TFE4188 - Lecture 3

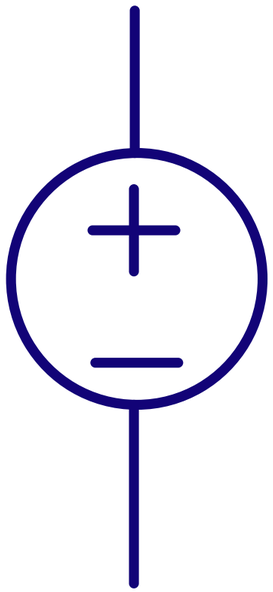
Reference and bias

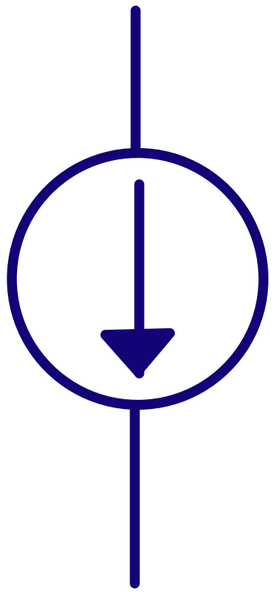
Goal for today

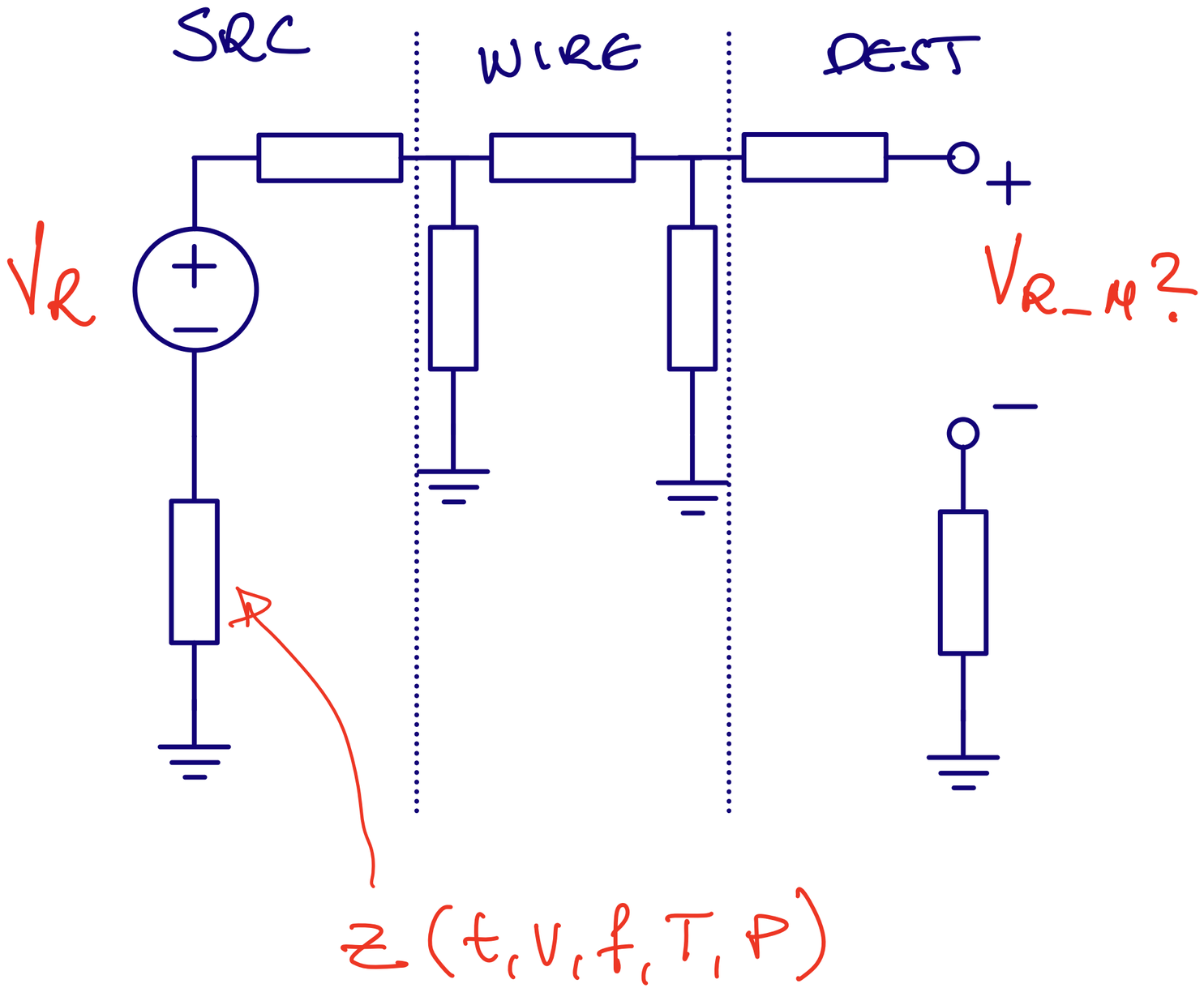
Understand **why** we need reference and bias circuits

