D1001618-v1 (ilspmc_servo3)

aLIGO PSL Circuit Board Documentation

Patrick Kwee, 23 Jun 2010

Abstract

Servo electronics used for locking the high power oscillator to the frontend and for locking the PMC. For more information see LIGO-T0900577.

Testplan Template: T1000342-v1

Contents

Safety Instructions

In order to operate the circuit properly and safely, review the following guidelines before installing and using the unit. Failure to do so may result in equipment damage or bodily injury:

This circuit was designed as a laboratory equipment to be operated only by trained and qualified technicians in research institutes or development departments. For safety reasons, usage by other persons or in other environments is *not* recommended.

- This circuit uses extra-low voltage ($< 50\,V_{AC}$ and $< 75\,V_{DC}$) and is therefore exempt from the regulations of the *Low Voltage Directive* (2006/95/EC).
- The unit does not contain any mechanical drive system. Therefore, the regulations of the *Machinery Directive* (2006/42/EC) do not apply.

Sicherheitshinweise

Nehmen Sie vor Aufbau und Inbetriebnahme des Geräts folgende Empfehlungen zur Kenntnis, um die Schaltung korrekt und sicher zu betreiben sowie Schäden und Verletzungen zu vermeiden:

Diese Schaltung wurde als Laborausrüstung entworfen, die nur von qualifizierten und eingewiesenen Technikern in Forschungsinstituten oder Entwicklungsabteilungen benutzt wird. Aus Sicherheitsgründen wird die Verwendung durch andere Personen oder in anderer Umgebung *nicht* empfohlen.

- Diese Schaltung verwendet Kleinspannung ($< 50\,V_{AC}$ und $< 75\,V_{DC}$) und unterliegt daher nicht den Bestimmungen der *Niederspannungsrichtlinie* (2006/95/EC).
- Das Gerät enthält kein mechanisches Antriebssystem – die Bestimmungen der *Maschinenrichtlinie* (2006/42/EC) sind daher nicht anwendbar.

