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# BOSEMDTR1

## *Circuit Board Documentation*

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### Abstract

This circuit (BOSEMDTR1) provides control circuitry for a BOSEM with the following features:

- Ultra low noise LED constant current driver with ability to drive 50 mA nominally and up to 450 mA with modification of component values
- Photodiode readout with whitening and differential sending
- Coil driver with dewhitening and differential receiving and ability to drive 50 mA nominally and up to 500 mA with modification of component values
- Differential coil current monitor
- Digital inputs for disabling LEDs and whitening/dewhitening
- LED error detector with corresponding digital output
- Board-to-board connector to interface with the BOSEMIO1 circuit.

The LED error monitor checks the voltage drop across each LED. If the voltage drop is outside the 1.3..1.6 V range (configurable with resistors), an error flag is triggered. The flag logic is active low. In normal operation, the error output is HIGH, and it goes LOW when an error is detected.

The !LED Disable input is nominally floating and should be brought LOW to disable the LED current and otherwise left floating.

Proper heat sinking must be used when the LED and coil drivers are configured to use higher than nominal current. Note that the voltage regulators cannot source or sink more than 1 A each.

*Key words: coil led driver photodiode readout digital error switch*

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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 warms up due to its power consumption. To enable proper cooling, observe the following rules:

- Do not block available air vents.
- Give the unit free access to the room ambient air for convection.



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 ( $< 50 \text{ V}_{\text{AC}}$  and  $< 75 \text{ V}_{\text{DC}}$ ) and is therefore exempt from the regulations of the *Low Voltage Directive* (2014/35/EU).
- 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 erwärmt sich aufgrund ihrer Verlustleistung. Zur Gewährleistung einer sinnvollen Kühlung sind folgende Punkte zu beachten:

- Vorhandene Lüftungsöffnungen nicht versperren.
- Gerät zur Konvektion freien Zugang zur Raumluft ermöglichen.



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 ( $< 50 \text{ V}_{\text{AC}}$  und  $< 75 \text{ V}_{\text{DC}}$ ) und unterliegt daher nicht den Bestimmungen der *Niederspannungsrichtlinie* (2014/35/EU).
- Das Gerät enthält kein mechanisches Antriebssystem – die Bestimmungen der *Maschinenrichtlinie* (2006/42/EG) sind daher nicht anwendbar.