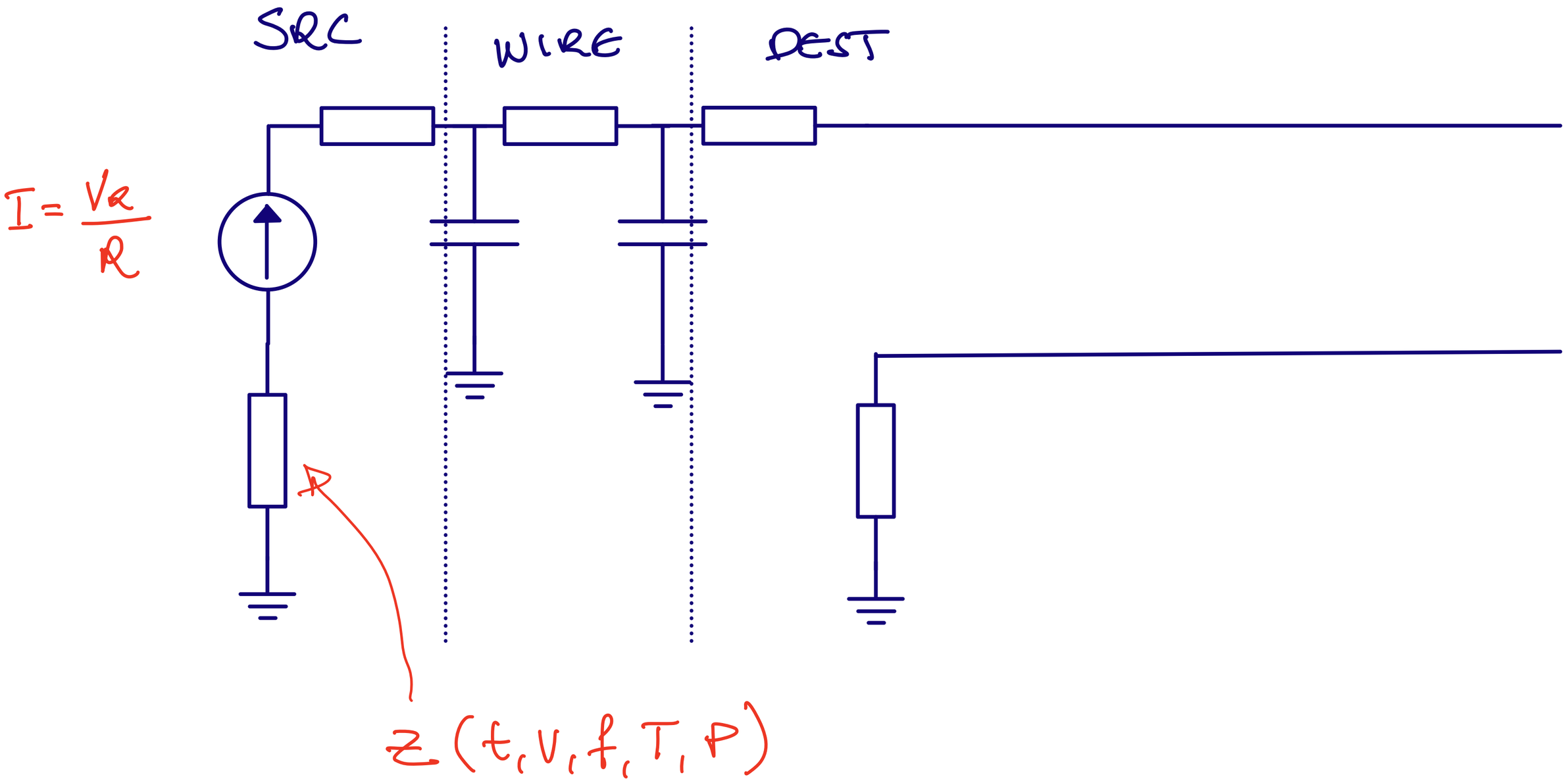
Introduction to **circuit architectures**

