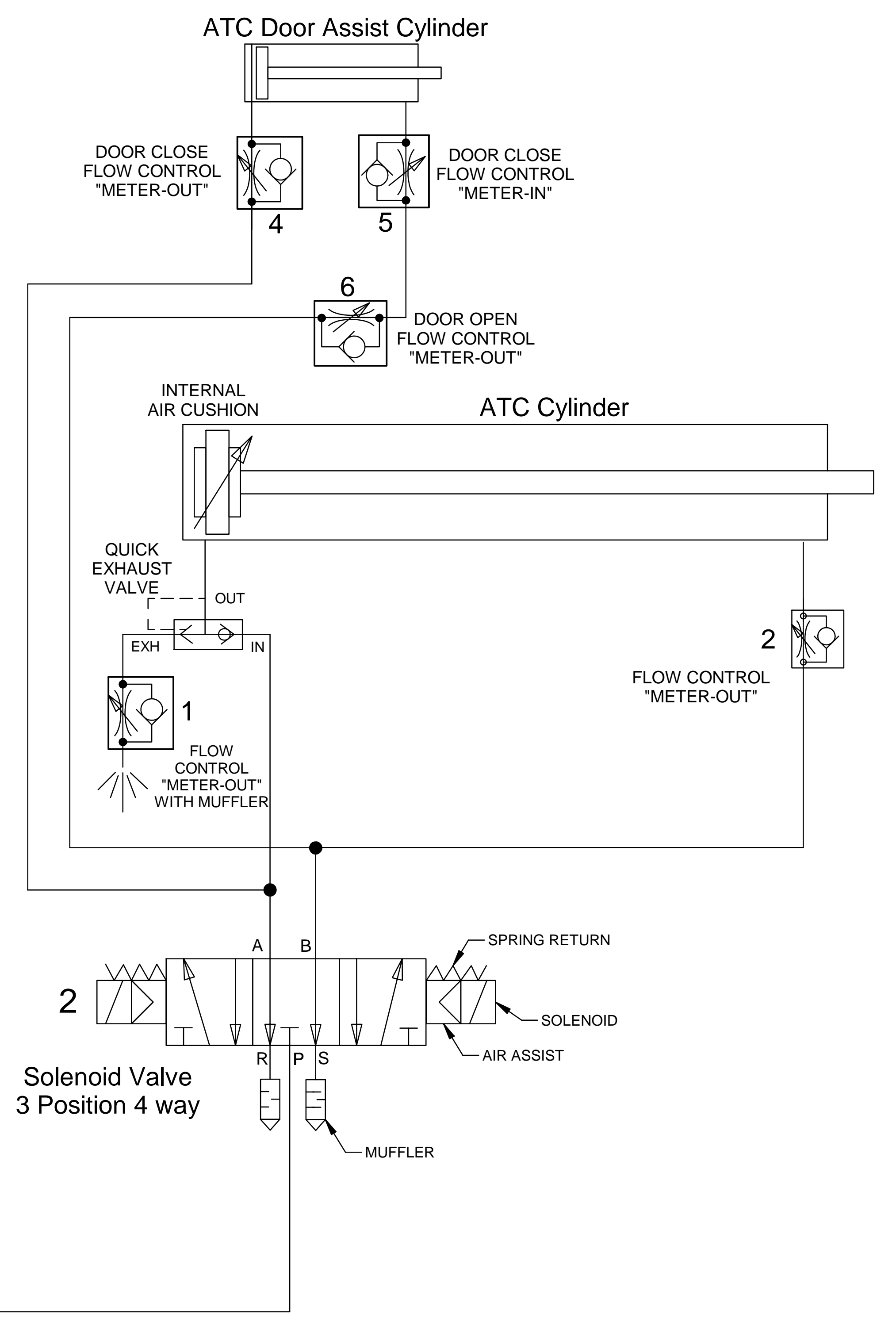
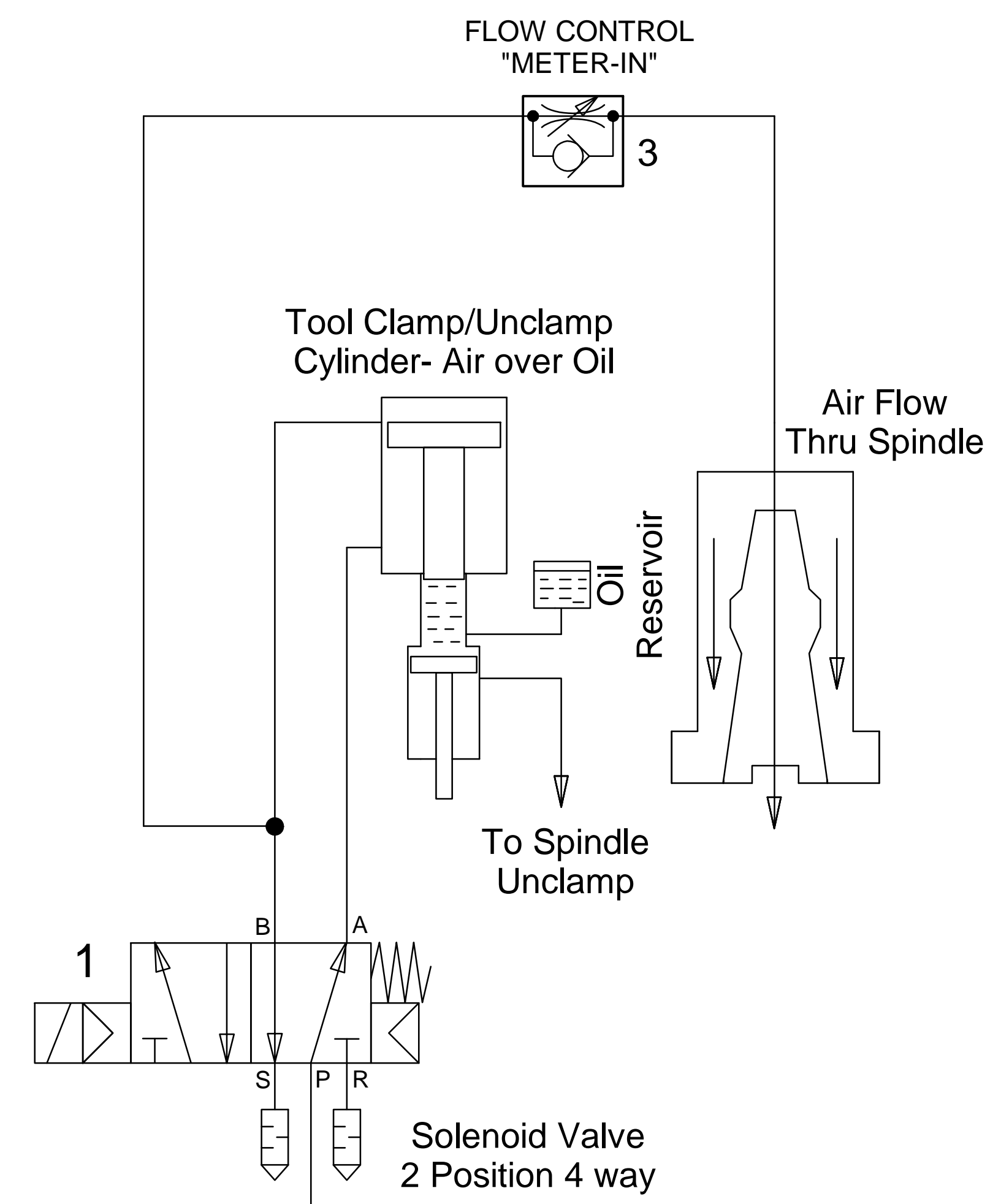
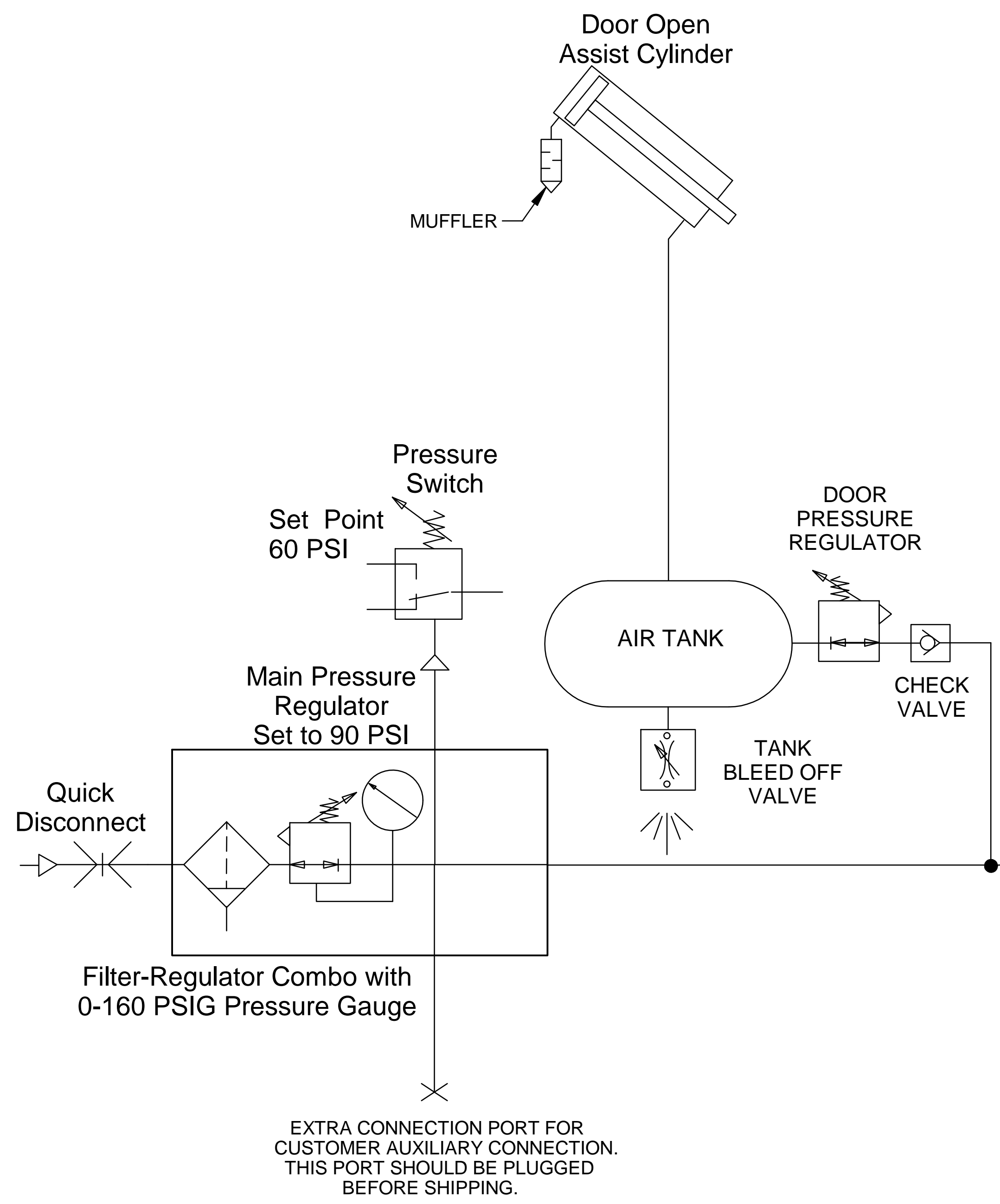
DIMENSIONS ARE IN INCHES DEC. X = ±.1, XX = ±.01, XXX = ±.005 ANGLES: XX = ±0°30' FRACTIONS = ±1/8 FINISH = 125 RMS REMOVE ALL SHARP EDGES MASK ALL TAPPED HOLES DIMENSIONING PER ASME Y14.5		APPROVALS	DATE	SOUTHWESTERN INDUSTRIES, INC. 2615 HOMESTEAD PLACE RANCHO DOMINGUEZ, CA 90220-5610	
DRAWN BY	BD	10/19/11	TITLE <b>PNEUMATIC SYSTEM- 2OP M10</b>		
ENGINEER	TO	3/25/13			
MATERIAL	FE		SIZE	CODE IDENT. NO.	DWG NO.
FINISH			D	06238	27563
THIRD ANGLE PROJECTION			SCALE:	SHEET	REV
				1	B

# Pneumatic Schematic



D  
C  
B  
A

D  
C  
B  
A



EXTRA CONNECTION PORT FOR CUSTOMER AUXILIARY CONNECTION. THIS PORT SHOULD BE PLUGGED BEFORE SHIPPING.

<small>DIMENSIONS ARE IN INCHES DEC. .X = ±.1, .XX = ±.01, .XXX = ±.005 ANGLES .XX = ±0°30' FRACTIONS = 1/8 FINISH = 125 RMS REMOVE ALL SHARP EDGES MASK ALL TAPPED HOLES DIMENSIONING PER ASME Y14.5</small>		<small>APPROVALS</small> DRAWN BY: BD TO: TO ENGINEER: PE	<small>DATE</small> 10/19/11 3/25/13	<b>SOUTHWESTERN INDUSTRIES, INC.</b> <small>2615 HOMESTEAD PLACE RANCHO DOMINGUEZ, CA 90220-5610</small>	
TITLE: <b>PNEUMATIC SYSTEM-2OP M10</b>			SIZE: <b>D</b>	CODE IDENT. NO.: 06238	DWG. NO.: 27563
THIRD ANGLE PROJECTION			SCALE: -	SHEET 2 OF 2	REV: B

8 | 7 | 6 | 5 | 4 | 3 | 2 | 1

Parts List for Assembly P/N: 27563

Printed 8/4/2015

**27563**  
PNEUMATIC SYSTEM-2OP M10

Type	PL	Dwg Size	D
Revision	B	Product	PT8
Status	R	Engineer	TAO
Date	12/8/2009	Planner Code	
By	TAO	Comm Code	

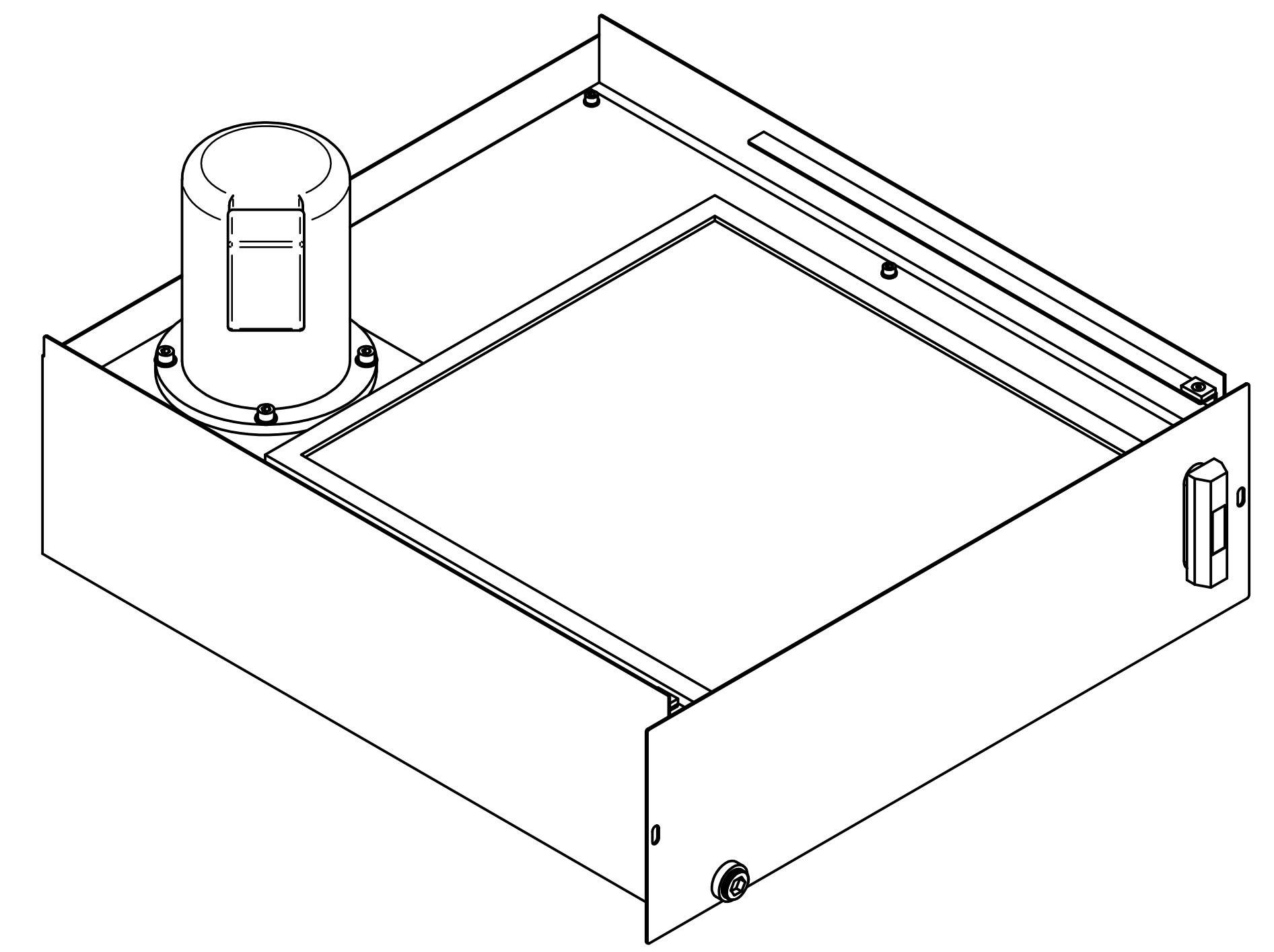
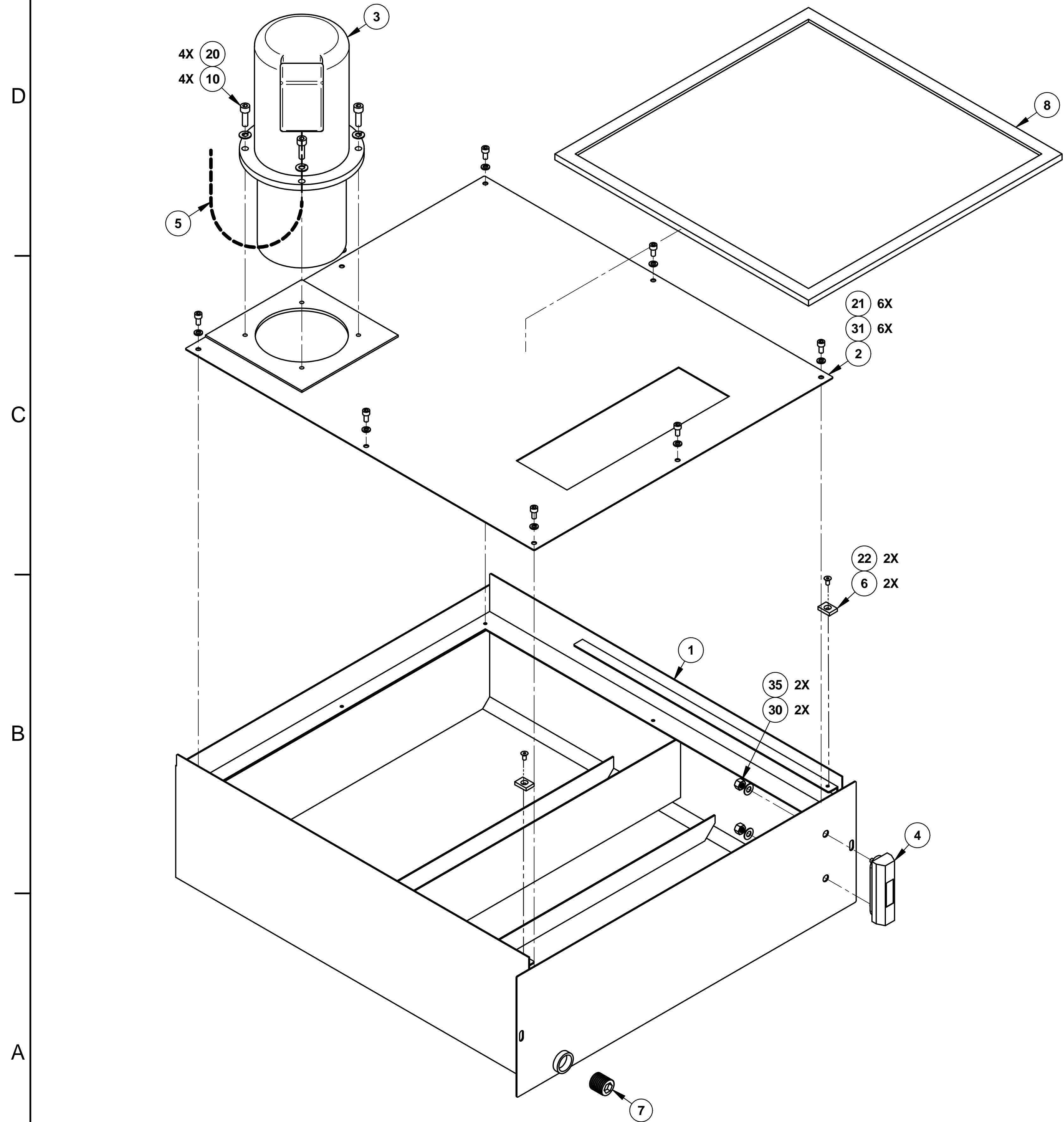
Item	P/N	Title	Detail	Qty	UseA	Rev	Stat	Type	Mfr
1	27531	TUBING-POLYURETHANE-6mm OD		A/R	IN	-	R	PS	KING RICH
2	27531-1	TUBING-POLYURETHANE-10mm OD		A/R	IN	-	R	PS	KING RICH
3	26931-1	SWITCH-AIR PRESSURE		(1)	EA	-	R	PS	KING RICH
4	27635-5	CABLE ASSY-LIMIT SW-AIR PRESSURE	DC300-110	(1)	EA	-	R	PL	
6	27635-11	CABLE ASSY-SOLENOID ATC BACK	DC300-108	(1)	EA	A	R	PL	
7	27635-12	CABLE ASSY-SOLENOID ATC FRONT	DC300-109	(1)	EA	A	R	PL	
8	27583-1	CYLINDER-AIR-32 BORE 300 STROKE		(1)	EA	-	R	DWG	
9	27583-5	CYLINDER-AIR-20mm BORE X 60mm S		(1)	EA	-	R	DWG	
10	27583-6	CYLINDER-AIR-40mm BORE 125mm STROKE		(1)	EA	-	R	DWG	
11	27502	CYLINDER ASSY-TOOL UNCLAMP		(1)	EA	A	R	PL	
12	27502-1	RESERVOIR-OIL MAKEUP-TOOL UNCLAMP CYLINDER	SEE 27563	(1)	EA	-	R	PS	KING RICH
13	27830	SPINDLE ASSY-2OP M10 MILL		(1)	EA	C	R	PL	
14	26938-4	VALVE-AIR-SOLENOID-SINGLE-4WAY-2POS- 24VDC		(1)	EA	-	R	DWG	
15	26938-5	VALVE-AIR-SOLENOID-DOUBLE-4WAY -3POS-NO-24VDC		(1)	EA	-	R	DWG	
16	28033	AIR TANK		(1)	EA	-	R	DWG	
17	28034	AIR REGULATOR	SEE 27563	(1)	EA	-	R	PS	
18	28035	DRAIN VALVE - AIR TANK	SEE 27563	(1)	EA	-	R	PS	KING RICH
19	22607-2	FILTER/REGULATOR-W/ 40µm FILTER, 0-160 PSI	FOR FILTER REPL SEE 24607-4	(1)	EA	B	R	DWG	
20	28071	VALVE-FLOW CONTROL-AIR		(2)	EA	-	R	PS	KING RICH
21	28071-1	VALVE-FLOW CONTROL W MUFFLER-AIR	SEE 27563	(1)	EA	-	R	PS	KING RICH

