CMOS 28FDSOI Varactor NMOS SG

Model documentation

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Outline

- Devices presentation
- Varactor SG NMOS Single Ended (SE) Cross Section & Layout
- Varactor SG NMOS SE model performances
- Conclusion

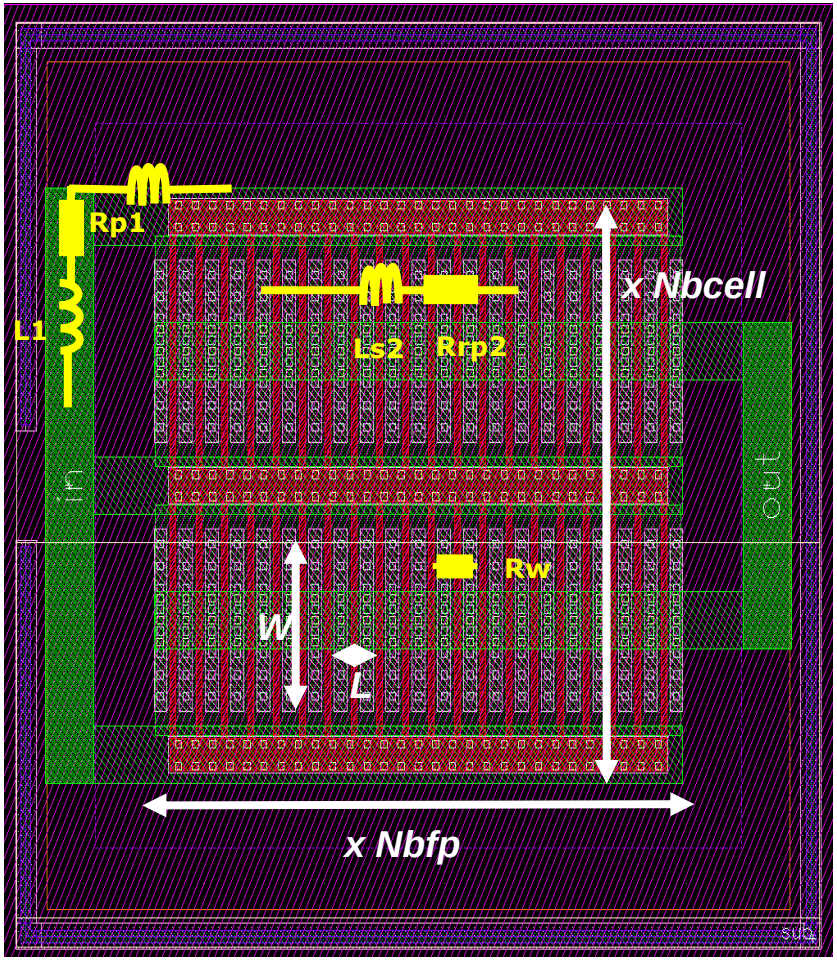
Devices presentation

- Devices name and maturity:
  - Varactor single ended SG: cvar_sg, MAT. 30
- Silicon characteristics and measurements details:
  - De-embedding technique: PAD-THRU
  - 3 lots have been used:
    - MPW C281748, Lot Q808034, for ambient behavior (wafer 8, die 66) and corners (4 wafers, 17 sites)
    - MPW C281748, Lot Q810217 , wafer 16, die 66 for temperature behavior and corners (1 wafer, 17 sites)
    - MPW C281748, Lot Q811230, 5 wafers, 9 sites for corners
  - Measurements setup: 2 ports S parameters 100 MHz up to 110 GHz

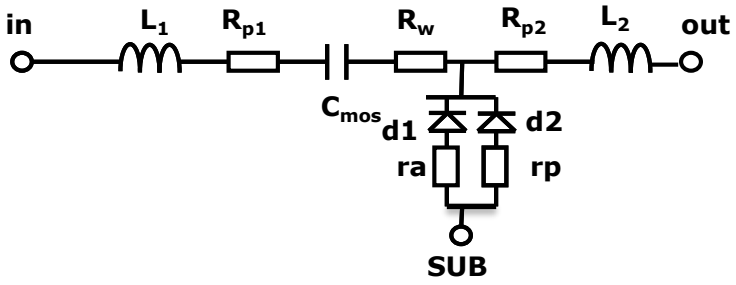
	Simulation with temperature	Worst case &Min/max	Pcell available	Model Si-based	Leakage
Cvar_sg	Yes (Si based)	Yes (Si based)	Yes	Yes, up to 110 GHz	Yes (with temp Si based)

