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.

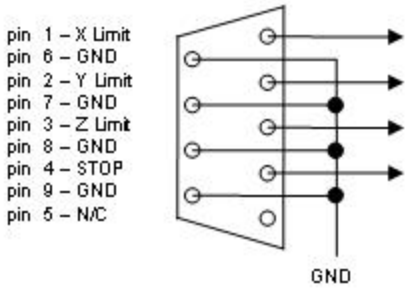
1) Drive Current Manipulated by CLOCK/STEP signal: It appears that an attempt was made to implement a feature where the driver would reduce current to the stepper motors when the motors were idle. This was accomplished by pulling the drive current set input low when the CLOCK signal was active. And although 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.

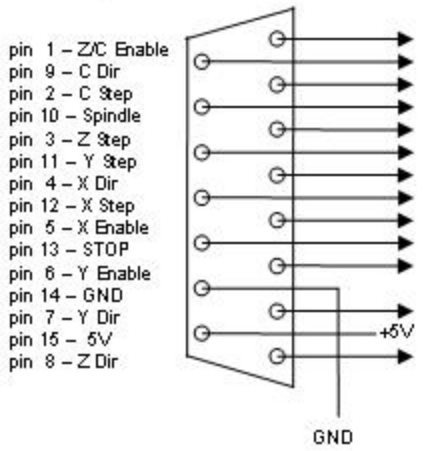
1) Operating Voltage Mis-information: The board is marked for input voltage "12v to 36v" but the IC spec indicates maximum operating voltage of 34V. But even that is probably not a safe operating point due to potential stepper motor generated voltage spikes. The controller board output diodes will clamp 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

