

# To SIT or not to SIT?

- 1 From Némésis to NéméSIT
- 2 Folding act – another way to SIT
- 3 Smoothie for the ears
- 4 Twisting the phase . .

*Thoughts within a vacuum about driving  
Static Induction Transistors (SIT)*

Albert Kuiper 2022  
aka Triode\_al

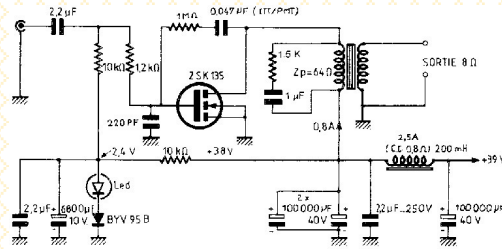
# The Némésis: a single mosfet amp 2SK135. Paris, 1985

Jean Hiraga in L'Audiophile issues 34, 35 in 1985

→ 2SK135 Lateral Mosfet, a buffer & 64-32/8 ohm transformer

Original idea 2SK60 V-FET (→ Arai Jan. 1985 Stereo Technic Jp)

A low impedance transformer Tango FG-50S: *Unobtainable*



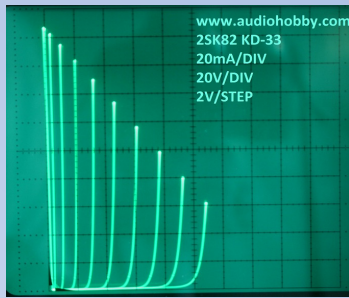
09-11-2022  
1/ Tap 64: L = 298mH, Rac = 54.91ohm, Rdc = 1.21ohm  
2/ Tap 32: L = 150.83mH, Rac = 27.17ohm, Rdc = 0.89ohm  
3/ Tap 16: L = 74.26mH, Rac = 13.30ohm, Rdc = 0.4ohm

2

Jean Hiraga made a great sounding amplifier, the best amplifier I ever heard at La Maison de L'Audiophile. But that transformer . . . I can't find one . There was a French E-I transformer but that is gone too.

Fast forward to 2015: *Nelson Pass* using the new SIT in his Arch Nemesis (*a déjà vu*)

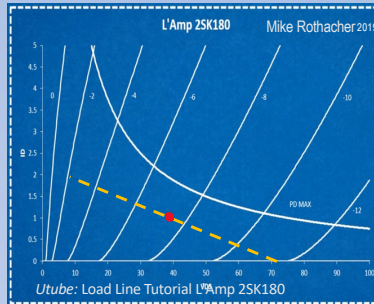
The Static Induction Transistor is like a DHT *on steroids*



Static Induction Transistor - V-FET

Looks like a VT52 or 10Y on steroids

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A useful implementation

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They are big

3

The first concept of a single transistor and a transformer came from the application of a V-Fet = Static Induction Transistor in application sheets of e.g. TOKIN. They were industrial switching devices and high power (water cooled 1.000 -3.000 watt) amplifiers.

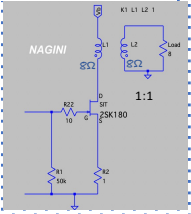
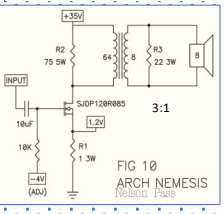
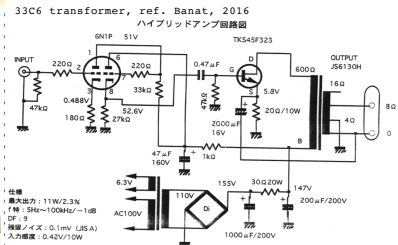
# Nothing on the shelf for a new Némésis with SIT?

**8/8 Ω SE Sowter 1410**  
 bifilar wound. Primary 150  
 mH, DC resistance 0.75  
 Ohms. DC 2 A max.

**600/8 Ω 6C33C Toroid**

**600/8 Ω and 64/8 Ω**  
 @ Aliexpress  
 Amorphous: 6C33C 6700  
 EI: 72 Ω, 400mH/55mH  
 frequency and current??

Hilaric texts: LOL! 😂  
 Hence questionable quality



What option available for these transformers now?

