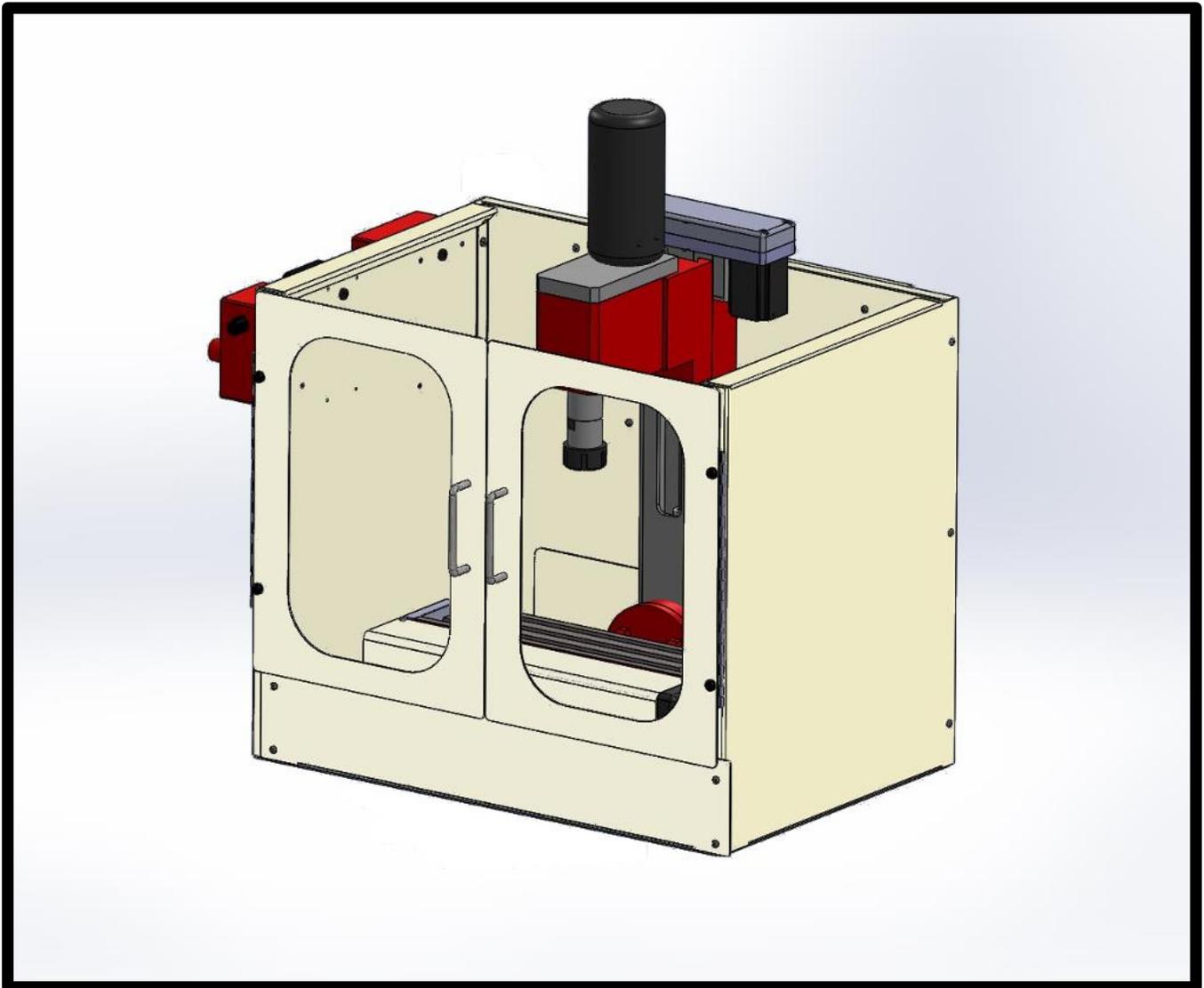


HX 8410

USER MANUAL



- Visit our website at <https://LeadingEdgeIndustrial.com> -

Version 1.15



HX8410 Vertical Machining Center

User Manual

Second Edition

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Lafayette, IN
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**Read this material before using this product.
Failure to do so can result in serious injury.
SAVE THIS MANUAL.**

Diagrams within this manual may not be drawn proportionally. Due to continuing improvements, actual product may differ slightly from the product described herein. Tools required for assembly and service may not be included.



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Leading Edge Industrial Technologies, LLC

LIMITED WARRANTY CERTIFICATE

Covering Leading Edge Industrial Technologies, LLC CNC Equipment
Effective March 1, 2016

Leading Edge Industrial Technologies, LLC (“LEI Tech” or “Manufacturer”) provides a limited warranty to all new mills and turning centers (collectively, “CNC Machines”) and its components (except those listed below under Limits and Exclusions of Warranty) (“Components”) that are manufactured by LEI Tech and sold by LEI Tech or its authorized distributors as set forth in this Certificate. The warranty set forth in this Certificate is a limited warranty and it is the only warranty by Manufacturer and is subject to the terms and conditions of this Certificate.

Limited Warranty Coverage

Each CNC Machine and its Components (collectively, “LEI Tech Products”) are warranted by Manufacturer against defects in material and workmanship. This warranty is provided only to the final purchaser and end-user of the CNC Machine (a “Customer”). The period of this limited warranty is one (1) year.

The warranty period commences on the date the CNC Machine is delivered to the Customer’s facility. Customer may purchase an extension of the warranty period from LEI Tech or an authorized LEI Tech distributor (a “Warranty Extension”).

Repair or Replacement Only

Manufacturer’s sole liability, and customer’s exclusive remedy, with respect to any and all LEI Tech products, shall be limited to repairing or replacing, at the discretion of the manufacturer, the defective LEI Tech Product under this warranty.

Disclaimer of Warranty

This warranty is manufacturer’s sole and exclusive warranty and is in lieu of all other warranties of whatever kind or nature, express or implied, written or oral, including, but not limited to, any implied warranty of merchantability, implied warranty of fitness for a particular purpose, or other warranty of quality or performance or non-infringement. All such other warranties of whatever kind are hereby disclaimed by the manufacturer and waived by the customer.

Limits and Exclusions of Warranty

Components subject to wear during normal use and over time, including, but not limited to, paint, window finish, and condition, light bulbs, seals, chip removal system, etc., are excluded from this warranty. Manufacturer’s specified maintenance procedures must be adhered to and recorded in order to maintain this warranty. This warranty is void if Manufacturer determines that (i) any LEI Tech Product was subjected to mishandling, misuse, abuse, neglect, accident, improper installation, improper maintenance, improper storage, or improper operation or application, (ii) any LEI Tech Product was improperly repaired or serviced by Customer, an unauthorized service technician, or other unauthorized person, (iii) Customer or any person makes or attempts to make any modification to any LEI Tech Product without the prior written authorization of Manufacturer, and/or (iv) any LEI Tech Product was used for any non-commercial use (such as personal or household use). This warranty does not cover damage or defect due to an external influence or matters beyond the reasonable control of Manufacturer, including, but not limited to, theft, vandalism, fire, weather condition (such as rain, flood, wind, lightning, or earthquake), or acts of war or terrorism.

