SAFARI

Development of the

FDM Baseband Feedback

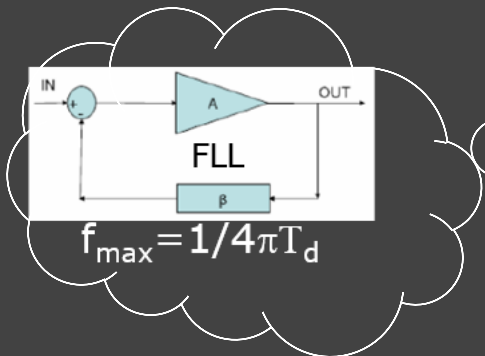
I. BBFB Transfer Function

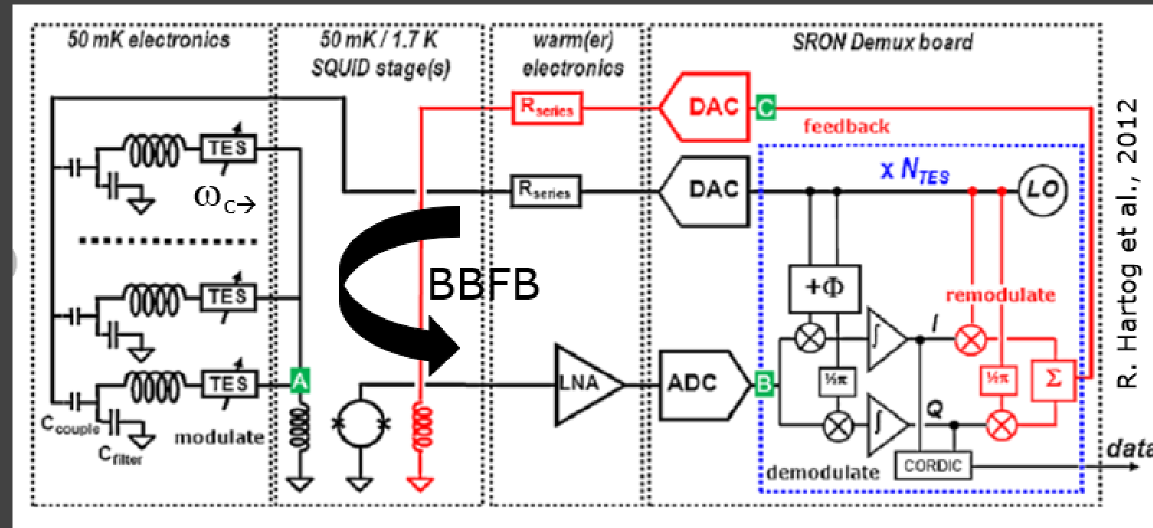
Amin Aminaei, 07 September 2020

SRON

Refs
[1]. SRON Report, A. Nieuwenhuizen et al., 2008
[2]. SRON Presentation, Transition Edge Sensors, P. de Korte

BBFB Transfer Function





$$H(\omega)=\ \mathrm{Gain}.\exp(-j(\omega\, T_d-\phi)/(1+j(\omega - \omega_c)\tau)[1]$$

Harness (Twisted pairs)
C = 133 pF/m, L = 0,45 μH/m Z0 = 58 Ohm,

T_d 7,7 ns/m

Q=10000, frequency
GBW = 1kHz, = 50x suppression @ 20Hz

Nominal Values

Signal Delay

T_d = 8m x 7.7 x 2 (roundtrip) + PCB delay

PCB delay= ~33/sqr.(ε_r) ps/cm

T_d = 150ns

ϕ= phase shift (ADC, de/remodulator) $\pi/8$?

ω_c = 2.π.(1MHz-4MHz)

τ (electrothermal response time)=0.2 ms?