din9 – sensors

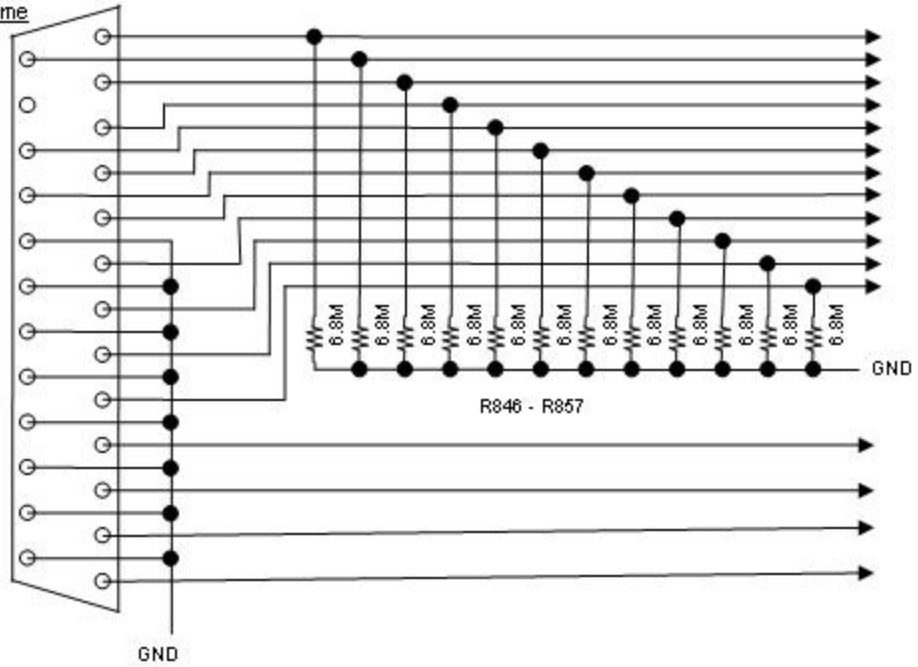


din15 – pendant / manual control

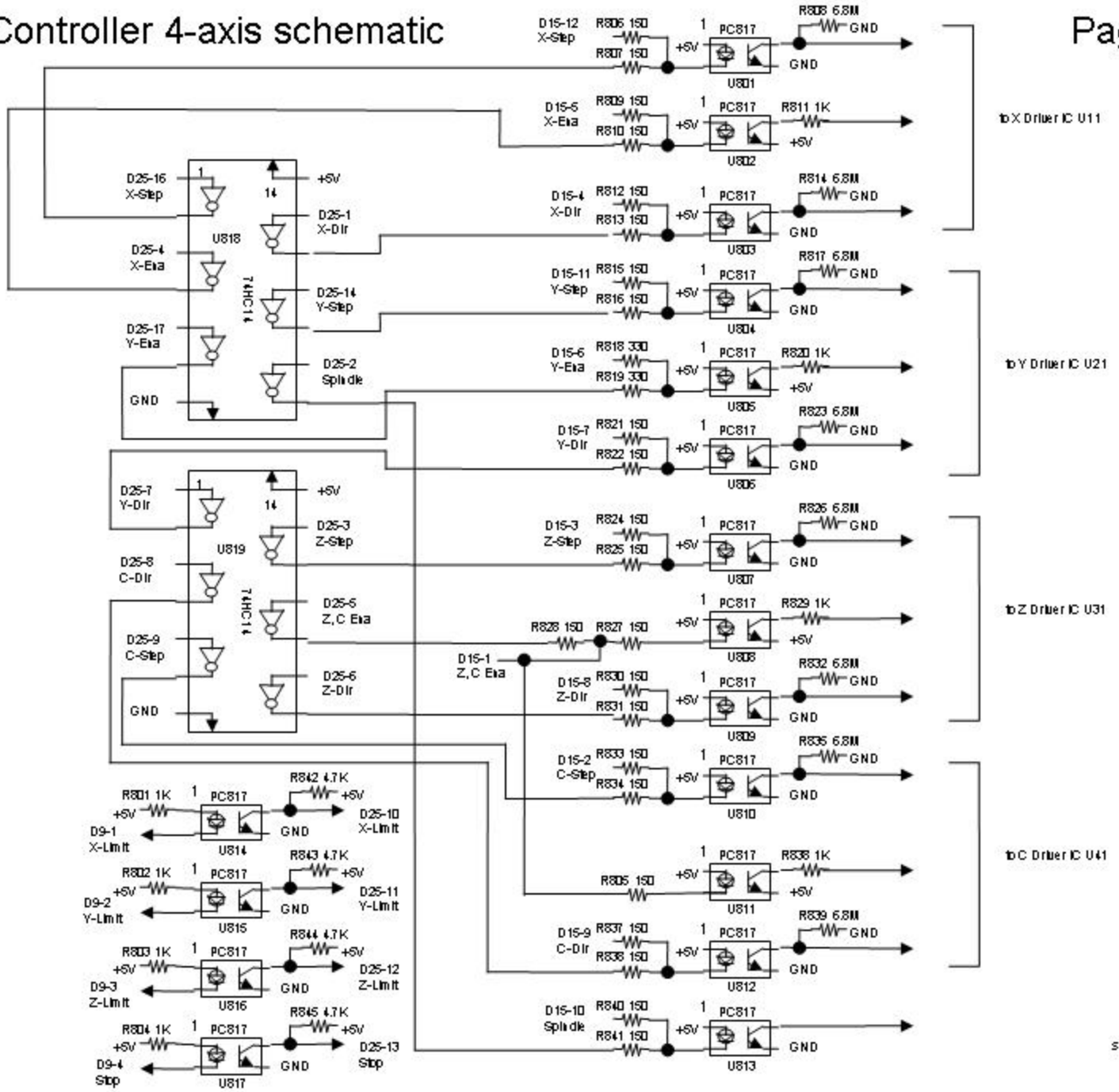


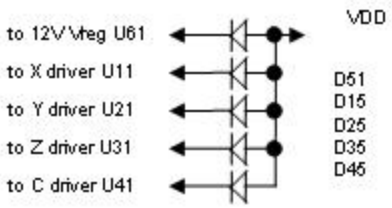
din25 – PC I/O

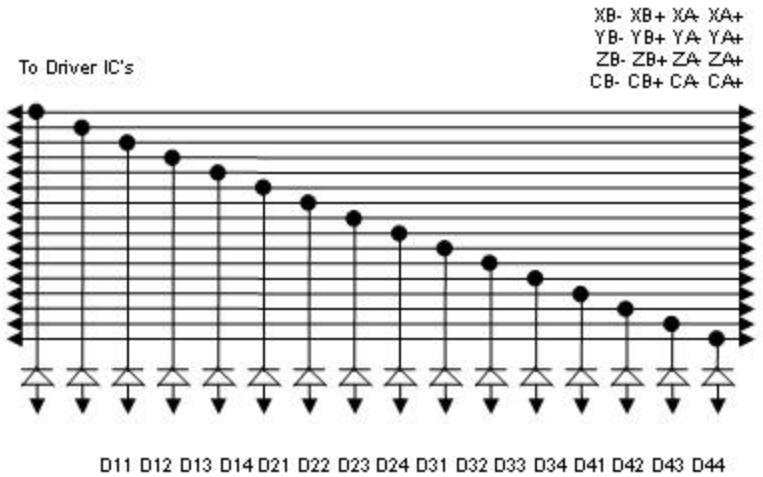
Function	LPT name
pin 1 – X Dir	C0
pin 14 – Y Step	C1
pin 2 – Spindle	D0
pin 15 – N/C	S3
pin 3 – Z Step	D1
pin 16 – X Step	C2
pin 4 – X Ena	D2
pin 17 – Y Ena	C3
pin 5 – Z,C Ena	D3
pin 18 –	GND
pin 6 – Z Dir	D4
pin 19 –	GND
pin 7 – Y Dir	D5
pin 20 –	GND
pin 8 – C Dir	D6
pin 21 –	GND
pin 9 – C Step	D7
pin 22 –	GND
pin 10 – X Limit	S6
pin 23 –	GND
pin 11 – Y Limit	S7
pin 24 –	GND
pin 12 – Z Limit	S5
pin 25 –	GND
pin 13 – STOP	S4

