
ISS SECOND LOOP SERVO

Circuit Board Documentation

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Abstract

This is the Servo for the aLIGO second loop power stabilization. It takes the input signal from PDs 1-4 and 5-8, selects the in-loop sensor and provides further filtering.

There is an additional channel that provides an IMC pole compensation, in case the first loop sensor is placed downstream the IMC.

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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.
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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 Laborausstattung 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.
-

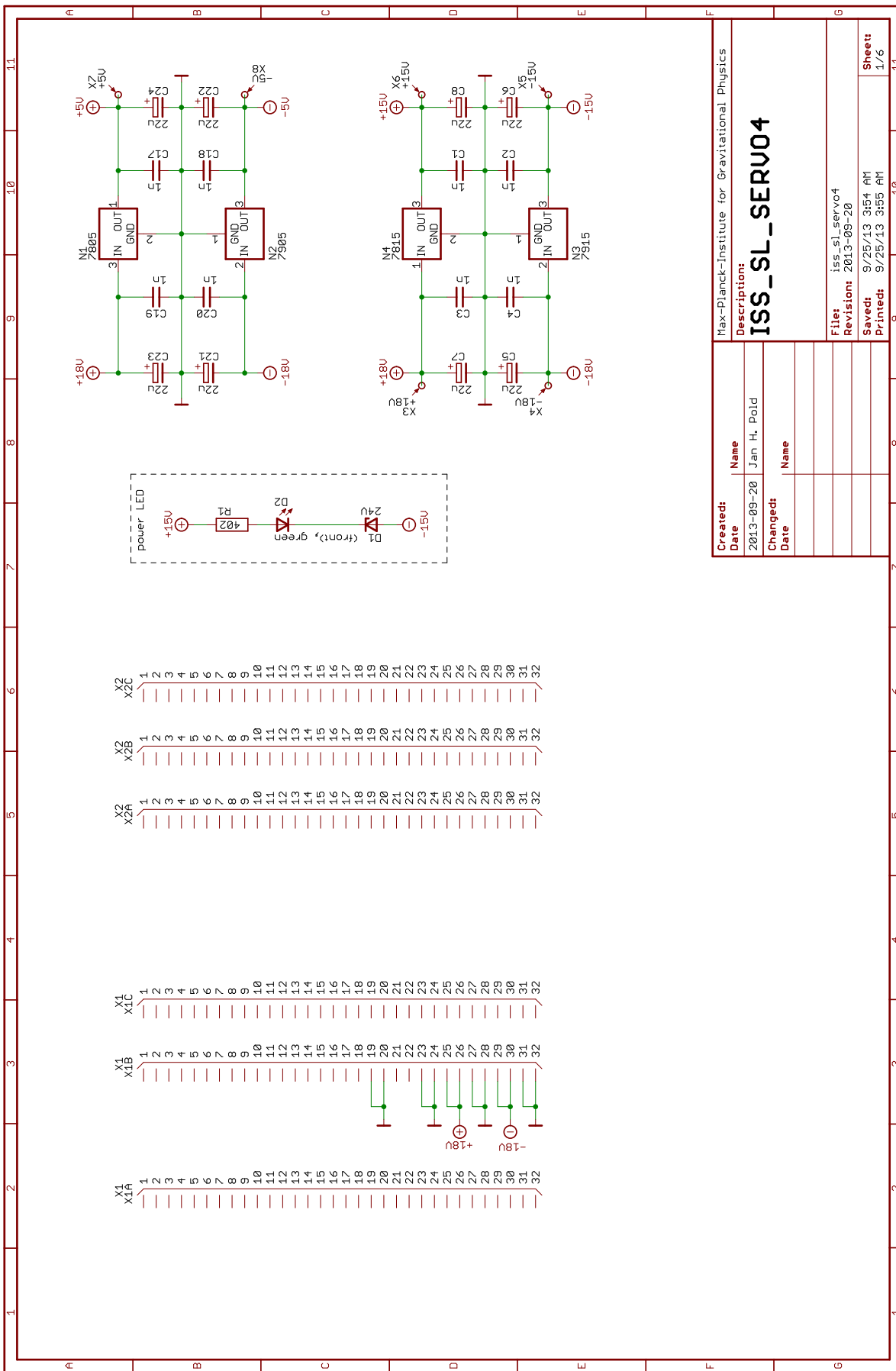
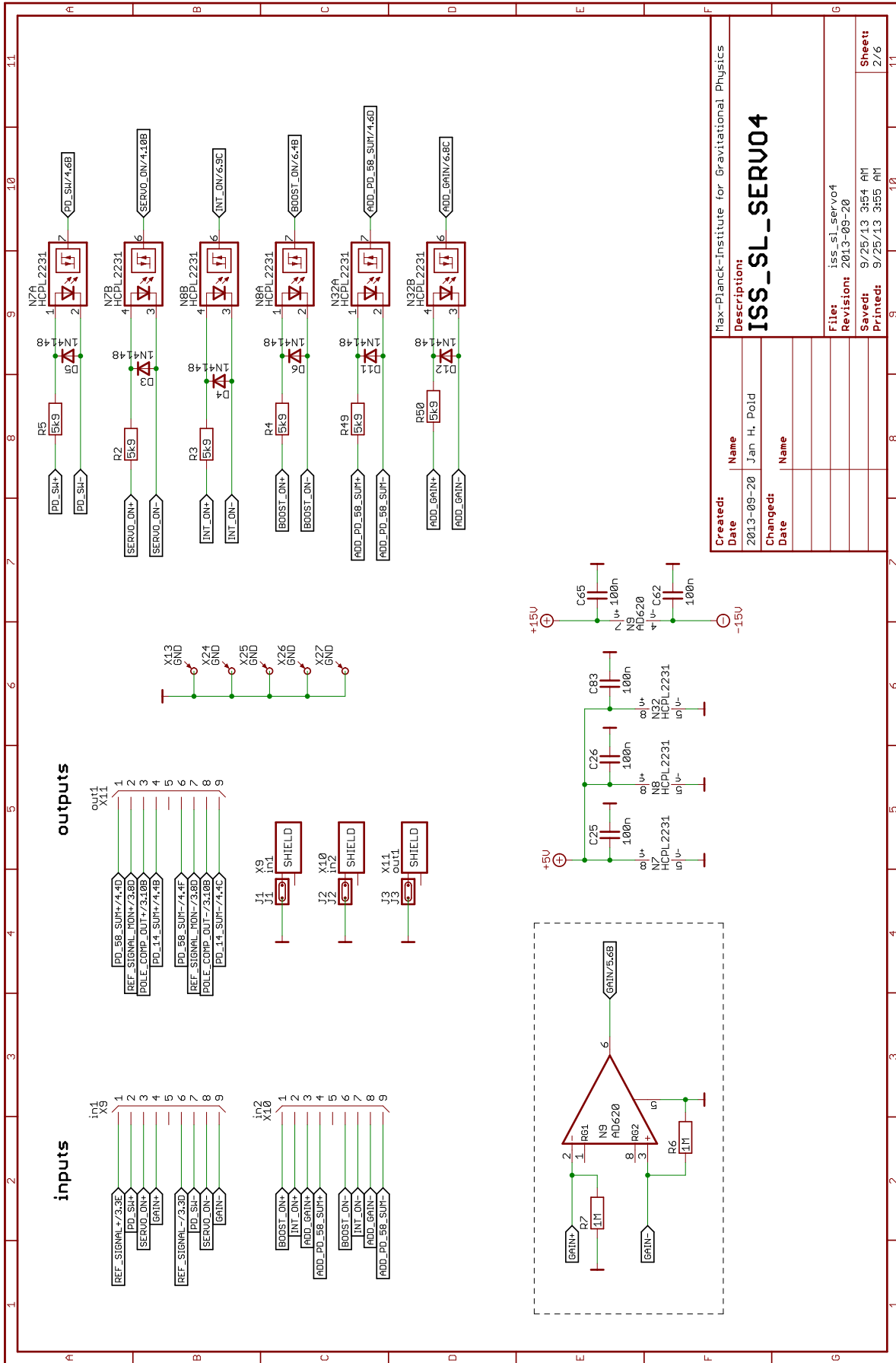


Figure 1: Project schematics (sheet 1)



Created:		Description:	
Date	Name	Max-Planck-Institute for Gravitational Physics	
2013-09-20	Jan H. Pojd	ISS_SL_SERVO4	
Changed:	Name		
Date	Name	File:	iss_sl_servo4
		Revision:	2013-09-20
		Saved:	9/25/13 3:54 AM
		Printed:	9/25/13 3:55 AM
		Sheet:	2/6

Figure 2: Project schematics (sheet 2)