Item	P/N	Title	Detail	Qty	UseA	Rev	Stat	Type	Mfr
22	28074	VALVE-QUICK EXHAUST	SEE 27563	(1)	EA	-	R	PS	KING RICH
23	27016-1	FITTING-QUICK CONNECT 6MM TO 1/8 BSPT		(1)	EA	A	R	DWG	
24	27694-21	LABEL-FLOW CONTROL VALVES		(1)	EA	-	R	DWG	
25	27076-2	FITTING-90°-1/4 HYDR SWVL TO 1/4 HYDR F/M		(2)	EA	-	R	PS	KING RICH
26	26952-3	FITTING-AIR-90°-1/4 BSPTx1/4 HYDR M/M	SEE 27563	(2)	EA	-	R	PS	KING RICH
27	28127	LINE-HYDRAULIC-1/4 X 180mm		(1)	EA	-	R	DWG	
28	28127-1	LINE-HYDRAULIC-1/4 X 450mm		(1)	EA	A	R	DWG	
29	28127-2	LINE-HYDRAULIC-1/8 X 2350mm		(1)	EA	A	R	DWG	
30	27574	MUFFLER-1/4 BSPT		(5)	EA	-	R	PS	KING RICH
31	27091-3	FITTING-STRAIGHT-1/4 BSPT X 1/4 HYDR M/M	SEE 27563	(1)	EA	-	R	PS	KING RICH
32	27091-2	FITTING-AIR-STRAIGHT-10mm-PUSH TO CONNECT	1/4 BSPT MALE THD	(1)	EA	-	R	PS	KING RICH
33	27085-1	FITTING-AIR-90°-6mm-PUSH TO CONNECT	1/4 BSPT MALE THD	(2)	EA	-	R	PS	KING RICH
34	27085-2	FITTING-AIR-90°-10mm-PUSH TO CONN-1/4 BSPT M	SEE 27542 OR 27563	(6)	EA	-	R	PS	KING RICH
35	28071-2	VALVE-FLOW CONTROL-AIR	1/4 BSPT TO 6mm PUSH TO CONNECT	(1)	EA	-	R	PS	KING RICH
36	24151-1	HEX NIPPLE BSPT 1/4 M		(1)	EA	-	R	PS	KING RICH
37	27725	CHECK VALVE-STRAIGHT-1/4 BSPT	SEE 27563	(1)	EA	-	R	PS	KING RICH
38	26952-2	ELBOW-STREET-1/4 BSPT	SEE 27563	(2)	EA	-	R	PS	KING RICH
39	27745	COUPLING-1/4 BSPT	SEE 27563	(1)	EA	-	R	PS	KING RICH
40	22169-3	FITTING-PIPE-TEE-1/4 BSPT	SEE 27563	(1)	EA	-	R	PS	KING RICH
41	24673-2	ELBOW-1/8 BSPT TO 6mm QUICK CONNECT		(2)	EA	-	R	PS	
42	28071-3	VALVE-FLOW CONTROL-INLINE-AIR	Ø6mm PUSH TO CONNECT	(2)	EA	-	R	PS	KING RICH
43	27745-1	COUPLING-Y-6mm PUSH TO CONNECT	SEE 27563	(2)	EA	-	R	PS	KING RICH
44	27745-2	COUPLING-Y-10mm PUSH TO CONNECT	SEE 27563	(1)	EA	-	R	PS	KING RICH
45	24673-1	ELBOW-STREET - 1/8 BSPT	SEE 27540 OR 27540-1	(2)	EA	-	R	PS	

Item	P/N	Title	Detail	Qty	UseA	Rev	Stat	Type	Mfr
46	28076	NIPPLE-ROUND- 1/8 BSPT X 2 LG	SEE 27540 OR 27540-1	(1)	EA	-	R	PS	
47	22169-4	FITTING-PIPE-TEE-F/M/F-1/4 BSPT	SEE 27542 OR 27563	(1)	EA	-	R	PS	KING RICH
48	28042-3	PLUG-1/4 BSPT	SEE 27563	(1)	EA	-	R	PS	KING RICH
49	26952-4	FITTING-AIR-90°-1/4 BSPT M/M	SEE 27542 OR 27563	(1)	EA	-	R	PS	KING RICH
50	27076-3	FITTING-90°-1/4 BSPT SWVLx1/4 BSPT F/F		(1)	EA	-	R	PS	KING RICH
51	27076-1	FITTING-STRAIGHT-1/8 BSPT TO 1/4 HYDR M/M	SEE 27563	(1)	EA	-	R	PS	KING RICH
52	27091-4	FITTING-STRAIGHT-3/8 BSPT X 1/4 HYDR M/M	SEE 27563	(1)	EA	-	R	PS	KING RICH
55	22607-4	FILTER ELEMENT-REPLACEMENT	SEE 22607-2	(1)	EA	-	R	PS	KING RICH

NOTICE: THIS DESIGN WAS ORIGINATED BY AND EMBODIES A CONFIDENTIAL PROPRIETARY DESIGN OWNED BY SOUTHWESTERN INDUSTRIES. IT IS DISCLOSED IN CONFIDENCE FOR A SPECIFIC PURPOSE AND THE RECIPIENT HEREOF AGREES NOT TO MAKE ANY REPRODUCTION, DISCLOSURE OR OTHER USE OF THIS INFORMATION WITHOUT THE WRITTEN CONSENT OF SOUTHWESTERN INDUSTRIES.

REVISIONS				
REV	DESCRIPTION	ECN	DATE	APPRV
-	ORIGINAL RELEASE	13915	04/25/12	TO
A	ADDED ITEM 8	14196	2/18/14	TO
B	ADDED ITEMS 12, 13, 14, 16, 18	14397	6/1/15	TO



RIGHT VIEW



TOOL COOLANT HOSE  
COOLANT WASH HOSE

NOTES: (UNLESS OTHERWISE SPECIFIED).

DIMENSIONS ARE IN INCHES DEC. X = ±.1, XX = ±.01, XXX = ±.005 ANGLES: XX = ±0°30' FRACTIONS = ±1/8 FINISH = 125 RMS REMOVE ALL SHARP EDGES MASK ALL TAPPED HOLES DIMENSIONING PER ASME Y14.5		APPROVALS	DATE	SOUTHWESTERN INDUSTRIES, INC. 2615 HOMESTEAD PLACE RANCHO DOMINGUEZ, CA 90220-5610	
DRAWN BY	Sal	05/01/09	TITLE	COOLANT SYSTEM ASSY- 20P MILL	
ENGINEER	TO	3/1/13	SIZE	CODE IDENT. NO.	REV
ENGINEER			D	06238	B
MATERIAL	FE		THIRD ANGLE PROJECTION	DWG NO.	27557
FINISH			SCALE: -	SHEET	1 OF 1

Parts List for Assembly P/N: 27557

Printed 6/1/2015

**27557**  
COOLANT SYSTEM ASSY-2OP MILL

Type	PL	Dwg Size	D
Revision	B	Product	2OP
Status	R	Engineer	TO
Date	5/1/2009	Planner Code	
By	SAL	Comm Code	

Item	P/N	Title	Detail	Qty	UseAs	Rev	Stat	Type	Mfr	Mfr P/N
1	27714	COOLANT TANK	SEE 27557	1	EA	-	R	PS	KING RICH	OP420100_V1.1
2	27714-1	COVER-COOLANT TANK	SEE 27557	1	EA	-	R	PS	KING RICH	
3	27713	COOLANT PUMP	SEE 27557	1	EA	-	R	PS		
4	27561	INDICATOR-COOLANT LEVEL	SEE 27557	1	EA	-	R	PS	KING RICH	
5	27176-1	CABLE ASSY-COOLANT PUMP	DC300-121C	1	EA	A	R	PL		
6	27615-1	WEAR PLATE-CHIP TRAY-2OP		2	EA	-	R	DWG		
7	28042	PLUG-BSTP 3/4 14TPI	SEE 27557	1	EA	-	R	PS	KING RICH	
8	28133	FILTER-FINE CHIP		1	EA	-	R	DWG		
12	27016-4	FITTING-90° BARB TO THD-3/8 TUBE ID x 3/8 MALE BSPT-STAINLESS STEEL		2	EA	A	R	DWG	KING RICH	
13	27016-5	FITTING-3/4 BSPT-3/8 BSPT-STAINLESS STEEL		1	EA	A	R	DWG	KING RICH	
14	27016-6	FITTING-TEE 3/8 BSPT-STAINLESS STEEL		1	EA	A	R	DWG	KING RICH	
16	26957-1	CLAMP-HOSE & TUBE-WORM DRIVE 7/16 TO 25/32		2	EA	A	R	DWG		
18	26956-1	HOSE-COOLANT-5/8 OD x 3/8 ID 200 PSI		24	FT	A	R	DWG		
20	M8-1.25X25 25B	SCREW-SHCS-STL-BO		4	EA		R	PS		
21	M6-1.0X12 25B	SCREW-SHCS-STL-BO		6	EA		R	PS		
22	M5-0.8X10 26B	SCREW-FHCS-STL-BO	NON STOCKABLE	2	EA		R	PS		
30	M8 73B	WASHER-SPLIT LOCK-STL-BO		8	EA		R	PS		
31	M6 73B	WASHER-SPLIT LOCK-STL-BO		8	EA	-	R	PS		
35	M8-1.25 50B	NUT-HEX-BLK OX	NON-STOCKABLE	2	EA	-	R	PS		



8 7 6 5 4 3 2 1

NOTICE: THIS DESIGN WAS ORIGINATED BY AND EMBODIES A CONFIDENTIAL PROPRIETARY DESIGN OWNED BY SOUTHWESTERN INDUSTRIES. IT IS DISCLOSED IN CONFIDENCE FOR A SPECIFIC PURPOSE AND THE RECIPIENT HEREOF AGREES NOT TO MAKE ANY REPRODUCTION, DISCLOSURE OR OTHER USE OF THIS INFORMATION WITHOUT THE WRITTEN CONSENT OF SOUTHWESTERN INDUSTRIES.

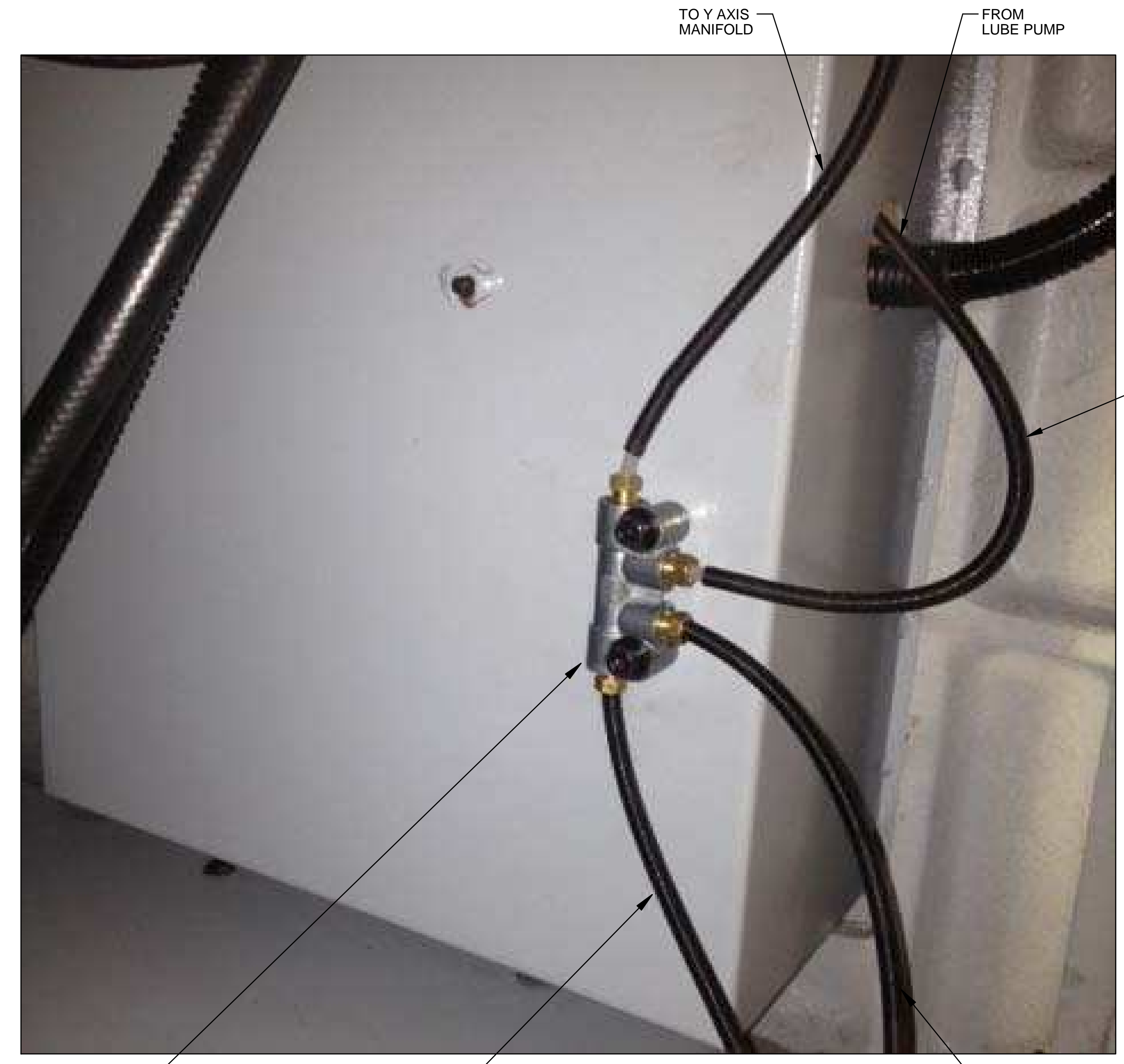
REVISIONS				
REV	DESCRIPTION	ECN	DATE	APPRV
1	ENGINEERING RELEASE	---	10/19/11	TO
-	ORIGINAL RELEASE	13916	7/10/12	TO
A	SHEET 4 PICTORIALY ADDED 26891-6	14361	2/13/15	PM

D  
C  
B  
A

LUBRICATION PUMP



MAIN DISTRIBUTION MANIFOLD MOUNTED BEHIND THE LUBRICATION PUMP. DISTRIBUTES LUBRICATION OIL TO THE 3 AXIS DISTRIBUTION MANIFOLDS.



- 2
- 10 4X
- 11 4X
- 12 4X
- 13 4X
- REF 14 2X
- REF 15 2X

8 7 6 5 4 3 2 1

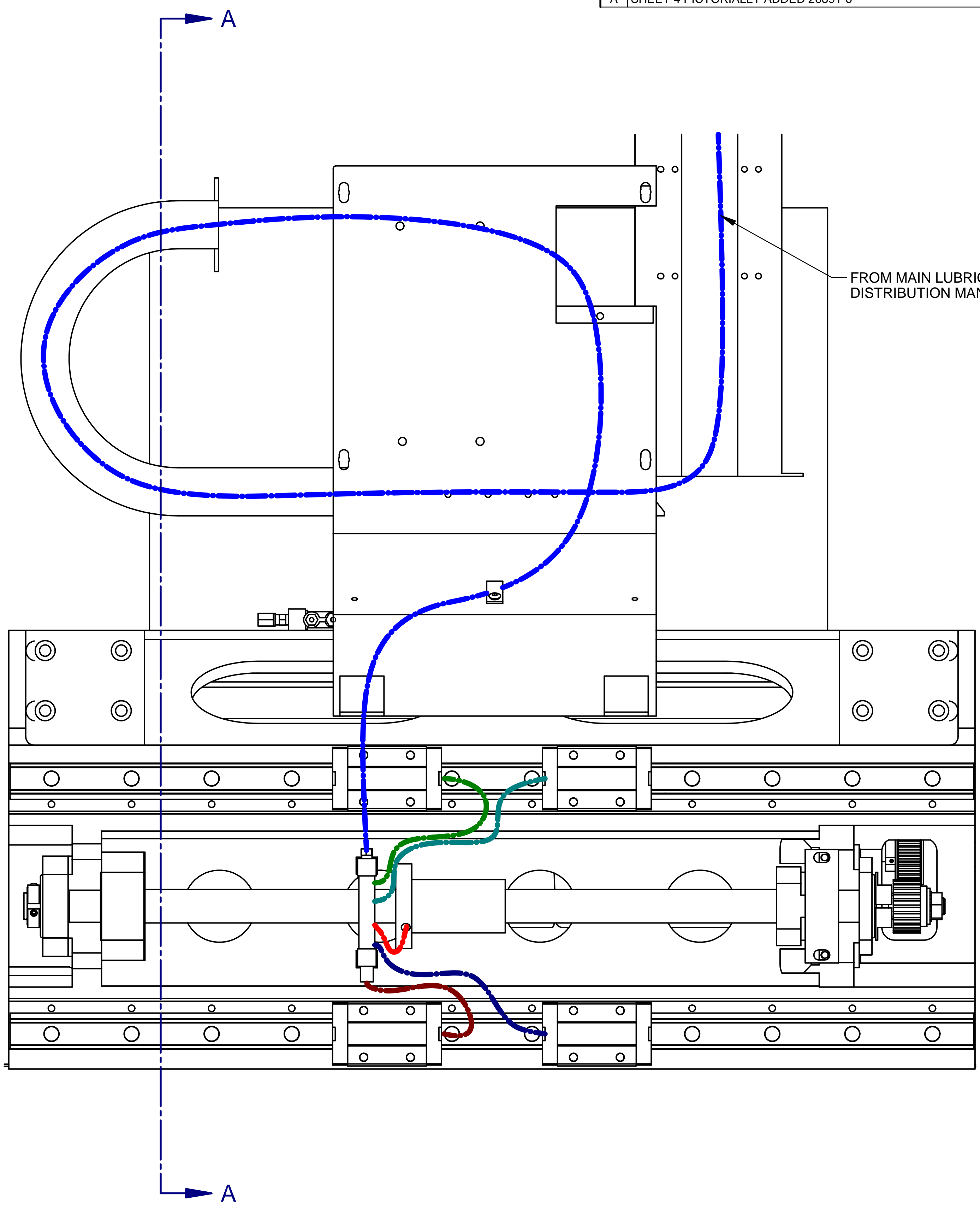
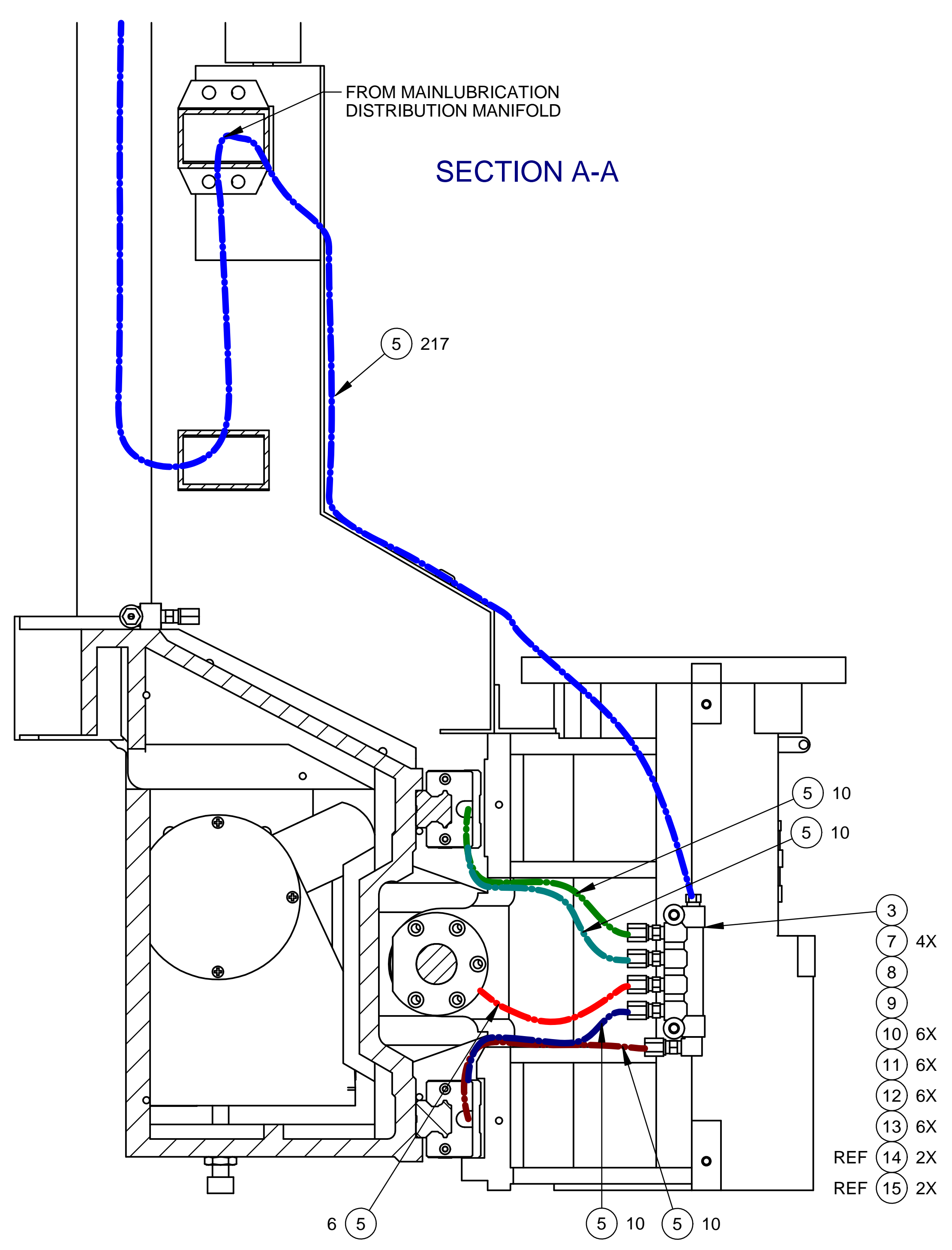
DIMENSIONS ARE IN INCHES DEC. X = ±.1, XX = ±.01, XXX = ±.005 ANGLES .XX = ±0°30' FRACTIONS = ±1/8 FINISH = 125 RMS REMOVE ALL SHARP EDGES MASK ALL TAPPED HOLES DIMENSIONING PER ASME Y14.5	APPROVALS	DATE	<b>SOUTHWESTERN INDUSTRIES, INC.</b> 2615 HOMESTEAD PLACE RANCHO DOMINGUEZ, CA 90220-5610	
	DRAWN BY BD	10/19/11	TITLE	
	ENGINEER TO	3/25/13	LUBRICATION SYSTEM- 2 OP MILL	
MATERIAL	FE	SIZE	CODE IDENT. NO.	DWG NO.
FINISH		D	06238	27591
	THIRD ANGLE PROJECTION	SCALE: -		SHEET 1 OF 7
				REV A