Why



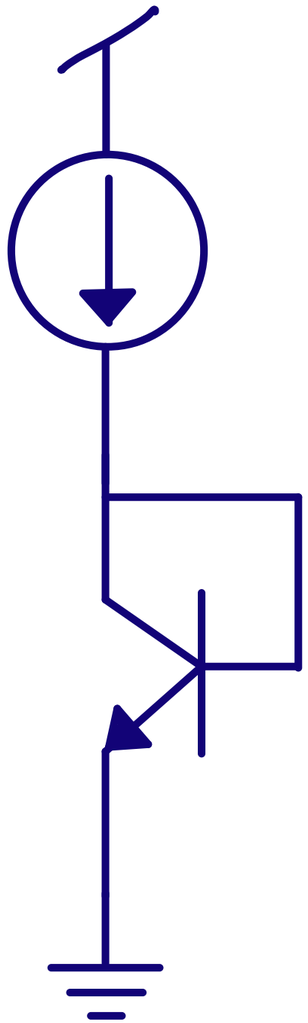



SRC
WIRE
DEST
+
V_R
V_{R_M}?
−
R
Z(t, V, f, T, P)


SRC
WIRE
DEST
$I = \frac{V_R}{R}$
R
$z(t, V, f, T, P)$

Q: What quantity do we have access to on an IC that is independent of PVT?

Bandgap voltage reference



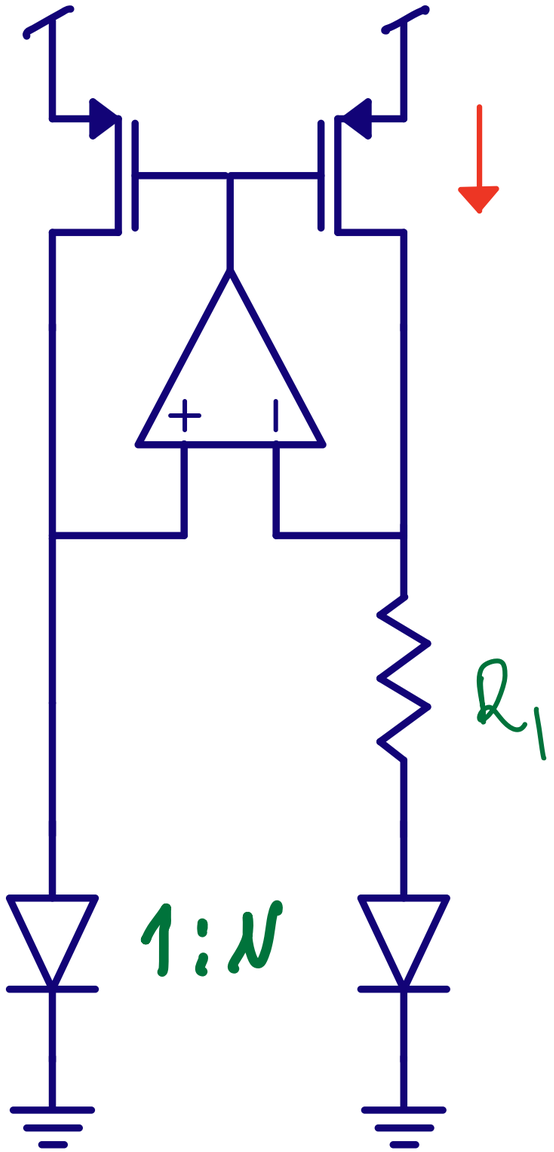
Q: How does VBE change with temperature?