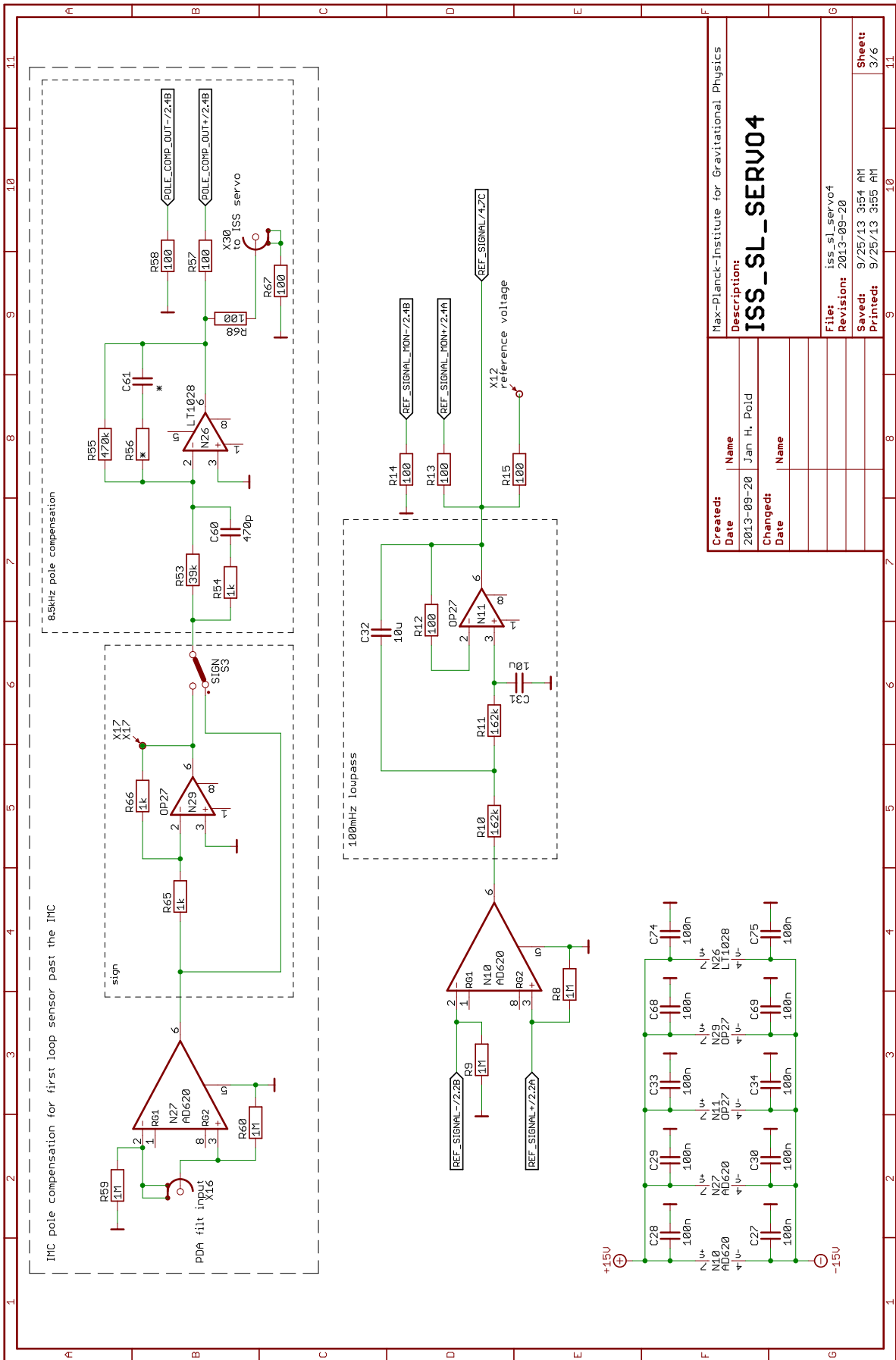
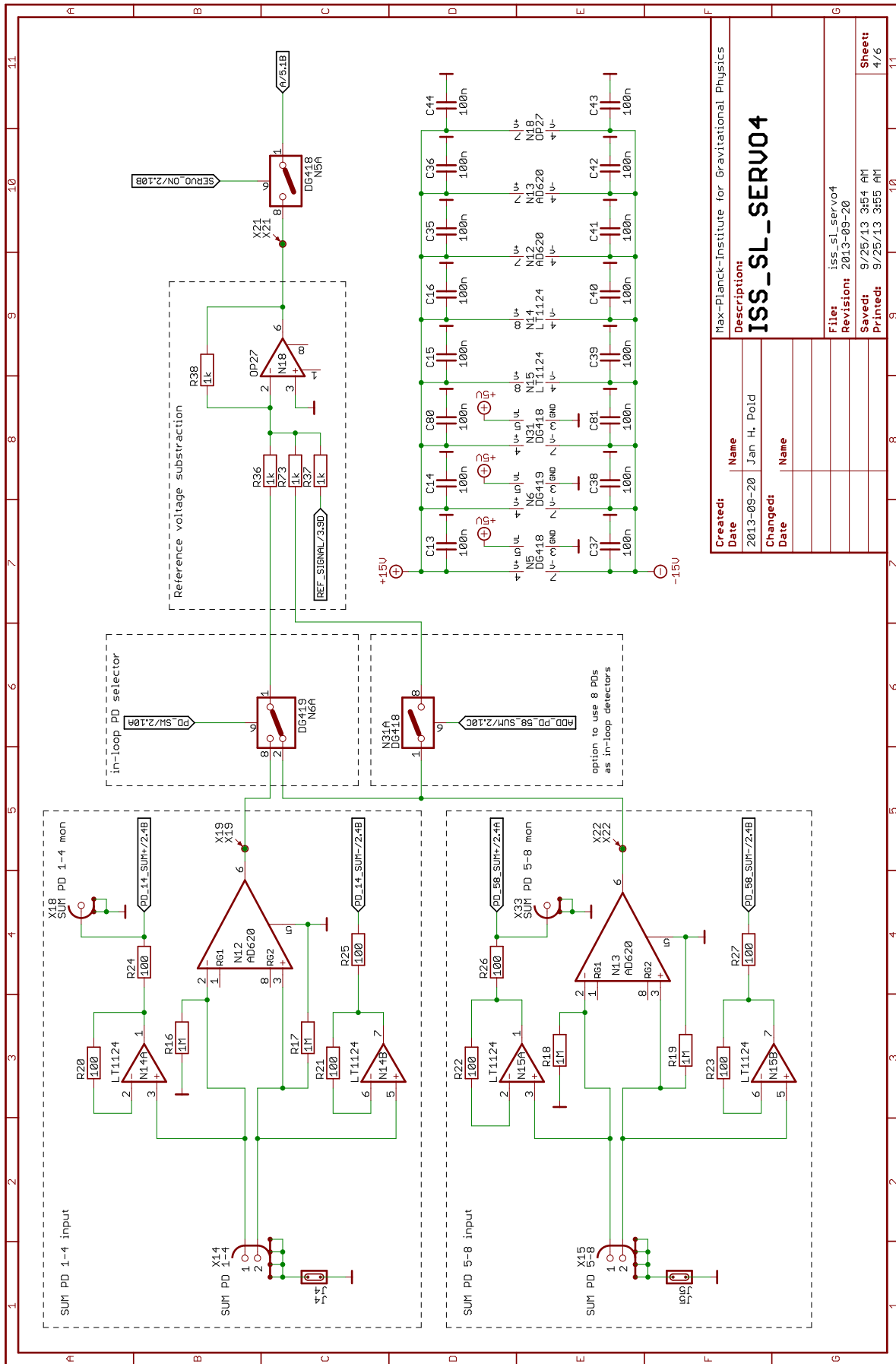


Figure 3: Project schematics (sheet 3)



Created:		Max-Planck-Institute for Gravitational Physics	
Date	Name	Description	
2013-09-20	Jan H. Pojd	ISS_SL_SERVO4	
Changed:	Name	File:	iss_sl_servo4
Date		Revision:	2013-09-20
		Saved:	9/25/13 3:54 AM
		Printed:	9/25/13 3:55 AM
		Sheet:	4/6

Figure 4: Project schematics (sheet 4)

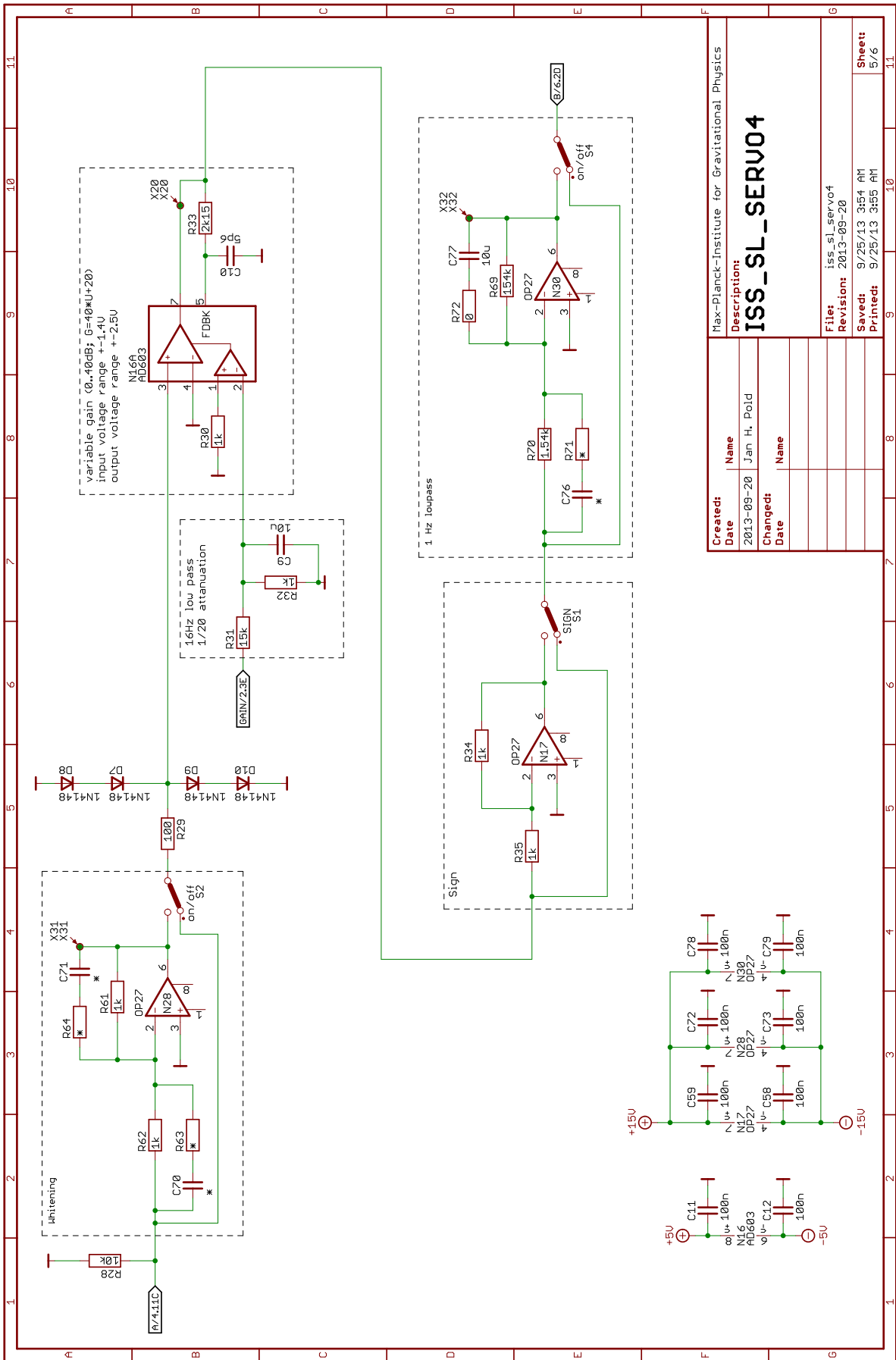


Figure 5: Project schematics (sheet 5)

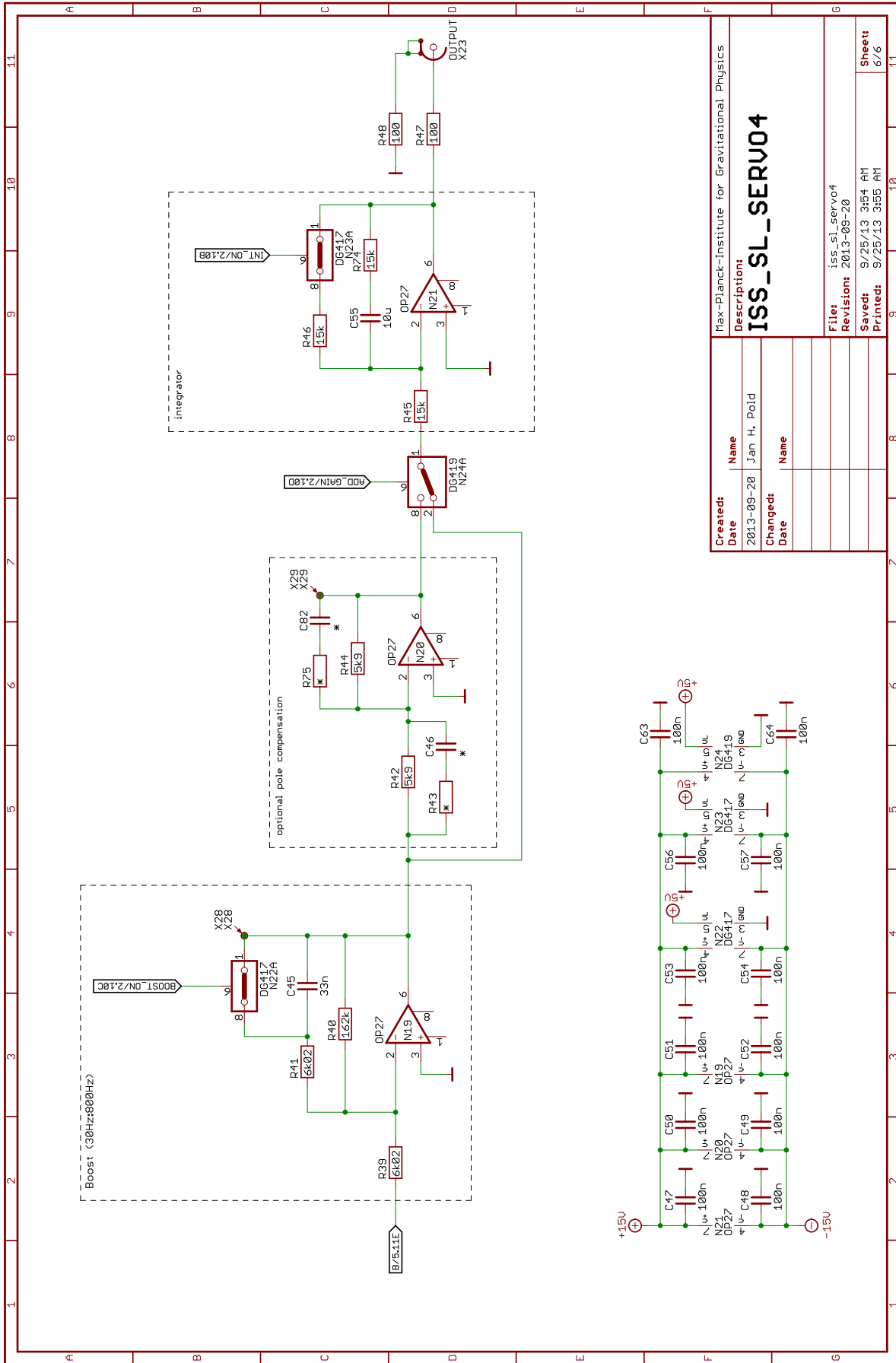


Figure 6: Project schematics (sheet 6)