NOTICE: THIS DESIGN WAS ORIGINATED BY AND EMBODIES A CONFIDENTIAL PROPRIETARY DESIGN OWNED BY SOUTHWESTERN INDUSTRIES. IT IS DISCLOSED IN CONFIDENCE FOR A SPECIFIC PURPOSE AND THE RECIPIENT HEREOF AGREES NOT TO MAKE ANY REPRODUCTION, DISCLOSURE OR OTHER USE OF THIS INFORMATION WITHOUT THE WRITTEN CONSENT OF SOUTHWESTERN INDUSTRIES.

REVISIONS				
REV	DESCRIPTION	ECN	DATE	APPRV
1	ENGINEERING RELEASE	---	10/19/11	TO
-	ORIGINAL RELEASE	13916	7/10/12	TO
A	SHEET 4 PICTORIALLY ADDED 26891-6	14361	2/13/15	PM

# X AXIS

## SECTION A-A



DIMENSIONS ARE IN INCHES DEC. X = ±.1, XX = ±.01, XXX = ±.005 ANGLES: XX = ±0°30' FRACTIONS = ±1/8 FINISH = 125 RMS REMOVE ALL SHARP EDGES MASK ALL TAPPED HOLES DIMENSIONING PER ASME Y14.5	APPROVALS DRAWN BY <b>BD</b> 10/19/11 ENGINEER <b>TO</b> 3/25/13 ENGINEER	DATE 10/19/11 3/25/13	<b>SOUTHWESTERN INDUSTRIES, INC.</b> 2615 HOMESTEAD PLACE RANCHO DOMINGUEZ, CA 90220-5610
	TITLE <b>LUBRICATION SYSTEM- 2 OP MILL</b>		CODE IDENT. NO. <b>06238</b> DWG NO. <b>27591</b> SCALE: -
MATERIAL FINISH	THIRD ANGLE PROJECTION 	SHEET 2 OF 7	REV <b>A</b>

8 7 6 5 4 3 2 1

NOTICE: THIS DESIGN WAS ORIGINATED BY AND EMBODIES A CONFIDENTIAL PROPRIETARY DESIGN OWNED BY SOUTHWESTERN INDUSTRIES. IT IS DISCLOSED IN CONFIDENCE FOR A SPECIFIC PURPOSE AND THE RECIPIENT HEREOF AGREES NOT TO MAKE ANY REPRODUCTION, DISCLOSURE OR OTHER USE OF THIS INFORMATION WITHOUT THE WRITTEN CONSENT OF SOUTHWESTERN INDUSTRIES.

REVISIONS				
REV	DESCRIPTION	ECN	DATE	APPRV
1	ENGINEERING RELEASE	---	10/19/11	TO
-	ORIGINAL RELEASE	13916	7/10/12	TO
A	SHEET 4 PICTORIALLY ADDED 26891-6	14361	2/13/15	PM

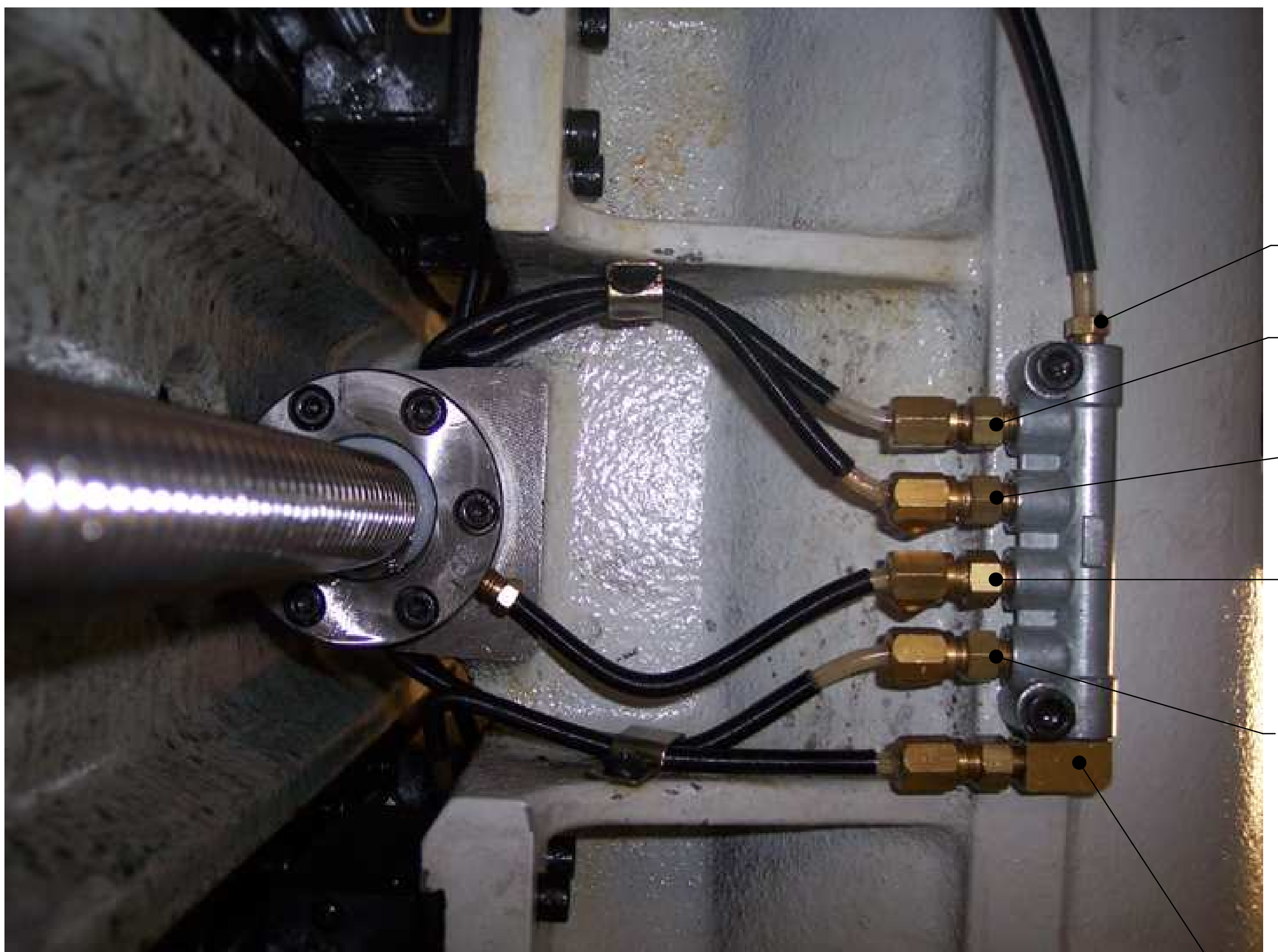
# X AXIS

X AXIS LUBRICATION LINE COMING FROM THE MAIN DISTRIBUTION MANIFOLD TO THE X AXIS DISTRIBUTION MANIFOLD VIEWED FROM THE RIGHT SIDE OF THE SPINDLE.



LUBRICATION LINE

LEFT SIDE VIEW OF THE X AXIS LUBRICATION DISTRIBUTION MANIFOLD AND THE LINES TO EACH OF THE RAIL GUIDE BLOCKS AND THE BALL NUT.



- FROM MAIN DISTRIBUTION MANIFOLD
- UPPER LEFT GUIDE LUBRICATION LINE. SIZE: NO 2
- UPPER RIGHT GUIDE LUBRICATION LINE. SIZE: NO 2
- TO BALLNUT SIZE: NO 5
- LOWER RIGHT GUIDE LUBRICATION LINE SIZE: NO 2
- LOWER LEFT GUIDE LUBRICATION LINE SIZE: NO 2

D  
C  
B  
A

D  
C  
B  
A

8 7 6 5 4 3 2 1

DIMENSIONS ARE IN INCHES DEC. X = ±.1, XX = ±.01, XXX = ±.005 ANGLES: XX = ±0°30' FRACTIONS = 1/8 FINISH = 125 RMS REMOVE ALL SHARP EDGES MASK ALL TAPPED HOLES DIMENSIONING PER ASME Y14.5		APPROVALS DRAWN BY: BD ENGINEER: TO ENGINEER:	DATE 10/19/11 3/25/13	SOUTHWESTERN INDUSTRIES, INC. 2615 HOMESTEAD PLACE RANCHO DOMINGUEZ, CA 90220-5610
MATERIAL: - FINISH: -		TITLE: LUBRICATION SYSTEM-2 OP MILL THIRD ANGLE PROJECTION		SIZE: D CODE IDENT. NO.: 06238 SCALE: -
DWG NO.: 27591 SHEET 3 OF 7			REV: A	REV: A

8 7 6 5 4 3 2 1

NOTICE: THIS DESIGN WAS ORIGINATED BY AND EMBODIES A CONFIDENTIAL PROPRIETARY DESIGN OWNED BY SOUTHWESTERN INDUSTRIES. IT IS DISCLOSED IN CONFIDENCE FOR A SPECIFIC PURPOSE AND THE RECIPIENT HEREOF AGREES NOT TO MAKE ANY REPRODUCTION, DISCLOSURE OR OTHER USE OF THIS INFORMATION WITHOUT THE WRITTEN CONSENT OF SOUTHWESTERN INDUSTRIES.

REVISIONS				
REV	DESCRIPTION	ECN	DATE	APPRV
1	ENGINEERING RELEASE	---	10/19/11	TO
-	ORIGINAL RELEASE	13916	7/10/12	TO
A	SHEET 4 PICTORIALY ADDED 26891-6	14361	2/13/15	PM

Y AXIS

D

D

C

C

B

B

A

A

LEFT

RIGHT

REAR

FRONT

- 3
- 7 4X
- 8
- 9 2X
- 10 6X
- 11 6X
- 12 6X
- 13 6X
- REF 14 2X
- REF 15 2X

- (26891-6)
- 5 12

NOT LUBRICATED BY LUBRICATION SYSTEM. HAND LUBRICATED.

FROM MAIN MANIFOLD

5 157

5 22

5 22

DIMENSIONS ARE IN INCHES DEC. X = ±.1, XX = ±.01, XXX = ±.005 ANGLES: XX = ±0°01' FRACTIONS = ±1/8 FINISH = 125 RMS REMOVE ALL SHARP EDGES MASK ALL TAPPED HOLES DIMENSIONING PER ASME Y14.5	APPROVALS	DATE	<b>SOUTHWESTERN INDUSTRIES, INC.</b> 2615 HOMESTEAD PLACE RANCHO DOMINGUEZ, CA 90220-5610	TITLE <b>LUBRICATION SYSTEM-          2 OP MILL</b>	REV <b>A</b>
	DRAWN BY <b>BD</b> ENGINEER <b>TO</b> ENGINEER	<b>10/19/11</b> <b>3/25/13</b>			

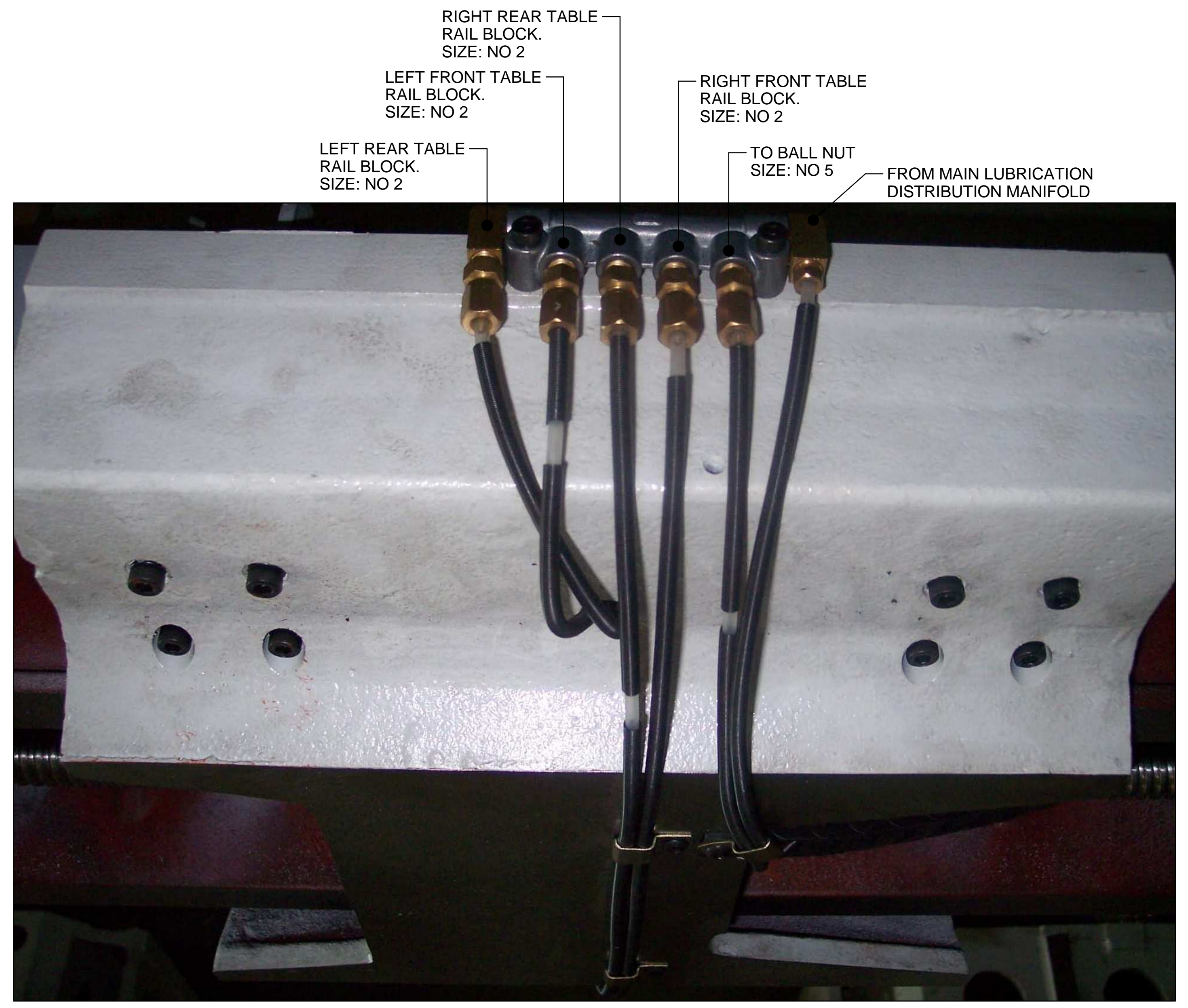
8 7 6 5 4 3 2 1

NOTICE: THIS DESIGN WAS ORIGINATED BY AND EMBODIES A CONFIDENTIAL PROPRIETARY DESIGN OWNED BY SOUTHWESTERN INDUSTRIES. IT IS DISCLOSED IN CONFIDENCE FOR A SPECIFIC PURPOSE AND THE RECIPIENT HEREOF AGREES NOT TO MAKE ANY REPRODUCTION, DISCLOSURE OR OTHER USE OF THIS INFORMATION WITHOUT THE WRITTEN CONSENT OF SOUTHWESTERN INDUSTRIES.

REVISIONS				
REV	DESCRIPTION	ECN	DATE	APPRV
1	ENGINEERING RELEASE	---	10/19/11	TO
-	ORIGINAL RELEASE	13916	7/10/12	TO
A	SHEET 4 PICTORIALLY ADDED 26891-6	14361	2/13/15	PM

# Y AXIS

D  
C  
B  
A



Y AXIS DISTRIBUTION MANIFOLD AND THE LUBRICATION LINES TO THE RAIL GUIDES AND THE BALL NUT.

8 7 6 5 4 3 2 1

DIMENSIONS ARE IN INCHES DEC. X = ±.1, XX = ±.01, XXX = ±.005 ANGLES: XX = ±0°30' FRACTIONS = 1/8 FINISH = 125 RMS REMOVE ALL SHARP EDGES MASK ALL TAPPED HOLES DIMENSIONING PER ASME Y14.5	APPROVALS	DATE	<b>SOUTHWESTERN INDUSTRIES, INC.</b> 2615 HOMESTEAD PLACE RANCHO DOMINGUEZ, CA 90220-5610				
	DRAWN BY	BD	10/19/11	TITLE			
	ENGINEER	TO	3/25/13	LUBRICATION SYSTEM- 2 OP MILL			
	ENGINEER			SIZE	CODE IDENT. NO.	DWG NO.	REV
MATERIAL			THIRD ANGLE PROJECTION	D	06238	27591	A
FINISH			SCALE: -			SHEET 5 OF 7	

8 7 6 5 4 3 2 1

Z AXIS

NOTICE: THIS DESIGN WAS ORIGINATED BY AND EMBODIES A CONFIDENTIAL PROPRIETARY DESIGN OWNED BY SOUTHWESTERN INDUSTRIES. IT IS DISCLOSED IN CONFIDENCE FOR A SPECIFIC PURPOSE AND THE RECIPIENT HEREOF AGREES NOT TO MAKE ANY REPRODUCTION, DISCLOSURE OR OTHER USE OF THIS INFORMATION WITHOUT THE WRITTEN CONSENT OF SOUTHWESTERN INDUSTRIES.