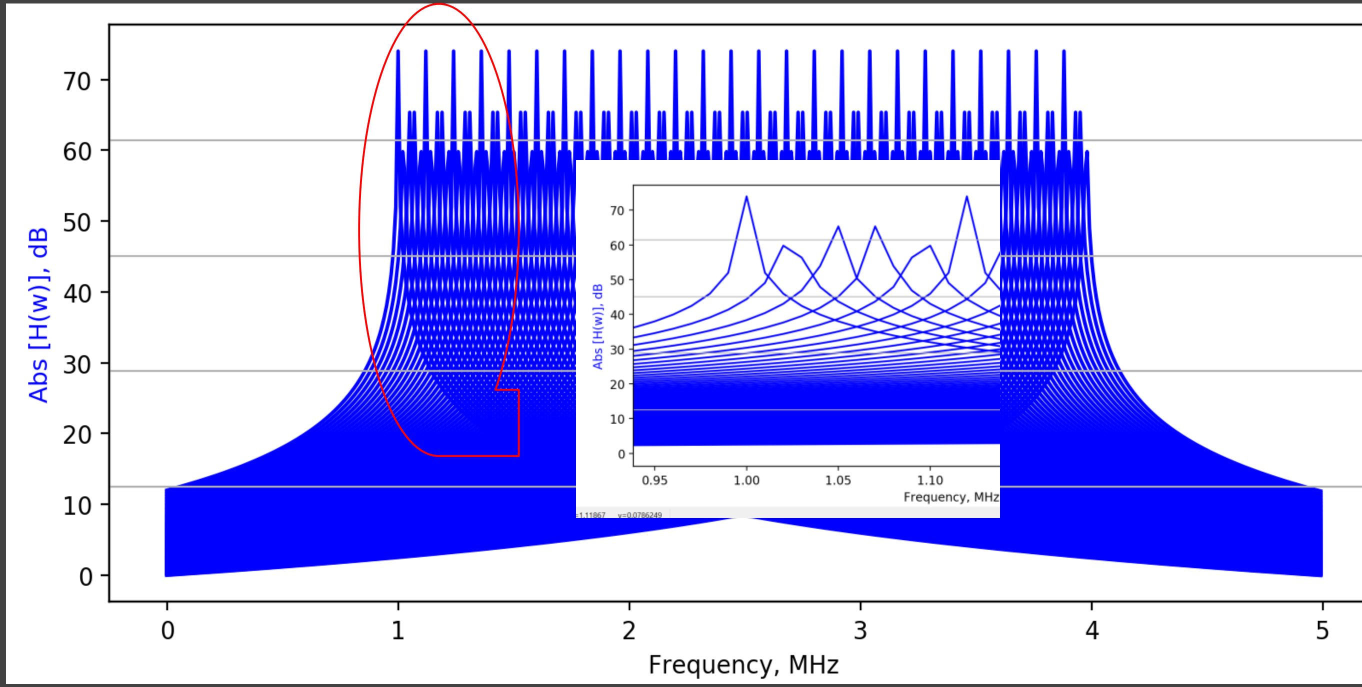
Gain=5000

Impact of τ_{eff}

