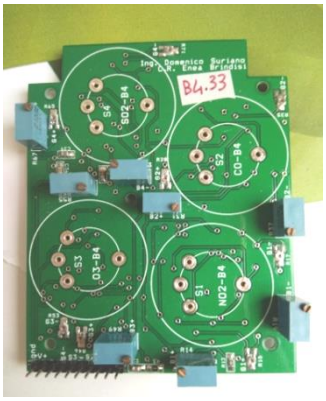
B4 Alphasense multisensor board user guide



Designer and developer

Dr. Domenico Suriano, domenico.suriano@enea.it

This user guide version (v. 1.0) refers to the *B4 Alphasense multisensor board* version 1.0. The complete project is available at https://github.com/domenico-suriano/Alphasense-B4-multisensor-board

Description

The *B4 Alphasense multisensor board* (*B4Amb*) is an electronic board designed to use the electrochemical gas sensor B4 series by Alphasense. The complete list of sensors usable with the *B4Amb* is shown below.

Table 1: sensor available for *B4Amb* use

Sensor name	Measuring gas
NO2-B43F	NO_2
OX-B431	O_3
SO2-B4	SO_2
H2S-B4	H_2S
CO-B4	CO

In figure 1, the top and bottom view of the *B4Amb* is shown. The maximum number of sensors usable with this board is four, they must be plugged into one of the slots named S1, S2, S3, or S4. Each of the sensors listed in table 1 can be plugged into any slot of the board, regardless of the placeholder text (e.g. the NO2B43F can be plugged into the S1, S2, S3, or S4, and so on).

The gain of each sensor signal can be regulated by a resistive trimmer as shown in table 2, while in figure 2 their location on the Printed Circuit Board (PCB) is shown along with the points where it is possible to check the resistive value of each trimmer (see also the PCB layout). The electronic "zero level" related to each sensor signal can be set by the precision trimmers listed in table 3 and shown in figure 3. The board connector where the power must be applied along with the sensor output signals is also shown in figure 3 (see also the board schematic). The output signals are direct current voltage levels coming out from the sensor electrodes. Their voltage range depends on the power

supply voltage. This board can be powered by a source ranging from a minimum of 3,3V to 5V maximum. The board's current consumption is less than 3 mA.

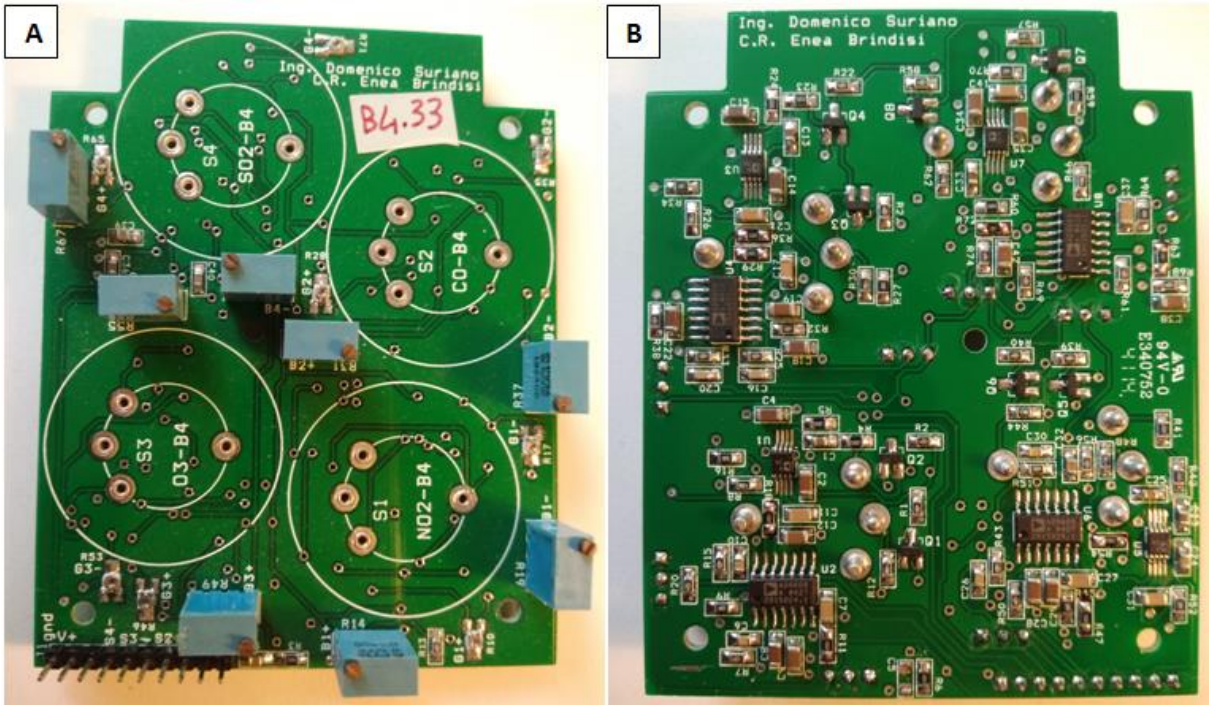


Figure 1: the *B4mb* top view (A), and bottom view (B). Its size are: 9,2 cm x 7,4 cm.