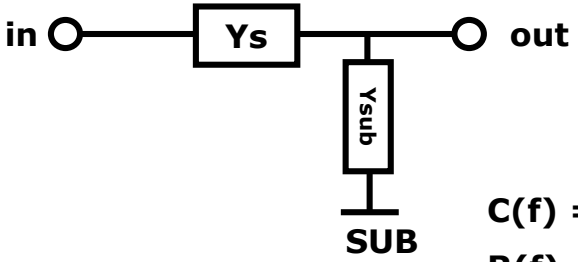
Varactor NMOS SG SE layout

Layout varactor NMOS Single Ended



Equivalent circuit





C(f) = [-imag(1/Ys)]/(2πf)

R(f) = real(1/Ys)

Q(f) = imag(Ys)/real(Ys)

Varactor NMOS SG SE parameters

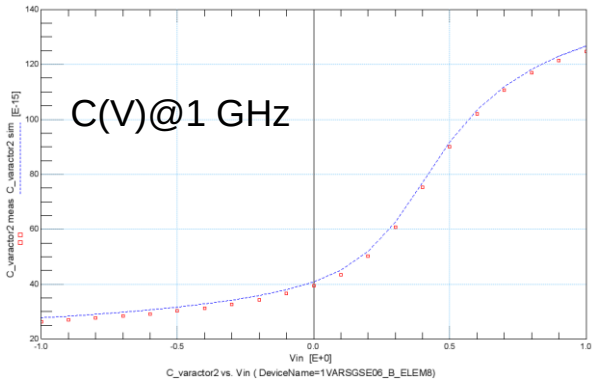
- Varactor NMOS SG single in CMOS 28FDSOI

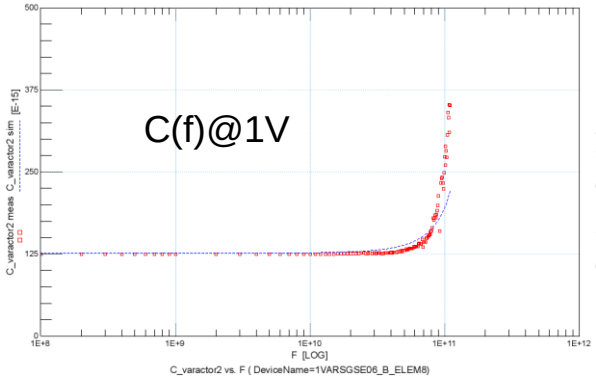
Varactor MOS **Cvar_sg**	**Cap. (F)**	**Gate Length (µm)**	**Gate Width (µm)**	**Nbfp**	**Nbcell**	**Bias (V)**	**TR**	**Worst Case & Min/max**
Min	20 f	0.048	1	1	1	-1.0	1.9	Yes
Max	150f	0.4	2	20	4	1.0	4.7	

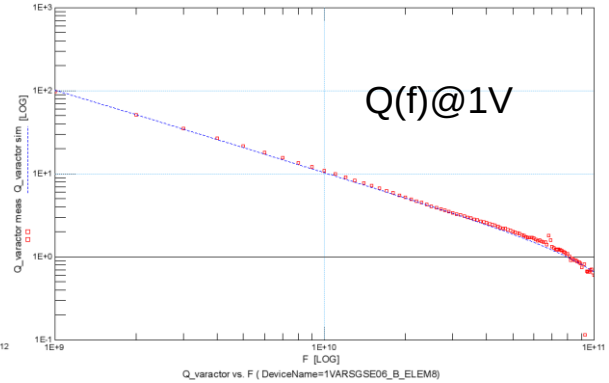
Varactor SG NMOS SE model performances C(V), C(f), Q(f) at 25 degrees