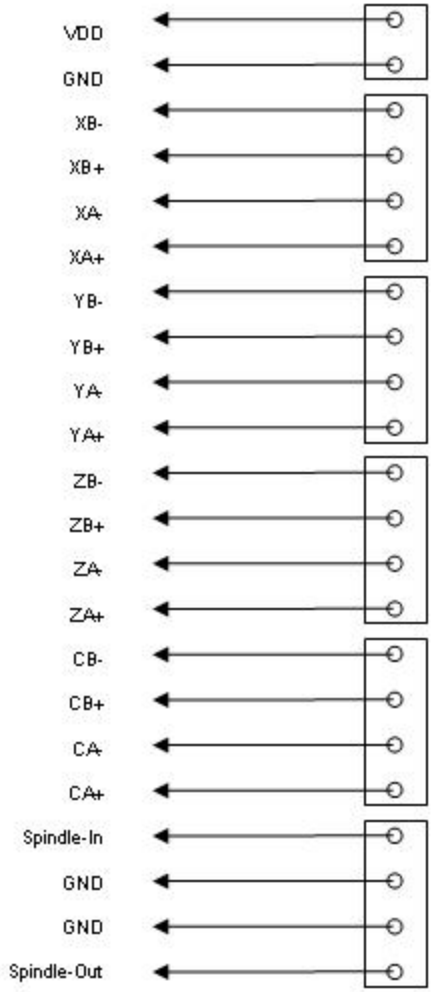


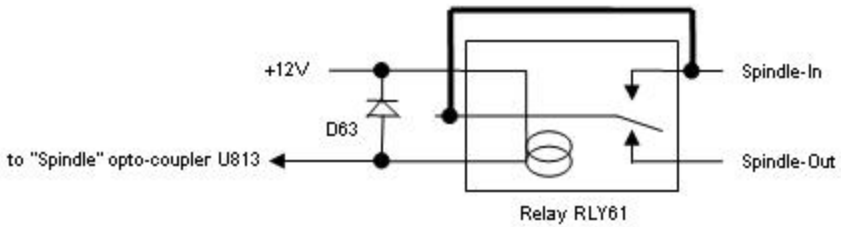
CNC Controller 4-axis schematic

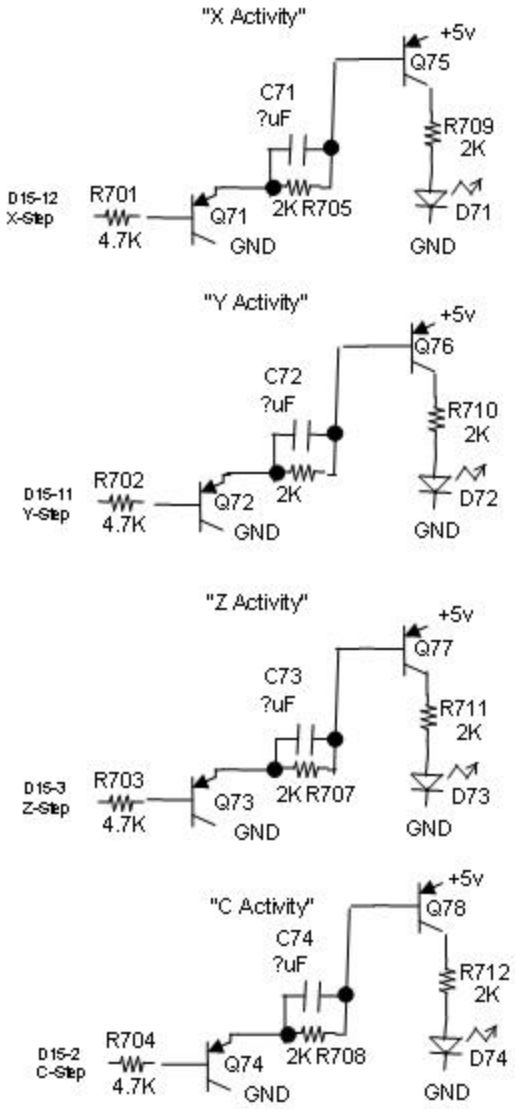


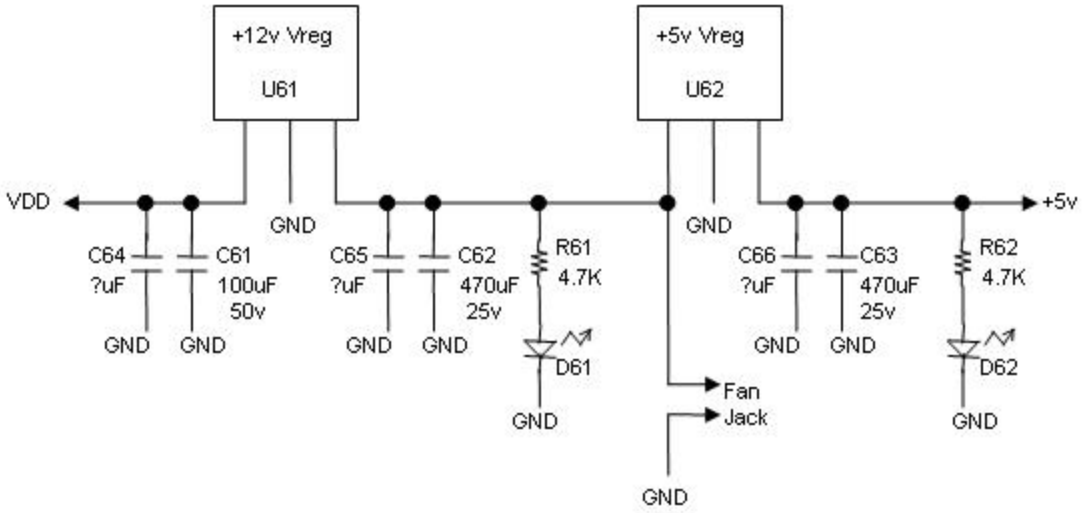

to 12V Vreg U61
to X driver U11
to Y driver U21
to Z driver U31
to C driver U41
VDD
D51
D15
D25
D35
D45