Table 2: trimmers to set the sensor signal gain.

Trimmer name and alias	Function
R17 (G1-)	Setting the gain of the S1 auxiliary signal
R10 (G1+)	Setting the gain of the S1 working signal
R35 (G2-)	Setting the gain of the S2 auxiliary signal
R28 (G2+)	Setting the gain of the S2 working signal
R53 (G3-)	Setting the gain of the S3 auxiliary signal
R46 (G3+)	Setting the gain of the S3 working signal
R71 (G4-)	Setting the gain of the S4 auxiliary signal
R65 (G4+)	Setting the gain of the S4 working signal

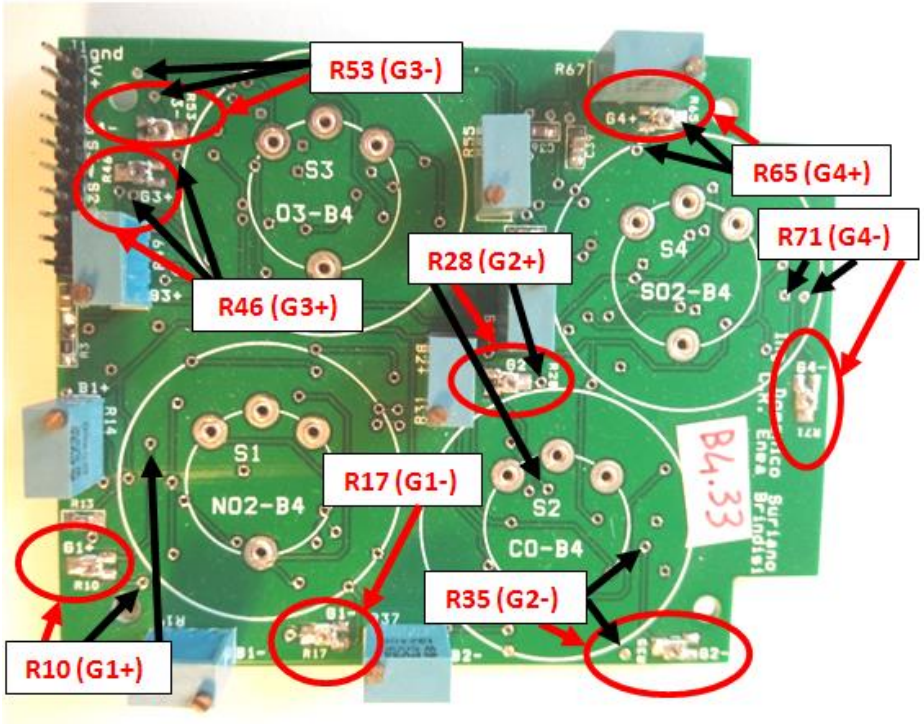


Figure 2: the gain trimmer location and the detection point to check the resistive value for each of them indicated by the black arrows.