DK 1.2 model **meas**

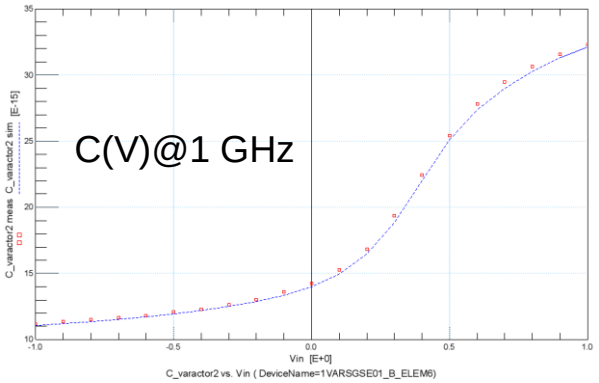
- **Varactor SG, C=125 fF (w=2 µm, l=0.4 µm, Nbfp=4, Nbcell=2)**

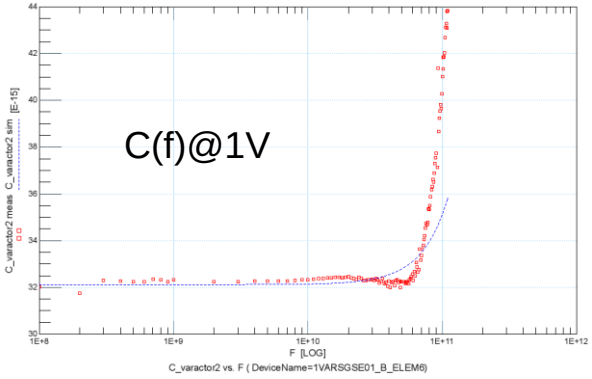


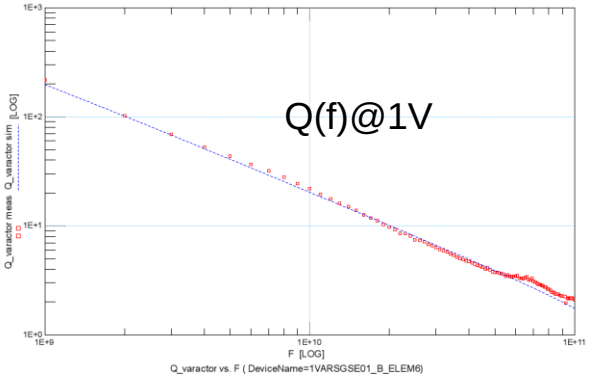




- **Varactor SG, C= 32 fF (w=2 µm, l=0.1 µm, Nbfp=7, Nbcell=1)**







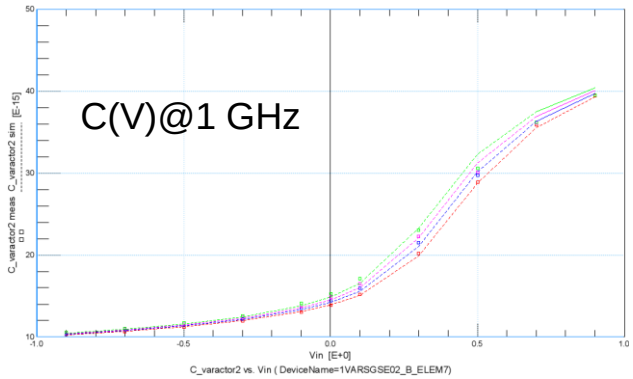
Measurement from Lot Q808034

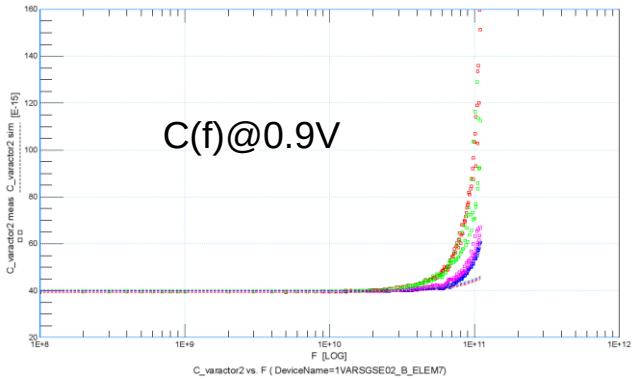
Varactor SG NMOS SE model performances - temperature bahavior