REVISIONS				
REV	DESCRIPTION	ECN	DATE	APPRV
1	ENGINEERING RELEASE	---	10/19/11	TO
-	ORIGINAL RELEASE	13916	7/10/12	TO
A	SHEET 4 PICTORIALY ADDED 26891-6	14361	2/13/15	PM

D  
C  
B  
A

D  
C  
B  
A

- 2X (15) REF
- 2X (14) REF
- 6X (13)
- 6X (12)
- 6X (11)
- 6X (10)
- (8)
- 4X (7)
- (3)

9 (5)

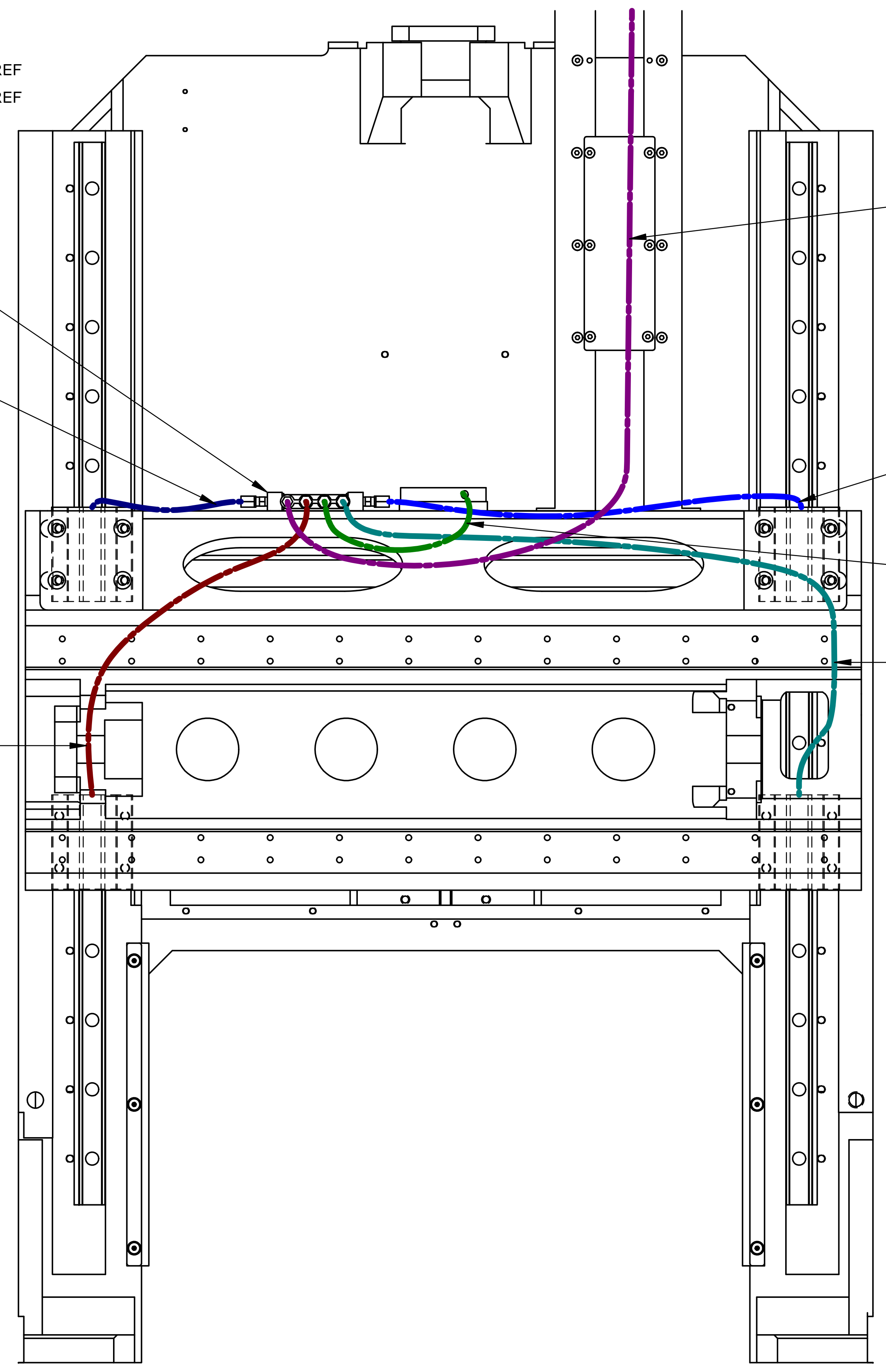
13 (5)

(5) 157

(5) 15

(5) 15

(5) 26



DIMENSIONS ARE IN INCHES DEC. X = ±.1, XX = ±.01, XXX = ±.005 ANGLES: XX = ±0°30' FRACTIONS = ±1/8 FINISH = 125 RMS REMOVE ALL SHARP EDGES MASK ALL TAPPED HOLES DIMENSIONING PER ASME Y14.5	APPROVALS	DATE	<b>SOUTHWESTERN INDUSTRIES, INC.</b> 2615 HOMESTEAD PLACE RANCHO DOMINGUEZ, CA 90220-5610	
	DRAWN BY: <b>BD</b> ENGINEER: <b>TO</b> ENGINEER:	<b>10/19/11</b> <b>3/25/13</b>	TITLE: <b>LUBRICATION SYSTEM- 2 OP MILL</b>	
MATERIAL	FE	SIZE	CODE IDENT. NO.	REV
FINISH	THIRD ANGLE PROJECTION	<b>D</b>	<b>06238</b>	<b>27591</b>
	SCALE: -			SHEET 6 OF 7

8 7 6 5 4 3 2 1

NOTICE: THIS DESIGN WAS ORIGINATED BY AND EMBODIES A CONFIDENTIAL PROPRIETARY DESIGN OWNED BY SOUTHWESTERN INDUSTRIES. IT IS DISCLOSED IN CONFIDENCE FOR A SPECIFIC PURPOSE AND THE RECIPIENT HEREOF AGREES NOT TO MAKE ANY REPRODUCTION, DISCLOSURE OR OTHER USE OF THIS INFORMATION WITHOUT THE WRITTEN CONSENT OF SOUTHWESTERN INDUSTRIES.

REVISIONS				
REV	DESCRIPTION	ECN	DATE	APPRV
1	ENGINEERING RELEASE	---	10/19/11	TO
-	ORIGINAL RELEASE	13916	7/10/12	TO
A	SHEET 4 PICTORIALY ADDED 26891-6	14361	2/13/15	PM

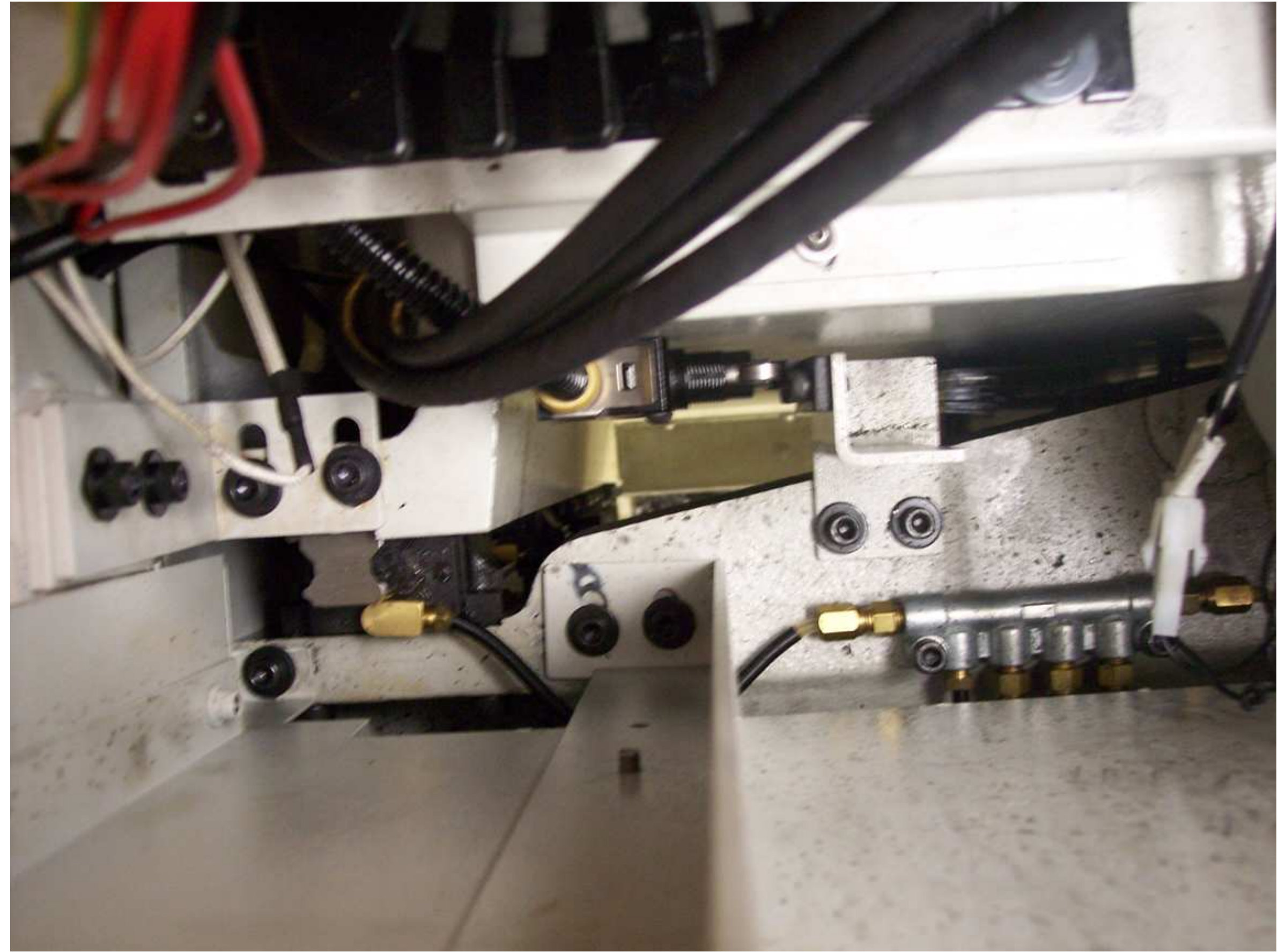
# Z AXIS

VIEW OF CABLE CARRIER FROM RIGHT SIDE OF MACHINE.



FROM MAIN MANIFOLD TO Z-AXIS LUBRICATION DISTRIBUTION MANIFOLD

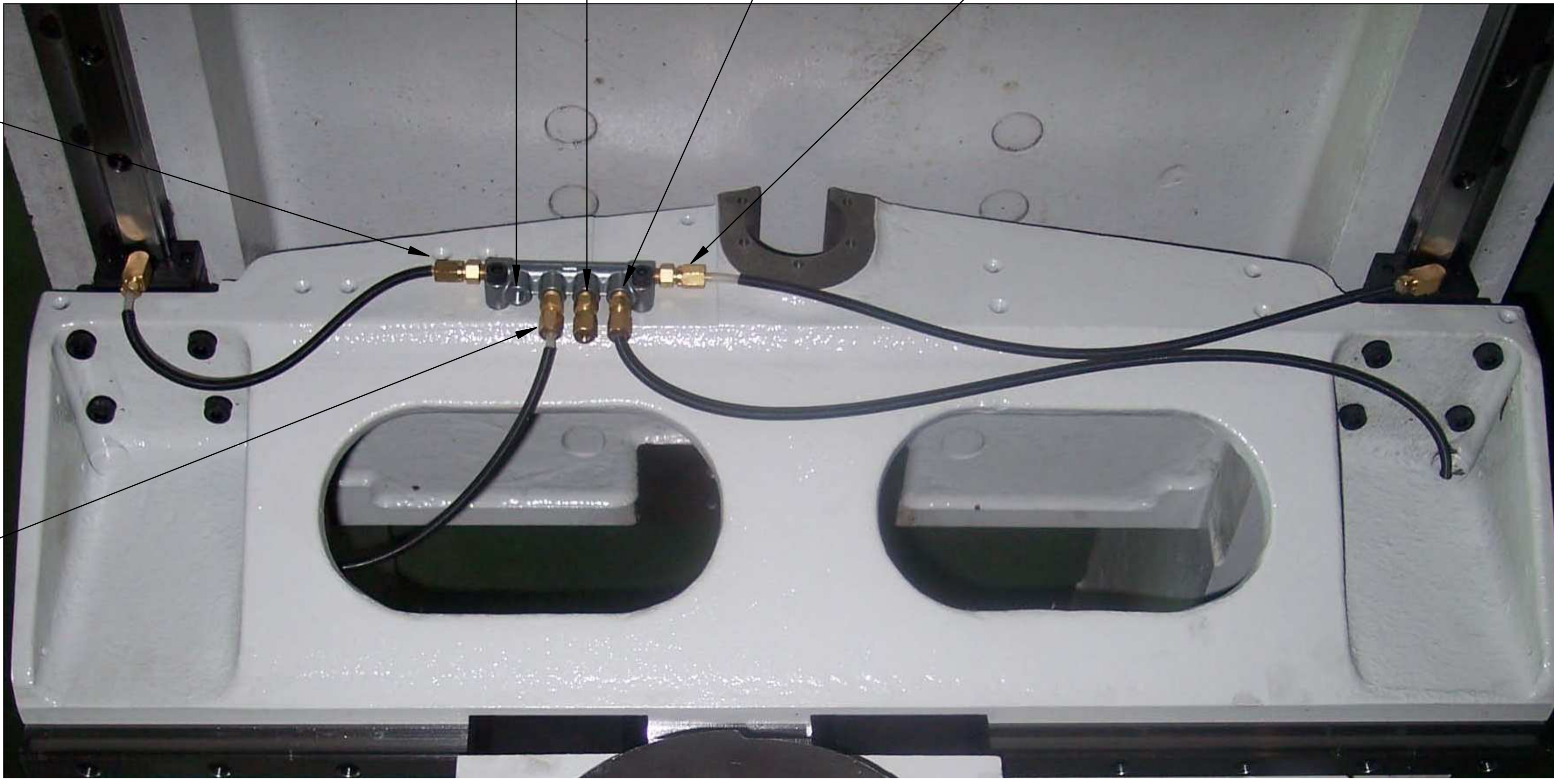
Z AXIS LUBRICATION DISTRIBUTION MANIFOLD FROM TOP OF MACHINE



FROM MAIN LUBRICATION DISTRIBUTION MANIFOLD  
 TO BALL NUT. SIZE: NO 5 (NOT SHOWN)  
 TO RIGHT BOTTOM GUIDE BLOCK. SIZE: NO 2  
 TO RIGHT TOP GUIDE BLOCK. SIZE: NO 2

TO LEFT TOP GUIDE BLOCK. SIZE: NO 2

TO LEFT BOTTOM GUIDE BLOCK. SIZE: NO 2



DIMENSIONS ARE IN INCHES DEC. X = ±.1, XX = ±.01, XXX = ±.005 ANGLES: XX = ±0°30' FRACTIONS = ±1/8 FINISH = 125 RMS REMOVE ALL SHARP EDGES MASK ALL TAPPED HOLES DIMENSIONING PER ASME Y14.5		APPROVALS	DATE	SOUTHWESTERN INDUSTRIES, INC. 2615 HOMESTEAD PLACE RANCHO DOMINGUEZ, CA 90220-5610	
DRAWN BY	BD	10/19/11	TITLE		
ENGINEER	TO	3/25/13	LUBRICATION SYSTEM- 2 OP MILL		
ENGINEER			SIZE	CODE IDENT. NO.	DWG NO.
MATERIAL			D	06238	27591
FINISH			THIRD ANGLE PROJECTION	SCALE: -	REV A
			SHEET 7 OF 7		

Parts List for Assembly P/N: 27591

Printed 2/13/2015

**27591**  
 LUBRICATION SYSTEM-2OP MILL  
 REFER TO 27591-KR XYZ

Type	PL	Dwg Size	D
Revision	A	Product	2OP
Status	R	Engineer	TO
Date	10/14/2010	Planner Code	
By	BD	Comm Code	

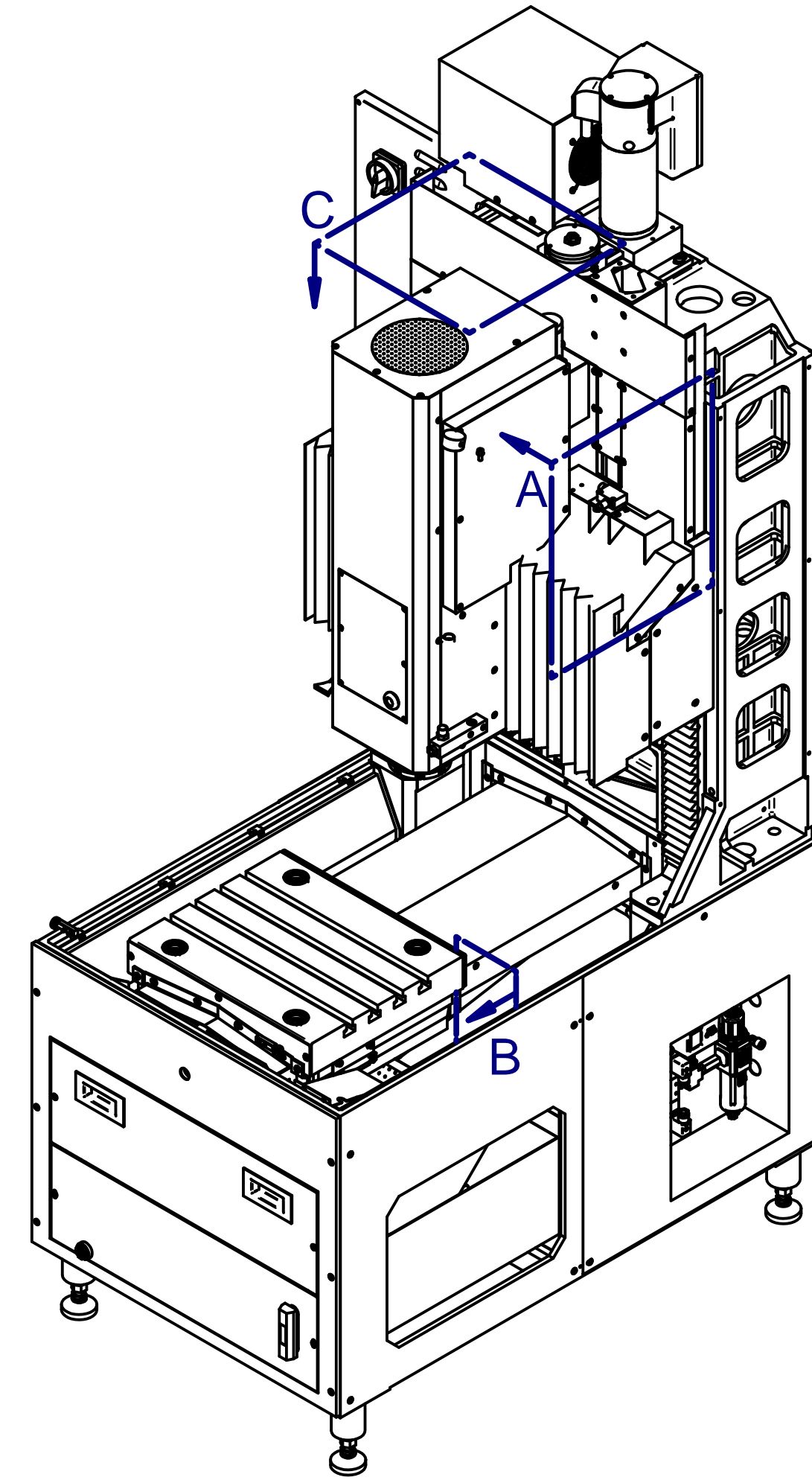
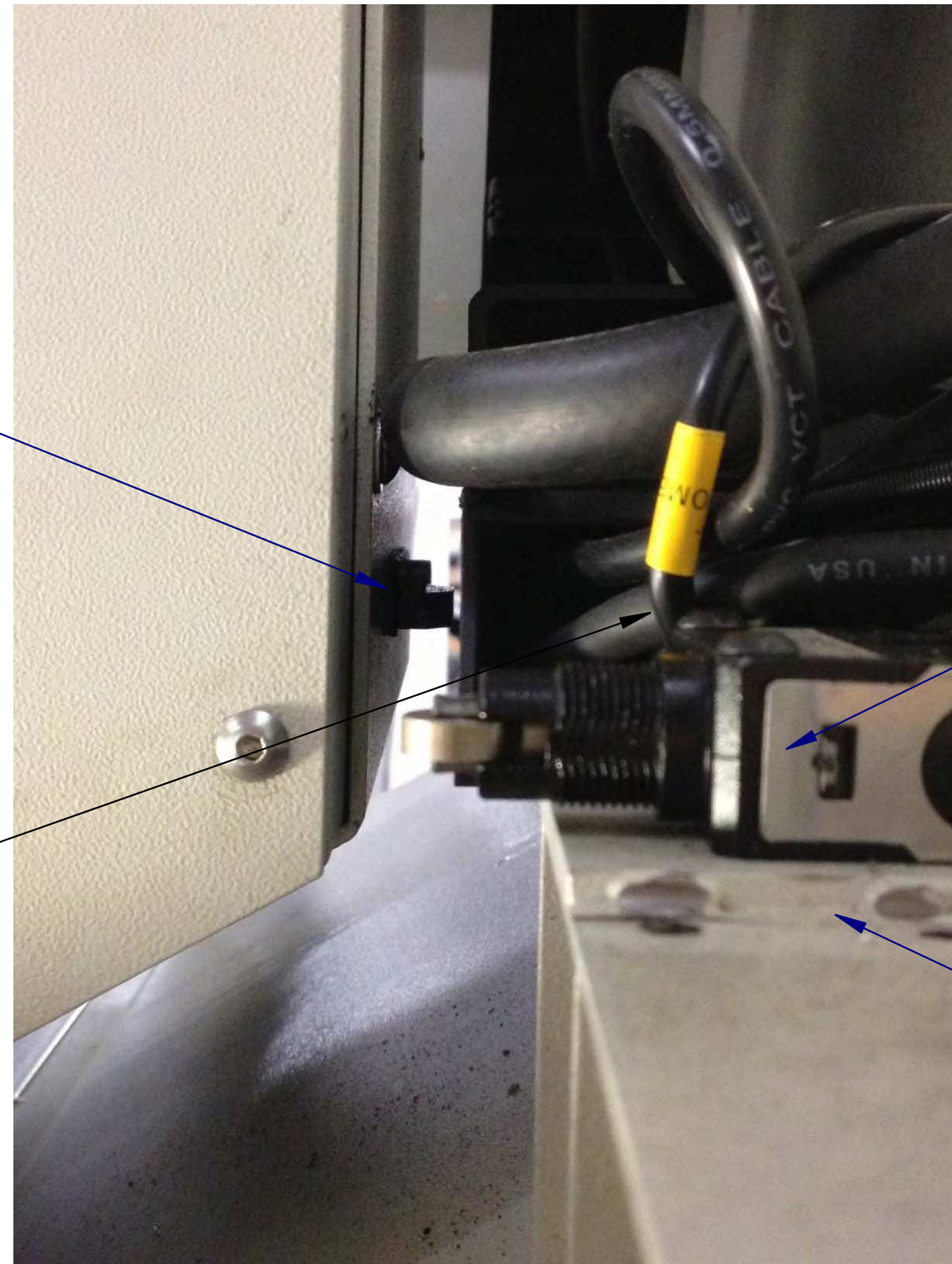
Item	P/N	Title	Detail	Qty	UseAs	Rev	Stat	Type	Mfr	Mfr P/N
1	22291-3	LUBRICATION PUMP-115 VAC		1	EA	-	R	DWG		
2	28042-1	MANIFOLD-TUBE FITTING-4 OUTLETS	SEE 27591	1	EA	-	R	PS	KING RICH	
3	28042-2	MANIFOLD-TUBE FITTING-6 OUTLETS		3	EA	-	R	PS	KING RICH	
5	26979-2	TUBING-PLASTIC-SOFT 2mm ID x 4mm OD		767	IN	-	R	PS	KING RICH	
7	26972-2	VALVE-CHECK/METER-SIZE 2		12	EA	-	R	PS	KING RICH	
8	26972-3	VALVE-CHECK/METER-SIZE 5		3	EA	-	R	PS	KING RICH	
9	28048	ELBOW-COMPRESSION FITTING		3	EA	-	R	PS	KING RICH	
10	28046	NUT-COMPRESSION-4mm-MANIFOLD		22	EA	-	R	PS	KING RICH	
11	28046-1	FITTING-COMPRESSION-4mm-MANIFOLD		22	EA	-	R	PS	KING RICH	
12	28047	SLEEVE-COMPRESSION-OUTER-4mm-MANIFOLD		22	EA	-	R	PS	KING RICH	
13	28047-1	SLEEVE-COMPRESSION-INNER-4mm-MANIFOLD		22	EA	-	R	PS	KING RICH	
14	M6-1.0X35 25B	SCREW-SHCS-STL-BO		(8)	EA	-	R	PS		
15	M6 73B	WASHER-SPLIT LOCK-STL-BO		(8)	EA	-	R	PS		



