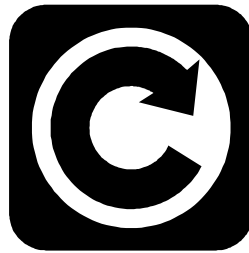


# CENTROID™



## **Retrofit for Bridgeport Boss Series I or Series II**

Version 1.2  
Rev. 020718



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## 1.0 - General Overview

Bridgeport Boss NC milling machines make excellent Centroid CNC retrofit machines. The original outdated NC controls have rendered many of these machines inoperative. The few machines that are still running are a real pain to operate and program.

The Boss machines were built out of good US cast iron and have quality ballscrews and bearings installed. Often .0005" backlash is observed on the X and Y axis on a 20 year old Boss machine.

The combination of the obsolete NC control with the good frame design makes the Boss series great candidates for updating to a modern Centroid CNC control. The Boss retrofit is a neat, clean install and can be completed in two days with basic tools.

## 2.0 - History

Bridgeport machines sold a line of NC Knee mills called the Boss series. These machines were first introduced in the 70s as Boss Series I NC mills. Both the machine and control were made by Bridgeport (Textron was the parent company) and are labeled as such. The Series I NC knee mills are a small knee mill specifically designed for NC operation. Don't confuse the Series I name with the Bridgeport manual milling machines designed in the 50s and still built to this day. These Boss NC machines have built-in motor mounts and are NOT a manual milling machines with axis motor adapters.

Over time, improvements were made to the machines and the model numbers changed. You will find machines with Boss 2,3,4,5,8,9 labels. Due to the popularity of the Series I Boss machines and the requests by customers for more axis travel and more horsepower, the Series II NC was introduced. This is a larger NC knee mill than the Series I NC with more axis travel, with a 40 taper spindle at usually 4 hp or more. Both the Series I and II were equipped with very similar control systems.

One unique difference is that the Series II machines would come with either the Z axis operating the Knee or the Quill (like the Series I). Having the Z axis operating the knee was an advantage due to the increased travel, however it introduced a technical challenge. The problem was with the weight of the knee itself. The axis motor could not lift this weight and accurately machine parts at the same time. Bridgeport installed an air bladder on the knee that counterbalanced the weight of the knee so that the axis drive motor was only doing the work of the tool.

Early Boss NC controls were Stepper-motor based; later, Boss 8 and 9 machines were equipped with servo motors. Ironically, the older Stepper-based systems have proven to be longer-lived.

Bridgeport also sold bare frames, so you may run into machines with other brand controls. A common one is the iBandit.†

When Bridgeport discontinued its own control, it began using Heidenhain on the Boss frames. These Heidenhain-equipped machines are often in good condition because they saw little use, presumably because the control is so hard to use.



Figure 3.0.1 - Boss Series I Rigid Ram before retrofit

## 3.0 - Boss Frame Types

**Series I NC Boss** machines come in two main types of frames.

1) Rigid Ram machine. R2E3 model number. Head is rigid, no knuckle. Z axis is in the head.

2) Knuckle head with moving ram, smaller head that can be moved in and out. Head can be tilted. Z axis in the head. All though it is rare I have retrofitted a two headed Series I frame. This machine was equipped with a iT ram which looks like a machine table and will have 2 or 3 spindles mounted to it.

**Series II NC Boss frames.** These machines are a larger version of the Series I machines. Two main types of frames.

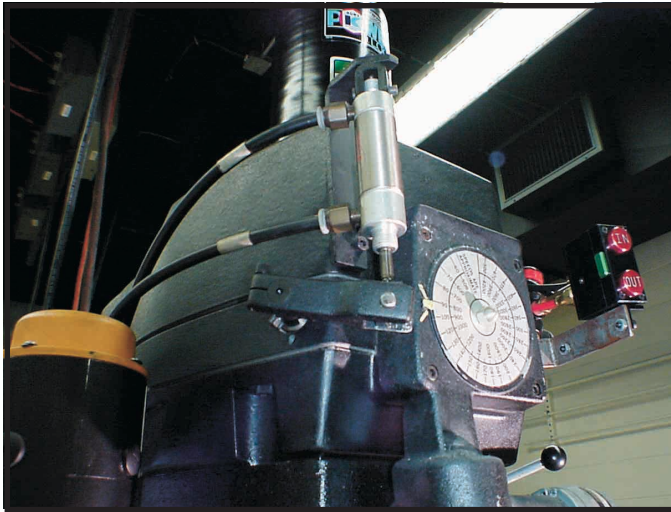
1) Rigid Z axis head similar to the R2E3 Series I, just bigger. Z axis in the head. Even though knee is manual it is equipped with an air counter balance to make cranking the huge knee easier.

