



Mach 3

Xbox Controller

XboxShilling - Ver. 1.0.4

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PREFACE

Mach 3 is a Windows based CNC controller. Using it to interface with a CNC often requires the use of a mouse and keyboard. Simple jogging, edge finding and referencing can be made comber sum by this digital interface. In addition, especially on larger machines, having to return to these input devices to trigger different functionality can add substantial delay in the production process. A wireless solution would allow the user to take the interface with them. If this controller had ample digital and analog inputs it would allow for convenient, precise and expeditious machine manipulation. The XBOX™ Controller for Windows by Microsoft™ provides all of this functionality in a cost effective and readily available package. This document covers the setup and use of the XboxShilling Mach 3 plugin. This plugin allows a wired or wireless Xbox controller to directly control Mach 3's motions, states and functions.

DISCLAIMER

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CHANGE LOG

Document Revisions:

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Software Revisions:

Version 1.0.0:

- Initial Release

Version 1.0.1:

- Adjustments made to Config Form Display for Various Resolutions
- Minimum .NET framework reduced to 2.0

Version 1.0.2:

- Removal of if(OEM 999 | OEM 804) run check, replaced with if(OEM 804)
- Fix to Safety Lockout. Original, even if both safeties were off, would still take into account the safeties' feed rate in calculations.

Version 1.0.3:

- Motor Deceleration added allowing motors to come to a smooth stop when input is stopped or reversed.
- of if(OEM 999 | OEM 804) re-added as no effects were found on last version
- Code("DOJOG") and Code("ENDJOG") added

Version 1.0.4:

- General optimization of Code

1. Overview

The XboxShilling plugin for Mach 3 is a very versatile interface for your CNC machine. The Xbox controller itself has two analog thumb sticks, one four direction gamepad, eight digital buttons and two analog triggers. The wireless version has a range of approximately 30 feet and accepts rechargeable batteries. A wired version is also available and is supported by this plugin. The interface between the controller and your computer is via a USB wireless receiver that is provided when you purchase your controller. The controller and plugin allow you to configure four different modes or configurations. These four modes are selectable via the controller and allow for up to 32 different digital inputs and the control of up to 6 axis in either a linear or MPG simulated mode.

2. Software

The XboxShilling plugin requires four pieces of software:

- Mach 3
 - www.MachSupport.com
- Direct X – 9.1 or newer
- .NET Framework 2.0 or newer
- Microsoft XBOX Controller Drivers
 - www.microsoft.com/hardware/en-us/d/xbox-360-controller-for-windows
- XboxShilling.dll

In order for this interface to work all four pieces must be installed and setup.

2.1. Mach 3

Mach 3, is available from Artsoft at www.MachSupport.com. A trial version is available with limitations and a full version for purchase. For further details on it and its setup, please refer to the wealth of information available on its website. For this document it is assumed the user already has experience with Mach 3.

2.2. Direct X – 9.1 or Newer

The second piece of software required is Direct X – 9.1 or newer. This handles the software interface between the controller and your computer. Specifically, the subcomponent XInput is used which was specifically designed as an easy interface with the Microsoft Xbox Controller. Most computers will already have this installed but if it doesn't, it is freely available from Microsoft and should be downloaded as a complete package. Follow the install and you should be good to proceed.

2.3. .Net Framework 2.0 of Newer

Most modern computers will already have the .Net framework installed. If you do not have version 2.0 or newer, you will need to download it from Microsoft and install it.

2.4. Microsoft XBOX Controller Drivers

If you purchased a wireless controller, this should come on the included CD. Otherwise, please download and install it from the link above.

2.5. XboxShilling.dll Plugin

You most likely have already downloaded the plugin. It should have come along with this document, if not, go download it now. There is no install, instead there is just the *.dll file. This is a dynamic link library and is used to interface directly with Mach 3. All you need to do for Mach 3 to be able to find it is to copy the file into the Mach3\Plugins directory on your computer.