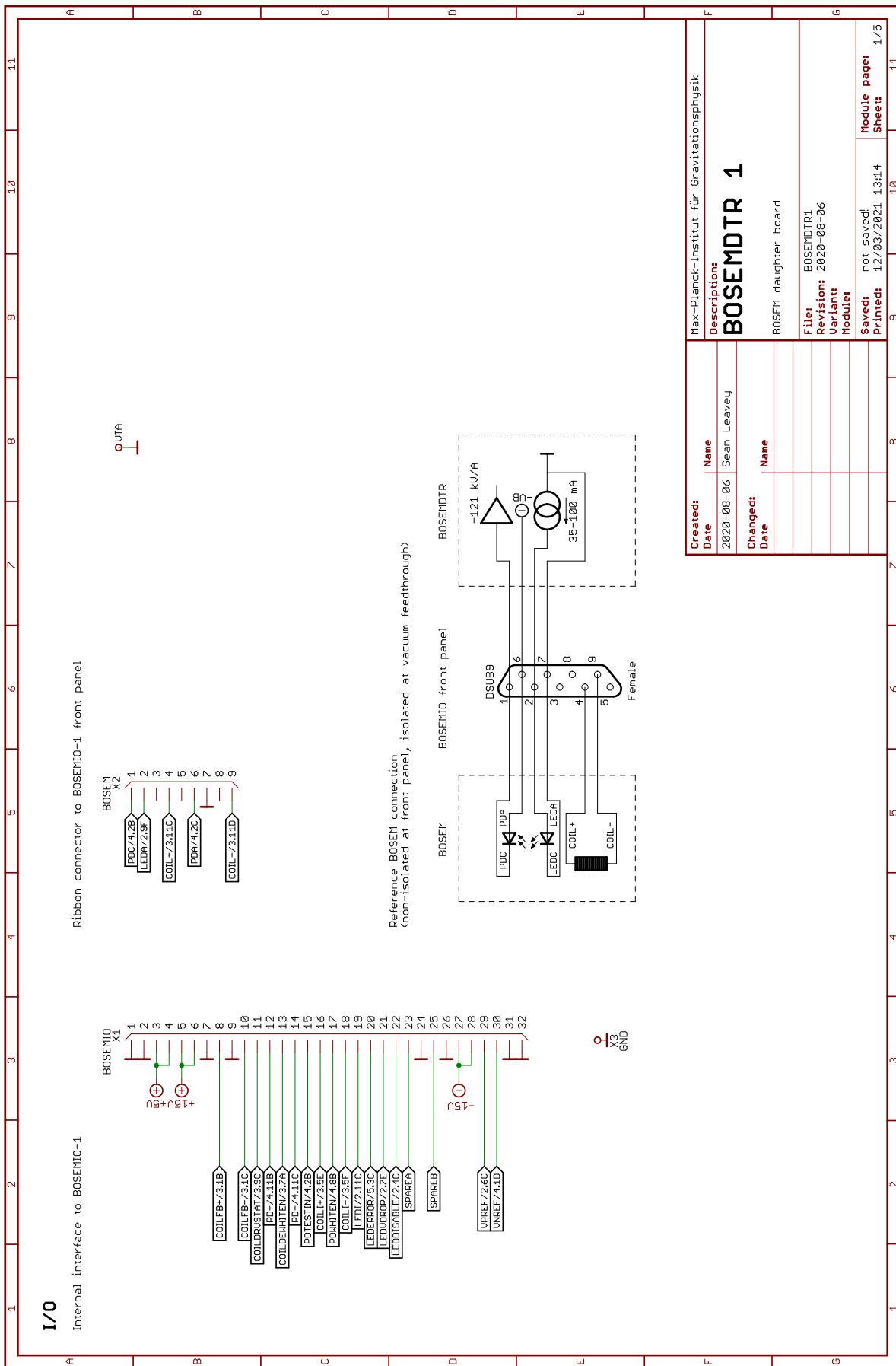


Figure 1: Design schematics (sheet 1)