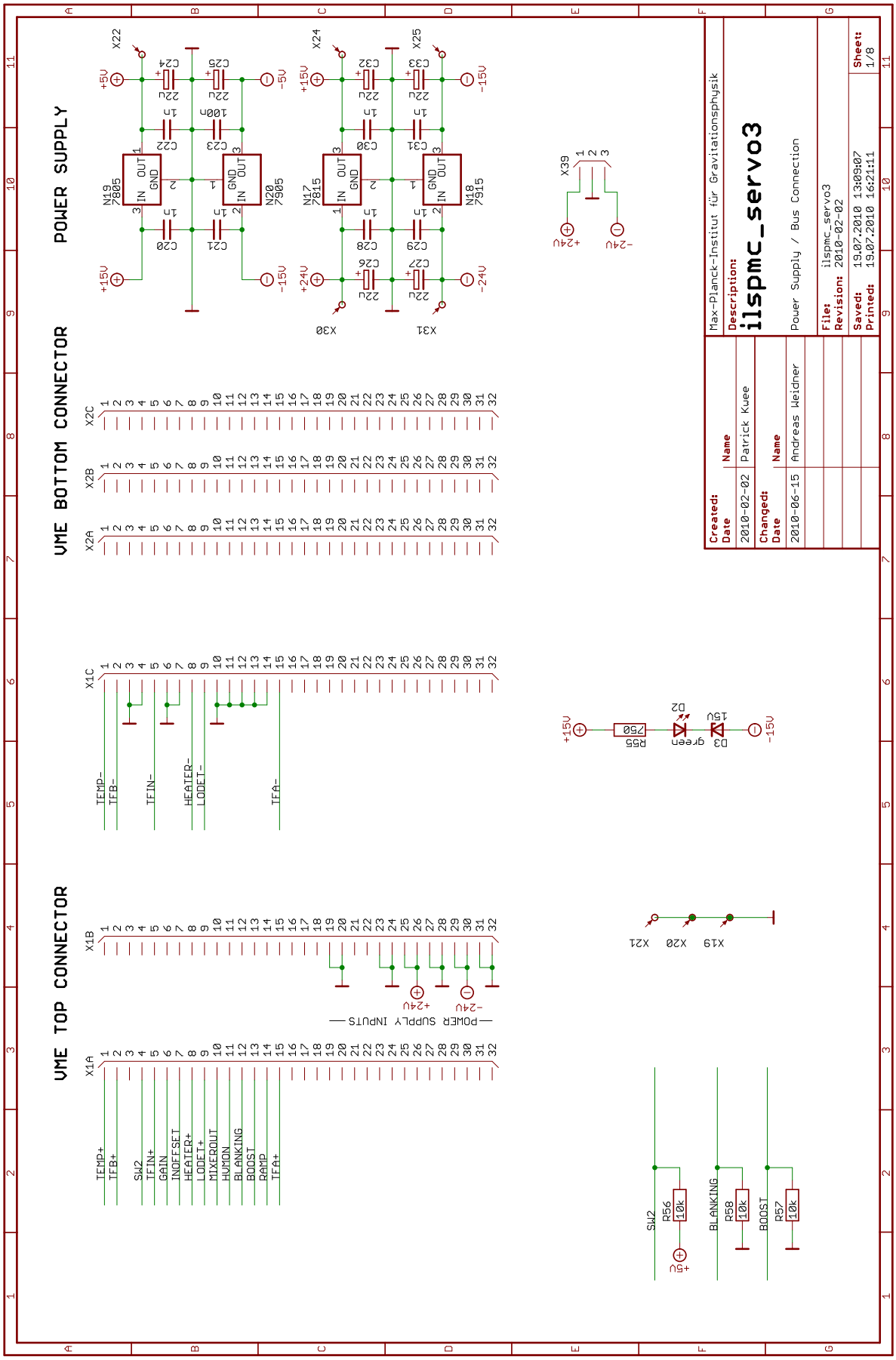

Figure 1: *Project schematics (sheet 1)*

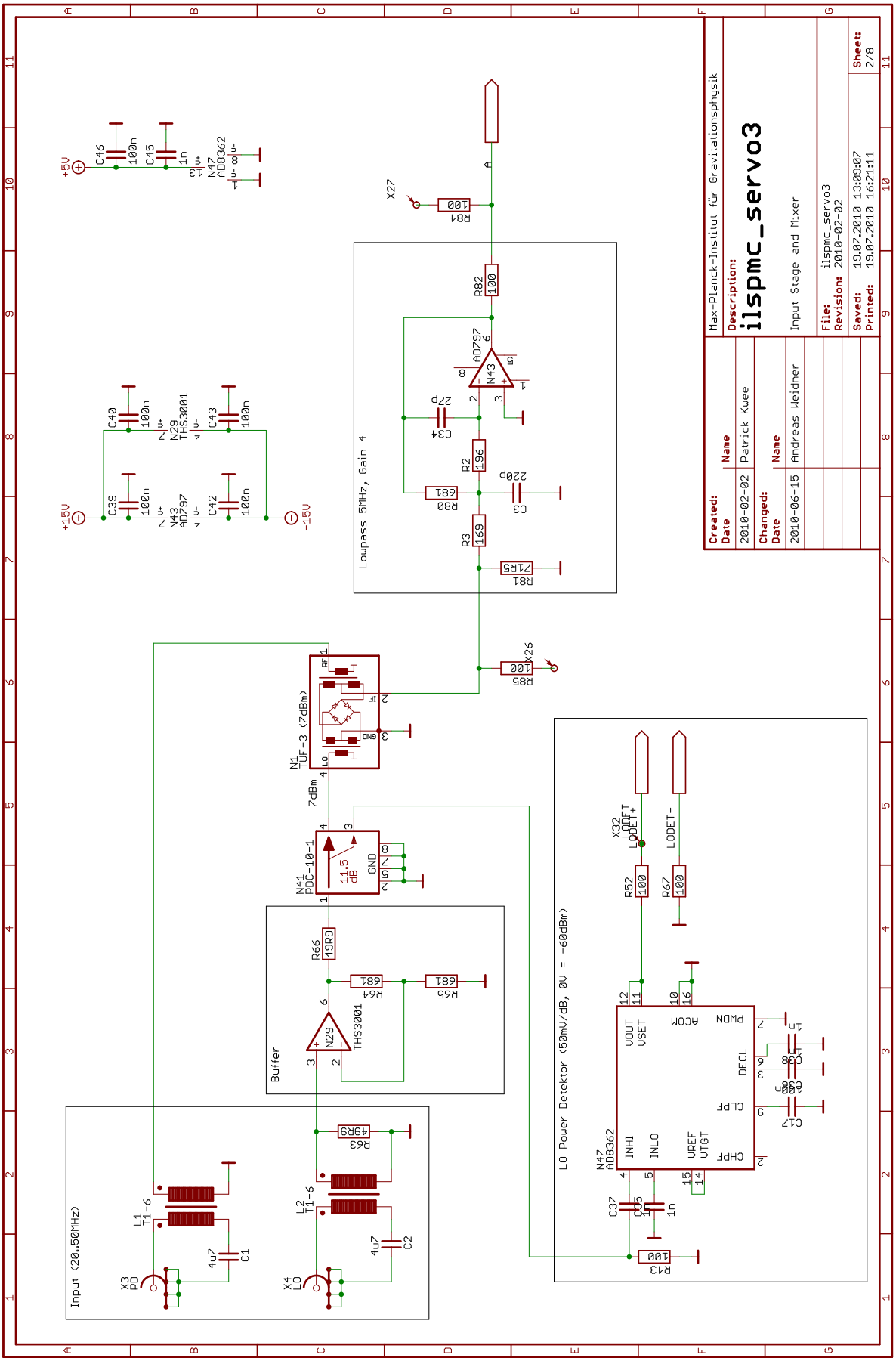

Figure 2: *Project schematics (sheet 2)*

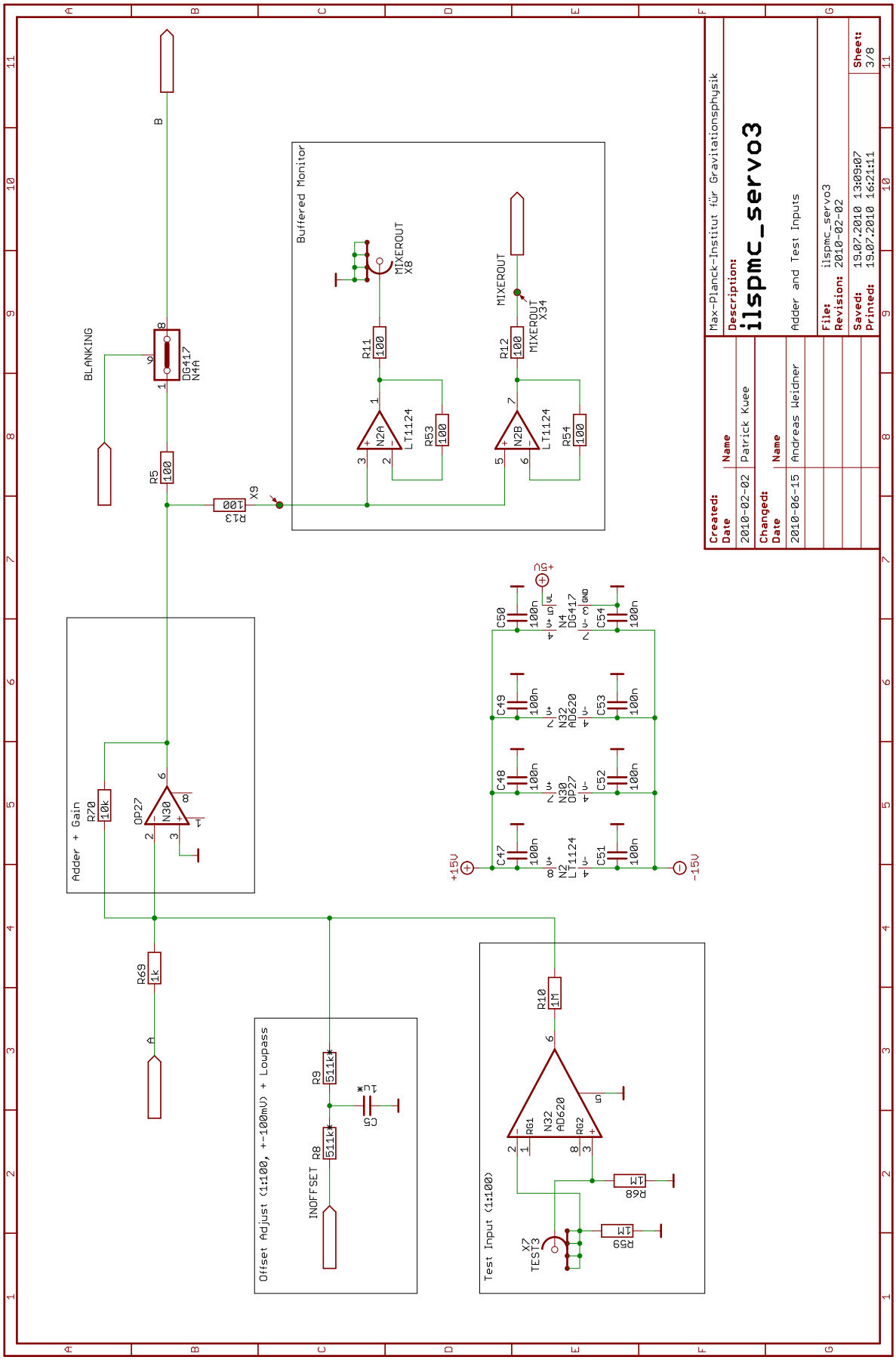

Figure 3: *Project schematics (sheet 3)*

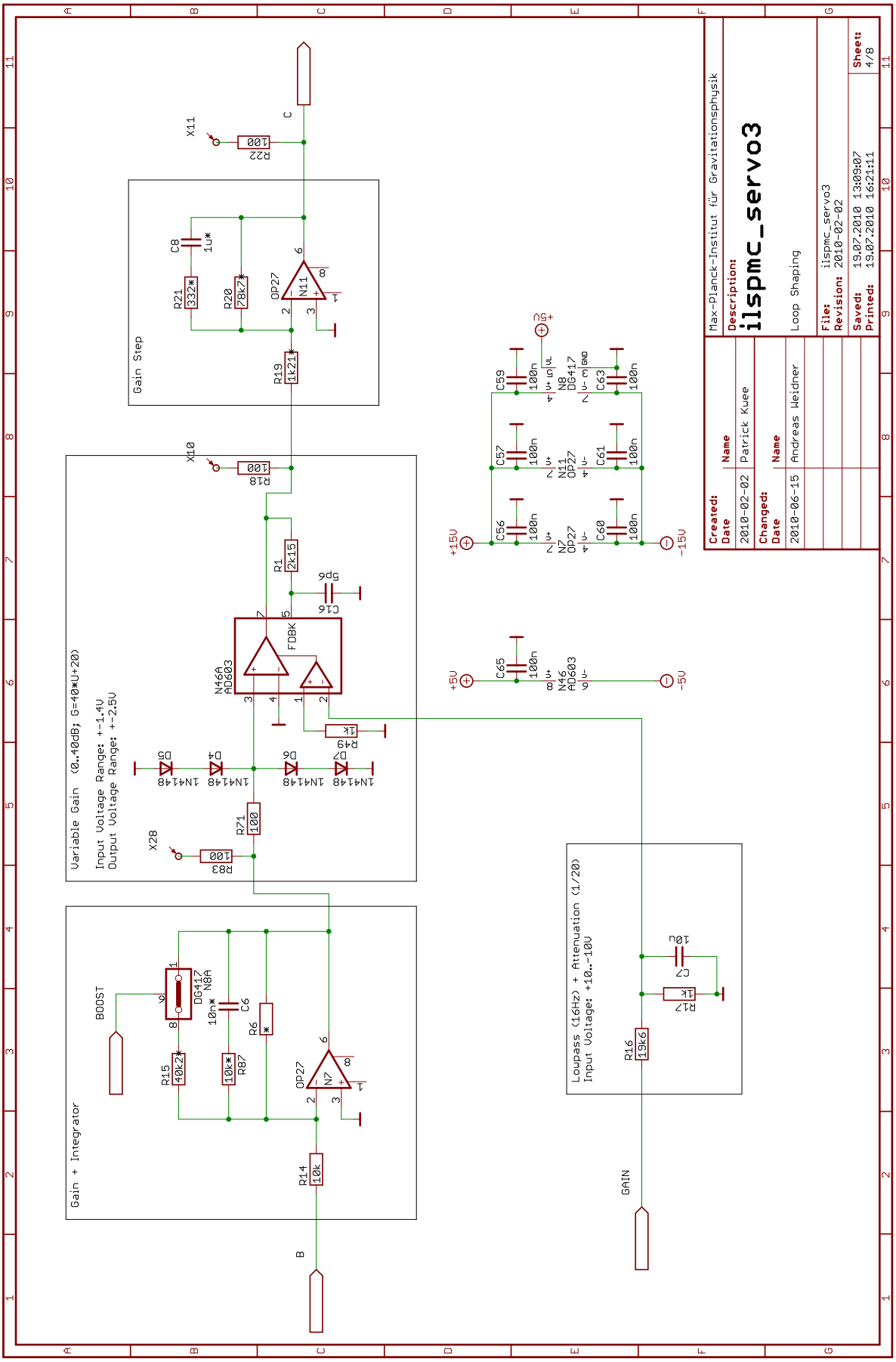

Figure 4: *Project schematics (sheet 4)*

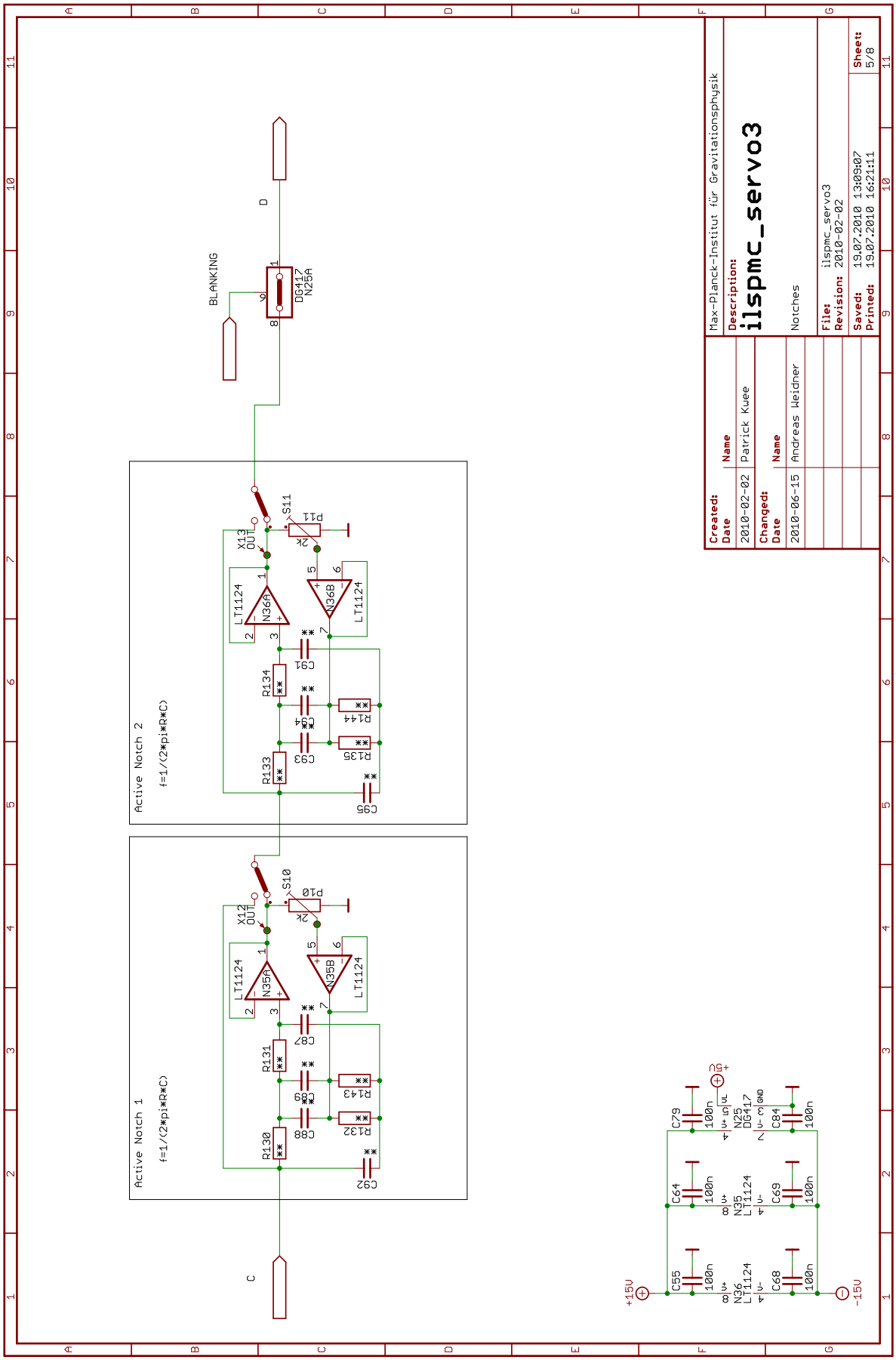

Figure 5: *Project schematics (sheet 5)*

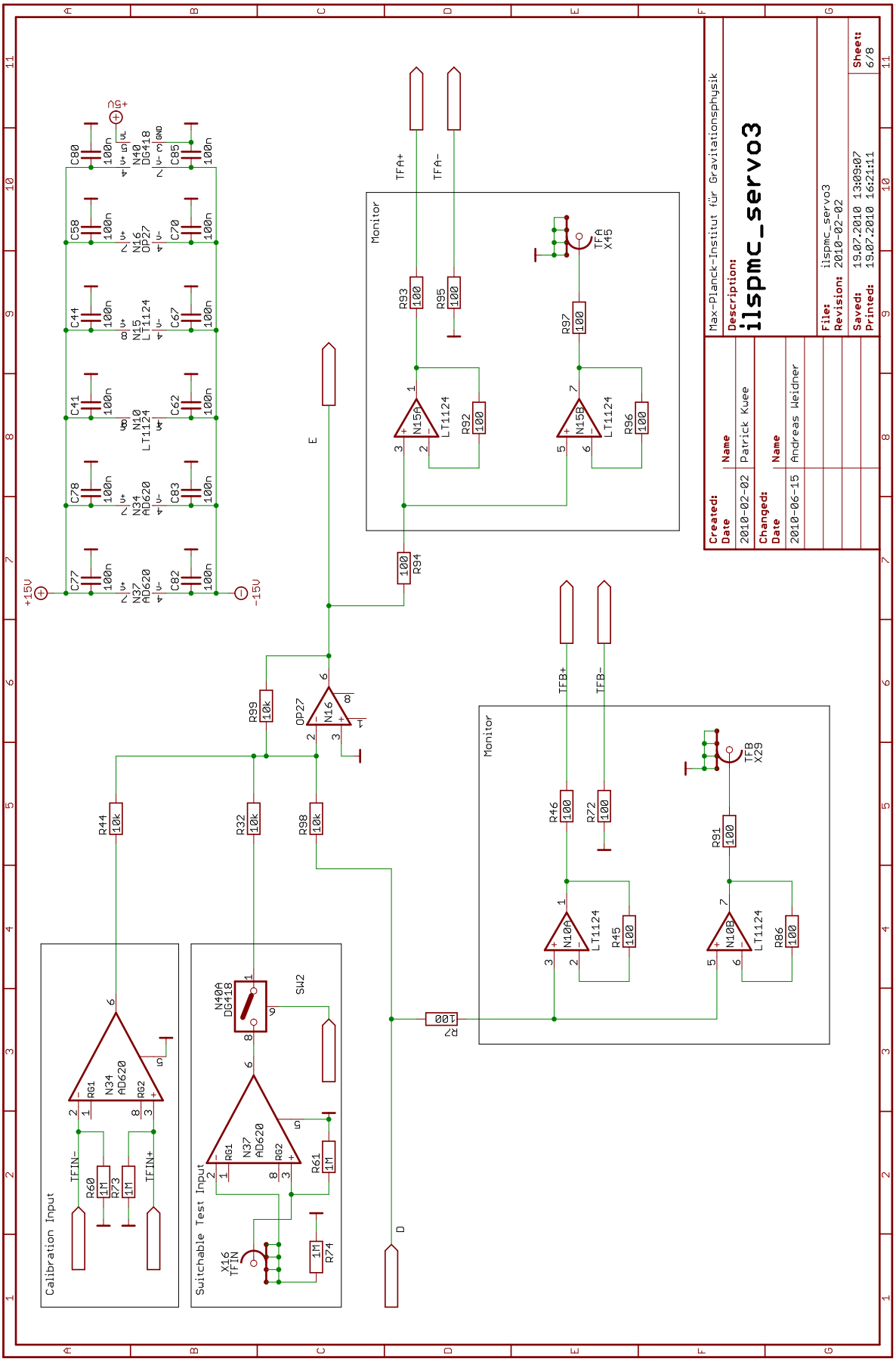

Figure 6: *Project schematics (sheet 6)*

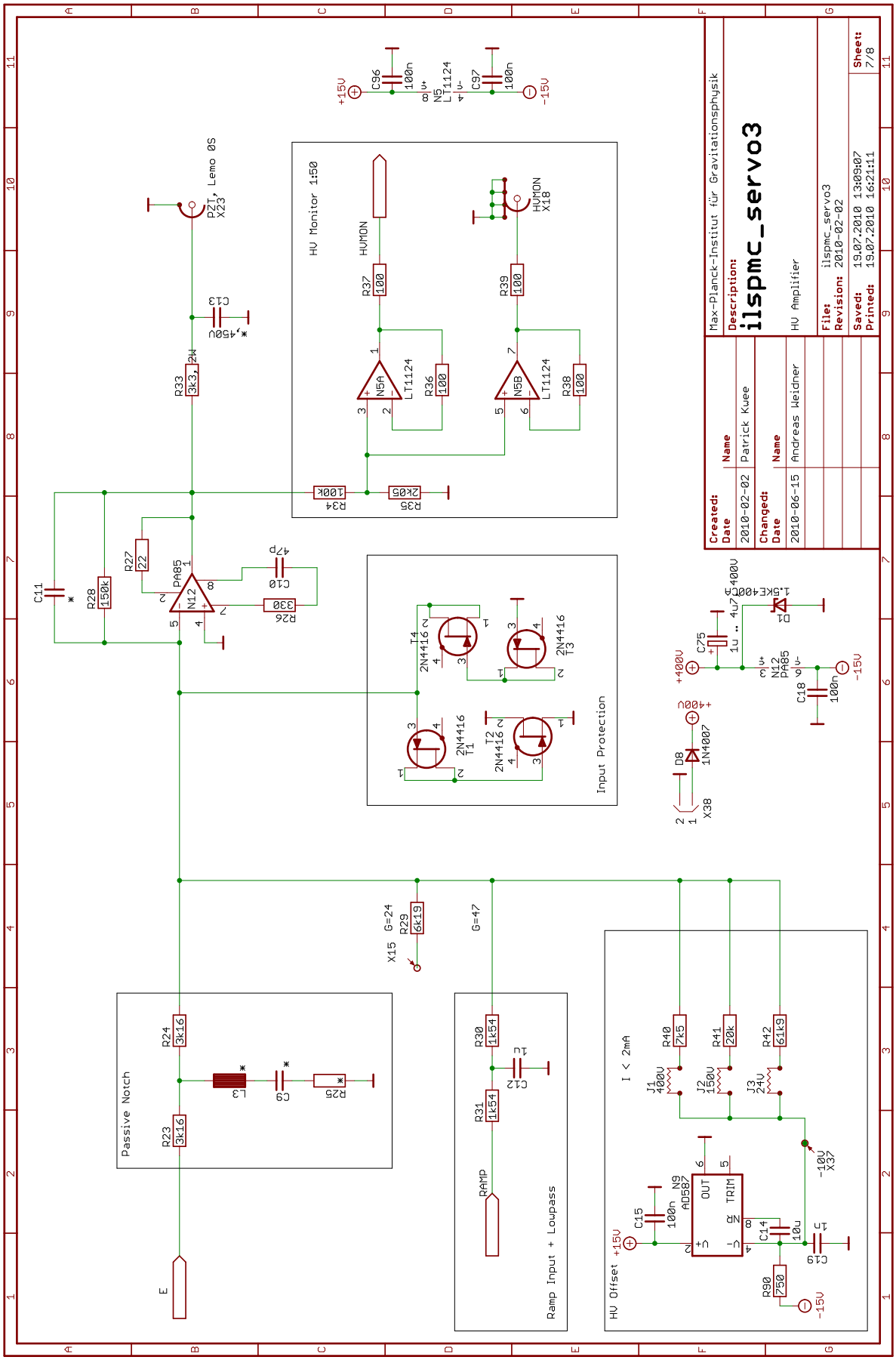

Figure 7: *Project schematics (sheet 7)*

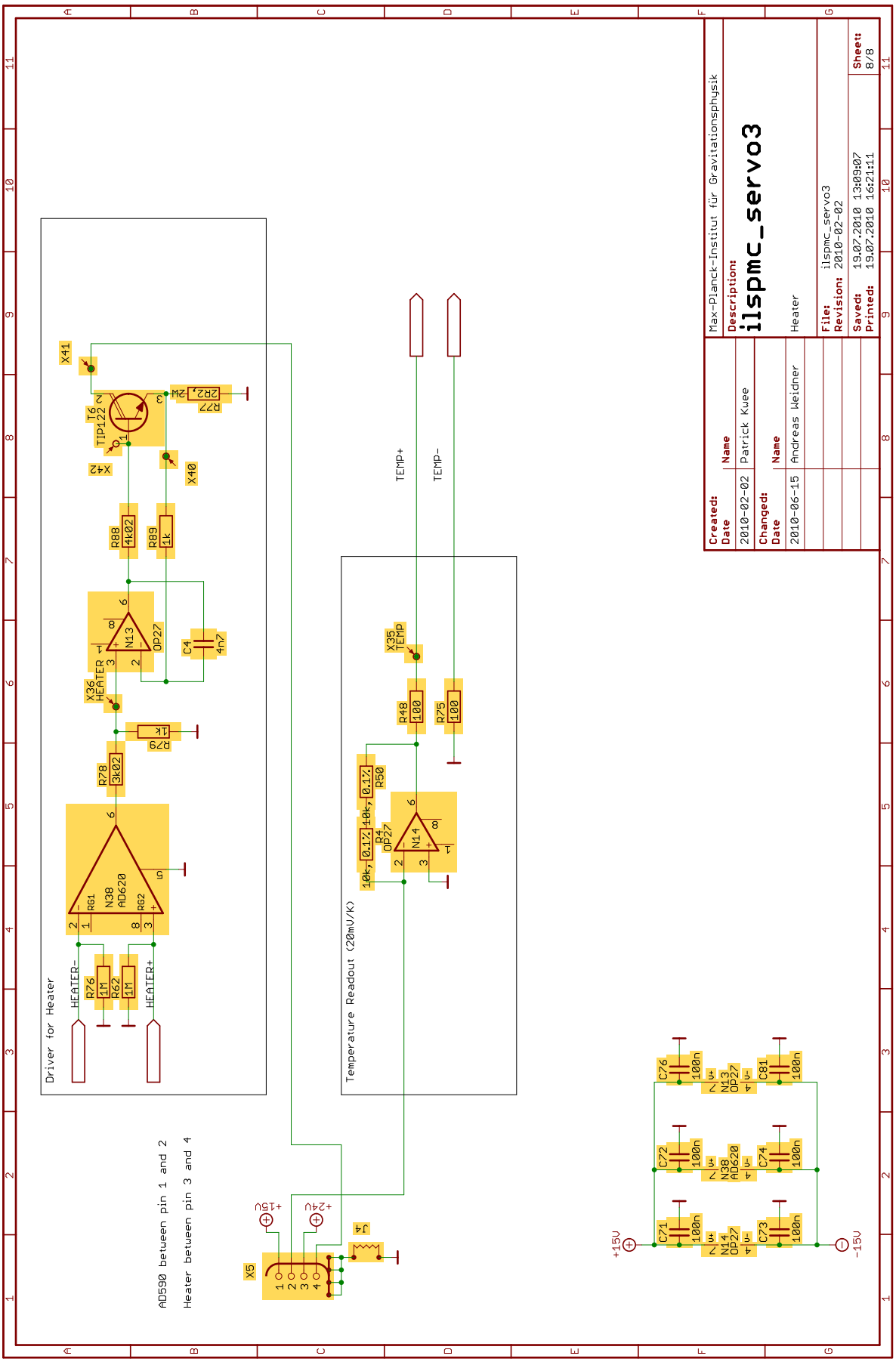