3. Setup

3.1. Mach 3 Plugin Config

After your software has all been installed and components copied as needed in the last section you can begin to setup the XboxShilling plugin. Begin by opening Mach 3. Once open, click on the menu item, Config/Config Plugin. The plugin configs window should appear:



Figure 1 - Enable Plugin

You will see a list of currently available plugins. Click the XboxShilling plugin so that it has a green checkmark next to it. If the plugin doesn't appear, then you most likely did not copy the XboxShilling.dll into the Mach 3 plugin directory. Restart Mach 3. When Mach 3 boots, if the plugin is enabled by the plugin configs screen, then it will automatically start. You should see a small window appear at the up left corner of the screen. This is the controller Status window. If the controller is not connected, it will be two black rectangles; otherwise it will show some other appropriate status. Please see the Status window section for further detail. For now, ignore it and click on the menu item, Plugin Control/XboxShilling:

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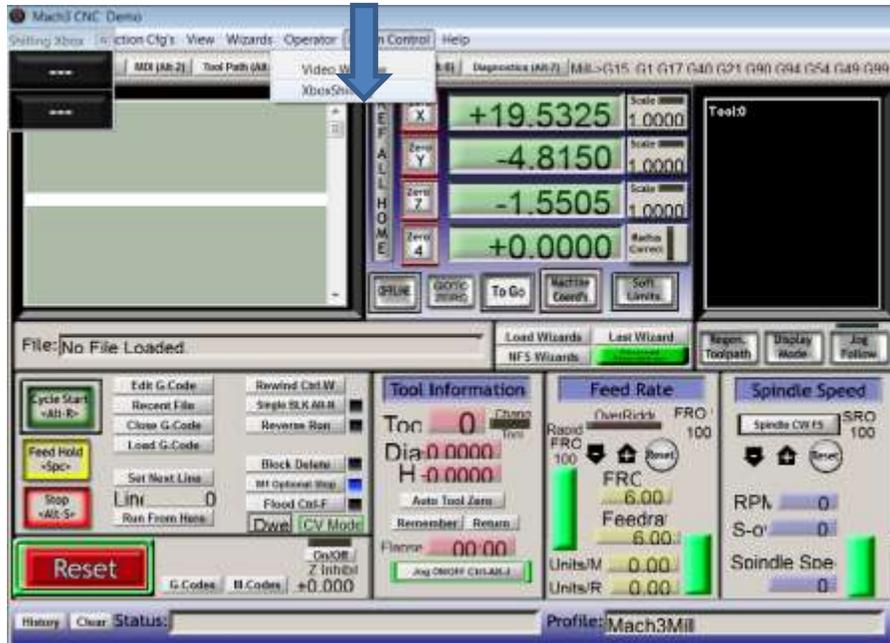


Figure 2 - Plugin Settings Menu

This will open the Config Dialog for the XboxShilling plugin. At this time, connect your controller. Ensure the controller's USB dongle is plugged into your computer and press and hold the silver button in the middle of your controller with a green X on it. In a second or two the flashing green lights will go solid and should show controller #1 as connected. If not, ensure that the USB cable is connected and a green light is shining on the wireless dongle. Then ensure the controller is fully charged or has a new battery installed.



Figure 3 - Plugin Config Form

4. Configuration

There are lots of options available for the configuration of your controller. Your settings are stored each time Mach is shutdown. These setting are automatically reloaded the next time Mach is opened. Your settings are stored in the currently active Mach profile xml file. This means that you can have different configurations for different profiles, say between your lathe and your mill, or mill and your router. You can bring up the configuration screen through the “Plugin Control\XboxShilling” menu.

NOTE

Whenever the Config screen is displayed an E-STOP condition will be set and no actions by your machine should occur.