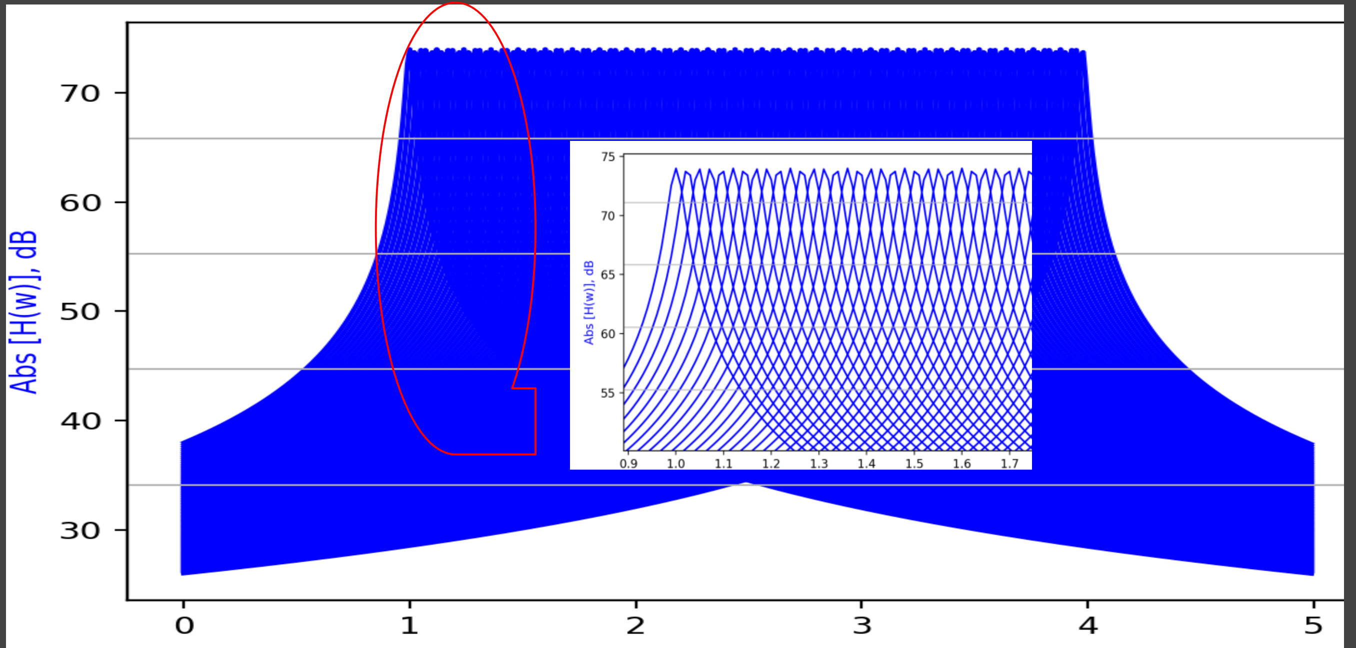
- τ_{eff} = 0.2ms [2]

Ignore Td for now.~0.