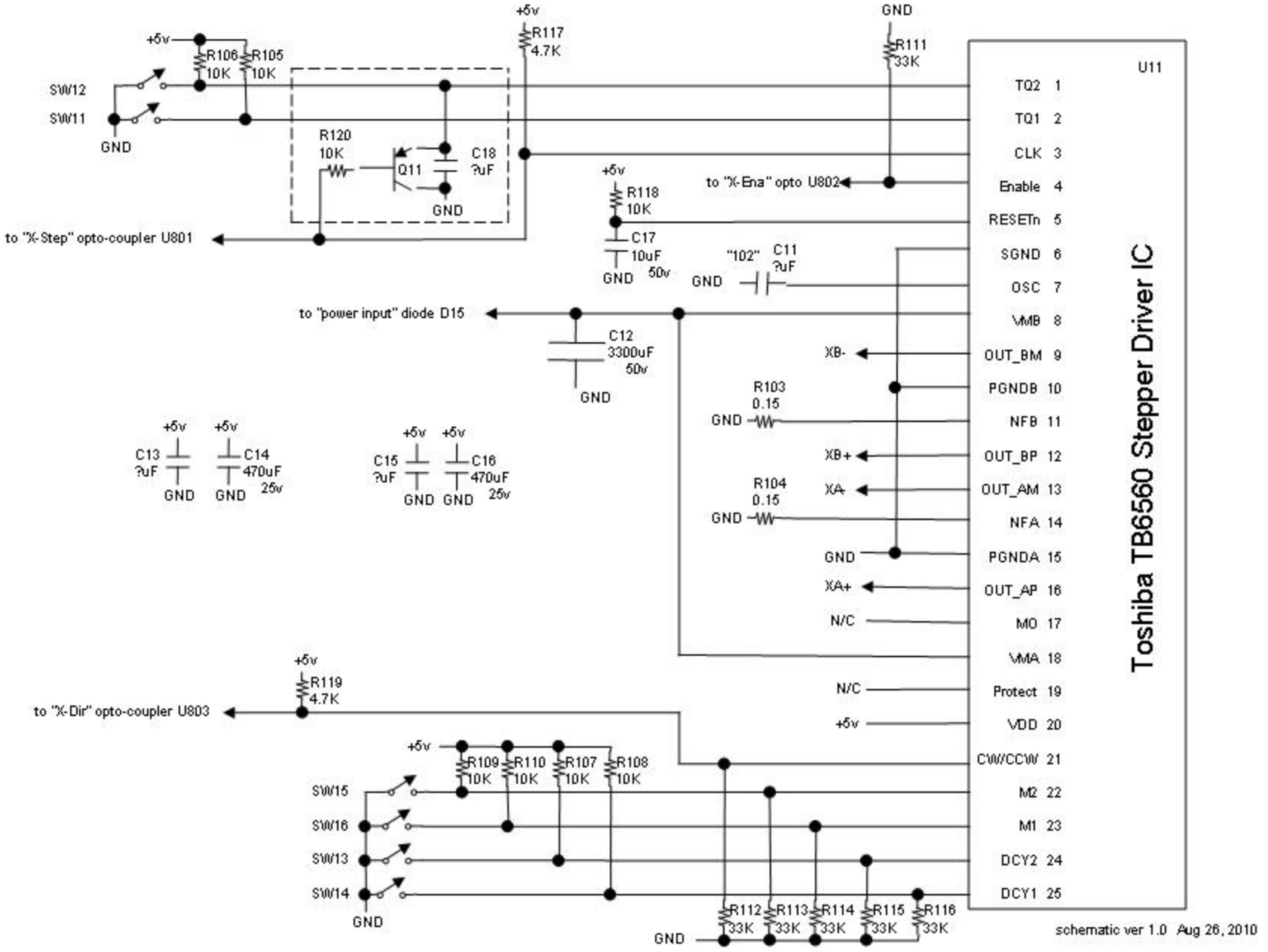

To Driver IC's
XB- XB+ XA- XA+
YB- YB+ YA- YA+
ZB- ZB+ ZA- ZA+
CB- CB+ CA- CA+
D11 D12 D13 D14 D21 D22 D23 D24 D31 D32 D33 D34 D41 D42 D43 D44

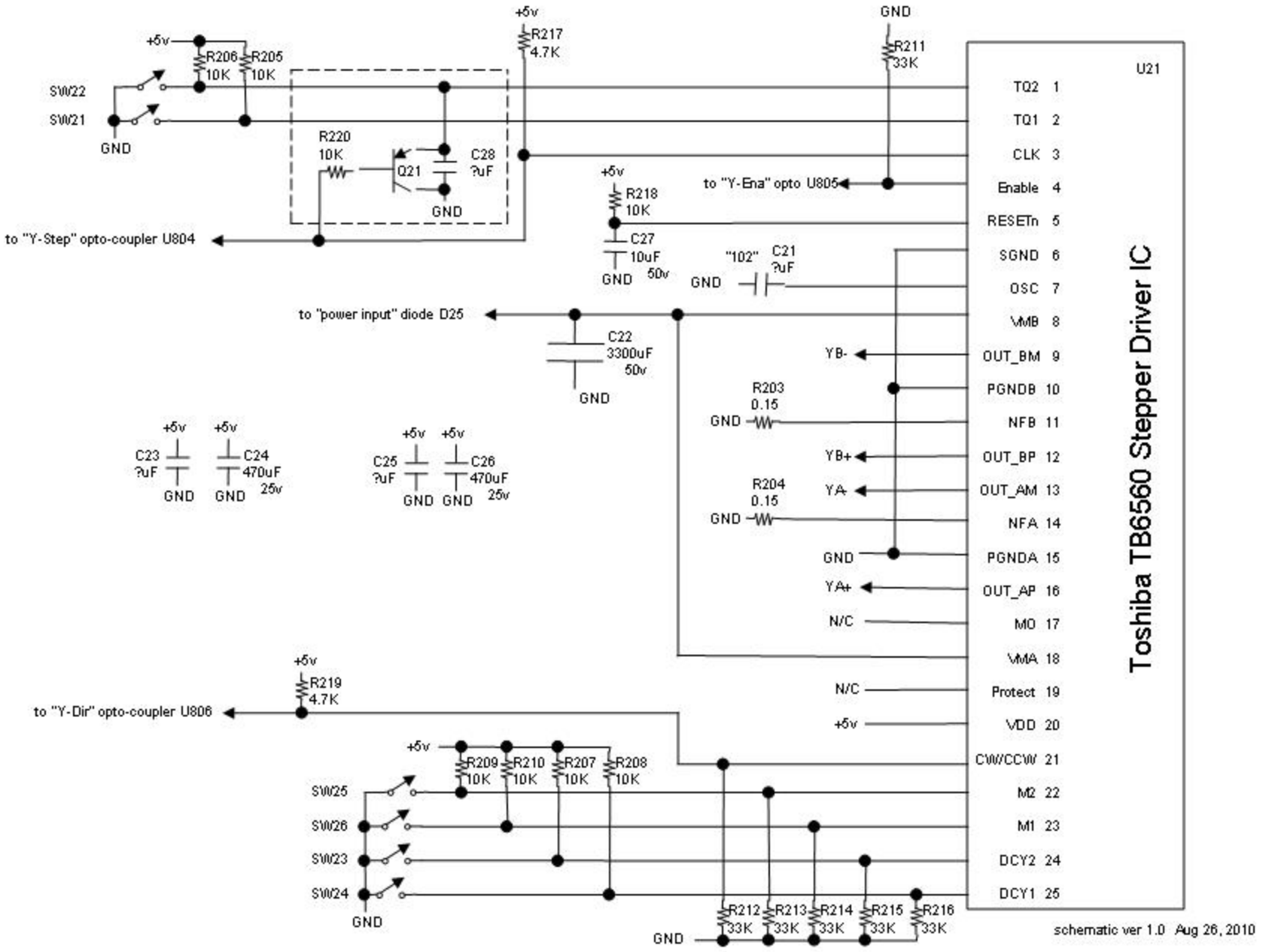

VDD
GND
XB-
XB+
XA-
XA+
YB-
YB+
YA-
YA+
ZB-
ZB+
ZA-
ZA+
CB-
CB+
CA-
CA+
Spindle-In
GND
GND
Spindle-Out