$$I_D = I_S \left(e^{\frac{V_{BE}}{V_T}} - 1 \right) + I_B$$

$$I_D \approx I_S e^{\frac{V_{BE}}{V_T}}$$

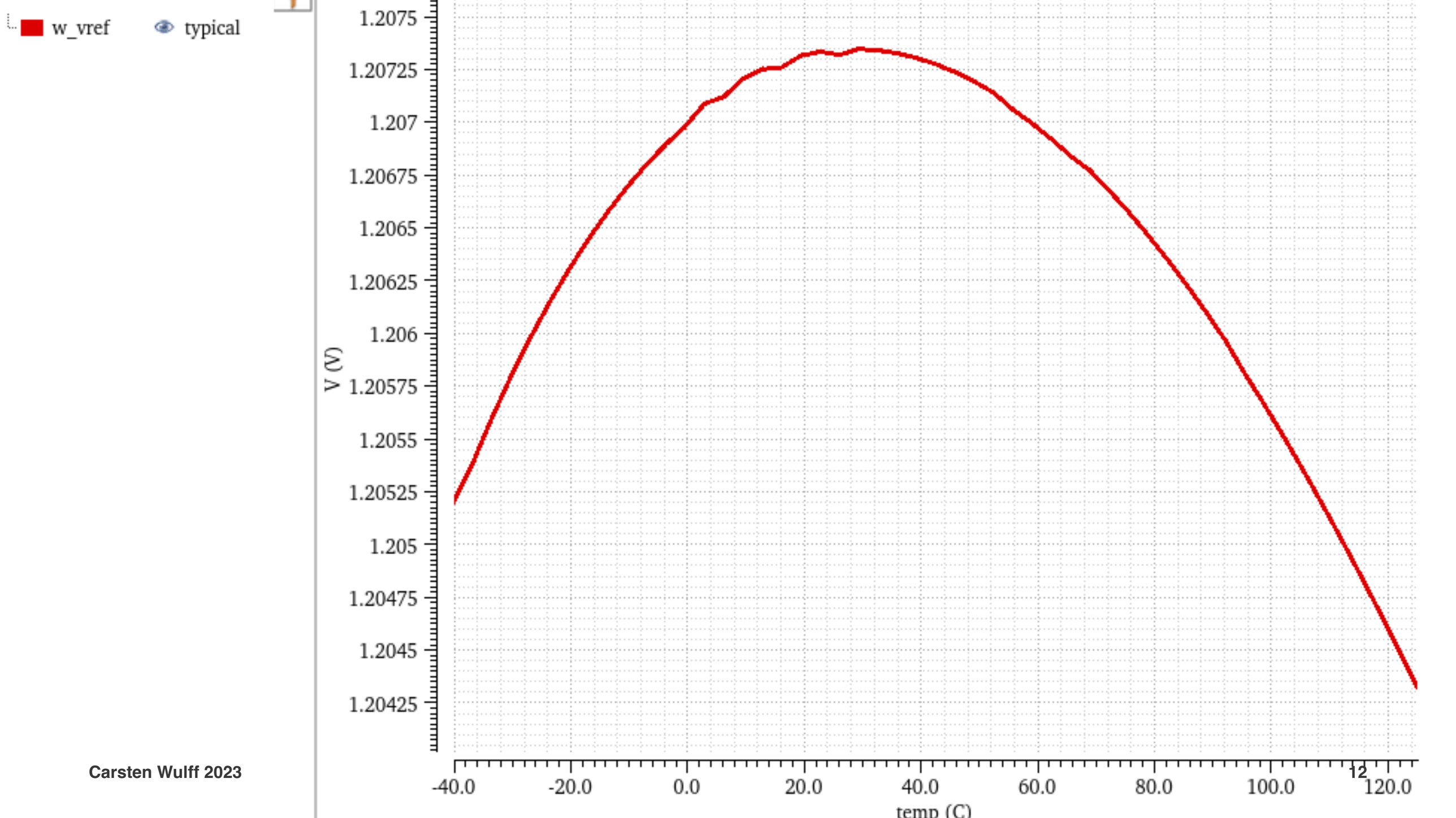