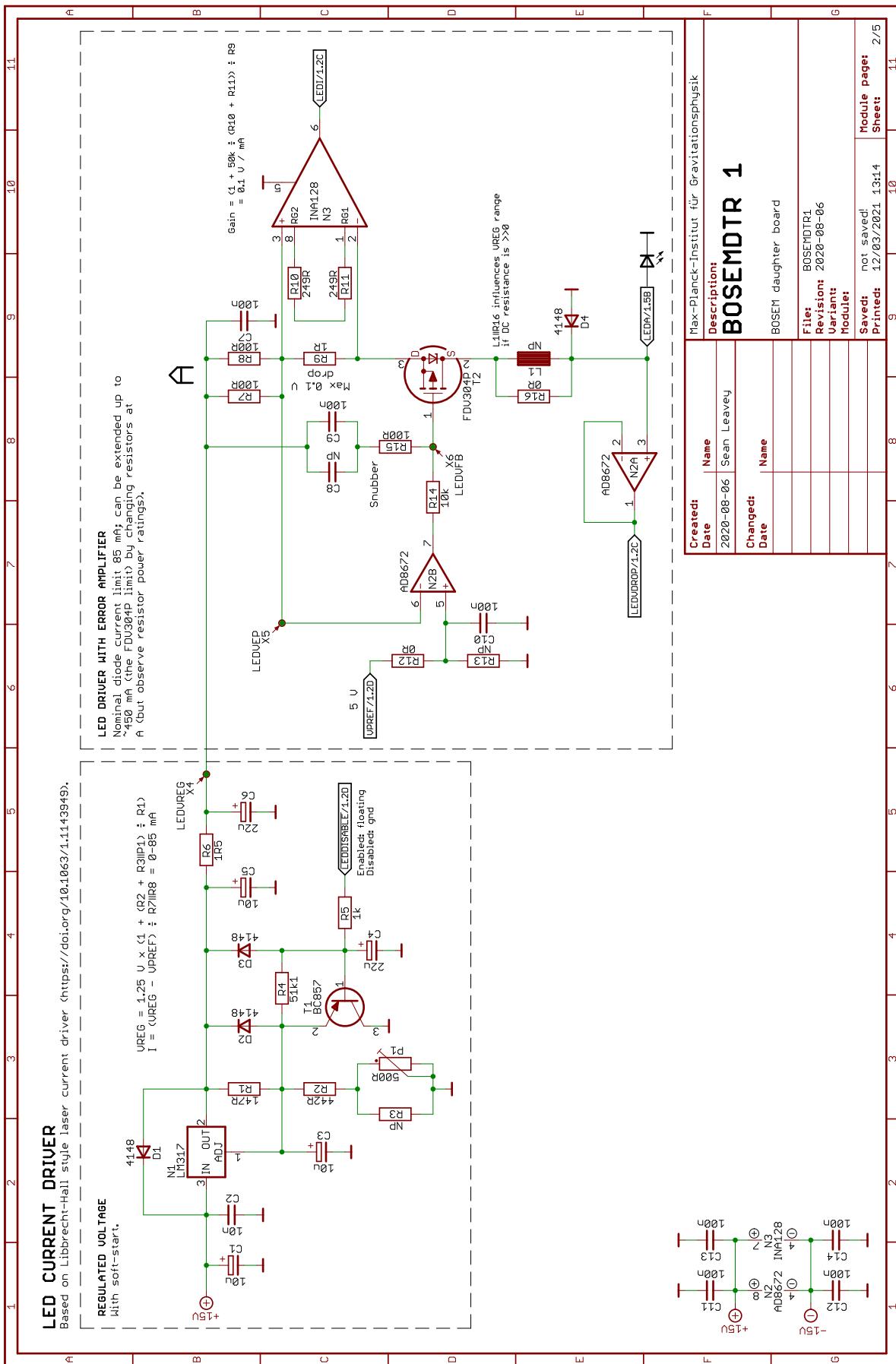
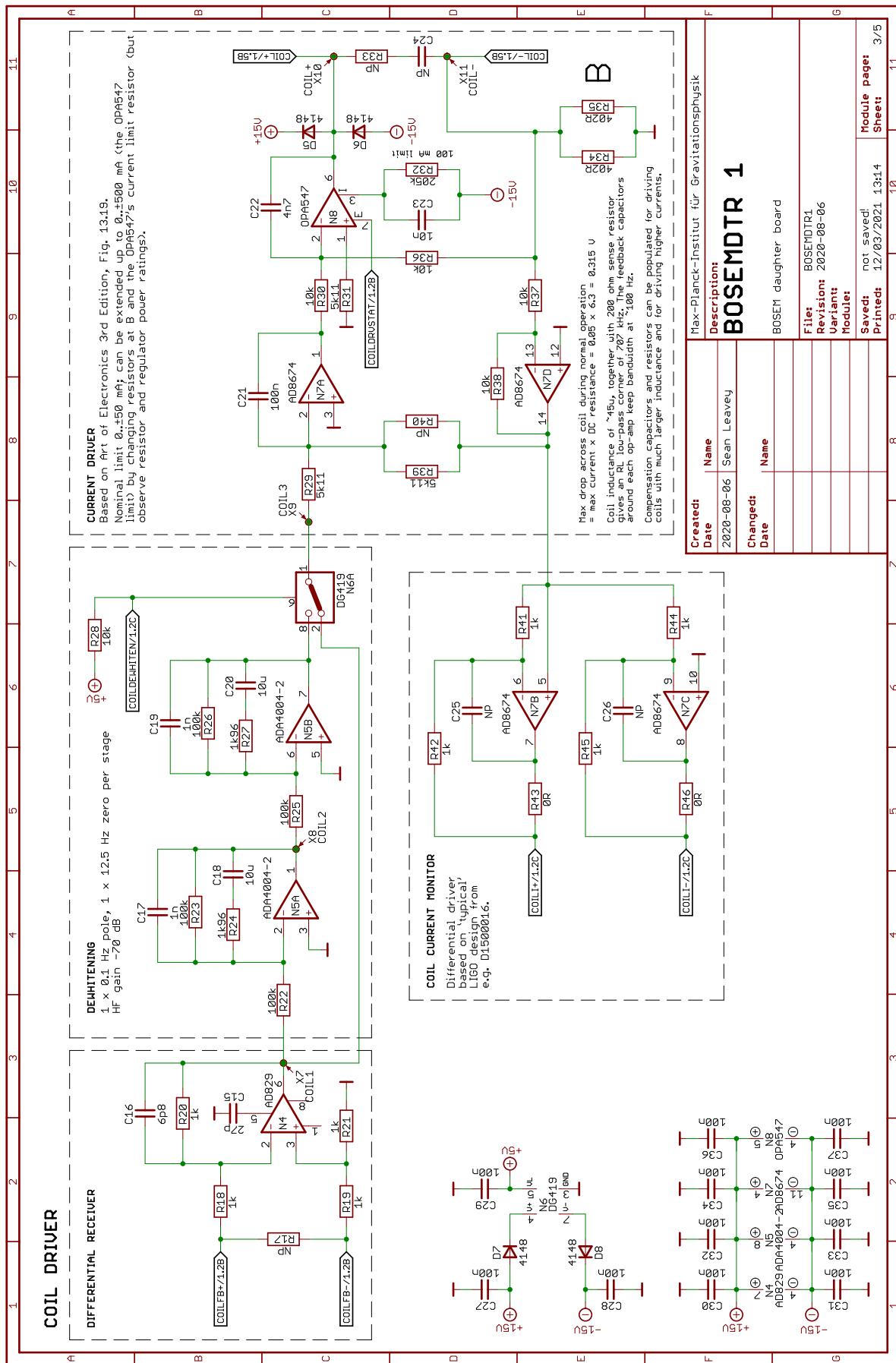