2) Big knuckle head with moving ram. Z axis on the KNEE! Has air bladder counter balance.

## 4.0 - What to look for in a candidate machine

1.) When qualifying a possible Boss retrofit candidate be sure to assess the mechanical condition of the machine. Are the axis ways in good shape? Rusted up? Worn away? Take off the motor covers (15 minutes tops for all three) and turn the axis motor pulleys by hand to see if each axis moves freely. Run the spindle and check for head noise. If the control is inoperable, use a common knife blade disconnect to test run the spindle motor by direct wire. (OR, at least put in high range and turn the spindle by hand and feel for gross mechanical problems). For quill drive units, open the quill cover and inspect the quill. Evidence of the lube pump quitting? Or not being used?

2) Check for back lash. (You can do this by turning the axis



**Figure 5.2.1 - Pneumatic spindle brake**

motor pulley and watching an indicator) If more than .0015", there is a mechanical problem that needs to be resolved.

3) Check to see if the machine is complete. If the old control is still installed your job will be easier. X,Y,Z Limit switches present? Spindle speed up/down and brake solenoids present? Etc...

## 5.0 - Control configuration

Reference #3111 and #6772 and #4817 build sheets for recent M-39, M-400 and M-400S Boss retrofit examples.

### 5.1 - Cable Lengths

Depending on which series Boss machine you have, use the information in Table 5.1.1 below to determine the axis motor cable lengths for that machine.

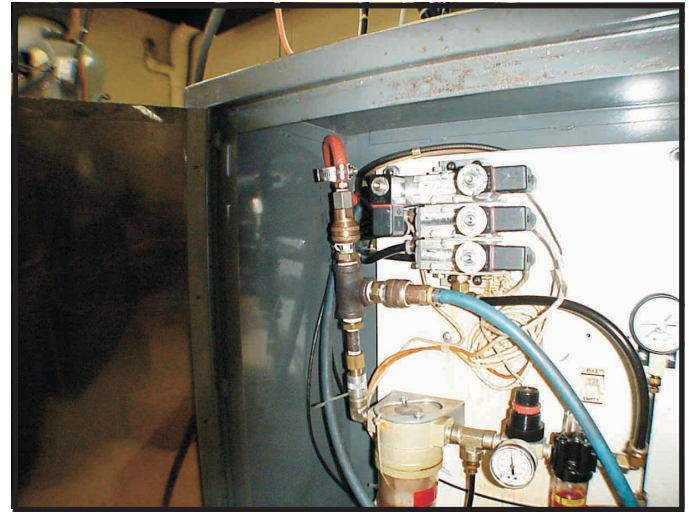
**Table 5.1.1 - Axis Motor Cable Lengths**

	X	Y	Z
Series I	12'	8'	14'
Series II	12'	10'	14'

For the rest of the cables such as Limit switches, lube pump, spindle motor etc. the standard lengths provided by Centroid and printed on the second page of the build sheet are more than long enough.

### 5.2 - Spindle control

Most Boss machines were equipped with a 24 vdc air solenoid controlled spindle speed up/down air motor installed on the head. This motor simply takes the place of a manual speed adjustment handle that would normally adjust the spindle variable speed belt mechanism. On a Boss control, instead of the operator having to manually turn a handle to adjust the spindle speed he would press an UP or DN button on the Boss control panel and the spindle speed would change. The Boss machine was also equipped with a pneumatic spindle brake controlled by a 24 vdc air solenoid (Figure 5.2.1). This brake was ON all the time except



**Figure 5.2.2 - 24 vdc up/dn solenoids**

when the spindle was running. On early Boss units three 24 vdc solenoids are mounted on the upper left hand side of the machine in a black box and on later units they are mounted on the side of the mill in a gray box (Figure 5.2.2).

