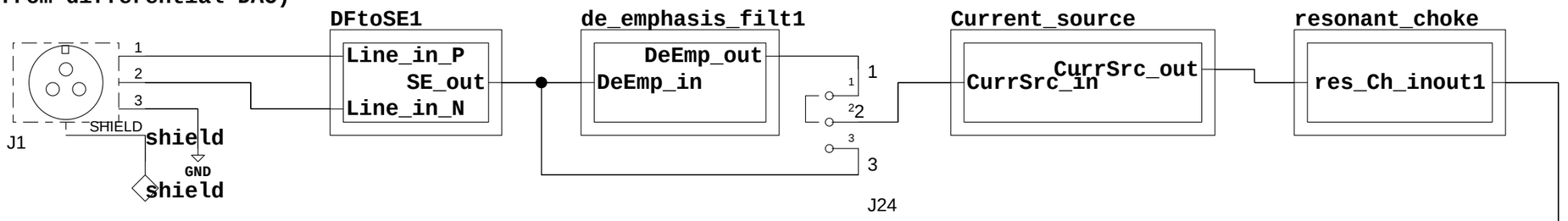
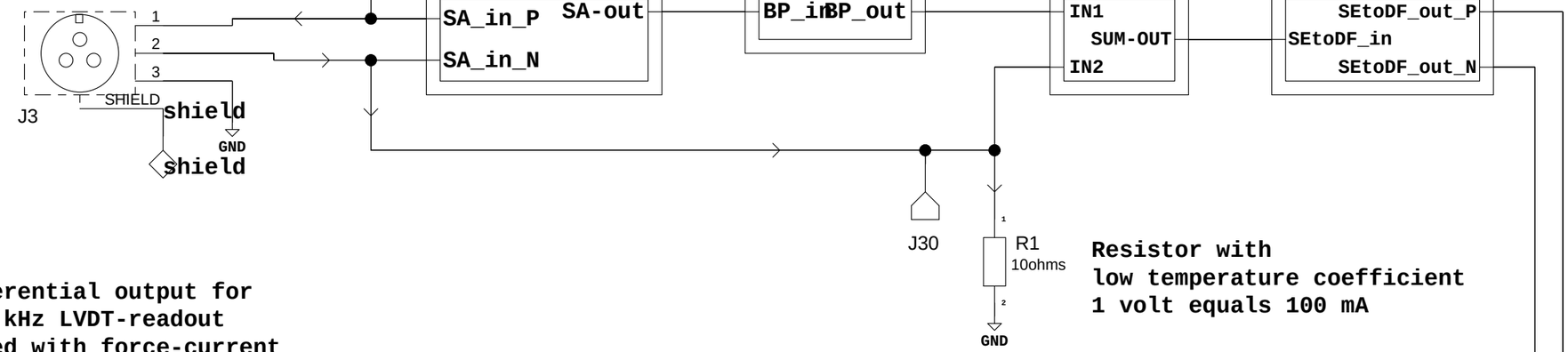
LF voice coil signal (force) input
(signals coming from differential DAC)



force current from resonant choke

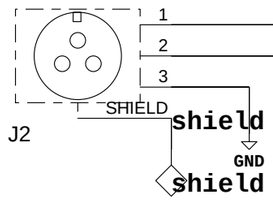
input for 10 kHz pick-up signal
coming from LVDT secondary coils

Also output of force current
to LVDT secondary coils

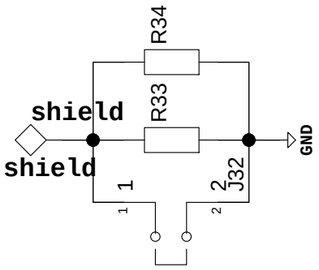


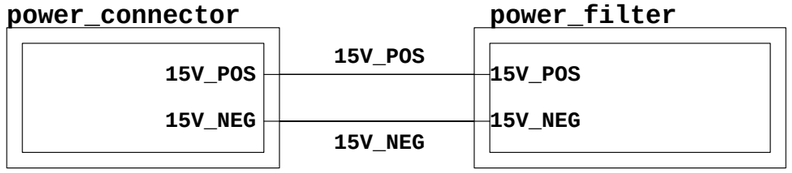
Resistor with
low temperature coefficient
1 volt equals 100 mA

differential output for
10 kHz LVDT-readout
combined with force-current
monitoring



(to ADC7674 board LAPP)





all resistors 1%
unless otherwise specified

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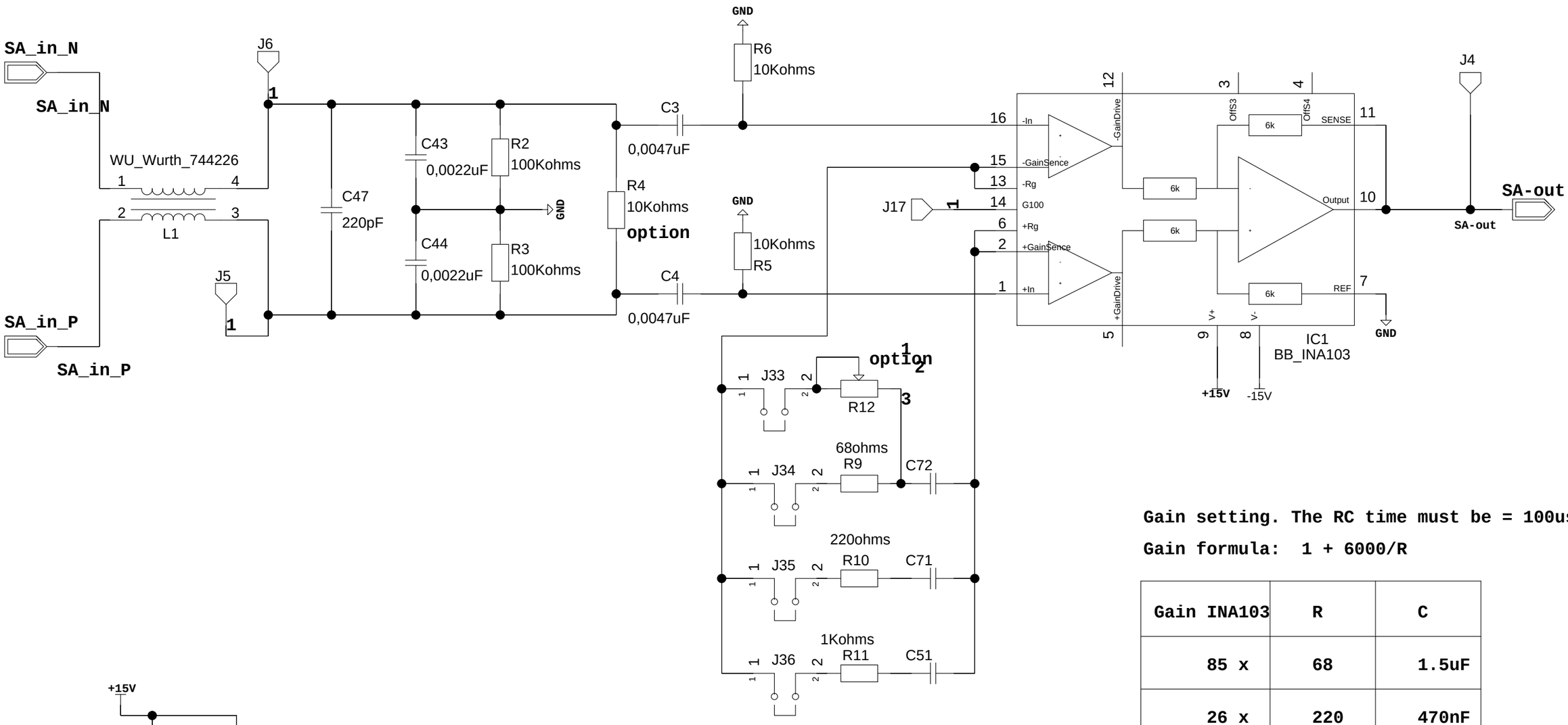
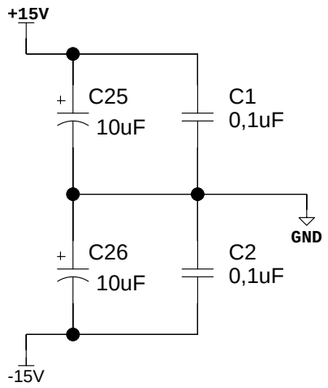
Elektronica Beta VU

Projectname : block diagram	
Projectnumber :	Pagename : Schematic1
Designer :	Start : --/--/--
Schematic :	Last modified : 25/08/2014:10:11
Pcb :	Pagenumber : 1 of 2

A3

C43, C44, R2, R3 use 1%C3, C4, R5, R6 use 1%





Gain setting. The RC time must be = 100us

Gain formula: 1 + 6000/R

Gain INA103	R	C
85 x	68	1.5uF
26 x	220	470nF
6.5 x	1k	100nF

C71 = XX_MKT_Cap_steek_10mm (lib: Han)

do not go below 27 ohm

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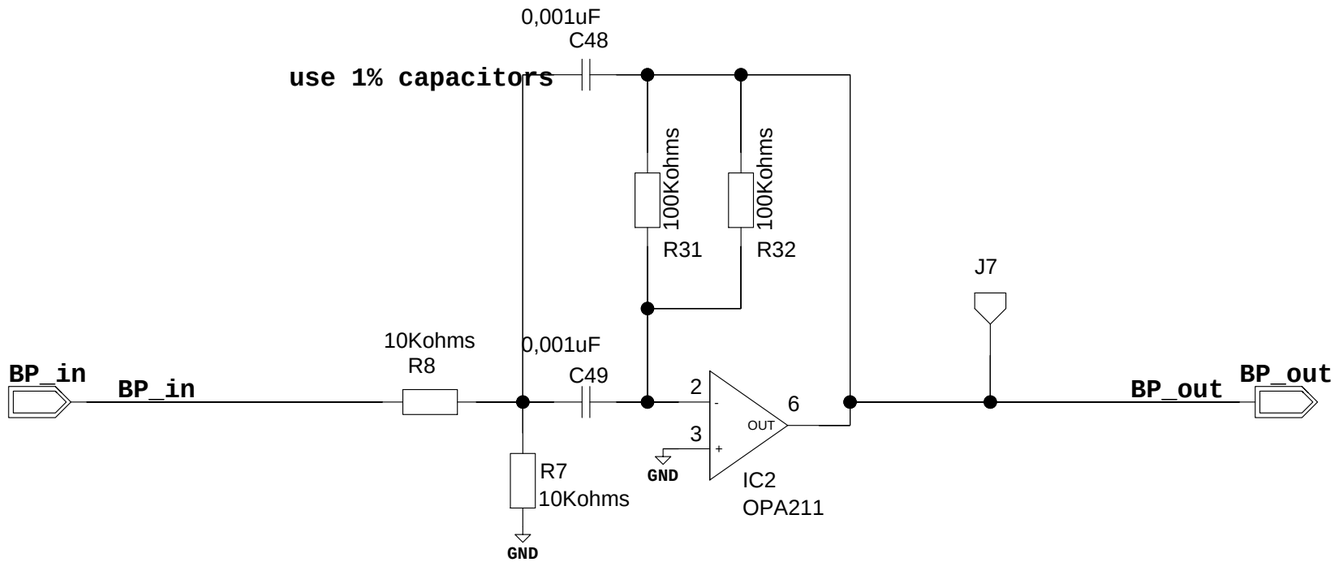
Elektronica Beta VU