- 125 x 24KHz
- 1MHz-4MHz



- τ_{eff} = 1e-5s



bbfb-TrFunction-all-ppt7sept.py

FDM BBFB TrFunction

T_d = 150ns

$\phi=\pi/8$

$\omega_c = 2.\pi.(1MHz\text{-}4MHz)$

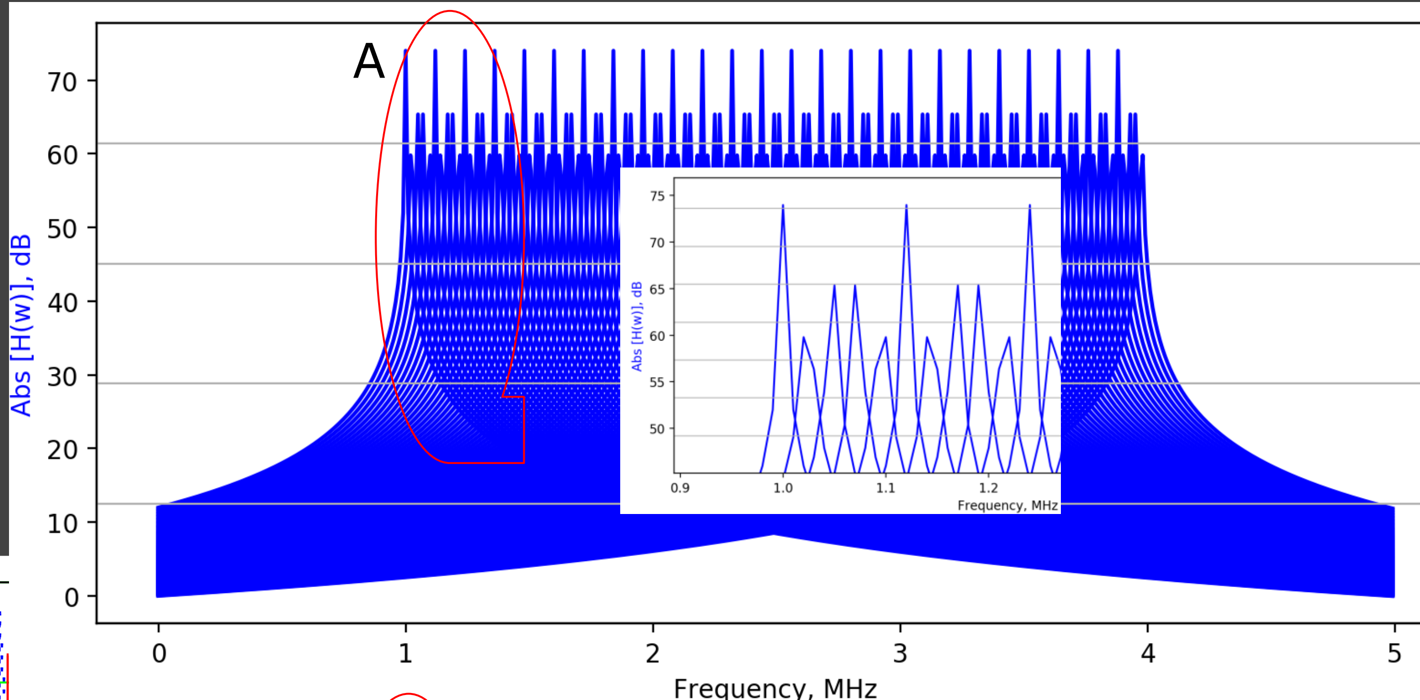
τ =0.2 ms

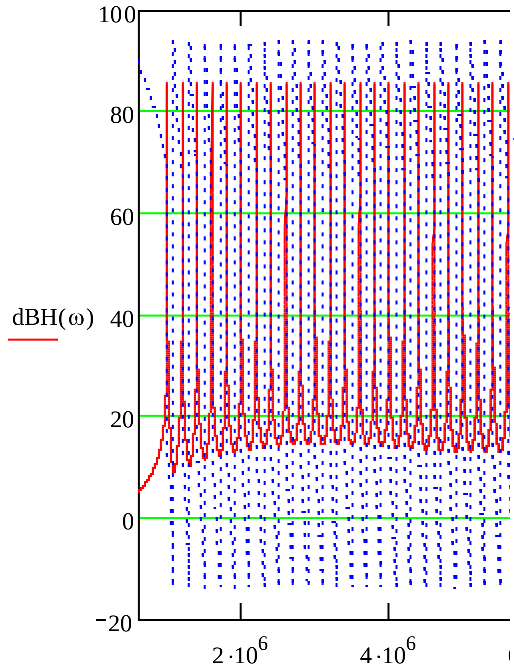
Gain=5000

125 channels,

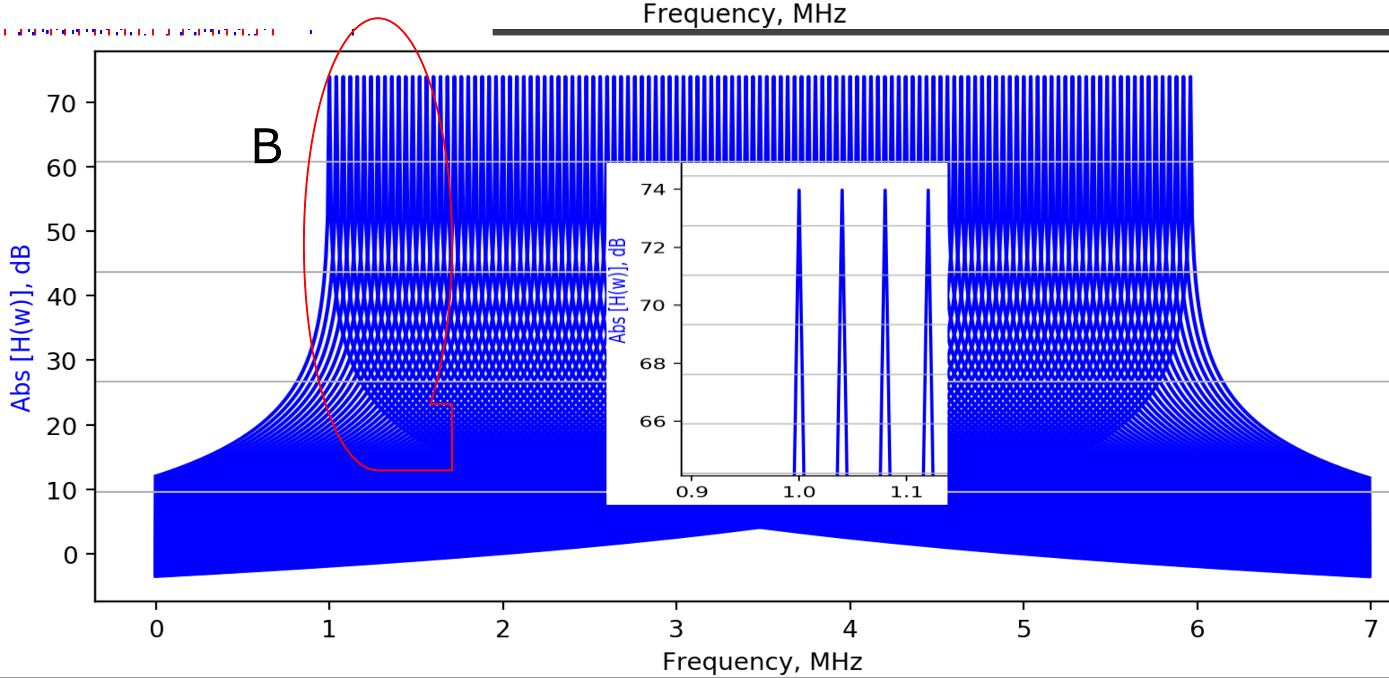
A) 24 kHz

B)40kHz(1MHz-6MHz)