Figure 8: *Project schematics (sheet 8)*
Parts with more than one population variant are highlighted in orange

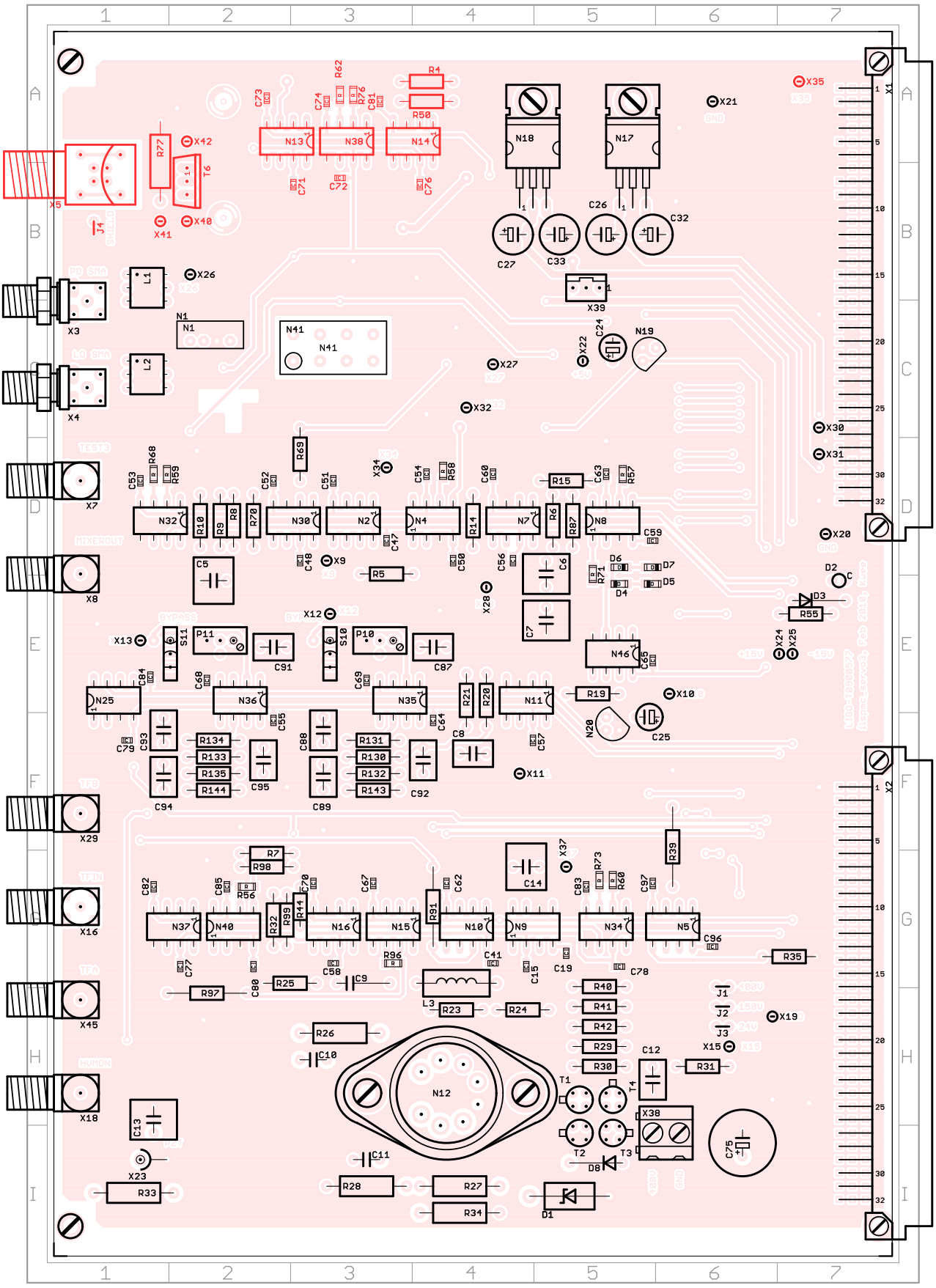

Figure 9: *Board top view showing placeplan with component names*
Components with more than one population variant are shown in red

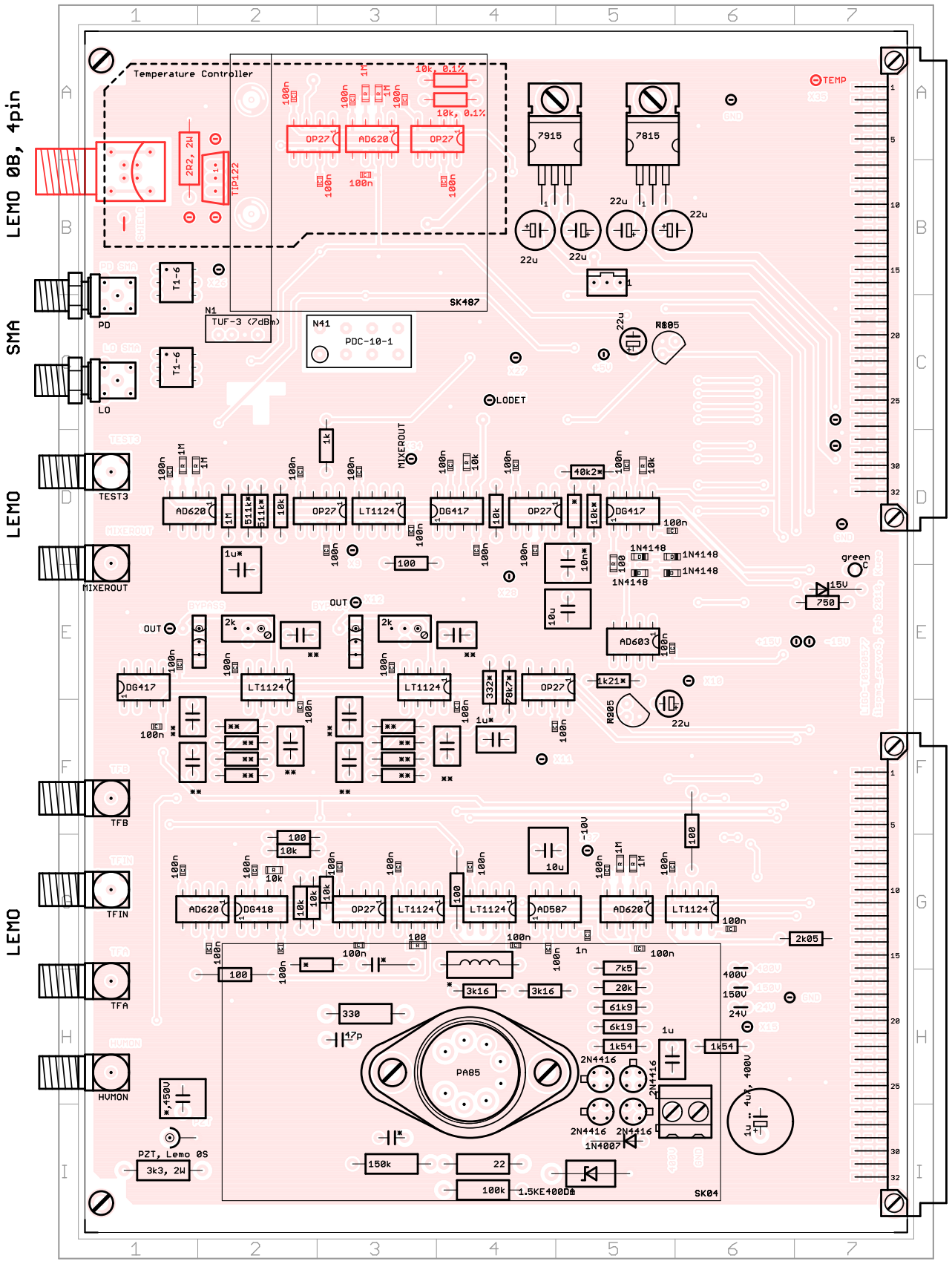

Figure 10: *Board top view showing placeplan with component values*
Components with more than one population variant are shown in red

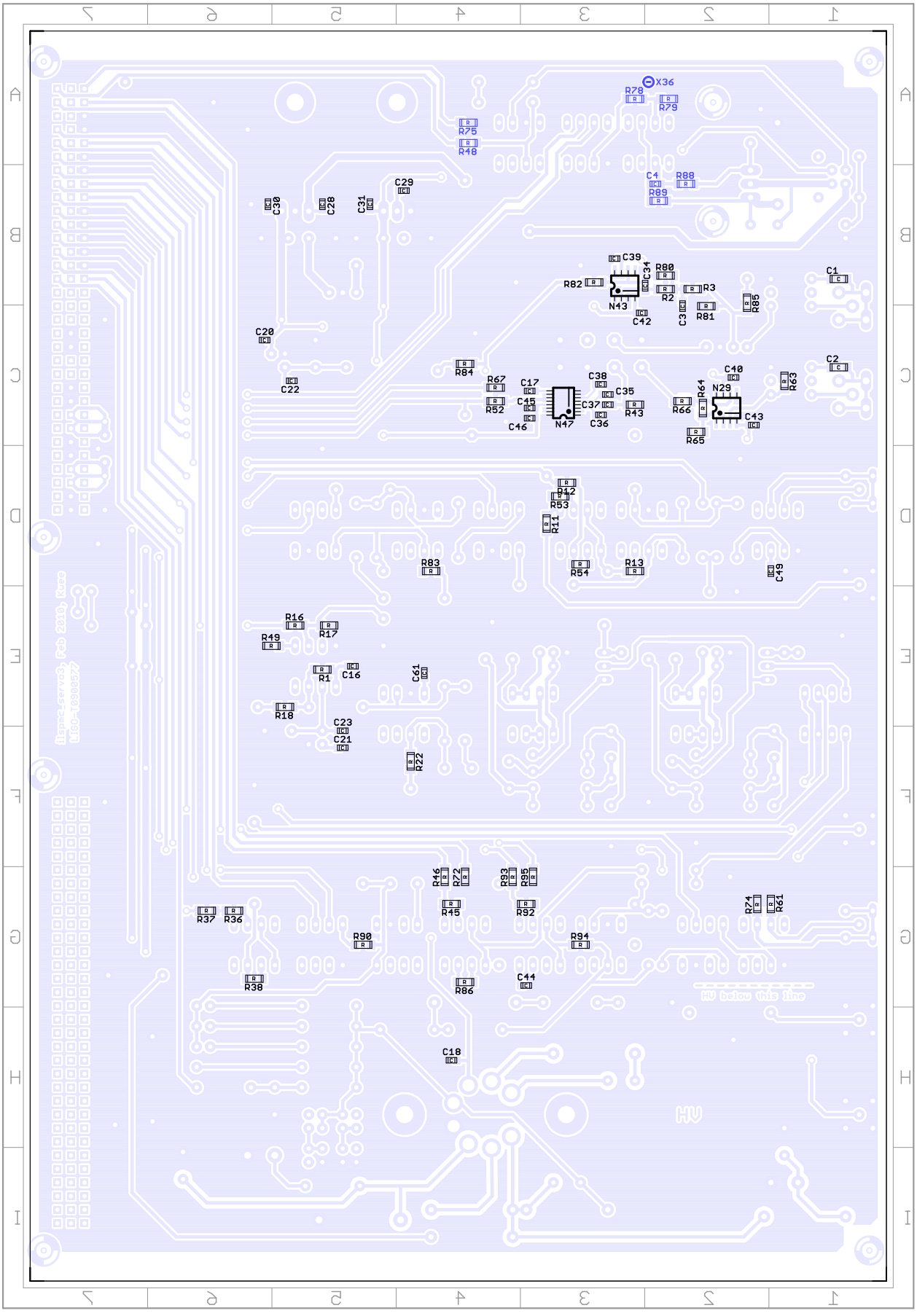

Figure 11: *Board bottom view showing placeplan with component names*
Components with more than one population variant are shown in blue