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## Buying a transformer . . . needs peace of mind

Trans Formers - poetry by A. Lie Express

*If you are quiet, move like a rabbit,  
then the noise is clean.*

can be  
used  
without  
plugging  
in

**Don't have a charm.  
If you listen, you will know**

*The treble is clear and the midrange is  
rounded, so that the problem of the lack  
of bass is also solved*

*it has the strength of a stone machine,  
shrinks freely under large dynamics,  
sows through the clouds*

*This transformer is not arbitrarily  
and sloppy in production because it  
is a cheap transistor.*



The texts that Alie provide are not assuring. Some descriptions are pertinently wrong:  
A Lie Express.

# My concept for a NémésIT

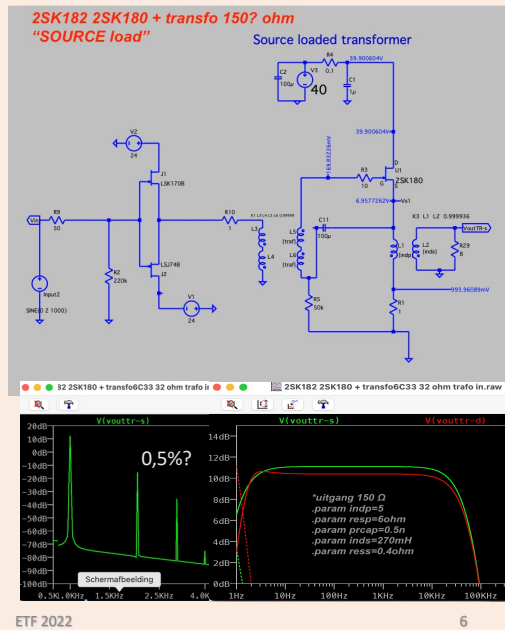
Auto-bias across output primary!  
*source loaded*

Drive  $V_g/V_s$ :  
**Western Electric style**  
 Same distortion as drain loaded  
 Smoother low end

Distortion @  $V_b=40V, 2W$   
 -43 dB, 0,2% @ 0,8 A<sub>d</sub>e

*imagine* this with a 300B tube in direct drive!  
 then. Drive it 1:4 / 1:10

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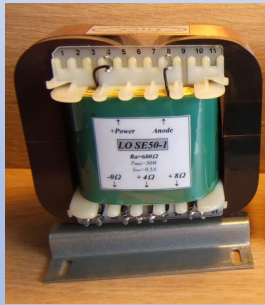
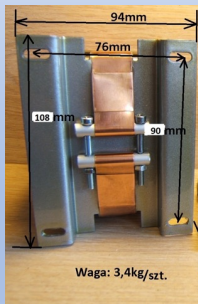
Normally a tube like 300B is driven with a voltage between cathode and grid where the cathode is earthed (for AC), with a bias applied. But in Western Electric amplifiers, often a stage is run with a transformer input, where the signal is applied between a floating cathode and the load on the cathode. The tube does not "know" the difference at all between the two types of using it – is just a variable current source ! The same then for a SIT, that is like a solid state triode. It is a variable current source. I note that driving the transformer this way reduces an artifact at low frequencies that occurs in drain loading (and similarly with a tube with a anode loading).

## The custom offer

**Custom possibilities** (L. Ogonowski, Poland)

- Good bandwidth, good current (1 Amp Id)
- $32\ \Omega$  (1:2)  $4\ \Omega$ ,  $8\ \Omega$  – a re-designed  $600\ \Omega/8\ \Omega$ ?

Has not materialized yet . .



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7



Leszek Ogonowski is willing to make a transformer fit for purpose. I have not decided yet what impedance it should have . .