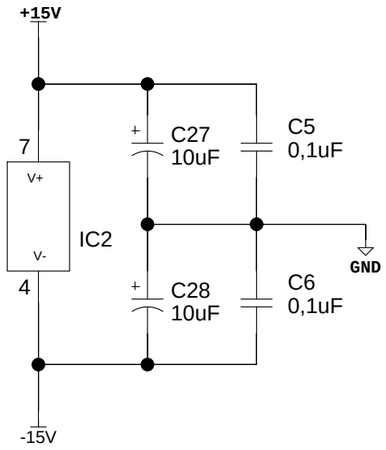
Projectname : ?	INA103
Projectnumber : ?	sens_Amp
Designer : ?	Pagename :
Schematic : ?	--/--/-- Start :
Pcb : ?	04/12/2014:09:32 Last modified :
	1 of 5 Pagenumber :

A3

10 kHz band pass filter
according to Delyiannis-friend circuit



f-resonance=10 kHz; gain=2.5x (8dB)



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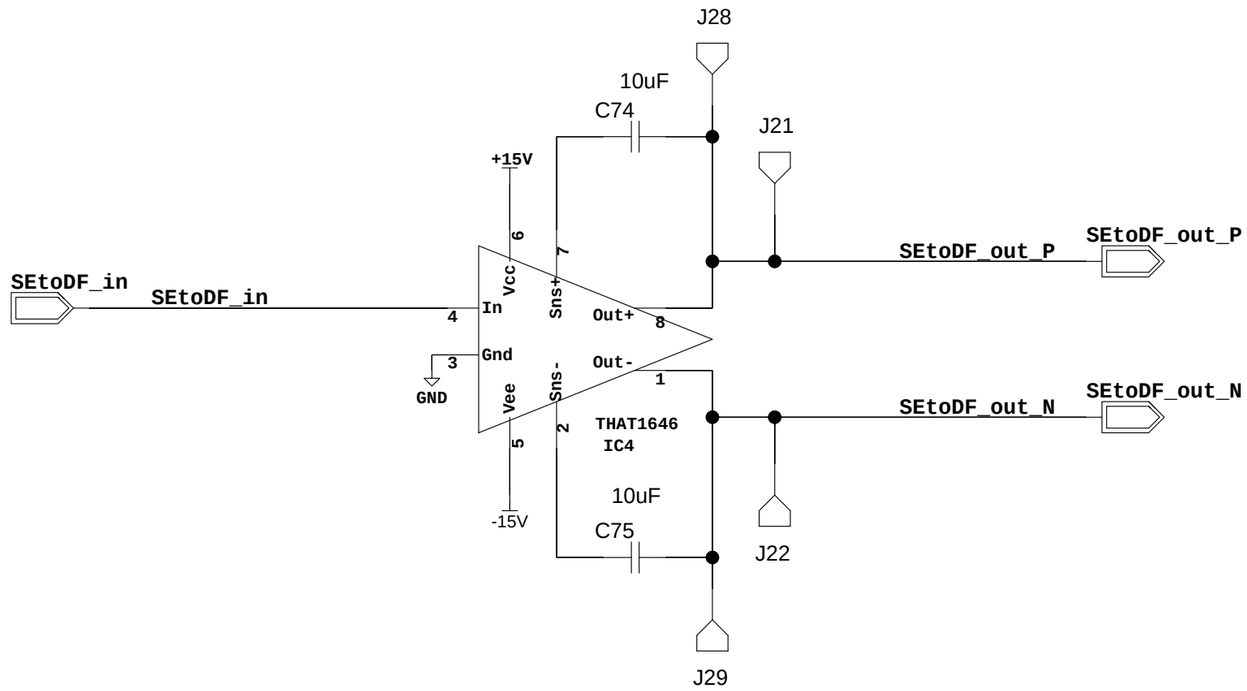
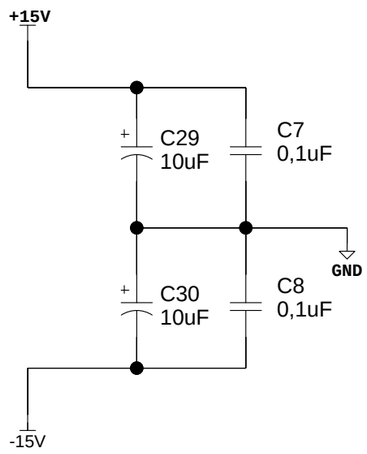
? Projectname :	10kHz band pass f
? Projectnumber :	band_pass_filter Pagename :
? Designer :	--/--/-- Start :
? Schematic :	13/09/2013:10:13 Last modified :
? Pcb :	1 Pagenumber : of 1

A3

C74 and C75 are to reduce the common mode offset

J28 and J22 can be used to mount smaller capacitors





vrije Universiteit amsterdam
Elektronica Beta VU

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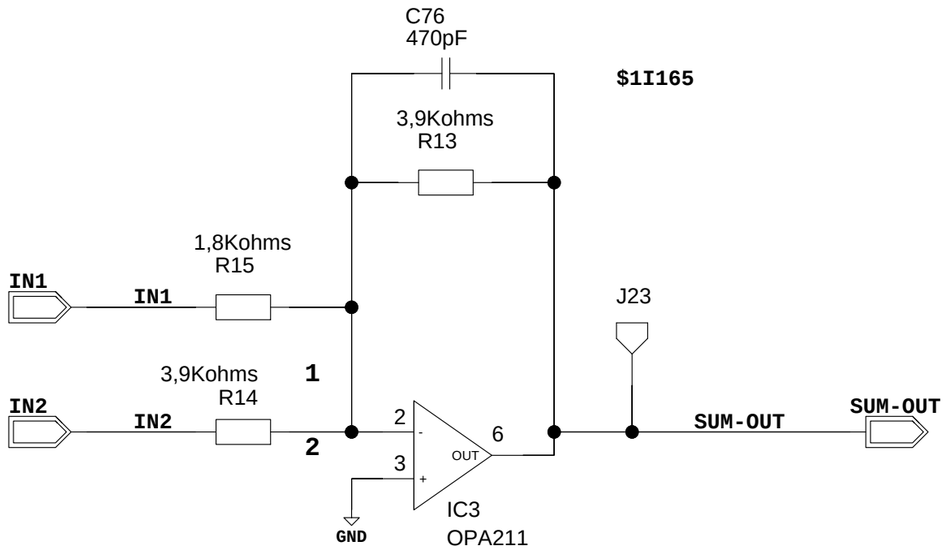
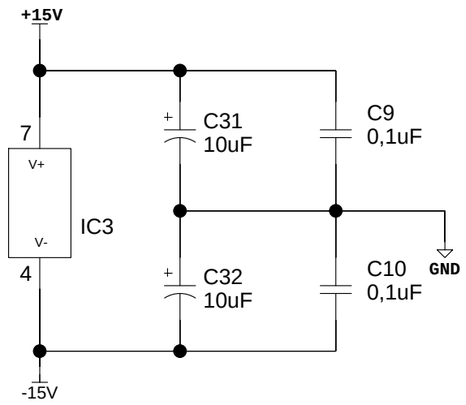
Projectnumber : ?	Pagename : SEtoDF_THAT1646
Designer : ?	Start : --/--/--
Schematic : ?	Last modified : 23/09/2013:14:49
Pcb : ?	Pagenumber : 1 of 16

A3

C76 is optional; to reduce bandwidth above 10 kHz



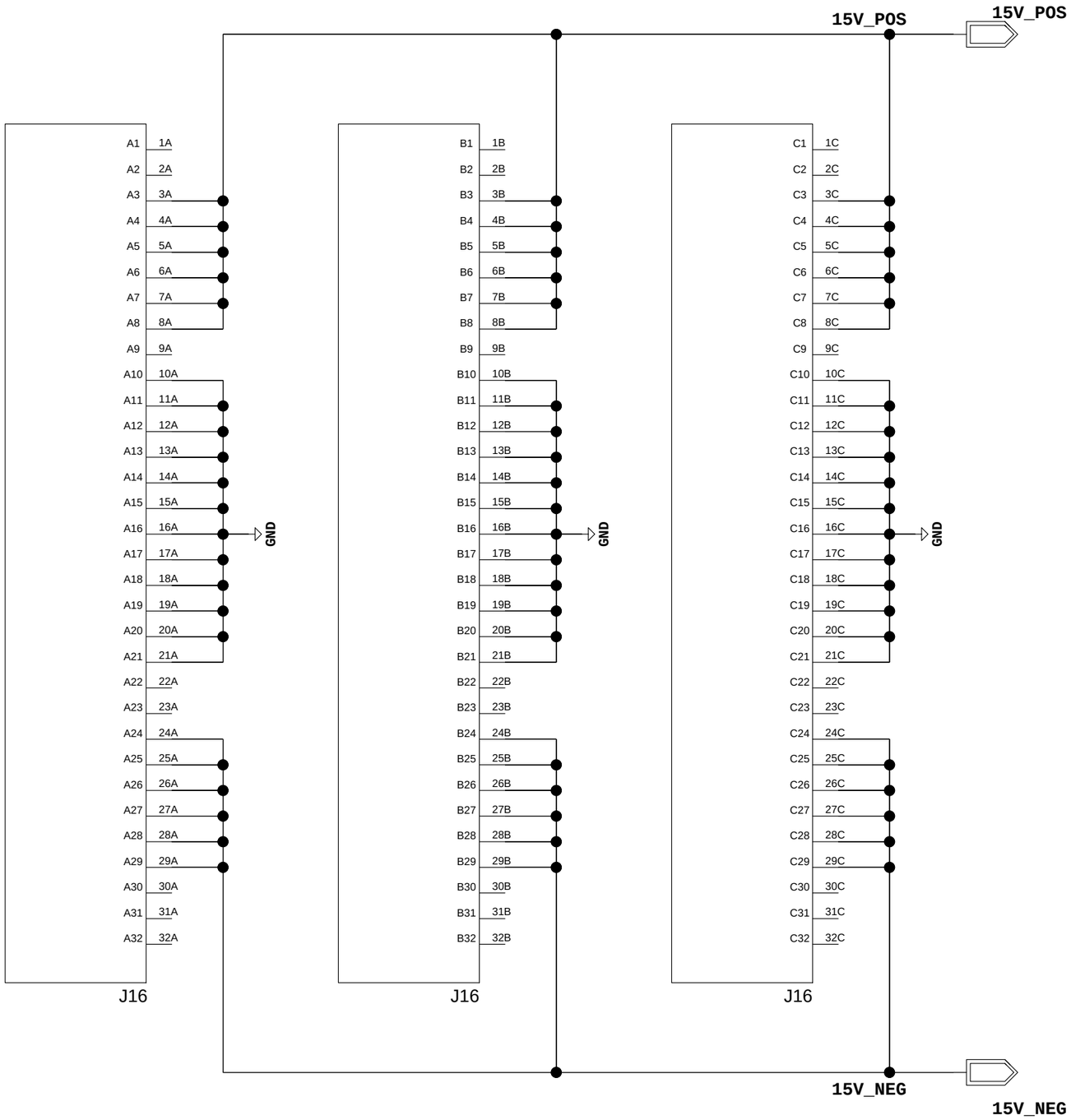
$1I179



vrije Universiteit amsterdam
Elektronica Beta VU

Projectname : ? Summing Amplifie	
Projectnumber : ?	Pagename : Sunmming_Amp
Designer : ?	Start : --/--/--
Schematic : ?	Last modified : 13/09/2013:11:08
Pcb : ?	Pagenumber : 1 of 33