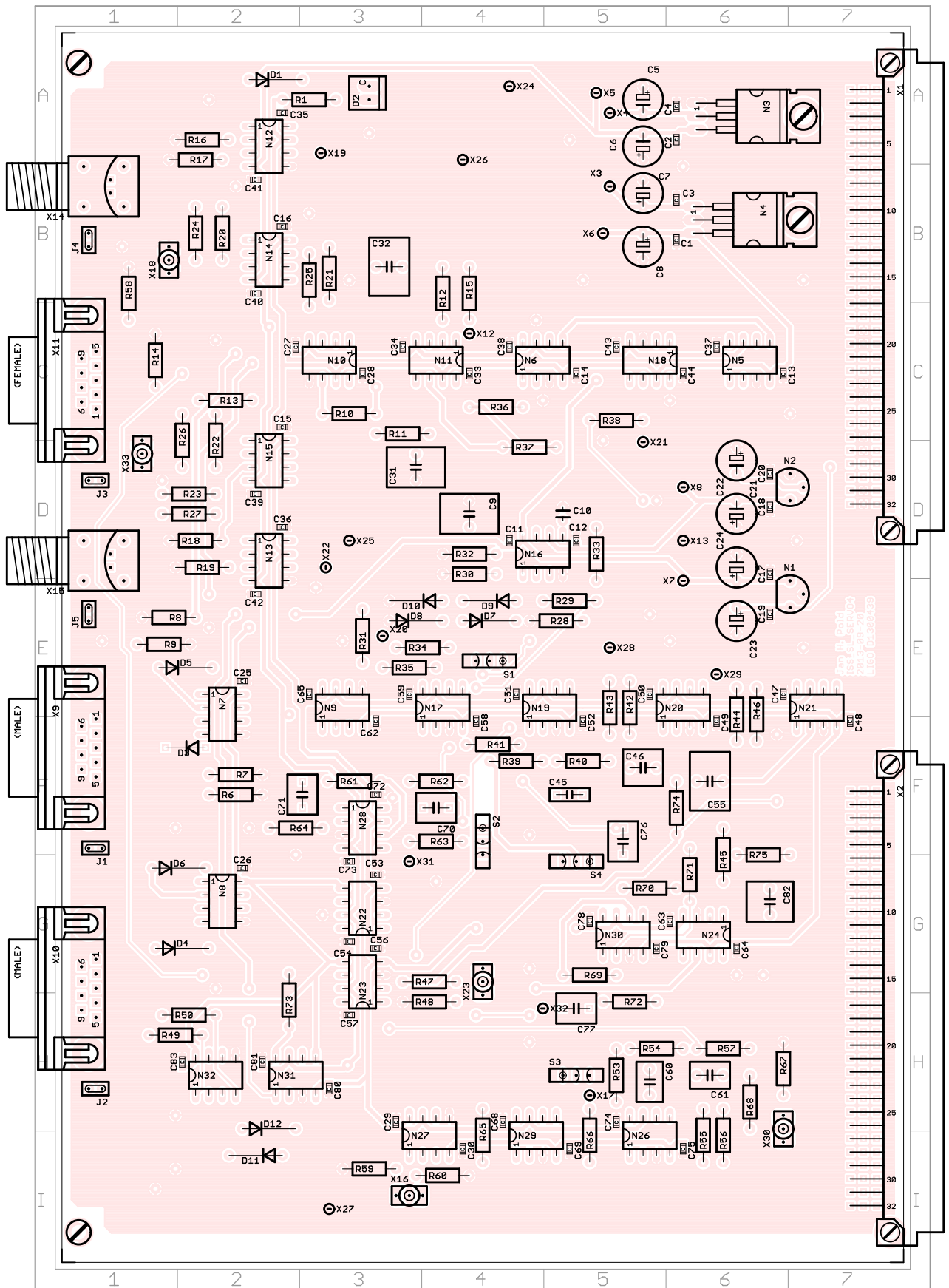


Figure 7: Board top view showing placeplan with component names

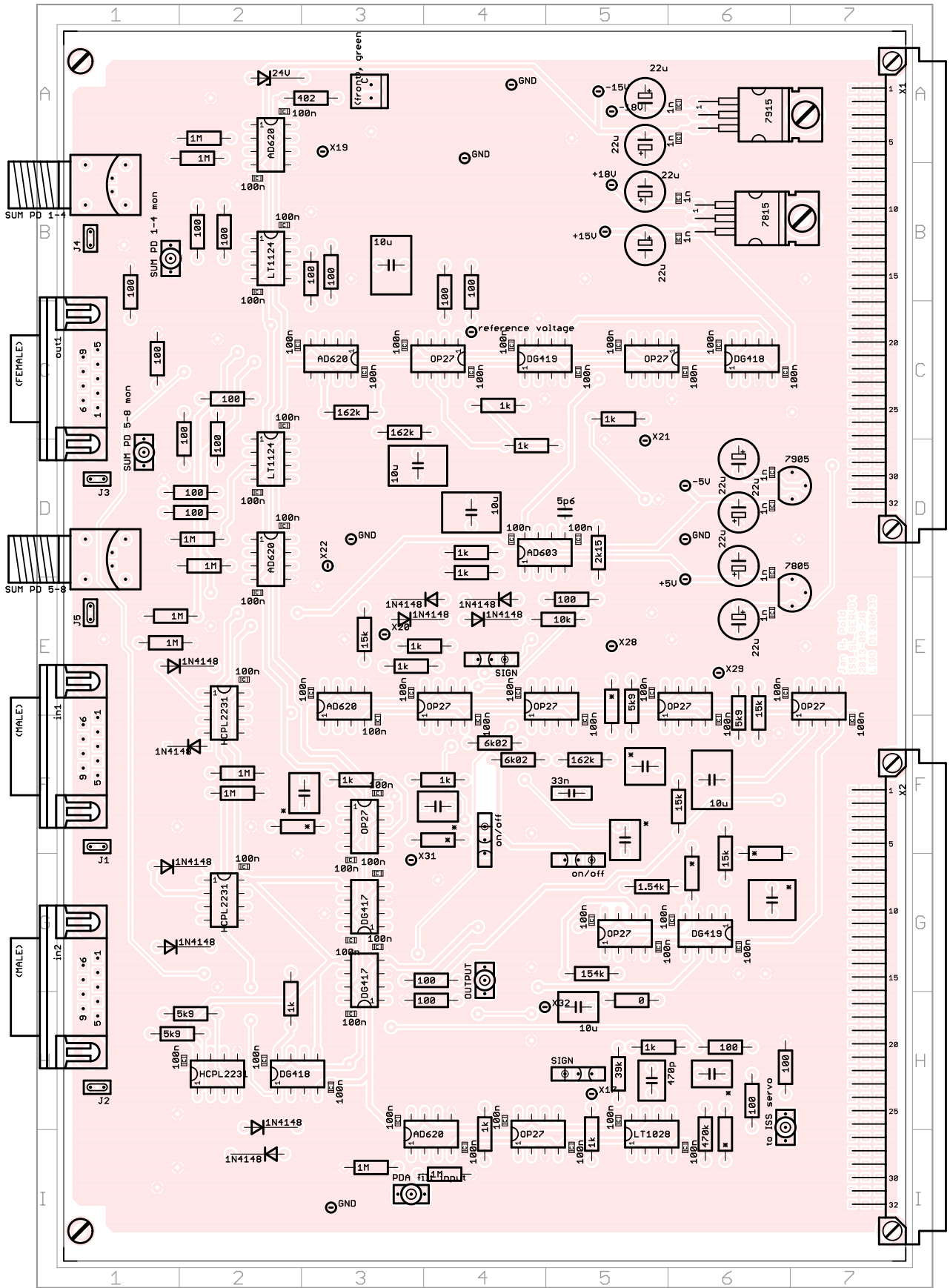


Figure 8: Board top view showing placeplan with component values

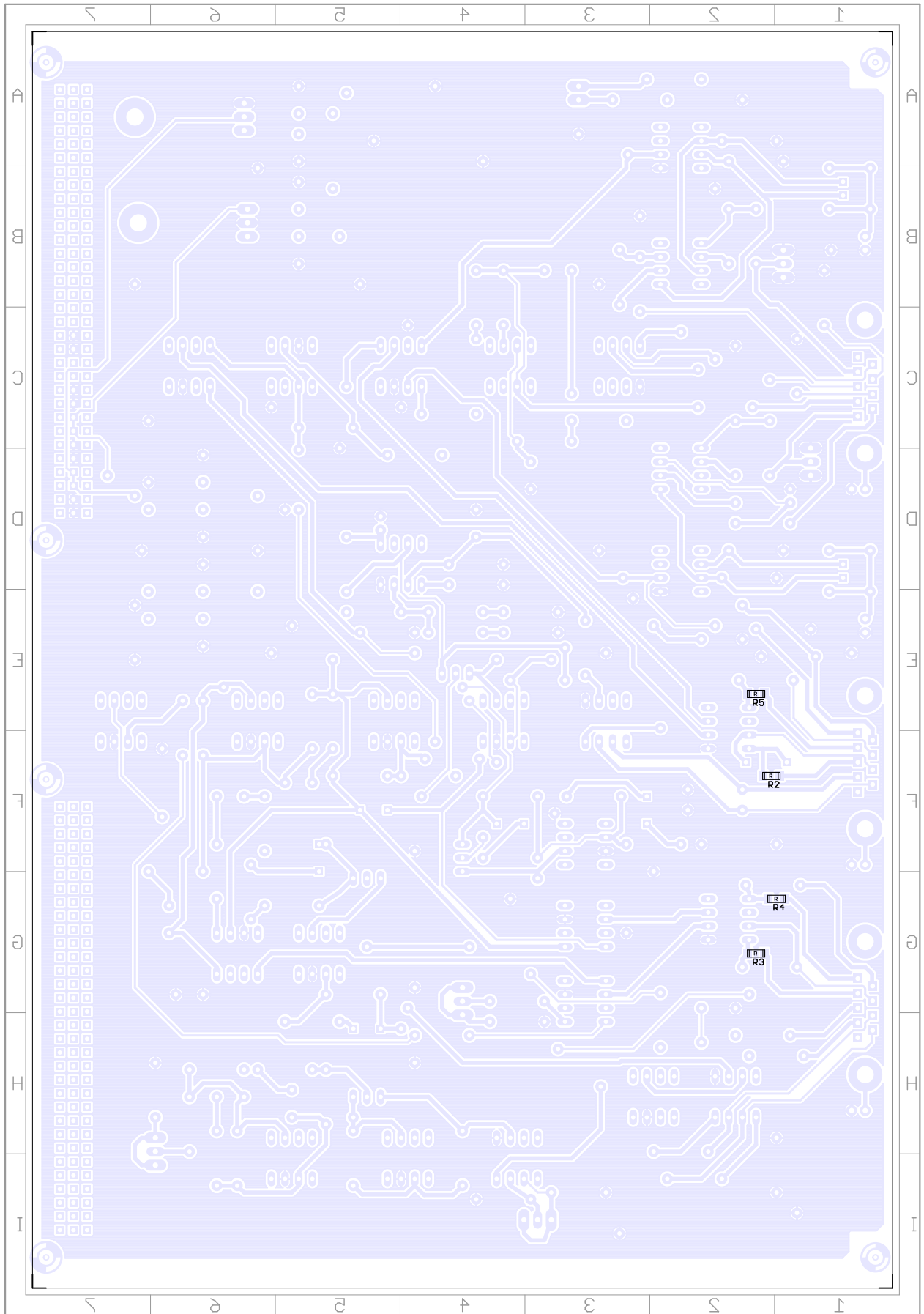


Figure 9: Board bottom view showing placeplan with component names

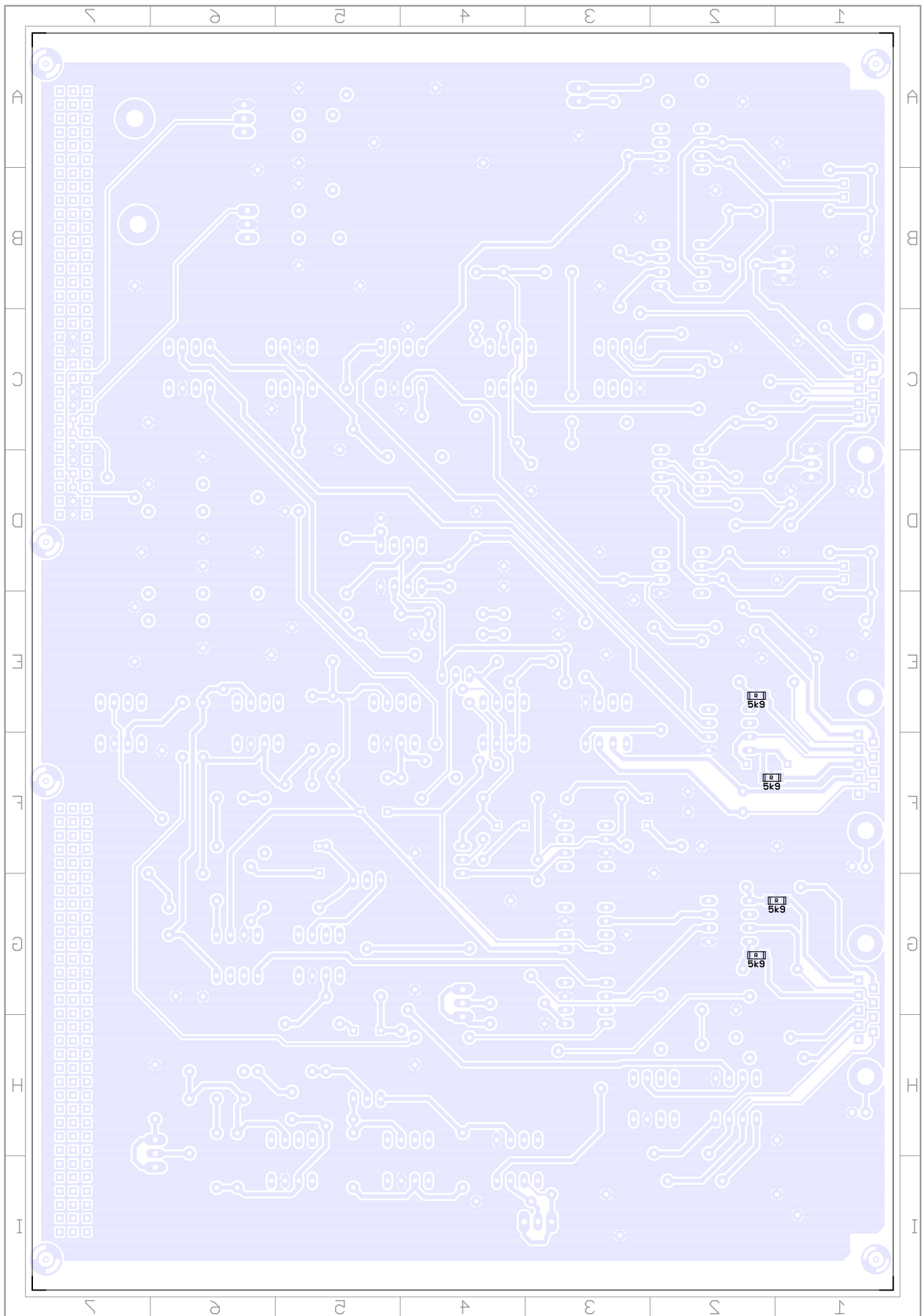