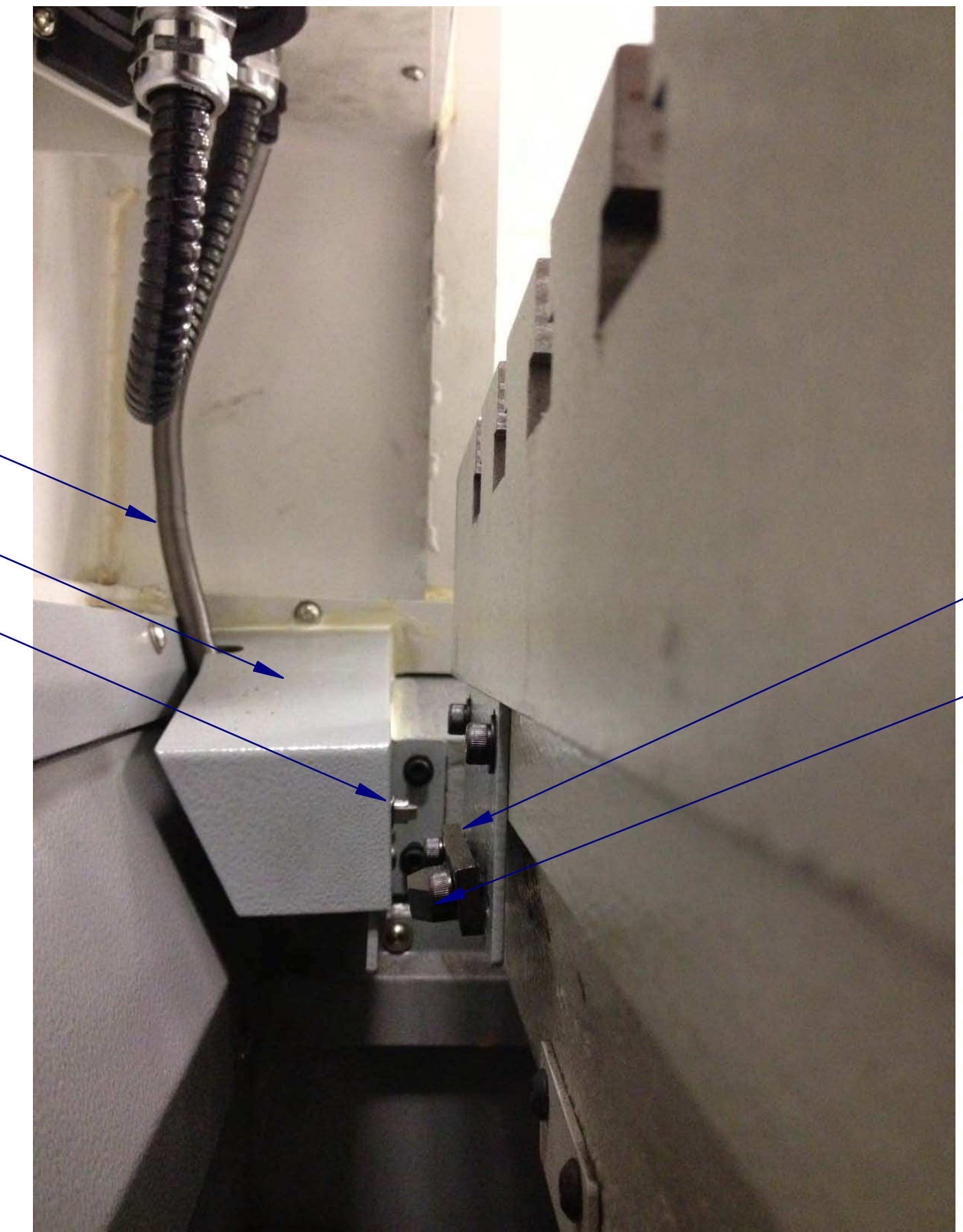
NOTICE: THIS DESIGN WAS ORIGINATED BY AND EMBODIES A CONFIDENTIAL PROPRIETARY DESIGN OWNED BY SOUTHWESTERN INDUSTRIES. IT IS DISCLOSED IN CONFIDENCE FOR A SPECIFIC PURPOSE AND THE RECIPIENT HEREOF AGREES NOT TO MAKE ANY REPRODUCTION, DISCLOSURE OR OTHER USE OF THIS INFORMATION WITHOUT THE WRITTEN CONSENT OF SOUTHWESTERN INDUSTRIES.

REVISIONS				
REV	DESCRIPTION	ECN	DATE	APPRV
1	ENGINEERING RELEASE	---	4/9/12	TO
-	ORIGINAL RELEASE	13915	5/2/12	TO

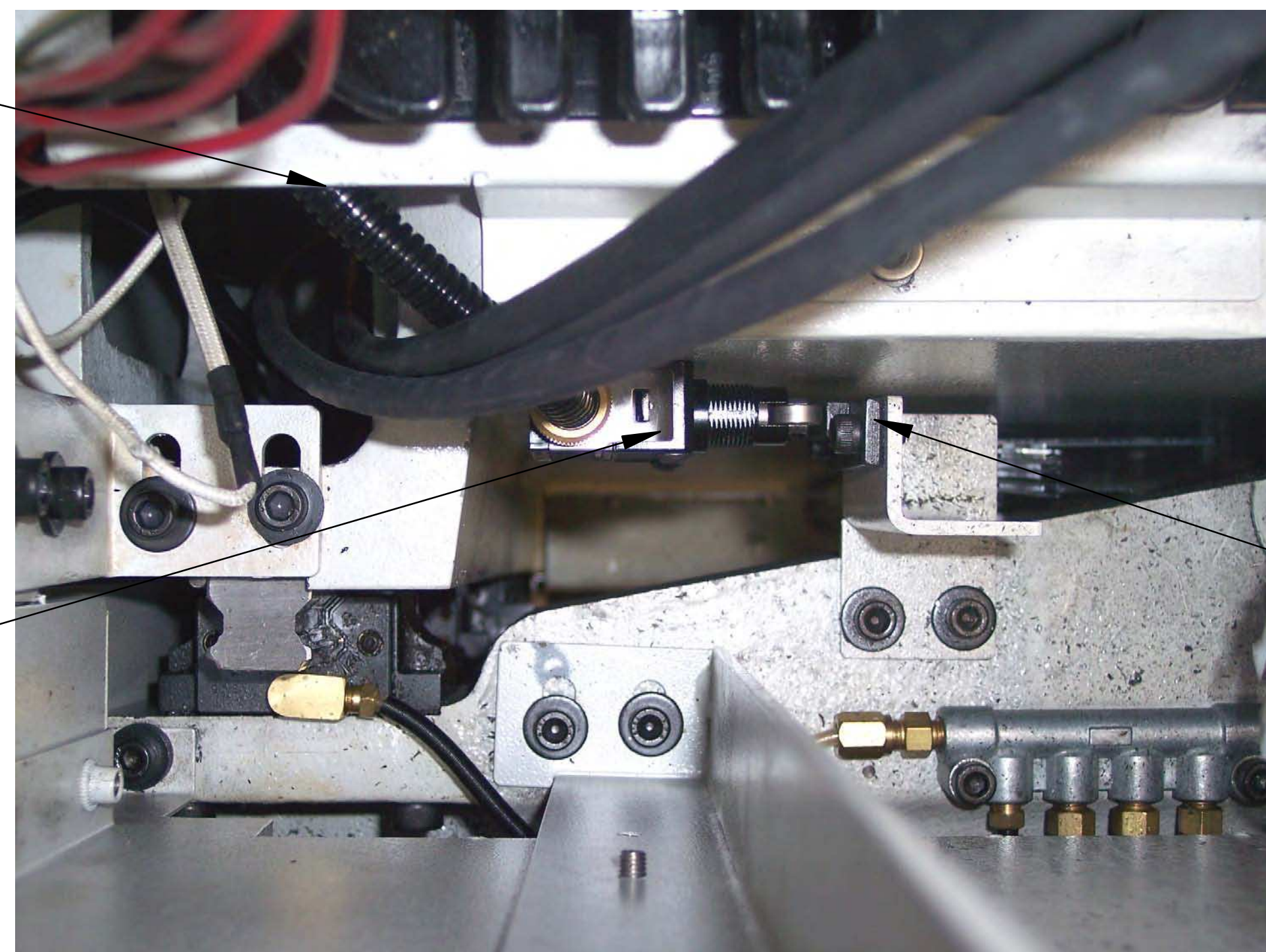
### X-AXIS HOME SWITCH



### Y-AXIS HOME SWITCH



### Z-AXIS HOME SWITCH



DETAIL A  
RIGHTSIDE VIEW

DETAIL B  
INSIDE VIEW

DETAIL C  
TOP VIEW

NOTES: (UNLESS OTHERWISE SPECIFIED).

1. FOR HOME AND SOFT LIMIT DEFINITION SEE DRAWING 25430.

DIMENSIONS ARE IN INCHES DEC. .X = ±.1, .XX = ±.01, .XXX = ±.005 ANGLES .XX = ±0°30' FRACTIONS = 1/8 FINISH = 125 RMS REMOVE ALL SHARP EDGES MASK ALL TAPPED HOLES DIMENSIONING PER ASME Y14.5		APPROVALS	DATE	SOUTHWESTERN INDUSTRIES, INC. 2615 HOMESTEAD PLACE RANCHO DOMINGUEZ, CA 90220-5610	
NEXT ASSY	USED ON	DRAWN BY	10/10/11	TITLE	
APPLICATION		ENGINEER	10/10/11	HOME SWITCH ASSY	
		ENGINEER		SIZE	REV
				D	-
				CODE IDENT. NO.	DWG NO.
				06238	27658
				SCALE:	SHEET 1 OF 1
				-	

Parts List for Assembly P/N: 27658

Printed 3/5/2013

**27658**

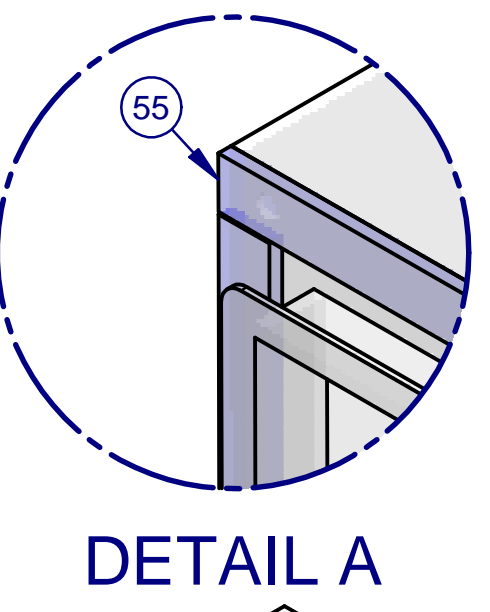
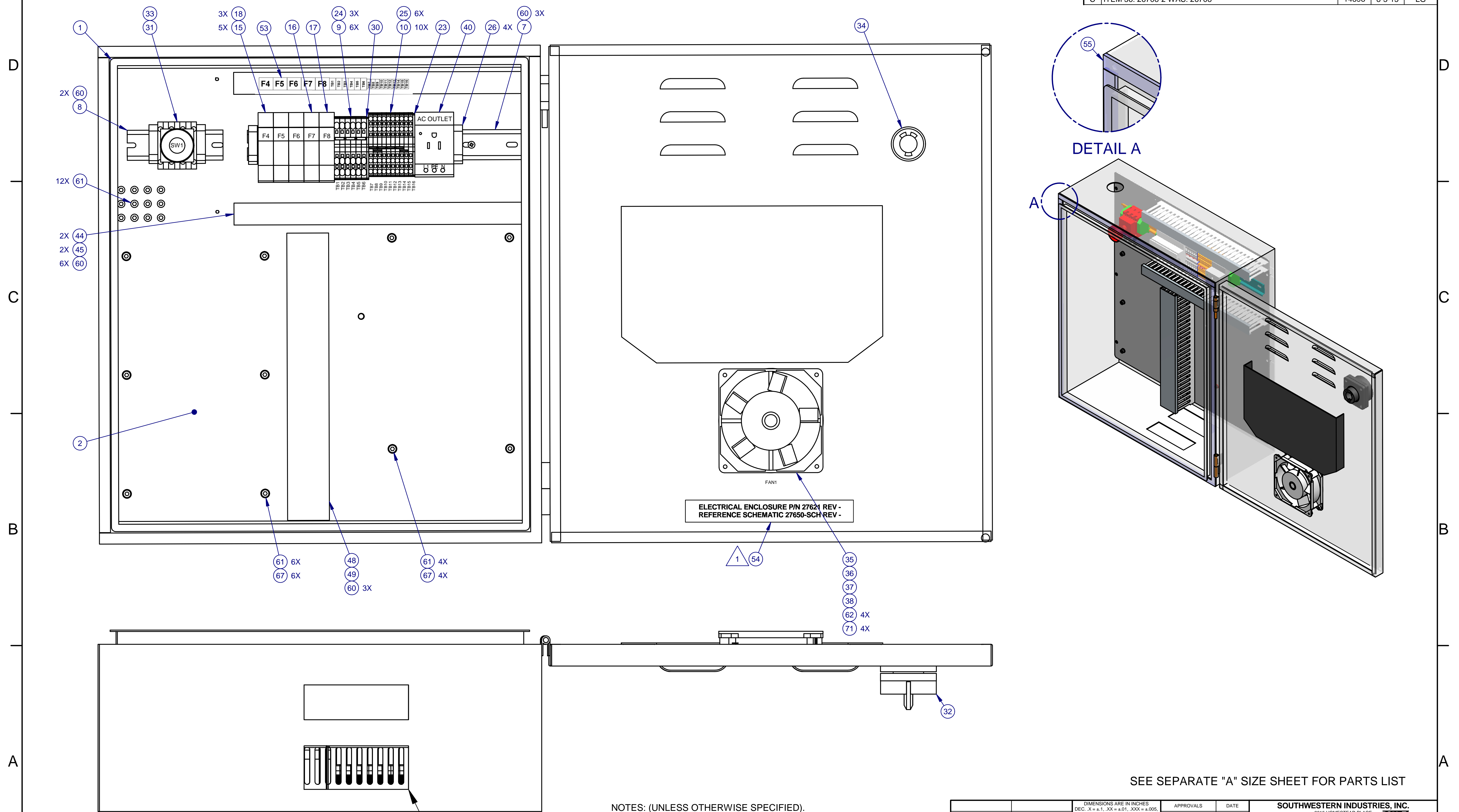
HOME SWITCH ASSY-2OP M10 MILL

Type	PL	Dwg Size	D
Revision	-	Product	2 OP
Status	R	Engineer	TO
Date	10/14/2010	Planner Code	
By	BD	Comm Code	

Item	P/N	Title	Detail	Qty	Rev	UseAs	Stat	Type	Mfr
1	22680-3	SWITCH-LIMIT-ROLLER PLUNGER		(3)	-	EA	R	DWG	
2	27635-1	CABLE ASSY-X AXIS HOME SW	DC300-111	(1)	-	EA	R	PL	
3	27635-2	CABLE ASSY-Y AXIS HOME SW	DC300-112	(1)	-	EA	R	PL	
4	27635-3	CABLE ASSY-Z AXIS HOME SW	DC300-113	(1)	-	EA	R	PL	
5	27690-1	COVER-HOME SWITCH-X AXIS	SEE 27520	(1)	-	EA	R	PS	
6	27690-2	COVER-HOME SWITCH-Y AXIS		(1)	-	EA	R	PS	
7	27691-1	BRACKET-HOME SWITCH-Y AXIS	SEE 27564	(1)	-	EA	R	PS	
9	27603-21	BRACE-RIGHT-X AXIS ASSY	SEE 27520	(1)	-	EA	R	PS	
10	27634	TRIGGER-HOME SWITCH-2 OP		(3)	-	EA	R	PS	KING RICH
15	M4-0.7X25 27B	SCREW-BHCS-STL-BO	NON STOCKABLE	(6)	-	EA	R	PS	

NOTICE: THIS DESIGN WAS ORIGINATED BY AND EMBODIES A CONFIDENTIAL PROPRIETARY DESIGN OWNED BY SOUTHWESTERN INDUSTRIES, INC. IT IS DISCLOSED IN CONFIDENCE FOR A SPECIFIC PURPOSE AND THE RECIPIENT HEREOF AGREES NOT TO MAKE ANY REPRODUCTION, DISCLOSURE OR OTHER USE OF THIS INFORMATION WITHOUT THE WRITTEN CONSENT OF SOUTHWESTERN INDUSTRIES, INC.

REVISIONS				
REV	DESCRIPTION	ECN	DATE	APPRV
A	ADDED ITEM 39 & NOTE 1.	14308	01/09/13	RO
B	(3B2-3) 115AC-2 & LIGHT-115AC WAS: 24AC-1 & LIGHT-24AC	14285	09/15/14	RO
C	ITEM 36: 26708-2 WAS: 26708	14398	8-3-15	LG



ELECTRICAL ENCLOSURE P/N 27621 REV -  
REFERENCE SCHEMATIC 27650-SCH REV -

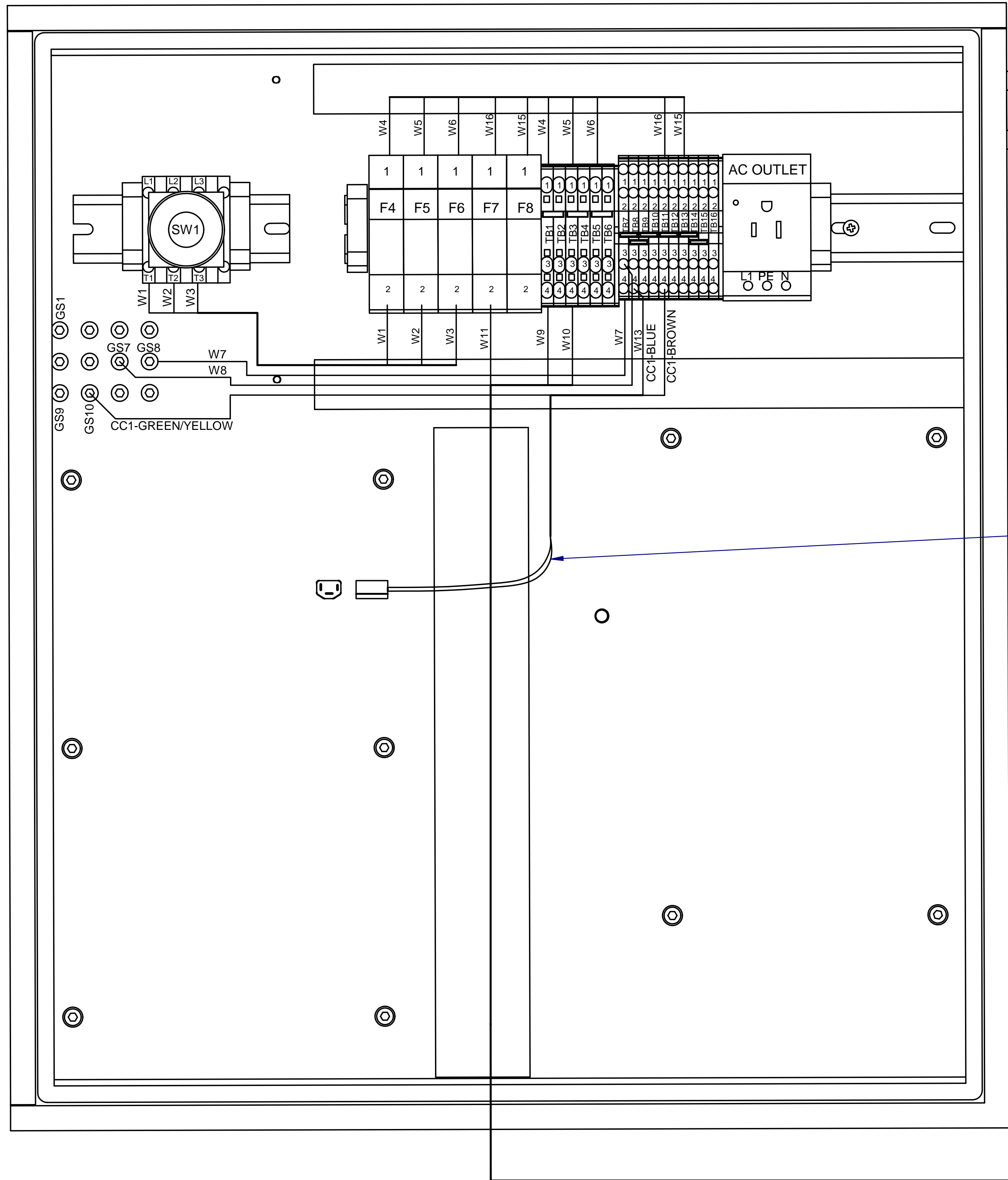
SEE SEPARATE "A" SIZE SHEET FOR PARTS LIST

NOTES: (UNLESS OTHERWISE SPECIFIED).  
1 LABEL TO HAVE CURRENT REVISIONS OF DRAWINGS INDICATED.