$$V_T = \frac{kT}{q}$$

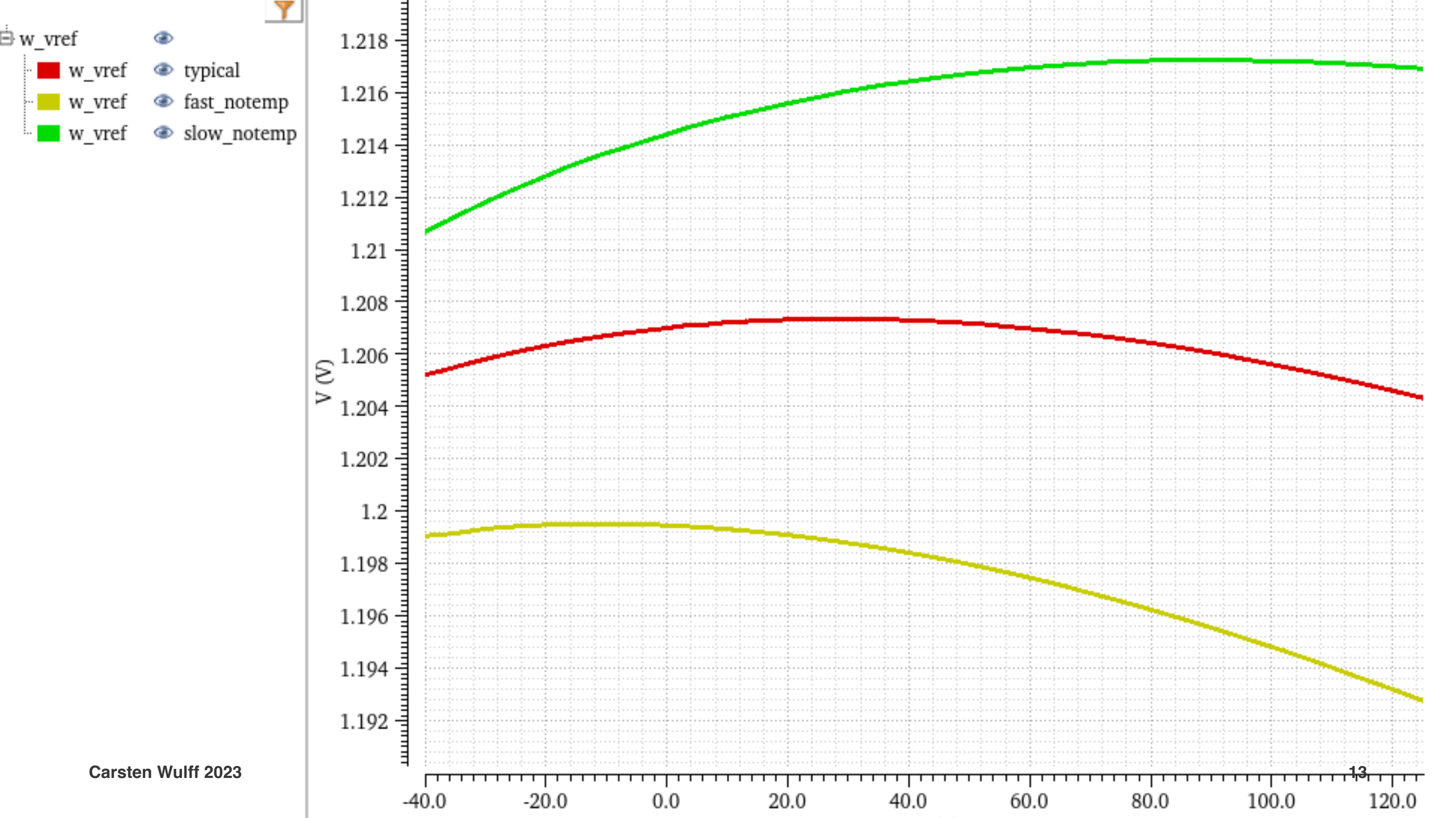
$$V_{BE} = \frac{kT}{q} \ln \frac{I_D}{I_S}$$