If the Boss machine is so equipped, and to simplify the Centroid installation, retain these three solenoids and specify a Boss spindle speed up/down and brake configuration and Boss PLC program. You can reference build sheet #3111, #6772 and #4817 for recent M-39, M-400 and M-400S examples. The single cable for all three of these solenoids should be a 4 conductor, 18 gauge, at least 10' long, and wired as:

- Brake solenoid - Red 24 vdc +
- Speed up solenoid - Green 24 vdc +
- Speed down solenoid - White 24 vdc
- Common - Black 24 vdc (-)

### 5.3 - Other spindle speed control configurations

1) If the spindle speed was adjusted manually, you could simply leave this as is.

2) If the variable speed mechanism is in bad shape or if the customer requests true programmable spindle speed control, an inverter can be used to control the spindle motor. It is advised that the variable speed mechanism be removed from the head and replaced with a direct drive belt and pulley set up.

It is true that you can simply pin the adjustment handle for the variable speed mechanism so that the variable speed mechanism will not move or drift during operation. This however is a temporary solution and only works if the variable speed mechanism is in good mechanical condition.

Note: There is about a 15 to 20% Horsepower increase **at the Tool** when the variable speed mechanism is removed. This is another advantage of directly belting the spindle motor to the spindle. The loss due to belt side load friction in the variable speed mechanism is regained back when belting direct (no mechanical adjustment of spindle speed).

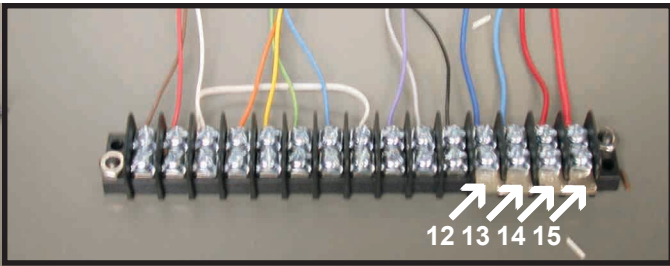


Figure 5.4.1 - Terminal strip for second E stop

## 5.4 - M-39 2nd E stop

Install a second E stop switch with any M-39 installs. On most Boss machines you can retain the factory E stop switch located on the small Boss control panel directly facing outward on the machine head. If this original switch is damaged or missing, add a second Centroid E stop switch to the head of the machine. The M-39 is equipped with an easy to hook up terminal strip (Figure 5.4.1) at the bottom of the cabinet that allows you to add a second E stop in minutes. This is a quick and easy install that adds a degree of safety to the retrofit.

Refer to the schematic below for wiring the second E stop.

## 6.0 - Control Installation

### 6.1 - Control electrical Cabinet mounting

On most machines, mount the new electrical cabinet on the back of the machine. Use two pieces of steel at least .25" thick, 2" wide and 22" long along with two pieces of tubing 2" long with

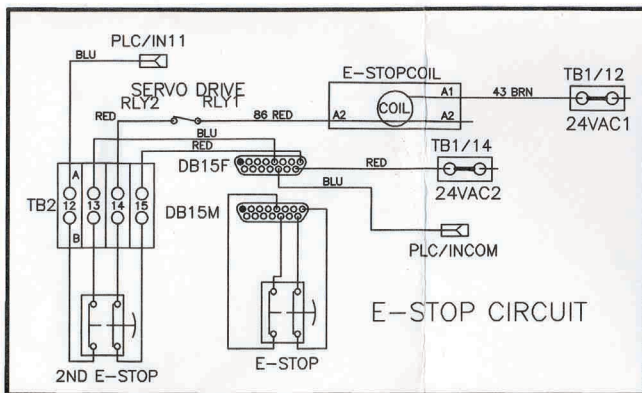


Figure 6.3.1 - Z axis quill switches

to bolt to the cabinet tabs.

### 6.2 - Control Arm Mounting

For all rigid ram machine that have a square ram with a vertical surface, use the iCî bracket control arm mounting hardware for all controls. For knuckle head machines use the iLî bracket since the ram is crowned and has no vertical surface. The iLî bracket allows the iCî bracket to bolt up in a vertical position. See Build sheet for all three of your control to machine mounting options. On Series I knuckle heads, extend the arm mount upward about 8 inches because the machine is so low. Extend the mounting location with a  $\Omega$  or 5/8 pc. of steel that bolts to the iLî bracket and extends the iCî Bracket upwards about 8" for proper control mounting height.

Your location of the control arm mounting may vary depending on height of the ram, type of ram etc. Shoot for getting the height of the screen at a easy to see and read height and position. (See Appendix I - Tech Bulletin #057).

