Calibrating a new servo motor control card on the Bridgeport EZ-TRAK mill.

John Hawkinson, <jhawk@MIT.EDU>

20 March 2003

1 Overview

These are the instructions I used replacing the servo motor controller card on the Bridgeport EZ-TRAK II milling machine at the Edgerton Center Student Shop in March 2003. There are at least two different kinds of servo controller cards in those mills, and they are not compatible.

DISCLAIMER: Don’t trust these instructions; we take no responsibility for anything that might happen to your mill, etc., etc.

2 Vendor Documentation

The Bridgeport service manual contains a summary of Bridgeport’s instructions on calibrating the servo card (Section 6: AXIS DRIVES), as well as the Original Equipment Manufacturer (OEM)’s documentation for the servo card (Section 7: XXX?). While inadequate, that documentation is well-worth review prior to this procedure.

3 Tool requirements

You should have an AT-style keyboard (mini-DIN connector), as well as tool suitable for adjusting potentiometers (preferrably an insulated screwdriver – “tweaker”).

4 Undocumented information

4.1 Keyboard

You can plug in the keyboard directly to the keyboard socket on the mill controller. Simply open the controller cabinet, disconnect the original keyboard cable, and plug in your keyboard.

4.2 DOS prompt

It’s not clear that it is necessary to access the DOS prompt as part of this procedure, but it can be handy. One way to get there is to hit CTRL-BREAK or CTRL-C as the software is booting. If you do this, in order for the mill software to operate properly, it is necessary that the TSRs in AUTOEXEC.BAT be loaded. So you’ll probably have to load them by hand.

Alternatively, when the EZTRAK software executes other sub-programs, you can hit CTRL-BREAK. This ensures that the software is properly loaded. A suitable sub-program is the Communications option in the Utilities (9) menu.
4.3 “System Terminal”

In the Bridgeport documentation, there are various vague references to the “System Terminal.” This refers to a menu of a hidden program called PFM.EXE (Parameter Function Manager?). PFM can be started either directly from the DOS prompt (`PFM`), or it can also be accessed through the EZTRAK software through a hidden function: select Utilities (9), then enter *, and enter the password 51443 ENTER, and then enter 1 to select the PFM program.

Once in PFM, choose the “Tuner” option to reach the “System Terminal.”

5 A note on the pots

The pots on these cards don’t have hard limits. Instead they click when you reach the limit. Keep this in mind.

6 Before you begin (DIP switches/configuration)

If you’re replacing a card, make sure that the new card is configured identically to the old card. In particular, there’s an array of 10 DIP switches that needs to match – all should be off except for positions (XXX?) 5 and 8, which are on.

Also, it is necessary to set the TEST/OFFSET switch (position 10) to ON for the initial portion of the procedure.

7 Voltage adjustment

Refer to page 6-32 of the Bridgeport documentation (reproduction of the OEM documentation).

1. With the power off, begin by setting TEST/OFFSET to on.
2. Disconnect the motor from the servo card. This is generally easiest at the motor end.
3. Power up the machine.
4. Go to the System Terminal.
5. Verify drive power is off and the servo cards all have red lights.
6. Enable power to the drives with F7.
7. Verify drive power is on and the serve cards all have green lights.
8. Measure the DC voltage to the motor on the servo card; it may be as high as hundreds of volts.
9. Adjust pot #4 (offset/test) until the voltage falls off; it will probably read as zero. The OEM documentation suggests adjusting for “minimum” voltage. We adjusted it about one turn counterclockwise past the point where voltage fell to zero.
10. Power down the mill.
11. Connect the motor.
12. Power up the mill, ensure the motor seems to be behaving normally (i.e. no shorts) when powered (F7).
13. Revert the TEST/OFFSET switch to OFF.

8 Single axis tuning/calibration.

Refer to page 6-1 of the Bridgeport documentation.

Initially, we found that the gain settings were such that the axis in question moved with heavy jerks and oscillated around its target position by about 1 inch. No single pot adjustment was sufficient to clear the problem, so we adjusted down both pot #1 (loop gain) and pot #2 (ref gain) until the behavior stopped. We then proceeded with normal calibration.

When the Bridgeport documentation refers to “following error,” this is the POS-ERR (positional error) field in the System Terminal.
FERROR.TXT is the “Following Error” program, which simply slews all axis motors simultaneously to the full limit of their travel, and then back again, continuously.

Procedure:

1. Adjust the Current Limit (pot #2) for maximum. Note that the pot is a 12-turn pot.
2. Power up the mill, go to the System Terminal.
3. Run the axis at maximum speed (100 IPM), and adjust the Reference Gain (pot#3) for minimum error. We found the easiest way to run the axis at maximum speed was to escape to DOS; copy TXTFILES\FERROR.TXT to TXTFILES\YERR.TXT; remove all references to axes other than the one under test (i.e. remove all Xnnn and Znnn directives); and then load and run the TXTFILES\YERR.TXT. To load a program, in the System Terminal, select Load Program (2), Reset program (3), Mode (4) Auto (A), and Cycle Start (5). You can stop the program with F7 (Drive off).
4. Stop the axis from moving (F7–drive off).
5. Adjust the Loop Gain (aka Current Gain) (pot #1); turn clockwise until the motor humms, and then turn back counterclockwise two full turns.
6. Adjust the Balance/Offset (pot #4) for minimum DAC-OFFSET in the System Terminal display. The DAC-OFFSET display is only updated after the axis moves, not during a move. I found it convenient to run the YERR.TXT program in Block mode (4) (B), repeatedly hitting (5) to start the next block. I would adjust the pot, run a block, check the DAC-OFFSET, and adjust again, etc.
7. You’re done. Proceed to setting the following error (below)

9  Multi-axis tuning (following error)

Apparently it’s important for the following error on both the X and Y axes to match [but not Z?].

1. Start at the System Terminal
2. Load and run TXTFILES\FERROR.TXT (see above)
3. Note which axis has the lowest POS-ERR.
4. Adjust that axis’ Reference Gain (#3) so it’s error matches the error of the other axis.

10  The End

Mill yourself a nice piece.