ROUTE ALL AC WIRES THROUGH HERE

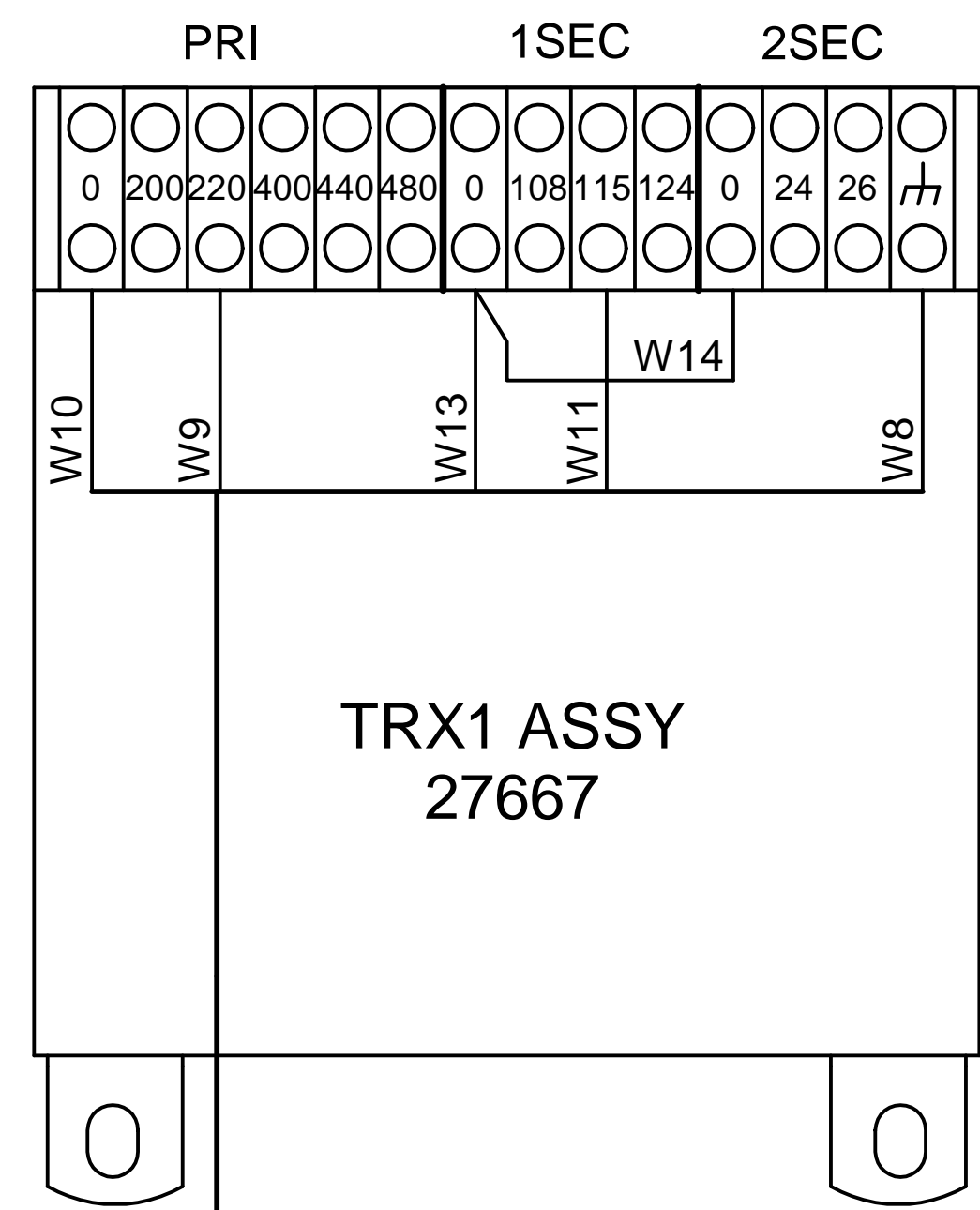
DIMENSIONS ARE IN INCHES DEC. .X = ±.1, .XX = ±.01, .XXX = ±.005 ANGLES .XX = ±0°30' FRACTIONS = ±1/8 FINISH = 125 RMS REMOVE ALL SHARP EDGES MASK ALL TAPPED HOLES DIMENSIONING PER ASME Y14.5		APPROVALS DRAWN BY RC ENGINEER RO ENGINEER	DATE 10/23/09 9/10/12	SOUTHWESTERN INDUSTRIES, INC. 2615 HOMESTEAD PLACE RANCHO DOMINGUEZ, CA 90220-5610	
MATERIAL		THIRD ANGLE PROJECTION		SIZE D	CODE IDENT. NO. 06238
NEXT ASSY	USED ON	SCALE: -		TITLE ENCLOSURE- ELEC ASSY-2OP M10 MILL	REV C
APPLICATION		SHEET 1 OF 3		DWG NO. 27621	

NOTICE: THIS DESIGN WAS ORIGINATED BY AND EMBODIES A CONFIDENTIAL PROPRIETARY DESIGN OWNED BY SOUTHWESTERN INDUSTRIES. IT IS DISCLOSED IN CONFIDENCE FOR A SPECIFIC PURPOSE AND THE RECIPIENT HEREOF AGREES NOT TO MAKE ANY REPRODUCTION, DISCLOSURE OR OTHER USE OF THIS INFORMATION WITHOUT THE WRITTEN CONSENT OF SOUTHWESTERN INDUSTRIES.

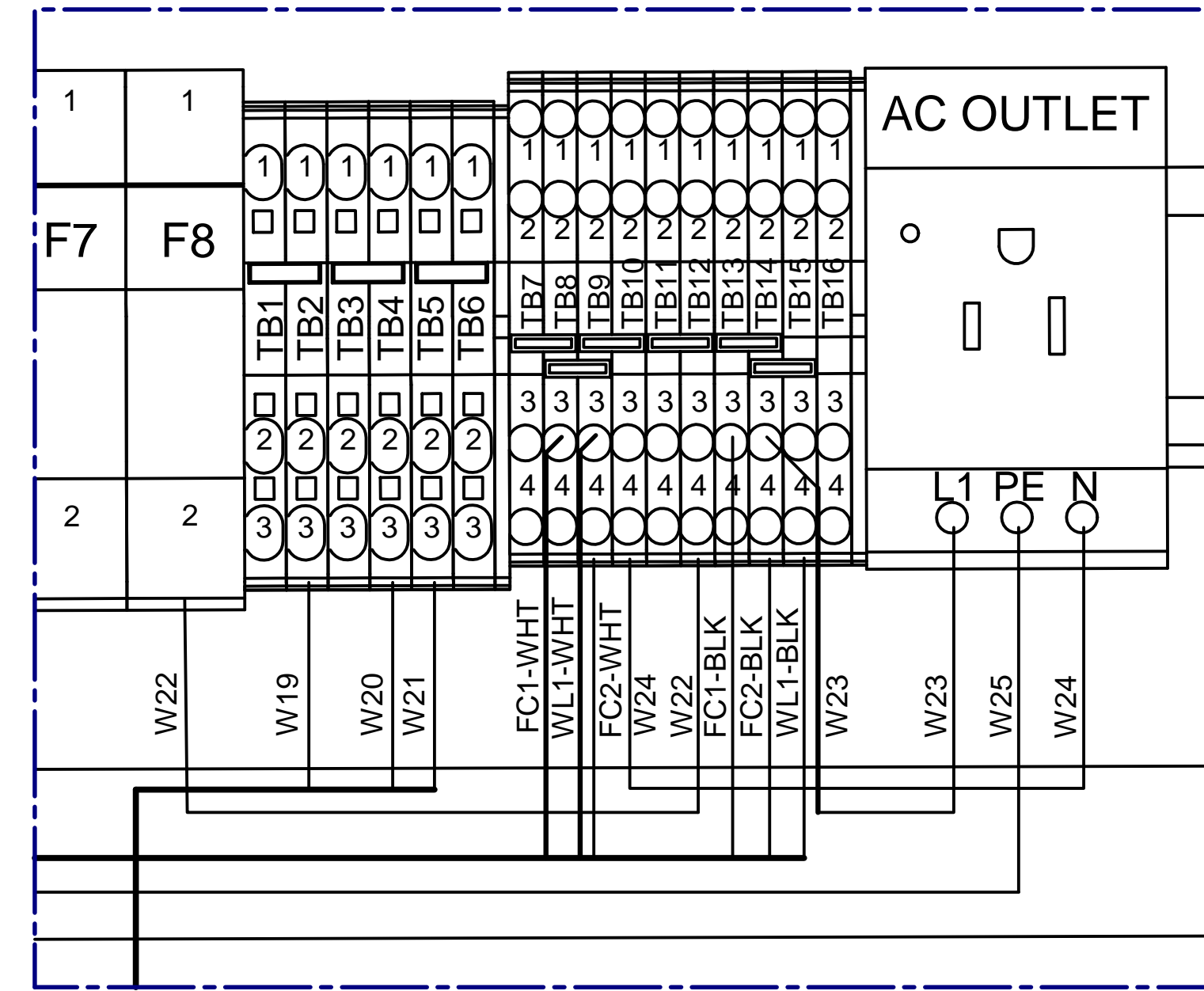
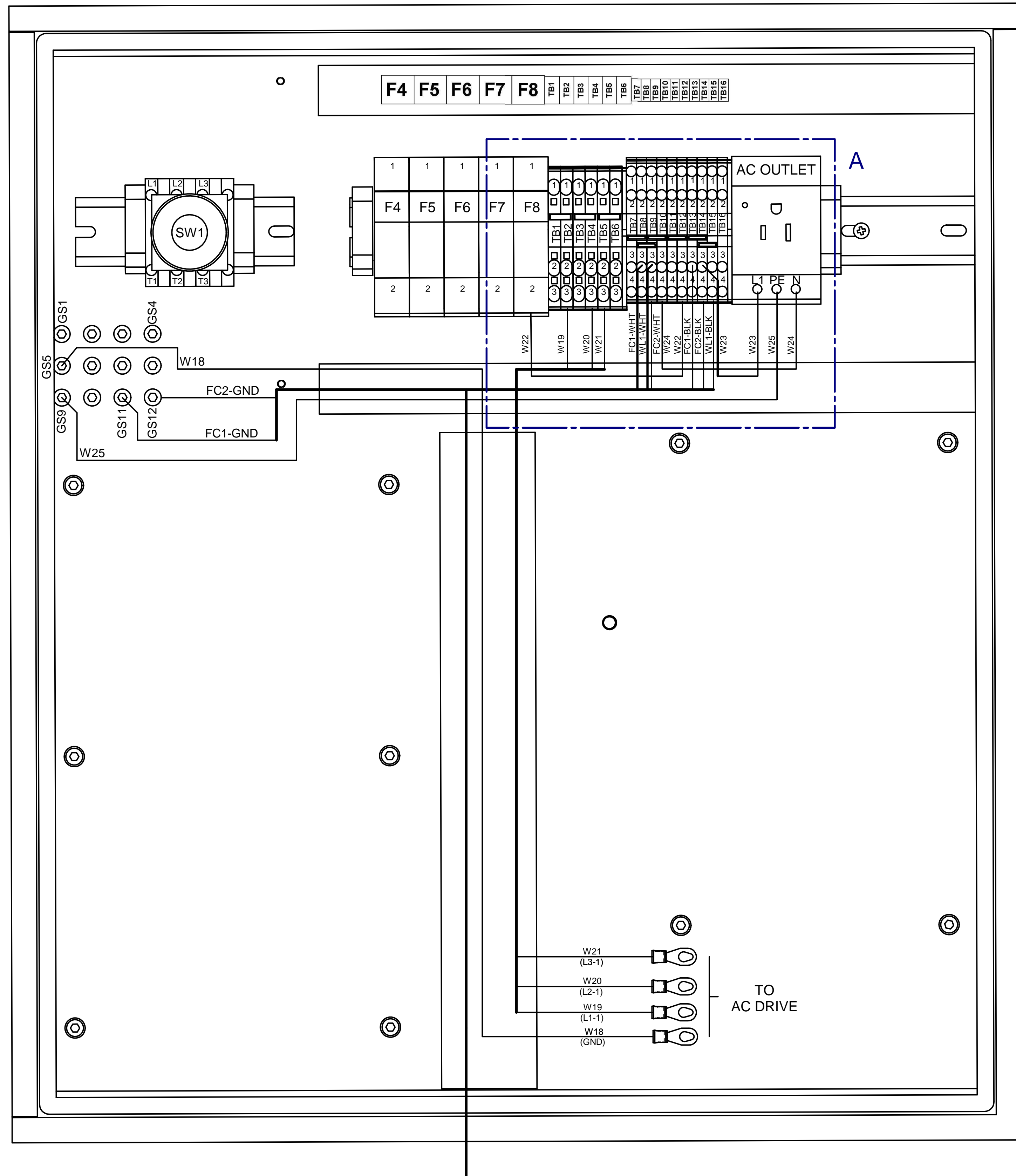


WIRE CHART							
WIRE/CABLE	SWI P/N	WIRE FROM	WIRE LABEL	WIRE GAGE	LENGTH	COLOR	WIRE TO
W1		SW1-T1	L1	2mm <sup>2</sup>		BLACK	F4-2
W2		SW1-T2	L2	2mm <sup>2</sup>		BLACK	F5-2
W3		SW1-T3	L3	2mm <sup>2</sup>		BLACK	F6-2
W4		F4-1	L1-1	2mm <sup>2</sup>		BLACK	TB1-1
W5		F5-1	L2-1	2mm <sup>2</sup>		BLACK	TB3-1
W6		F6-1	L3-1	2mm <sup>2</sup>		BLACK	TB5-1
W7		GS8	GND	2mm <sup>2</sup>		GREEN	TB7-4
W8		GS7	GND	2mm <sup>2</sup>		GREEN	TRX1-2SEC-GND
W9		TB1-4	L1-1	2mm <sup>2</sup>		BLACK	TRX1-PRI-220
W10		TB3-4	L2-1	2mm <sup>2</sup>		BLACK	TRX1-PRI-0
W11		F7-2	115AC	2mm <sup>2</sup>		RED	TRX1-1SEC-115
W13		TB7-3	0V	2mm <sup>2</sup>		WHITE	TRX1-1SEC-0
W14		TRX1-1SEC-0	0V	2mm <sup>2</sup>		WHITE	TRX1-2SEC-0
W15		F8-1	115AC-2	2mm <sup>2</sup>		BLACK	TB13-1
W16		F7-1	115AC-1	2mm <sup>2</sup>		RED	TB11-1

WIRE CHART							
WIRE/CABLE	SWI P/N	WIRE FROM	WIRE LABEL	WIRE GAGE	LENGTH	COLOR	WIRE TO
COMPUTER CABLE (CC1)	26592-1	GS-10	GND	2mm <sup>2</sup>		GREEN/YELLOW	COMPUTER MODULE
		TB8-4	0V	2mm <sup>2</sup>		BLUE	
		TB11-4	115AC-1	2mm <sup>2</sup>		BROWN	

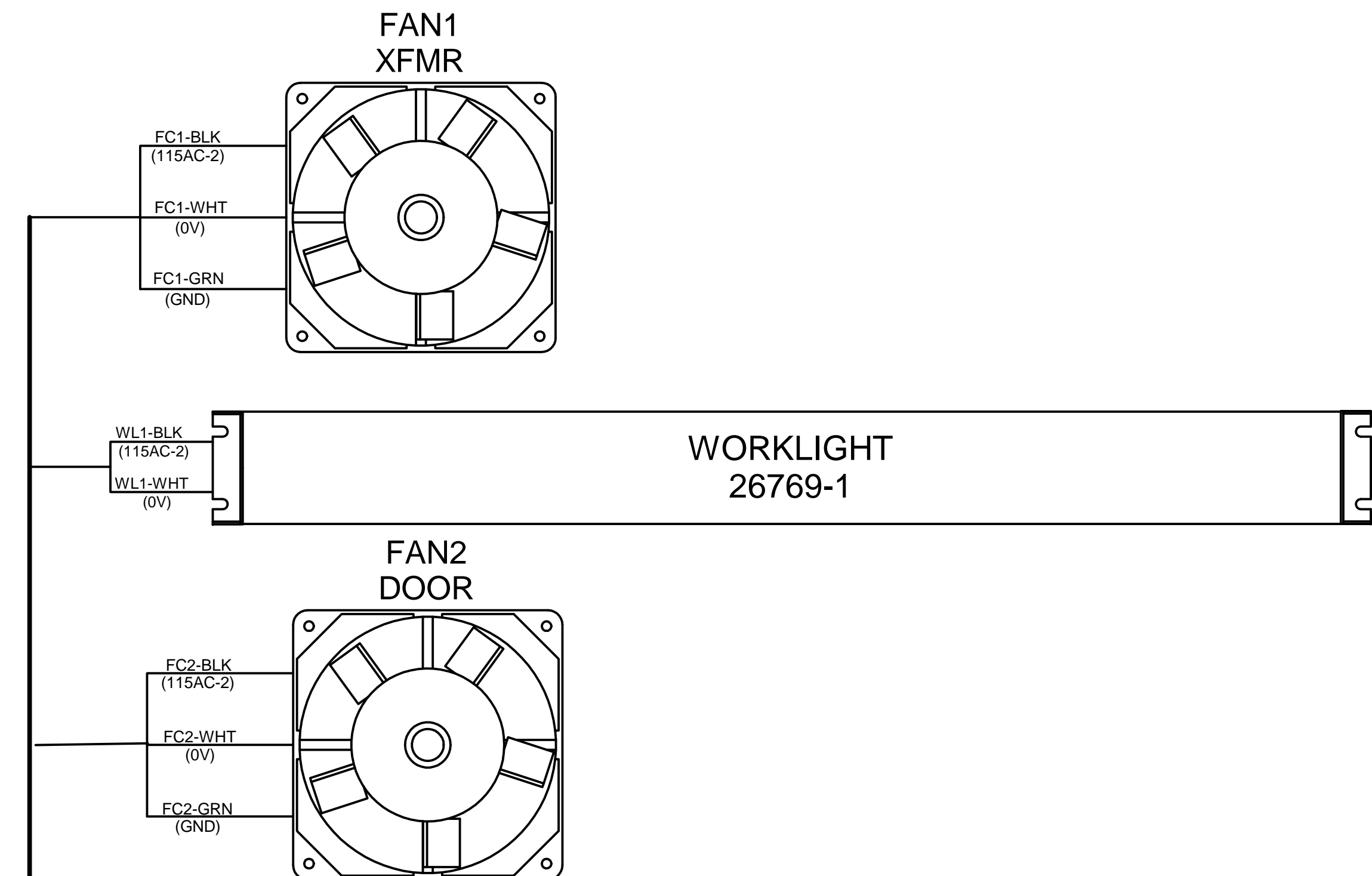


NOTICE: THIS DESIGN WAS ORIGINATED BY AND EMBODIES A CONFIDENTIAL PROPRIETARY DESIGN OWNED BY SOUTHWESTERN INDUSTRIES. IT IS DISCLOSED IN CONFIDENCE FOR A SPECIFIC PURPOSE AND THE RECIPIENT HEREOF AGREES NOT TO MAKE ANY REPRODUCTION, DISCLOSURE OR OTHER USE OF THIS INFORMATION WITHOUT THE WRITTEN CONSENT OF SOUTHWESTERN INDUSTRIES.