4.1. Controller Preview

On the right of the config screen is a preview of your controller’s state. All buttons are displayed with their current state. If the controller is unplugged the entire controller will be grayed out. When connected, if a digital button is pressed, it will be evident in this display as being pressed. These buttons are A, B, X, Y, Start, Back, the left and right Shoulder buttons and the thumb stick depression buttons. The triggers and thumb sticks are analog devices. They will move as you move these inputs, however they will only highlight (In orange) when their inputs would affect your machine.

4.2. Mode

The mode dropdown box allows you to select one of four modes for configuration. When the mode is changed the other settings on the page will be updated with that modes information. When you change modes, press apply or close the plugin form, the mode changes are saved.

4.3. Copy

Copy is simply a tool to copy the configuration of the currently selected mode to another. Usually the user would configure one mode how they want it and copy it to all other modes. Then make the changes on the other modes as needed. This allows the user to easily setup common functions like the safety triggers for all modes.

4.4. Left (thumb) Stick / Right (thumb) Stick

4.4.1. Axis Selection and MPG mode

The left and right (thumb) sticks are two dimensional analog inputs. They can be configured to control one or two axis (X, Y, Z, A, B or C). The axis that are controlled by these sticks are determined by the left to right (L-R) and up to

down (U-D) dropdown lists. Selecting a “-” will disable the input in that motion mode. If L-R is set to “X”, moving the stick left and right would move the “X” axis. You can also configure the stick to act as an MPG (Manual Pulse Generator). This means that moving the stick around in a circular motion along the outside edge of the sticks displacement will move the axis proportional to the arc length traveled by the stick. The axis this controls is selected with the L-R dropdown. The U-D dropdown will be ignored in MPG mode.

NOTE

Selecting the same Axis multiple times on the same or other input stick within the same mode will cause the axis to not be able to be moved. An axis can only be selected for a single input per mode, not multiple.

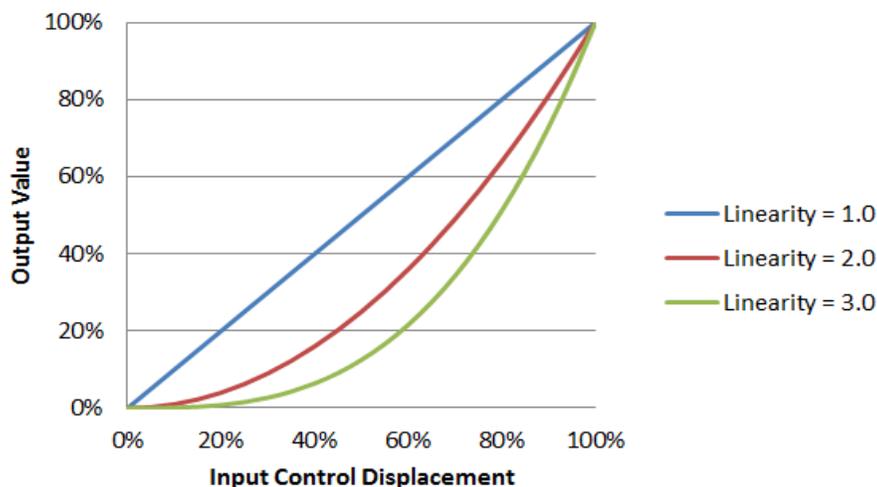
4.4.2. Invert

The invert checkbox allows you to reverse the direction of inputs.

4.4.3. Linearity

Linearity allows you to gain more precise control over movements. Stick displacement is raised to the power of the linearity setting. Meaning, if Linearity is 2, a full deflection of the stick would result in a value of 100%. If only moved half the distance (Between full deflection and dead zone) the resulting value would be 50% to the power of 2, or an output of 25% (Figure 4 – Linearity).