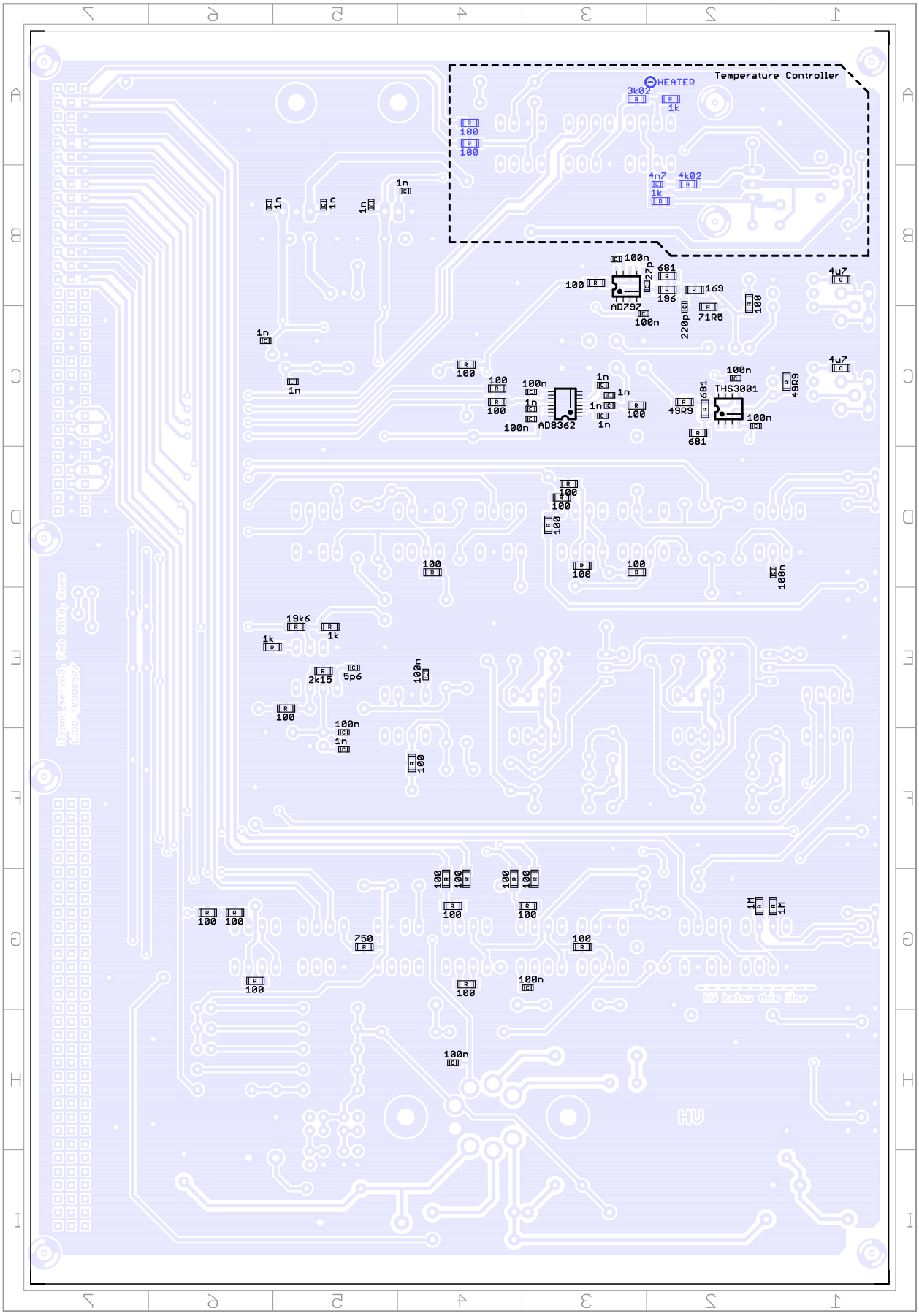

Figure 12: *Board bottom view showing placeplan with component values*
Components with more than one population variant are shown in blue

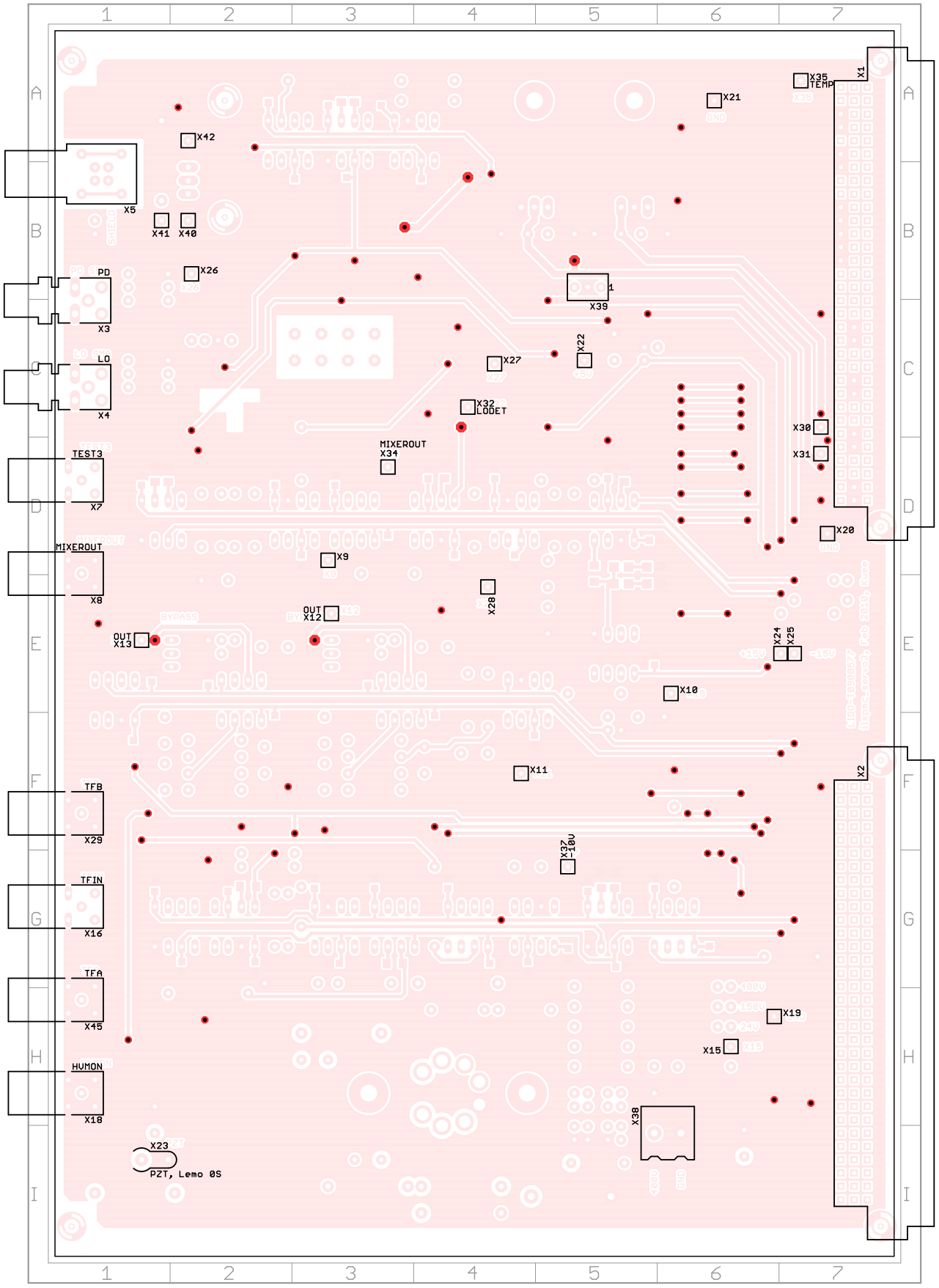

Figure 13: *Board top view showing connectors, test points, vias and wired components*

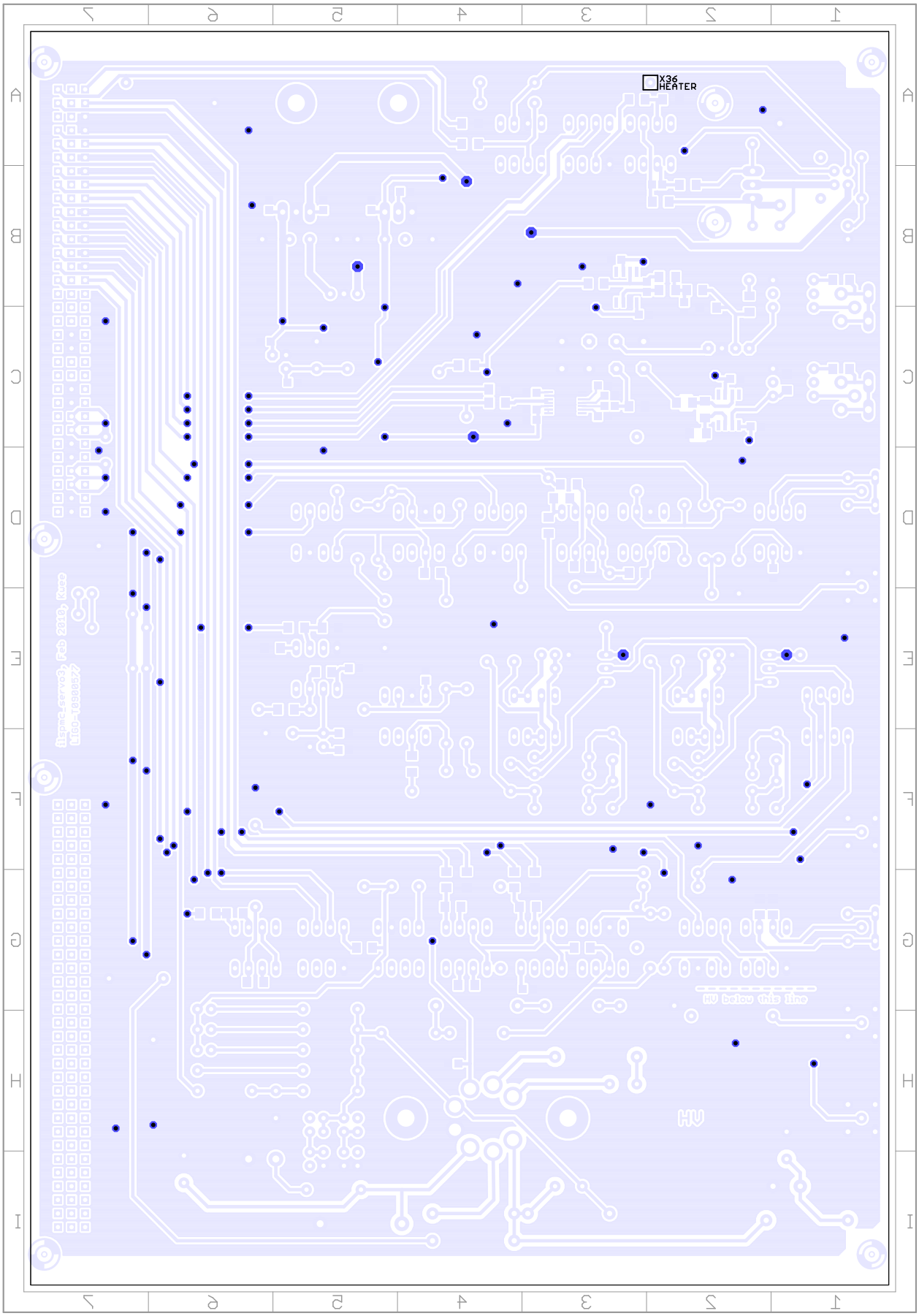

Figure 14: *Board bottom view showing connectors, test points, vias and wired components*