Comments on a dual spindle on a "T-Ram" machine retrofit: The arm directly bolted to the top of the T-ram using an existing large threaded hole. The top of the T-ram is wide and flat so the arm needed no other bracket for installation. The bolt went directly through the arm and bolted to the top of the T ram.

Some M-39 customers don't even want the control mounted to the machine. This is most common with M-39 installs. Most of them will create a display/control console out of an available roll cart or stand of some sort.

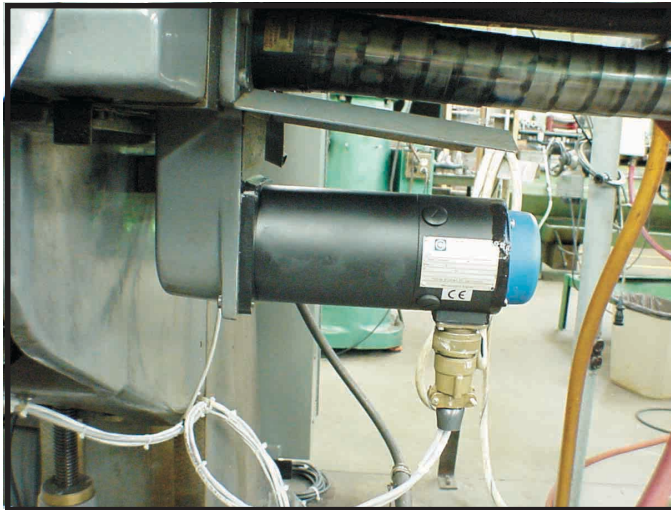
### 6.3 - Limit switches

Boss machines (provided with Bridgeport controls) use one switch for both positive and negative travel limits on the X and Y axes. The switches are a good quality roller arm type. Reuse and reconfigure these switches. With a multimeter, simply determine which of the four terminals inside the switch are normally closed and use those terminals. Set the bumpers for the switch to trip out on the ihomeî side of the travel. In most cases this is X - and Y + . Use software travel limits to take care of the other end of the

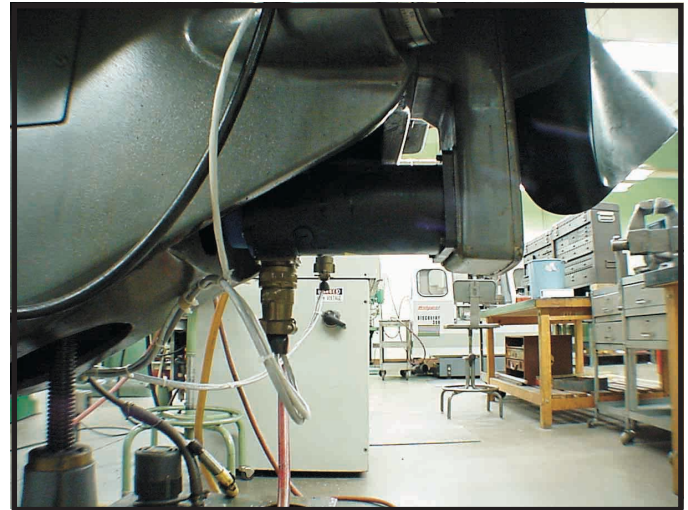
an ID that will provided clearance for a 3/8-16 bolt. Use the following hardware to bolt the electrical cabinet to the mill frame:

- 2 1" 3/8-16 bolts
- 4 .5" 3/8-16 bolts
- 2 3" 3/8-16 bolts.

Make use of two existing 3/8-16 threaded holes located on the back of the machine. These holes are about 6" from the floor. (They used to hold the original boss electrical cabinet on the back of the machine.) The top bracket has four holes in it, two center thru holes that are used to bolt to the bar to the machine and two threaded holes that bolt to the cabinets tabs. The lower bracket has two slots near the center of the bar made to accept the existing bolts found on the boss machine from the original cabinet. The bottom bracket then has two outer threaded holes



**Figure 7.0.1 - X axis motor mounting**



**Figure 7.0.2 - Y axis motor mounting**

axis. Set the software travel limits to about 0.1" before the axis hits a hard stop.

On a Z axis quill machine you will find three original switches installed in the quill housing: Two limit switches and one home switch (Figure 6.3.1). The home switch can be identified by its location and type. It is a plunger type switch and is located in the upper left of the quill housing. Retain this Z home switch and use it for both Z home and Z + limit. Remove the original Bridgeport Z + switch, but retain the original Z - switch.