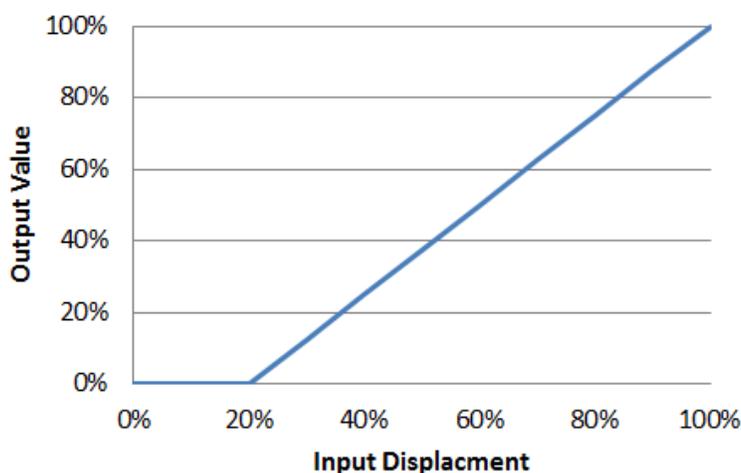
Figure 4 – Linearity



4.4.4. Dead zone

The analog inputs on the Xbox Controller have varying degrees of hysteresis, or slop. This means they do not necessarily return to true center. To remove the error this could cause, a dead zone value was implemented. Control outputs are not made until the dead zone value is exceeded. As seen below (Figure 5 - Dead Zone, 20%), the output is also scaled to be 0% at the dead zone value and 100% at full deflection. When the output value is greater than 0%, the stick in the preview image will be highlighted.

Figure 5 - Dead Zone, 20%



4.4.5. L-R / U-D Value

These are the display of the current controller input values with Linearity and dead zone applied.

4.5. *Left and Right Trigger*

The left and right triggers are used to control feedrates and act as optional safety switches.

4.5.1. Safety

The Safety dropdown boxes allow you to select how the safeties operate. This configuration setting allows you to lockout certain function unless the corresponding trigger is squeezed. For instance, if the safety is selected as “Button”, pressing a button on the controller will do nothing unless the trigger is depressed. This works equally as well for the thumb sticks, where if “Stick” is selected, the controller cannot cause an axis to move unless the trigger is depressed. Additionally, the safeties can be set to “Buttons and Sticks” which

will not allow the controller to perform any actions unless the trigger is depressed.

WARNING

Setting both Left and Right safeties to the same values causes either or both triggers to allow activation. They do not both have to be depressed at the same time for activation to occur.

CAUTION

Controller Mode selection is not affected by any safety setting and a mode change will occur anytime the gamepad is depressed.

4.5.2. Feed Percent

Feed percent sets the federate of the system in percent of max axis velocity (Set in motor tuning within Mach). This is the feedrate that will be used when the trigger is fully depressed. An intermediate value will be used if the trigger is only partially depressed. If both triggers are depressed at the same time, the system will take the greater of the two as the desired feedrate.

4.5.3. Linearity

Linearity act the same for the triggers as it does for the thumb sticks.

4.5.4. Dead zone

Dead zone on the triggers operates identically to that on the thumb sticks.

4.5.5. Value

Value displays the current output of the trigger with Linearity and dead zone accounted for.

4.6. Buttons

The Buttons section allows you to configure the function to be performed when one of the eight available buttons is pressed. In the dropdown list you will find a list of predefined functions. These are self-explanatory, such as “Zero All” or “Stop” which usually have a corresponding button on your Mach screens. If a function you desire is not available in this list, you can define a custom OEM code or Macro.

4.6.1. Macros

Selecting Macro from the dropdown list will enable a number box adjacent to it. Input the desired macro number 0-9999 that you would like run when that button is pressed. This is the same functionality you would have by entering M#

(# = you macro number) into the MDI line. Please see Mach documentation for how to write and implement macros in Mach.

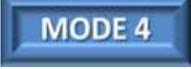
4.6.2. OEM

An OEM code is a code built into Mach to execute a given function. There are a large range of functions available. Selecting OEM from the dropdown list will enable a number box adjacent to it. Input the desired OEM number 0-9999 that you would like run when that button is pressed. Please see Appendix A – OEM Codes for available OEM functions.