Figure 2: Design schematics (sheet 2)



**Figure 3:** Design schematics (sheet 3)

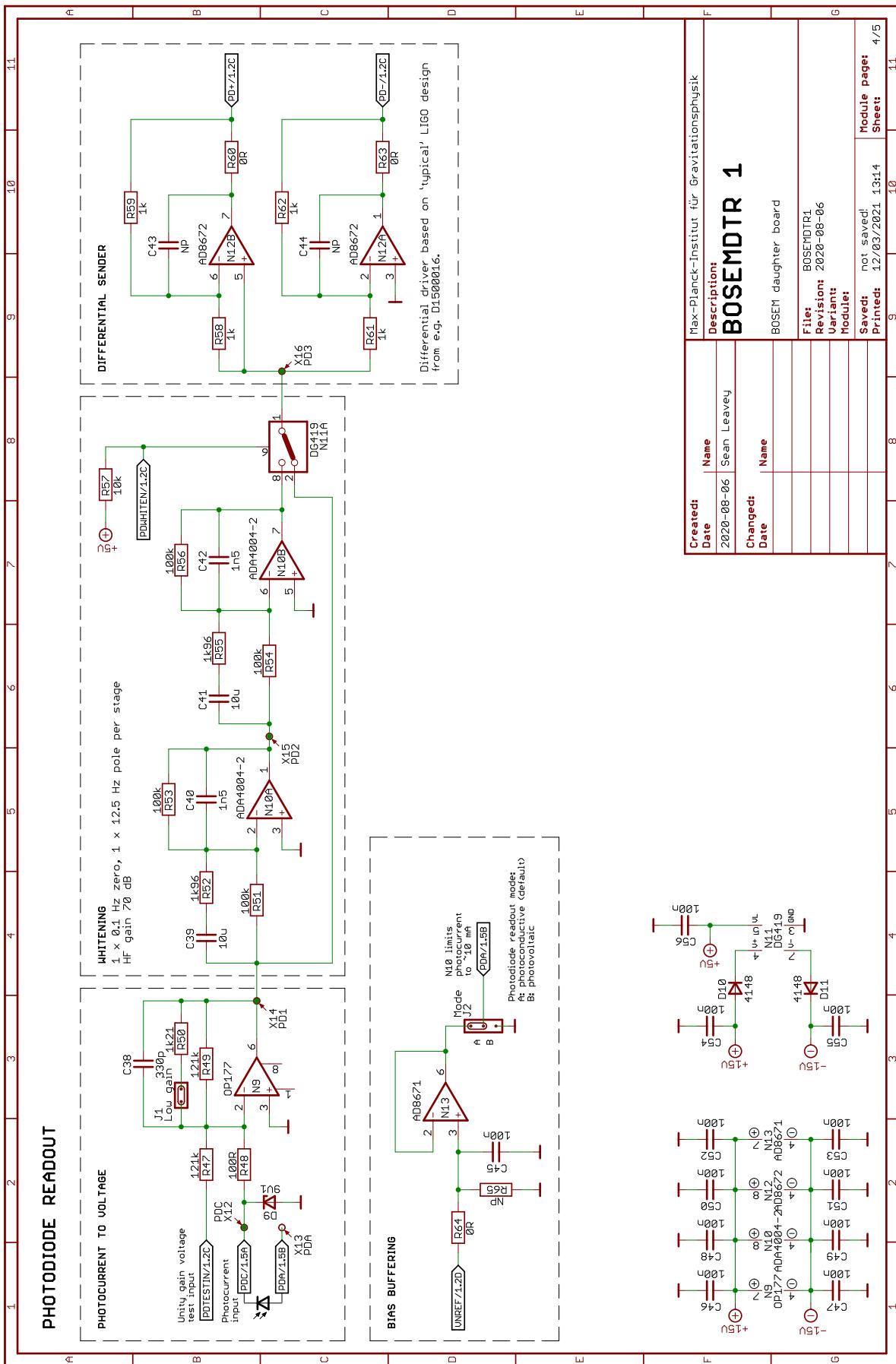


Figure 4: Design schematics (sheet 4)