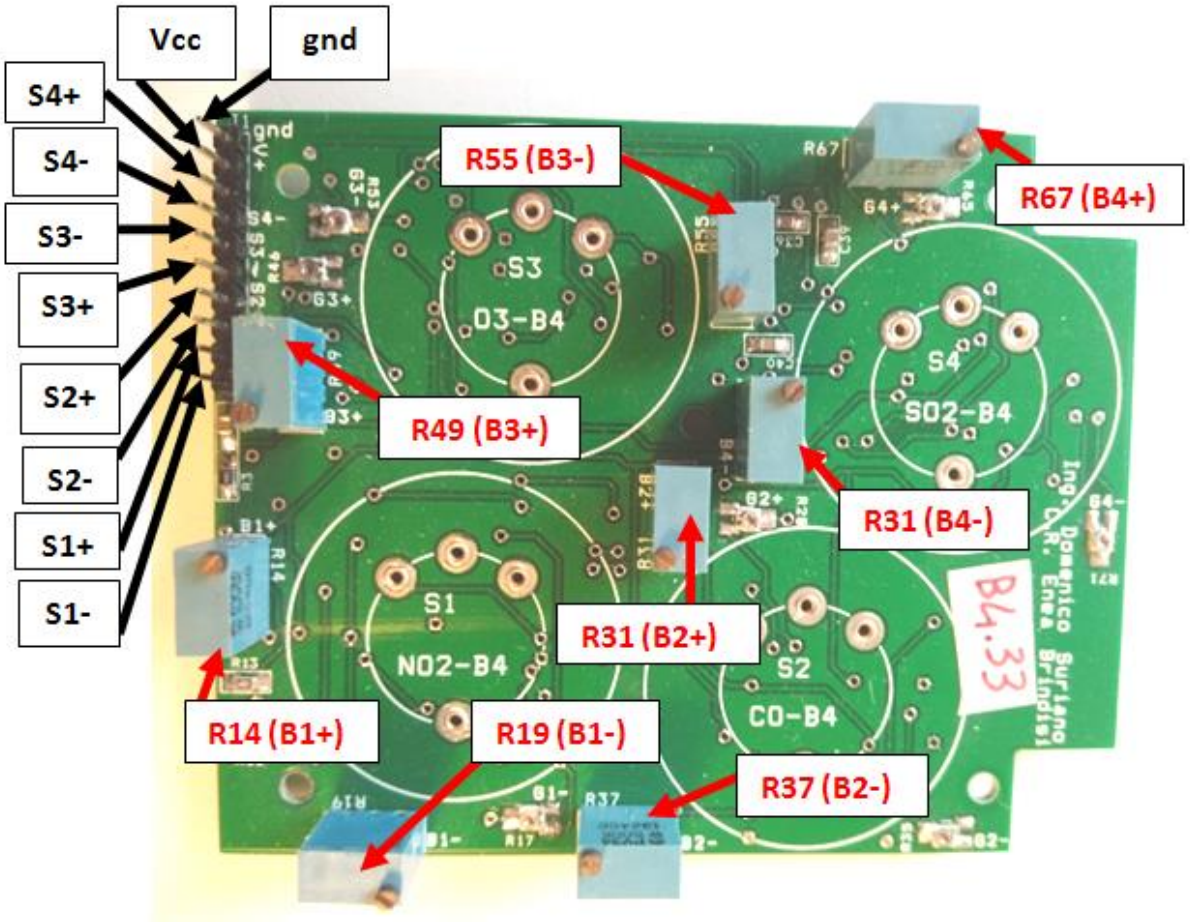


Figure 3: the precision trimmers to be used to set the electronic “zero level” related to each of the sensor signals. The figure shows also the board connector where there are the pins related to the board power supply and the sensor electrode outputs. S1+ is the output of the working electrode of the S1 sensor. S1- is the output of the auxiliary electrode of the S1 sensor, and so on.

Table 3: the precision trimmers and their aliases with their function. To facilitate their use, the effect of the clockwise screw turning is reported.

Trimmer name and alias	Function	Screw clockwise effect
R19 (B1-)	Setting the zero level of the S1 sensor auxiliary signal (denoted as S1-)	Decreasing the S1- voltage level
R14 (B1+)	Setting the zero level of the S1 sensor working signal (denoted as S1+)	Increasing the S1- voltage level
R37 (B2-)	Setting the zero level of the S2 sensor auxiliary signal (denoted as S2-)	Decreasing the S2- voltage level
R31 (B2+)	Setting the zero level of the S2 sensor working signal (denoted as S2+)	Increasing the S2+ voltage level
R55 (B3-)	Setting the zero level of the S3 sensor auxiliary signal (denoted as S3-)	Decreasing the S3- voltage level
R49 (B3+)	Setting the zero level of the S3 sensor working signal (denoted as S3+)	Increasing the S3+ voltage level
R31 (B4-)	Setting the zero level of the S4 sensor auxiliary signal (denoted as S4-)	Decreasing the S4- voltage level
R67 (B4+)	Setting the zero level of the S4 sensor working signal (denoted as S4+)	Increasing the S4+ voltage level

Board hardware assembly

At the time of writing this guide, the board is not available on the market already assembled, thus the user must assembly the hardware by himself. To build the PCB, the user can use the Gerber files released in the project repository and upload them to one of the PCB assembly service websites available on the internet web. The schematic project was created by the ORCAD 10.5 CAD, while the PCB layout was created by the LAYOUT application belonging to the ORCAD 10.5 suite. Once the PCB is ready for use, the user must solder the electronic components listed in the *"B4 alphasense mulitsensor board bill of materials.xlsx"* file released in the project repository. In this file, all the components of the board are listed along with one of the suppliers available on the web, and their costs. Each component must be soldered by following the indications on the silkscreen layers (see the layout board files). Optionally, the user can use one of the PCB assembly services available on the web.

Board set up

The first operation is plugging the sensors into their slots (see figure 1), then if they are plugged for the first time, it is necessary to wait for their signal stabilization for about 12 hours. The second operation is setting the gain for each of the sensor signals. It can be carried out by rotating the screws of the trimmers listed in table 2 and shown in figure 2 (see also the board schematic and layout). To accomplish this operation, it will be needed a multimeter capable of measuring resistive values and check if the desired trimmer value is set by applying the multimeter probes on the detection points illustrated in figure 2. The maximum value of the trimmer is 500 Kohm, which increases the signal gain by five times. Once each signal gain has been set, the user must also set the "zero level" of output signals. This operation can be done by rotating the screws on the top of the precision resistive trimmers listed in table 3 and shown in figure 3. To properly carry out this operation, it is recommended to turn the regulation screw of the trimmers by a quarter of a turn at a time and subsequently to check the relative output voltage. It is advisable to set the "zero level" of the auxiliary electrodes to about half of the power supply value. In the case of the "zero levels"

working electrode setting, the user must consider the sensor working electrode voltage direction when the gas concentration is increasing. For example, in the case of the CO-B4 sensor, the working electrode will decrease its output voltage when the CO concentration will increase. Therefore, in adjusting the "zero level" of the CO-B4 working electrode, it will be suitable to set it on a voltage level next to the highest value. This way, when the CO concentration will increase, and the working electrode output will decrease, the user will not risk having the signal cut at the ground level. This procedure will be exactly the opposite in the case of the NO2B43F sensor, or in all the cases where the working electrode output voltage is going to increase while the gas concentration increases.