## (2) Then - a Pass P-VFET/SIT Mu-amplifier

Goal:  $8 V_{rms}$  from 40Vb , by using a **choke load**

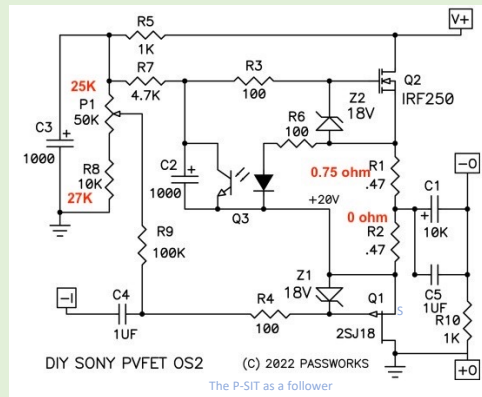
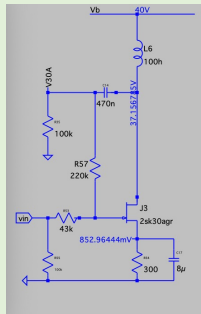
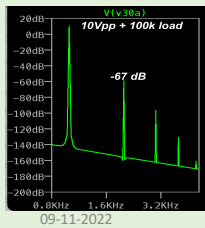
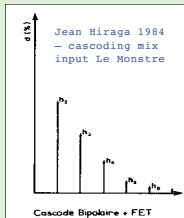
Single, Cascoded, Folded jFET : 2SK170, 2SK30

2SK170: 2<sup>nd</sup> H -63 dB, cascoded: -100 dB

2SK30: -67 dB; cascoded -83 dB

Non-Inverted

H2 get the right 2<sup>nd</sup> H *mélange?*

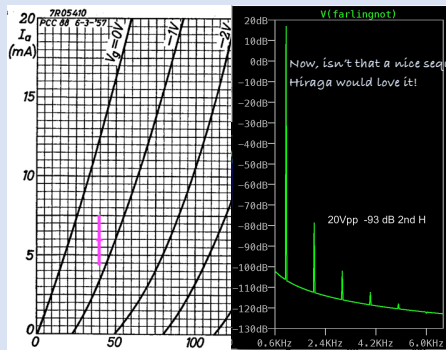


This is a first attempt at getting a 25V pp from the 40V power line.  
It works. Good even . .  
But I wanted to use a tube.

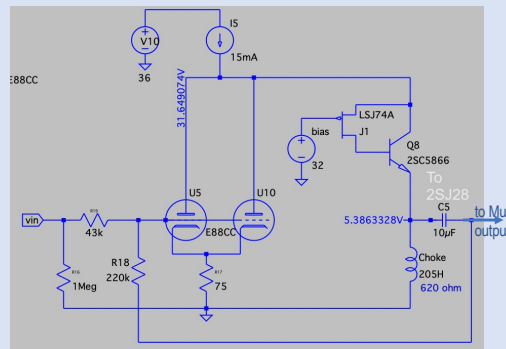
Triode folded cascode driver for the Mu-drive follower 2SJ28

A modern folded cascode implementation utilizing  $V_b = 40V$ , Sziklai pair. Can make 40Vpp.

- Implemented for E90CC/6J6 or PCC88/ECC88
- Cascode with **DarlingNot** - Bartola *simplified*
  - Nice degradation of harmonics in simulation
  - CCS = J721 @ Idss 15 mA
  - JFET+NPN = 2SJ103/BD140 (in sim 2SJ74)



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9

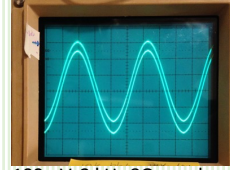
A Darlingnot using a PNP transistor and a NPN power transistor will be: -65 dB 2<sup>nd</sup> H. The Darlingnot has a much better distortion domain than a Darlington. The Darlington is two PNP transistors. The Darlington exhibits 5-7 Harmonics. But the Sziklai pair has a smooth harmonics decaying to 0%, in simulation, and handles a capacitive load much better too. The gate of the 2SJ28 can be seen as a capacitive load. It has a very low output impedance. 2SJ74 is not good enough: just 25Vgd. 2SJ103 can handle 60V gate-drain easily and BD140 can handle 90 V safely.