5. Status Screen

The Status Screen is your visual display of the current state of the controller. It shows you two things, the current mode of the controller (Top Block) and the state of the controller's power (Bottom Block).

Table 1 - Satus Screen

Mode Display		Battery Display	
	Not Connected		Not Connected
	Mode 1		Battery < 25%
	Mode 2		Battery 25%-50%
	Mode 3		Battery 50%-75%
	Mode 4		Battery 75%-100%
			Wired Controller
			Unknown

The plugin stores the last location of the Status Screen at shutdown. When Mach loads, it will restore the location of the screen automatically to the last known position. You have two options for this screen. You can turn it off by unchecking the Show Status checkbox (1) and you can change its transparency (2). All settings are automatically restored to their last value at the start of each session.



6. Modes

Four modes are selectable by the user via the controller. Each mode can be configured to control the machine in different ways. For instance, Mode 2 could be set to only effect the X axis, Mode 3, the Y, Mode 4, that Z and so on. In this way you can expand the I/O capabilities of the controller four times and you gain a greater level of control over your CNC system. Modes are configured via the Plugin Config screen and during operation are selected using the 4 way gamepad on the controller. When you press the gamepad, either up, down, left or right, it will select the corresponding mode and vibrate a given number of times (Table 2 - Gamepad Mode Selector).

Table 2 - Gamepad Mode Selector

	Gamepad	Vibrate		Gamepad	Vibrate
Mode 1		Once	Mode 3		Three Times
Mode 2		Twice	Mode 4		Four Times

The selected mode will be reflected on the Status screen and remains in effect until changed. Mode is volatile and reset to mode 1 on Mach reboot.

7. Conclusion

Hopefully this document introduced you to the XboxShilling plugin to a level at which you can now begin to experiment. Please take care when using new settings and ensure the machine operates as expected before performing any critical tasks. The controller offers a wide range of functions and should provide a great deal of convenience to you and your machine operators. On initial startup all setting will be set to off or at their lowest state. Take some time when configuring to think through and plan how you will utilize your controller. Pick it up and feel how different moves and controls operate, something's will feel more natural than others.

Appendix A – OEM Codes

OEM Codes: 1-132					
Description		Code	Description		Code
Screen 1 select(e.g. Program Run screen)		1	Flood toggle		113
Screen 2 select (e.g. MDI screen select)		2	Mist toggle		114
e.g. Toolpath screen select		3	Edit G-code		115
e.g. Positioning screen select		4	Zero radius DRO on X		116
e.g. Diagnostics screen select		5	Zero radius DRO on Y		117
e.g. Corrections screen select		6	Zero radius DRO on Z		118
e.g. Tables screen select		7	Software limits		119
Inc Inc		100	Touch button for Tool length offset		120
Inc Inc D		101	Tool Tab Save		121
Reset Int		102	Fixture Tab Save		122
Jog mode toggle		103	Torch Enable Toggle		123
Goto Safe Z		104	Torch Cal Zero		124
Home Z then X then Y, A, B		105	Enc Load X		125
Units		106	Enc To X		126
Mach coords		107	Enc Load Y		127
Feed raise		108	Enc To Y		128
Feed lower		109	Enc Load Z		129
Spindle CW, reset THC height		110	Enc To Z		130
Slow Jog Up		111	Toggle Mill/Turn mode		131
Slow Jog Dn		112	Tool Path Toggle		132
OEM Codes: 133-172					
Description		Code	Description		Code
Zero X Encoder		133	reserved		153
Zero Y Encoder		134	reserved		154
Zero Z Encoder		135	Units/rev - Units/min toggle		155
Tool Offset Tog		136	Set this line as next to execute		156
Fixture Off		137	Jog Follow		157
Go Home		138	Joystick ON		158
Part X Offset Touch		139	Joystick OFF		159
Part Y Offset Touch		140	Regen toolpath display		160
Part Z Offset Touch		141	Zero X-Z to stock as defined in DROs (Turn)		161
Part A Offset Touch		142	Coordinate mode (G90/91)		162
Part B Offset Touch		143	Raise spindle speed		163
Part C Offset Touch		144	Lower spindle speed		164
Tool X Offset Touch		145	Laser Probe Enable Toggle		165
Tool Z Offset Touch		146	Zero laser grid at current location		166
Joy Throttle select		147	Z inhibit toggle		167
Touch Corr Enable Toggle		148	Ignore Tool Change toggle		168
Auto Lim Override Toggle		149	Close current file		169