Bill of materials

Here below, it is possible to find the board "bill of materials". In this document, the supplier, the unit price, and the item numbers are not reported. To obtain this information, please refer to the *"B4 alphasense mulitsensor board bill of materials.xlsx"* file released in the project repository.

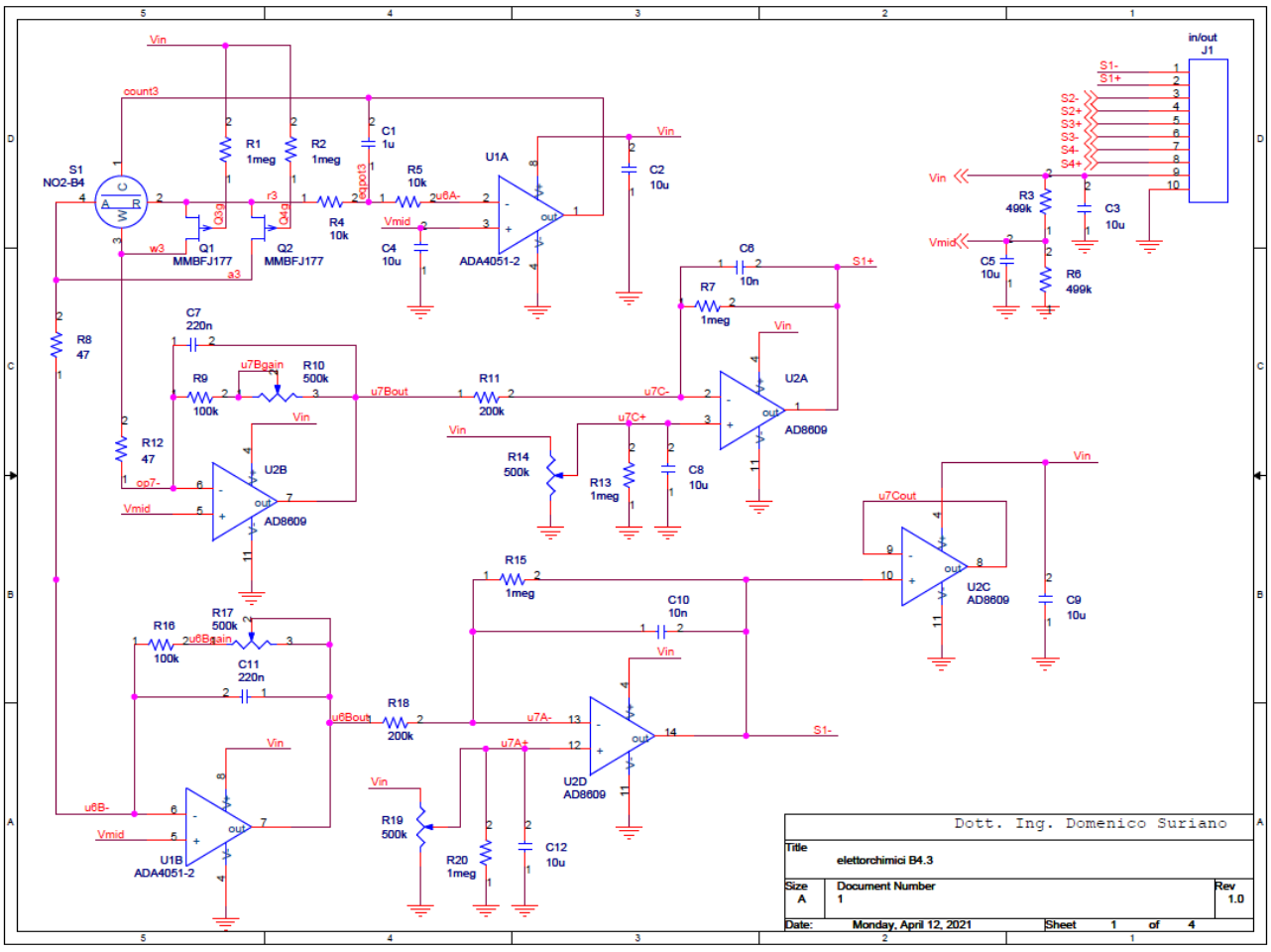
Item	Quantity	Reference	Part	CASE
1	4	C1	1u	805
		C13	1u	805
		C23	1u	805
		C33	1u	805
2	22	C2	10u	805
		C3	10u	805
		C4	10u	805
		C5	10u	805
		C8	10u	805
		C9	10u	805
		C12	10u	805
		C14	10u	805
		C15	10u	805
		C18	10u	805
		C19	10u	805
		C22	10u	805
		C24	10u	805
		C25	10u	805
		C28	10u	805
		C29	10u	805
		C32	10u	805
		C34	10u	805
		C35	10u	805
		C38	10u	805
		C39	10u	805
		C42	10u	805
3	8	C6	10n	805
		C10	10n	805