A3



vrije Universiteit amsterdam
Elektronica Beta VU

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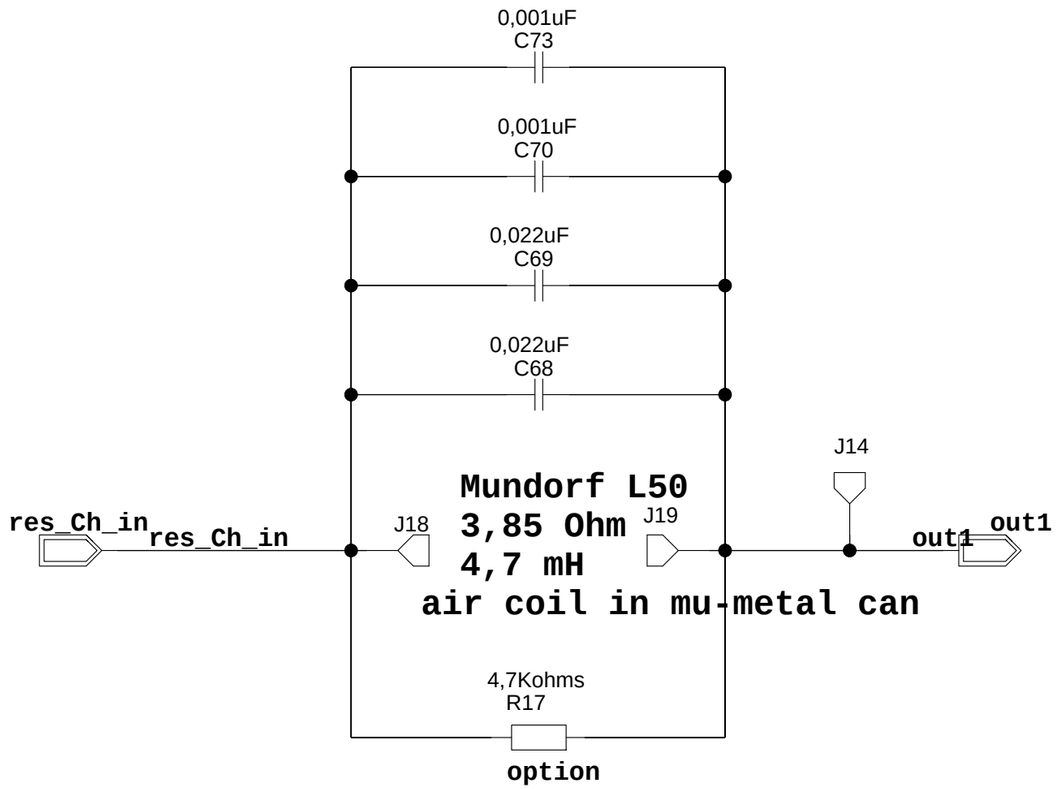
Projectnumber : ?	Pagename : power_connector
Designer : ?	Start : --/--/--
Schematic : ?	Last modified : 12/09/2013:11:48
Pcb : ?	Pagenumber : 1 of 10

A3

total capacitance 53 nF
in practice about 47n + 4,7n



resonant choke (10kHz)

vrije Universiteit amsterdam
Faculteit der Elektronica Beta VU

Projectname : ?	**Resonant choke**
Projectnumber : ?	Pagename : resonant_choke
Designer : ?	Start : --/--/--
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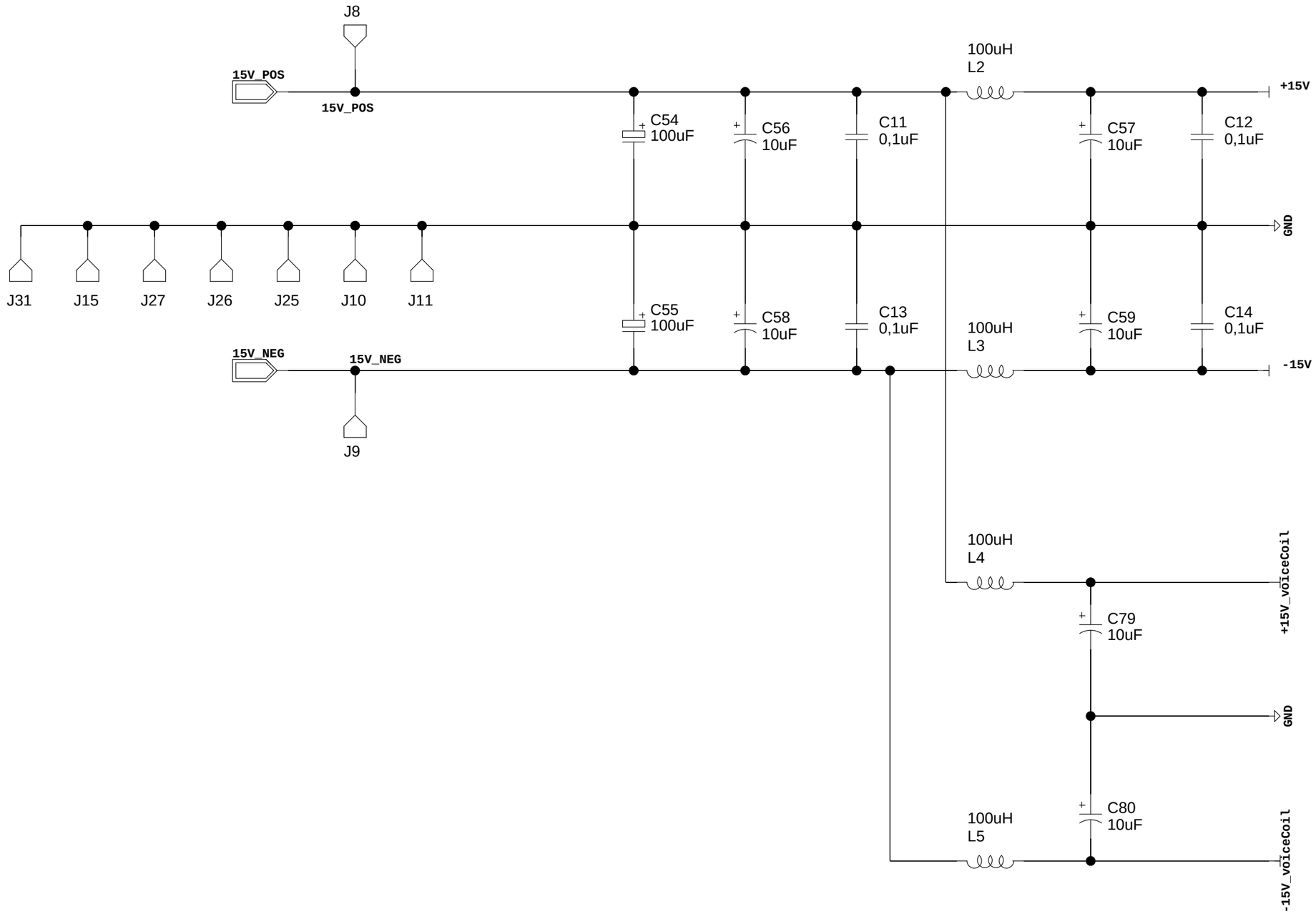
Pcb : ?	Pagenumber : 1 of 11

A3



vrije Universiteit amsterdam
Faculteit der Elektronica Beta VU

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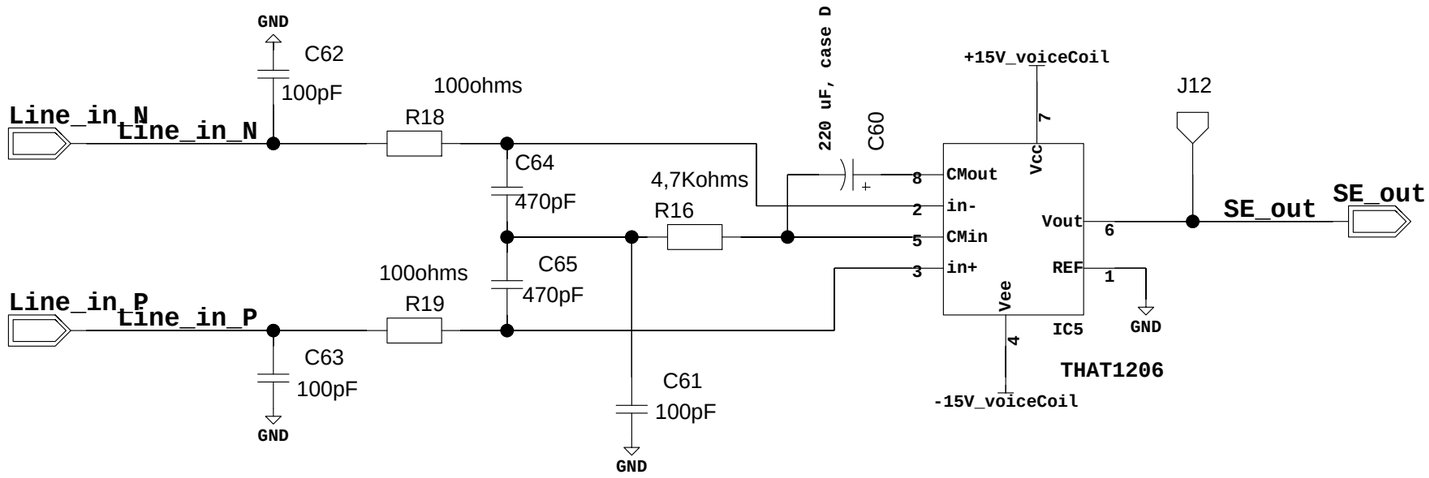
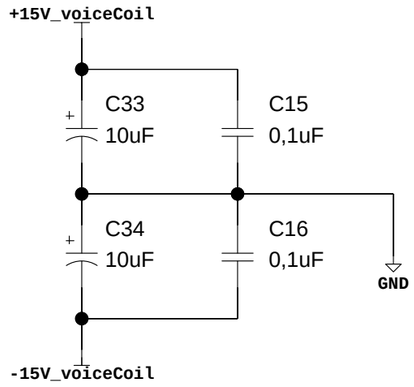
Projectnumber : ?	Pagename : power_stuff
Designer : ?	Start : --/--/--
Schematic : ?	Last modified : 24/07/2014:10:01
Pcb : ?	Pagenumber : 1 of 1