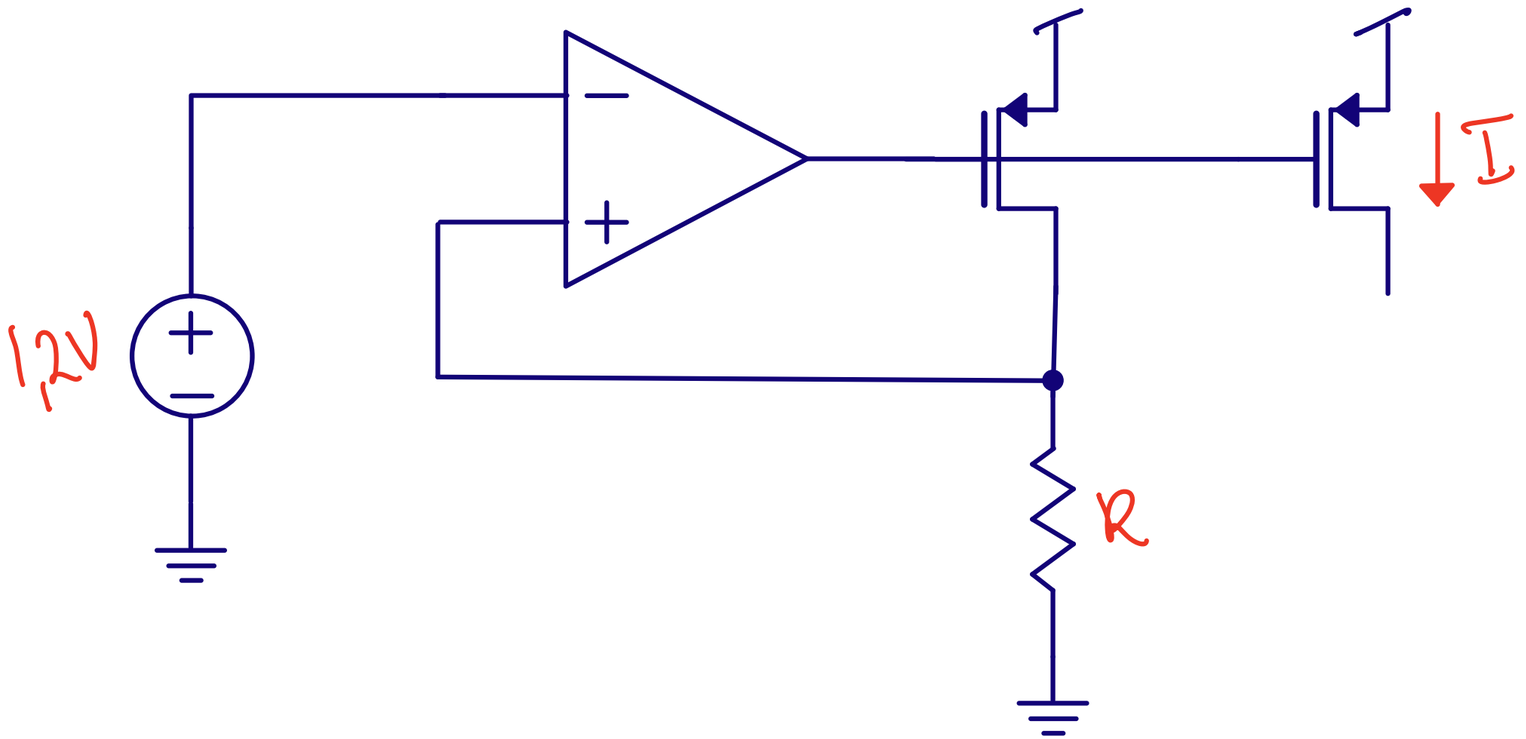
Q: The current is proportional to temperature (PTAT), why?

Q: How can we combine a CTAT voltage with a PTAT current to get a constant voltage?


w_vref
typical
1.2075
1.20725
1.207
1.20675
1.2065
1.20625
1.206
1.20575
1.2055
1.20525
1.205
1.20475
1.2045
1.20425
V (V)
-40.0
-20.0
0.0
20.0
40.0
60.0
80.0
100.0
120.0
temp (C)

