Plasma Table Control Refit Requirements
20/09/15

Purpose

This document describes the functional requirements for a new controller to be refitted to an existing plasma table. The description will be as generic in nature as possible.

Documents

Torchmate 2 Bolt Together Assembly Instructions.pdf
Gecko G540 REV8 Manual.pdf
Mesa Electronics thcadman.pdf

Reused Mechanics and Structure

The table to be refitted is a much modified Torchmate 2 bolt together with a 48” by 48” cutting area. The table is now fitted with a water box to catch dross and debris from cutting. The water box is drained into a storage tank between uses.

The X axis is now driven from both sides of the gantry. The X axis drive racks (24 DP) have been moved from the inside surfaces of the structure to the outside surfaces. Each gantry side is driven by a 1” PD spur gear attached to the output of a 5:1 planetary gear reducer. The gear reducer is powered by 600oz/in, 3.5A, 200 steps per revolution stepper motor. This gives a basic resolution of .0031416” per full step. The stepper motor is operated open loop. The present X axis is not equipped with Limit or Home switches. These may be added to allow auto gantry squaring when initializing the machine.

New freeside drive arrangement.

The Y axis is stock with the exception of the drive motor. The Y axis drive is a14.5˚ pressure angle 24DP rack. The Y carriage is driven with a .709” PD spur gear attached to a 3.42871:1 belt reduction. The belt reduction is driven by a 600oz/in, 3.5A, 200 steps per revolution stepper motor. This gives a basic resolution of .0032482759” per full step. The stepper motor is operated open loop. The present X & Y axis drives will be retained. The present Y axis is not equipped with Limit or Home switches.

The present Z axis is part of a Torchmate AVHC system and will be replaced by an as yet unbuilt Z axis drive. The new Z axis drive will be driven with a 5mm (.19685”) pitch ball screw. The ball screw will be directly coupled to a 495oz/in, 3.0A, 200 steps per revolution stepper motor. This gives a basic resolution of .00098425” per full step. The Z axis will be fitted with Limit and Home switches.

The present stepper motor electronic driver is a Gecko G540 that is powered with a 48VDC switch mode power supply capable of delivering 10A continuously. The new controller should be able to reuse the present drive electronics. If a KFLOP based system is used it should be designed such that it can use the Gecko G540 or a KSTEP board for stepper driver.

New Controller General Requirements

The new controller will be PC based with or without an external motion controller. The new controller will accept normal RS-274 NGC ASCII text files as input. Example post processors for SheetCAM and Inkscape (Gcodetools) should be available for the controller. The function of the new controller will not be adversely affected by the controller being attached to a network either through a cable or WIFI. The controller will support OS native graphical file browsing and manipulation. Controller will not be adversely affected by having other applications open at the same time, examples Calculator, File Browsing, pdf file viewing, and a text editor. The Graphical User Interface (GUI) must be capable of being modified to support plasma table and plasma torch height control exclusively (dedicated controller). The controller software will be able to be modified to support automatic torch height control without the need for an external dedicated controller. The three most likely choices for the controller are LinuxCNC with a Mesa 5I25 card, KmotionCNC with a KFLOP Card, and UCCNC using either a UC100 or UC300 module.

The new controller will have a remote control pendant that can be positioned near the plasma table for setup. The interface between the controller and the pendant can be any of the common serial communication types. The pendant will allow jogging of all axis at a minimum of 3 preset speeds and at 4 single step resolutions settable at the pendant. Continuous or single step control will be settable at the pendant. The pendant will have Feedhold and E-Stop switches.

The human interface will be classic PC controls, keyboard, mouse (track ball, touch pad, joy stick) and video monitor. The hardware interface for the keyboard and mouse will be USB based. The controller will use generic video hardware and not require a specific video card and drivers. The video monitor used with the controller will be 17” diagonal measure or larger. The minimum screen resolution will be 1024 X 768 pixels.

The motion planner in the new controller will support continuous contouring by joining together small Gcode segments into long continuous motions. The continuous contouring will not be interrupted by S, F and M codes that do not require axis movement to stop.

The new controller will support custom user M codes.

The new controller will provide galvanically isolated I/O to the plasma power supply. This can be done with an external interface assembly. The control will provide a Start (Start Plasma) output which is typically a dry contact closure or opto isolator that can withstand unregulated 24VDC open circuit. The control will receive a Transfer (Arc Ok) input which is typically a dry contact closure.

Machine motion will stop and an error message will be displayed on loss of Transferred (Arc Ok) signal during cutting.