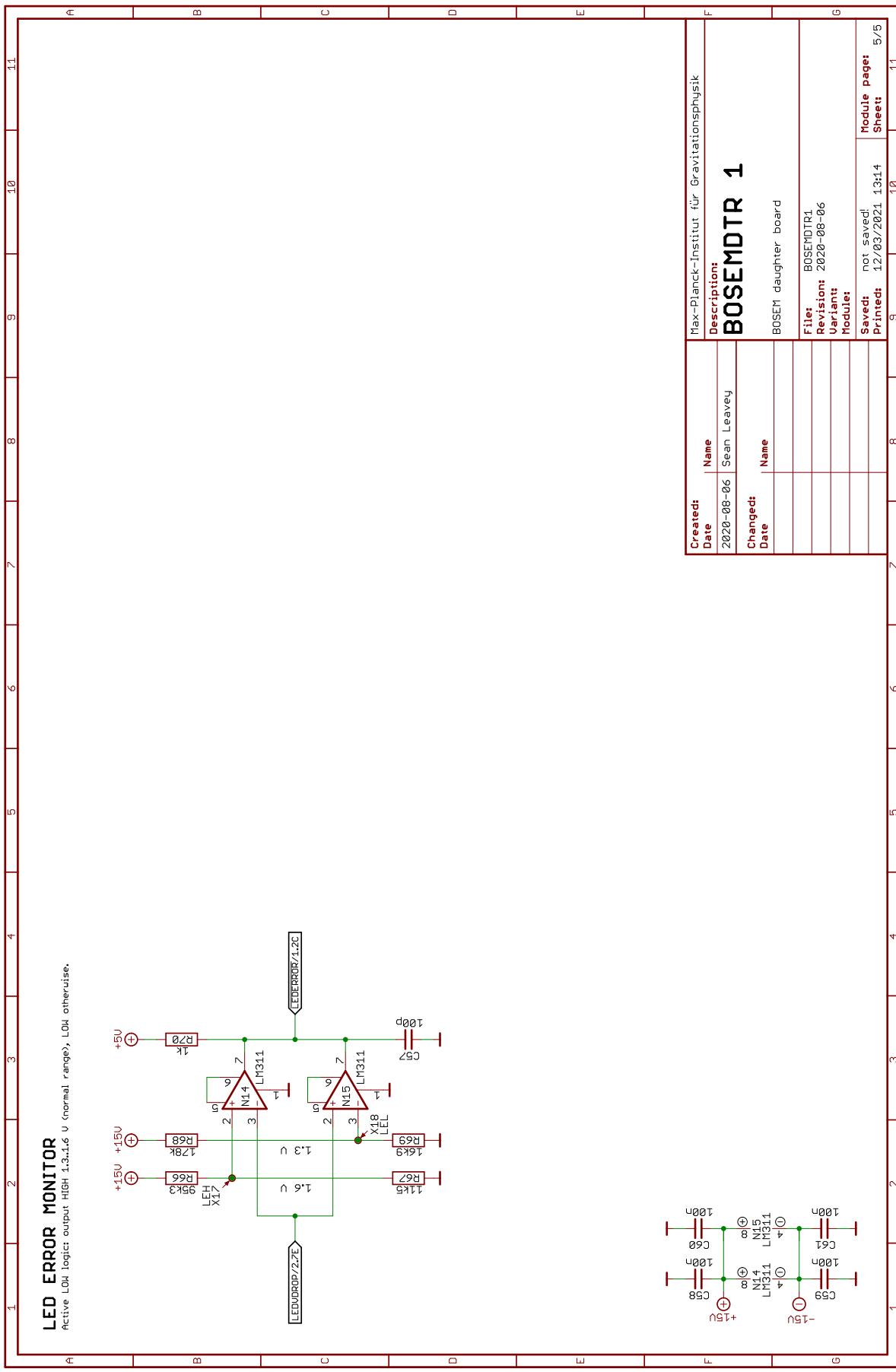
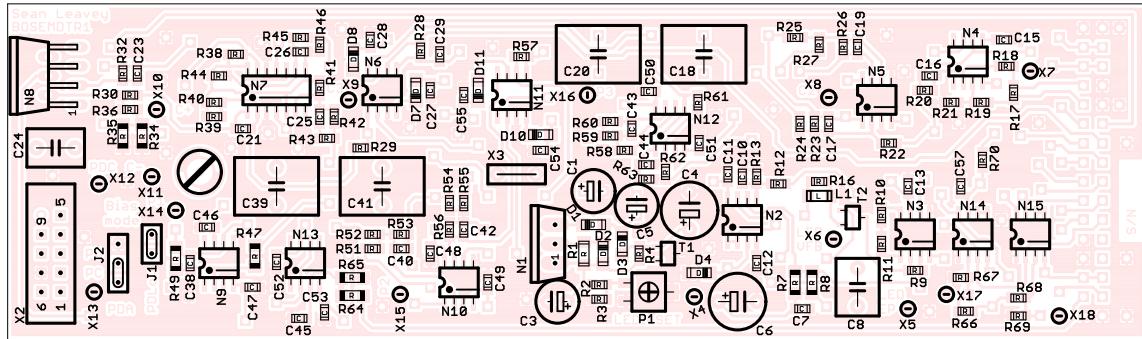
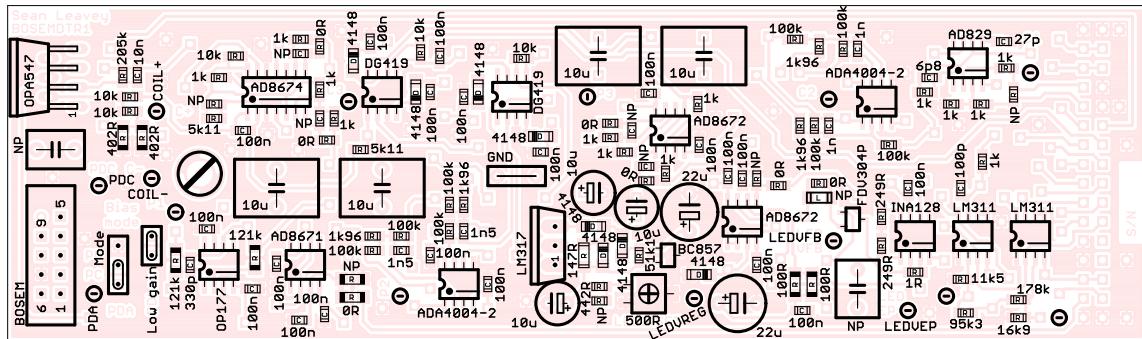


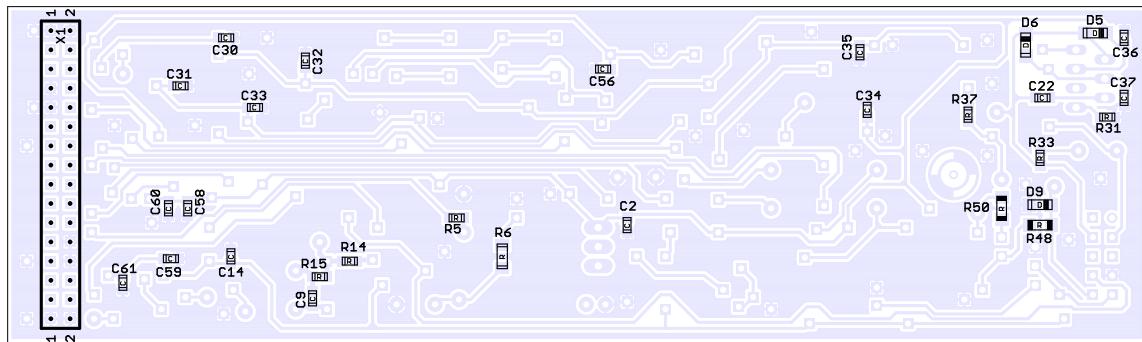
Figure 5: Design schematics (sheet 5)