Without limiting the generality of any of the exclusions or limitations described in this Certificate, this warranty does not include any warranty that any LEI Tech Product will meet any person’s production specifications or other requirements or that operation of any LEI Tech Product will be uninterrupted or error-free. Manufacturer assumes no responsibility with respect to the use of any LEI Tech Product by any person, and Manufacturer shall not incur



any liability to any person for any failure in design, production, operation, performance or otherwise of any LEI Tech Product other than repair or replacement of same as set forth in this warranty above.

Limitation of Liability and Damages

Manufacturer will not be liable to customer or any other person for any compensatory, incidental, consequential, punitive, special, or other damage or claim, whether in an action in contract, tort, or other legal or equitable theory, arising out of or related to any LEI Tech Product, other products or services provided by manufacturer or an authorized distributor, service technician or other authorized representative of manufacturer (collectively, "authorized representative"), or the failure of parts or products made by using any LEI Tech Product, even if manufacturer or any authorized representative has been advised of the possibility of such damages, which damage or claim includes, but is not limited to, loss of profits, lost data, lost products, loss of revenue, loss of use, cost of downtime, business goodwill, any damage to equipment, premises or other property of any person, and any damage that may be caused by a malfunction of any LEI Tech Product. All such damages and claims are disclaimed by the manufacturer and waived by the customer. Manufacturer's sole liability, and customer's exclusive remedy, for damages and claims for any cause whatsoever, shall be limited to repair or replacement, at the discretion of the manufacturer, of the defective LEI Tech Product as provided in this warranty.

The customer has accepted the limitations and restrictions set forth in this Certificate, including, but not limited to, the restriction on its right to recover damages, as part of its bargain with Manufacturer or its Authorized Representative.

Customer realizes and acknowledges that the price of the LEI Tech Products would be higher if Manufacturer were required to be responsible for damages and claims beyond the scope of this warranty.

Entire Agreement

This Certificate supersedes any and all other agreements, promises, representations or warranties, either oral or in writing, between the parties or by Manufacturer with respect to subject matter of this Certificate, and contains all of the covenants and agreements between the parties or by Manufacturer with respect to such subject matter. Manufacturer hereby expressly rejects any other agreements, promises, representations or warranties, either oral or in writing, that are in addition to or inconsistent with any term or condition of this Certificate. No term or condition set forth in this Certificate may be modified or amended unless by a written agreement signed by both Manufacturer and Customer. Notwithstanding the foregoing, Manufacturer will honor a Warranty Extension only to the extent that it extends the applicable warranty period.

Transferability

This warranty is transferable from the original Customer to another party if the CNC Machine is sold via private sale before the end of the warranty period, provided that written notice thereof is provided to Manufacturer and this warranty is not void at the time of transfer. The transferee of this warranty will be subject to all terms and conditions of this Certificate.

This warranty shall be governed by the laws of the State of Indiana without application of rules on conflicts of laws. Any and all disputes arising from this warranty shall be resolved in a court of competent jurisdiction located in Tippecanoe County, Indiana. Any term or provision of this Certificate that is invalid or unenforceable in any situation in any jurisdiction shall not affect the validity or enforceability of the remaining terms and provisions hereof or the validity or enforceability of the offending term or provision in any other situation or in any other jurisdiction.



CUSTOMER SATISFACTION POLICY

Dear LEI Tech Customer,

Your complete satisfaction and goodwill are of the utmost importance to both *Leading Edge Industrial Technologies* (LEI Tech) and the *Leading Edge Industrial Technologies* distributor where you purchased your equipment. Normally, any concerns you may have about the sales transaction or the operation of your equipment will be rapidly resolved by your distributor.

However, if your concerns are not resolved to your complete satisfaction, and you have discussed your concerns with a member of the dealership's management team, the general manager, or the dealership's owner directly, please do the following:

Contact *Leading Edge Industrial Technologies Customer Service Center* by calling (765)-471-7007 and ask for the Customer Service Department. So that we may resolve your concerns as quickly as possible, please have the following information available when you call:

- Your name, company name, address, and phone number
- The machine model and serial number
- The dealership name and the name of your latest contact at the dealership
- The nature of your concern

Once you contact the *Leading Edge Industrial Technologies Customer Service Center*, we will make every effort to work directly with you and your distributor to quickly resolve your concerns. At *Leading Edge Industrial Technologies* we know that a good Customer-Distributor-Manufacturer relationship will help ensure continued success for all concerned.

If you wish to write *Leading Edge Industrial Technologies*, please use this address:

Leading Edge Industrial Technologies, LLC
3323 Concord Rd., Suite 2
Lafayette, IN 47909
Att: Customer Service

Sincerely,

Larry K. Fultz
Owner/Lead Designer
LEI Tech, LLC

Customer Feedback

If you have any concerns or questions in regard to the *Leading Edge Industrial Technologies Operator's manual*, please contact us via our e-mail, support@leadingedgeindustrial.com . We look forward to any suggestions you may have.

Save This Manual



You will need this manual for the safety warnings and precautions, assembly instructions, operating and maintenance procedures, parts list and diagrams. Keep your invoice with this manual. Write the invoice number on the inside of the front cover. Keep the manual and invoice in a safe and dry place for future reference.

SPECIFICATIONS

ITEM	DESCRIPTION
Power Consumption	120 VAC, 60 Hz, Single phase
Spindle Motor	4/5 HP
Speed Ranges	0 – 4500 RPM
Drive System	Belt Drive
Spindle	R-8 Taper Collet system with 3/4 inch shank tool holders
Chuck	JT33 Taper; 7/64 to 1/2-inch capacity
End Mill Capacity	1/2 inch
Face Mill Capacity	1 inch
Drill Capacity	1/2 inch
Table Slot Width	1/2 inch
Number of T-Slots	3
Center Distance	1-1/8 inch
Table Size	15-1/3 (L) x 3-2/3 (W) inches
Travel	8 inches (X-axis) x 4 inches (Y-axis) x 10 inches (Z-axis)
Unit Height	22 – 1/4 inches (from base to top of metal enclosure); 31 and 7/8-inches (from bottom of metal enclosure to top of Vertical Axis motor at highest point)
Weight	150 lbs



SAFETY

READ ALL APPROPRIATE WARNINGS, CAUTIONS, AND INSTRUCTIONS BEFORE OPERATING THIS MACHINE.

All milling machines contain hazards from rotating cutting tools, belts and pulleys, high voltage electricity, noise, and compressed air. When using milling machines and their components, basic safety precautions should always be followed to reduce the risk of personal injury and mechanical damage.