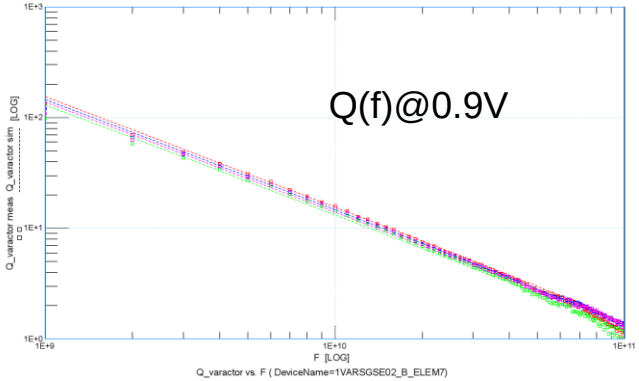
model DK1.2 □□ meas

-40°C / 25°C / 75°C /125°C

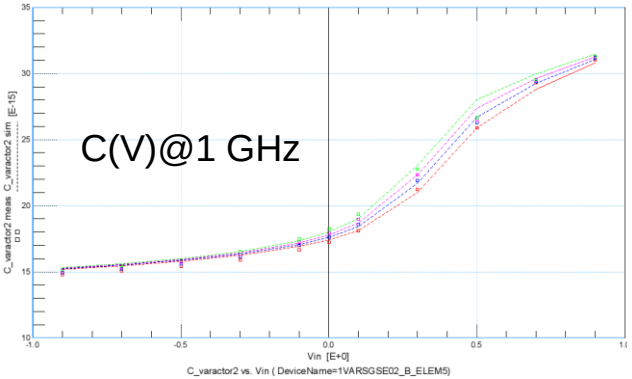
- **Varactor SG, C=31.2 fF (w=2 µm, l=0,048 µm, Nbfp=6, Nbcell=2)**