DETAIL A

WIRE CHART							
WIRE/ CABLE	SWI P/N	WIRE FROM	WIRE LABEL	WIRE GAGE	LENGTH	COLOR	WIRE TO
W18		GS5	GND	2mm <sup>2</sup>		GREEN	VFD-GND
W19		TB2-4	L1-1	2mm <sup>2</sup>		BLACK	VFD-L1
W20		TB4-4	L2-1	2mm <sup>2</sup>		BLACK	VFD-L2
W21		TB5-4	L3-1	2mm <sup>2</sup>		BLACK	VFD-L3
W22		TB12-4	115AC-1	2mm <sup>2</sup>		BLACK	F8-2
W23		TB14-3	115AC-1	0.75mm <sup>2</sup>		BLACK	AC OUTLET-L1
W24		TB10-4	OV	0.75mm <sup>2</sup>		WHITE	AC OUTLET-N
W25		GS9	GND	0.75mm <sup>2</sup>		GREEN	AC OUTLET-PE
FAN CABLE 1 (FC1)	27176-3	TB8-3	0V	0.75mm <sup>2</sup>		WHITE	FAN 1-0V
		TB13-3	115AC-2	0.75mm <sup>2</sup>		BLACK	FAN 1-115AC
		GS11	GND	0.75mm <sup>2</sup>		GREEN	GND
FAN CABLE 2 (FC2)	27176-2	TB9-4	0V	0.75mm <sup>2</sup>		WHITE	FAN 2-0V
		TB14-4	115AC-2	0.75mm <sup>2</sup>		BLACK	FAN 2-115AC
		GS12	GND	0.75mm <sup>2</sup>		GREEN	GND
WORK LIGHT CABLE (WL1)	27635-15	TB9-3	0V	0.75mm <sup>2</sup>		WHITE	LIGHT-0V
		TB15-4	115AC-2	0.75mm <sup>2</sup>		BLACK	LIGHT-115AC



Parts List for Assembly P/N: 27621

Printed 8/3/2015

27621  
ENCLOSURE-ELEC ASSY-2OP M10 MILL

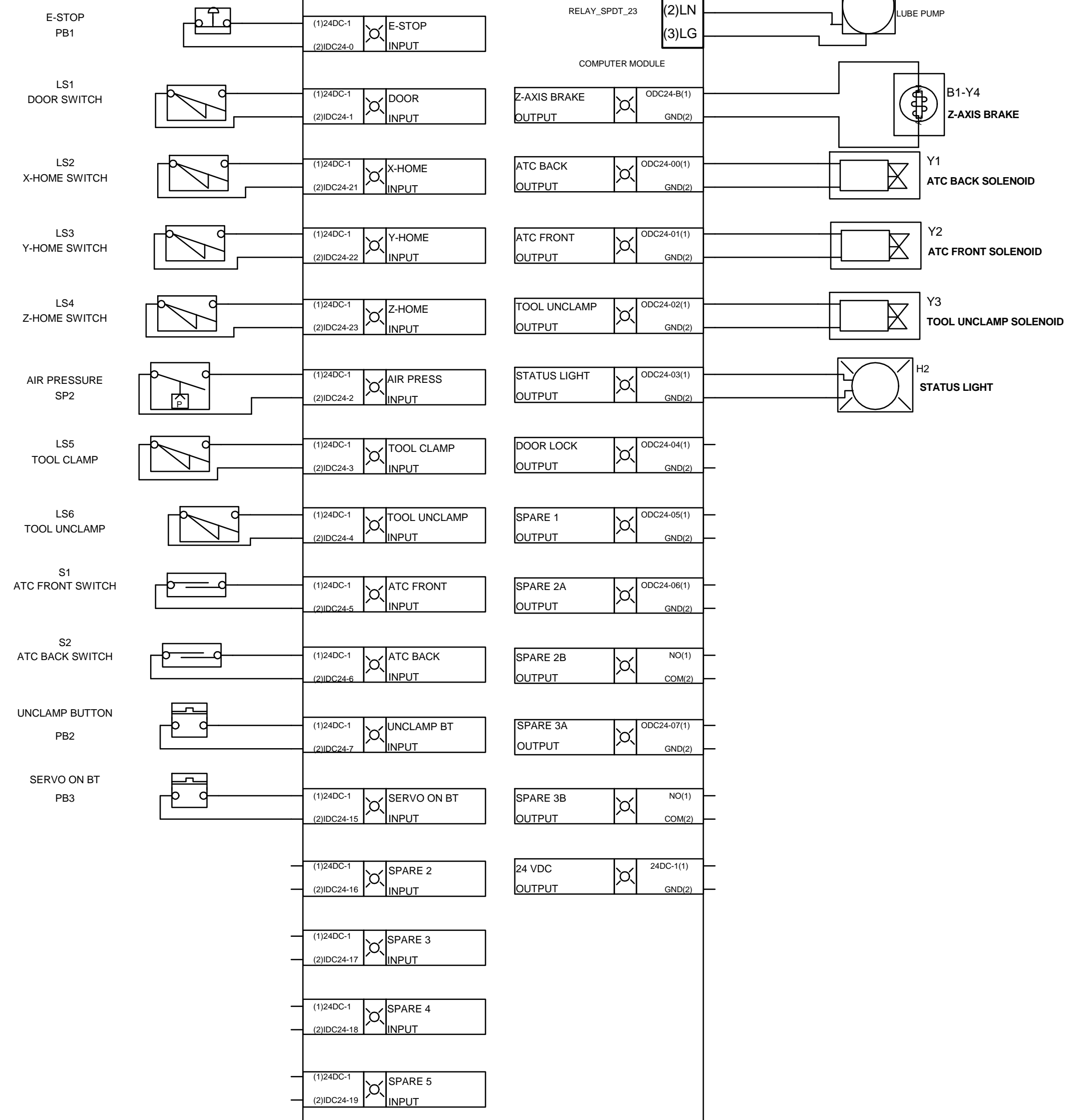
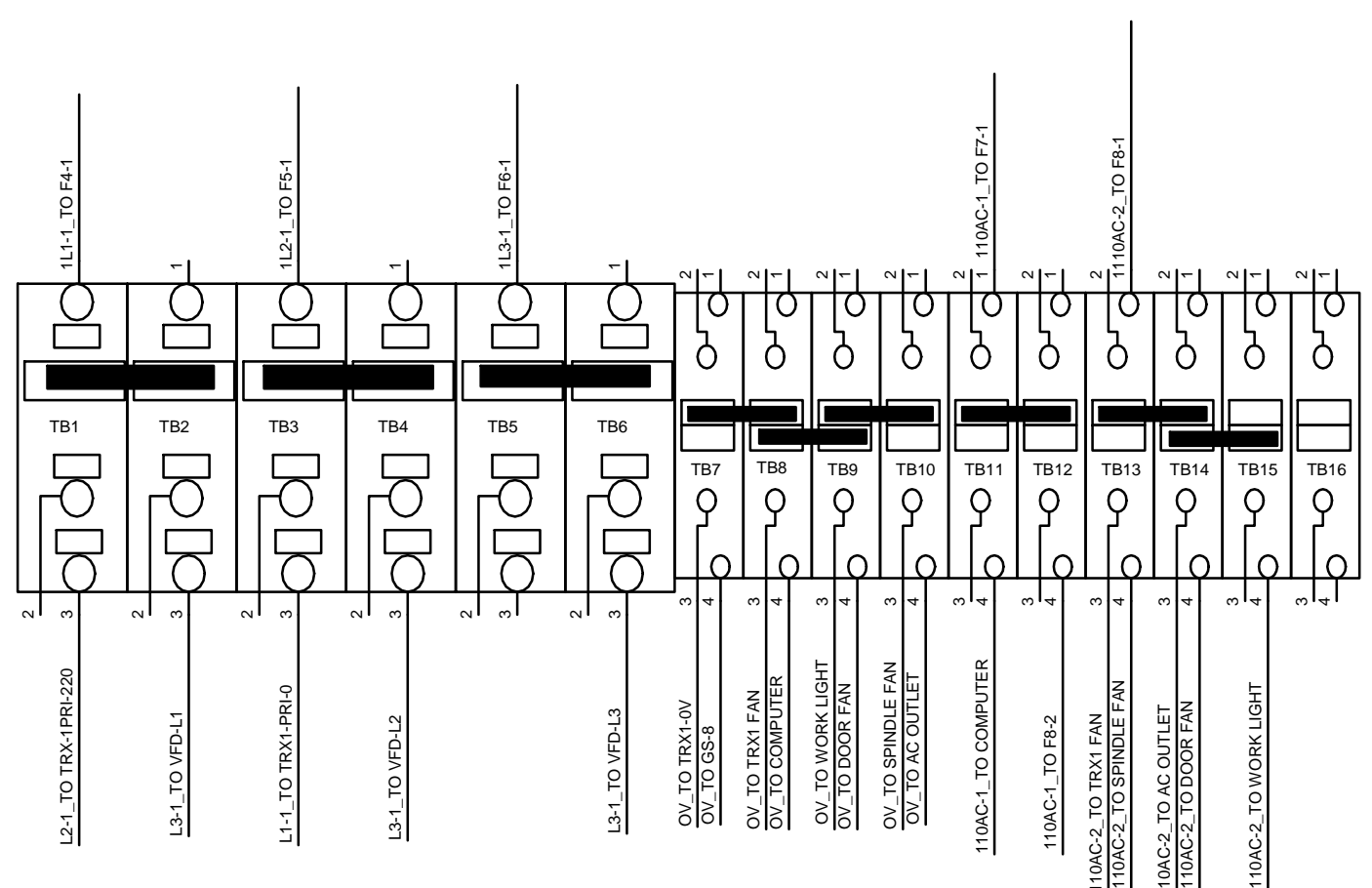
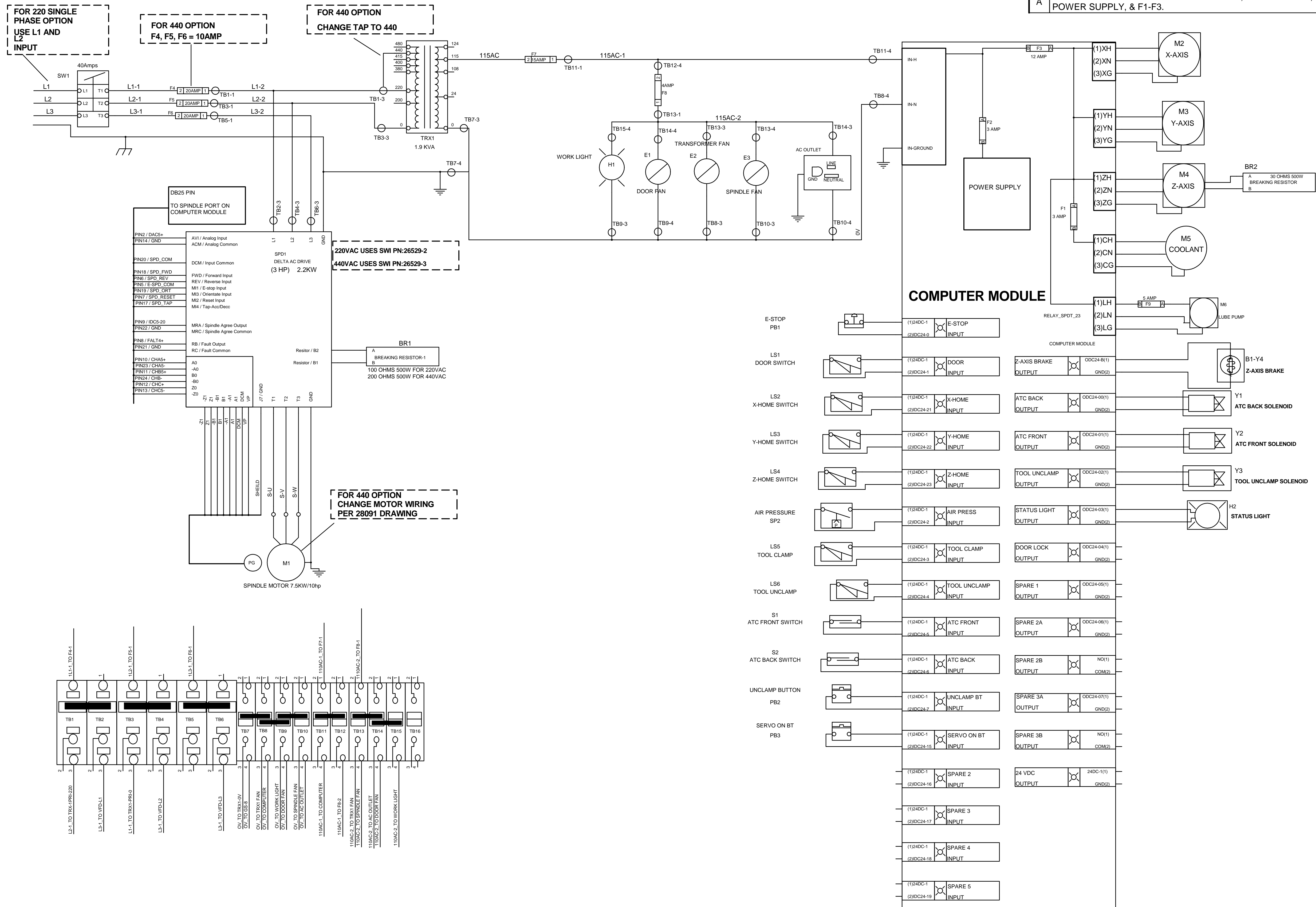
Type	PL	Dwg Size	D
Revision	C	Product	2 OP
Status	R	Engineer	RO
Date	10/15/2009	Planner Code	
By	RC	Comm Code	

Item	P/N	Title	Detail	Qty	UseA	Rev	Stat	Type	Mfr
1	27620	SHEET METAL-ELEC ENCLOSURE-2 OP MILL		1	EA	B	R	DWG	
2	27620-1	SHEET METAL-BACK PANEL		1	EA	B	R	DWG	
7	26589-0320	RAIL-DIN	320mm	1	EA	-	R	DWG	
8	26589-0110	RAIL-DIN	110mm	1	EA	-	R	DWG	
9	22557-8	TERMINAL BLOCK-DIN RAIL-3 POS		6	EA	-	R	DWG	
10	22557-9	TERMINAL BLOCK-DIN RAIL-4POS	28-12AWG	10	EA	-	R	DWG	
15	23036-1	FUSE HOLDER-32 AMP-690V		5	EA	B	R	DWG	
16	23152-16	FUSE-500 VOLT	16 AMP	1	EA	B	R	DWG	
17	23152-4	FUSE-500 VOLT	4 AMP	1	EA	B	R	DWG	
18	23152-20	FUSE-500 VOLT	20 AMP	3	EA	B	R	DWG	
23	22557-9-C1	TERMINAL BLOCK-COVER-4 POS		1	EA	-	R	DWG	
24	22557-8-J1	TERMINAL BLOCK- JUMPER		3	EA	-	R	DWG	
25	22557-9-J1	TERMINAL BLOCK- JUMPER		6	EA	-	R	DWG	
26	23095-1	TERMINAL BLOCK-RAIL END STOP		4	EA	-	R	DWG	
30	22557-8-C1	TERMINAL BLOCK-COVER-3 POS		1	EA	-	R	DWG	
31	24182-2	SWITCH-BODY-3 PHASE-25A		1	EA	-	R	DWG	
32	24210-2	SWITCH-ROD-SHAFT EXTENSION		1	EA	-	R	DWG	
33	27549-2	SWITCH-DOOR-INTERLOCK		1	EA	-	R	DWG	
34	24183-2	SWITCH-DISCONNECT-HANDLE-3 PHASE		1	EA	-	R	DWG	
35	26564-1	FAN-115 VAC		1	EA	-	R	DWG	
36	26708-2	FILTER GUARD-PLASTIC-120mm		1	EA	A	R	DWG	

Item	P/N	Title	Detail	Qty	UseA	Rev	Stat	Type	Mfr
37	26708-1	FAN GUARD-120 mm		1	EA	-	R	DWG	
38	27176-2	CABLE ASSY-DOOR FAN	DC300-122	1	EA	A	R	PL	
39	26592-1	CABLE ASSY-COMPUTER MODULE POWER-2OP		1	EA	A	R	PL	
40	27548	AC OUTLET-115VAC-WITHOUT FUSE		1	EA	-	R	DWG	
44	27153-0362	WIREWAY-GRAY-5mm SLOT-45mm x 63mm		2	EA	-	R	PS	
45	27154-0362	WIREWAY-COVER-GRAY-48mm x 330mm		2	EA	-	R	PS	
48	27155-0330	WIREWAY-GRAY-5mm SLOT-22mm x 63mm	330mm	1	EA	A	R	DWG	
49	27156-0330	COVER-WIREWAY-GRAY-25mm x 8mm	330mm	1	EA	A	R	DWG	
53	27621-LB1	LABEL-TEXT-F4-F8, TB1-TB16		1	EA	A	R	PL	
54	27621-LB2	LABEL-TEXT-ELEC ENCLOSURE-27621		1	EA	A	R	PL	
55	27669-1	GASKET-BEZEL-ROLL		210 4	MM	-	R	DWG	
60	M4-0.7.X6 27B	SCREW-BHCS-STL-BO		14	EA	-	R	PS	
61	M5-0.8X12 25B	SCREW-SHCS-STL-BO		22	EA	-	R	PS	
62	M4-0.7X50 10Z	SCREW-PH-PHIL-STL-ZINC	NON STOCKABLE	4	EA	-	R	PS	
67	24009-4	WASHER-BELLEVILLE SPRING LOCK-SERRATED	10 OR M5	10	EA	C	R	PS	
71	M4-0.7 50Z	NUT-HEX-STL-ZINC		4	EA	-	R	PS	

NOTICE: THIS DESIGN WAS ORIGINATED BY AND EMBODIES A CONFIDENTIAL PROPRIETARY DESIGN OWNED BY SOUTHWESTERN INDUSTRIES. IT IS DISCLOSED IN CONFIDENCE FOR A SPECIFIC PURPOSE AND THE RECIPIENT HEREOF AGREES NOT TO MAKE ANY REPRODUCTION, DISCLOSURE OR OTHER USE OF THIS INFORMATION WITHOUT THE WRITTEN CONSENT OF SOUTHWESTERN INDUSTRIES.

REVISIONS				
REV	DESCRIPTION	ECN	DATE	APPRV
-	ORIGINAL RELEASE	13917	04/17/12	RO
A	ADDED: 220 SINGLE PHASE & 440 OPTIONS, SERVO ON SW, POWER SUPPLY, & F1-F3.	14076	5/11/13	RO



NOTES: (UNLESS OTHERWISE SPECIFIED).