OverRide Limits	150	Re-load last file	170
SS on Act4 Toggle	151	Jog increment cycle	171
reserved	152	Clear error label	172
OEM Codes: 173-213			
Description	Code	Description	Code
Spindle CCW toggle	173	Select Jog Increment 4	194
Parallel Port Encoder3 MPG Jog Toggle	174	Select Jog Increment 5	195
Cycle axis controlled by MPG 1	175	Select Jog Increment 6	196
Block Delete "switch" toggle	176	Select Jog Increment 7	197
Optional Stop "switch" toggle	177	Select Jog Increment 8	198
Offline toggle	178	Select Jog Increment 9	199
Display Abs Machine coordinates	179	Select Jog Increment 10	200
Display Work + G92 coordinates	180	Feed override Off	201
Display Work coords (i.e. not with G92)	181	Feed override Jog	202
??? Toggle Spindle actual	182	Feed override Feed	203
Home X, Home Z (Turn)	184	Jog mode Continuous (same as button 276)	204
Select X for MPG 1	185	Jog mode Step (same as button 275)	205
Select Y for MPG 1	186	Joystick On	206
Select Z for MPG 1	187	Joystick Off	207
Select A for MPG 1	188	Clear Z tool offset (Turn)	208
Select B for MPG 1	189	Clear X tool offset (Turn)	209
Select C for MPG 1	190	Set stock correction to Zero (Turn)	210
Select Jog Increment 1	191	Home X Home Z (Turn)	211
Select Jog Increment 2	192	Home X (Turn)	212
Select Jog Increment 3	193	Home Z (Turn)	213
OEM Codes: 214-253			
Description	Code	Description	Code
Show recent G-code files list	214	Output 4 OFF	234
Display history	215	Output 5 ON	235
Load G-code	216	Output 5 OFF	236
Tool flip toggle (Turn front/rear toolposts)	217	Output 6 ON	237
Z-inhibit ON	218	Output 6 OFF	238
Z-inhibit OFF	219	Set Help context	239
Port Bit-Test Set (diagnostic)	220	Def-Ref all axes	240
Anti-dive enabled toggle	221	Tangential toggle	241
THC Anti-dive OFF	222	Save XYZ to G59.254 work offset	242
THC Anti-dive ON	223	do G0G53 to G59.254 offset location	243
Flood ON	224	Move to G59.254 with midpoint selection	244
Flood OFF	225	Toggle Jog Mode through Cont/Step/MPG	245
Mist ON	226	Force Referenced on all axes	246
Mist OFF	227	CV feed toggle	247
Load Teach file	228	CV feed OFF	248