Figure 10: Board bottom view showing placeplan with component values

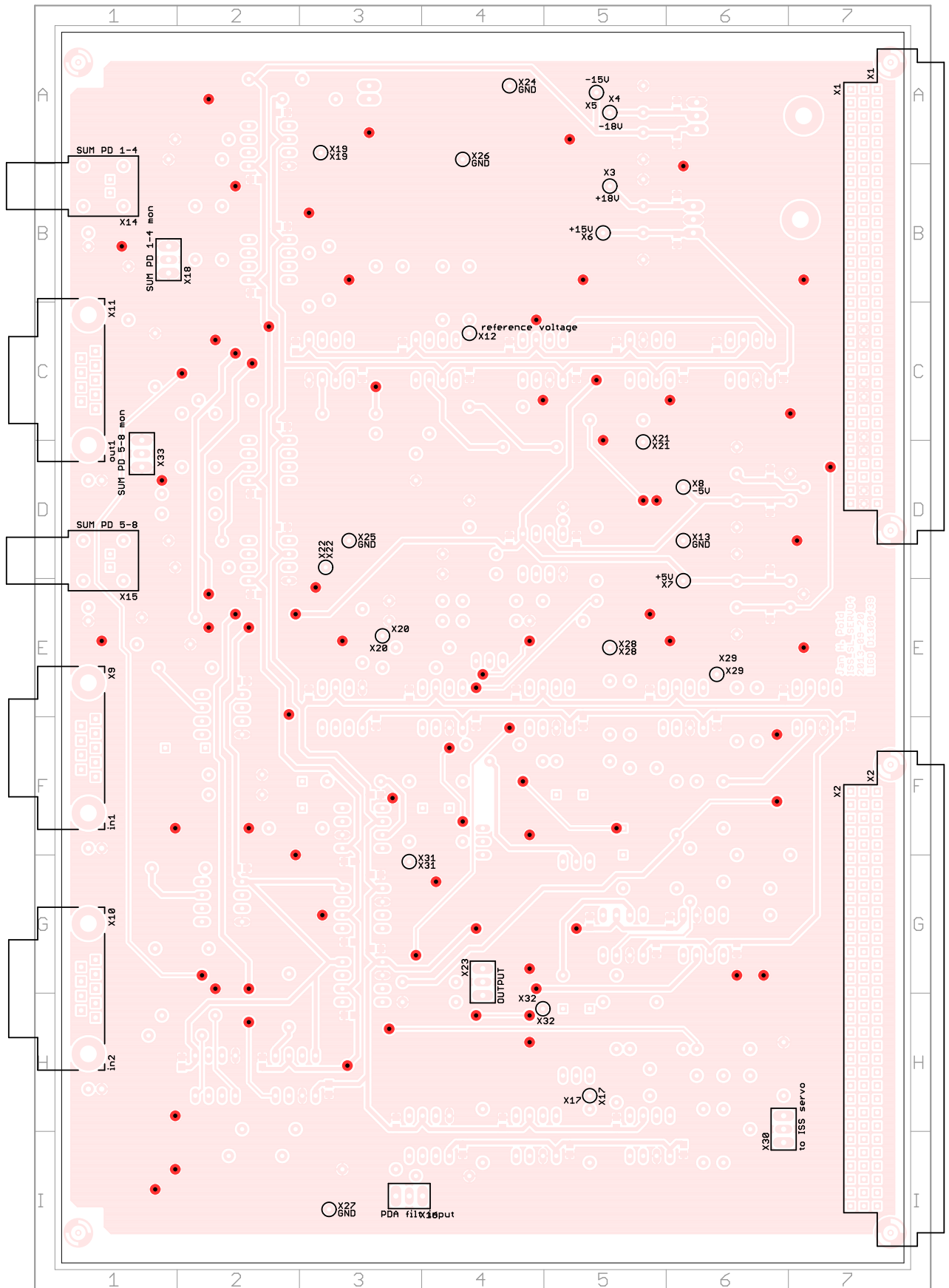


Figure 11: Board top view showing connectors, test points, vias and wired components

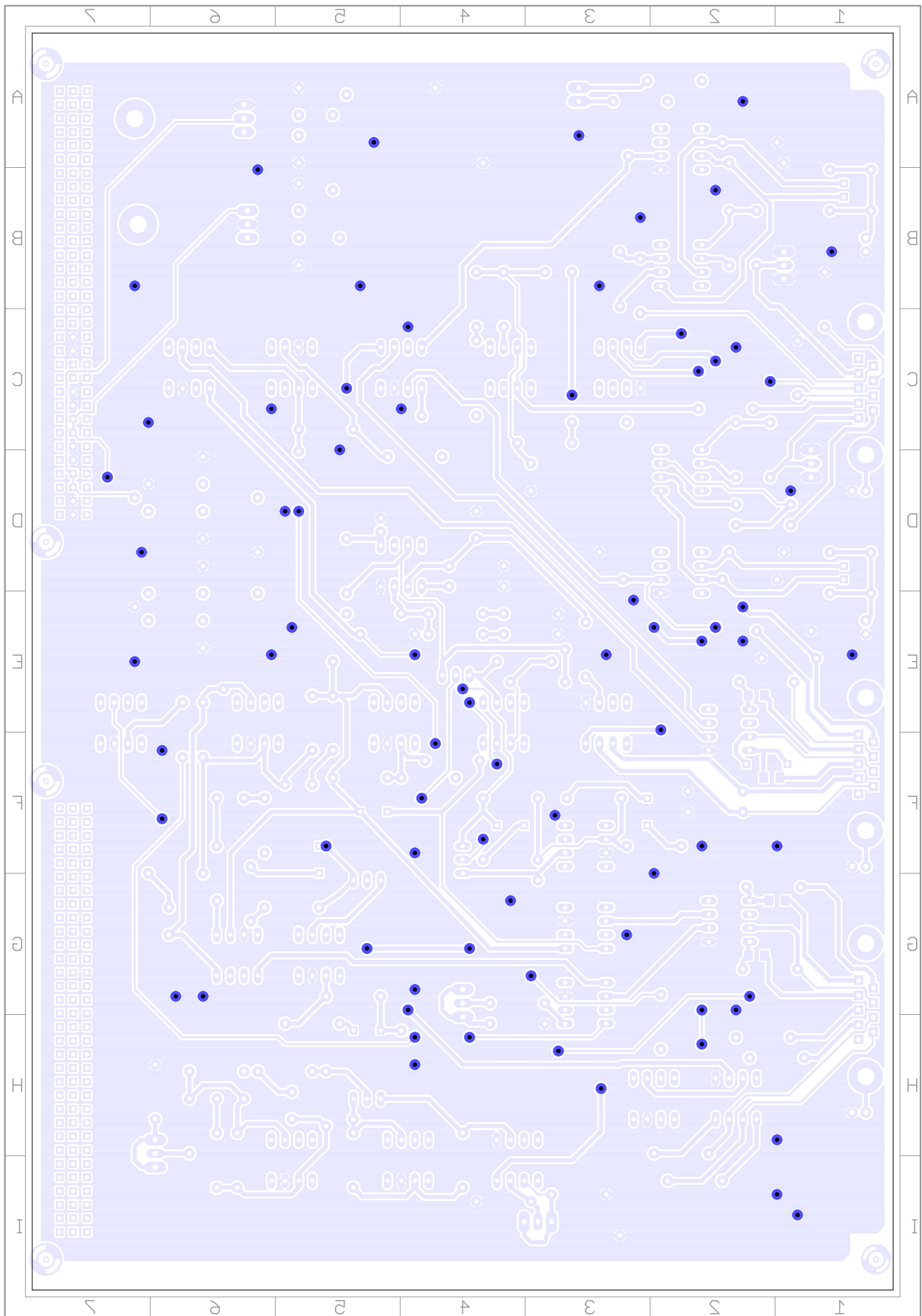


Figure 12: Board bottom view showing connectors, test points, vias and wired components