A3





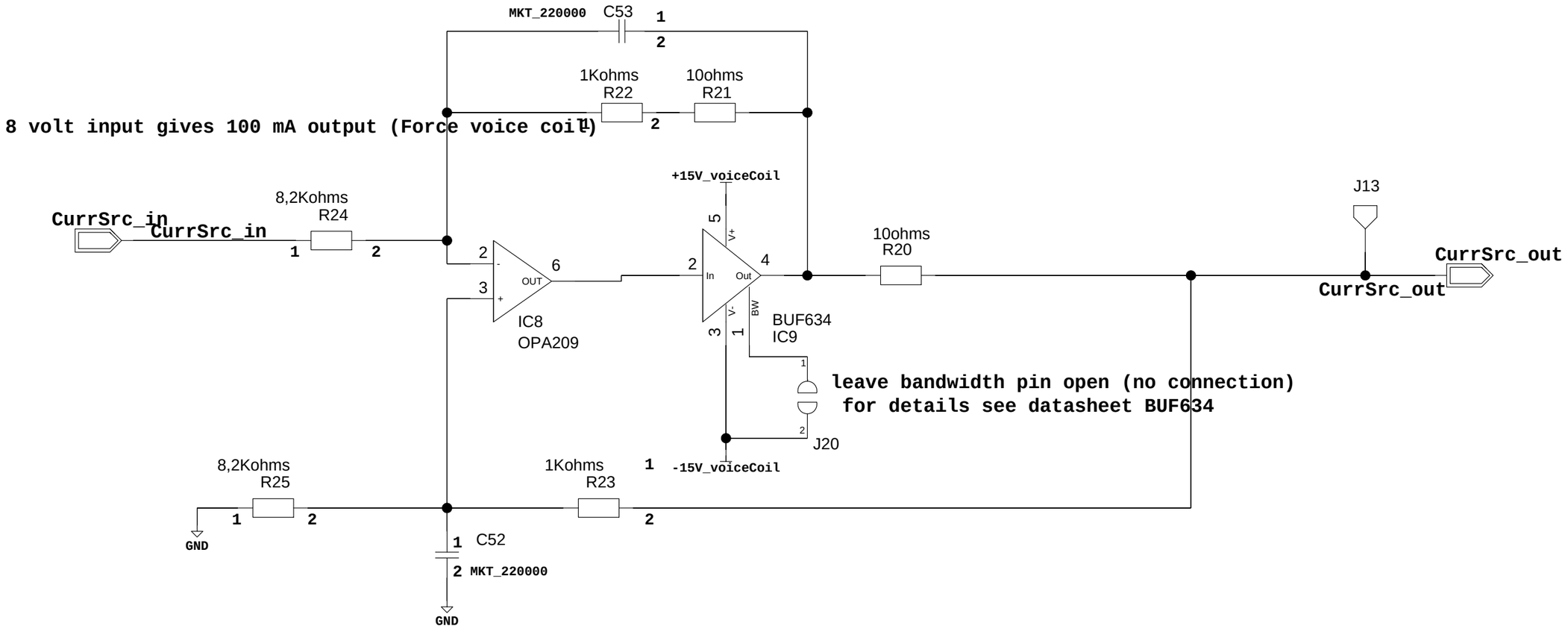
vrije Universiteit amsterdam
Elektronica Beta VU

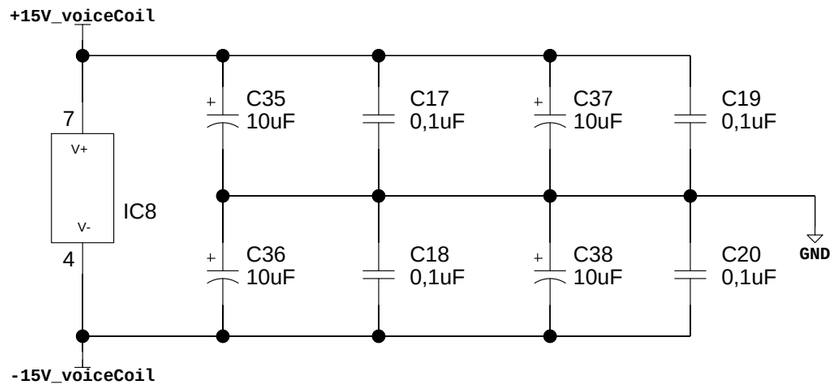
Projectname : ?	line receiver THAT1206
Projectnumber : ?	Pagename : DFtoSE
Designer : ?	Start : --/--/--
Schematic : ?	Last modified : 30/09/2013:16:19
Pcb : ?	Pagenumber : 1 of 1

A3

Howland bipolar current source (only for low frequencies)

C52, C53 of 220nF gives the nicest step response. It takes about 3ms

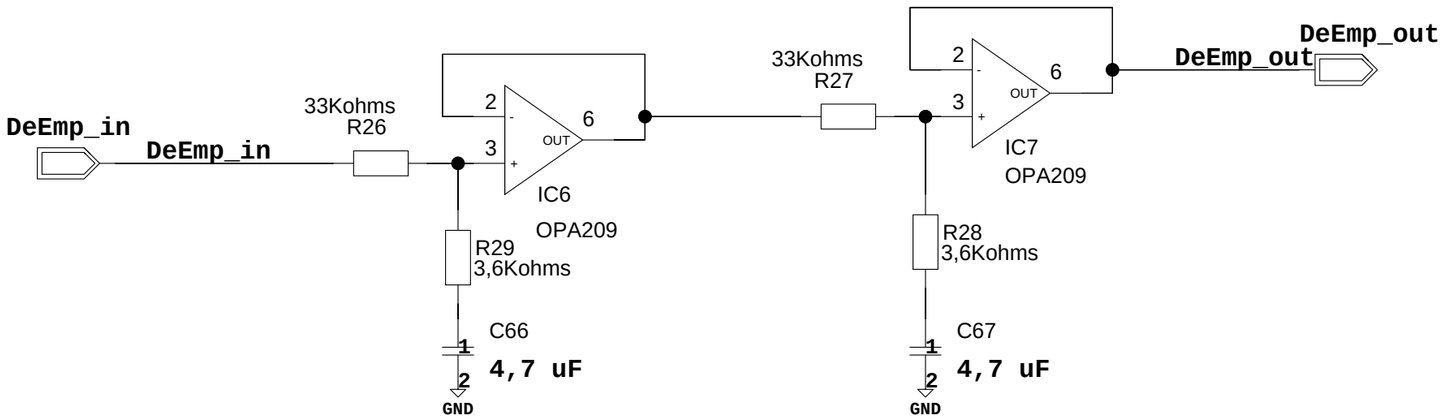


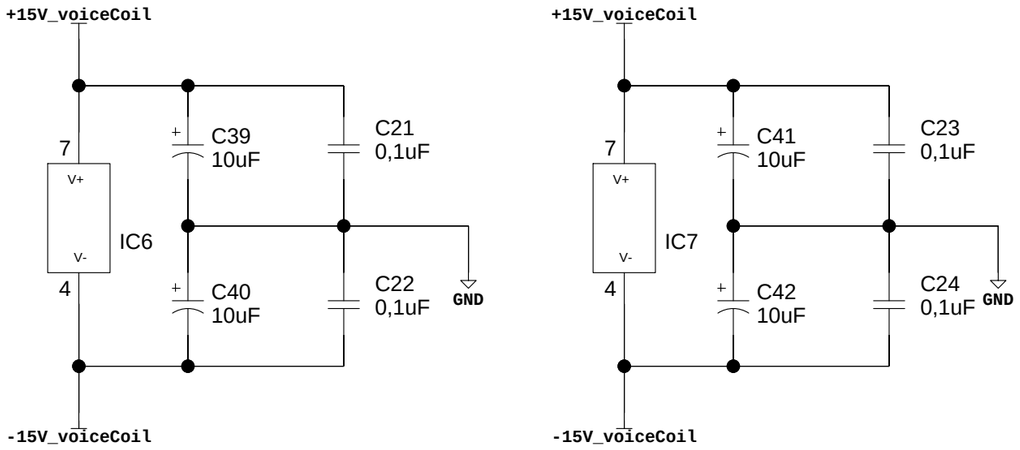


vrije Universiteit amsterdam
Elektronica Beta VU

Projectname :	Current_source
Projectnumber :	Pagename : Current_source_with_
Designer :	Start : --/--/--
Schematic :	Last modified : 20/08/2014:14:29
Pcb :	Pagenumber : 1 of 1