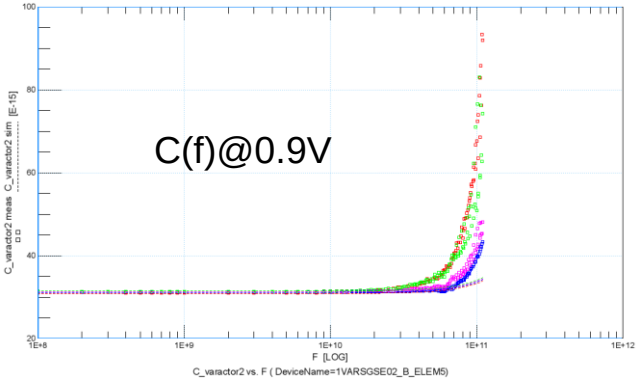


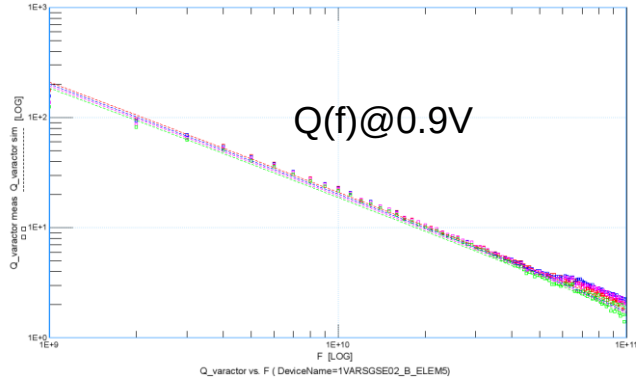




- **Varactor SG, C=39.5 fF (w=2 µm, l=0.25 µm, Nbfp=4, Nbcell=1)**



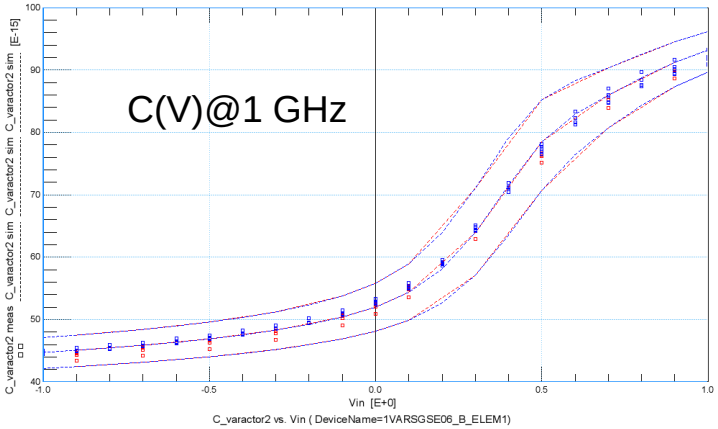


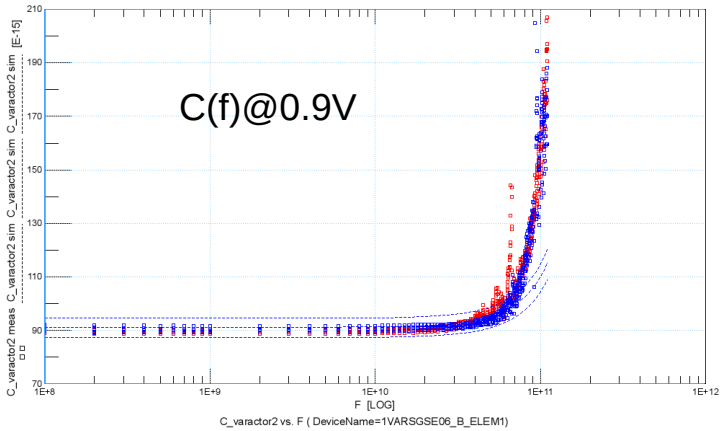


Measurement from Lot Q810217

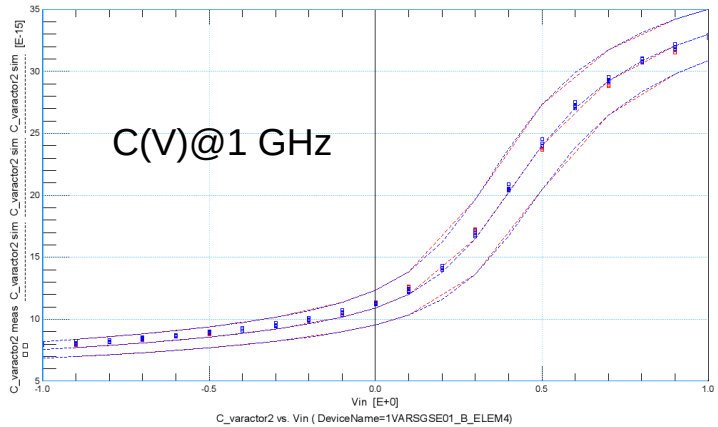
Corners – at 25 degrees

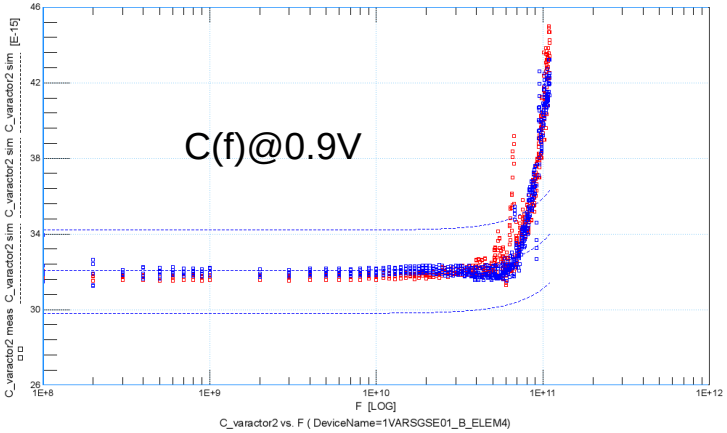
- **Varactor SG, C=93 fF (w=1 µm, l=0.048 µm, Nbfp=17, Nbcell=4)**