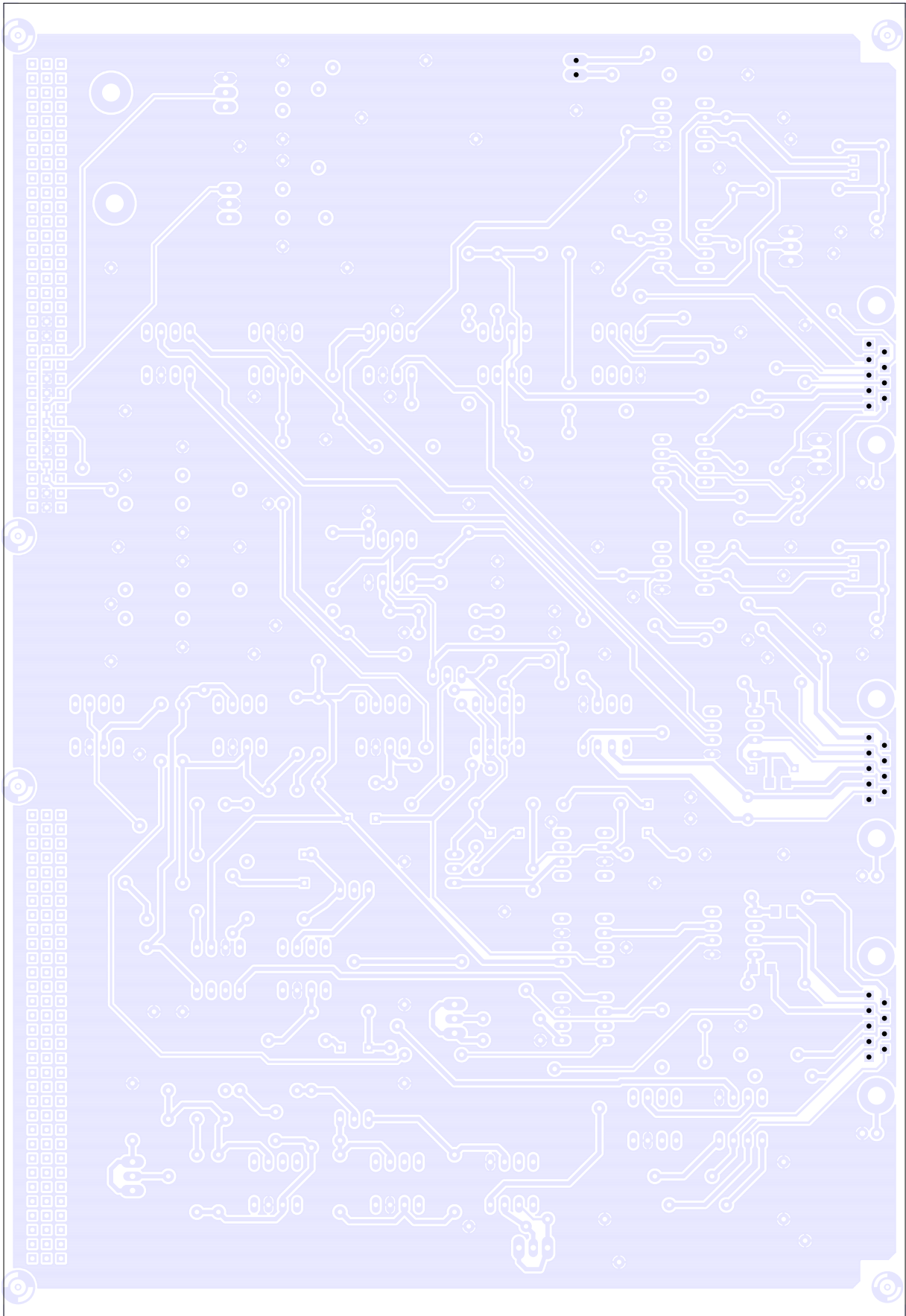


Figure 13: Board bottom view showing drills with 0.9 mm (0.035 in) diameter

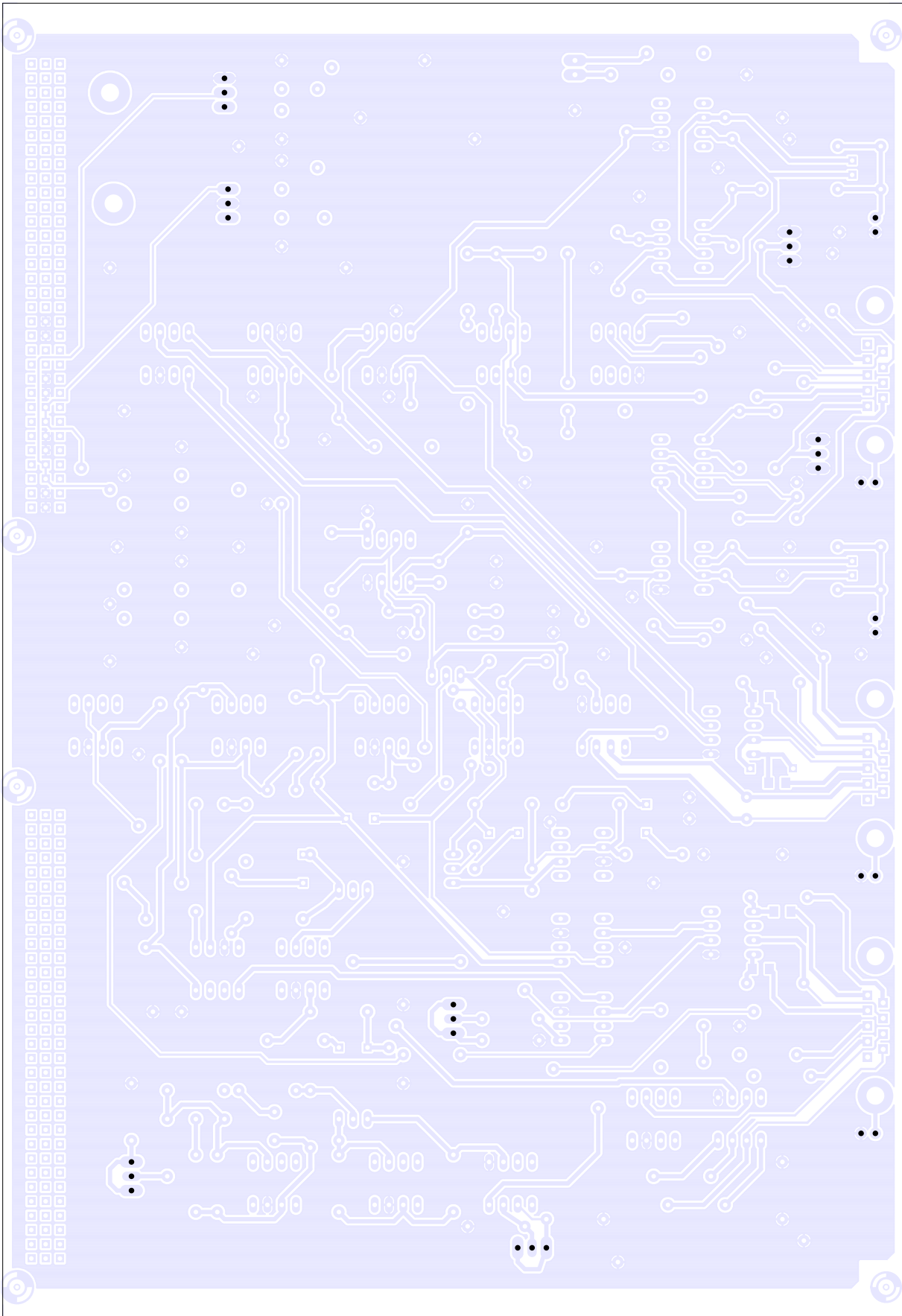


Figure 14: Board bottom view showing drills with 1.0 mm (0.039 in) diameter

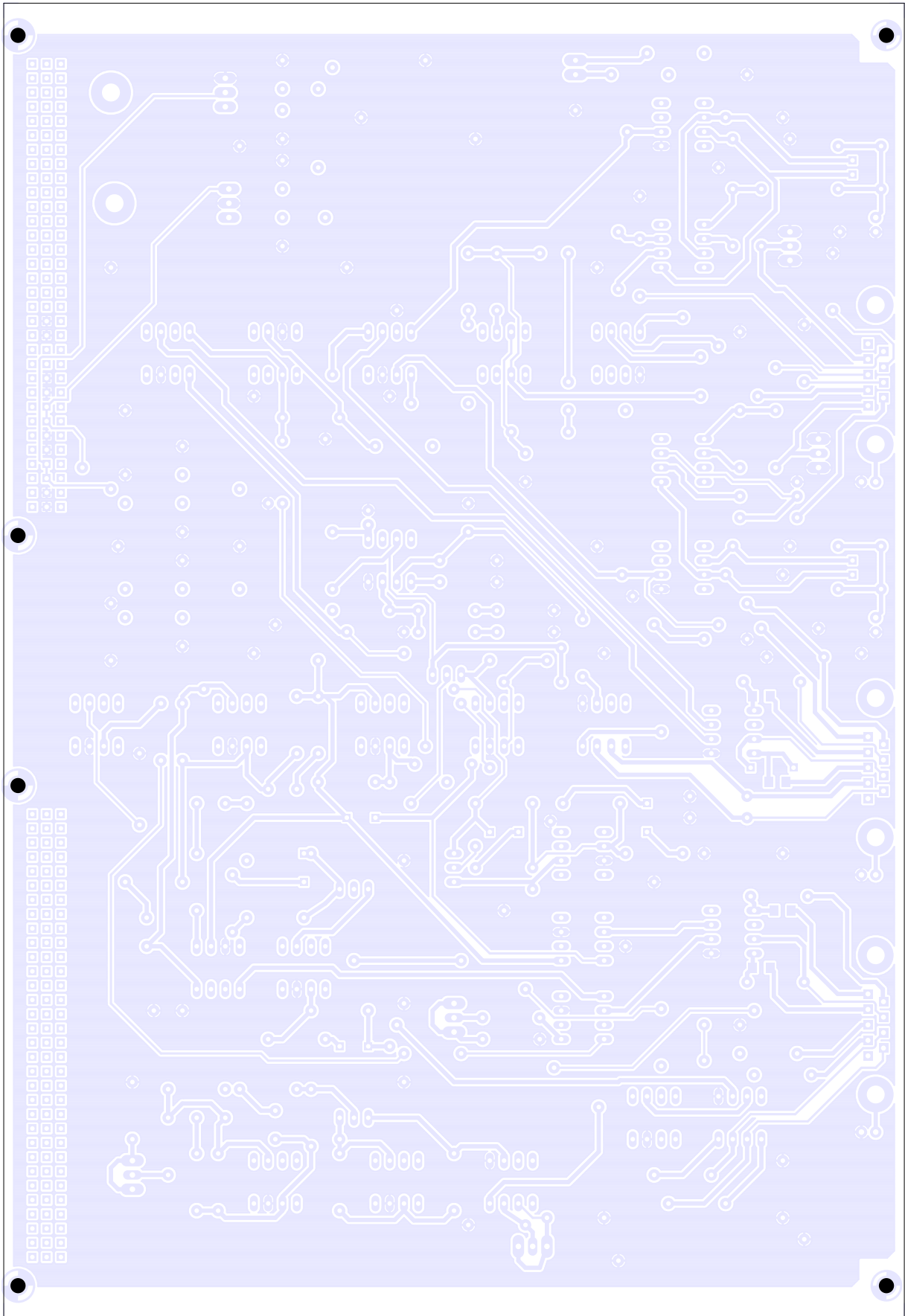


Figure 15: Board bottom view showing drills with 2.7 mm (0.106 in) diameter

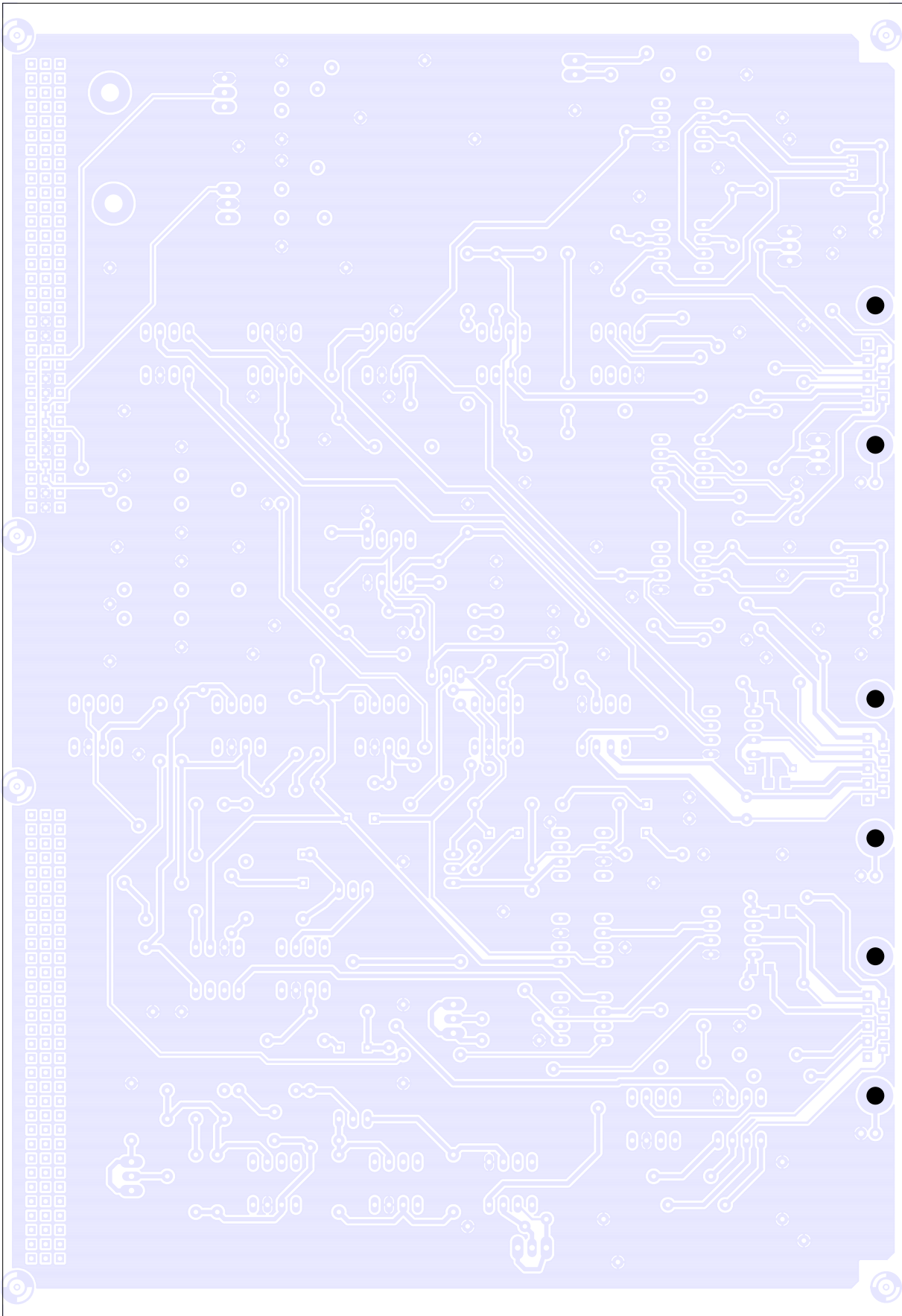