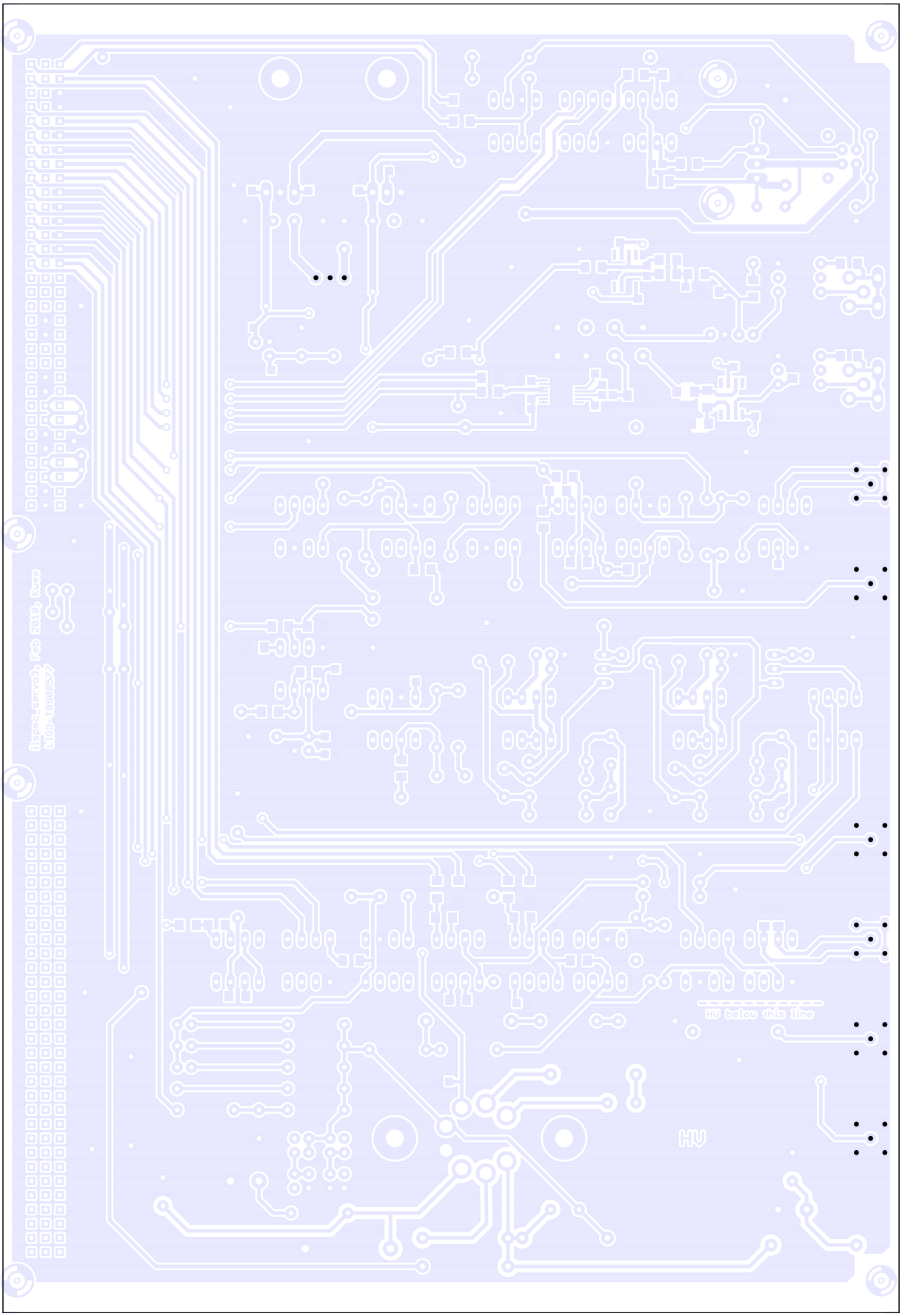

Figure 15: *Board bottom view showing drills with 0.9 mm (0.035 in) diameter*

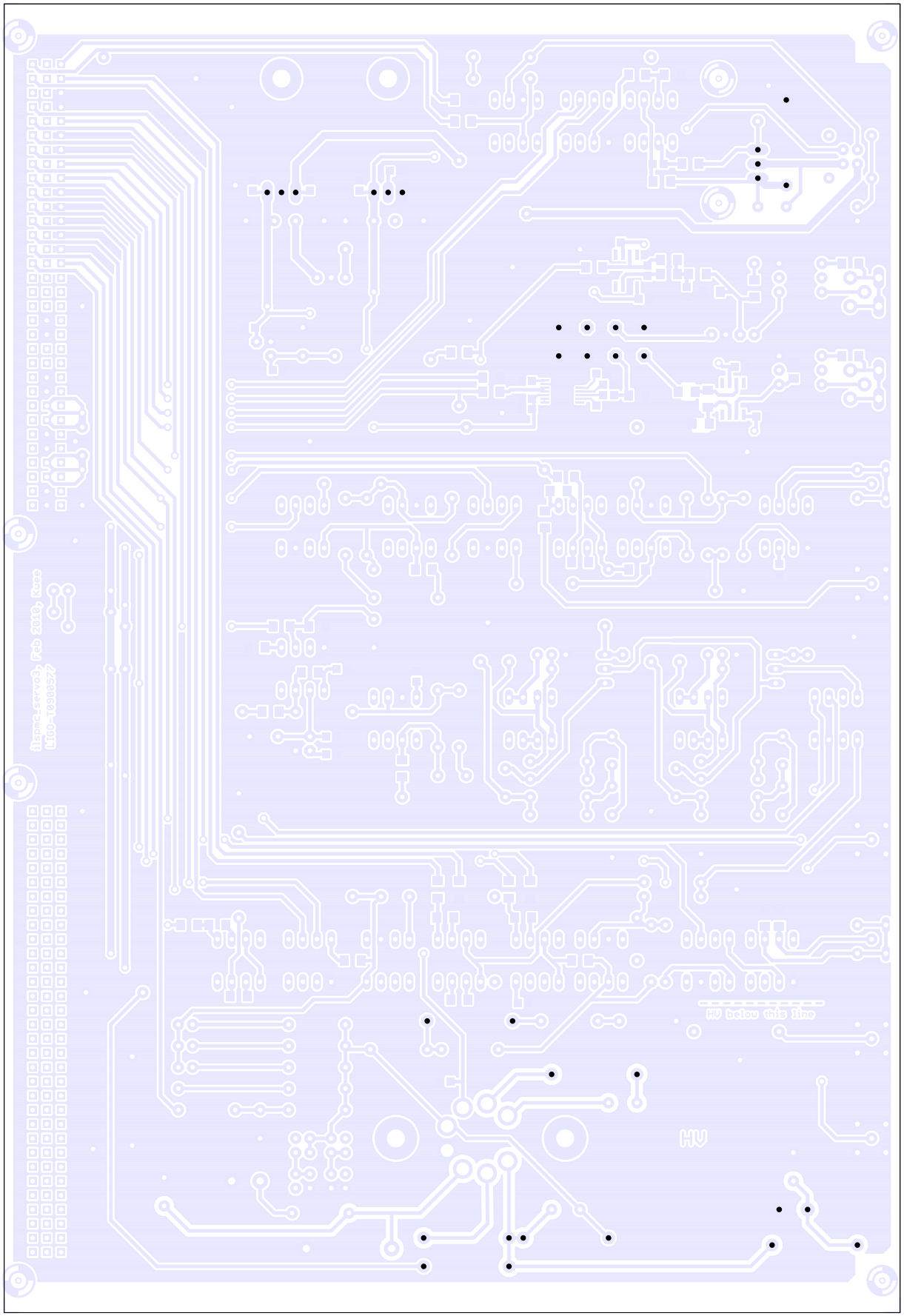

Figure 16: *Board bottom view showing drills with 1.0 mm (0.039 in) diameter*

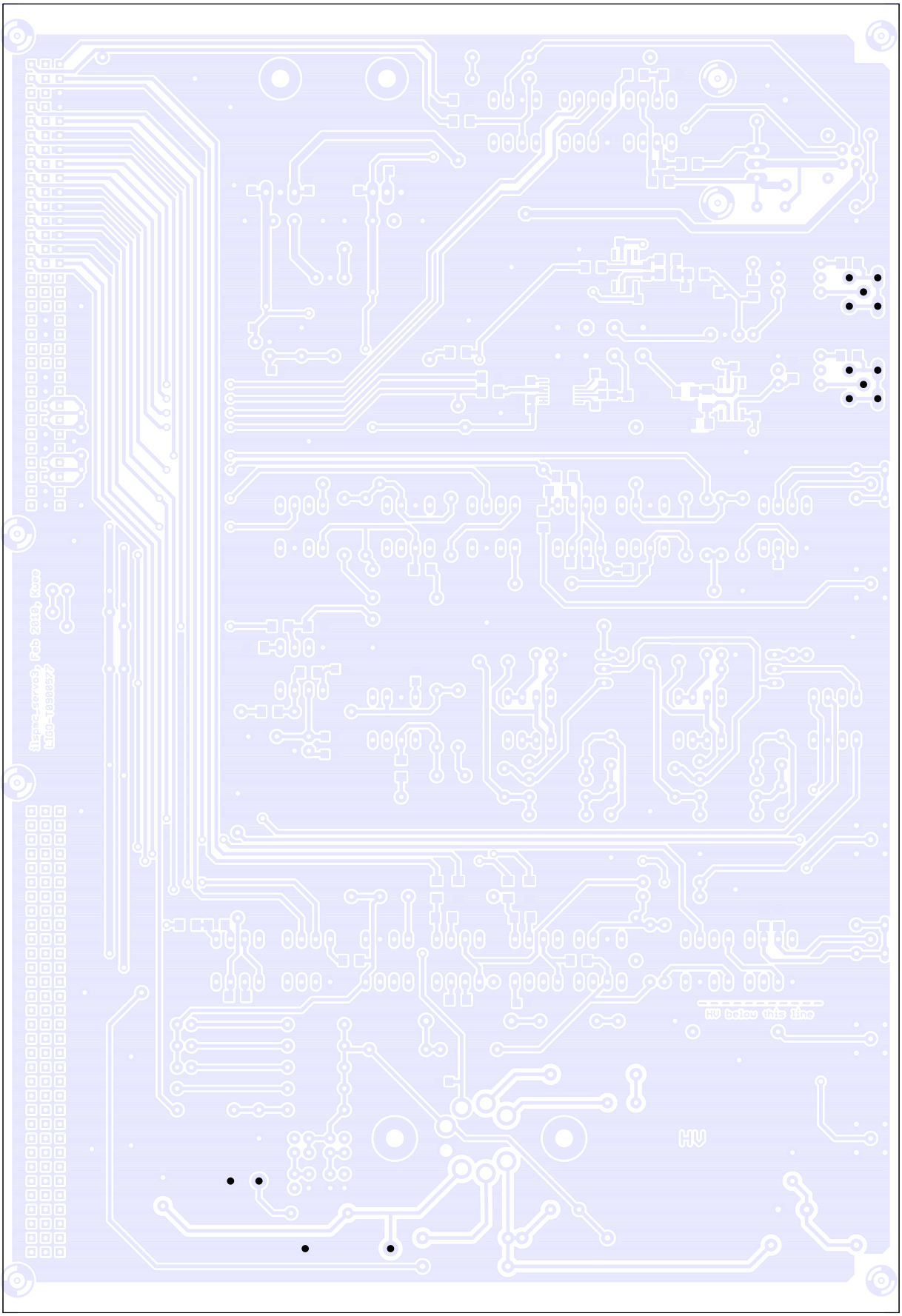

Figure 17: *Board bottom view showing drills with 1.3 mm (0.051 in) diameter*

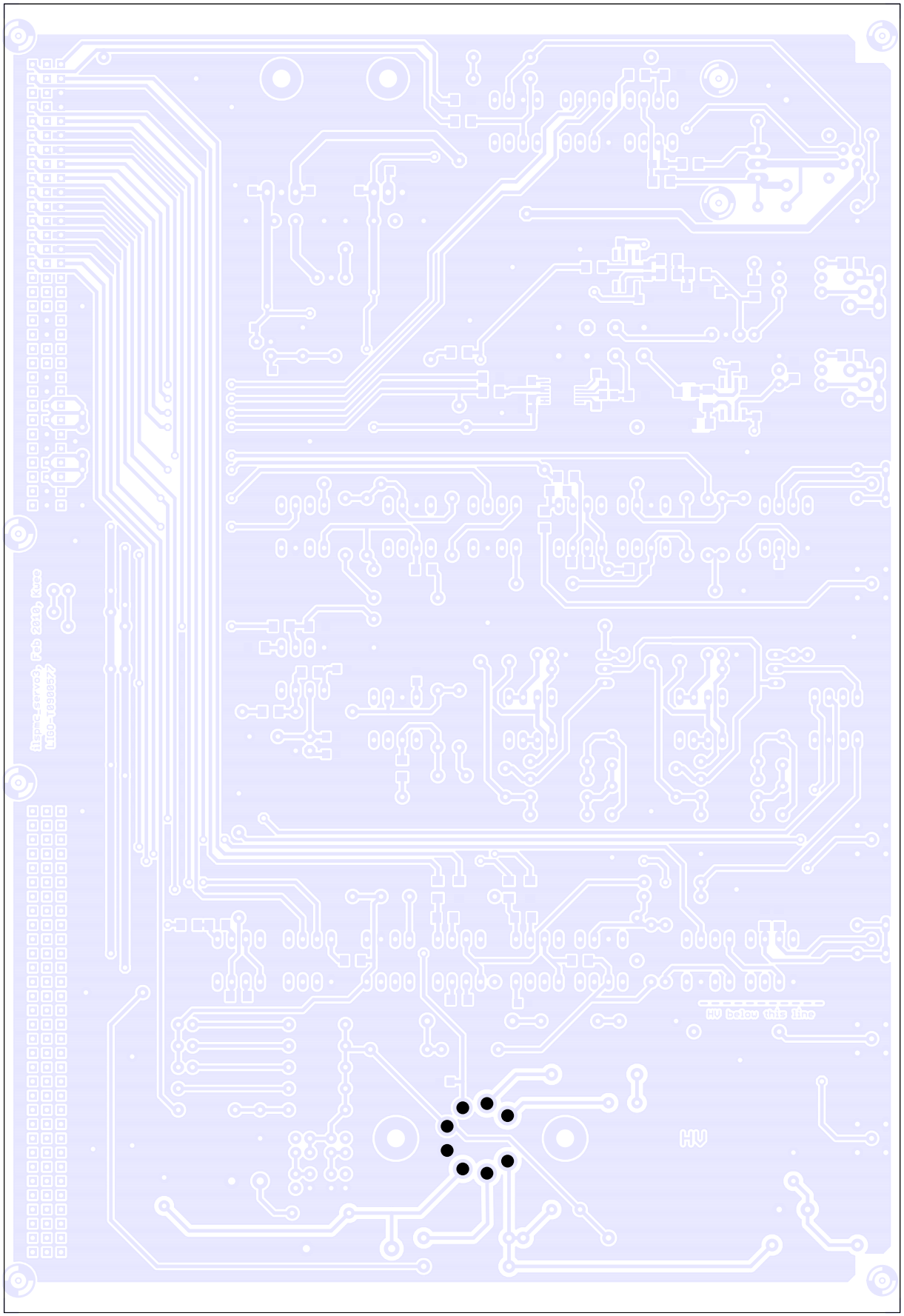

Figure 18: *Board bottom view showing drills with 2.3 mm (0.090 in) diameter*

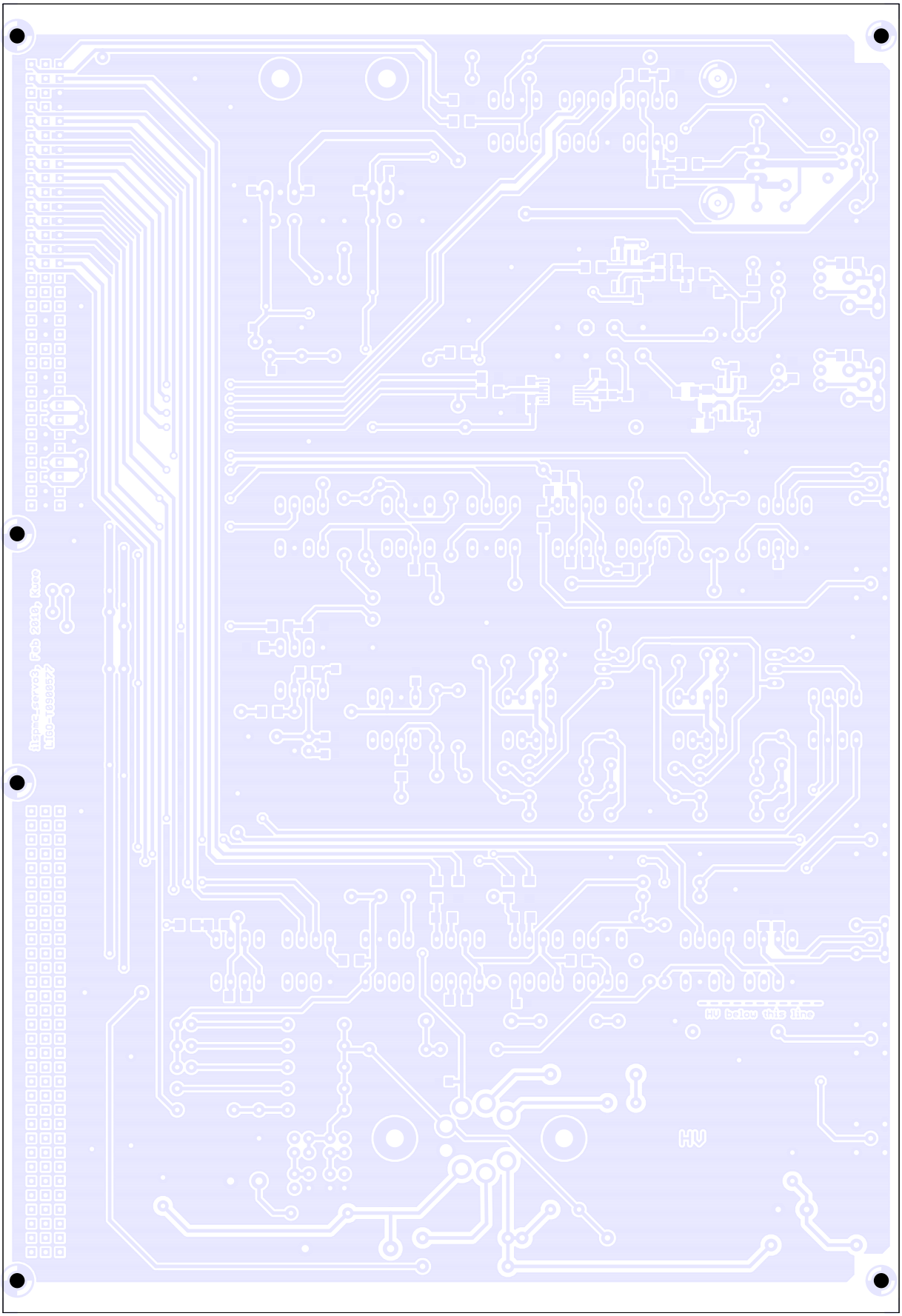

Figure 19: *Board bottom view showing drills with 2.7 mm (0.106 in) diameter*

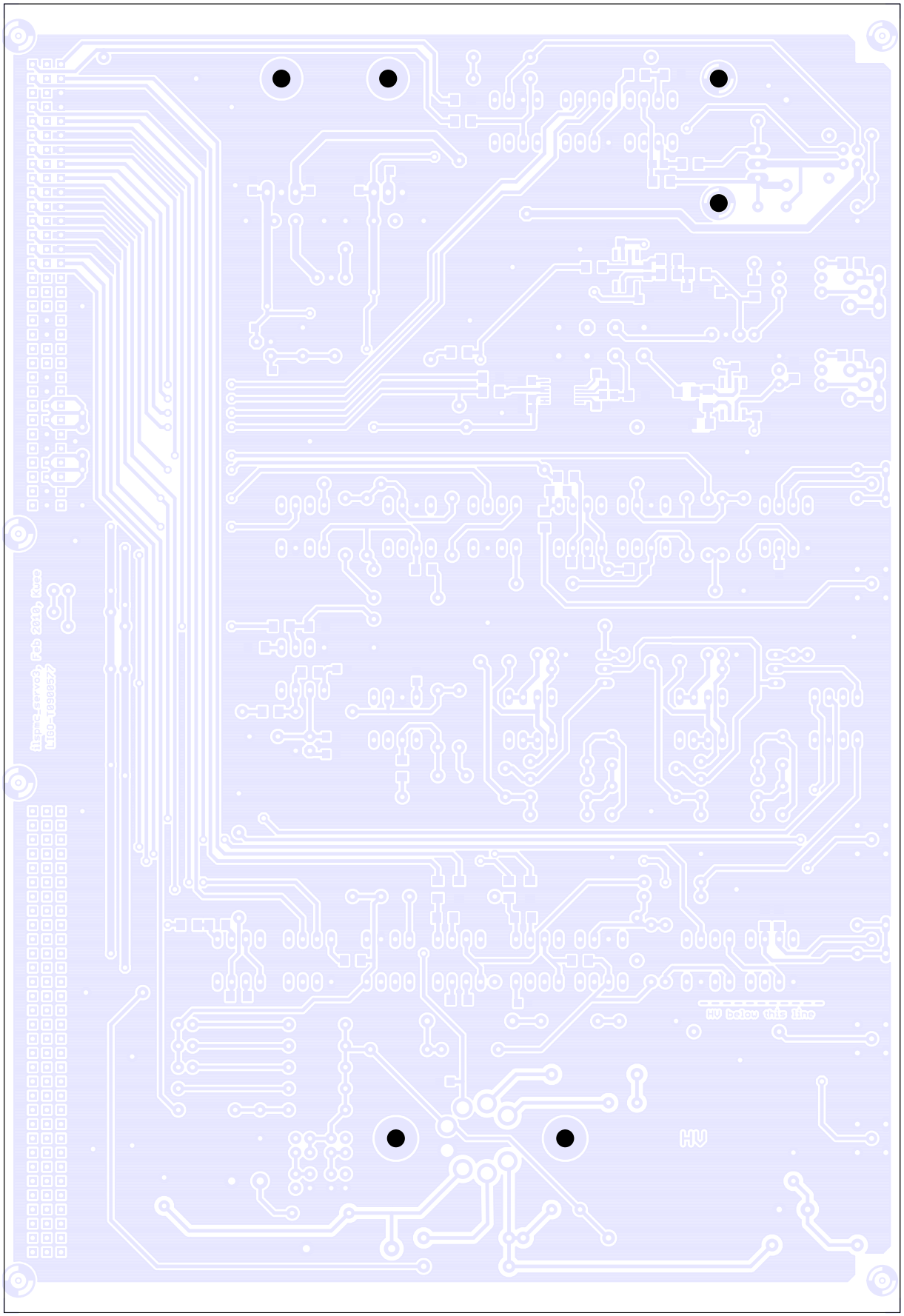

Figure 20: *Board bottom view showing drills with 3.2 mm (0.126 in) diameter*

Circuit Lists

Drill list: The following table shows all *final* drill diameters used in the board. When manually drilling the clearance holes, round up to the nearest available drill bit diameter, ensuring that all components fit well. When manufacturing *through-plated* boards, adjust for the additional copper coating by increasing the diameter accordingly.

∅ [µm]	∅ [mm]	∅ [in]	Count
812	0.8	0.032	692
889	0.9	0.035	33
990	1.0	0.039	33
1295	1.3	0.051	14
2286	2.3	0.090	8
2692	2.7	0.106	6
3200	3.2	0.126	6
		Total	792

Table 1: *Drill diameters used in the board*

Standard properties: If not explicitly stated otherwise in the schematics or value and part lists, the circuit components have the following standard properties. Parts with 'better' properties can be easily substituted, but care should be taken if the specifications are *not* met.

- Wired resistors: Metal film 0.6 W, 1%, 200 V, TK 100
- SMD resistors: 1%, 150 V, TK 50, MiniMELF in thin film, other packages in thick film technology

Value list: The following list shows all components available on the board (sorted by part *values*) and can be used to quickly gather components. Names of components with more than one population variant are shown in red, the component values correspond to the standard population. Additional information can possibly be found directly on the board (or in the schematics).

```
EAGLE Version 5.10.0 Copyright (c) 1988-2010 CadSoft
Board value list of 'ilspmc_servo3.brd'
Exported at 2010-07-19 16:21
Created with macro 'plot.ulp' (c) Andreas Weidner
Shown are: Value/Type,Package,Number,Names (Library)

---C---
5p6              C-SMD:0805          (1*)    C16 (miscs)
27p              C-SMD:0805          (1*)    C34 (miscs)
47p              C-0.2"              (1*)    C10 (miscs)
220p             C-SMD:0805          (1*)    C3 (miscs)
1n               C-SMD:0805          (13*)   C19,C20,C21,C22,C28,C29,C30,C31,C35,C36,
                                             C37,C38,C45 (miscs)
4n7              C-SMD:0805          (1*)    C4 (miscs)
10n*             C02C                (1*)    C6 (miscs)
100n             C-SMD:0805          (50*)   C15,C17,C18,C23,C39,C40,C41,C42,C43,C44,
                                             C46,C47,C48,C49,C50,C51,C52,C53,C54,C55,
                                             C56,C57,C58,C59,C60,C61,C62,C63,C64,C65,
                                             C67,C68,C69,C70,C71,C72,C73,C74,C76,C77,
                                             C78,C79,C80,C81,C82,C83,C84,C85,C96,C97
                                             (miscs)
1u               C02B                (1*)    C12 (miscs)
1u .. 4u7, 400V  CE02B               (1*)    C75 (miscs)
1u*              C02B                (1*)    C8 (miscs)
                 C02C                (1*)    C5 (miscs)
4u7              C-SMD:1206          (2*)    C1,C2 (miscs)
```

10u	C02C	(2*)	C7,C14 (miscs)
22u	CE-TANTAL:0.2"	(2*)	C24,C25 (miscs)
	CE02D	(4*)	C26,C27,C32,C33 (miscs)
*	C-0.2"	(1*)	C11 (miscs)
	C-0.4"	(1*)	C9 (miscs)
**	C02B	(8*)	C87,C88,C89,C91,C92,C93,C94,C95 (miscs)
*,450V	C02C	(1*)	C13 (miscs)
---D---			
1N4007	D-0.4"	(1*)	D8 (diodes)
1N4148	D-SMD:MiniMELF	(4*)	D4,D5,D6,D7 (diodes)