A3





vrije Universiteit amsterdam
Elektronica Beta VU

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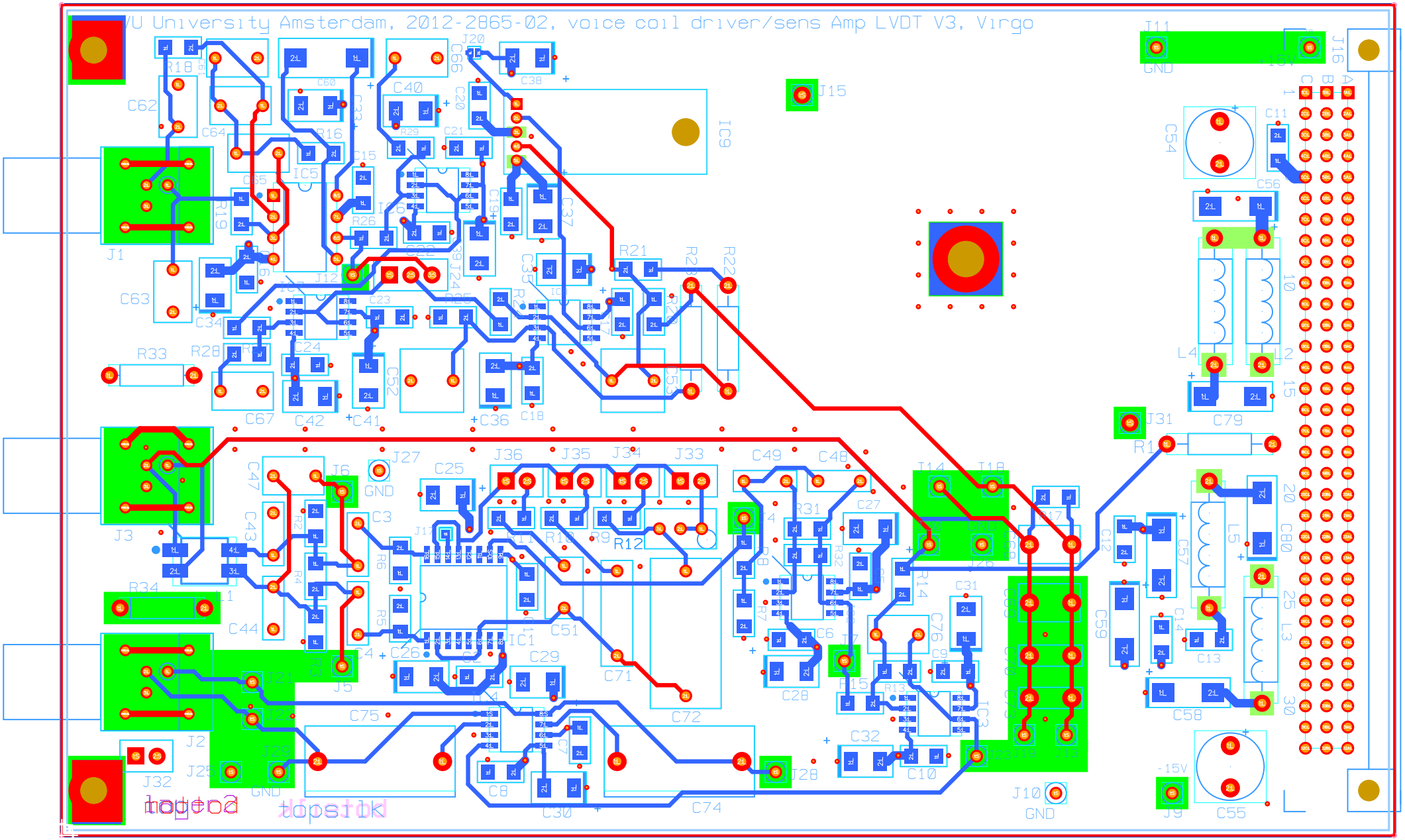
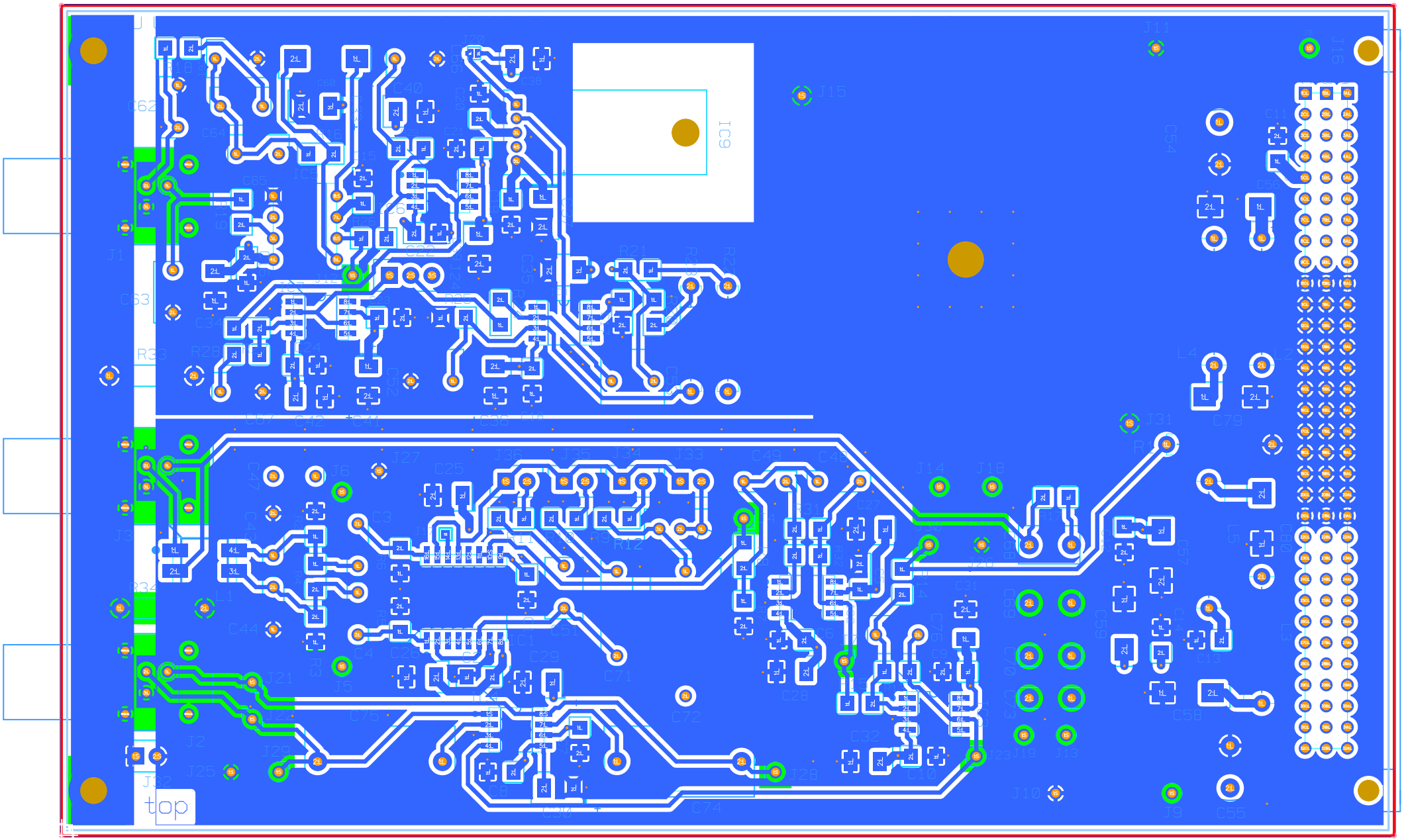
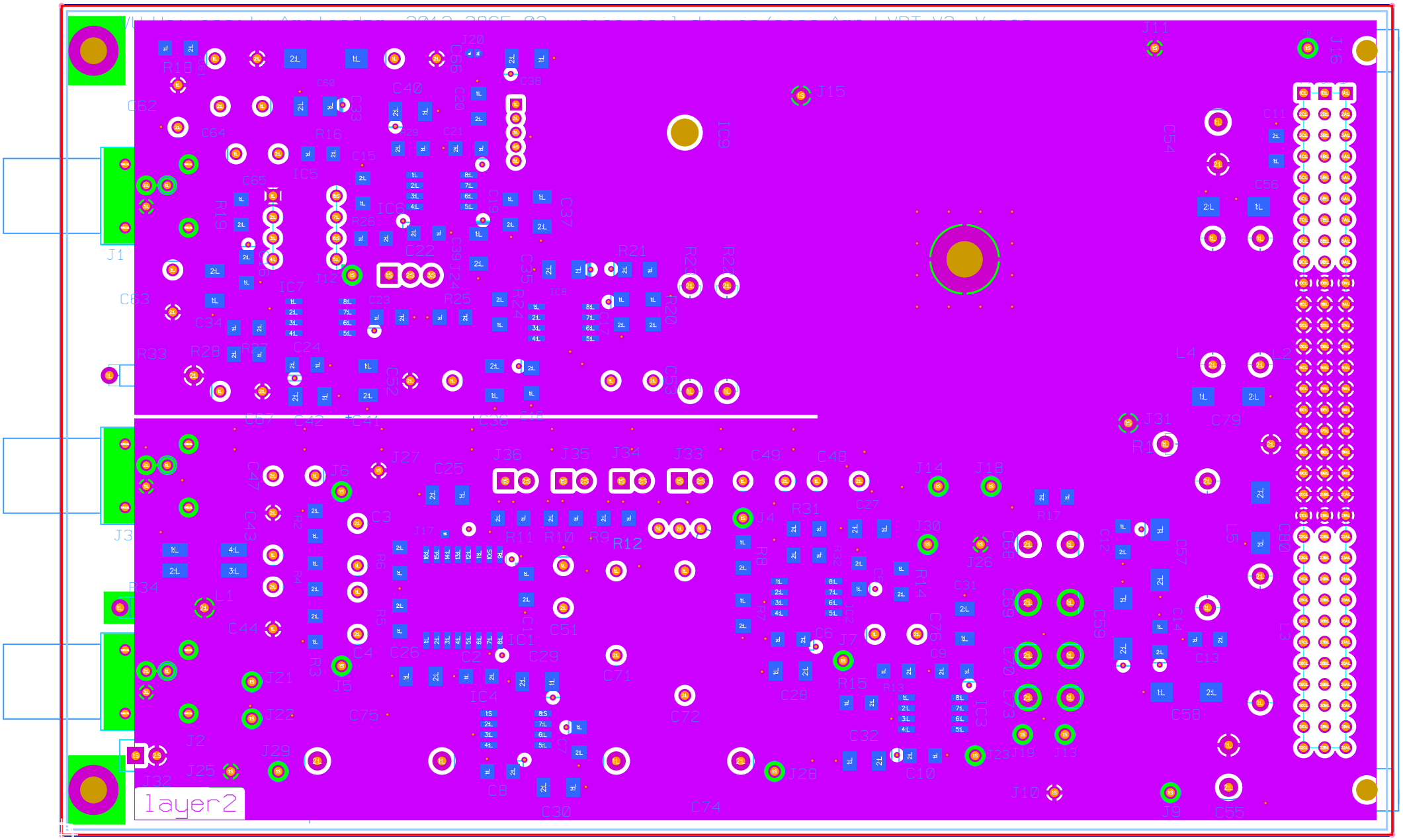
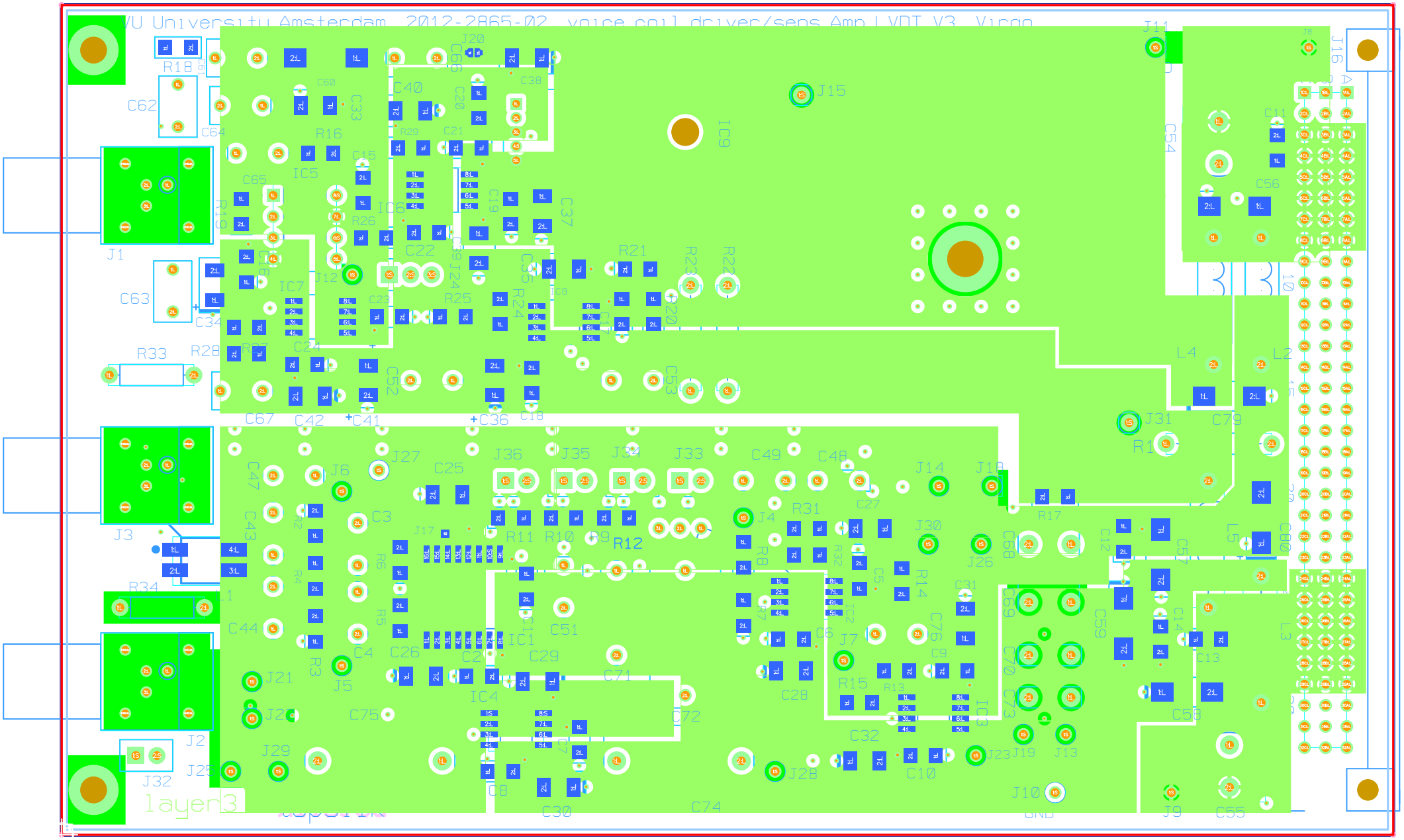
Projectnumber : ?	Pagename : De_empfasis_filter
Designer : ?	Start : --/--/--
Schematic : ?	Last modified : 04/12/2014:09:26
Pcb : ?	Pagenumber : 1 of 1