- ◆ Only authorized personnel should work on this machine. Untrained personnel presents a hazard to themselves and the machine, and improper operation will void the warranty.
- ◆ Check for damaged parts and tools before operating the machine. Any part or tool that is damaged should be properly repaired or replaced. Do not operate the machine if any component does not appear to be functioning correctly. Contact your shop supervisor.
- ◆ Use appropriate eye and ear protection while operating the machine. ANSI approved impact safety goggles and OSHA-approved ear protection is recommended to reduce the risks of sight damage and hearing loss.
- ◆ Dress properly. Do not wear loose clothing or jewelry as they can be caught in moving parts. Protective, electrically non-conductive clothes, and non-skid footwear are recommended when working. Wear restrictive hair covering to contain long hair.
- ◆ Do not operate the machine unless the doors are closed and the magnetic door switch is functioning properly. Rotating cutting tools can cause severe injury. When a program is running, the mill table and spindle head can move rapidly at any time, in any direction. Therefore, avoid entering the machine enclosure while operating the machine, and avoid the area directly under the spindle head.
- ◆ The Emergency Stop buttons are the large, circular red switches located on the left side panel of the machine. Pressing the Emergency Stop buttons will instantly stop all motion of the machine and the servo motors. The Emergency Stop button located on the black box controls the x-,y-,z-axis servo motors. The Emergency Stop button located on the red box controls the spindle-head servo motor. Use the Emergency Stop button only in emergencies to avoid crashing the machine or inflicting bodily harm.
- ◆ The electrical panel, located on the back of the machine, should be closed and secured at all times except during service. At those times, only qualified electricians should have access to the panel. When the main circuit breaker is on, there is high voltage throughout the electrical panel (including the circuit boards and logic circuits) and some components operate at high temperatures. Therefore, extreme caution is required.
- ◆ DO NOT modify or alter this equipment in any way. If modifications are necessary, all such requests must be handled by LEI Tech. Any modification or alteration of any LEI Tech Product could lead to personal injury and/or mechanical damage and will void your warranty.
- ◆ Consult your local safety codes and regulations before operating the machine. Contact your dealer anytime safety issues need to be addressed.
- ◆ It is the shop owner's responsibility to make sure that everyone who is involved in installing and operating the machine is thoroughly acquainted with the installation, operation, and safety instructions provided with the machine BEFORE they perform any actual work. The ultimate responsibility for safety rests with the shop owner and the



individuals who work with the machine.

- ◆ The electrical power supply must meet the specifications listed in this manual. Attempting to run the machine from any other source can cause severe damage and will void the warranty. Never service the machine with the power connected.
- ◆ Improperly clamped parts, machined at high speeds and/or high feed rates may be ejected and may damage or puncture the safety door window. Machining over-sized or marginally clamped parts is NOT safe.
- ◆ Safety door windows must be replaced if damaged or severely scratched - REPLACE DAMAGED WINDOWS IMMEDIATELY.
- ◆ Do NOT process toxic or flammable material. Deadly fumes can be present. Consult with the material manufacturer and review material safety data sheets (MSDS) for safe handling of material by-products before processing.
- ◆ Store idle Equipment. When not in use, machines must be stored in a dry location to inhibit rust. Always lock up tools and keep out of reach of children.
- ◆ Do NOT force tool. It will do the job better and more safely at the rate for which it was intended. Do not use inappropriate attachments in an attempt to exceed the tool capacity.
- ◆ Use the right tool for the job. Do not attempt to force a small tool or attachment to do the work of a larger industrial tool. There are certain applications for which this machine was designed. Do not modify this machine and do not use this machine for a purpose for which it was not intended.
- ◆ Do not overreach. Keep proper footing and balance at all times. Do not reach over or across running machines.
- ◆ Maintain tools with care. Keep tools sharp and clean for better and safer performance. Follow instructions for lubricating and changing accessories. Inspect tool cords periodically and, if damaged, have them repaired by an authorized technician. The handles and panels must be kept clean, dry, and free from oil and grease at all times.
- ◆ Disconnect power. Unplug machine when not in use.
- ◆ Remove adjusting keys and wrenches. Check that keys and adjusting wrenches are removed from the tool or machine work surface before plugging it in.
- ◆ Avoid unintentional starting. Be sure the switch is in the Off position when not in use & before plugging in.
- ◆ Stay alert. Watch what you are doing, use common sense. Do not operate any tool when you are tired.
- ◆ Check for damaged parts. Before using any tool, any part that appears damaged should be carefully checked to determine that it will operate properly and perform its intended function. Check for alignment and binding of moving parts; any broken parts or mounting fixtures; and any other condition that may affect proper operation. Any part that is damaged should be properly repaired or replaced by a qualified technician. Do not use the tool if any switch does not turn On and Off properly.
- ◆ Guard against electric shock. Prevent body contact with grounded surfaces such as pipes, radiators, ranges, and refrigerator enclosures.
- ◆ Replacement parts and accessories. When servicing, use only identical replacement parts. Use of any other parts will void the warranty. Only use accessories intended for use with this machine. Approved accessories are available from Leading Edge Industrial (www.LeadingEdgeIndustrial.com).
- ◆ Do not operate the machine if under the influence of alcohol or drugs. Read warning labels on prescriptions to



determine if your judgment or reflexes are impaired while taking drugs. If there is any doubt, do not operate the machine.

◆ Use proper size and type extension cord. If an extension cord is required, it must be of the proper size and type to supply the correct current to the machine without heating up. Otherwise, the extension cord could melt and catch fire, or cause electrical damage to the machine. This machine may require the use of an extension cord of 0 to 10 amps capability (up to 50 feet), with wire size rated at 18 AWG. Longer extension cords require larger size wire. If you are using the machine outdoors, use an extension cord rated for outdoor use (signified by "WA" on the jacket).

Unattended Operation

Fully-enclosed, Leading Edge Industrial Technology CNC machines are designed to operate unattended; however, your project-specific machining processes may not be safe for unmonitored operation. Discretion is advised.

As it is the shop owner's responsibility to safely set up the machines and to use best practice machining techniques, it is also the shop owner's responsibility to manage the progression of these methods. If a hazardous material is used or hazardous condition occurs, the machining process **MUST** be monitored to prevent damage.

For example: if there is the risk of fire due to the material being machined, then an appropriate fire suppression system must be installed to reduce the risk of harm to personnel, equipment, and the building. A suitable specialist must be contacted to install monitoring tools before machines are allowed to run unattended.

It is especially important to select monitoring equipment that can immediately perform an appropriate action, without human intervention, to prevent an accident, should a problem be detected.

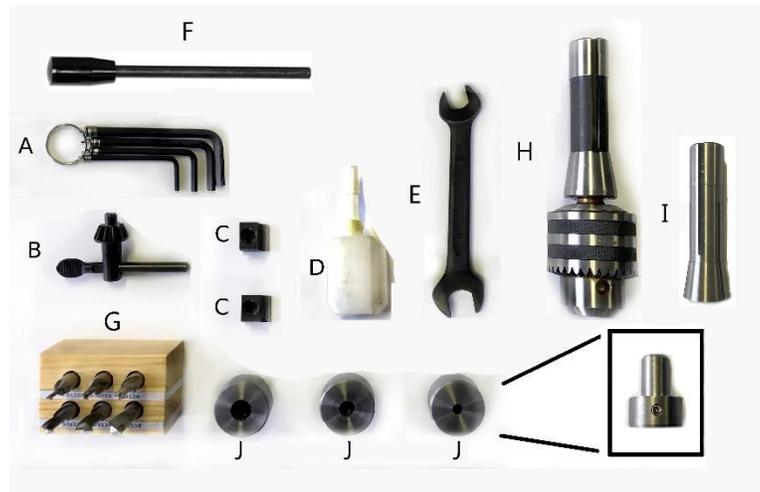
Note: Performance of this machine (if powered by line voltage) may vary depending on variations in local line voltage. Extension cord usage may also affect tool performance.

Warning: The warnings, cautions, and instructions discussed in this instruction manual cannot cover all possible conditions and situations that may occur. It must be understood by the operator that common sense and caution are factors which cannot be built into this product but must be supplied by the operator.