# Implemented & 2SJ28 Static Induction Transistor

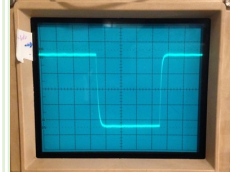
Driver & 6J6:  $4.5V_{rms}$   
 $\rightarrow < 0,05\%$  most 2<sup>nd</sup>



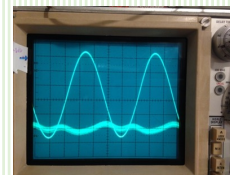
2SJ28 Mu-stage output,  
no clip, 1kHz,  $8V_{rms}$



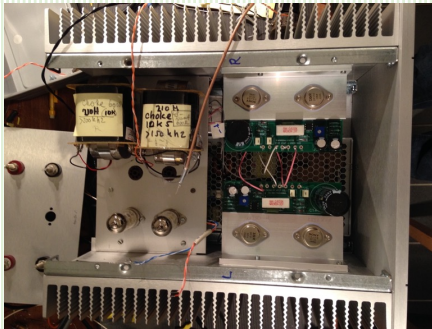
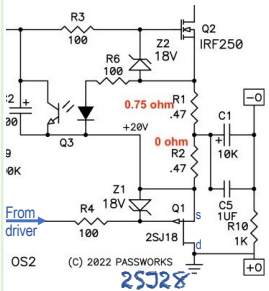
100mV, 3 kHz  $8\Omega$ , no shoot



2Vrms,  $8\Omega$ , 1kHz. 0.1%



Source follower, P-FET



Residual noise:  $< 0,1$  mV RMS. Sound?  
 Coming from a great dark background. Explosive or whispered.  
 How about a Mu-Follower + 6C33C?

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10

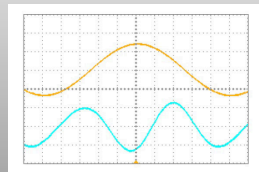
(3) A smoothie for our ears



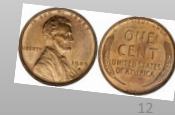


### (3) Why a negative phase 2<sup>nd</sup> Harmonic? My 24 hybris looking for its nemesis

- Peter van Willenswaard once commented to me:
  - It must have something to do with talking, that we hear the change of a waveform, projection (1983)
- My suggestion:
  - A positive 2<sup>nd</sup> comes around when shouting, raising anxiety
  - A neg 2<sup>nd</sup> H slows the envelope of the sound, acts as Doppler effect: the source moving away – safe, hence 'comforting'
  - For me, too strong positive projection (pos 2<sup>nd</sup> H) is felt as nervous, gives anxiety, *audio nervosa*



2<sup>nd</sup> neg phase



09-11-2022

ETF 2022

12

Dave Griesinger calls it the "feeling of proximity"

- Proximity – the perception that a source is acoustically close - is an important determinant of attention and recall.
- The ear detects proximity through the phase coherence of upper harmonics in the direct sound, which are randomized by early reflections.



### (3) How to force an amplifier into negative 2<sup>nd</sup> H?

- Recipes to reduce the “projection” with 2<sup>nd</sup> H

We know:

- Jean Hiraga used it (e.g. input Le Monstre)
- Héphaïstos showed it in a pre amp LTP stage
- Nelson Pass - JFET-amplifier & knob for the sweet spot : *how smooth that must have been.*
- Pass: Lower operating point of jFET (*pinch it*)
- Pass: Turn around the poles (*experience phase*)

- What I found:

- In my 1985 pre-amplifier I ‘dialled in’ the phase of the distortion (by changing bias of a LTP);
- Changing the **V+/V-** balance in Le Monstre and F5

*Any other tricks?*

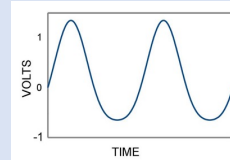
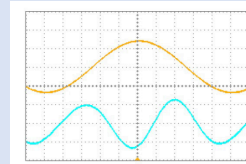


FIG 2 SINE WAVE WITH 2<sup>ND</sup> H

*from pos phase*



*to neg phase*

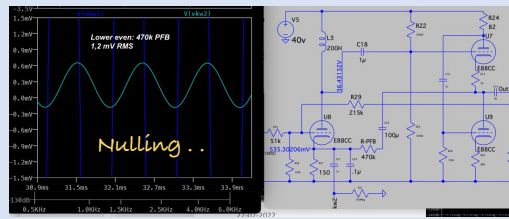
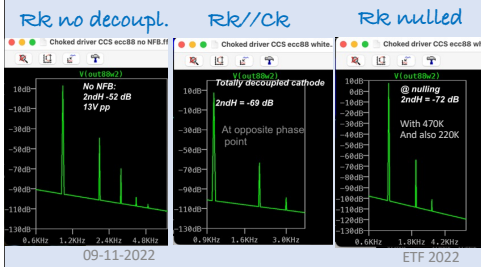
### (3) Twisting the phase with Positive Feedback

Hiraga used PFB to null the cathode of the driver stage in his RIAA.

