CNC Controller schematic Issues List

1) Driver IC CLOCK input improperly driven: The TB6560 uses the rising edge of the CLOCK input (not explicitly called out in IC spec except for "rising edge" symbol shown in one table). The slow turn off time of the opto-coupler combined with the passive pull-up resistor are insufficient and allow system noise to cause unstable driver circuit operation. Solution: Actively drive the CLOCK input using added 74HC14 IC as buffer.

1) Driver IC ENABLE input improperly driven: The opto-coupler for the ENABLE input is wired incorrectly having the npn emitter connected to supply. Although the circuit does function, the improper wiring of the npn will cause very low transistor gain opening the possibility of system noise corrupting the ENABLE signal. Solution: Rewire the npn of the opto-coupler with collector to supply and emitter to output.

1) Activity LED improper function: The activity LED circuit works properly when the STEP signal from the PC has high duty cycle (active low orientation). However, the TB6560 spec directly states that proper operation requires low CLOCK (e.g., STEP) signal duty cycle (or active high orientation). With active high orientation signal the activity LED remains lit even when the driver is not being 'stepped'. Solution: None.

1) Potential for Overheating of 12V Voltage Regulator: The cooling fan is fed directly from the 12V Vreg output adding significantly to the loading of the device. The 12V Vreg will shut down if it overheats protecting itself; such a shutdown would result in lost steps of an active motor. Solution: Power the cooling fan with an external supply or (with suitable step down circuit) from the stepper motor supply voltage directly.

1) System Not Optically Isolated: Despite having opto-couplers on all PC inputs and output, the controller does not properly implement optical isolation of the PC from the driver IC's nor from the stepper motor power supply. This is due to sharing of ground among all circuits. Solution: Assure PC and stepper motor power supply externally share the same earth ground.

1) Drive Current Manipulated by CLOCK/STEP signal: It appears that an attempt was made to implement a feature where the driver would reduce current to the stepper motors when the motors were idle. This was accomplished by pulling the drive current set input low when the CLOCK signal was active. And although the feature does work for current settings of 25% and 50%, the implementation has negative side effects that outweigh the feature usefulness:
- the feature departs from the reference design of the TB6560 reference spec resulting in the spec no longer accurately describing operation
- motors may be overdriven with higher than programmed drive current
- artificially raises the lowest current motor that the controller board can safely drive
Solution: Disconnect the non-spec circuit.

1) Operating Voltage Mis-information: The board is marked for input voltage “12v to 36v” but the IC spec indicates maximum operating voltage of 34V. But even that is probably not a safe operating point due to potential stepper motor generated voltage spikes. The controller board output diodes will clamp large overvoltage spikes when the diode breakdown voltage is reached, but the breakdown voltage is likely above the maximum voltage the driver IC can sustain without damage. Solution: Recommend limiting input voltage to 30v or less to provide margin of safety for operation.
CNC Controller 4-axis schematic
CNC Controller schematic (one axis shown)