UNPACKING

When unpacking, check to make sure the following parts and accessories are included.

Bag	ITEM	DESCRIPTION
A	A	L - Hex. Wrenches, S: 3, 4, 5, 6
	B	Chuck Key
	C	T-nut (x2)
	D	Oil Bottle
B	E	Double-end Wrench, 14-17 mm
	F	Drawbar
L O O S E	G	HSS End Mill Set, 6 pieces 2 Flute
	H	13mm Drill Chuck with Taper Shank
	I	¾ R8 Collet
	J	End mill tool holders (¼-inch, 3/8-inch, ½-inch)



INSTALLATION

1. Remove the machine and tool cart from shipping pallet. Place the machine on top of a tool cart or on a level, flat, and heavy work table or bench. A proper table or bench is one that can sufficiently support the weight and use of the machine and its products.
2. Before operation, remove the cardboard cylinder protecting the spindle-head. Unfasten and reattach the door handles so that they are facing outwards. They were reversed (attached facing inwards) for shipping.
3. Remove all packing materials from the pallet and machines. Keep the materials in a safe place for future reference. Clean the machine with nonflammable solvents. Oil the machine according to lubrication requirements before running the machine.

ASSEMBLY

1. Install the Chuck.
 - Thoroughly clean the tapered hole in the Chuck (B) and the Spindle (E) shaft of all grease, oil, and protective coatings (paint thinner may be necessary).
 - Slide the Chuck onto the Spindle shaft. Tighten the spindle drawbar (A) on top of the spindle-head, using the #14 open end wrench (C; Item "E" in packing list) to secure the Chuck on the Spindle shaft.
 - Turn the Chuck sleeve clockwise and open the jaws completely.

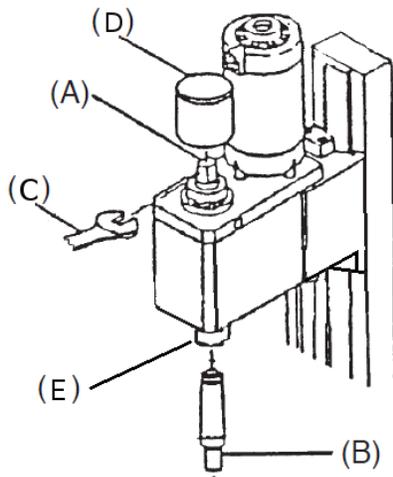


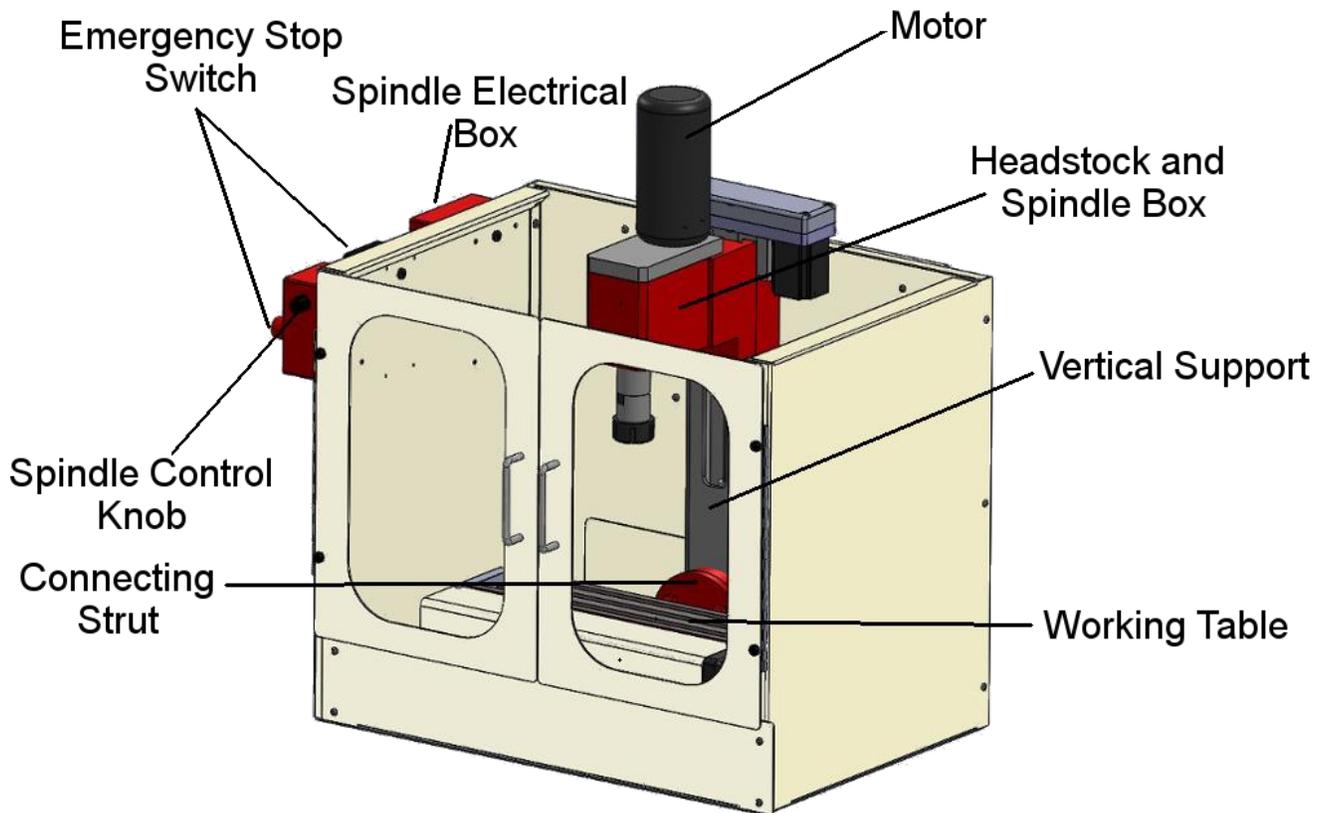
Illustration 1: Installing the Chuck

2. Check all bolts for tightness.

OPERATION

This HX8410 is capable of machining metal and nonmetallic stock by cutting, drilling, and milling. It can cut circular surfaces, both inside and out, cones, mill planes or grooves, and other cutting functions depending on the tools used.

The machine consists of the following main components as shown in the photo below.



Checks before Operation

1. Turn on the machine by pressing the power switch on the driver electronics box, which is located on the back of the machine, to "I". Disengage the Emergency Stop Switches.
2. Turn the Speed Control Knob clockwise and verify that the spindle speed changes.
3. Verify that the spindle is rotating clockwise.
4. Operate the Longitudinal (X), Lateral (Y), and Vertical (Z) Axes, and verify their proper operation and movement.

Caution: Avoid injury to you or damage to the machine. Unplug the power cord from the electrical outlet before performing any adjustments, tool replacement, or maintenance.



WCS/MACHINE COORDINATE SYSTEM AND UCS CARTESIAN COORDINATES

This section of the manual is still in development. Please go to the following link and watch this video on our LEI TV YouTube channel for setting and using the Work Coordinate System.

<https://www.youtube.com/watch?v=nMUu1-TPJ-Y>

Click LIKE and SUBSCRIBE to get notifications of new videos!

For more help, be sure to check out our FAQ's and Resource Center at <https://LeadingEdgeIndustrial.com/resource-center/>.