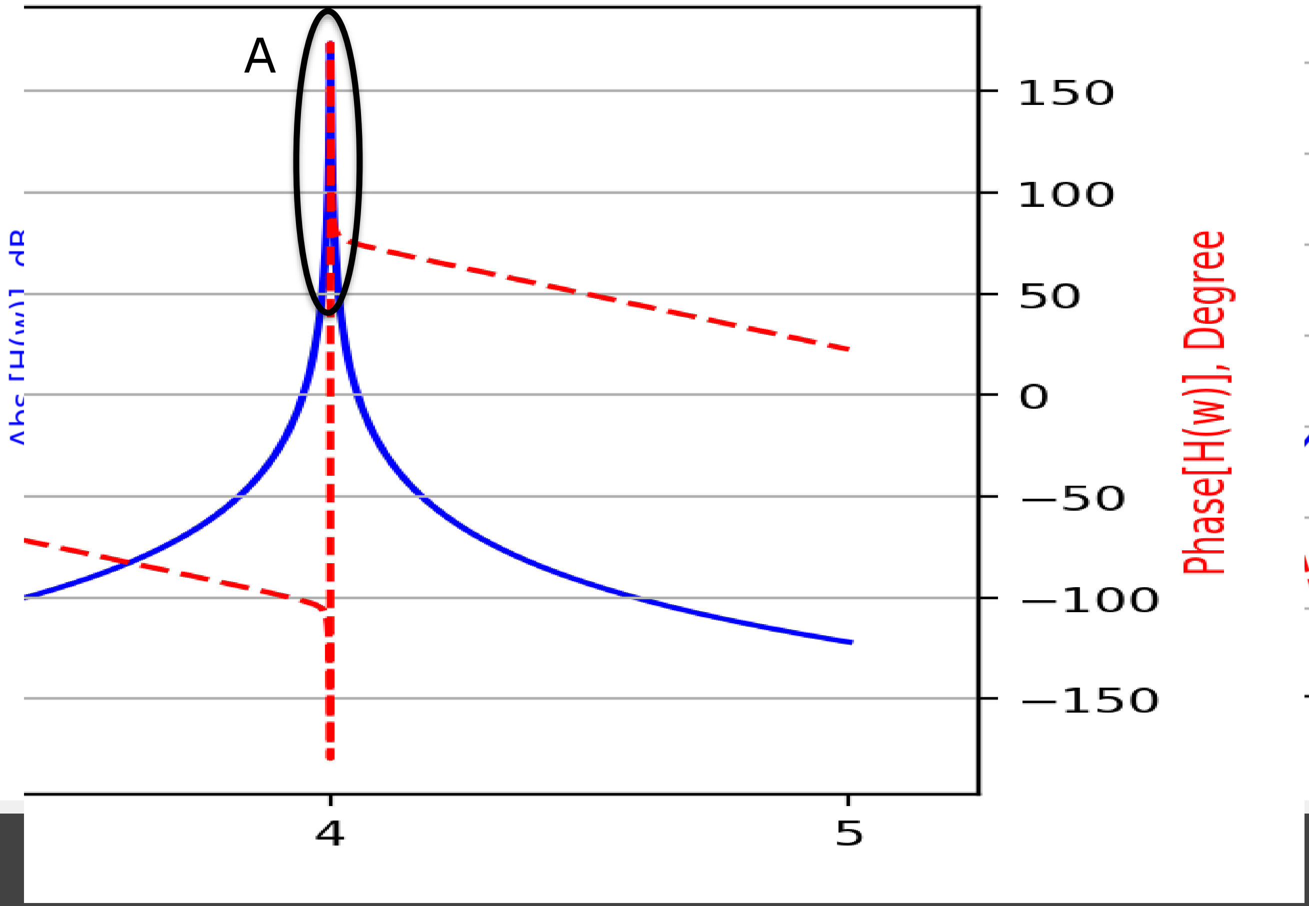


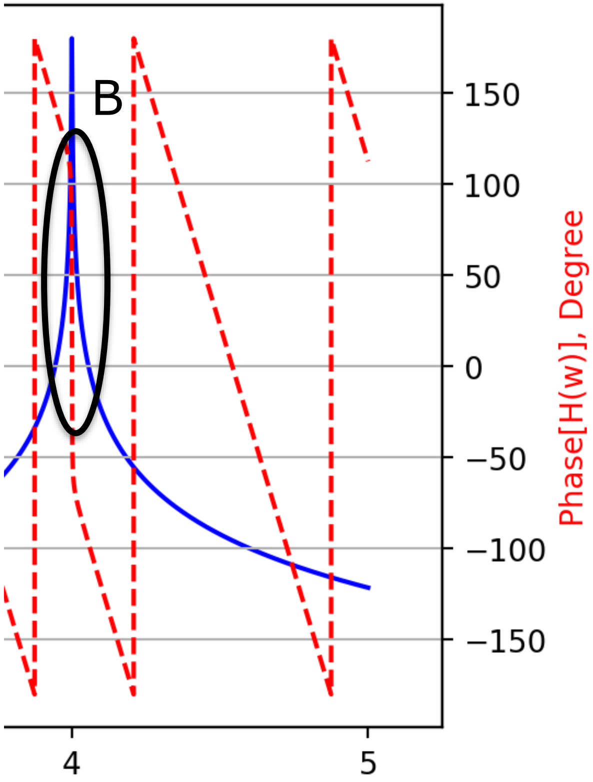


After[1]



The phase effect (phase of H(ω))





Phase margin 170 (?)degree for A)150ns delay: Δf/2.11: 11.4KHz gain bandwidth around this carrier (worst case) for 24KHz separation.