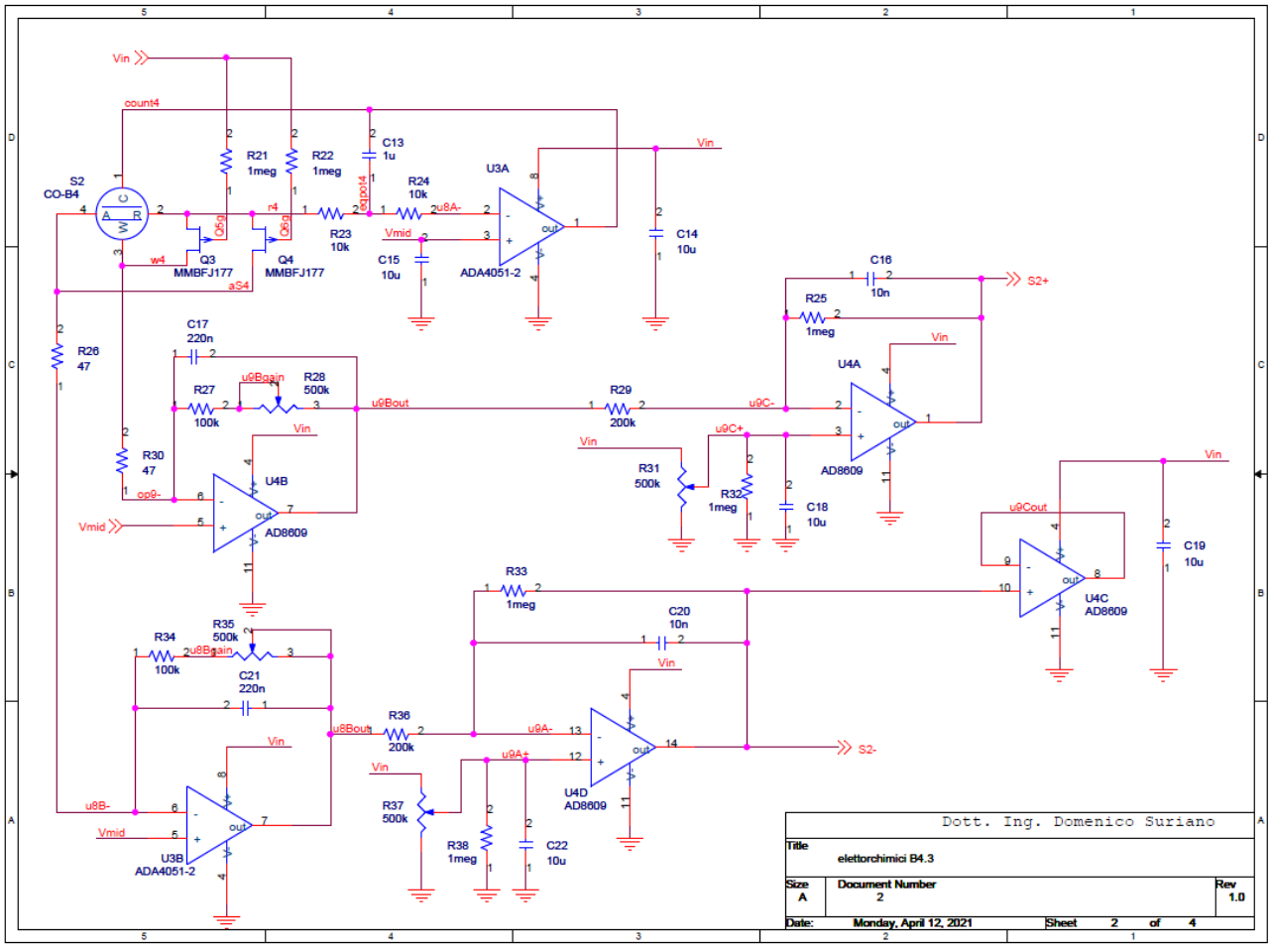
		C16	10n	805
		C20	10n	805
		C26	10n	805
		C30	10n	805
		C36	10n	805
		C40	10n	805
4	8	C7	220n	805
		C11	220n	805
		C17	220n	805
		C21	220n	805
		C27	220n	805
		C31	220n	805
		C37	220n	805
		C41	220n	805
5	1	J1	in/out pcb connector	2.54 mm pitch
6	8	Q1	MMBFJ177	SOT-23
		Q2	MMBFJ177	SOT-23
		Q3	MMBFJ177	SOT-23
		Q4	MMBFJ177	SOT-23
		Q5	MMBFJ177	SOT-23
		Q6	MMBFJ177	SOT-23
		Q7	MMBFJ177	SOT-23
		Q8	MMBFJ177	SOT-23
7	24	R1	1meg	805
		R2	1meg	805
		R7	1meg	805
		R13	1meg	805
		R15	1meg	805
		R20	1meg	805
		R21	1meg	805
		R22	1meg	805
		R25	1meg	805
		R32	1meg	805
		R33	1meg	805
		R38	1meg	805
		R39	1meg	805
		R40	1meg	805
		R43	1meg	805
		R50	1meg	805
		R51	1meg	805
		R56	1meg	805
		R57	1meg	805
		R58	1meg	805
		R61	1meg	805
		R68	1meg	805
		R69	1meg	805
		R74	1meg	805