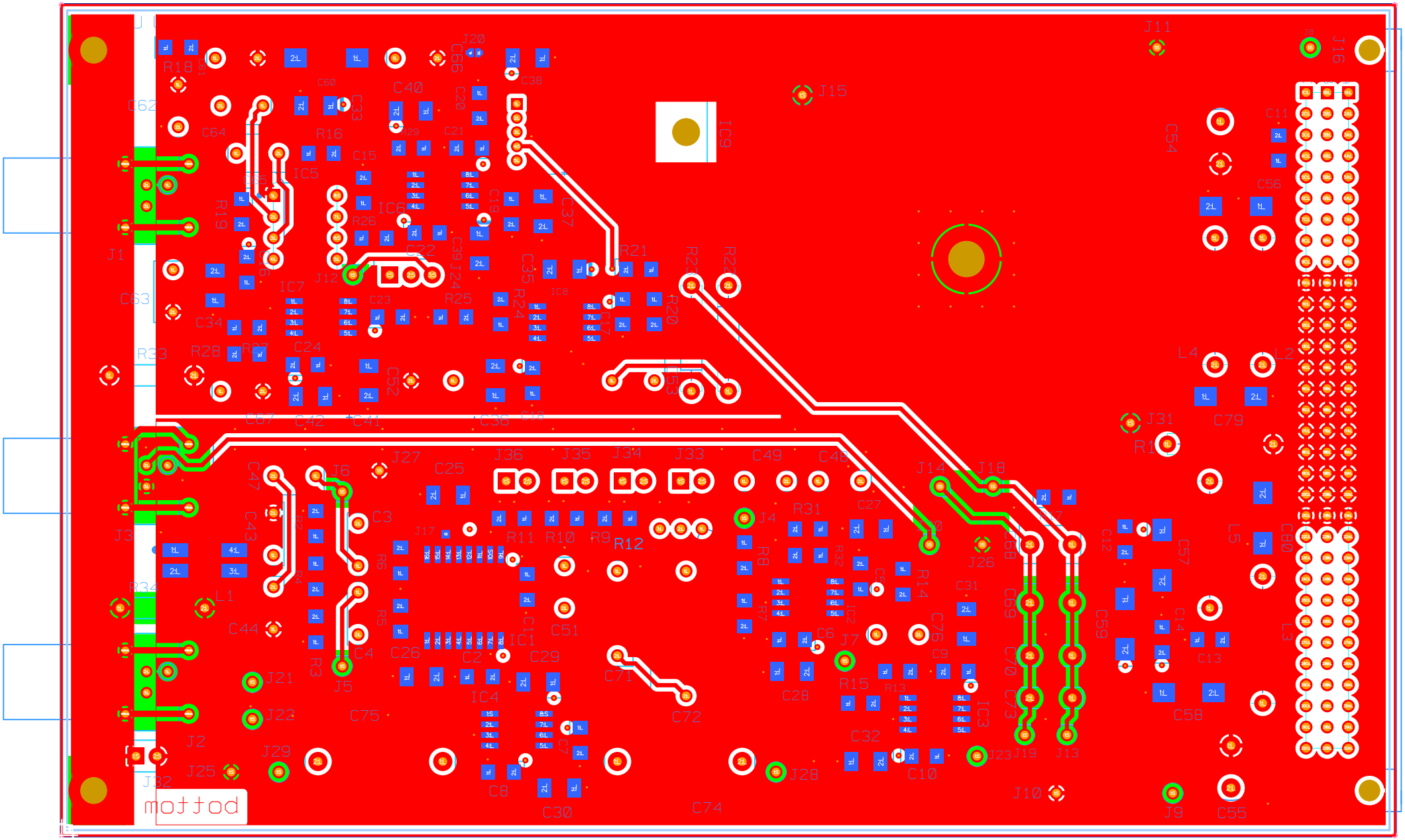
A3


VU University Amsterdam, 2012-2865-02, voice coil driver/sens Amp LVDT V3, Virgo
GND
-15V
layer2
topstk


top


layer2


VU University Amsterdam 2012-2865-02 voice coil driver/sens Amp LVDT V3 Virgo
layer3


mattod

Bench_LVDT_Advanced_Virgo

Force-voice-coil_sens-Amp_V3

Technical Note

vrije Universiteit amsterdam

Han Voet, Alessandro Bertolini , October, 2014
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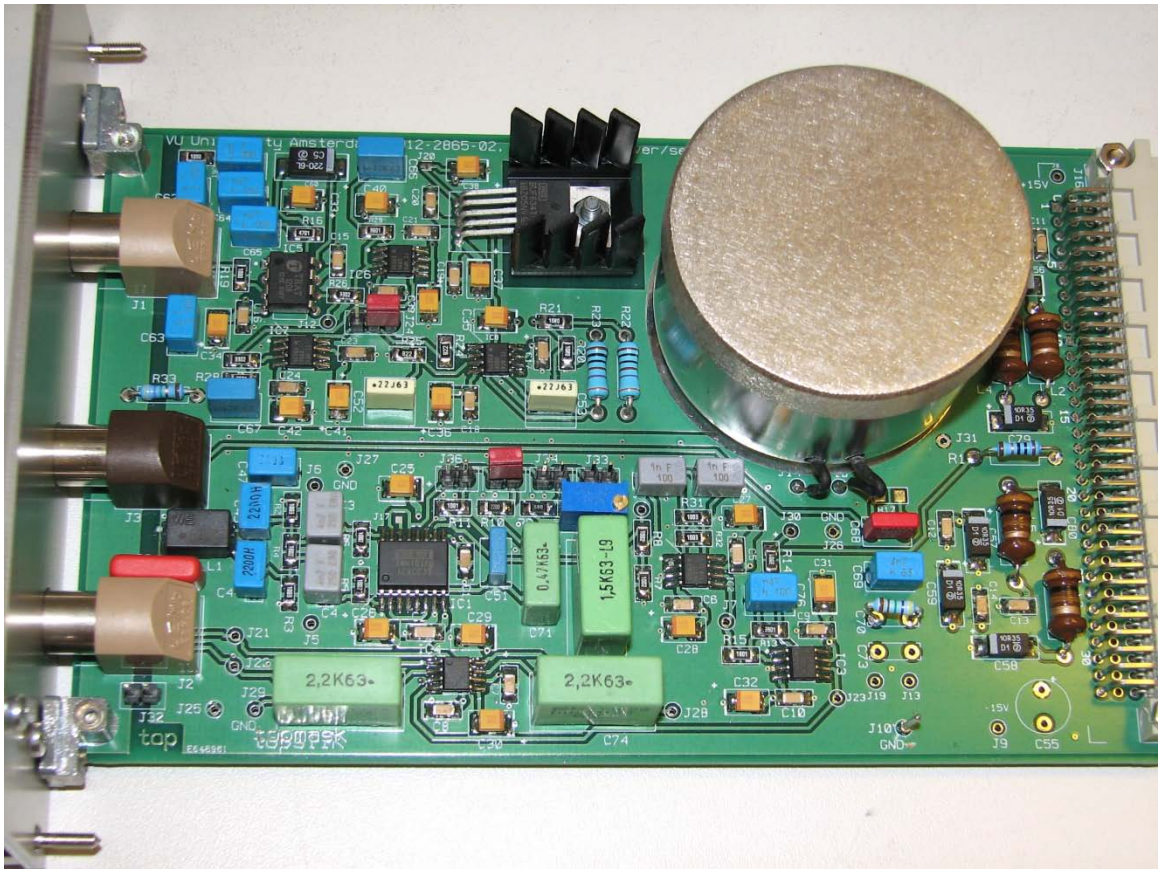
Project ID : 2012-2865-02
Filename : Voice-coil_sens-Amp_board_V3.docx
Pages : 10
Last save : (December 4, 2014)