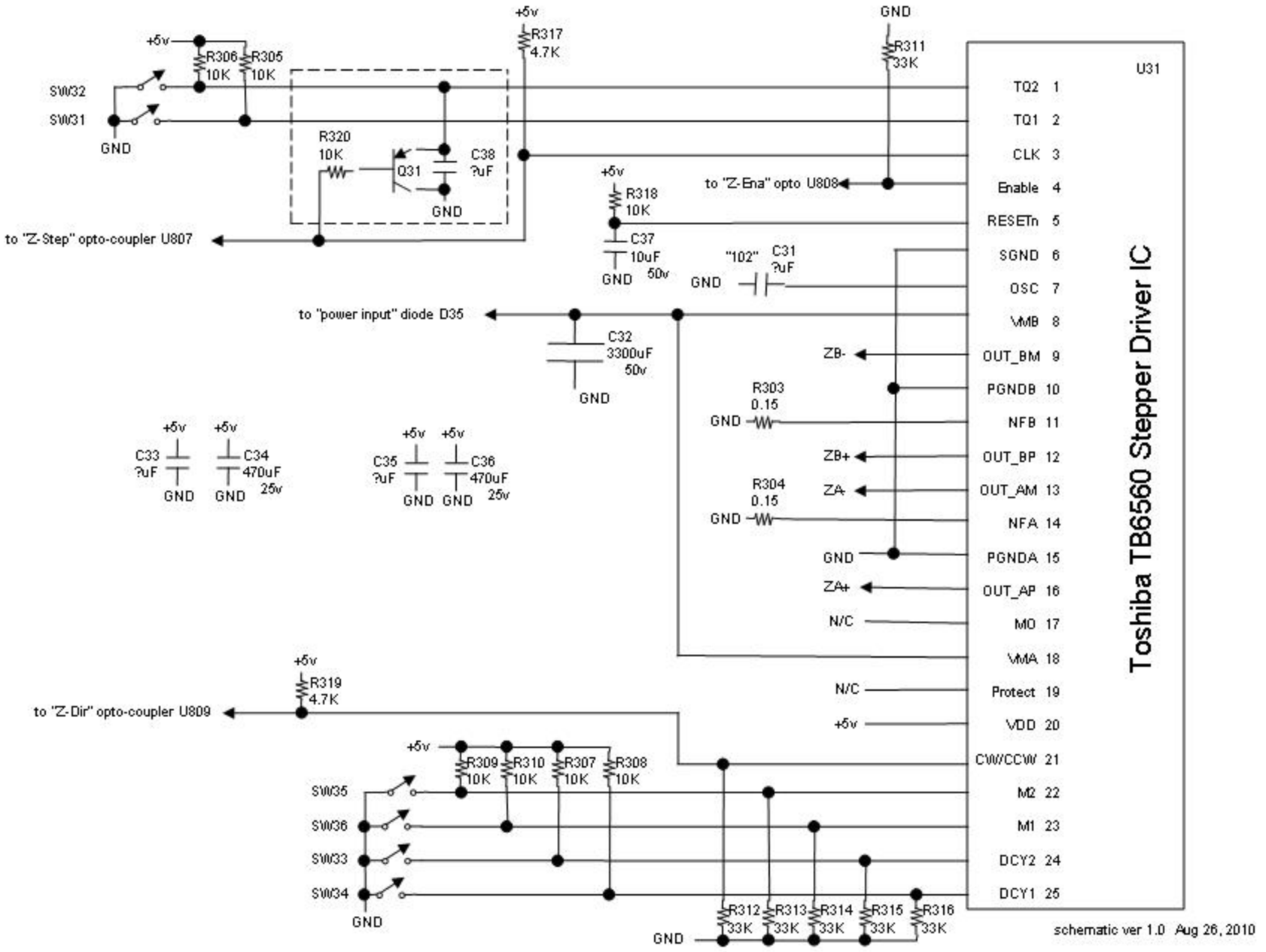

+12V
D63
to "Spindle" opto-coupler U813
Spindle-In
Spindle-Out
Relay RLY61

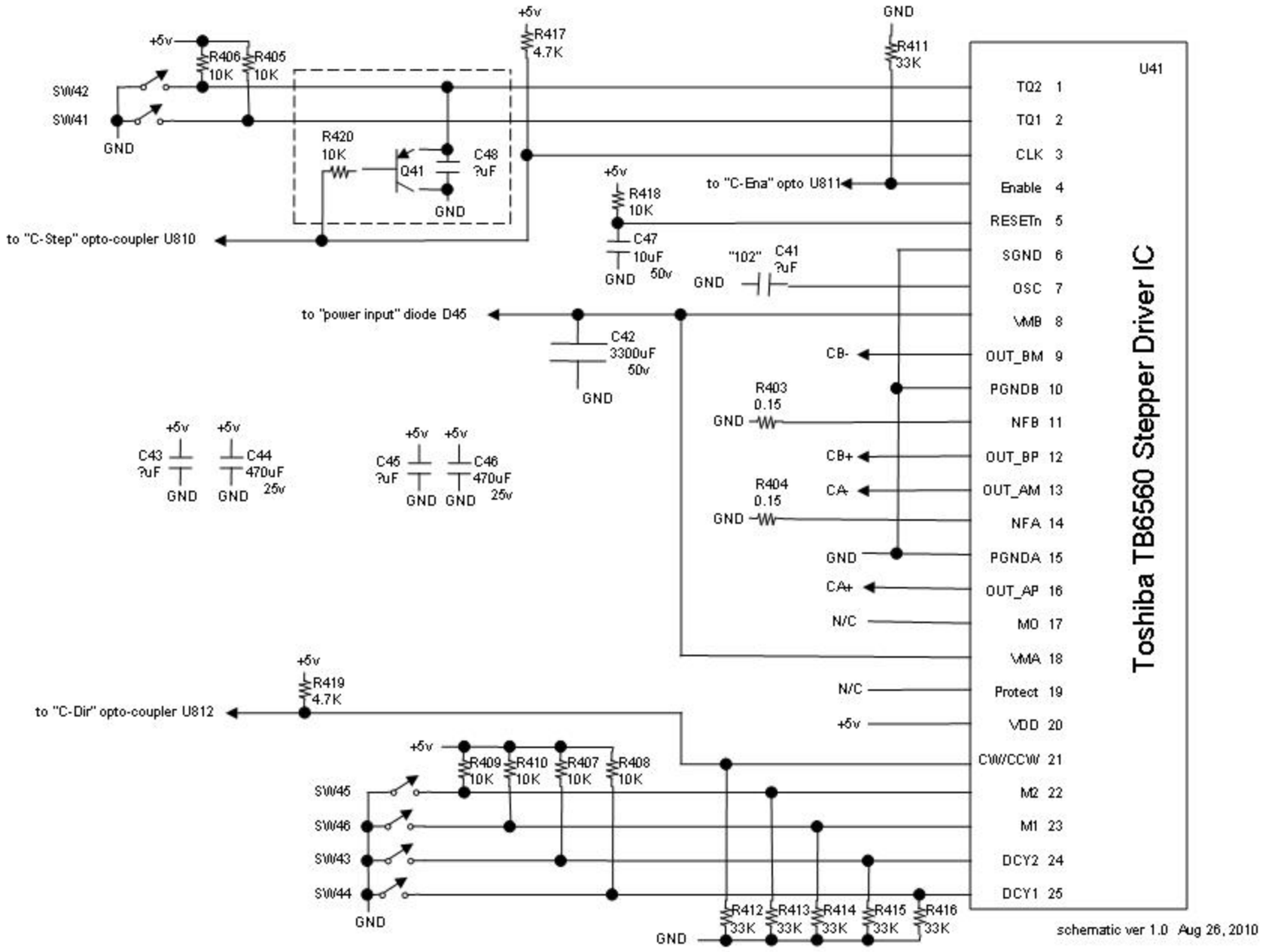

"X Activity"
+5v
Q75
C71
?uF
R709
2K
D15-12
X-Step
R701
4.7K
Q71
2K R705
D71
GND
GND
"Y Activity"
+5v
Q76
C72
?uF
R710
2K
D15-11
Y-Step
R702
4.7K
Q72
2K
D72
GND
GND
"Z Activity"
+5v
Q77
C73
?uF
R711
2K
D15-3
Z-Step
R703
4.7K
Q73
2K R707
D73
GND
GND
"C Activity"
+5v
Q78
C74
?uF
R712
2K
D15-2
C-Step
R704
4.7K
Q74
2K R708
D74
GND
GND


+12v Vreg
U61
+5v Vreg
U62
VDD
GND
+5v
C64
?uF
C61
100uF
50v
C65
?uF
C62
470uF
25v
R61
4.7K
D61
C66
?uF
C63
470uF
25v
R62
4.7K
D62
Fan
Jack
GND

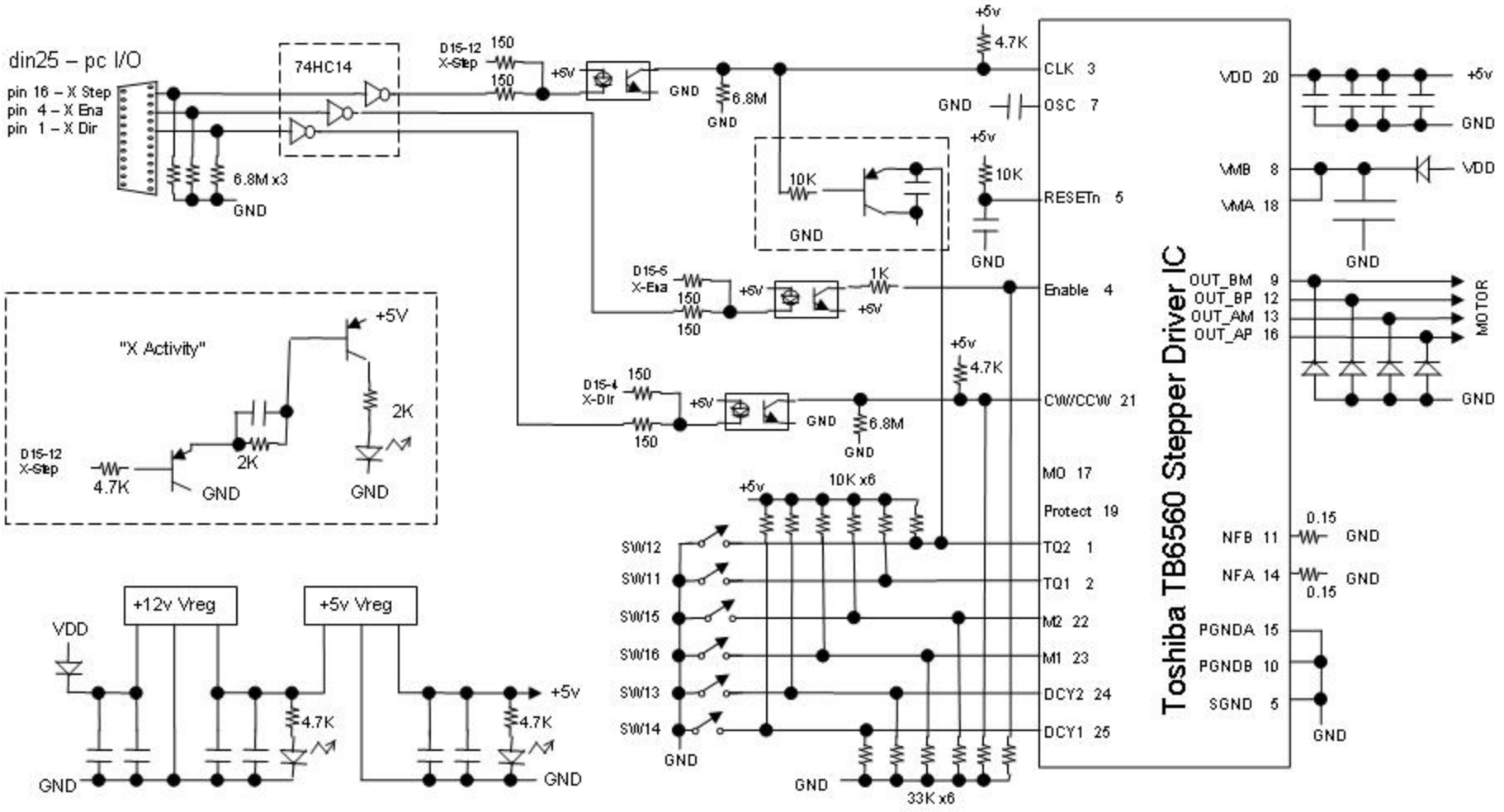

+5v
R106 10K
R105 10K
SW12
SW11
GND