15V	DZ-0.4"	(1*)	D3 (diodes)
1.5KE400CA	DSU06N2	(1*)	D1 (diodes)
green	LED-3mm	(1*)	D2 (optos)
---J---			
24V	JMP:Wire-0.1"	(1*)	J3 (connectors)
150V	JMP:Wire-0.1"	(1*)	J2 (connectors)
400V	JMP:Wire-0.1"	(1*)	J1 (connectors)
[undefined]	JMP:Wire-0.1"	(1*)	J4 (connectors)
---L---			
*	L06A	(1*)	L3 (miscs)
T1-6	LT11-W38	(2*)	L1,L2 (miscs)
---N---			
7805	TO92D@1	(1*)	N19 (ics)
7905	TO92D@1	(1*)	N20 (ics)
7815	TO220L	(1*)	N17 (ics)
7915	TO220L	(1*)	N18 (ics)
AD587	DIP-8	(1*)	N9 (ics)
AD603	DIP-8	(1*)	N46 (ics)
AD620	DIP-8	(4*)	N32,N34,N37,N38 (opamps)
AD797	SO-8	(1*)	N43 (opamps)
AD8362	TSSOP16	(1*)	N47 (ics)
DG417	DIP-8	(3*)	N4,N8,N25 (ics)
DG418	DIP-8	(1*)	N40 (ics)
LT1124	DIP-8	(6*)	N2,N5,N10,N15,N35,N36 (opamps)
OP27	DIP-8	(6*)	N7,N11,N13,N14,N16,N30 (opamps)
PA85	TO3-8-SOCKET	(1*)	N12 (opamps)
PDC-10-1	A01	(1*)	N41 (miscs)
THS3001	SO-8	(1*)	N29 (opamps)
TUF-3 (7dBm)	B02	(1*)	N1 (ics)
---P---			
2k	PT06N	(2*)	P10,P11 (miscs)
---PAD---			
[undefined]	Pad:[empty]	(2*)	PAD11,PAD12 (connectors)
---R---			
2R2, 2W	R06-2W	(1*)	R77 (miscs)
22	R06-2W	(1*)	R27 (miscs)
49R9	R-SMD:1206	(2*)	R63,R66 (miscs)
71R5	R-SMD:1206	(1*)	R81 (miscs)
100	R-0.4"	(2*)	R5,R7 (miscs)
	R-0.6"	(3*)	R39,R91,R97 (miscs)
	R-SMD:1206	(29*)	R11,R12,R13,R18,R22,R36,R37,R38,R43,R45, R46,R48,R52,R53,R54,R67,R71,R72,R75,R82,

				R83,R84,R85,R86,R92,R93,R94,R95,R96 (miscs)
169		R-SMD:1206	(1*)	R3 (miscs)
196		R-SMD:1206	(1*)	R2 (miscs)
330		R06-2W	(1*)	R26 (miscs)
332*		R-0.4"	(1*)	R21 (miscs)
681		R-SMD:1206	(3*)	R64,R65,R80 (miscs)
750		R-0.4"	(1*)	R55 (miscs)
		R-SMD:1206	(1*)	R90 (miscs)
1k		R-0.4"	(1*)	R69 (miscs)
		R-SMD:1206	(4*)	R17,R49,R79,R89 (miscs)
1k21*		R-0.4"	(1*)	R19 (miscs)
1k54		R-0.4"	(2*)	R30,R31 (miscs)
2k05		R-0.4"	(1*)	R35 (miscs)
2k15		R-SMD:1206	(1*)	R1 (miscs)
3k02		R-SMD:1206	(1*)	R78 (miscs)
3k16		R-0.4"	(2*)	R23,R24 (miscs)
3k3, 2W		R06-2W	(1*)	R33 (miscs)
4k02		R-SMD:1206	(1*)	R88 (miscs)
6k19		R-0.4"	(1*)	R29 (miscs)
7k5		R-0.4"	(1*)	R40 (miscs)
10k		R-0.3"	(1*)	R44 (miscs)
		R-0.4"	(5*)	R14,R32,R70,R98,R99 (miscs)
		R-SMD:1206	(3*)	R56,R57,R58 (miscs)
10k*		R-0.4"	(1*)	R87 (miscs)
10k, 0.1%		R-0.4"	(2*)	R4,R50 (miscs)
19k6		R-SMD:1206	(1*)	R16 (miscs)
20k		R-0.4"	(1*)	R41 (miscs)
40k2*		R-0.4"	(1*)	R15 (miscs)
61k9		R-0.4"	(1*)	R42 (miscs)
78k7*		R-0.4"	(1*)	R20 (miscs)
100k		R06-2W	(1*)	R34 (miscs)
150k		R06-2W	(1*)	R28 (miscs)
511k*		R-0.4"	(2*)	R8,R9 (miscs)
1M		R-0.4"	(1*)	R10 (miscs)
		R-SMD:1206	(8*)	R59,R60,R61,R62,R68,R73,R74,R76 (miscs)
*		R-0.4"	(2*)	R6,R25 (miscs)
**		R-0.4"	(8*)	R130,R131,R132,R133,R134,R135,R143,R144 (miscs)
---S---				
[undefined]		S1X2S01L	(2*)	S10,S11 (miscs)
---T---				
2N4416		TO-72	(4*)	T1,T2,T3,T4 (transistors)
TIP122		TO-220	(1*)	T6 (transistors)
---X---				
-10V		Testpin	(1*)	X37 (connectors)
HEATER		Testpin	(1*)	X36 (connectors)
HVMON		LEMO:1-pin/horz.	(1*)	X18 (connectors)
LO		SMA/horz.	(1*)	X4 (connectors)
LODET		Testpin	(1*)	X32 (connectors)
MIXEROUT		LEMO:1-pin/horz.	(1*)	X8 (connectors)
		Testpin	(1*)	X34 (connectors)
OUT		Testpin	(2*)	X12,X13 (connectors)
PD		SMA/horz.	(1*)	X3 (connectors)
PZT, Lemo OS		ShieldedCable	(1*)	X23 (connectors)
TEMP		Testpin	(1*)	X35 (connectors)

```
TEST3           LEMO:1-pin/horz.      (1*)    X7 (connectors)
TFA             LEMO:1-pin/horz.      (1*)    X45 (connectors)
TFB             LEMO:1-pin/horz.      (1*)    X29 (connectors)
TFIN            LEMO:1-pin/horz.      (1*)    X16 (connectors)
[undefined]     Backplane:96-pin/ABC  (2*)    X1,X2 (connectors)
                Testpin               (18*)   X9,X10,X11,X15,X19,X20,X21,X22,X24,X25,
                                              X26,X27,X28,X30,X31,X40,X41,X42
                                              (connectors)
                X02T02                (1*)    X38 (connectors)
                X03AN                 (1*)    X39 (connectors)
                XS04-LEMON            (1*)    X5 (connectors)
```