INSTALLING SOFTWARE

1. Navigate to: <http://LeadingEdgeIndustrial.com/resource-center/manuals-and-operators-information/g-codes/mills/hx8410/>
2. Download Universal-G-Code-Sender V1.0.9. Universal-G-Code-Sender (UGS) is a java-based application and does not require an installation.
3. Unzip the downloaded file to your desktop (or location of your choosing). Open the application.
4. Plug in the provided USB cable to the back of the HX8410 (the USB B port is located on the electronics box, on the back of your HX8410) and to the computer, from which you will be controlling your HX8410.
5. Power on the HX8410. The I/O button is located on the electronics box, which is attached to the back of the machine. The lights may not come on instantaneously, as the capacitors need to charge.
6. Open your web browser and navigate to <https://www.youtube.com/watch?v=muSlo5jvFB4>. This video will step you through the basics of using UGS.
7. Then, watch the following video to learn how to set work coordinates and do tool changes: <https://www.youtube.com/watch?v=nMUu1-TPJ-Y>.
8. As always, click **LIKE AND SUBSCRIBE** to receive updates when new videos and projects are posted!

For more help, be sure to check out our FAQ's and Resource Center at <https://LeadingEdgeIndustrial.com/resource-center/>.

Questions or concerns?

Leave us feedback at <https://LeadingEdgeIndustrial.com/contact-us>,

or by phone at 1-888-202-9398.

SUPPORTED G- AND M-CODES

G-Code

G-code	Meaning	Notes	Support
A	Position of A axis	(Rotational axis around X-axis)	
B	Position of B axis	(Rotational axis around Y-axis)	
C	Position of C axis	(Rotational axis around Z-axis)	
D	Defines diameter or radial offset used for cutter compensation.	D is used for depth of cut on lathes. It is used for aperture selection and commands on photo-plotters.	
E	Precision feed rate for lathe threading		
F	Defines feed rate		
G	Address for preparatory commands	G commands often tell the control what kind of motion is wanted (E.g., rapid positioning, linear feed, circular feed, and fixed cycle) or what offset value to use.	
H	Defines tool length offset	Incremental axis corresponding to C axis	
I	Defines arc center in X axis for G02 or G03 arc commands.	Also used as a parameter within some fixed cycles	
J	Defines arc center in Y axis for G02 or G03 arc commands.	Also used as a parameter within some fixed cycles	
K	Defines arc center in Z axis for G02 or G03 arc commands.	Also used as a parameter within some fixed cycles, equal to L address	
L	Fixed cycle loop count		
M	Miscellaneous function	Action code, auxiliary command; descriptions vary. Many M-codes call for machine functions, which is why people often say that the "M" stands for "machine", although it was not intended for this.	
N	Line (block) number in program		
O	Program name		
P	Serves as parameter address for various G and M codes	With G04, defines dwell time value	
Q	Peck increment in canned cycles		



G-code	Meaning	Notes	Support
R	Defines size of arc radius, or defines retract height in milling canned cycles		
S	Defines spindle speed		
T	Tool selection		
U	Incremental axis corresponding to X axis (typically only lathe group A controls)	Also defines dwell time on some machines (instead of "P" or "X").	
V	Incremental axis corresponding to Y-axis		
W	Incremental axis corresponding to Z axis	(Typically only lathe group A controls)	
X	Absolute or incremental position of X-axis.	Also defines dwell time on some machines (instead of "P" or "U").	
Y	Absolute or incremental position of Y-axis		
Z	Absolute or incremental position of Z-axis	The main spindle's axis of rotation often determines which axis of a machine tool is labeled as Z.	
G0/G00	Rapid positioning	Switch to rapid linear motion mode (seek). Used to get the tool somewhere quickly without cutting --- moves the machine as quickly as possible along each axis --- an axis which needs less movement will finish before the others, so one cannot count on the movement being a straight line.	All Grbl versions
G1/G01	Linear interpolation	Switch to linear motion at the current feed rate. Used to cut a straight line --- the interpreter will determine the acceleration needed along each axis to ensure direct movement from the original to the destination point at no more than the current Feed rate (F see below).	All Grbl versions
G2/G02	Circular interpolation, clockwise	Switch to clockwise arc mode. The interpreter will cut an arc or circle from the current position to the destination using the specified radius (R) or center (IJK location) at the current Feed rate (F see below) in the plane selected by G17/18/19 (see below).	All Grbl versions
G-code	Meaning	Notes	Support

G3/G03	Circular interpolation, counterclockwise	Switch to anti-clockwise arc mode. A corollary to G02 above.	All Grbl versions
G4/G04	Dwell (pause)	This should probably be calculated to be only one or two spindle rotations for best efficiency. Dwell time is expressed using a parameter (may be X, U, or P) which determines the time unit (seconds, milliseconds, &c.) P, for seconds, is supported and used by Grbl., typically X and U express the duration in milliseconds.	All Grbl versions
G10	Set Work Coordinate Origin (and resultant Offsets)	Coordinate system origin setting. This setting is persistent and expects the user to follow good practices and not manually move the machine, instead only using jogging commands via the interface or a pendant which works through the control system, or to have and use homing switches. Examples: <ul style="list-style-type: none"> • G10 P1 L20 --- (which is the equivalent of G92 X0 Y0 Z0) for work coordinate system G54 (#P1)(#P2--#P6 are G55--G59 respectively) • G10 Px L2 (by automatically setting the specified axes from the machine position data) to (re)set the persistent work coordinate offsets. 	(v0.8 or later)
G17	Select the XY plane (for arcs)		All Grbl versions
G18	Select the XZ plane (for arcs)		All Grbl versions
G19	Select the YZ plane (for arcs)		All Grbl versions
G20	After this, units will be in inches	Best practice: do this at the start of a program and nowhere else. The usual minimum increment in G20 is one ten-thousandth of an inch (0.0001").	All Grbl versions
G21	After this, units will be in mm	Best practice: do this at the start of a program and nowhere else. The usual minimum increment in G21 (one thousandth of a millimeter, .001 mm, that is, one micrometer).	All Grbl versions
G28	Go to Predefined Position	Takes an argument of an X Y Z coordinate for the intermediate point that the tool tip will pass through on its way home to machine zero. v0.7 "Incorrectly performed the homing cycle" Usually used to park the machine. http://www.cnccookbook.com/CCNCNCCodeG28ReturntoReference.htm	(v0.8 or later)
G-code	Meaning	Notes	Support
G28.1	Set Pre-Defined Position	Takes X Y Z addresses which define the intermediate point that the	(v0.8 or later)