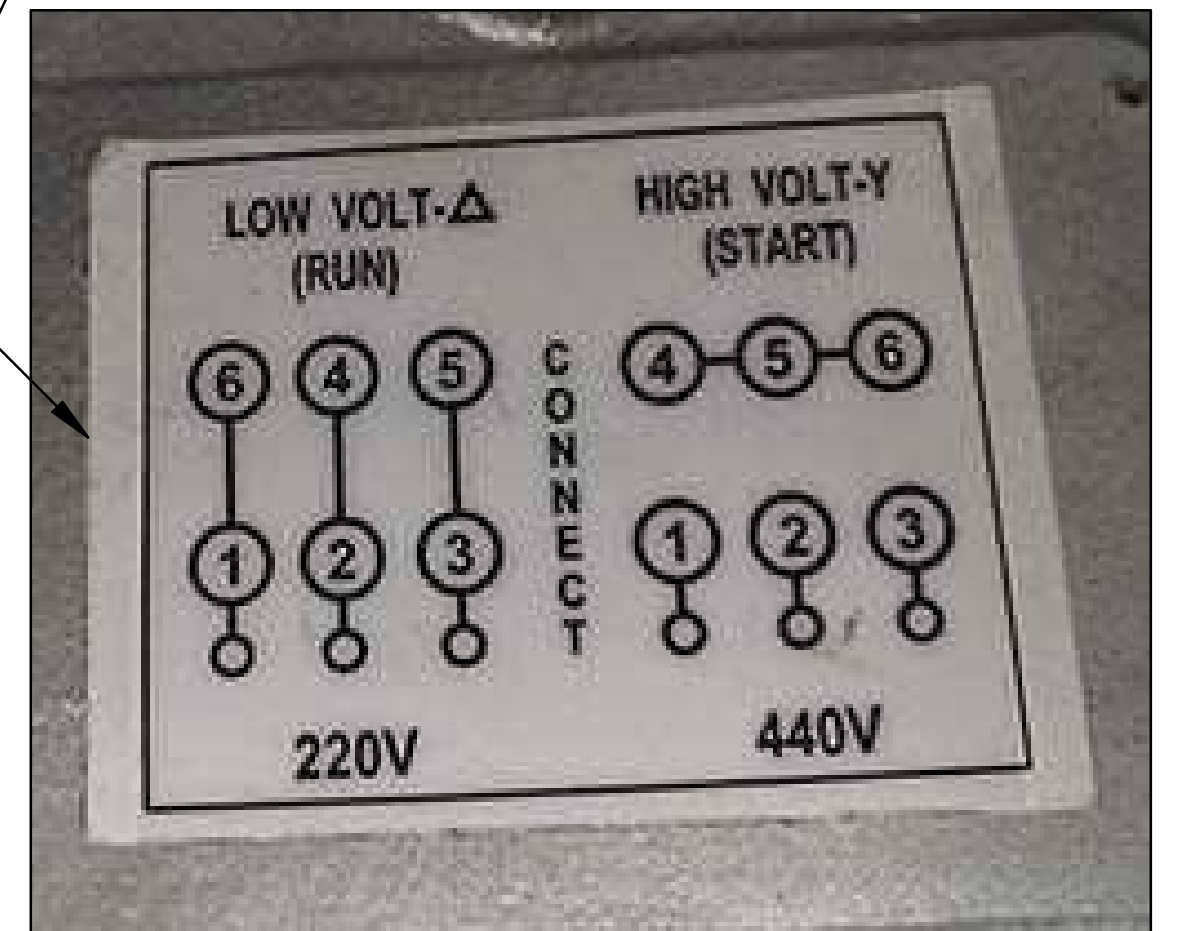
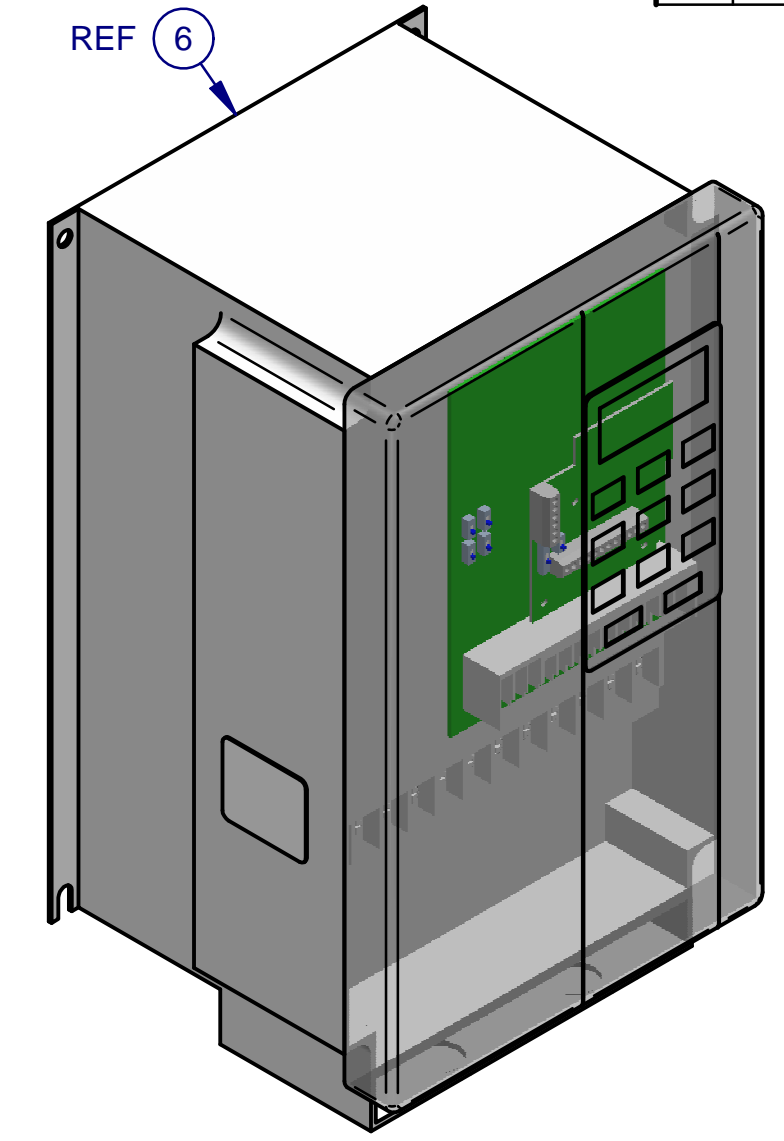
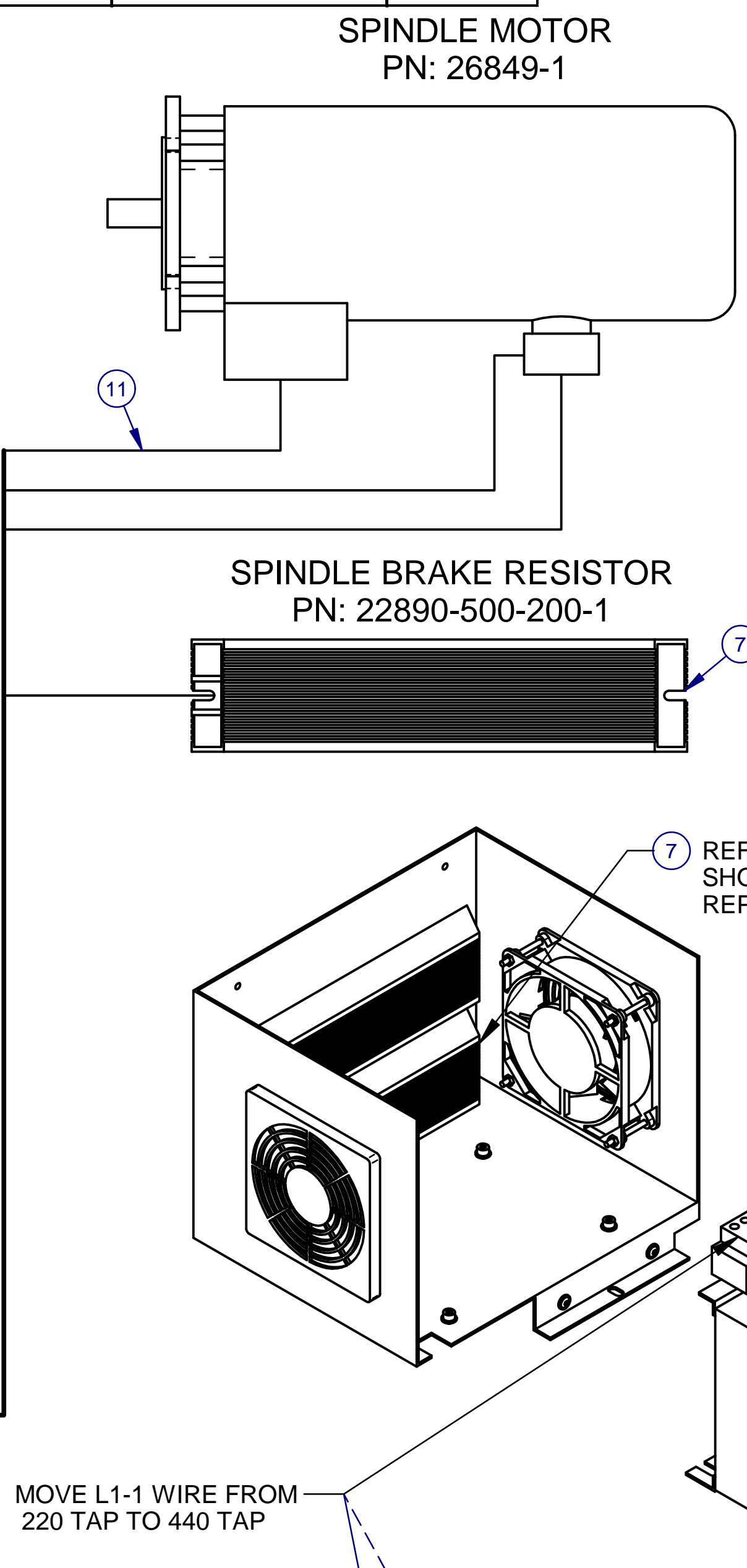
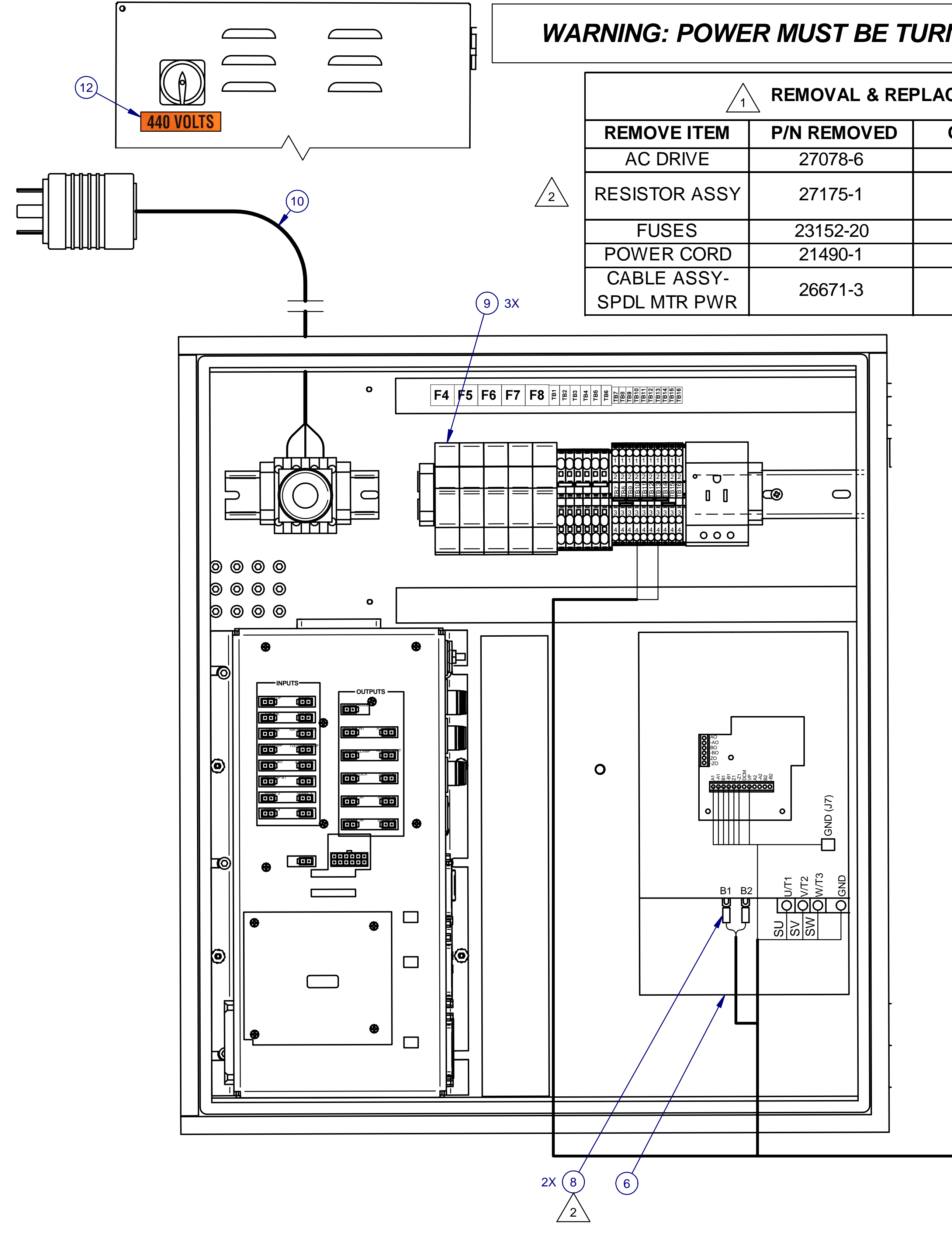
DIMENSIONS ARE IN INCHES DEC. X = ±.1, XX = ±.01, XXX = ±.005 ANGLES: XX = ±0.01° FRACTIONS = ±1/8 FINISH = 125 RMS REMOVE ALL SHARP EDGES MASK ALL TAPPED HOLES DIMENSIONING PER ASME Y14.5		APPROVALS DRAWN BY RC ENGINEER RO ENGINEER	DATE 11/21/11 9/16/12	SOUTHWESTERN INDUSTRIES, INC. 2615 HOMESTEAD PLACE RANCHO DOMINGUEZ, CA 90220-5610	
MATERIAL FINISH		THIRD ANGLE PROJECTION		TITLE <b>SCHEMATIC- ELECTRICAL-2OP MILL</b>	
SCALE: -		SIZE <b>D</b>	CODE IDENT. NO. 06238	DWG NO. 27650-SCH	REV A
		SHEET 1 OF 1			



REVISIONS				
REV	DESCRIPTION	ECN	DATE	APPRV
-	ORIGINAL RELEASE	14056	02/21/13	RO
A	REVISED ITEM 7 WAS:27175-2. ITEMS 9-11,15 WAS: 8-11. ADDED ITEMS 12 & 14	14037	6/5/13	PM

**WARNING: POWER MUST BE TURNED OFF PRIOR TO MODIFYING**

REMOVAL & REPLACEMENT CHART				
REMOVE ITEM	P/N REMOVED	QTY	REPLACE WITH	REF DES
AC DRIVE	27078-6	1	26529-3	---
RESISTOR ASSY	27175-1	1	22890-500-200-1 22404-18 (2X)	△ 2
FUSES	23152-20	3	23153-10	F4,F5,F6
POWER CORD	21490-1	1	21490-2	---
CABLE ASSY-SPDL MTR PWR	26671-3	1	26671-4	---



RE-WIRE SPINDLE PER LABEL AS SHOWN BELOW FROM 220V TAPS TO 440V TAPS

MOVE L1-1 WIRE FROM 220 TAP TO 440 TAP



- NOTES: UNLESS OTHERWISE SPECIFIED.
- REMOVE (ITEMS 1-5) & REPLACE WITH ITEMS 6-11, PER CHART. RETURN ALL REMOVED ASSEMBLIES TO STOCK.
  - CUT OFF WIRE TERMINALS (QTY 2) FROM RESISTOR ASSY 27175-1. REMOVE BRAKING RESISTOR (22890-500-100-1) & RETURN TO STOCK PER ITS PART NUMBER. ROUTE WIRES OF BRAKING RESISTOR (22890-500-200-1) THROUGH CONDUIT & CRIMP ON WIRE TERMINALS (ITEM 8). THIS ASSEMBLY IS NOW DESIGNATED 27175-2.
  - AFTER INSTALLATION PERFORM 20P-M10 440 VOLT OPTION INSPECTION.

APPROVALS		DATE	SOUTHWESTERN INDUSTRIES, INC.	
DRAWN BY	Sal	02/21/13	2615 HOMESTEAD PLACE	
ENGINEER	RO	02/21/13	RANCHO DOMINGUEZ, CA 90220-5610	
ENGINEER			TITLE	
PE			440 VOLTS OPTION KIT-20P	
MATERIAL			SIZE	CODE IDENT. NO.
NEXT ASSY	USED ON	FINISH	D	06238
APPLICATION			DWG NO.	28091
			SCALE:	SHEET 1 OF 1

NOTICE: THIS DESIGN WAS ORIGINATED BY AND EMBODIES A CONFIDENTIAL PROPRIETARY DESIGN OWNED BY SOUTHWESTERN INDUSTRIES. IT IS DISCLOSED IN CONFIDENCE FOR A SPECIFIC PURPOSE AND THE RECIPIENT HEREOF AGREES NOT TO MAKE ANY REPRODUCTION, DISCLOSURE OR OTHER USE OF THIS INFORMATION WITHOUT THE WRITTEN CONSENT OF SOUTHWESTERN INDUSTRIES.

Parts List for Assembly P/N: 28091

Printed 6/5/2013

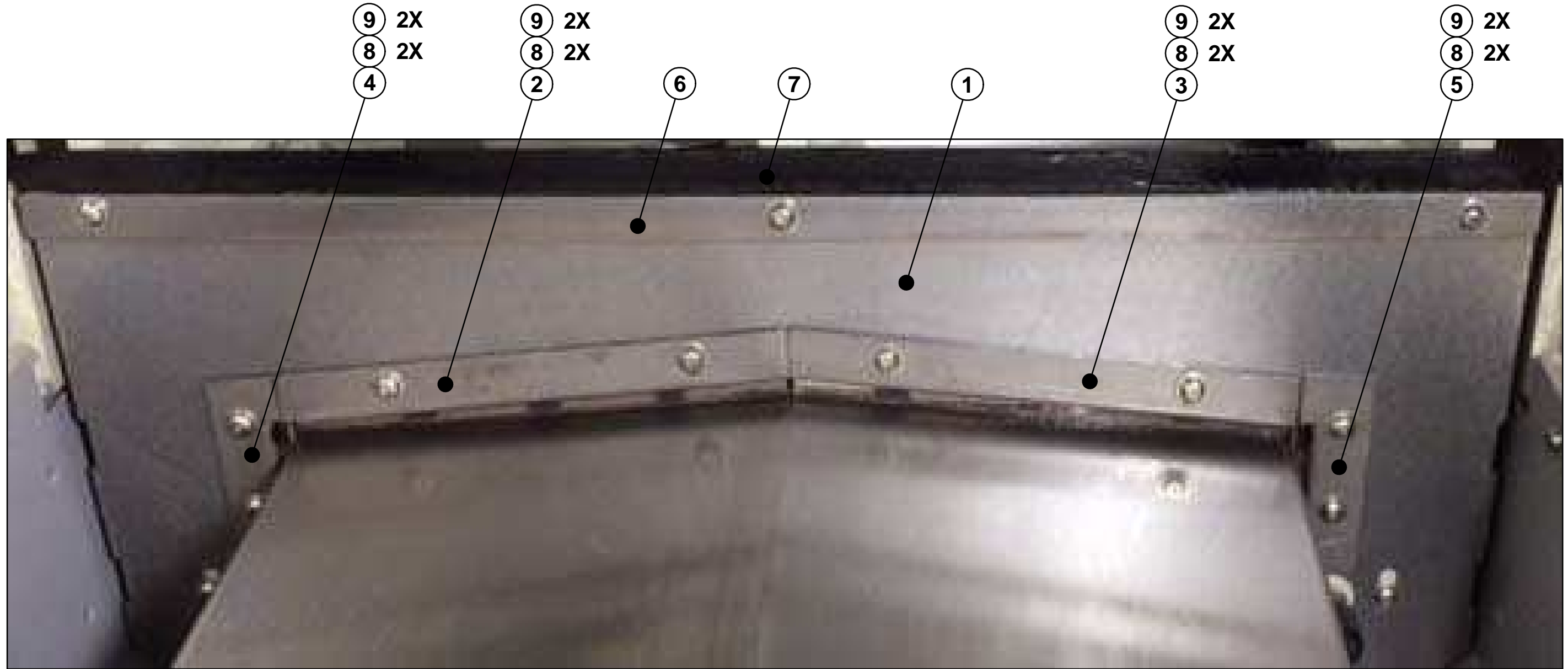
**28091**  
440VOLTS OPTION KIT-2OP

Type	PL	Dwg Size	D
Revision	A	Product	2OP
Status	R	Engineer	RO
Date	2/21/2013	Planner Code	
By	Sal	Comm Code	

Item	P/N	Title	Detail	Rev	UseA	Qty	Stat	Type	Mfr	Mfr P/N
1	27078-6	AC DRIVE ASSY-3HP-220 VAC-NOT PROGRAMMED		-	EA	(-1)	R	PL		
2	27175-1	RESISTOR ASSY-SPINDLE BRAKE-100 OHMS		-	EA	(-1)	R	PL		
3	23152-20	FUSE-500 VOLT	20 AMP	A	EA	(-3)	R	DWG		
4	21490-1	POWER CORD-3 PHASE-220V-2 OP		-	EA	(-1)	R	PL		
5	26671-3	CABLE ASSY-SPINDLE MOTOR POWER	DC300-101	-	EA	(-1)	R	PL		
6	26529-3	AC DRIVE ASSY-3HP-440 VAC-PROGRAMMED		-	EA	1	R	PL		
7	22890-500-200-1	RESISTOR-BRAKING	500W-200ohm	-	EA	1	R	DWG		
8	22404-18	TERMINAL- WIRE PIDG FORK	18 GA	-	EA	2	R	DWG		
9	23153-10	FUSE-600 VAC-TIME DELAY-CLASS CC	10 AMP	-	EA	3	R	DWG		
10	21490-2	POWER CORD-3 PHASE-440V-2 OP		-	EA	1	R	PL		
11	26671-4	CABLE ASSY-SPINDLE MOTOR POWER	DC300-101 A	-	EA	1	R	PL		
12	22537-440	LABEL-440 VOLTS		-	EA	1	R	DWG	PANDUIT	PCV-440C
14	21214-52	NAMEPLATE-S/N-440V-2OP-M10-MILL		-	EA	(1)	R	DWG		
15	28091-DOC	440VOLTS OPTION KIT-2OP		-	EA	1	R	DOC		

NOTICE: THIS DESIGN WAS ORIGINATED BY AND EMBODIES A CONFIDENTIAL PROPRIETARY DESIGN OWNED BY SOUTHWESTERN INDUSTRIES. IT IS DISCLOSED IN CONFIDENCE FOR A SPECIFIC PURPOSE AND THE RECIPIENT HEREOF AGREES NOT TO MAKE ANY REPRODUCTION, DISCLOSURE OR OTHER USE OF THIS INFORMATION WITHOUT THE WRITTEN CONSENT OF SOUTHWESTERN INDUSTRIES.

REVISIONS				
REV	DESCRIPTION	ECN	DATE	APPRV
A	PICTORIAL RELEASE	14196	2/18/14	TO



DIMENSIONS ARE IN MILLIMETERS 1-4 ±0.020, 4-16 ±0.025, 16-63 ±0.050, 63-250 ±0.070, 250-1000 ±0.100, 1000-1500 ±0.200 REMOVE ALL SHARP EDGES MASK ALL TAPPED HOLES DIMENSIONS PER ASME Y14.5	APPROVALS		DATE		<b>SOUTHWESTERN INDUSTRIES, INC.</b> 2615 HOMESTEAD PLACE RANCHO DOMINGUEZ, CA. 90220-5610		
	DRAWN BY <b>Bob</b>		1/16/14				
	ENGINEER <b>TO</b>		2/13/14		<b>COVER ASSY-TOOL-20P</b>		
	MFE						
MATERIAL	-	THIRD ANGLE PROJECTION		SIZE <b>B</b>	CODE IDENT. NO. <b>06238</b>	DWG NO. <b>27682</b>	REV <b>A</b>
FINISH	-			SCALE: -	SHEET 1 OF 1		

NOTES: (UNLESS OTHERWISE SPECIFIED).

**27682**

COVER ASSY-TOOL -2OP

Type	PL	Dwg Size	B
Revision	A	Product	2OP
Status	R	Engineer	TO
Date	9/9/2011	Planner Code	
By	Sal	Comm Code	

Item	P/N	Title	Detail	Rev	Qty	UseAs	Stat	Type	Mfr	Mfr P/N
1	27682-1	PLATE-WIPER HOLDER ASSY-TOOLS		-	1	EA	R	PS		
2	27682-2	WIPER-TOP/LEFT-COVER ASSY-TOOL		-	1	EA	R	PS		
3	27682-3	WIPER-TOP/RIGHT-COVER ASSY-TOOL		-	1	EA	R	PS		
4	27682-4	WIPER-LEFT SIDE-COVER ASSY-TOOL		-	1	EA	R	PS		
5	27682-5	WIPER-RIGHT SIDE-COVER ASSY-TOOL		-	1	EA	R	PS		
6	27682-10	RETAINER-SEAL-COVER ASSY-TOOL		-	1	EA	R	PS		
7	27682-11	SEAL-COVER ASSY-TOOL		-	1	EA	R	PS		
8	M5-0.8X8 27B	SCREW-BHCS-STL-BO		-	8	EA	R	PS		
9	M5 70B	WASHER-FLAT USS-STL-BO			8	EA	R	PS		