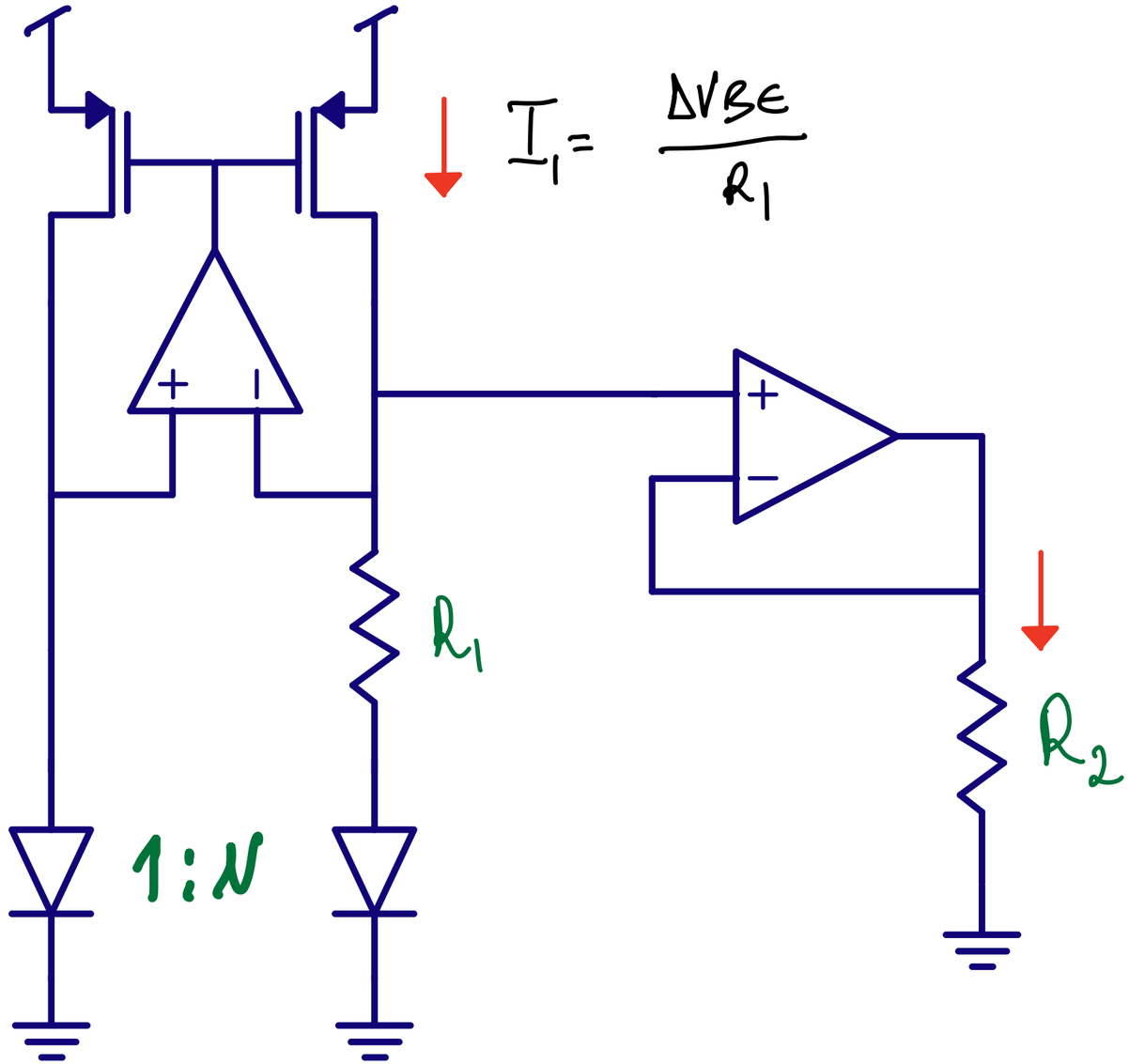

w_vref
w_vref typical
w_vref fast_notemp
w_vref slow_notemp
V (V)
1.218
1.216
1.214
1.212
1.21
1.208
1.206
1.204
1.202
1.2
1.198
1.196
1.194
1.192
-40.0
-20.0
0.0
20.0
40.0
60.0
80.0
100.0
120.0

Q: How does a VI converter circuit work?