G30	Go to Pre-Defined Position (Return to secondary home position)	<p>tool tip will pass through on its way home to part zero, not machine zero.</p> <p>Takes a P address specifying which machine zero point is desired, if the machine has several secondary points (P1 to P4). Takes X Y Z addresses which define the intermediate point that the tool tip will pass through on its way home to machine zero. v0.7 “Incorrectly performed the homing cycle”</p> <p>Usually used to park the machine. G28 above.</p>	(v0.8 or later)
G30.1	Set Pre-Defined Position	Stores the current absolute position.	(v0.8 or later)
G38.1	Probe cycle		(v0.9 or later)
G38.2	Straight Probe	Probe toward workpiece, stop on contact, signal error if failure	(v0.9h or later)
G38.3	Probe	Probe toward workpiece, stop on contact	(v0.9i or later)
G38.4	Probe	Probe away from workpiece, stop on loss of contact, signal error if failure	(v0.9i or later)
G38.5	Probe	Probe away from workpiece, stop on loss of contact	(v0.9i or later)
G40	Tool radius comp off	This actually is the only mode which Grbl runs in (there's no way to turn on tool radius compensation), please see below.	(v0.9i edge or later)
G43.1	Dynamic tool length offset	Change subsequent motions by offsetting the Z and/or X offsets stored in the tool table. Does not cause any motion, but will be applied the next time a compensated axis is moved, that axis's endpoint will be the compensated location. See G38.1 above for a link which discusses using this.	(v0.9h or later)
G49	Cancel tool offset.	Cancels tool offset set by G43 or G44	(v0.9h or later)
G53	Absolute mode override	Move in Machine Coordinates. Preface to a movement command on the same line which causes the machine to disregard any coordinate system which is in effect. G53 G0 X0 Y0 Z0 will return to the machine home / origin.	All Grbl versions
G54-- G59	Work Coordinate Systems	Fixture offset	(v0.8 or later)
G61	Exact path control mode	This is the default path mode Grbl run in.	(v0.9i build 20150529 or later)
G-code	Meaning	Notes	Support
G80	Motion mode cancel	Canned cycle	All Grbl versions



G90	Switch to absolute distance mode	Coordinates are now relative to the origin of the currently active coordinate system, as opposed to the current position. G0 X-10 Y5 will move to the position 10 units to the left and 5 above the origin X0,Y0. cf. G91 below.	All Grbl versions
G91	Switch to incremental distance mode	Coordinates are now relative to the current position, with no consideration for machine origin. G0 X-10 Y5 will move to the position 10 units to the left and 5 above the current position. cf. G90 above.	All Grbl versions
G91.1	Arc radius mode	(Offset mode for certain CAM programs) incremental distance mode for arcs	(v0.9i or later)
G92	Coordinate offset. Change the current coordinates without moving	E.g., "G92 x0 y0 z0" makes the current position a temporary home position. The intent is to allow one to re-use code (say for a part when doing multiples) which has a given origin. The temporary origin can then be cleared and the actual machine origin, set via G10 restored by the command below.	All Grbl versions
G92.1	Clear (temporary) Coordinate System Offsets	Previously set by G92 (see above).	(v0.8 or later)
G93	Set inverse time feed rate mode	An F-word is interpreted to mean that the move should be completed in (one divided by the F number) minutes. For example, if F is 2, the move should be completed in half a minute	All Grbl versions
G94	Set units per minute feed rate mode	An F Word is interpreted to mean the controlled point should move at a certain number of units (or degrees) per minute	All Grbl versions



M-Code

M-code	Meaning	Notes	Support
M0	Program Pause and End	Stop --- stops the machine so you can change the tool	(v0.8 or later) Idle fixed in 0.9i[21]
M1	Optional Stop	The machine will only stop at M01 if the operator has pushed the optional stop button.	(v0.9 or later)
M2	Program Pause and End	M02 was the original program end code, now considered obsolete, but still supported for backward compatibility. See M30 below.	(v0.8 or later)
M3	Spindle direction	Clockwise	All Grbl versions
M4	Spindle direction	Counterclockwise	All Grbl versions
M5	Spindle Control	Stop spindle	(v0.8 or later)
M6	Tool change		(v0.9 or later supports this as an option which may be enabled at compilation)
M7	Coolant Control	Mist	
M8	Coolant Control	Flood coolant	(v0.8 or later)
M9	Coolant Control	All coolant off	(v0.8 or later)
M10	Vacuum/Pallet Clamp	On	
M11	Vacuum/Pallet Clamp	Off	
M30	Program Pause and End	End and rewind. Rewinding refers to programs on punched paper tape. Shorter programs would be connected into an endless loop and be terminated by an M2 (see above), while longer programs would of necessity be rewound at their end by the M30 command. On modern machines, M2 and M30 may be considered equivalent.	(v0.8 edge or later)



G-code *Not* Supported by Grbl

Please note that unsupported G-code may cause Grbl to behave oddly, such as drifting into a corner.

G-code	Meaning	Notes
G40	Tool radius comp off	This actually is the only mode which Grbl runs in (there's no way to turn on tool radius compensation), so arguably this command should simply be ignored. Note this is now supported in Grbl v0.9i
G41	Tool radius compensation left	
G64	Constant velocity mode	
G81	Canned drilling cycle	Try setting the Drilling Method to Spiral instead of Canned Cycle
G83	Deep hole drilling canned cycle	A Perl program for post-processing a file which contains such commands is available on GitHub .
G91.1	incremental distance mode for arcs	Note this is now supported in Grbl v0.9i

Grbl Specific Commands

Command	Meaning	Notes
?	Current status	Displays Grbl's active state and the real-time current position, both in machine coordinates and work coordinates.
\$#	View gcode parameters	Display the stored offsets from machine coordinates for each coordinate system G54--G59, G28 and 30 and G92.
\$G	View gcode parser state	Displays all of the active g-code modes that the parser will use when interpreting any incoming command.
\$H	Run homing cycle	
~	Cycle start	
!	Feed hold	Brings the active cycle to a stop via a controlled deceleration, so as not to lose position. Once finished or paused, Grbl will wait until a cycle start command is issued to resume to the program.
Ctrl-x	Reset Grbl	Resets Grbl, but in a controlled way, retaining your machine position.



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SETTING UP AND RUNNING YOUR FIRST PART