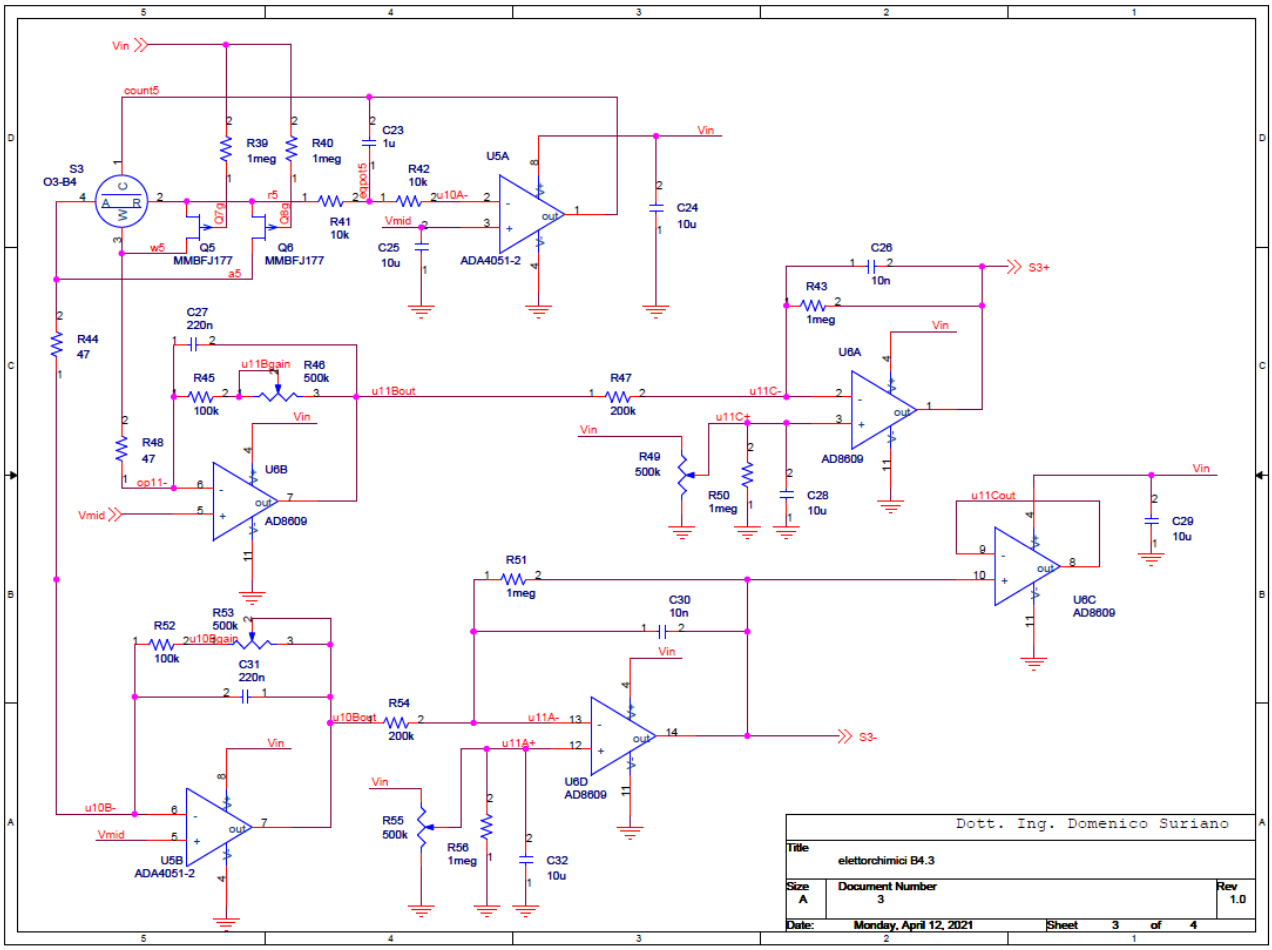
8	2	R3	499 K	805
		R6	499 K	805
9	16	R4	10K	805
		R5	10K	805
		R11	10K	805
		R18	10K	805
		R23	10K	805
		R24	10K	805
		R29	10K	805
		R36	10K	805
		R41	10K	805
		R42	10K	805
		R47	10K	805
		R54	10K	805
		R59	10K	805
		R60	10K	805
		R63	10K	805
		R72	10K	805
10	8	R8	47	805
		R12	47	805
		R26	47	805
		R30	47	805
		R44	47	805
		R48	47	805
		R62	47	805
		R66	47	805
11	8	R9	100k	805
		R16	100k	805
		R27	100k	805
		R34	100k	805
		R45	100k	805
		R52	100k	805
		R64	100k	805
		R70	100k	805
12	8	R10	500k	SMD/2.2x0.81x2.81
		R17	500k	SMD/2.2x0.81x2.82
		R28	500k	SMD/2.2x0.81x2.83
		R35	500k	SMD/2.2x0.81x2.84
		R46	500k	SMD/2.2x0.81x2.85
		R53	500k	SMD/2.2x0.81x2.86
		R65	500k	SMD/2.2x0.81x2.87
		R71	500k	SMD/2.2x0.81x2.88
13	8	R14	500k	PHT/rs769-2198/9.6x5x10mm
		R19	500k	PHT/rs769-2198/9.6x5x10mm
		R31	500k	PHT/rs769-2198/9.6x5x10mm
		R37	500k	PHT/rs769-2198/9.6x5x10mm
		R49	500k	PHT/rs769-2198/9.6x5x10mm