Table of contents

1 Introduction i
2 Description 1
3 De-emphasis filter 3
4 Gain setting of the INA103 4
5 Check if signal levels are right 4
6 How to check whether the resonant choke is in resonance 6
7 Connecting front to power ground. 6
8 Suggestions how the connect the device 7
9 Power supply 7
10 Meaning of LVDT 7
11 Schematics and PCB layout 8
12 LEMO pinning of differential input en output 8

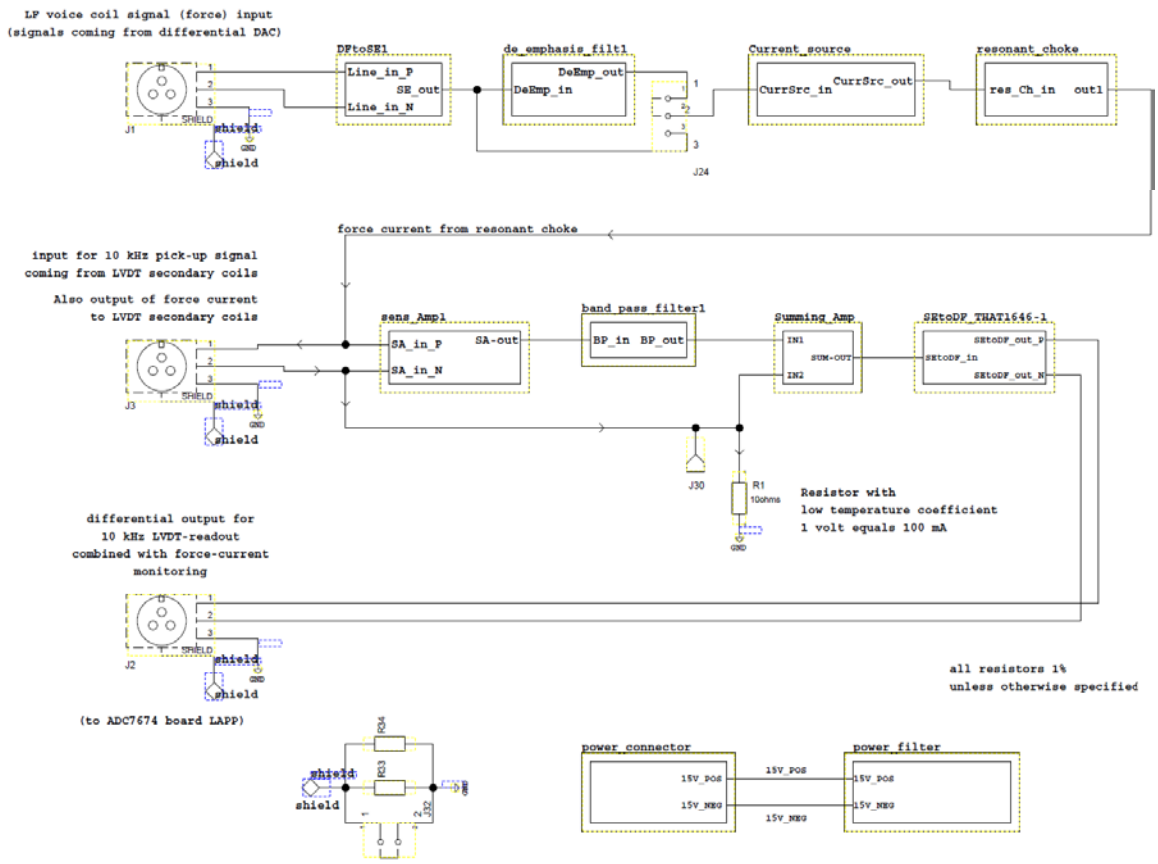


1 Introduction

The purpose of the Voice-coil-driver & sense-Amp board is pick up and amplify a 10 kHz sine wave signal from the secondary LVDT coils.

It is part of a control system which damps the motion of mechanical pendulums caused by seismic disturbances

2 Description



See for more details the file:
VoiceCoilDriver_senseAmp_Schematic_2014_V3.pdf
On the first page you have rectangles with a double line. Click on it and choose: “Push Schematic” to see the underlying schematic.

J3 must be connected to the secondary coils of the LVDT. The balanced 10 kHz signal is amplified by an INA103 (the INA103 output is single ended).
After that it goes through a 10 kHz band pass filter.
Then it goes through the summing amplifier and through a THAT1646 which makes the signal balanced again.
J2 is the output, which should be connected to an ADC for further signal processing.

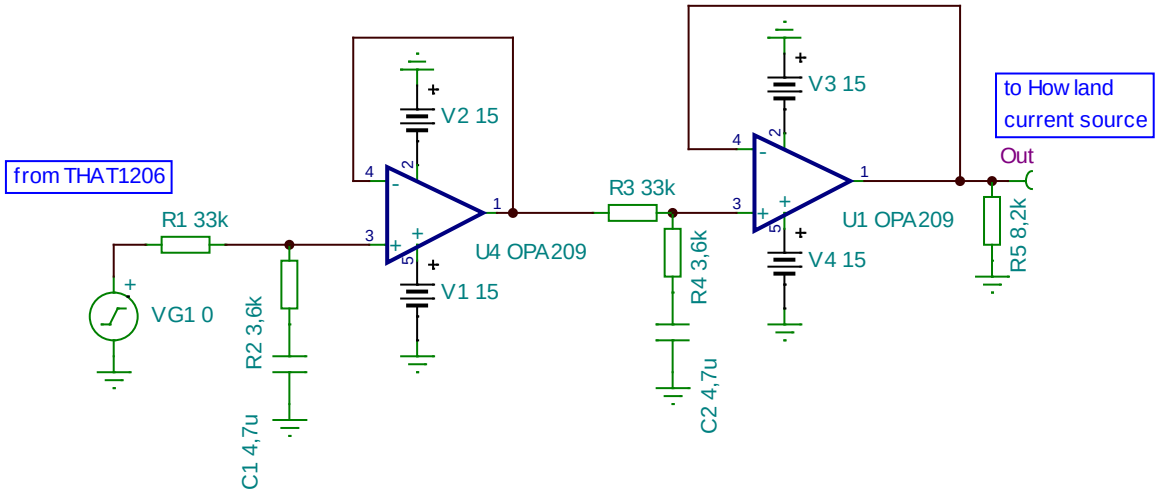
After this digital processing, the derived control signal appears on a DAC. This DAC must be connected to the balanced input connector J1.
The signal may or may not go through the de-emphasis filter (jumper J24).
If the jumper piece is placed in the position closest to the front, the de-emphasis is active.

The current source has a high output impedance for low frequencies (DC-1kHz) and a low output impedance for high frequencies (10 kHz).

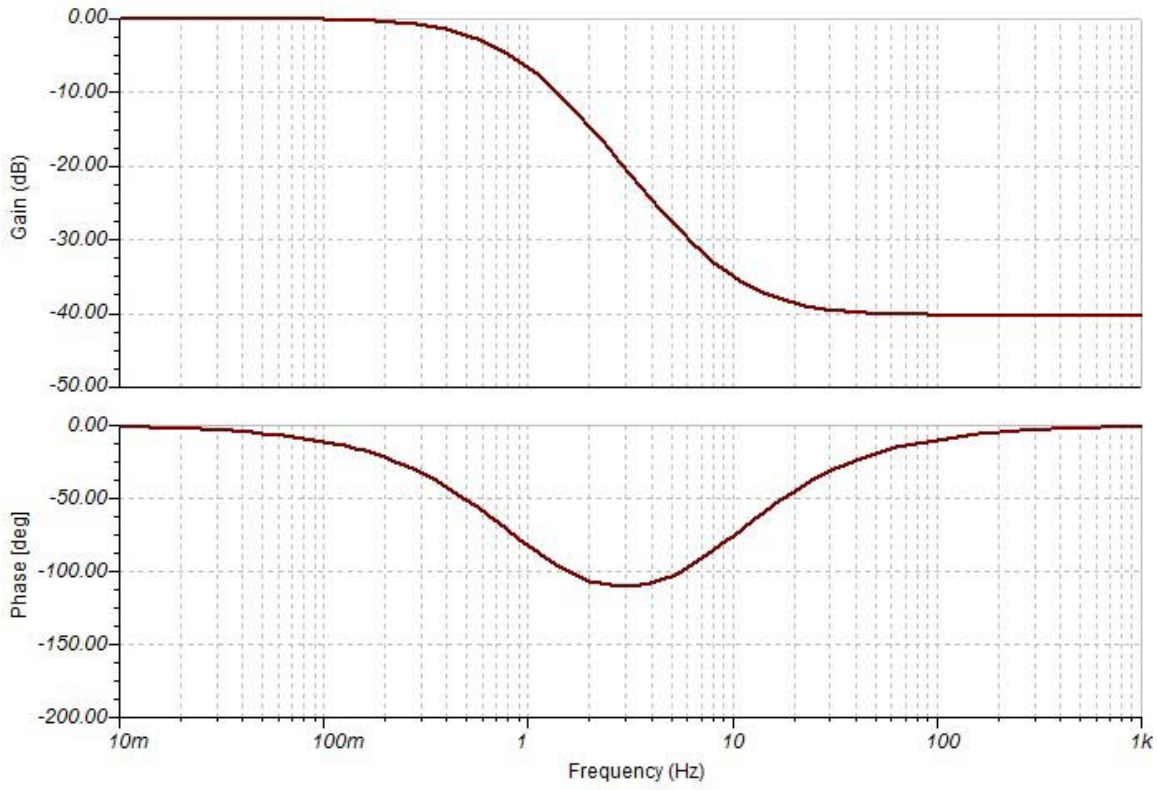
The low frequency current can flow through the resonant choke with ease, while the choke forms a blockade to 10 kHz. So the 10 kHz pickup signal from the LVDT is not “eaten”.
The choke also ensures that noise from the current source does not end up in the measured 10 kHz signal.

The (DC-1kHz) part of the DAC-signal produces a force because the secondary coils of the LVDT form a voice coil motor with the help of a magnet, which is mounted at the mechanically opposite side.
The (DC-1kHz) part of the DAC-signal also produces a voltage drop across R1. Through the summing amplifier this signal finds its way to the ADC.