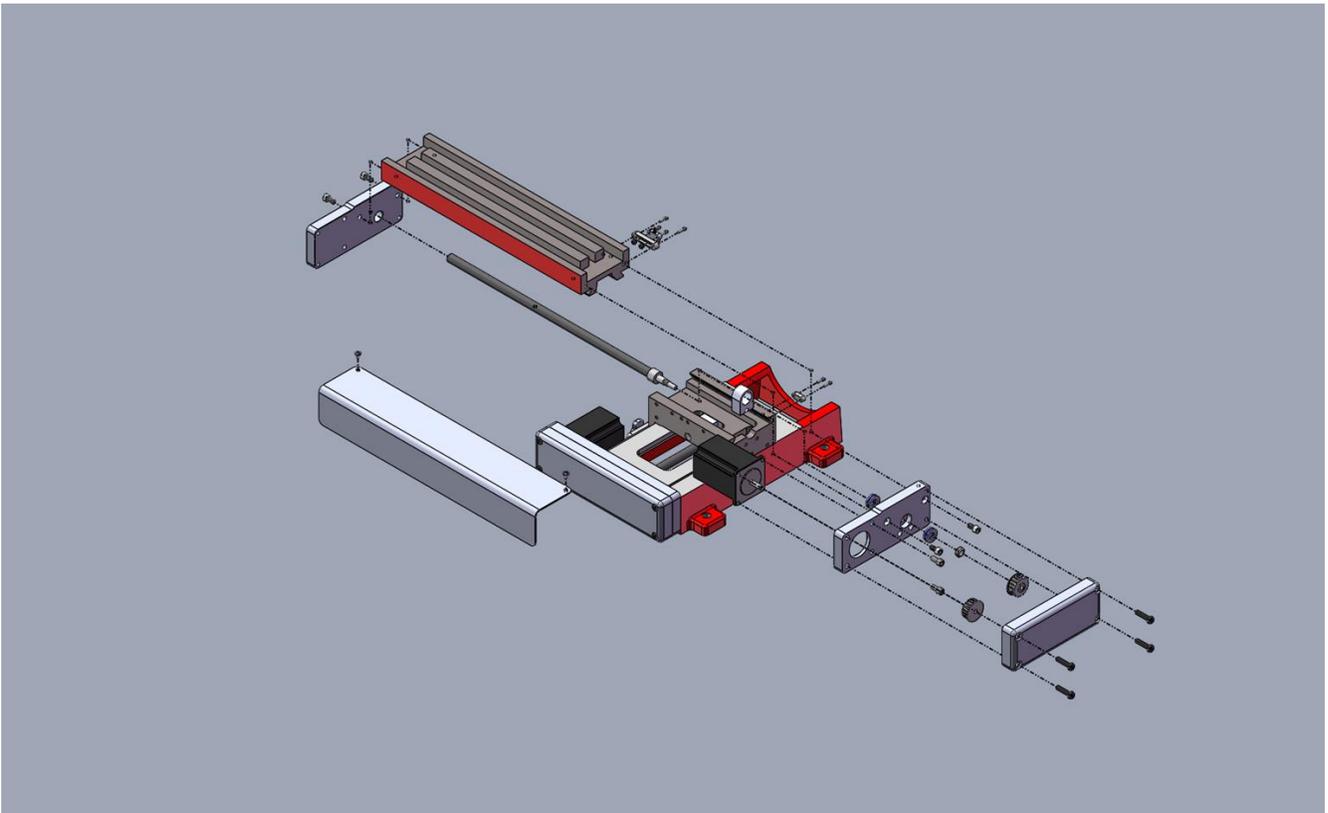
This section still in development. Please see the videos posted on our YouTube channel:

<https://www.youtube.com/channel/UCYKoe7G04ZpYAyunwoeysZg>

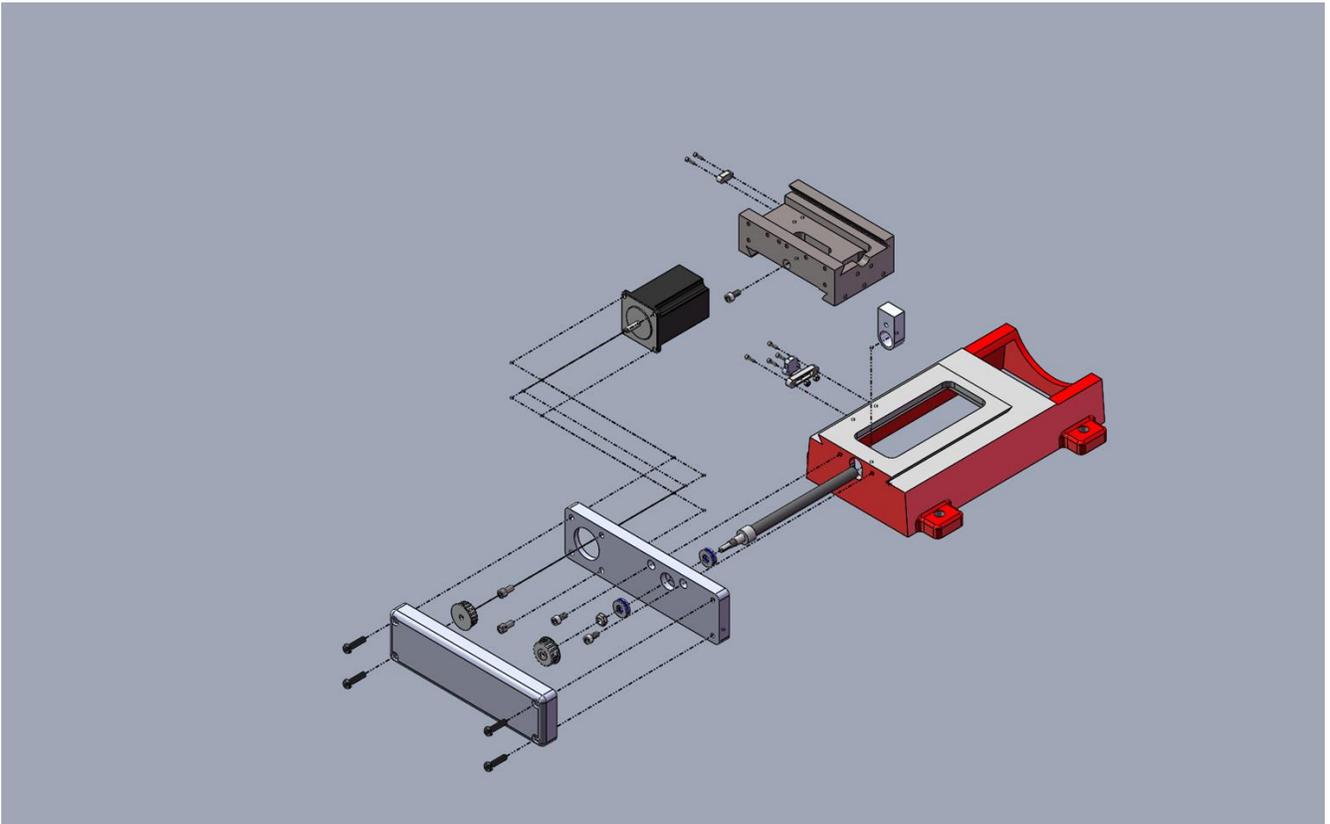
Click LIKE and SUBSCRIBE to get notifications of new videos!

For more help, be sure to check out our FAQ's and Resource Center at www.LeadingEdgeIndustrial.com/resource-center/.