Part list: The following list shows all components available in the schematics (sorted by part *names*) and can be used to quickly locate components. The column *Layer/Cell* shows the position of the part on the board: *T* for top side and *B* for bottom side, followed by the cell of the surrounding frame (if available). The column *Sheets/Cells* shows the position of *all* the part's gates in the schematics: Sheet number followed by the cell of the surrounding frame (if available). Names of components with more than one population variant are shown in **red**, the component values correspond to the standard population. Additional information can possibly be found directly in the schematics.

```
EAGLE Version 5.10.0 Copyright (c) 1988-2010 CadSoft
Schematics part list of 'ilspmc_servo3.sch'
Exported at 2010-07-19 16:22
Created with macro 'plot.ulp' (c) Andreas Weidner
Shown are: Name,Value/Type,Package,Device,Layer/Cell,Sheets/Cells

---C---
C1      4u7             C-SMD:1206          C1206       B-B1  2-B1
C2      4u7             C-SMD:1206          C1206       B-C1  2-D1
C3      220p            C-SMD:0805          CS          B-C2  2-E8
C4      4n7             C-SMD:0805          CS          B-B2  8-B6
C5      1u*             CO2C                CO2C        T-E2  3-C3
C6      10n*            CO2C                CO2C        T-D5  4-B3
C7      10u             CO2C                CO2C        T-E5  4-F4
C8      1u*             CO2B                CO2B        T-F4  4-B10
C9      *               C-0.4"              CO4N        T-G3  7-C3
C10     47p             C-0.2"              C           T-H3  7-C7
C11     *               C-0.2"              C           T-I3  7-A7
C12     1u              CO2B                CO2B        T-H5  7-E3
C13     *,450V          CO2C                CO2C        T-H1  7-B9
C14     10u             CO2C                CO2C        T-G4  7-G2
C15     100n            C-SMD:0805          CS          T-G4  7-F2
C16     5p6             C-SMD:0805          CS          B-E5  4-C7
C17     100n            C-SMD:0805          CS          B-C3  2-G3
C18     100n            C-SMD:0805          CS          B-H4  7-G6
C19     1n              C-SMD:0805          CS          T-G5  7-G1
C20     1n              C-SMD:0805          CS          B-C6  1-B10
C21     1n              C-SMD:0805          CS          B-F5  1-B10
C22     1n              C-SMD:0805          CS          B-C5  1-B10
C23     100n            C-SMD:0805          CS          B-F5  1-B10
C24     22u             CE-TANTAL:0.2"      CE02C       T-C5  1-B11
C25     22u             CE-TANTAL:0.2"      CE02C       T-F5  1-B11
C26     22u             CE02D               CE02D       T-B5  1-C9
C27     22u             CE02D               CE02D       T-B4  1-D9
C28     1n              C-SMD:0805          CS          B-B5  1-C10
C29     1n              C-SMD:0805          CS          B-B4  1-D10
C30     1n              C-SMD:0805          CS          B-B6  1-C10
C31     1n              C-SMD:0805          CS          B-B5  1-D10
C32     22u             CE02D               CE02D       T-B5  1-C11
```

C33	22u	CE02D	CE02D	T-B5	1-D11
C34	27p	C-SMD:0805	CS	B-B2	2-D8
C35	1n	C-SMD:0805	CS	B-C3	2-F2
C36	1n	C-SMD:0805	CS	B-C3	2-G3
C37	1n	C-SMD:0805	CS	B-C3	2-E2
C38	1n	C-SMD:0805	CS	B-C3	2-G3
C39	100n	C-SMD:0805	CS	B-B3	2-A7
C40	100n	C-SMD:0805	CS	B-C2	2-A8
C41	100n	C-SMD:0805	CS	T-G4	6-A8
C42	100n	C-SMD:0805	CS	B-C3	2-B7
C43	100n	C-SMD:0805	CS	B-C2	2-B8
C44	100n	C-SMD:0805	CS	B-G3	6-A9
C45	1n	C-SMD:0805	CS	B-C3	2-B10
C46	100n	C-SMD:0805	CS	B-C3	2-A10
C47	100n	C-SMD:0805	CS	T-D3	3-E5
C48	100n	C-SMD:0805	CS	T-D3	3-E5
C49	100n	C-SMD:0805	CS	B-D1	3-E6
C50	100n	C-SMD:0805	CS	T-D4	3-E7
C51	100n	C-SMD:0805	CS	T-D3	3-E5
C52	100n	C-SMD:0805	CS	T-D2	3-E5
C53	100n	C-SMD:0805	CS	T-D1	3-E6
C54	100n	C-SMD:0805	CS	T-D4	3-E7
C55	100n	C-SMD:0805	CS	T-F2	5-F1
C56	100n	C-SMD:0805	CS	T-D4	4-E7
C57	100n	C-SMD:0805	CS	T-F4	4-E8
C58	100n	C-SMD:0805	CS	T-G3	6-A10
C59	100n	C-SMD:0805	CS	T-D5	4-E8
C60	100n	C-SMD:0805	CS	T-D4	4-E7
C61	100n	C-SMD:0805	CS	B-E4	4-E8
C62	100n	C-SMD:0805	CS	T-G4	6-B8
C63	100n	C-SMD:0805	CS	T-D5	4-E8
C64	100n	C-SMD:0805	CS	T-F4	5-F2
C65	100n	C-SMD:0805	CS	T-E5	4-E6
C67	100n	C-SMD:0805	CS	T-G3	6-B9
C68	100n	C-SMD:0805	CS	T-E2	5-G1
C69	100n	C-SMD:0805	CS	T-E3	5-G2
C70	100n	C-SMD:0805	CS	T-G3	6-B10
C71	100n	C-SMD:0805	CS	T-B3	8-F2
C72	100n	C-SMD:0805	CS	T-B3	8-F2
C73	100n	C-SMD:0805	CS	T-A2	8-G2
C74	100n	C-SMD:0805	CS	T-A3	8-G2
C75	1u .. 4u7, 400V	CE02B	CE02B	T-I6	7-F6
C76	100n	C-SMD:0805	CS	T-B4	8-F3
C77	100n	C-SMD:0805	CS	T-G2	6-A7
C78	100n	C-SMD:0805	CS	T-G5	6-A8
C79	100n	C-SMD:0805	CS	T-F1	5-F2
C80	100n	C-SMD:0805	CS	T-G2	6-A10
C81	100n	C-SMD:0805	CS	T-A3	8-G3
C82	100n	C-SMD:0805	CS	T-G1	6-B7
C83	100n	C-SMD:0805	CS	T-G5	6-B8
C84	100n	C-SMD:0805	CS	T-E1	5-G2
C85	100n	C-SMD:0805	CS	T-G2	6-B10
C87	**	C02B	C02B	T-E4	5-C3
C88	**	C02B	C02B	T-F3	5-C2
C89	**	C02B	C02B	T-F3	5-C3
C91	**	C02B	C02B	T-E2	5-C6
C92	**	C02B	C02B	T-F4	5-C2
C93	**	C02B	C02B	T-F1	5-C5
C94	**	C02B	C02B	T-F1	5-C6

C95	**	C02B	C02B	T-F2	5-C5
C96	100n	C-SMD:0805	CS	T-G6	7-D11
C97	100n	C-SMD:0805	CS	T-G5	7-D11
---D---					
D1	1.5KE400CA	DSU06N2	DSU06N2	T-I5	7-G7
D2	green	LED-3mm	DL	T-E7	1-F6
D3	15V	DZ-0.4"	DZ	T-E7	1-F6
D4	1N4148	D-SMD:MiniMELF	DS	T-E5	4-B5
D5	1N4148	D-SMD:MiniMELF	DS	T-E5	4-B5
D6	1N4148	D-SMD:MiniMELF	DS	T-D5	4-C5
D7	1N4148	D-SMD:MiniMELF	DS	T-D5	4-C5
D8	1N4007	D-0.4"	D	T-I5	7-F5
---J---					
J1	400V	JMP:Wire-0.1"	J01	T-G6	7-F3
J2	150V	JMP:Wire-0.1"	J01	T-H6	7-F3
J3	24V	JMP:Wire-0.1"	J01	T-H6	7-G3
J4	[undefined]	JMP:Wire-0.1"	J01	T-B1	8-C1
---L---					
L1	T1-6	LT11-W38	LT11-T1-1	T-B1	2-B2
L2	T1-6	LT11-W38	LT11-T1-1	T-C1	2-C2
L3	*	L06A	L	T-G4	7-B3
---N---					
N1	TUF-3 (7dBm)	B02	TUF-3MH	T-C2	2-C6
N2	LT1124	DIP-8	LT1124	T-D3	3-C8,3-E4,3-E8
N4	DG417	DIP-8	DG417	T-D4	3-B9,3-E7
N5	LT1124	DIP-8	LT1124	T-G6	7-C8,7-D11,7-E8
N7	OP27	DIP-8	OP27	T-D4	4-C3,4-E7
N8	DG417	DIP-8	DG417	T-D5	4-B3,4-E8
N9	AD587	DIP-8	AD587	T-G4	7-F2
N10	LT1124	DIP-8	LT1124	T-G4	6-B8,6-E4,6-F4
N11	OP27	DIP-8	OP27	T-E4	4-C9,4-E8
N12	PA85	TO3-8-SOCKET	PA85-SOCKET	T-H4	7-B7,7-G6
N13	OP27	DIP-8	OP27	T-A2	8-A6,8-F3
N14	OP27	DIP-8	OP27	T-A4	8-D5,8-F1
N15	LT1124	DIP-8	LT1124	T-G3	6-B9,6-D8,6-E8
N16	OP27	DIP-8	OP27	T-G3	6-B10,6-C6
N17	7815	TO220L	7815L	T-B5	1-C10
N18	7915	TO220L	7915L	T-B4	1-D10
N19	7805	TO92D@1	78XXL2	T-C5	1-B10
N20	7905	TO92D@1	79XXL2	T-F5	1-B10
N25	DG417	DIP-8	DG417	T-E1	5-C9,5-F2
N29	THS3001	SO-8	THS3001	B-C2	2-B8,2-C3
N30	OP27	DIP-8	OP27	T-D3	3-B5,3-E5
N32	AD620	DIP-8	AD620	T-D1	3-E3,3-E6
N34	AD620	DIP-8	AD620	T-G5	6-A3,6-B7
N35	LT1124	DIP-8	LT1124L	T-E3	5-C4,5-F2
N36	LT1124	DIP-8	LT1124L	T-E2	5-C7,5-F1
N37	AD620	DIP-8	AD620	T-G2	6-B2,6-B7
N38	AD620	DIP-8	AD620	T-A3	8-A4,8-F2
N40	DG418	DIP-8	DG418	T-G2	6-B3,6-B10
N41	PDC-10-1	A01	PDC-10-1	T-C3	2-C4
N43	AD797	SO-8	AD797S	B-B3	2-B7,2-D9
N46	AD603	DIP-8	AD603	T-E5	4-C6,4-E6
N47	AD8362	TSSOP16	AD8362	B-C3	2-B10,2-F3

---P---					
P10	2k	PT06N	PT06N	T-E3	5-C4
P11	2k	PT06N	PT06N	T-E2	5-C7
---PAD---					
PAD11	[undefined]	Pad:[empty]	XPADN	?-E3	5-C4
PAD12	[undefined]	Pad:[empty]	XPADN	?-E2	5-C7
---R---					
R1	2k15	R-SMD:1206	RS	B-E5	4-C7
R2	196	R-SMD:1206	RS	B-B2	2-D8
R3	169	R-SMD:1206	RS	B-B2	2-D7
R4	10k, 0.1%	R-0.4"	R	T-A4	8-C5
R5	100	R-0.4"	R	T-D3	3-B8
R6	*	R-0.4"	R	T-D5	4-C3
R7	100	R-0.4"	R	T-G2	6-D3
R8	511k*	R-0.4"	R	T-D2	3-C2
R9	511k*	R-0.4"	R	T-D2	3-C3
R10	1M	R-0.4"	R	T-D2	3-E3
R11	100	R-SMD:1206	RS	B-D3	3-C9
R12	100	R-SMD:1206	RS	B-D3	3-E9
R13	100	R-SMD:1206	RS	B-D3	3-B7
R14	10k	R-0.4"	R	T-D4	4-C2
R15	40k2*	R-0.4"	R	T-D5	4-B3
R16	19k6	R-SMD:1206	RS	B-E5	4-F3
R17	1k	R-SMD:1206	RS	B-E5	4-F3
R18	100	R-SMD:1206	RS	B-E5	4-B8
R19	1k21*	R-0.4"	R	T-E5	4-C9
R20	78k7*	R-0.4"	R	T-E4	4-B9
R21	332*	R-0.4"	R	T-E4	4-B9
R22	100	R-SMD:1206	RS	B-F4	4-B10
R23	3k16	R-0.4"	R	T-H4	7-B2
R24	3k16	R-0.4"	R	T-H4	7-B3
R25	*	R-0.4"	R	T-G2	7-C3
R26	330	R06-2W	R06-2W	T-H3	7-C7
R27	22	R06-2W	R06-2W	T-I4	7-B7
R28	150k	R06-2W	R06-2W	T-I3	7-A7
R29	6k19	R-0.4"	R	T-H5	7-D4
R30	1k54	R-0.4"	R	T-H5	7-D3
R31	1k54	R-0.4"	R	T-H6	7-D3
R32	10k	R-0.4"	R	T-G2	6-B5
R33	3k3, 2W	R06-2W	R06-2W	T-I1	7-B8
R34	100k	R06-2W	R06-2W	T-I4	7-C8
R35	2k05	R-0.4"	R	T-G7	7-D8
R36	100	R-SMD:1206	RS	B-G6	7-D8
R37	100	R-SMD:1206	RS	B-G6	7-C9
R38	100	R-SMD:1206	RS	B-G6	7-E8
R39	100	R-0.6"	R06	T-F6	7-E9
R40	7k5	R-0.4"	R	T-G5	7-F3
R41	20k	R-0.4"	R	T-H5	7-F3
R42	61k9	R-0.4"	R	T-H5	7-G3
R43	100	R-SMD:1206	RS	B-C3	2-F1
R44	10k	R-0.3"	R03	T-G3	6-A5
R45	100	R-SMD:1206	RS	B-G4	6-E4
R46	100	R-SMD:1206	RS	B-G4	6-E5
R48	100	R-SMD:1206	RS	B-A4	8-D6
R49	1k	R-SMD:1206	RS	B-E6	4-C6
R50	10k, 0.1%	R-0.4"	R	T-A4	8-C5
R52	100	R-SMD:1206	RS	B-C4	2-F4