To connect the switches, simply run new wire from the control up thru the body of the machine into the head and connect the Z + wires to the home switch, using the normally closed terminals on the switch, and then connect up to the original Z - limit switch. Check for proper limit and home switch positioning by moving the axis by hand using the motor pulley to each extreme of travel checking for binding or hitting or misalignment of limit switches.



**Figure 7.0.3 - Z axis motor mounting**

## 7.0 - Items common to both Series I and II frames.

1.) Axis motor installation is simple for most Boss machines. The original motor bolts went thru the casting of the motor mount and threaded into the motor flange. Early machines were equipped with a Stepper motor based NC control. These motors use the same bolt pattern, and shaft diameter as the Centroid 29 in-lb axis motors. Therefore the 29s are a direct bolt up saving you a lot of time and effort. The original Bridgeport motors have a 5/16-18 threaded flange bolt holes, so you simply tap the thru holes on the new Centroid 29 servo motors and reuse the original mounting bolts. The thru holes on the new motors are ready to tap 5/16-18 so, no drilling is necessary (Figures 7.0.1, 7.0.2 and 7.0.3).

2.) On later machines the Bridgeport controls changed to DC Servo based systems. These systems (oddly enough) used two different bolt patterns on the axis motors. One pattern was exactly the same as the old steppers (and Centroidis 29 in-lb motors). The other is a round flange bolt pattern. When you find a round flange motor, you can simply make your own adapter plate which

will allow the new Centroid 29 in lb motor to bolt up to the existing mounting holes. This adapter plate bolts to the motor and then you bolt the motor with the adapter plate to the machine. Follow the motor mount adapter plate blueprint shown in Appendix III of this manual. You can also order the adapter plates with your M-39, M-400S or M-400 order.

When installing axis motors, keep in mind common sense knowledge about proper pulley alignment, pulley installation and belt tension. Most common is over-tensioning of the belt which causes broken motor shafts. Other problems caused by bad axis motor installation include: poor machining performance, high drag, position errors. Future problems and service calls can all be avoided if time is taken at this stage of the install to do it right.

3.) Axis motor pulleys: Most boss machines are equipped with steel taper lock pulleys. These high quality pulleys are easily reused and they require no key! No broaching is necessary. Often on the Z axis motor, a solid AL pulley and has to have a keyway broached for use with the new 29 in-lb motors. So, have

a 3/16 broach ready to go. The original Bridgeport motors use a smaller keyway so you will have to broach a new 3/16 keyway in the original pulley so that it will mount to the new motor.

4.) Air operated spindle speed up and down: Most boss machines are equipped with a semi automatic spindle speed adjustment system. It consists of an air motor that, thru two worm gear drives, rotates a shaft that adjusts the mechanical spindle speed variable drive mechanism. (conical type speed adjust). This is similar to a machine equipped with a manual vari drive except that instead of the operator turning the handle for spindle speed an air motor does it. The air is controlled by two 24 VDC solenoids, one solenoid is Speed UP and the other is Speed Down. (The direction in which the air runs thru the air motor determines the direction of rotation therefore, UP or Down.)

For a retrofit, simply retain the original 24vdc solenoids and connect them to the PLC, follow the hook up diagram. If you order a M-400 or M-39 iBoss ready the speed UP/DN will be prewired for you, ready to connect to the solenoids.

When using a Boss PLC program, two of the available PLC outputs will turn on with the Aux 1 and 2 keys on the jog pendant. Simply run the 24 vdc in one side of the output relays and the other out to the solenoids. Follow the hook up diagram. Aux 1 is speed up and Aux 2 is speed down. When you press Aux 1 while the spindle is running the spindle speed will increase and Aux 2 will decrease the speed. The Aux 1 and 2 are interlocked to the spindle on therefore they will not operate unless the spindle is running.

The solenoids on the early machines are mounted in a small black box on the left hand side of the head. On later machines they are mounted in a metal enclosure with the lube pump and the mister, located on the left side of the body of the machine.

Note: Not all Boss machines are equipped with the air speed up/down. Some of them simply have a manually operated handle wheel just like a manual milling machine.

5.) Air operated spindle brake. All boss machines equipped with the air operated spindle speed adjust are equipped with an air operated spindle brake. This brake is on when the spindle is off. You can override the brake by switching it off with the spindle brake on/off button located on the jog pendant (aux 3). The brake is controlled by a 24 vdc air solenoid, just like the speed up down. The hookup is just the same as the speed up down solenoids. The boss PLC program has Aux 3 programmed as a manual brake ON/OFF.