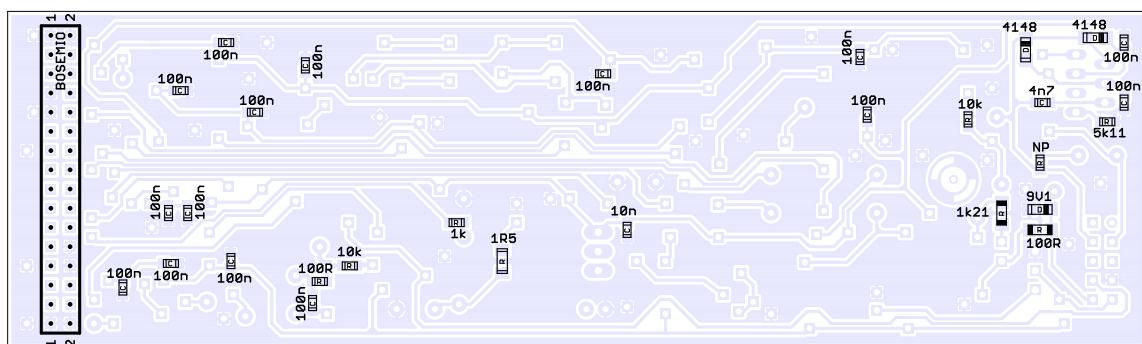
**Figure 6:** Board top view showing placeplan with component names



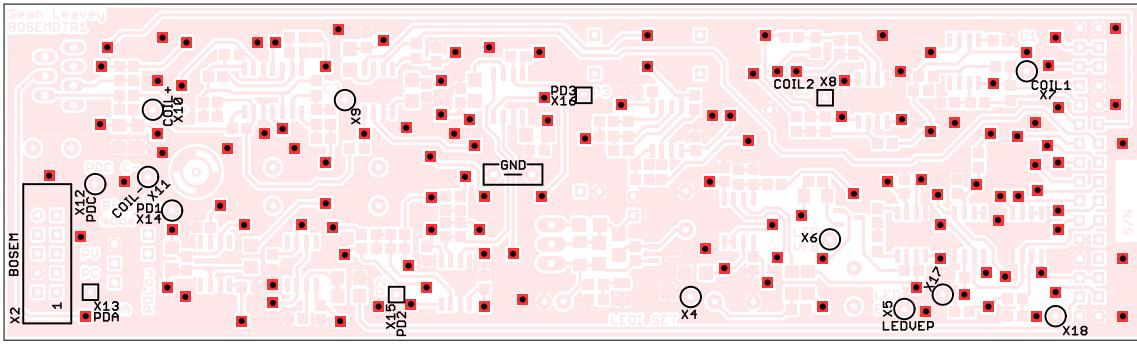
**Figure 7:** Board top view showing placeplan with component values



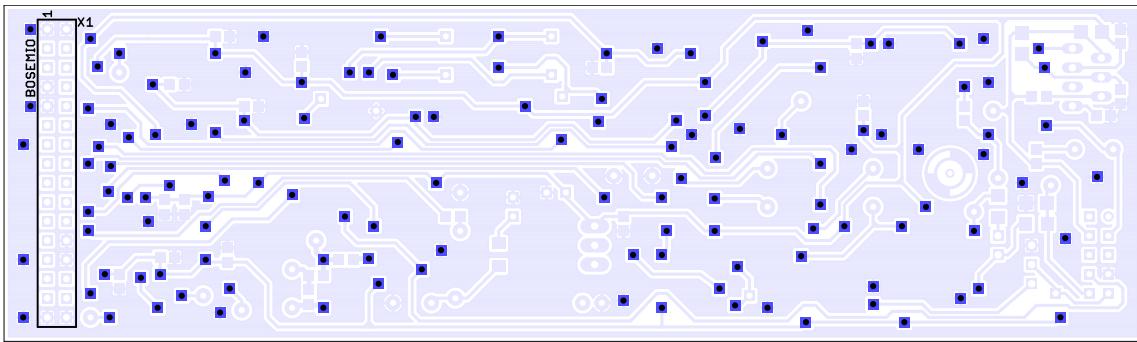
**Figure 8:** Board bottom view showing placeplan with component names



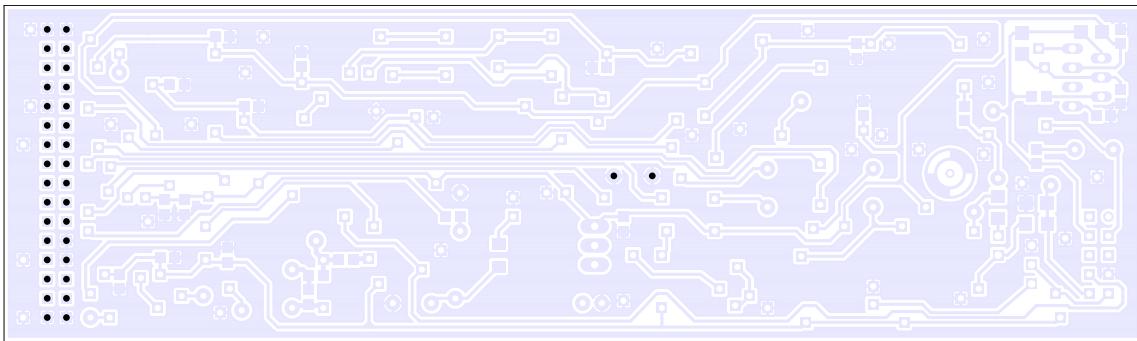
**Figure 9:** Board bottom view showing placeplan with component values