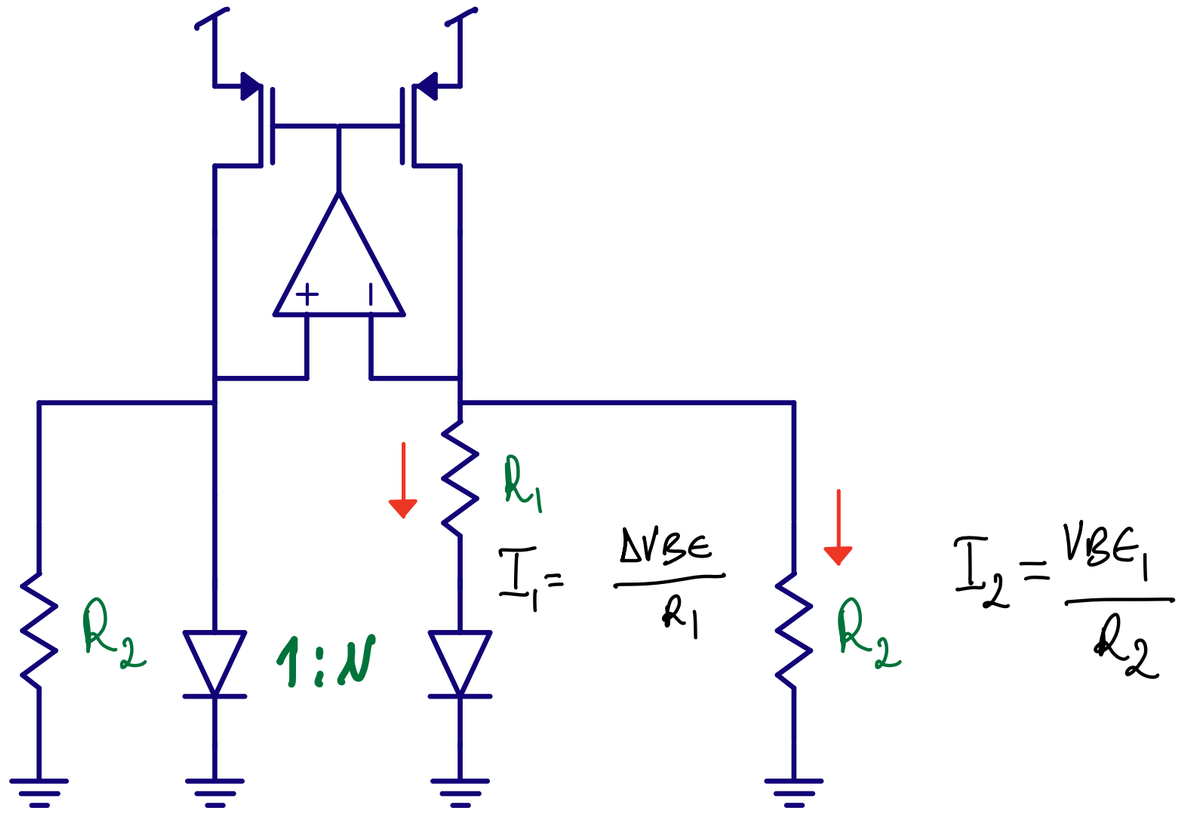


Low voltage bandgap

Q: What is the current in R1 and R2?

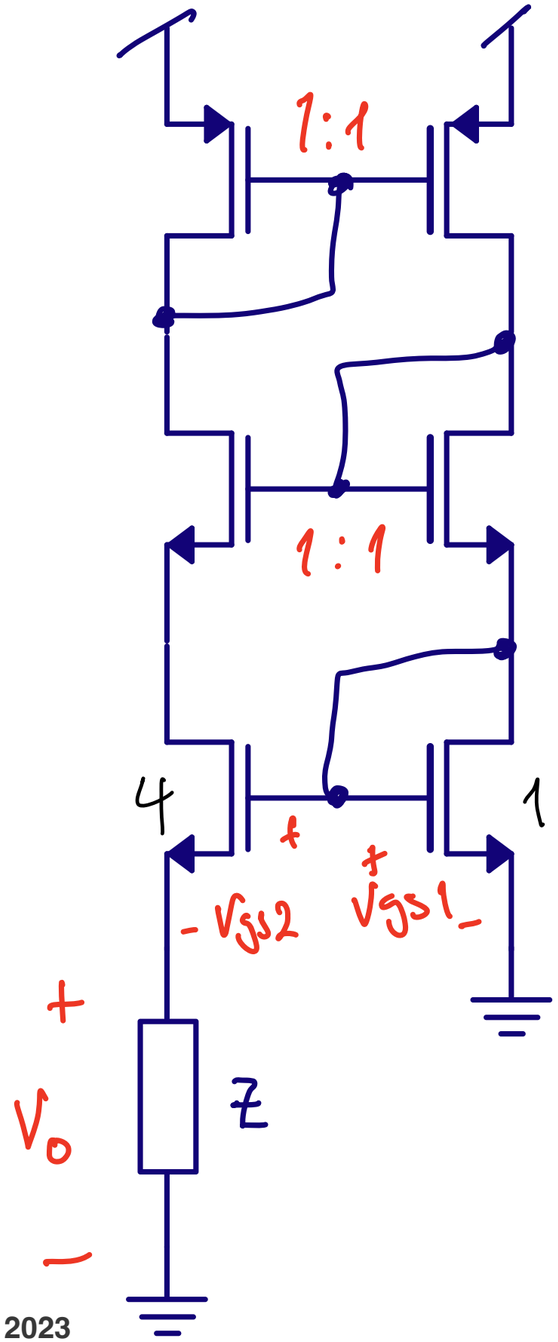


Q: Is the current through R2 the same without the OTA?



Bias

Sometimes we just need a current



Q: Why is 1/Z proportional to transistor transconductance?

Thanks!