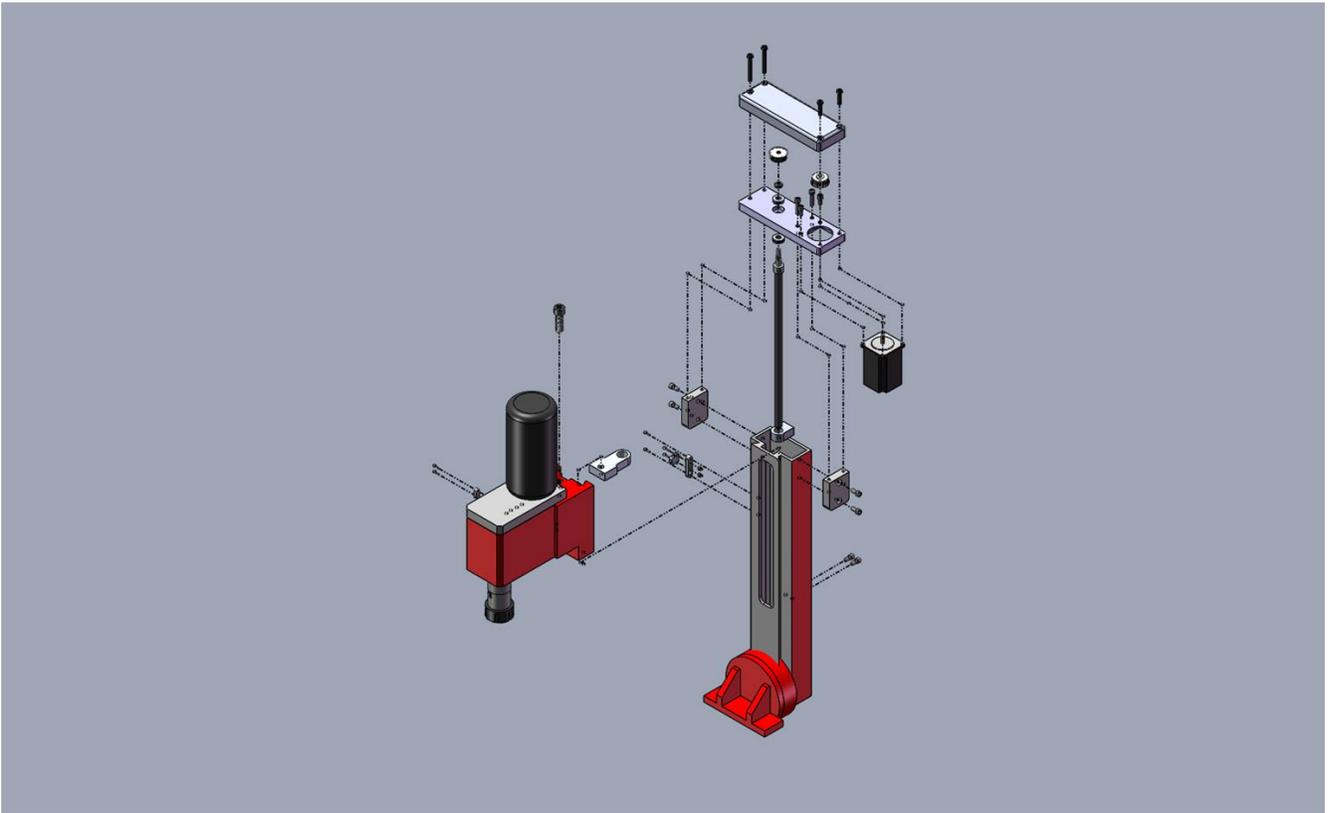
Appendix A: X-axis Assembly



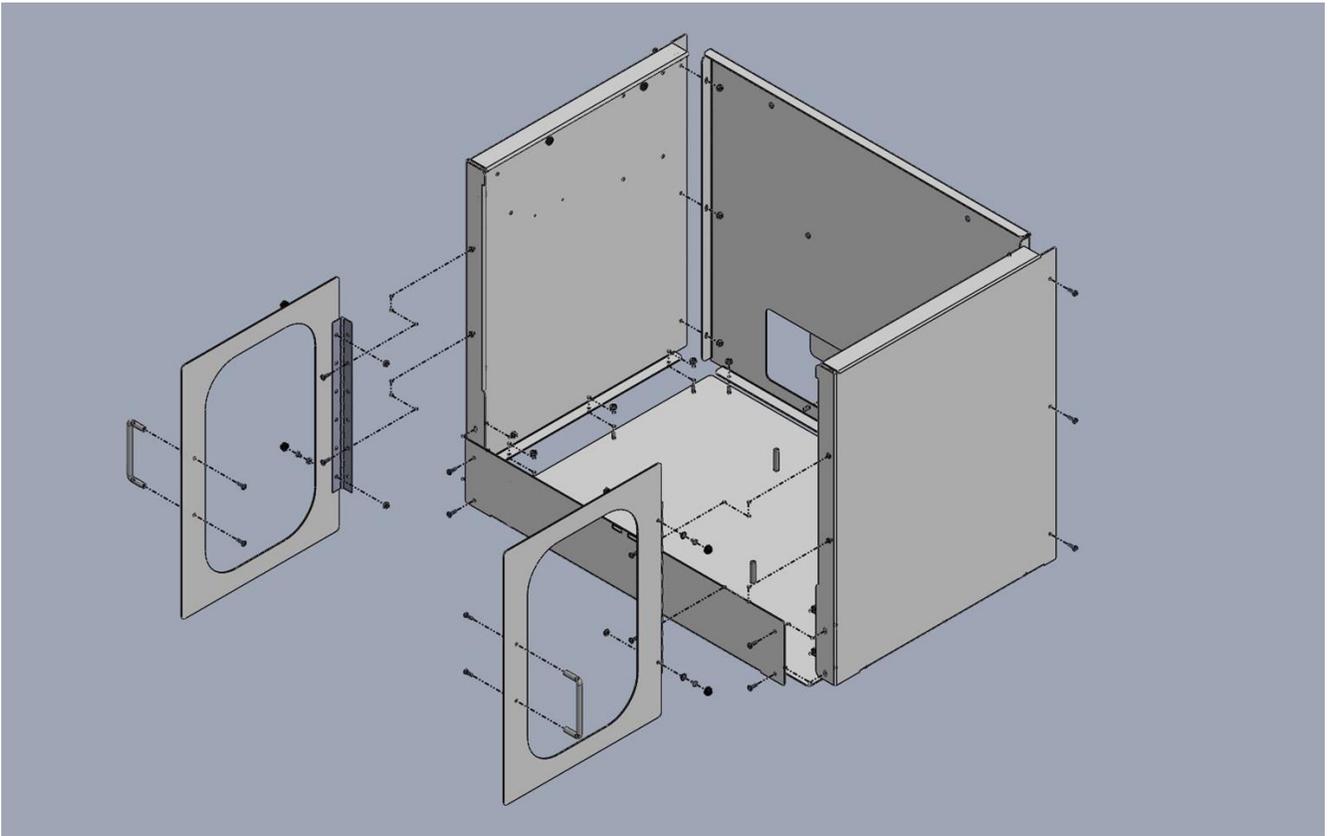
Appendix A: Y-axis Assembly



Appendix A: Z-axis Assembly



Appendix A: Sheet Metal Assembly





Appendix B: Maintenance

Caution: Avoid injuries or damage to equipment. Before performing any maintenance on this machine, unplug the power cord from the electrical outlet.

Lubrication Requirements

1. Using a light oil and clean cloth, after each use, wipe down all metal parts of the machine to prevent rusting.

(We recommend using *B'laster Multi-Purpose Lubricant* - a high-performance formula designed to lubricate moving parts such as screws, glides, and gears; Available for purchase on our website: www.LeadingEdgeIndustrial.com/shop)

2. Using machine lubrication grease, periodically apply to the X-axis feed screw (Longitudinal), Y-axis feed screw (Lateral), and Z-axis feed screw (Vertical support).

(We recommend using *B'laster White Lithium Grease* – a low-odor, clean, white grease that lubricates by creating a protective barrier; Available for purchase on our website: www.LeadingEdgeIndustrial.com/shop)

Periodic General Maintenance

1. Inspect all moving parts for lack of lubrication. If necessary, lubricate as described above.
2. Using compressed air, blow the machine clean of all foreign material. Wear eye protection during this operation.
3. Check all adjustment screws, bolts, and gibs for tightness.
4. Store cutting tools in a wooden box or another moisture-proof package.
5. Cover the machine when not in use.
6. Sharpen cutting tools as soon as they become dull.
7. Always keep the taper shank clean.
8. Store all tools and accessories in a clean and dry location, near the machine.
9. Always use the supplied tools and wrenches to make repairs and adjustments.