6.) Bridgeport solenoids. Bridgeport used Versa solenoids for the UP/DN and brake control describe above in items 4 and 5. These solenoid coils go bad from time to time. They are an odd size and a easy direct replacement has not been found. We have found a common readily available \$12 24vdc coil that can be used with a simple modification.

## 8.0 - Installation information specific to Series I frames

Y axis motor mounts have been found to be either to the right side of the knee or mounted under the knee (better). On machines where the Y axis motor mount is located under the knee, the



### Boss Series I Rigid Ram after retrofit

clearance between the back of the motor and the knee is about 1/8", a tight fit. This is no problem. To install the motor you simply unbolt the four bolts holding the motor mount to the frame and rotate it to one side (about 30 degrees CCW or CW) insert the motor shaft thru the hole in the motor mount and swing the motor AND motor mount back into place at the same time.

For Y axis motors mounted to the right of the knee, be sure to reuse the existing motor splash guard to protect it from oil. Create a splash guard if one is not present. You can view a picture of an original Bridgeport splash guard on our web page [www.retrofityourmachine.com](http://www.retrofityourmachine.com).

## 9.0 - Common Problems found on Boss machines

1.) Bad Variable Speed Mechanism. Worn out bushings and keyways on the conical speed adjustment pulleys. Can be identified by loud growling spindle noise while spindle is running. Also lost torque at tool. Solution: Repair Mechanism and retain stock air speed up/dn, OR gut Mechanism and install direct drive pulleys and inverter control.

New replacement inverter ready motors can be ordered from:

Lesson Model Catalog # 131514 / 5HP Motor 3500 RPM

Lesson Model Catalog # 131492 / 5 HP Motor 1725 RPM or Lafert Model HE112ME2-24 / 5HP Motor 3600 RPM ( Requires C Flange Adapter # FL112B14 )

### Inverters

Yaskawa Inverter Model VS606V7 CIMR-V7AT23P7

Lesson Cat # 174919 Micro Series Compact

Or your favorite 5hp AC inverter. Safetronics, Hatachi etc...

### Pulleys and Belts



Lesson Cat# 174919 Micro Series Compact

qty. 2 (2-3V-335-sh) Pulleys

qty. 1 (SH-1 1/8 Q.D. Bushing)

qty. 1 (SH 1 3/8 Q.D. Bushing)

qty. 2 (3VX-300 V Belts) May need (3VX-280) Depending on motor mounting plate arrangement.

2.) Rusted Motor and Ballscrew Drive pulleys. Remove, sand-blast/glass bead to remove rust, paint with a clear coat polyurethane to protect pulley from rusting again and to protect belt from rough edges left by the rust. Seal pulley housing from coolant.

3.) Air Bladder on a Series II knee lift is leaking, doesn't work or simply needs the air pressure adjusted. The Air counter balance needs to be operational for the Z axis to work on the knee. Use Kg to determine how bad the out of balance is. Hopefully just the air pressure needs to be adjusted to set the balance properly. However if the air balance is leaking, the seals can be rebuilt with new gaskets. Note: A 29 in lb motor works fine on the knee IF the air balance is working and adjusted properly.

4.) Oil system gummed up from lack of use. Thoroughly clean and flush out with kerosene and run through light spindle oil then refill with way lube.

## 10.0 - Suggested Tools and parts necessary for proper installation

Volt meter

Good Electric drill

Soldering Iron, + rosin core solder

Ball end allen wrenches

3/16 - 5/8 dia Keyway cutter

5/8 Broach

Pulley puller

Punch set

Drill bit set

Drill and Tap set with handles, 6-32 thru 1/2-13

Dial indicator and magnetic stand

Tachometer

Electrical contact cleaner.

Good quality wire cutters Large, Med, Small

Extension cord, Extension cord with light.

Small seat so you can sit close to the floor.

Hand Cleaner and lots of rags

WD-40

Complete typical tool set: set of sockets, wrenches, pliers, ball peen hammer, screw drivers, etc.