Figure 16: Board bottom view showing drills with 3.2 mm (0.125 in) diameter

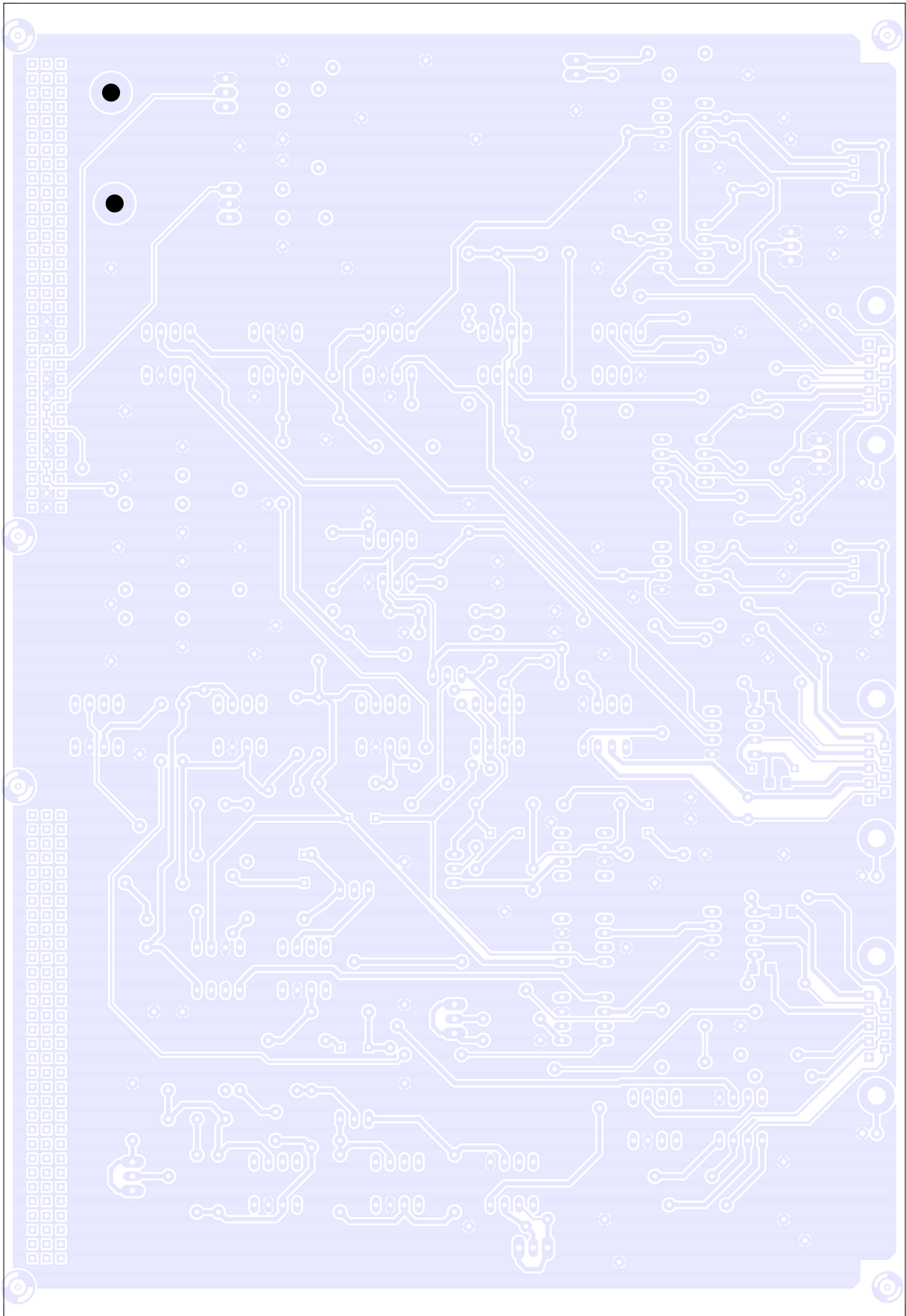


Figure 17: Board bottom view showing drills with 3.2 mm (0.126 in) diameter

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.

\varnothing [μm]	\varnothing [mm]	\varnothing [in]	Count
813	0.8	0.032	738
889	0.9	0.035	29
991	1.0	0.039	31
2692	2.7	0.106	6
3175	3.2	0.125	6
3200	3.2	0.126	2
Total			812