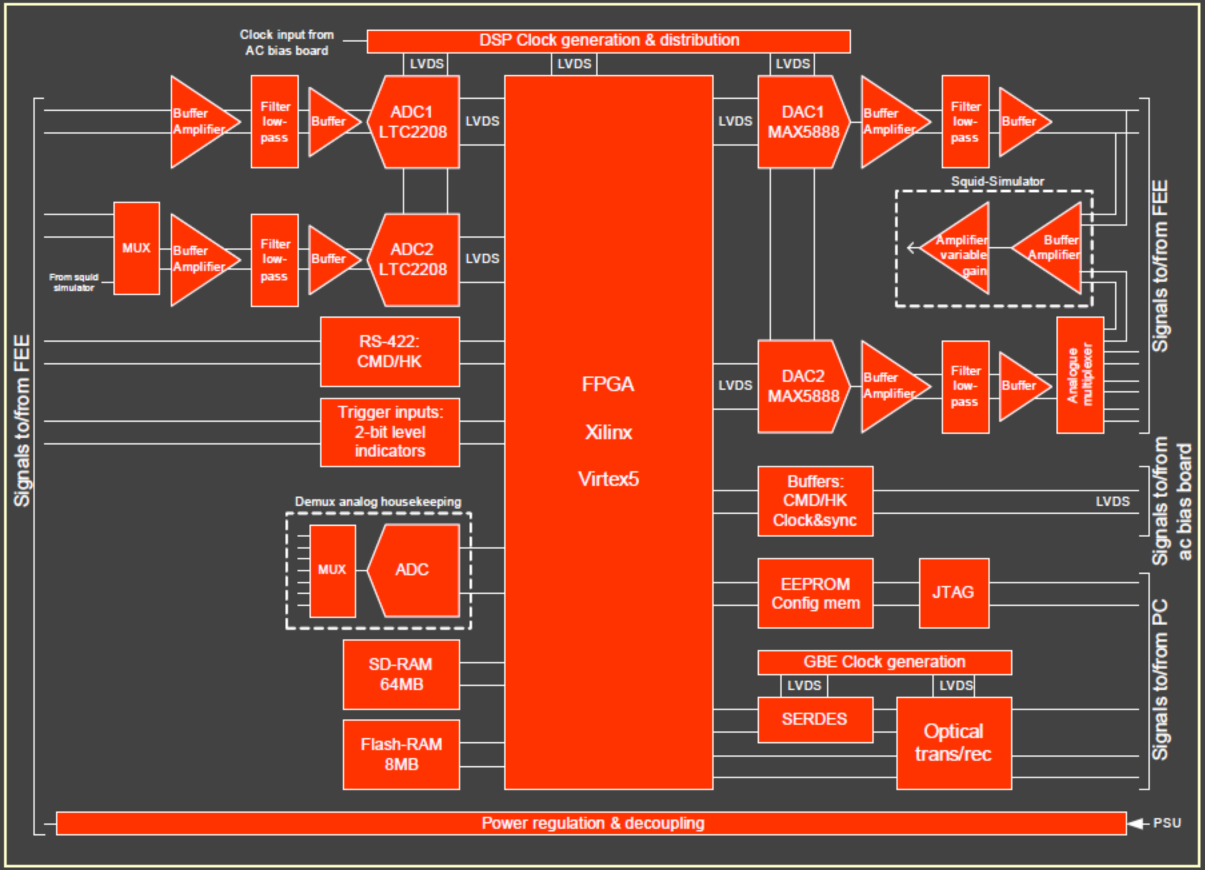
Phase margin 100 degree for B)1500ns : 6.7KHz GBW.

SRON SAFARI

bbfb-TrFunction-1-7sept20ppt.py

Phase Shift (To be Investigated)

BaseBand Feedback Electronics board



After [2]

Transfer function of the second order:

With $L_0 = \frac{\alpha.P}{G.T}$ the electro-thermal loop gain and $\tau_{eff} = \tau_0 / L_0 - 1$

This equation shows one pole (fall time) at : $\tau_{fall} = \frac{C}{G}\frac{1}{1 + L_0/(1+\alpha_I)}$

And a 2nd pole (rise time) at : $\tau_{el} = L/(R_{th} + R_0(1+\alpha_I))$

After [2]

(To be studied)