Electrical tape

Wire ties, selection of all sizes

Set Screw kit (contains 5 each of all the common set screw sizes)

Fuses: Full set of all fuses used in any Centroid CNC control

Spare/Extra E stop button

Spare Limit Switches (Omron sealed plunger type MSC part # 54047121, approx. \$56 each. MSC's phone number is 800 645 7270)

MSC catalog (they ship VERY fast and have almost anything you would need, they also have their catalog on CD)

Full set of common Socket head Cap screws 6-32,8-32,10-32,1/4-20,5/16-18,3/8-16 everywhere from .375 long to 3" in the bigger sizes.

Common Spare Hardware used on Centroid controls such as: 5/16-18 bolts for arm to machine.

Full set of common Electrical crimp on connectors, Yellow, Blue and Red Ring terminals and spade terminals.

1/2" liquid tight to rubber cord connectors (any good electrical supply house has these)

Selection of cable hold down/hangers. .25" to 1.5" (used to route cables on machine)

Selection of sand paper.

Misc. Spare wire

Alligator clips

Set of files

Hacksaw

Flashlight

Level

## Overview

The purpose of this document is to provide information on the correct installation of a console for appropriate height and arm length.

## Correct Height

The correct height of the console is determined by putting the middle of the console at eye level. The average height user should be able to stand at the console and look directly into the middle of the console without having to bend their neck. It is important to take into account the shipping pallet if present. To adjust for the pallet, stand on an equal height pallet when checking the console height. For a knee mill, the bottom of the console should be no lower than the bottom of the spindle when it is fully retracted and a tool is not present.

## Correct Arm Length

The arm must always put the console at a comfortable height and within easy reach. The arm should not place the console too far back or too far forward. An easy test to determine that the arm length is correct is whether or not the operator has to lean over the table to operate the console. The operator should not have to do this. If a table guard is to be mounted on the table later, this should be taken into consideration when testing the arm length.

The arm should not place the console too far in front of the machine. The arm length of the console should be such that the operator can stand close to the machine without hitting the table and not have to lean back or step away from the machine to operate the control. If the operator needs to lean back or step away from the machine, the arm is too long.

When an M15 is to be mounted on a knee mill, the best place to mount the arm is in the shipping eyebolt hole using the Centroid designed iLi bracket and bolt. This avoids drilling holes in the frame and results in quick installation. The arm can then be removed for shipping.

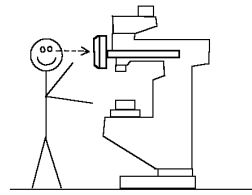
It is not always necessary to design a special arm in every case. An arm that is appropriate in length but is mounted too far back on the column appears too short. In this case, a longer arm may be fabricated. A longer arm will cause the keyboard to bounce when the operator types. The original shorter arm would not do this. The original arm would be the correct length if it were properly mounted as far forward on the column as possible.

Also, use a stop bolt to prevent the arm from swinging into the head or shop light. Mount the shop light on the left if an automatic tool changer (ATC) is not present.

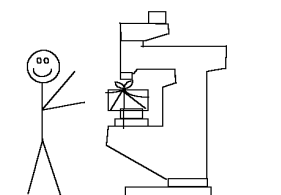
## Shipping the Console

The machine should never be shipped with the console mounted to the arm. Do not pad and shrink wrap the console to the back to the head. Shipping damage will almost surely result if this is done. The correct method for shipping is to first remove the console from the table. Next, pad and box the console and finally shrink wrap it. The cables can even be left connected. This process is especially easy with the M15 console. It can also be done with M400 PC Console, which can quickly be unbolted

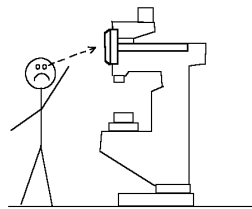
from the arm swivel. Leave the flexible conduit attached to the console.



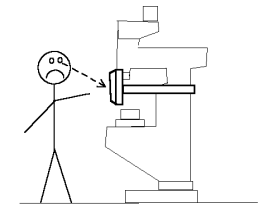
**Eye level; not too high, not too low (about 64" from floor to bottom of LCD)**



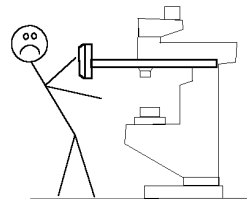
**Remove control console and pack separately for safe shipping**