To make it more silent than with a smoothing capacitor & enhance **dynamics**

Get *lower harmonics* ?

Can we go *beyond* nulling the cathode ??

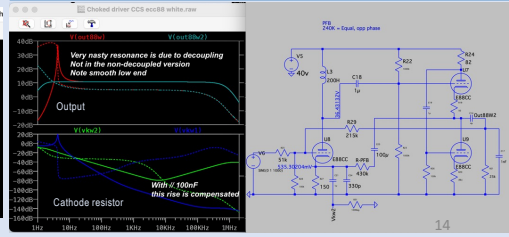


Top: - Blue line non-decoupled cathode = 30 mV pp

- Aqua cathode with PFB to give 0,6 mV pp
- on a breadboard can be nulled precisely with trimpot

Bottom:

- 1) Red line is output with decoupled cathode of Ecc88, aqua is nulled cathode = a smooth line.
- 2) Blue is Rk decoupled; green is nulled, and lift >10kHz can be compensated with small cap.



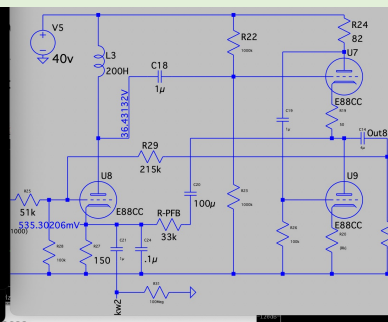
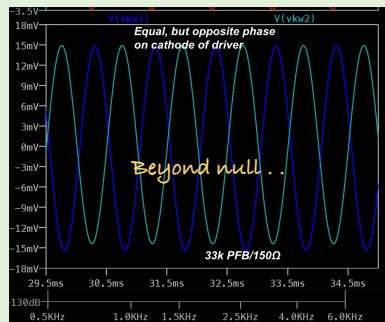
Dialing in *more*  
PFB - going  
*beyond null*

What happens if we go beyond nulling?

- Blue line non-decoupled cathode = 30 mV pp
- Aqua with PFB to give 30 mV pp ; quite opposite phase

This SHOULD show up:

- Influence harmonic structure (how about 2<sup>nd</sup> H) ?
- Is not instable (yet)
- Dynamics improved
- Is used in my line stage (on show)



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15

## Positive feedback in a line-stage → beyond null . . .

Top:

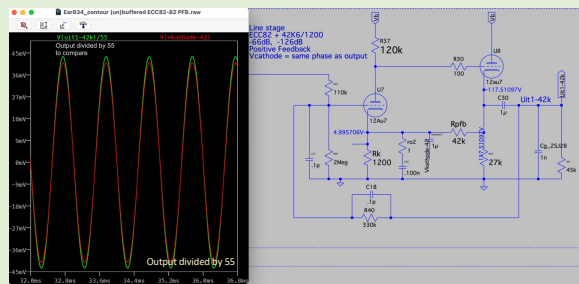
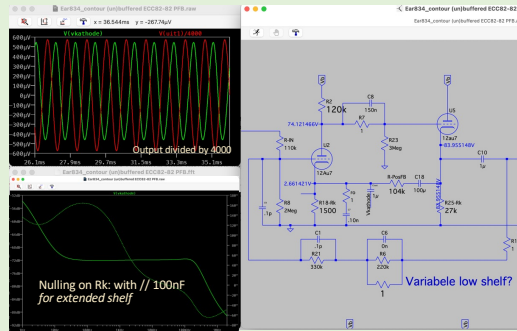
- With  $R_{fb} = 104K$ , the cathode is effectively **nulled** (= 1 mVpp)
- Opposite phase

Bottom:

- $R_{fb} = 42K$ ,  $V_{kathode}$  is **in phase**
- Influence on output harmonics? Preamp has 3-pole switch on side:  $R_k$  can be decoupled with
  - 100 $\mu$ F
  - not at all
  - 100nF (too high)



09-11-2022



16

In first case, // 100nF is required. Because of ECC82. (With a ECC83 the nulling is better and more extended)

In second case, // 100nF is too high, **gives a .5dB dip at 10kHz**, should be less than 1nF rather none.