R53	100	R-SMD:1206	RS	B-D3	3-D8
R54	100	R-SMD:1206	RS	B-D3	3-E8
R55	750	R-0.4"	R	T-E7	1-E6
R56	10k	R-SMD:1206	RS	T-G2	1-F2
R57	10k	R-SMD:1206	RS	T-D5	1-G2
R58	10k	R-SMD:1206	RS	T-D4	1-F2
R59	1M	R-SMD:1206	RS	T-D1	3-E2
R60	1M	R-SMD:1206	RS	T-G5	6-A2
R61	1M	R-SMD:1206	RS	B-G1	6-C2
R62	1M	R-SMD:1206	RS	T-A3	8-A4
R63	49R9	R-SMD:1206	RS	B-C1	2-C2
R64	681	R-SMD:1206	RS	B-C2	2-C4
R65	681	R-SMD:1206	RS	B-C2	2-D4
R66	49R9	R-SMD:1206	RS	B-C2	2-C4
R67	100	R-SMD:1206	RS	B-C4	2-F4
R68	1M	R-SMD:1206	RS	T-D1	3-E2
R69	1k	R-0.4"	R	T-D3	3-B4
R70	10k	R-0.4"	R	T-D2	3-A5
R71	100	R-SMD:1206	RS	T-D5	4-B5
R72	100	R-SMD:1206	RS	B-G4	6-E5
R73	1M	R-SMD:1206	RS	T-G5	6-A2
R74	1M	R-SMD:1206	RS	B-G2	6-C1
R75	100	R-SMD:1206	RS	B-A4	8-D6
R76	1M	R-SMD:1206	RS	T-A3	8-A4
R77	2R2, 2W	R06-2W	R06-2W	T-A1	8-B8
R78	3k02	R-SMD:1206	RS	B-A3	8-A5
R79	1k	R-SMD:1206	RS	B-A2	8-B6
R80	681	R-SMD:1206	RS	B-B2	2-D8
R81	71R5	R-SMD:1206	RS	B-C2	2-E7
R82	100	R-SMD:1206	RS	B-B3	2-D9
R83	100	R-SMD:1206	RS	B-D4	4-B5
R84	100	R-SMD:1206	RS	B-C4	2-D10
R85	100	R-SMD:1206	RS	B-B2	2-E6
R86	100	R-SMD:1206	RS	B-G4	6-G4
R87	10k*	R-0.4"	R	T-D5	4-B3
R88	4k02	R-SMD:1206	RS	B-B2	8-A7
R89	1k	R-SMD:1206	RS	B-B2	8-B7
R90	750	R-SMD:1206	RS	B-G5	7-G1
R91	100	R-0.6"	R06	T-G4	6-F5
R92	100	R-SMD:1206	RS	B-G3	6-D8
R93	100	R-SMD:1206	RS	B-G4	6-D9
R94	100	R-SMD:1206	RS	B-G3	6-D7
R95	100	R-SMD:1206	RS	B-G3	6-D9
R96	100	R-SMD:1206	RS	T-G3	6-F8
R97	100	R-0.6"	R06	T-H2	6-E9
R98	10k	R-0.4"	R	T-G2	6-C5
R99	10k	R-0.4"	R	T-G2	6-C6
R130	**	R-0.4"	R04N	T-F3	5-C2
R131	**	R-0.4"	R04N	T-F3	5-C3
R132	**	R-0.4"	R04N	T-F3	5-C2
R133	**	R-0.4"	R04N	T-F2	5-C5
R134	**	R-0.4"	R04N	T-F2	5-C6
R135	**	R-0.4"	R04N	T-F2	5-C5
R143	**	R-0.4"	R	T-F3	5-C3
R144	**	R-0.4"	R	T-F2	5-C6
---S---					
S10	[undefined]	S1X2S01L	S1X2S01L	T-E3	5-B4
S11	[undefined]	S1X2S01L	S1X2S01L	T-E2	5-B7

---T---					
T1	2N4416	TO-72	2N4416	T-H5	7-D5
T2	2N4416	TO-72	2N4416	T-I5	7-E5
T3	2N4416	TO-72	2N4416	T-I5	7-E6
T4	2N4416	TO-72	2N4416	T-H5	7-D6
T6	TIP122	TO-220	TIP122	T-B2	8-A8
---X---					
X1	[undefined]	Backplane:96-pin/ABC	XB96	T-B7	1-C3,1-C4,1-C6
X2	[undefined]	Backplane:96-pin/ABC	XB96	T-H7	1-C7,1-C8
X3	PD	SMA/horz.	XS-4S-SMA3	T-C1	2-B1
X4	LO	SMA/horz.	XS-4S-SMA3	T-C1	2-C1
X5	[undefined]	XSO4-LEMON	XSO4-4S-LEMON	T-B1	8-C1
X7	TEST3	LEMO:1-pin/horz.	XS-4S-LEMOOOHL	T-D1	3-E1
X8	MIXEROUT	LEMO:1-pin/horz.	XS-4S-LEMOOOHL	T-D1	3-C9
X9	[undefined]	Testpin	XT	T-D3	3-C7
X10	[undefined]	Testpin	XT	T-E6	4-B8
X11	[undefined]	Testpin	XT	T-F4	4-B10
X12	OUT	Testpin	XT	T-E3	5-C4
X13	OUT	Testpin	XT	T-E1	5-C7
X15	[undefined]	Testpin	XT	T-H6	7-D4
X16	TFIN	LEMO:1-pin/horz.	XS-4S-LEMOOOHL	T-G1	6-B1
X18	HVMON	LEMO:1-pin/horz.	XS-4S-LEMOOOHL	T-H1	7-E10
X19	[undefined]	Testpin	XT	T-H6	1-F4
X20	[undefined]	Testpin	XT	T-D7	1-F4
X21	[undefined]	Testpin	XT	T-A6	1-F4
X22	[undefined]	Testpin	XT	T-C5	1-B11
X23	PZT, Lemo OS	ShieldedCable	XS	T-I1	7-B10
X24	[undefined]	Testpin	XT	T-E7	1-C11
X25	[undefined]	Testpin	XT	T-E7	1-D11
X26	[undefined]	Testpin	XT	T-B2	2-E6
X27	[undefined]	Testpin	XT	T-C4	2-D10
X28	[undefined]	Testpin	XT	T-E4	4-B5
X29	TFB	LEMO:1-pin/horz.	XS-4S-LEMOOOHL	T-F1	6-F5
X30	[undefined]	Testpin	XT	T-C7	1-C9
X31	[undefined]	Testpin	XT	T-D7	1-D9
X32	LODET	Testpin	XT	T-C4	2-F5
X34	MIXEROUT	Testpin	XT	T-D3	3-E9
X35	TEMP	Testpin	XT	T-A7	8-D6
X36	HEATER	Testpin	XT	B-A2	8-A6
X37	-10V	Testpin	XT	T-G5	7-G2
X38	[undefined]	XO2TO2	XO2T	T-I6	7-F5
X39	[undefined]	XO3AN	XO3AN	T-B5	1-E10
X40	[undefined]	Testpin	XT	T-B2	8-B8
X41	[undefined]	Testpin	XT	T-B1	8-A9
X42	[undefined]	Testpin	XT	T-A2	8-A8
X45	TFA	LEMO:1-pin/horz.	XS-4S-LEMOOOHL	T-H1	6-E10

Population Variants

This circuit features a flexible design, so that its behaviour can be adapted to the user's needs by modifying the board population. The following predefined *population variants* are supported:

Standard: With temperature controller

Value list: The following list shows all *standard* components of the board (sorted by part *values*) that *might* differ from other population variants.

```
EAGLE Version 5.10.0 Copyright (c) 1988-2010 CadSoft
Board value list of 'ilspmc_servo3.brd' (Standard)
Exported at 2010-07-19 16:22
Created with macro 'plot.ulp' (c) Andreas Weidner
Shown are: Value/Type,Package,Number,Names (Library)

---C---
4n7         C-SMD:0805  (1*)    C4 (miscs)
100n        C-SMD:0805  (6*)    C71,C72,C73,C74,C76,C81 (miscs)

---N---
AD620       DIP-8       (1*)    N38 (opamps)
OP27        DIP-8       (2*)    N13,N14 (opamps)

---R---
2R2, 2W     RO6-2W      (1*)    R77 (miscs)
100         R-SMD:1206  (2*)    R48,R75 (miscs)
1k          R-SMD:1206  (2*)    R79,R89 (miscs)
3k02        R-SMD:1206  (1*)    R78 (miscs)
4k02        R-SMD:1206  (1*)    R88 (miscs)
10k, 0.1%   R-0.4"      (2*)    R4,R50 (miscs)
1M          R-SMD:1206  (2*)    R62,R76 (miscs)

---T---
TIP122      TO-220      (1*)    T6 (transistors)

---X---
HEATER      Testpin     (1*)    X36 (connectors)
TEMP        Testpin     (1*)    X35 (connectors)
```

Part list: The following list shows all *standard* components available in the schematics (sorted by part *names*) that *might* differ from other population variants.

```
EAGLE Version 5.10.0 Copyright (c) 1988-2010 CadSoft
Schematics part list of 'ilspmc_servo3.sch' (Standard)
Exported at 2010-07-19 16:22
Created with macro 'plot.ulp' (c) Andreas Weidner
Shown are: Name,Value/Type,Package,Device,Layer/Cell,Sheets/Cells

---C---
C4   4n7        C-SMD:0805  CS      B-B2  8-B6
C71  100n       C-SMD:0805  CS      T-B3  8-F2
C72  100n       C-SMD:0805  CS      T-B3  8-F2
C73  100n       C-SMD:0805  CS      T-A2  8-G2
C74  100n       C-SMD:0805  CS      T-A3  8-G2
C76  100n       C-SMD:0805  CS      T-B4  8-F3
C81  100n       C-SMD:0805  CS      T-A3  8-G3

---N---
N13  OP27       DIP-8       OP27    T-A2  8-A6,8-F3
```

```
N14  OP27       DIP-8       OP27    T-A4  8-D5,8-F1
N38  AD620      DIP-8       AD620   T-A3  8-A4,8-F2

---R---
R4   10k, 0.1%  R-0.4"       R       T-A4  8-C5
R48  100        R-SMD:1206  RS      B-A4  8-D6
R50  10k, 0.1%  R-0.4"       R       T-A4  8-C5
R62  1M         R-SMD:1206  RS      T-A3  8-A4
R75  100        R-SMD:1206  RS      B-A4  8-D6
R76  1M         R-SMD:1206  RS      T-A3  8-A4
R77  2R2, 2W    R06-2W      R06-2W  T-A1  8-B8
R78  3k02       R-SMD:1206  RS      B-A3  8-A5
R79  1k         R-SMD:1206  RS      B-A2  8-B6
R88  4k02       R-SMD:1206  RS      B-B2  8-A7
R89  1k         R-SMD:1206  RS      B-B2  8-B7

---T---
T6   TIP122     TO-220      TIP122  T-B2  8-A8

---X---
X35  TEMP       Testpin     XT      T-A7  8-D6
X36  HEATER     Testpin     XT      B-A2  8-A6
```

Variant 1: Without temperature controller

Value list: The following list shows all components of the board (sorted by part *values*) that differ from the standard population.

```
EAGLE Version 5.10.0 Copyright (c) 1988-2010 CadSoft
Board value list of 'ilspmc_servo3.brd' (Variant 1)
Exported at 2010-07-19 16:22
Created with macro 'plot.ulp' (c) Andreas Weidner
Shown are: Value/Type,Package,Number,Names (Library)

---[unpopulated]---
[undefined]             C4,C71,C72,C73,C74,C76,C81,J4,N13,N14,N38,R4,R48,R50,R62,R75,
                        R76,R77,R78,R79,R88,R89,T6,X5,X35,X36,X40,X41,X42 (miscs)
```

Part list: The following list shows all components available in the schematics (sorted by part *names*) that differ from the standard population.

```
EAGLE Version 5.10.0 Copyright (c) 1988-2010 CadSoft
Schematics part list of 'ilspmc_servo3.sch' (Variant 1)
Exported at 2010-07-19 16:22
Created with macro 'plot.ulp' (c) Andreas Weidner
Shown are: Name,Value/Type,Package,Device,Layer/Cell,Sheets/Cells

---C---
C4   [unpopulated]      B-B2  8-B6
C71  [unpopulated]      T-B3  8-F2
C72  [unpopulated]      T-B3  8-F2
C73  [unpopulated]      T-A2  8-G2
C74  [unpopulated]      T-A3  8-G2
C76  [unpopulated]      T-B4  8-F3
C81  [unpopulated]      T-A3  8-G3

---J---
J4   [unpopulated]      T-B1  8-C1

---N---
```

```
N13  [unpopulated]      T-A2  8-A6,8-F3
N14  [unpopulated]      T-A4  8-D5,8-F1
N38  [unpopulated]      T-A3  8-A4,8-F2

---R---
R4   [unpopulated]      T-A4  8-C5
R48  [unpopulated]      B-A4  8-D6
R50  [unpopulated]      T-A4  8-C5
R62  [unpopulated]      T-A3  8-A4
R75  [unpopulated]      B-A4  8-D6
R76  [unpopulated]      T-A3  8-A4
R77  [unpopulated]      T-A1  8-B8
R78  [unpopulated]      B-A3  8-A5
R79  [unpopulated]      B-A2  8-B6
R88  [unpopulated]      B-B2  8-A7
R89  [unpopulated]      B-B2  8-B7

---T---
T6   [unpopulated]      T-B2  8-A8

---X---
X5   [unpopulated]      T-B1  8-C1
X35  [unpopulated]      T-A7  8-D6
X36  [unpopulated]      B-A2  8-A6
X40  [unpopulated]      T-B2  8-B8
X41  [unpopulated]      T-B1  8-A9
X42  [unpopulated]      T-A2  8-A8
```

Version History

The circuit has undergone changes since the initial design, either to improve the circuit behaviour or to add functionality. The following table gives a short overview of these changes:

Version date	Description
2010-02-02	➤ Initial design by Patrick Kwee
2010-06-15	➤ Population variant support added ➤ Direction of D4 and D5 corrected ➤ TLE2227 replaced by LT1124 ➤ Corrected wrong package of D1 ➤ Moved several names/values on board for readable documentation ➤ Some values changed in the schematics to reflect the new version 4 (but with the mechanical layout of version 3). With the exception of the logical position of R83/X28, the circuit is now identical to version 4

Table 2: *Version history overview*