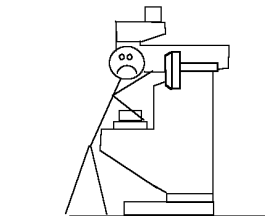
**Control too high**



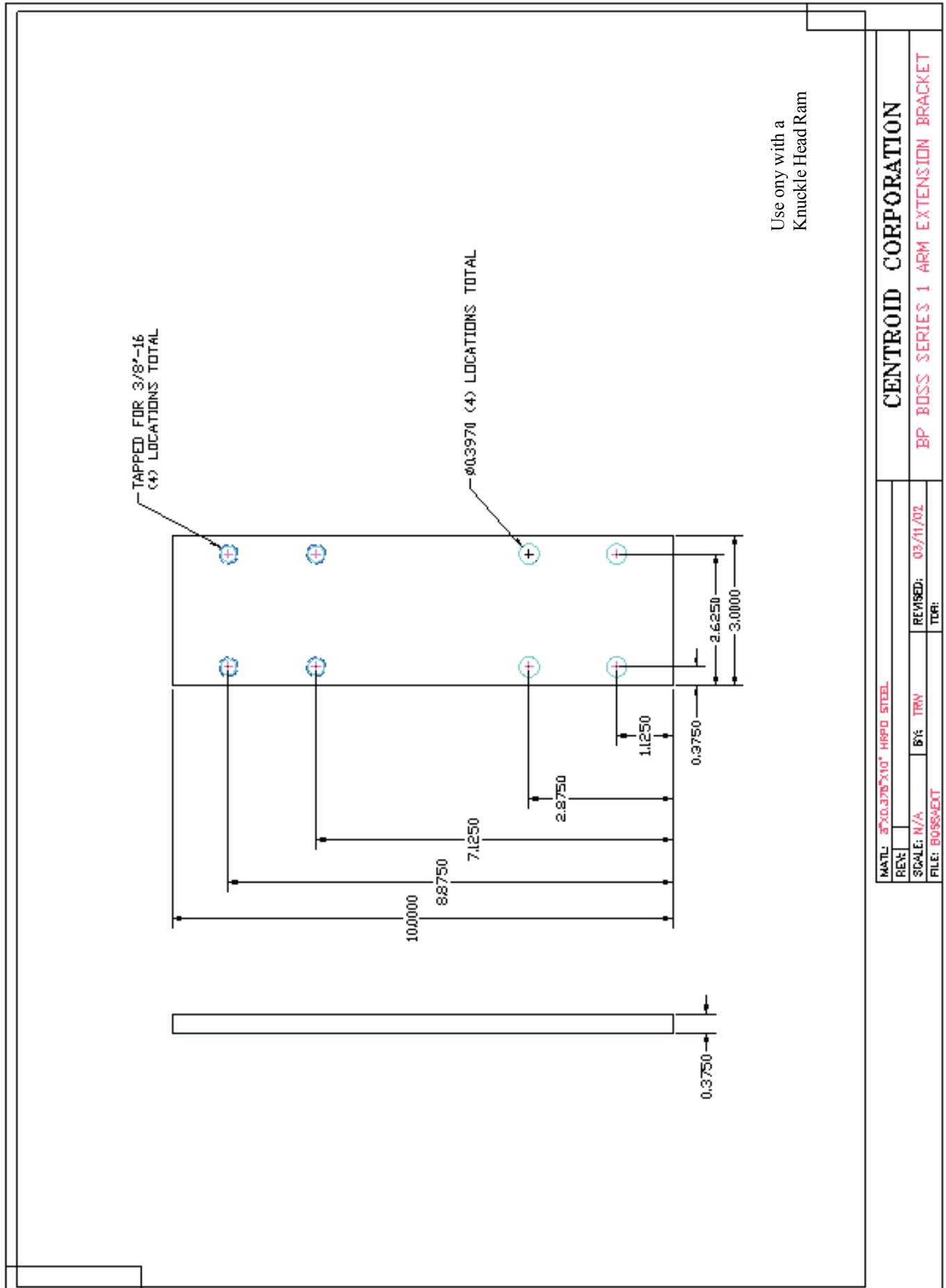
**Control too low**



**Control arm too long**



**Control arm too short**



Use only with a  
Knuckle Head Ram

**CENTROID CORPORATION**

**BP BOSS SERIES I ARM EXTENSION BRACKET**

MATL: 3"X0.375"X10" H690 STEEL

REV: [ ]

SCALE: N/A

FILE: BOSS-EXT

BY: TRV

REvised: 03/11/02

TDR:

# Appendix III - Boss Motor Adapter Plate