R120 10K
Q11
C18 ?uF
GND
R117 4.7K
to "X-Step" opto-coupler U801
GND
R111 33K
U11
TQ2 1
TQ1 2
CLK 3
Enable 4
RESETn 5
SGND 6
OSC 7
VMB 8
OUT_BM 9
PGNDB 10
NFB 11
OUT_BP 12
OUT_AM 13
NFA 14
PGNDA 15
OUT_AP 16
MO 17
VMA 18
Protect 19
VDD 20
CW/CCW 21
M2 22
M1 23
DCY2 24
DCY1 25
to "X-Ena" opto U802
+5v
R118 10K
C17 10uF 50v
GND
"102" C11 ?uF
GND
to "power input" diode D15
C12 3300uF 50v
GND
XB-
R103 0.15
GND
XB+
XA-
R104 0.15
GND
GND
XA+
N/C
N/C
+5v
C13 ?uF
C14 470uF 25v
C15 ?uF
C16 470uF 25v
+5v
R119 4.7K
to "X-Dir" opto-coupler U803
+5v
R109 10K
R110 10K
R107 10K
R108 10K
SW15
SW16
SW13
SW14
GND
R112 33K
R113 33K
R114 33K
R115 33K
R116 33K
GND
Toshiba TB6560 Stepper Driver IC
schematic ver 1.0 Aug 26, 2010