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Toolpath Machine/Job toggle	229	CV feed ON	249
Display Wizard selection window	230	Disable movement on axis X	250
Load the normal screens when Wizard done	231	Disable movement on axis Y	251
Simple Complex screen toggle	232	Disable movement on axis Z	252
Output 4 ON	233	Disable movement on axis A	253
OEM Codes: 254-293			
Description	Code	Description	Code
Disable movement on axis B	254	Select Step value 10	274
Disable movement on axis C	255	Set Jog mode STEP (same as button 205)	275
Machine Coordinates toggle	256	Set Jog mode CONT (same as button 204)	276
Engine OFFline	257	Increment feedrate	277
Engine ONline	258	Decrement feedrate	278
Select encoder jog on axis X	259	Run reverse	279
Select encoder jog on axis Y	260	Switch to last used Wizard	280
Select encoder jog on axis Z	261	Cycle axis controlled by MPG 2	281
Select encoder jog on axis A	262	Toggle taper mode on MPG 2	282
Select encoder jog on axis B	263	Toggle dual MPG flag	283
Select encoder jog on axis C	264	Toggle shuttle mode for MPG	284
Select Step value 1	265	Return to paused state	285
Select Step value 2	266	Remember paused state	286
Select Step value 3	267	Toggle override of rapid feeds	287
Select Step value 4	268	Crop current dwell now	288
Select Step value 5	269	??? Set formlas	289
Select Step value 6	270	Inhibit jog of X axis	290
Select Step value 7	271	Inhibit jog of Y axis	291
Select Step value 8	272	Inhibit jog of Z axis	292
Select Step value 9	273	Inhibit jog of A axis	293
OEM Codes: 294-333			
Description	Code	Description	Code
Inhibit jog of B axis	294	Push to jog A--	314
Inhibit jog of C axis	295	Calibrate MPGs	315
Do screw calibration routine	296	Save tool table	316
Unconditional crop any dwell now	297	Save work offset table	317
reserved	298	Drag on toolpath does Zoom toggle	318
Toggle bypass feed	299	Drag on toolpath does Pan toggle	319
Toggle current tool is in front toolpost	300	Display Wizard select dialog	320
Runs the macro in SetTriggerMacro	301	Run Newfangled Wizard	321
Cycle MPG jogging mode	302	Emergency bailout - tester use only	322
Set MPG jogging mode = Velocity	303	Toggle visibility of screen 50	323
Set MPG jogging mode = Velocity/Step	304	Turn mode tool touch off X axis	324
Set MPG jogging mode = do single exact steps	305	Toggle use of spindle step line to control Torch volts	325
Set MPG jogging mode = do multiple exact	306	Turn mode tool touch off Z axis	326

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steps			
Push to jog X++	307	Select MPG jog mode	327
Push to jog X--	308	unknown	328
Push to jog Y++	309	Push to Jog B++	329
Push to jog Y--	310	Push to Jog B--	330
Push to jog Z++	311	Push to Jog C++	331
Push to jog Z--	312	Push to Jog C--	332
Push to jog A++	313	Toggle axis DROs display Dist to Go	333
OEM Codes: 334-1031			
Description	Code	Description	Code
Toggle X jog off	334	Zero All	1007
Toggle Y jog off	335	Zero X	1008
Toggle Z jog off	336	Zero Y	1009
Toggle A jog off	337	Zero Z	1010
Toggle B jog off	338	Zero A	1011
Toggle C jog off	339	Zero B	1012
Set a temporary softlimit minimum at current location	340	Zero C	1013
Set a temporary softlimit maximum at current location	341	Feedrate reset	1014
reserved343 -	347	Estimate Job	1015
Turn off display of menu bar	348	Run from here	1016
Turn on display of menu bar	349	GotoZs	1017
Increment spindle speed by value not % (Turn)	350	Coord System	1018
Decrement spindle speed by value not % (Turn)	351	Verify	1020
Jog X and A axis ++ together (foam machines)	352	Reset	1021
Jog X and A axis -- together (foam machines)	353	Ref X	1022
Jog Y and A axis ++ together (foam machines)	354	Ref Y	1023
Jog Y and A axis -- together (foam machines)	355	Ref Z	1024
Cycle start	1000	Ref A	1025
Pause (Feed Hold)	1001	Ref B	1026
Rewind	1002	Ref C	1027
Stop	1003	Joystick Toggle	1028
Single	1004	Softlimits Toggle	1029
Resume	1005	Radius Tracking Toggle	1030
Edit File	1006	Jog Toggle	1031