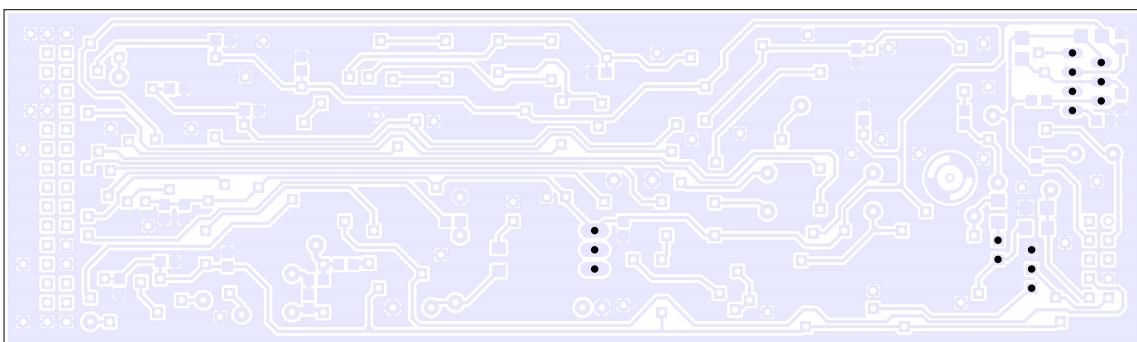
**Figure 10:** Board top view showing connectors, test points, vias and wired components



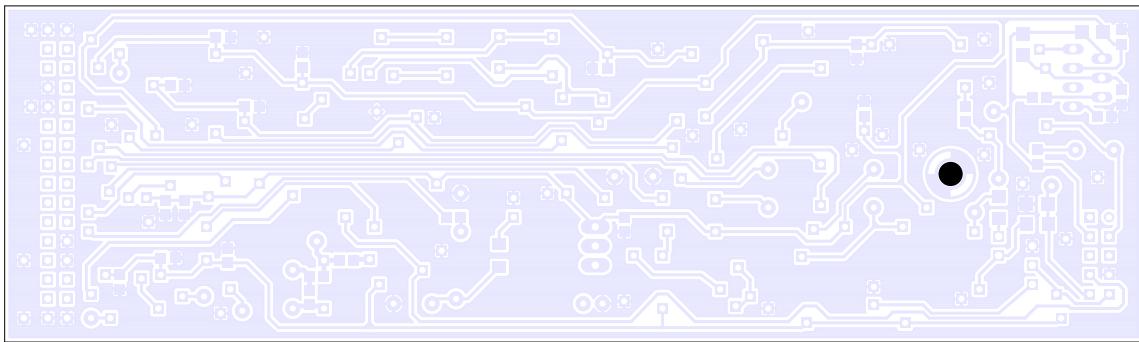
**Figure 11:** Board bottom view showing connectors, test points, vias and wired components



**Figure 12:** Board bottom view showing drills with  $\approx 0.9\text{ mm}$  ( $\approx 0.03543\text{ in}$ ) diameter  
( $34 \times 889\text{ }\mu\text{m}$ )



**Figure 13:** Board bottom view showing drills with  $\approx 1.0\text{ mm}$  ( $\approx 0.03937\text{ in}$ ) diameter  
( $15 \times 991\text{ }\mu\text{m}$ )



**Figure 14:** Board bottom view showing drills with 3.2 mm (0.12598 in) diameter  
( $1 \times 3200 \mu\text{m}$ )

## 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	Plan $\varnothing$ [mm]
813	0.813	0.03201	177	—
889	0.889	0.035	34	0.9
991	0.991	0.03902	15	1.0
3200	3.2	0.12598	1	3.2
<b>Total:</b> 227				

**Table 1:** Drill diameters used in the board

**Value list:** The following list shows all components available on the board (sorted by part *prefixes* and *values*) and can be used to quickly gather components. Additional information can possibly be found directly on the board (or in the schematics).