+5v
R206 10K
R205 10K
SW22
SW21
GND
R220 10K
Q21
C28 ?uF
GND
R217 4.7K
to "Y-Step" opto-coupler U804
GND
R211 33K
U21
TQ2 1
TQ1 2
CLK 3
Enable 4
RESETn 5
SGND 6
OSC 7
VMB 8
OUT_BM 9
PGNDB 10
NFB 11
OUT_BP 12
OUT_AM 13
NFA 14
PGNDA 15
OUT_AP 16
MO 17
VMA 18
Protect 19
VDD 20
CW/CCW 21
M2 22
M1 23
DCY2 24
DCY1 25
to "Y-Ena" opto U805
+5v
R218 10K
C27 10uF 50v
GND
"102"
C21 ?uF
GND
to "power input" diode D25
C22 3300uF 50v
GND
YB-
R203 0.15
GND
YB+
YA-
R204 0.15
GND
GND
YA+
N/C
N/C
+5v
C23 ?uF
GND
C24 470uF 25v
GND
C25 ?uF
GND
C26 470uF 25v
GND
+5v
R219 4.7K
to "Y-Dir" opto-coupler U806
+5v
R209 10K
R210 10K
R207 10K
R208 10K
SW25
SW26
SW23
SW24
GND
R212 33K
R213 33K
R214 33K
R215 33K
R216 33K
GND
Toshiba TB6560 Stepper Driver IC
schematic ver 1.0 Aug 26, 2010