3 De-emphasis filter



Bode plot:



The de-emphasis filter is according to Virgo standards.
The purpose is to reduce the noise of the DAC. In the digital world before the DAC, the opposite correction has to be done.

4 Gain setting of the INA103

According to the datasheet of the INA103 the gain is 1 + 6000 / Rg

See file: VoiceCoilDriver_senseAmp_Schematic_2014_V3.pdf

There are 3 fixed gain settings which can be chosen by Jumper
J34 (gain = 85),
J35 (gain = 26),
J36 (gain = 6.5).

With J33 one has potentiometer R12 (500 ohm) to control the gain.

The capacitors (C51, C71 and C72) are to reduce the gain at low frequencies. This is to avoid that the (DC-1kHz) voice coil signal is amplified to an unnecessary amount.
The value of the capacitors (C51, C71 and C72) is such that the RC-time is about 100 us.

5 Check if signal levels are right

Connect the secondary coil of a spare LVDT to the “LVDT secondary coils pick-up & force current” input.
Connect the primary coil of the spare LVDT to a sine wave signal generator.
Connect an oscilloscope to one of the signal pins of the “LVDT position readout & force current monitor” output.

10 kHz part:

Set the signal generator on 10 kHz and 600 mVpp. (high impedance load)

Look at the oscilloscope and find the minimum signal position of the LVDT. Then move a part of the LVDT 15 mm.

Closed jumper:	output with respect to ground should be about:
J36 (low gain)	1.5 Vpp
J35 (medium gain)	6.0 Vpp
J34 (hight gain)	18.8 Vpp

If the values are quite beside these, the resonant choke may not be in resonance.

Voice coil part (2.8 Hz):

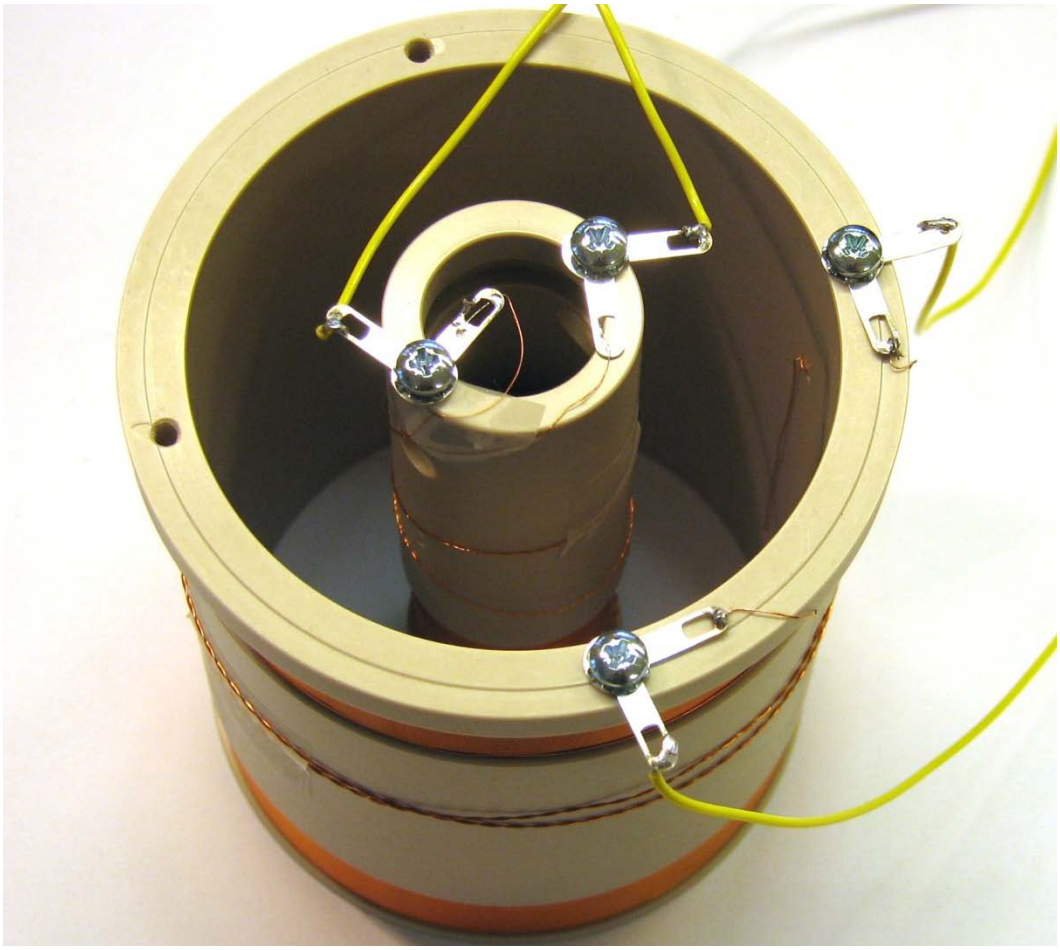
Ensure that jumper J24 is in the position furthest from the front
Connect a signal generator to the “Voice Coil force signal” input. Most signal generators do not have a differential output. In this case (generator with single ended output) the not used input pin should be grounded.

Set the signal generator on 2.8 Hz and 4 Vpp. (high impedance load)

This should generate a current of 25 mApp which produces a voltage drop of 0.25 Vpp across R1. This can be measured with the oscilloscope on J30 or pin 2 of the LEMO receptacle (the coldest side of the secondary coil of the LVDT), but you can also keep the oscilloscope to one of the differential signal pins of the “LVDT position readout & force current monitor” output. The signal should be 0.25 Vpp as well with respect to ground.

Test of the de-emphasis filter:

Put jumper J24 is in the position closest to the front. The amplitude should go down to about 25 mVpp (20dB).



6 How to check whether the resonant choke is in resonance

The resonant choke is connected to the secondary coils of the LVDT. So the resonance frequency is influenced by the self-inductance of these LVDT coils. To check whether the resonant choke is in resonance, connect a signal generator to the “sine wave reference input” of the Exciters board. If there is no Exciters board connect the signal generator to the primary coil of the LVDT.
Connect the secondary coils to the “LVDT secondary coils pick-up & force current” Lemo socket. Also connect an oscilloscope to the J4 test pin (output of INA103) of the Voice coil driver & Sense Amp board.
Connecting in this manner ensures that no band pass filter is in the signal path.

If you trust the band pass filter (consisting of IC2), it is easier to connect an oscilloscope to one of the signal pins of the “LVDT position readout & force current monitor” output.

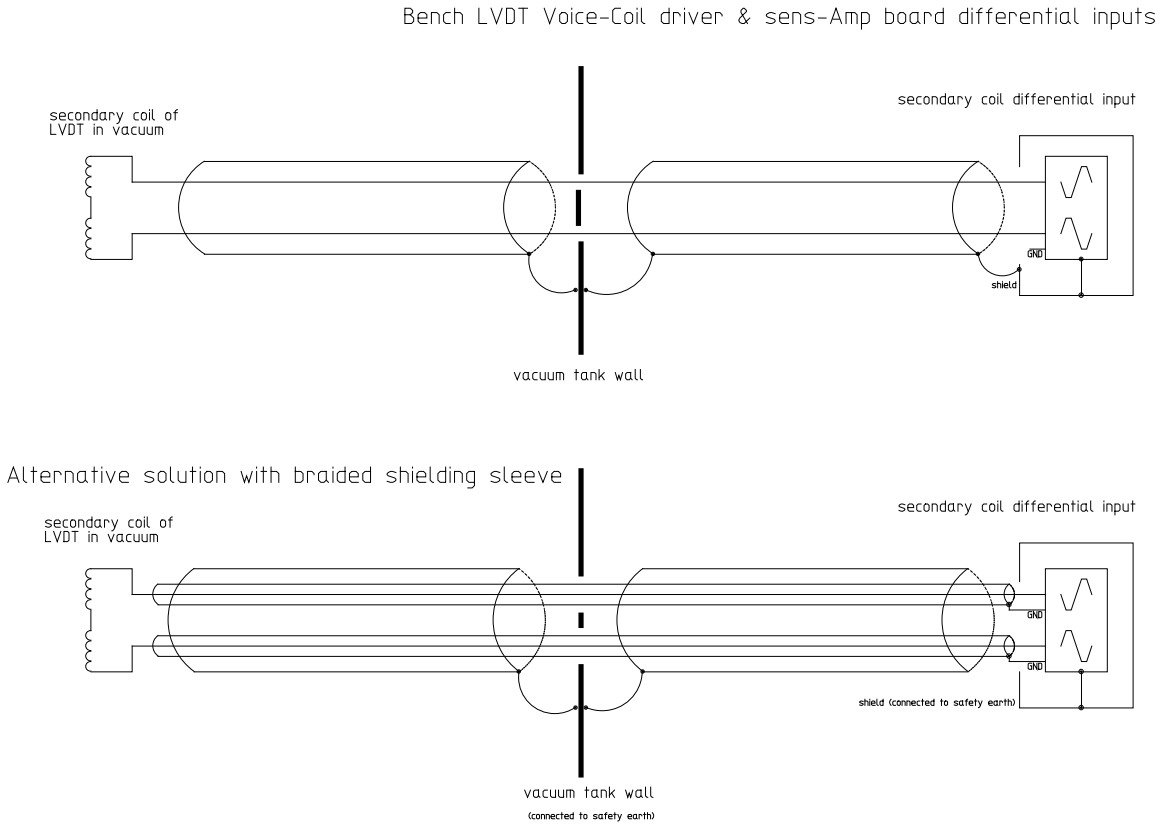
Sweep the signal generator back and forth to see if the maximum is at 10kHz.

If not, create the right capacitor value with C68, C69, C70 and C73. If you find the Q-factor to high put a resistor (4.7kohm is already mounted) on R17.
The normal capacitor combination is 47nF plus 6.8nF.

7 Connecting front to power ground.

The user has to decide whether there is a connection with a jumper (J32) between the front and the GND of the board.
There is also a possibility to make a soft connection with a resistor or capacitor (R33, R34).
The shielding of the LEMO connectors is connected to the front.

8 Suggestions how the connect the device



Matching LEMO plug: FGG.0B.303.CLAD52Z

9 Power supply

The board runs on
+15Volt current 45 mA
-15Volt current 45 mA
The Delta Elektronika power supply 75 SX 15-15 has fuses of 2 AT (slow) at the 230 V~ side.

10 Meaning of LVDT

LVDT = Linear Variable Differential Transformer
or
Linear Variable Displacement Transducer

11 Schematics and PCB layout

See file:

LVDT_VoiceCoilDriver_senseAmp_Schematic_Layout_2014_V3.pdf

12 LEMO pinning of differential input en output