Value	Package	Count	Component names ( <i>library</i> )
<b>— C —</b>			
1 6p8	C-SMD:0805	1	C16 ( <i>misscs</i> )
2 27p	C-SMD:0805	1	C15 ( <i>misscs</i> )
3 100p	C-SMD:0805	1	C57 ( <i>misscs</i> )
4 330p	C-SMD:0805	1	C38 ( <i>misscs</i> )
5 1n	C-SMD:0805	2	C17, C19 ( <i>misscs</i> )
6 1n5	C-SMD:0805	2	C40, C42 ( <i>misscs</i> )
7 4n7	C-SMD:0805	1	C22 ( <i>misscs</i> )
8 10n	C-SMD:0805	2	C2, C23 ( <i>misscs</i> )
9 100n	C-SMD:0805	35	C7, C9, C10, C11-C14, C21, C27-C29, C30, C31-C37, C45-C49, C50, C51-C56, C58, C59, C60, C61 ( <i>misscs</i> )
10 10u	C02-MKS2-11.0-N	2	C39, C41 ( <i>misscs</i> )
11 10u	C02-MKS2-11.0-R	2	C18, C20 ( <i>misscs</i> )
12 10u	CE01-TANTAL-5.7-N	1	C3 ( <i>misscs</i> )
13 10u	CE01-TANTAL-5.7-R	2	C1, C5 ( <i>misscs</i> )
14 22u	CE-TANTAL:0.2"	2	C4, C6 ( <i>misscs</i> )
<b>— D —</b>			
15 9V1	D-SMD:MiniMELF	1	D9 ( <i>diodes</i> )
16 4148	D-SMD:MiniMELF	10	D1, D2, D3, D4, D5, D6, D7, D8, D10, D11 ( <i>diodes</i> )
<b>— J —</b>			
17 [ignored]	JMP:SIL-2p.	1	J1 ( <i>connectors</i> )
18 [ignored]	JMP:SIL-3p.	1	J2 ( <i>connectors</i> )
<b>— N —</b>			
19 AD829	S0-8	1	N4 ( <i>opamps</i> )
20 AD8671	S0-8	1	N13 ( <i>opamps</i> )
21 AD8672	S0-8	2	N2, N12 ( <i>opamps</i> )
22 AD8674	S0-14	1	N7 ( <i>opamps</i> )
23 ADA4004-2	S0-8	2	N5, N10 ( <i>opamps</i> )
24 DG419	S0-8	2	N6, N11 ( <i>ics</i> )
25 INA128	S0-8	1	N3 ( <i>opamps</i> )
26 LM311	S0-8	2	N14, N15 ( <i>opamps</i> )
27 LM317	T0-220	1	N1 ( <i>ics</i> )
28 OP177	S0-8	1	N9 ( <i>opamps</i> )
29 OPA547	T0-220	1	N8 ( <i>opamps</i> )
<b>— P —</b>			
30 500R	PTS-3314G	1	P1 ( <i>misscs</i> )
<b>— R —</b>			

— continued on next page —

**Table 1:** Value list — continued

Value	Package	Count	Component names ( <i>library</i> )
31 0R	R-SMD:0805	6	R12,R16,R43,R46,R60,R63 ( <i>miscs</i> )
32 0R	R-SMD:MiniMELF	1	R64 ( <i>miscs</i> )
33 1R	R-SMD:0805	1	R9 ( <i>miscs</i> )
34 1R5	R-SMD:1206	1	R6 ( <i>miscs</i> )
35 100R	R-SMD:0805	1	R15 ( <i>miscs</i> )
36 100R	R-SMD:MiniMELF	3	R7,R8,R48 ( <i>miscs</i> )
37 147R	R-SMD:1206	1	R1 ( <i>miscs</i> )
38 249R	R-SMD:0805	2	R10,R11 ( <i>miscs</i> )
39 402R	R-SMD:MiniMELF	2	R34,R35 ( <i>miscs</i> )
40 442R	R-SMD:0805	1	R2 ( <i>miscs</i> )
41 1k	R-SMD:0805	14	R5,R18,R19,R20,R21,R41,R42,R44,R45,R58,R59,R61,R62,R70 ( <i>miscs</i> )
42 1k21	R-SMD:MiniMELF	1	R50 ( <i>miscs</i> )
43 1k96	R-SMD:0805	4	R24,R27,R52,R55 ( <i>miscs</i> )
44 5k11	R-SMD:0805	3	R29,R31,R39 ( <i>miscs</i> )
45 10k	R-SMD:0805	7	R14,R28,R30,R36–R38,R57 ( <i>miscs</i> )
46 11k5	R-SMD:0805	1	R67 ( <i>miscs</i> )
47 16k9	R-SMD:0805	1	R69 ( <i>miscs</i> )
48 51k1	R-SMD:0805	1	R4 ( <i>miscs</i> )
49 95k3	R-SMD:0805	1	R66 ( <i>miscs</i> )
50 100k	R-SMD:0805	8	R22,R23,R25,R26,R51,R53,R54,R56 ( <i>miscs</i> )
51 121k	R-SMD:MiniMELF	2	R47,R49 ( <i>miscs</i> )
52 178k	R-SMD:0805	1	R68 ( <i>miscs</i> )
53 205k	R-SMD:0805	1	R32 ( <i>miscs</i> )
<b>— T —</b>			
54 BC857	SOT-23	1	T1 ( <i>transistors</i> )
55 FDV304P	SOT-23	1	T2 ( <i>transistors</i> )
<b>— X —</b>			
56 [ignored]	GND-0.2"	1	X3 ( <i>connectors</i> )
57 [ignored]	IDC:10p./ribbon	1	X2 ( <i>connectors</i> )
58 [ignored]	PIN-HDR:2x16p./vert.	1	X1 ( <i>connectors</i> )
59 [ignored]	PIN:0.8mm/ceram.	15	X4,X5,X6,X7,X8,X9,X10,X11–X18 ( <i>connectors</i> )
<b>— [unpopulated] —</b>			
60 [undefined]		13	C8–C26,C43,C44,L1,R3,R13,R17,R33,R40,R65 ( <i>miscs</i> )

**Table 1:** Value list