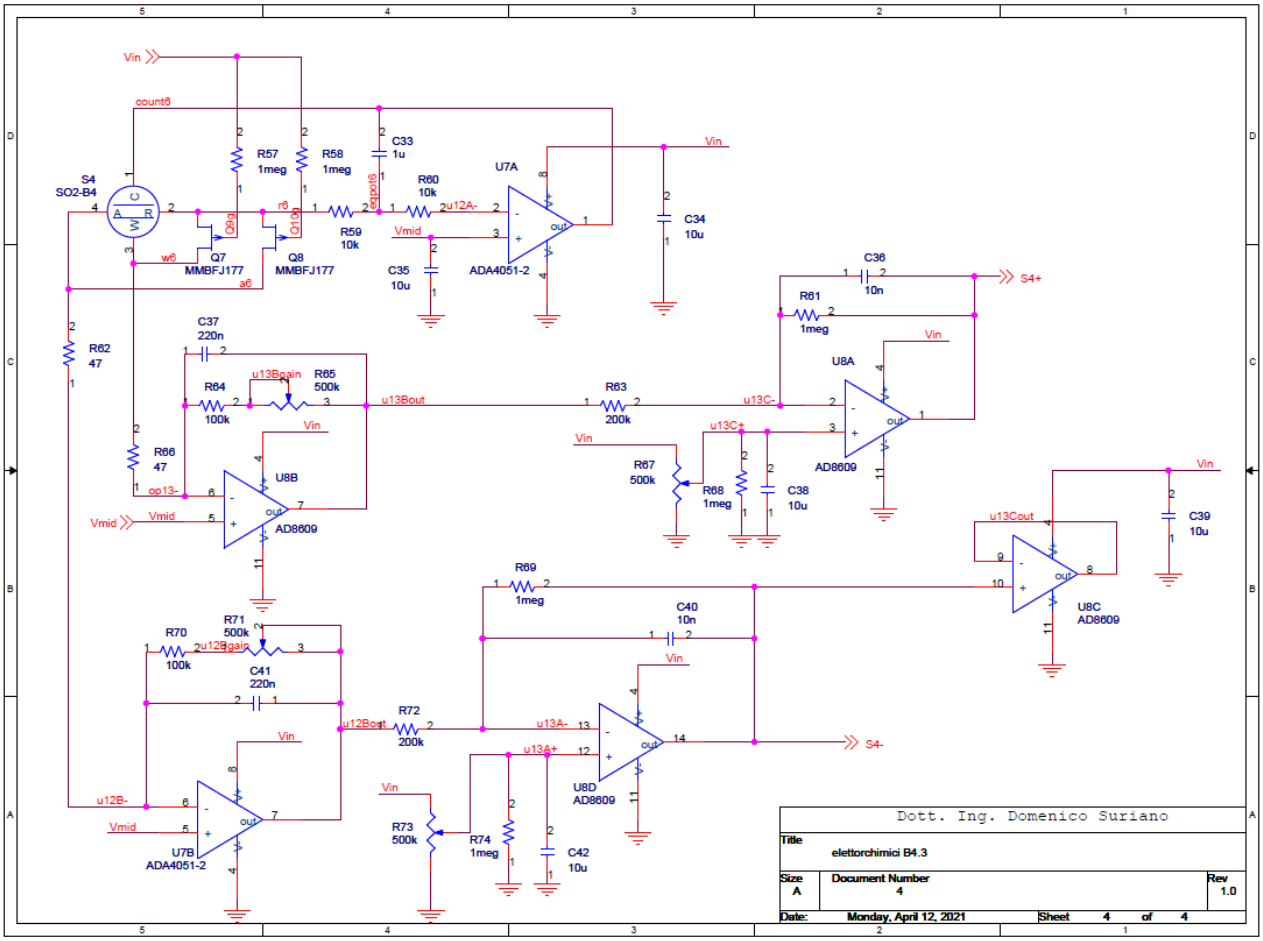
		R55	500k	PHT/rs769-2198/9.6x5x10mm
		R67	500k	PHT/rs769-2198/9.6x5x10mm
		R73	500k	PHT/rs769-2198/9.6x5x10mm
14	16	S1a	pin for sensor connector	1,91mmx5,23mm
		S1b	pin for sensor connector	1,91mmx5,23mm
		S1c	pin for sensor connector	1,91mmx5,23mm
		S1d	pin for sensor connector	1,91mmx5,23mm
		S2a	pin for sensor connector	1,91mmx5,23mm
		S2b	pin for sensor connector	1,91mmx5,23mm
		S2c	pin for sensor connector	1,91mmx5,23mm
		S2d	pin for sensor connector	1,91mmx5,23mm
		S3a	pin for sensor connector	1,91mmx5,23mm
		S3b	pin for sensor connector	1,91mmx5,23mm
		S3c	pin for sensor connector	1,91mmx5,23mm
		S3d	pin for sensor connector	1,91mmx5,23mm
		S4a	pin for sensor connector	1,91mmx5,23mm
		S4b	pin for sensor connector	1,91mmx5,23mm
		S4c	pin for sensor connector	1,91mmx5,23mm
		S4d	pin for sensor connector	1,91mmx5,23mm
15	4	U1	ADA4051-2ARMZ	MSOP-8
		U3	ADA4051-2ARMZ	MSOP-8
		U5	ADA4051-2ARMZ	MSOP-8
		U7	ADA4051-2ARMZ	MSOP-8
16	4	U2	AD8609	SOICN-R14
		U4	AD8609	SOICN-R14
		U6	AD8609	SOICN-R14
		U8	AD8609	SOICN-R14