## Jean Hiraga l' AUDIOPHILE Sept 1981

Hiraga introduced Positive Feedback C-C in designs of phono stage,

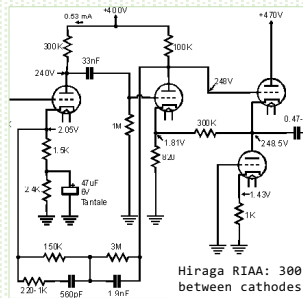
- Dynaco PAS and MacIntosh C22
- Jean Hiraga used it in his 1981 RIAA preamp: 300kΩ from cathode fol. to cathode 820Ω

Why? "Increased dynamics, depth, stage". Layers."

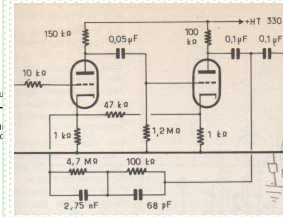
- No electrolytics memory effect - cathode is nulled >80dB

This inspired me:

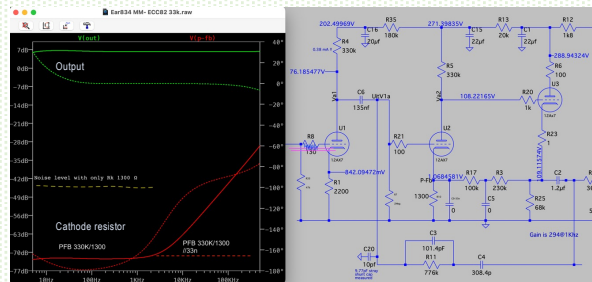
1. Use in EAR-834 RIAA stage instead of cathode decoupling
2. & also used in my "EAR" line stage: Gives + 2 dB open loop (beyond null)



Hiraga RIAA: 300 kΩ between cathodes



Dynaco PAS phono: PFB between cathodes ! Daring.



Positive Feedback Implemented in EAR-834 phono preamplifier -the cathode decoupling replaced by nulling 17

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Hiraga: "Positive Feedback [cathode-cathode ak] procure subjectivement une impression de grande dynamique, d'espace, de profondeur. Aussi: correction [increase] de la tension de sortie maximum" *l' AUDIOPHILE Sept 1981*

So maybe said in an other way [ak]: it reduced Transient Distortion, and at least I see no overshoot that I would normally attribute to capacitor inductance.

Also positive feedback is used to decouple cathode of the driver of the output in the MacIntosh C22 RIAA preamplifier -

- 330kΩ from cathode follower (at 170V) to cathode of the second stage driver of 820Ω (at 1,3V)

## (4) Balancing a double triode

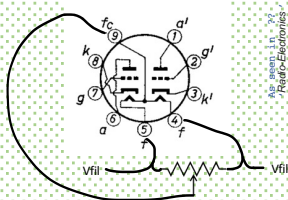
Fact: differences between tube halves

**A trick:**

S and  $\mu$  depend on temperature . . .

Shift the  $V_{fil}$  (6.3V +/- 10%)  
to **balance  $\mu$**

⊕ change 2<sup>nd</sup> H phase in a LTP?



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LTD or its  
subsidiaries

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Just a doodle

As on show,  
somewhere



Preamplifier with positive feedback

- Phono stage based on EAR-834 RIAA (Tim de Paravicini) *with active nulling*  
+ PFB using 330k/1k3, no decoupling cap.
- Line stage built on EAR-834 board –  
inverting (1 stage) + PFB using 42k/1k3

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V-FET Amplifier & folded-cascode driver

- Nelson Pass Mu stage
- 2SJ28 P-SIT as follower
- Driver = PCC88 & folded cascode with a  
big choke *but no PFB*

19

As in one of the rooms at Baarlo.