- **Varactor SG, C= 33 fF (w=1 µm, l=0.4 µm, Nbfp=2, Nbcell=2)**



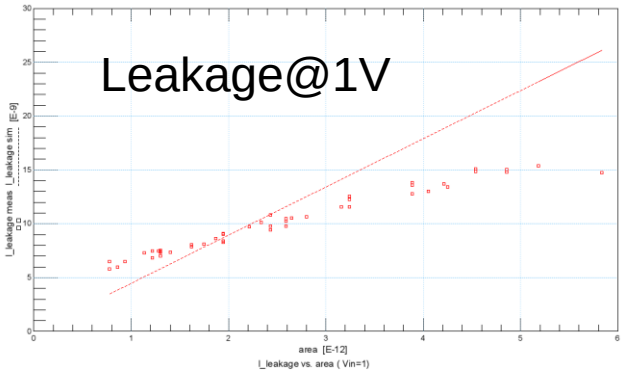


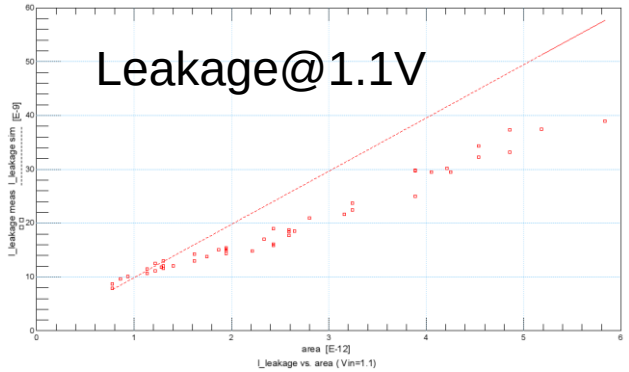
Measurement from Lot Q808034, 5 dices

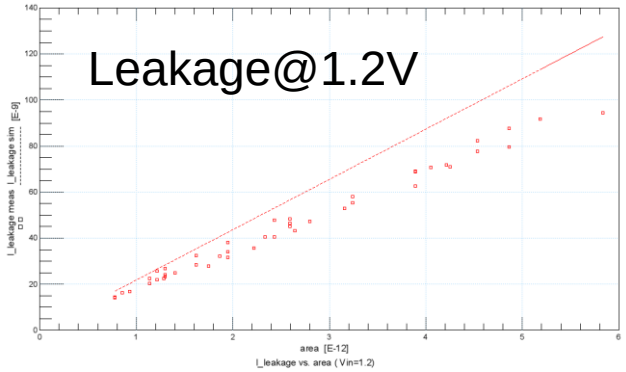
Measurement from Lot Q810217, 5 dices

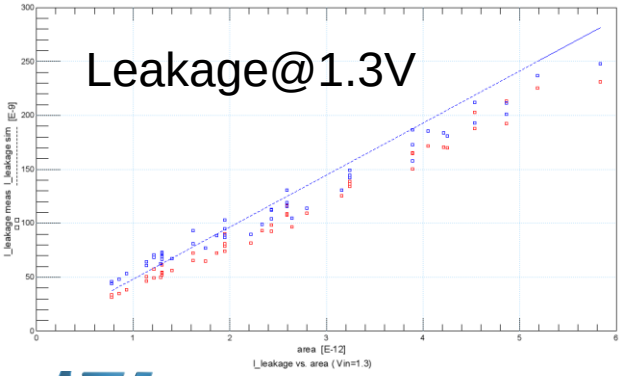
Leakage at ambient temperature

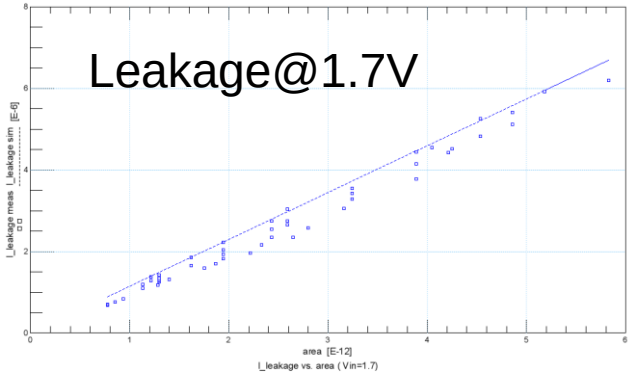
- Results are presented vs. Area at 25°C
  - For 48 devices
  - Using data from 2 lots