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. Additional information can possibly be found directly on the board (or in the schematics).

```

1 EAGLE Version 5.12.0 Copyright (c) 1988-2011 CadSoft
2 Board value list of 'iss_sl_servo4.brd'
3 Exported at 2013-09-25 03:56
4 Created with macro 'plot.ulp' (c) Andreas Weidner
5 Shown are: Value/Type,Package,Number,Names (Library)
6
7 ---C---
8 5p6          C-0.1"          (1*)   C10 (miscs)
9 470p        C-WIMA:MKS2-0.2" (1*)   C60 (miscs)
10 1n          C-SMD:0805       (8*)   C1,C2,C3,C4,C17,C18,C19,C20 (miscs
11 )
12 33n        C-WIMA:MKS2-0.2" (1*)   C45 (miscs)
13 100n       C-SMD:0805       (51*)  C11,C12,C13,C14,C15,C16,C25,C26,
14 C27,
15
16
17
18
19
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21
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23	---D---			
24	24V	DZ-0.4"	(1*)	D1 (diodes)
25	(front), green	LED:Header/coded	(1*)	D2 (optos)
26	1N4148	D-0.3":D0-35	(1*)	D3 (diodes)
27		D-0.4":D0-35	(9*)	D4,D5,D6,D7,D8,D9,D10,D11,D12
28				(diodes)
29				
30	---J---			
31	J1	JMP:2-pin	(1*)	J1 (connectors)
32	J2	JMP:2-pin	(1*)	J2 (connectors)
33	J3	JMP:2-pin	(1*)	J3 (connectors)
34	J4	JMP:2-pin	(1*)	J4 (connectors)
35	J5	JMP:2-pin	(1*)	J5 (connectors)
36				
37	---N---			
38	7805	T0-92	(1*)	N1 (ics)
39	7815	T0-220	(1*)	N4 (ics)
40	7905	T0-92	(1*)	N2 (ics)
41	7915	T0-220	(1*)	N3 (ics)
42	AD603	DIP-8	(1*)	N16 (ics)
43	AD620	DIP-8	(5*)	N9,N10,N12,N13,N27 (opamps)
44	DG417	DIP-8	(2*)	N22,N23 (ics)
45	DG418	DIP-8	(2*)	N5,N31 (ics)
46	DG419	DIP-8	(2*)	N6,N24 (ics)
47	HCPL2231	DIP-8	(3*)	N7,N8,N32 (optos)
48	LT1028	DIP-8	(1*)	N26 (opamps)
49	LT1124	DIP-8	(2*)	N14,N15 (opamps)
50	OP27	DIP-8	(9*)	N11,N17,N18,N19,N20,N21,N28,N29,
51	N30			(opamps)
52				
53	---R---			
54	0	R-0.4"	(1*)	R72 (miscs)
55	100	R-0.4"	(19*)	R12,R13,R14,R15,R20,R21,R22,R23,
56	R24,			R25,R26,R27,R29,R47,R48,R57,R58,
57				R67,
58	402	R-0.4"	(1*)	R68 (miscs)
59	1k	R-0.4"	(13*)	R1 (miscs)
60	R61,			R30,R32,R34,R35,R36,R37,R38,R54,
61	1.54k	R-0.4"	(1*)	R62,R65,R66,R73 (miscs)
62	2k15	R-0.4"	(1*)	R70 (miscs)
63	5k9	R-0.4"	(4*)	R33 (miscs)
64		R-SMD:1206	(4*)	R42,R44,R49,R50 (miscs)
65	6k02	R-0.4"	(2*)	R2,R3,R4,R5 (miscs)
66	10k	R-0.4"	(1*)	R39,R41 (miscs)
67	15k	R-0.4"	(4*)	R28 (miscs)
68	39k	R-0.4"	(1*)	R31,R45,R46,R74 (miscs)
69	154k	R-0.4"	(1*)	R53 (miscs)
70	162k	R-0.4"	(3*)	R69 (miscs)
71	470k	R-0.4"	(1*)	R10,R11,R40 (miscs)
72	1M	R-0.4"	(10*)	R55 (miscs)
73	R60			R6,R7,R8,R9,R16,R17,R18,R19,R59,
74	*	R-0.4"	(6*)	(miscs)
75				R43,R56,R63,R64,R71,R75 (miscs)
76	---S---			

77	SIGN	Toggle-DIP:1*2	(2*)	S1,S3 (miscs)
78	on/off	Toggle-DIP:1*2	(2*)	S2,S4 (miscs)
79				
80	---X---			
81	-18V	Testpin:0.8mm/ceramic	(1*)	X4 (connectors)
82	-15V	Testpin:0.8mm/ceramic	(1*)	X5 (connectors)
83	-5V	Testpin:0.8mm/ceramic	(1*)	X8 (connectors)
84	+5V	Testpin:0.8mm/ceramic	(1*)	X7 (connectors)
85	+15V	Testpin:0.8mm/ceramic	(1*)	X6 (connectors)
86	+18V	Testpin:0.8mm/ceramic	(1*)	X3 (connectors)
87	GND	Testpin:0.8mm/ceramic	(5*)	X13,X24,X25,X26,X27 (connectors)
88	OUTPUT	Crimp:RG174/vert.	(1*)	X23 (connectors)
89	PDA filt input	Crimp:RG174/vert.	(1*)	X16 (connectors)
90	SUM PD 1-4	LEM0:2-pin/0B/horz.	(1*)	X14 (connectors)
91	SUM PD 1-4 mon	Crimp:RG174/vert.	(1*)	X18 (connectors)
92	SUM PD 5-8	LEM0:2-pin/0B/horz.	(1*)	X15 (connectors)
93	SUM PD 5-8 mon	Crimp:RG174/vert.	(1*)	X33 (connectors)
94	X1	Backplane:96-pin/ABC	(1*)	X1 (connectors)
95	X2	Backplane:96-pin/ABC	(1*)	X2 (connectors)
96	X17	Testpin:0.8mm/ceramic	(1*)	X17 (connectors)
97	X19	Testpin:0.8mm/ceramic	(1*)	X19 (connectors)
98	X20	Testpin:0.8mm/ceramic	(1*)	X20 (connectors)
99	X21	Testpin:0.8mm/ceramic	(1*)	X21 (connectors)
100	X22	Testpin:0.8mm/ceramic	(1*)	X22 (connectors)
101	X28	Testpin:0.8mm/ceramic	(1*)	X28 (connectors)
102	X29	Testpin:0.8mm/ceramic	(1*)	X29 (connectors)
103	X31	Testpin:0.8mm/ceramic	(1*)	X31 (connectors)
104	X32	Testpin:0.8mm/ceramic	(1*)	X32 (connectors)
105	in1	D-SUB:9-pin/US/male	(1*)	X9 (connectors)
106	in2	D-SUB:9-pin/US/male	(1*)	X10 (connectors)
107	out1	D-SUB:9-pin/US/female	(1*)	X11 (connectors)
108	reference voltage	Testpin:0.8mm/ceramic	(1*)	X12 (connectors)
109	to ISS servo	Crimp:RG174/vert.	(1*)	X30 (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. Additional information can possibly be found directly in the schematics.

```

1 EAGLE Version 5.12.0 Copyright (c) 1988-2011 CadSoft
2 Schematics part list of 'iss_sl_servo4.sch'
3 Exported at 2013-09-25 03:56
4 Created with macro 'plot.ulp' (c) Andreas Weidner
5 Shown are: Name,Value/Type,Package,Device,Layer/Cell,Sheets/Cells
6
7 ---C---
8 C1 1n C-SMD:0805 C0805 T-B6 1-D10
9 C2 1n C-SMD:0805 C0805 T-A6 1-D10
10 C3 1n C-SMD:0805 C0805 T-B6 1-D9
11 C4 1n C-SMD:0805 C0805 T-A6 1-D9
12 C5 22u CE-TANTAL:0.2" CE02D T-A5 1-D9
13 C6 22u CE-TANTAL:0.2" CE02D T-A5 1-D11
14 C7 22u CE-TANTAL:0.2" CE02D T-B5 1-D9
15 C8 22u CE-TANTAL:0.2" CE02D T-B5 1-D11
16 C9 10u C02-MKS2-11.0-N C02-MKS2-11.0-N T-D4 5-C7
17 C10 5p6 C-0.1" C01N T-D5 5-B9
18 C11 100n C-SMD:0805 C0805 T-D4 5-F2
19 C12 100n C-SMD:0805 C0805 T-D5 5-G2
20 C13 100n C-SMD:0805 C0805 T-C6 4-D7
21 C14 100n C-SMD:0805 C0805 T-C5 4-D8

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22	C15	100n	C-SMD:0805	C0805	T-C2	4-D9
23	C16	100n	C-SMD:0805	C0805	T-B2	4-D9
24	C17	1n	C-SMD:0805	C0805	T-D6	1-B10
25	C18	1n	C-SMD:0805	C0805	T-D6	1-B10
26	C19	1n	C-SMD:0805	C0805	T-E6	1-B9
27	C20	1n	C-SMD:0805	C0805	T-D6	1-B9
28	C21	22u	CE-TANTAL:0.2"	CE02D	T-D6	1-B9
29	C22	22u	CE-TANTAL:0.2"	CE02D	T-D6	1-B11
30	C23	22u	CE-TANTAL:0.2"	CE02D	T-E6	1-B9
31	C24	22u	CE-TANTAL:0.2"	CE02D	T-D6	1-B11
32	C25	100n	C-SMD:0805	C0805	T-E2	2-E5
33	C26	100n	C-SMD:0805	C0805	T-G2	2-E5
34	C27	100n	C-SMD:0805	C0805	T-C2	3-G2
35	C28	100n	C-SMD:0805	C0805	T-C3	3-F2
36	C29	100n	C-SMD:0805	C0805	T-H3	3-F2
37	C30	100n	C-SMD:0805	C0805	T-I4	3-G2
38	C31	10u	C02-MKS2-11.0-N	C02-MKS2-11.0-N	T-D3	3-E6
39	C32	10u	C02-MKS2-11.0-N	C02-MKS2-11.0-N	T-B3	3-C6
40	C33	100n	C-SMD:0805	C0805	T-C4	3-F3
41	C34	100n	C-SMD:0805	C0805	T-C3	3-G3
42	C35	100n	C-SMD:0805	C0805	T-A2	4-D10
43	C36	100n	C-SMD:0805	C0805	T-D2	4-D10
44	C37	100n	C-SMD:0805	C0805	T-C6	4-E7
45	C38	100n	C-SMD:0805	C0805	T-C4	4-E8
46	C39	100n	C-SMD:0805	C0805	T-D2	4-E9
47	C40	100n	C-SMD:0805	C0805	T-B2	4-E9
48	C41	100n	C-SMD:0805	C0805	T-B2	4-E10
49	C42	100n	C-SMD:0805	C0805	T-E2	4-E10
50	C43	100n	C-SMD:0805	C0805	T-C5	4-E11
51	C44	100n	C-SMD:0805	C0805	T-C6	4-D11
52	C45	33n	C-WIMA:MKS2-0.2"	C02-MKS2-2.5-R	T-F5	6-C4
53	C46	*	C-WIMA:MKS2-0.2"	C02-MKS2-7.0-N	T-F5	6-D5
54	C47	100n	C-SMD:0805	C0805	T-E6	6-F2
55	C48	100n	C-SMD:0805	C0805	T-F7	6-F2
56	C49	100n	C-SMD:0805	C0805	T-F6	6-F2
57	C50	100n	C-SMD:0805	C0805	T-E5	6-F2
58	C51	100n	C-SMD:0805	C0805	T-E4	6-F3
59	C52	100n	C-SMD:0805	C0805	T-F5	6-F3
60	C53	100n	C-SMD:0805	C0805	T-G3	6-F4
61	C54	100n	C-SMD:0805	C0805	T-G3	6-F4
62	C55	10u	C02-MKS2-11.0-N	C02-MKS2-11.0-N	T-F6	6-C9
63	C56	100n	C-SMD:0805	C0805	T-G3	6-F5
64	C57	100n	C-SMD:0805	C0805	T-H3	6-F5
65	C58	100n	C-SMD:0805	C0805	T-F4	5-G3
66	C59	100n	C-SMD:0805	C0805	T-E3	5-F3
67	C60	470p	C-WIMA:MKS2-0.2"	C02-MKS2-5.0-N	T-H5	3-B7
68	C61	*	C-WIMA:MKS2-0.2"	C02-MKS2-5.0-N	T-H6	3-B8
69	C62	100n	C-SMD:0805	C0805	T-F3	2-F7
70	C63	100n	C-SMD:0805	C0805	T-G6	6-F6
71	C64	100n	C-SMD:0805	C0805	T-G6	6-G6
72	C65	100n	C-SMD:0805	C0805	T-E3	2-E7
73	C68	100n	C-SMD:0805	C0805	T-H4	3-F3
74	C69	100n	C-SMD:0805	C0805	T-I5	3-G3
75	C70	*	C-WIMA:MKS2-0.2"	C02-MKS2-5.5-R	T-F4	5-B2
76	C71	*	C-WIMA:MKS2-0.2"	C02-MKS2-5.5-R	T-F3	5-A4
77	C72	100n	C-SMD:0805	C0805	T-F3	5-F3
78	C73	100n	C-SMD:0805	C0805	T-G3	5-G3
79	C74	100n	C-SMD:0805	C0805	T-H5	3-F4
80	C75	100n	C-SMD:0805	C0805	T-I6	3-G4