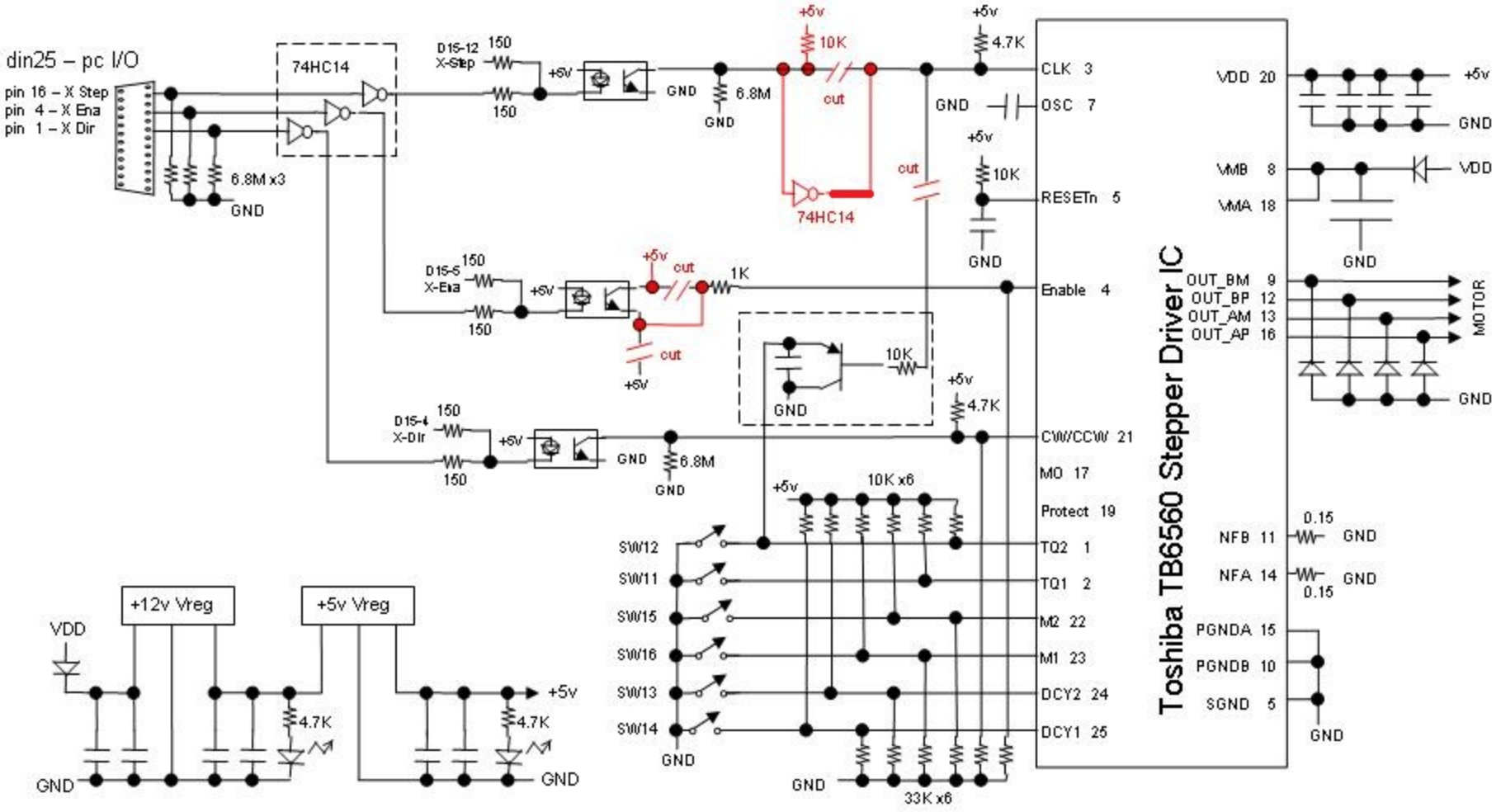

+5v
R306 10K
R305 10K
SW32
SW31
GND
R320 10K
Q31
C38 ?uF
GND
R317 4.7K
to "Z-Step" opto-coupler U807
GND
R311 33K
U31
TQ2 1
TQ1 2
CLK 3
to "Z-Ena" opto U808
Enable 4
+5v
R318 10K
C37 10uF 50v
GND
RESETn 5
"102"
C31 ?uF
GND
SGND 6
OSC 7
to "power input" diode D35
C32 3300uF 50v
GND
VMB 8
ZB-
OUT_BM 9
R303 0.15
GND
PGNDB 10
NFB 11
ZB+
OUT_BP 12
ZA-
OUT_AM 13
R304 0.15
GND
NFA 14
GND
PGNDA 15
ZA+
OUT_AP 16
N/C
MO 17
VMA 18
C33 ?uF
C34 470uF 25v
C35 ?uF
C36 470uF 25v
+5v
R319 4.7K
to "Z-Dir" opto-coupler U809
N/C
Protect 19
+5v
VDD 20
R309 10K
R310 10K
R307 10K
R308 10K
CW/CCW 21
SW35
SW36
SW33
SW34
M2 22
M1 23
DCY2 24
DCY1 25
R312 33K
R313 33K
R314 33K
R315 33K
R316 33K
GND
Toshiba TB6560 Stepper Driver IC
schematic ver 1.0 Aug 26, 2010


+5v
R406 10K
R405 10K
SW42
SW41
GND
R417 4.7K
R420 10K
Q41
C48 ?uF
GND
to "C-Step" opto-coupler U810
GND
R411 33K
U41
TQ2 1
TQ1 2
CLK 3
Enable 4
RESETn 5
SGND 6
OSC 7
VMB 8
OUT_BM 9
PGNDB 10
NFB 11
OUT_BP 12
OUT_AM 13
NFA 14
PGNDA 15
OUT_AP 16
MO 17
VMA 18
Protect 19
VDD 20
CW/CCW 21
M2 22
M1 23
DCY2 24
DCY1 25
to "C-Ena" opto U811
R418 10K
C47 10uF 50v
"102" C41 ?uF
to "power input" diode D45
C42 3300uF 50v
CB-
CB+
CA-
CA+
N/C
R403 0.15
R404 0.15
C43 ?uF
C44 470uF 25v
C45 ?uF
C46 470uF 25v
R419 4.7K
to "C-Dir" opto-coupler U812
R409 10K
R410 10K
R407 10K
R408 10K
SW45
SW46
SW43
SW44
R412 33K
R413 33K
R414 33K
R415 33K
R416 33K
Toshiba TB6560 Stepper Driver IC
schematic ver 1.0 Aug 26, 2010

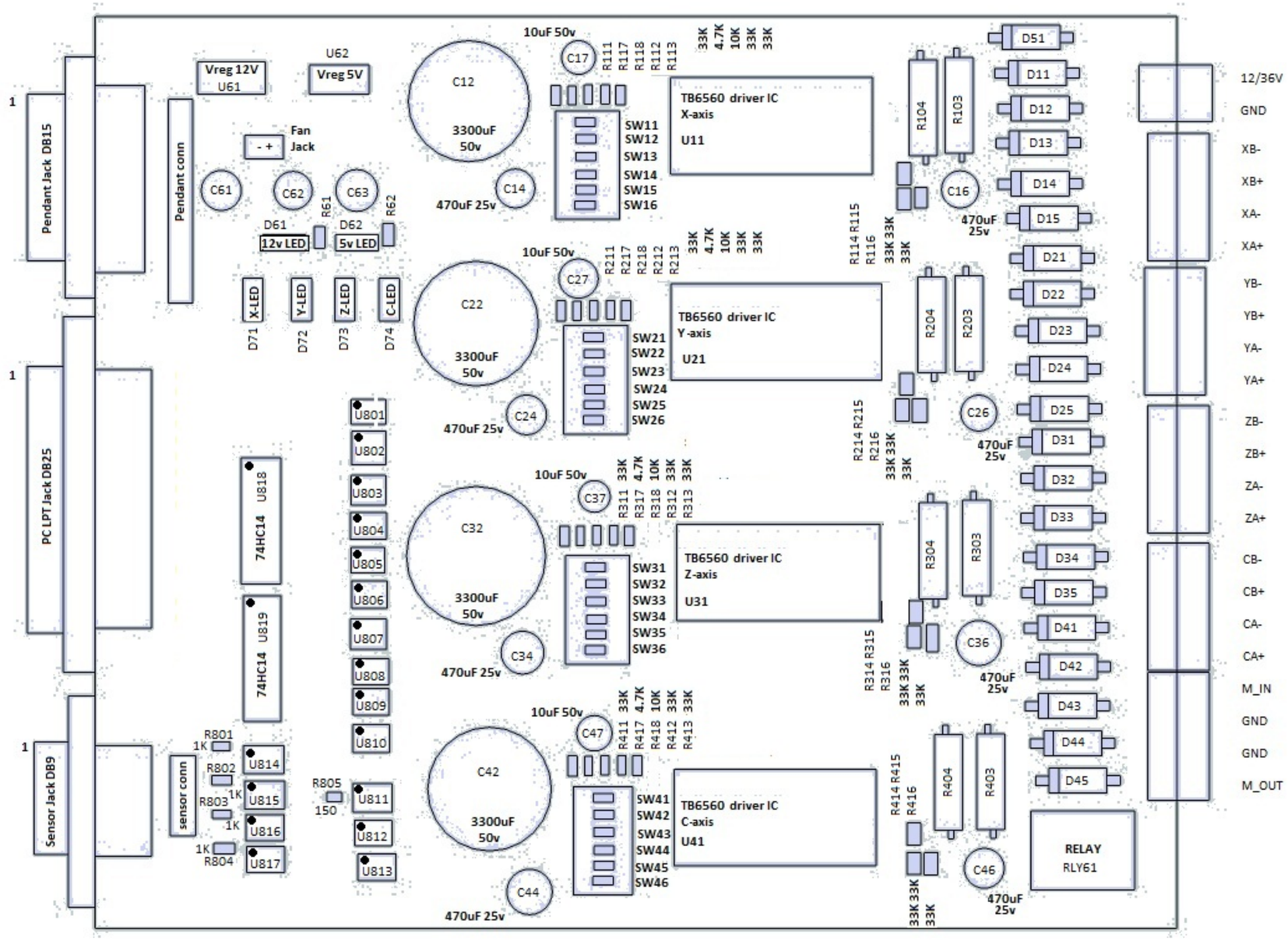
CNC Controller schematic (one axis shown)



CNC Controller schematic (one axis shown) With Fixes Version 2



TOP SIDE View



BOTTOM (X-Ray) View