The material probing control (plate find) will check for reasonable user adjustable Z position. In the event that that Z position is outside the user adjustable range the torch will not be allowed to fire and an error message will be displayed. The probing control will use ohmic (conductive) sensing for the plate surface. The probing will use a Z axis “floating torch” switch for failsafe detection of torch to plate contact. The probing control will test the ohmic (conductive) sensing for a contact condition (shorted or wet) prior to starting a probing cycle and stop then display an error message if found. The probing circuit will be disconnected from the torch and the plate with a relay while cutting.

Torch Height Control

The new control will have integral control of the Z axis for torch height control. The new controller will use a Mesa Electronics THCad board to measure the plasma arc voltage. The THCad interface is a RS-422 signal level frequency modulated representation of the arc voltage. The use of a custom interface for the THCad is acceptable. The frequency (rate) of the arc voltage feedback signal will be read over a period greater than 8ms to allow a minimum of 12bits resolution. The THC will allow user calibration of arc feedback voltage offset and scale. The response speed of the THC will be user adjustable through either the main Z axis control functions or the THC. The THC will have user adjustable “Tip Saver” (arc feedback voltage and rate limiting) and “Antidive” (horizontal feedrate control of torch height also known as corner lockout) functions. The THC will allow user adjustment of the number of arc feedback voltage samples used as a running average for torch height control. The THC will have user adjustable pierce delay setting from 0 to 5s in .01s steps. The THC will have pierce height and initial cut height set points between 0 and .5" with a maximum step size of .005". The THC will have user adjustable torch height servo delay between 0 to 5s in .1s steps. The THC will have the arc voltage set point minimum range of 100V between 50V and 150V with a step size of 1V.

The THC will be able to hold the torch height to better than +/- .005" maximum deviation for a given arc voltage set point. This works out to the arc voltage servo holding approximately better than +/-6.5V for the Finecut (.06" height and 75V) consumables and +/-11.25V (.06" height and 135V) for 45A and 60A consumables on carbon steel.

The THC arc voltage servo will have a minimum update rate of 25hz (.04s period). The THC arc voltage servo will be implemented with both Proportional (P) and Integral (I) terms minimum. The P and I gains will be user adjustable. The I term will have a user adjustable "anti windup" maximum value.

Controller GUI Requirements

The GUI will be the main user interface to the control for all operational and routine setup tasks. The user will interact with the control using a USB keyboard and USB pointing devise. The GUI will use a standard OS native window for the OS type, controls and message boxes. The GUI will have 5 main display areas. The first will be a graphical representation of the cut area (plotter). The second is the G code display/editor area. The Third is the DRO display area for all three axis. The forth will be an area with tab selected functional content. The fifth area is for status machine indicators. The indicated display area sizes are for reference only to give an idea of the desired proportions and do add up to over 100% of the display area.

The graphical representation of the cut area (plotter) will take up approximately 3/8 of the display area. The extent of the cut should be clearly identifiable. Different line colors or types will be used to distinguish between planned cuts (preplot), rapid movement and completed cuts (backplot). Crosshairs will be displayed and synchronized with the active line in the Gcode viewer/editor display area. The cut area graphics are only required to display a plan view of the XY plane, other additional views are acceptable. The user will have full Zoom and Pan control over the displayed area. When jumping to a new line in the Gcode display/editor the crosshairs will track the scrolling through the Gcode listing.

The Gcode display/editor will display in an OS native text editor style. The display will be at least 5 lines in height and 25 characters wide. Display panning will support the reading of long lines and scrolling through the file. When the control is off line the display will support OS native basic editing of the active Gcode file. Full OS native file browsing will be supported for file selection and saving. The Gcode display/ editor will take about 1/8 of the screen area. The active Gcode block will be highlighted in reverse video.

The DRO display area will display the torch position for the X, Y and Z axis. The X and Y DROs will also display the distance to go during all moves. The text color of the DROs may be used to indicate machine state and/or axis status or errors. The DROs will indicate whether the axis is in absolute or incremental mode. The Z axis will have use the milling machine standard (Z+ moves up away from work piece) of machine Z zero being the top of the axis travel. Z home will be at machine Z zero. The feedrate display and feedrate override controls will be part of the DRO display area. The arc voltage and arc voltage setpoint will be part of the DRO display area. The DRO will take about 3/16 to ¼ of the display area.

The Tab selected function area will be about ¼ of the display area. Tabbed areas will be provided for Gcode execution control (cycle and feed hold buttons), Axis Jogging, MDI, THC setup (multiple levels), Auxiliary Functions (outputs), Point Moves and Homing if fitted.

The remainder of the display area will be used to monitor the status of the I/O bits and processes required for operation. The minimum required displays are: Torch Enabled (logic), Torch On (output), Arc Ok (input), Touch Probe State (input), Floating Torch Switch State (input), THC mode (logic), THC ON (logic), Corner Hold ON (logic),