Measurement from Lot Q808034

Measurement from Lot Q810217

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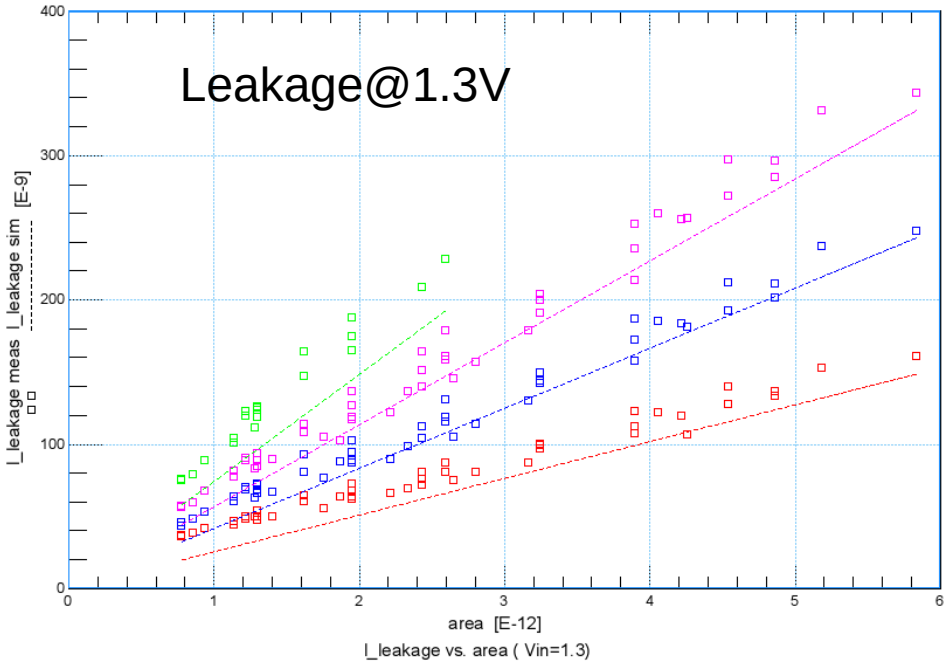
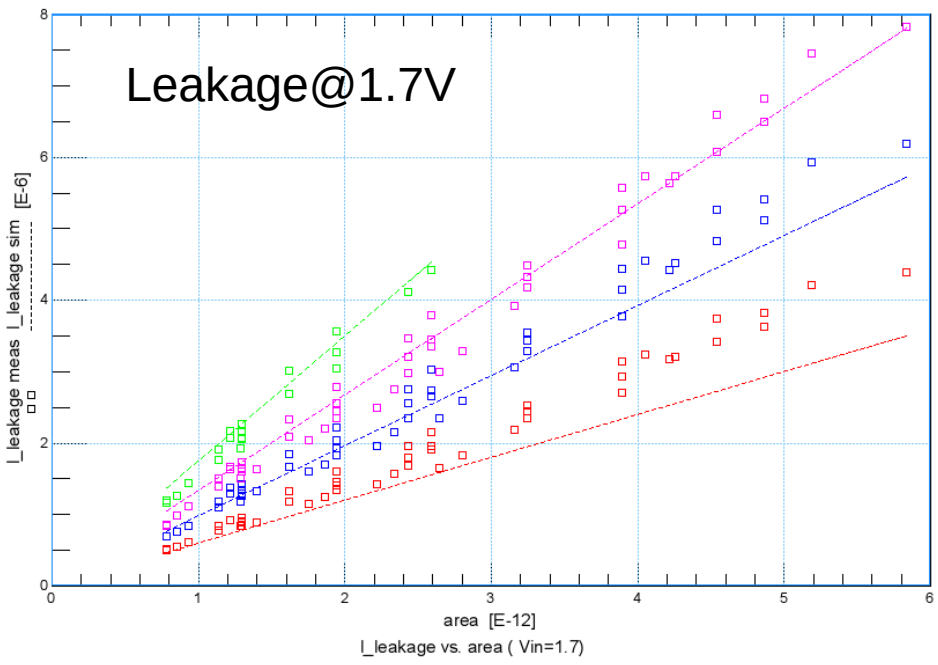
Leakage Temperature dependency

- Measurement have been performed at 4 different temperatures

-40°C / 25°C / 75°C /125°C

- model DK1.2 □□ meas





Measurement from Lot Q810217

Conclusions

- Cvar_sg model is MAT 30.
- Frequency use recommendations:
  - We recommend not to use the varactors at frequencies higher than the frequency for which the varactor Q factors falls below 5. For higher frequencies, the model accuracy is decreased.
- Please note that when using Spectre (version 17.10.198) in Transient and PSS (Periodic Steady State) simulations, the frequency dependency of varactors resistances is ignored, i.e. only DC resistance (constant) is simulated.