Board schematics


Vin
count3
S1
NO2-B4
R1
1meg
R2
1meg
C1
1u
R5
10k
U1A
ADA4051-2
C2
10u
C4
10u
R4
10k
Q1
MMBFJ177
Q2
MMBFJ177
w3
a3
r3
Qdg
Vmid
u6A-
expot3
in/out
J1
S1-
S1+
S2-
S2+
S3+
S3-
S4-
S4+
R3
499k
C3
10u
C5
10u
R6
499k
C6
10n
R7
1meg
S1+
U2A
AD8609
u7C-
u7C+
R8
47
C7
220n
u7Bgain
R10
500k
R9
100k
u7Bout
R11
200k
R12
47
op7-
U2B
AD8609
R14
500k
R13
1meg
C8
10u
u7Cout
U2C
AD8609
C9
10u
R15
1meg
C10
10n
R16
100k
R17
500k
u6Bgain
C11
220n
u6Bout
R18
200k
u7A-
u7A+
U2D
AD8609
S1-
u6B-
U1B
ADA4051-2
R19
500k
R20
1meg
C12
10u
Dott. Ing. Domenico Suriano
Title
elettorchimici B4.3
Size
A
Document Number
1
Rev
1.0
Date:
Monday, April 12, 2021
Sheet
1
of
4


Vin
count4
S2
CO-B4
R21
1meg
R22
1meg
C13
1u
R24
10k
U3A
ADA4051-2
C14
10u
R23
10k
C15
10u
Vmid
Q3
MMBFJ177
Q4
MMBFJ177
w4
aS4
r4
u8A-
C16
10n
S2+
R25
1meg
U4A
AD8609
R26
47
C17
220n
R27
100k
u9Bgain
R28
500k
u9Bout
R29
200k
u9C-
u9C+
R31
500k
R32
1meg
C18
10u
R30
47
op9-
U4B
AD8609
u9Cout
C19
10u
U4C
AD8609
R33
1meg
C20
10n
R34
100k
R35
500k
u8Bgain
C21
220n
u8Bout
R36
200k
u9A-
u9A+
U4D
AD8609
S2-
u8B-
U3B
ADA4051-2
R37
500k
R38
1meg
C22
10u
Dott. Ing. Domenico Suriano
Title
elettorchimici B4.3
Size
A
Document Number
2
Rev
1.0
Date:
Monday, April 12, 2021
Sheet
2
of
4


Vin
count5
S3
O3-B4
R39
1meg
R40
1meg
C23
1u
R42
10k
U5A
C24
10u
R41
10k
C25
10u
ADA4051-2
Q5
MMBFJ177
Q6
MMBFJ177
C26
10n
S3+
R43
1meg
U6A
AD8609
C27
220n
R44
47
R45
100k
u11Bgain
R46
500k
u11Bout
R47
200k
u11C-
u11C+
R48
47
op11-
U6B
AD8609
R49
500k
R50
1meg
C28
10u
u11Cout
C29
10u
U6C
AD8609
R51
1meg
C30
10n
R52
100k
R53
500k
u10Bgain
C31
220n
u10Bout
R54
200k
u11A-
u11A+
U6D
AD8609
S3-
u10B-
Vmid
U5B
ADA4051-2
R55
500k
R56
1meg
C32
10u
Dott. Ing. Domenico Suriano
Title
elettorchimici B4.3
Size
A
Document Number
3
Rev
1.0
Date:
Monday, April 12, 2021
Sheet
3
of
4



Board layouts