81	C76	*	C-WIMA:MKS2-0.2"	C02-MKS2-5.5-R	T-F5	5-E8
82	C77	10u	C-WIMA:MKS2-0.2"	C02-MKS2-5.5-R	T-H5	5-D9
83	C78	100n	C-SMD:0805	C0805	T-G5	5-F4
84	C79	100n	C-SMD:0805	C0805	T-G5	5-G4
85	C80	100n	C-SMD:0805	C0805	T-H3	4-D8
86	C81	100n	C-SMD:0805	C0805	T-H2	4-E8
87	C82	*	C-WIMA:MKS2-0.2"	C02-MKS2-8.5-N	T-G6	6-C7
88	C83	100n	C-SMD:0805	C0805	T-H2	2-E6
89						
90	---D---					
91	D1	24V	DZ-0.4"	DZ	T-A2	1-C7
92	D2	(front), gre	LED:Header/coded	DL-CABLE-CODED-L	T-A3	1-C7
93	D3	1N4148	D-0.3":D0-35	1N4148-03R	T-F2	2-B9
94	D4	1N4148	D-0.4":D0-35	1N4148	T-G2	2-B8
95	D5	1N4148	D-0.4":D0-35	1N4148	T-E2	2-A9
96	D6	1N4148	D-0.4":D0-35	1N4148	T-G2	2-C9
97	D7	1N4148	D-0.4":D0-35	1N4148	T-E4	5-A5
98	D8	1N4148	D-0.4":D0-35	1N4148	T-E3	5-A5
99	D9	1N4148	D-0.4":D0-35	1N4148	T-E4	5-B5
100	D10	1N4148	D-0.4":D0-35	1N4148	T-E3	5-B5
101	D11	1N4148	D-0.4":D0-35	1N4148	T-I2	2-C9
102	D12	1N4148	D-0.4":D0-35	1N4148	T-H2	2-D9
103						
104	---J---					
105	J1	J1	JMP:2-pin	JP02	T-F1	2-C4
106	J2	J2	JMP:2-pin	JP02	T-H1	2-C4
107	J3	J3	JMP:2-pin	JP02	T-D1	2-D4
108	J4	J4	JMP:2-pin	JP02	T-B1	4-C1
109	J5	J5	JMP:2-pin	JP02	T-E1	4-F1
110						
111	---N---					
112	N1	7805	T0-92	7805L1	T-E7	1-A10
113	N2	7905	T0-92	7905L1	T-D7	1-B10
114	N3	7915	T0-220	7915L	T-A6	1-E10
115	N4	7815	T0-220	7815L	T-B6	1-D10
116	N5	DG418	DIP-8	DG418	T-C6	4-C10,4-E7
117	N6	DG419	DIP-8	DG419	T-C4	4-C6,4-E8
118	N7	HCPL2231	DIP-8	HCPL2231	T-E2	2-A9,2-B9,2-F5
119	N8	HCPL2231	DIP-8	HCPL2231	T-G2	2-B9,2-C9,2-F5
120	N9	AD620	DIP-8	AD620	T-E3	2-E3,2-E7
121	N10	AD620	DIP-8	AD620	T-C3	3-D4,3-F1
122	N11	OP27	DIP-8	OP27	T-C4	3-D7,3-F3
123	N12	AD620	DIP-8	AD620	T-A2	4-B4,4-E9
124	N13	AD620	DIP-8	AD620	T-D2	4-E4,4-E10
125	N14	LT1124	DIP-8	LT1124	T-B2	4-B3,4-C3,4-E9
126	N15	LT1124	DIP-8	LT1124	T-D2	4-E3,4-E8,4-G3
127	N16	AD603	DIP-8	AD603	T-D4	5-B9,5-F2
128	N17	OP27	DIP-8	OP27	T-E4	5-E5,5-F2
129	N18	OP27	DIP-8	OP27	T-C5	4-C9,4-E10
130	N19	OP27	DIP-8	OP27	T-E5	6-D3,6-F3
131	N20	OP27	DIP-8	OP27	T-E6	6-D6,6-F2
132	N21	OP27	DIP-8	OP27	T-E7	6-D9,6-F2
133	N22	DG417	DIP-8	DG417	T-G3	6-B4,6-F4
134	N23	DG417	DIP-8	DG417	T-G3	6-C9,6-F5
135	N24	DG419	DIP-8	DG419	T-G6	6-D8,6-F5
136	N26	LT1028	DIP-8	LT1028	T-I5	3-B8,3-F4
137	N27	AD620	DIP-8	AD620	T-I4	3-B3,3-F2
138	N28	OP27	DIP-8	OP27	T-F3	5-B3,5-F3
139	N29	OP27	DIP-8	OP27	T-I4	3-B5,3-F3

140	N30	OP27	DIP-8	OP27	T-G5	5-E9,5-F4
141	N31	DG418	DIP-8	DG418	T-H2	4-D6,4-E8
142	N32	HCPL2231	DIP-8	HCPL2231	T-H2	2-C9,2-D9,2-F6
143						
144	---	R---				
145	R1	402	R-0.4"	R	T-A3	1-B7
146	R2	5k9	R-SMD:1206	RS	B-F2	2-A8
147	R3	5k9	R-SMD:1206	RS	B-G2	2-B8
148	R4	5k9	R-SMD:1206	RS	B-G1	2-C8
149	R5	5k9	R-SMD:1206	RS	B-E2	2-A8
150	R6	1M	R-0.4"	R	T-F2	2-F2
151	R7	1M	R-0.4"	R	T-F2	2-E2
152	R8	1M	R-0.4"	R	T-E1	3-E4
153	R9	1M	R-0.4"	R	T-E1	3-D3
154	R10	162k	R-0.4"	R	T-C3	3-D5
155	R11	162k	R-0.4"	R	T-C3	3-D6
156	R12	100	R-0.4"	R	T-B4	3-D7
157	R13	100	R-0.4"	R	T-C2	3-D8
158	R14	100	R-0.4"	R	T-C1	3-D8
159	R15	100	R-0.4"	R	T-B4	3-E8
160	R16	1M	R-0.4"	R	T-A2	4-B3
161	R17	1M	R-0.4"	R	T-A2	4-C3
162	R18	1M	R-0.4"	R	T-D2	4-E3
163	R19	1M	R-0.4"	R	T-D2	4-F3
164	R20	100	R-0.4"	R	T-B2	4-A3
165	R21	100	R-0.4"	R	T-B3	4-C3
166	R22	100	R-0.4"	R	T-D2	4-D3
167	R23	100	R-0.4"	R	T-D2	4-F3
168	R24	100	R-0.4"	R	T-B2	4-B4
169	R25	100	R-0.4"	R	T-B3	4-C4
170	R26	100	R-0.4"	R	T-D2	4-D4
171	R27	100	R-0.4"	R	T-D2	4-F4
172	R28	10k	R-0.4"	R	T-E5	5-A1
173	R29	100	R-0.4"	R	T-E5	5-B5
174	R30	1k	R-0.4"	R	T-D4	5-B8
175	R31	15k	R-0.4"	R	T-E3	5-B6
176	R32	1k	R-0.4"	R	T-D4	5-C7
177	R33	2k15	R-0.4"	R	T-D5	5-B10
178	R34	1k	R-0.4"	R	T-E4	5-D5
179	R35	1k	R-0.4"	R	T-E3	5-E5
180	R36	1k	R-0.4"	R	T-C4	4-C8
181	R37	1k	R-0.4"	R	T-D4	4-C8
182	R38	1k	R-0.4"	R	T-C5	4-B9
183	R39	6k02	R-0.4"	R	T-F4	6-D2
184	R40	162k	R-0.4"	R	T-F5	6-C3
185	R41	6k02	R-0.4"	R	T-F4	6-C3
186	R42	5k9	R-0.4"	R	T-E5	6-D5
187	R43	*	R-0.4"	R	T-E5	6-D5
188	R44	5k9	R-0.4"	R	T-E6	6-C6
189	R45	15k	R-0.4"	R	T-G6	6-D8
190	R46	15k	R-0.4"	R	T-E6	6-C9
191	R47	100	R-0.4"	R	T-G4	6-D10
192	R48	100	R-0.4"	R	T-H4	6-D10
193	R49	5k9	R-0.4"	R	T-H1	2-C8
194	R50	5k9	R-0.4"	R	T-H2	2-D8
195	R53	39k	R-0.4"	R	T-H5	3-B7
196	R54	1k	R-0.4"	R	T-H5	3-B7
197	R55	470k	R-0.4"	R	T-I6	3-A8
198	R56	*	R-0.4"	R	T-I6	3-B8

199	R57	100	R-0.4"	R	T-H6	3-B9
200	R58	100	R-0.4"	R	T-B1	3-B9
201	R59	1M	R-0.4"	R	T-I3	3-A2
202	R60	1M	R-0.4"	R	T-I4	3-B2
203	R61	1k	R-0.4"	R	T-F3	5-A3
204	R62	1k	R-0.4"	R	T-F4	5-B2
205	R63	*	R-0.4"	R	T-F4	5-B2
206	R64	*	R-0.4"	R	T-F2	5-A3
207	R65	1k	R-0.4"	R	T-I4	3-B4
208	R66	1k	R-0.4"	R	T-I5	3-B5
209	R67	100	R-0.4"	R	T-H6	3-C9
210	R68	100	R-0.4"	R	T-H6	3-B9
211	R69	154k	R-0.4"	R	T-G5	5-D9
212	R70	1.54k	R-0.4"	R	T-G5	5-E8
213	R71	*	R-0.4"	R	T-G6	5-E8
214	R72	0	R-0.4"	R	T-H5	5-D9
215	R73	1k	R-0.4"	R	T-H2	4-C8
216	R74	15k	R-0.4"	R	T-F6	6-C9
217	R75	*	R-0.4"	R	T-G6	6-C6
218						
219	---	S---				
220	S1	SIGN	Toggle-DIP:1*2	S1X2-TOGGLE-DIP-L	T-E4	5-E7
221	S2	on/off	Toggle-DIP:1*2	S1X2-TOGGLE-DIP-L	T-F4	5-B4
222	S3	SIGN	Toggle-DIP:1*2	S1X2-TOGGLE-DIP-L	T-H5	3-B6
223	S4	on/off	Toggle-DIP:1*2	S1X2-TOGGLE-DIP-L	T-G5	5-E10
224						
225	---	X---				
226	X1	X1	Backplane:96-pin/ABC	XB96-ABC	T-B7	1-C2,1-C3
227	X2	X2	Backplane:96-pin/ABC	XB96-ABC	T-H7	1-C5,1-C6
228	X3	+18V	Testpin:0.8mm/ceramic	XT	T-B5	1-D8
229	X4	-18V	Testpin:0.8mm/ceramic	XT	T-A5	1-E8
230	X5	-15V	Testpin:0.8mm/ceramic	XT	T-A5	1-E11
231	X6	+15V	Testpin:0.8mm/ceramic	XT	T-B5	1-D11
232	X7	+5V	Testpin:0.8mm/ceramic	XT	T-E6	1-A11
233	X8	-5V	Testpin:0.8mm/ceramic	XT	T-D6	1-B11
234	X9	in1	D-SUB:9-pin/US/male	X09-2S-DSUBMALE-US	T-F1	2-B3,2-C5
235	X10	in2	D-SUB:9-pin/US/male	X09-2S-DSUBMALE-US	T-G1	2-C3,2-C5
236	X11	out1	D-SUB:9-pin/US/female	X09-2S-DSUBFEMALE-US	T-C1	2-B5,2-D5
237	X12	reference vo	Testpin:0.8mm/ceramic	XT	T-C4	3-E8
238	X13	GND	Testpin:0.8mm/ceramic	XT	T-D6	2-B6
239	X14	SUM PD 1-4	LEM0:2-pin/0B/horz.	XS02-4S-LEM00B-HR	T-B1	4-B1
240	X15	SUM PD 5-8	LEM0:2-pin/0B/horz.	XS02-4S-LEM00B-HR	T-D1	4-E1
241	X16	PDA filt inp	Crimp:RG174/vert.	XS01-2S-RG174	T-I3	3-B2
242	X17	X17	Testpin:0.8mm/ceramic	XT	T-H5	3-B5
243	X18	SUM PD 1-4 m	Crimp:RG174/vert.	XS01-2S-RG174	T-B1	4-A4
244	X19	X19	Testpin:0.8mm/ceramic	XT	T-A3	4-B5
245	X20	X20	Testpin:0.8mm/ceramic	XT	T-E3	5-B10
246	X21	X21	Testpin:0.8mm/ceramic	XT	T-D5	4-C10
247	X22	X22	Testpin:0.8mm/ceramic	XT	T-D3	4-E5
248	X23	OUTPUT	Crimp:RG174/vert.	XS01-2S	T-G4	6-D11
249	X24	GND	Testpin:0.8mm/ceramic	XT	T-A4	2-B6
250	X25	GND	Testpin:0.8mm/ceramic	XT	T-D3	2-C6
251	X26	GND	Testpin:0.8mm/ceramic	XT	T-A4	2-C6
252	X27	GND	Testpin:0.8mm/ceramic	XT	T-I3	2-C6
253	X28	X28	Testpin:0.8mm/ceramic	XT	T-E5	6-B4
254	X29	X29	Testpin:0.8mm/ceramic	XT	T-E6	6-C7
255	X30	to ISS servo	Crimp:RG174/vert.	XS01-2S-RG174	T-H6	3-B10
256	X31	X31	Testpin:0.8mm/ceramic	XT	T-G3	5-A4
257	X32	X32	Testpin:0.8mm/ceramic	XT	T-H4	5-D10

