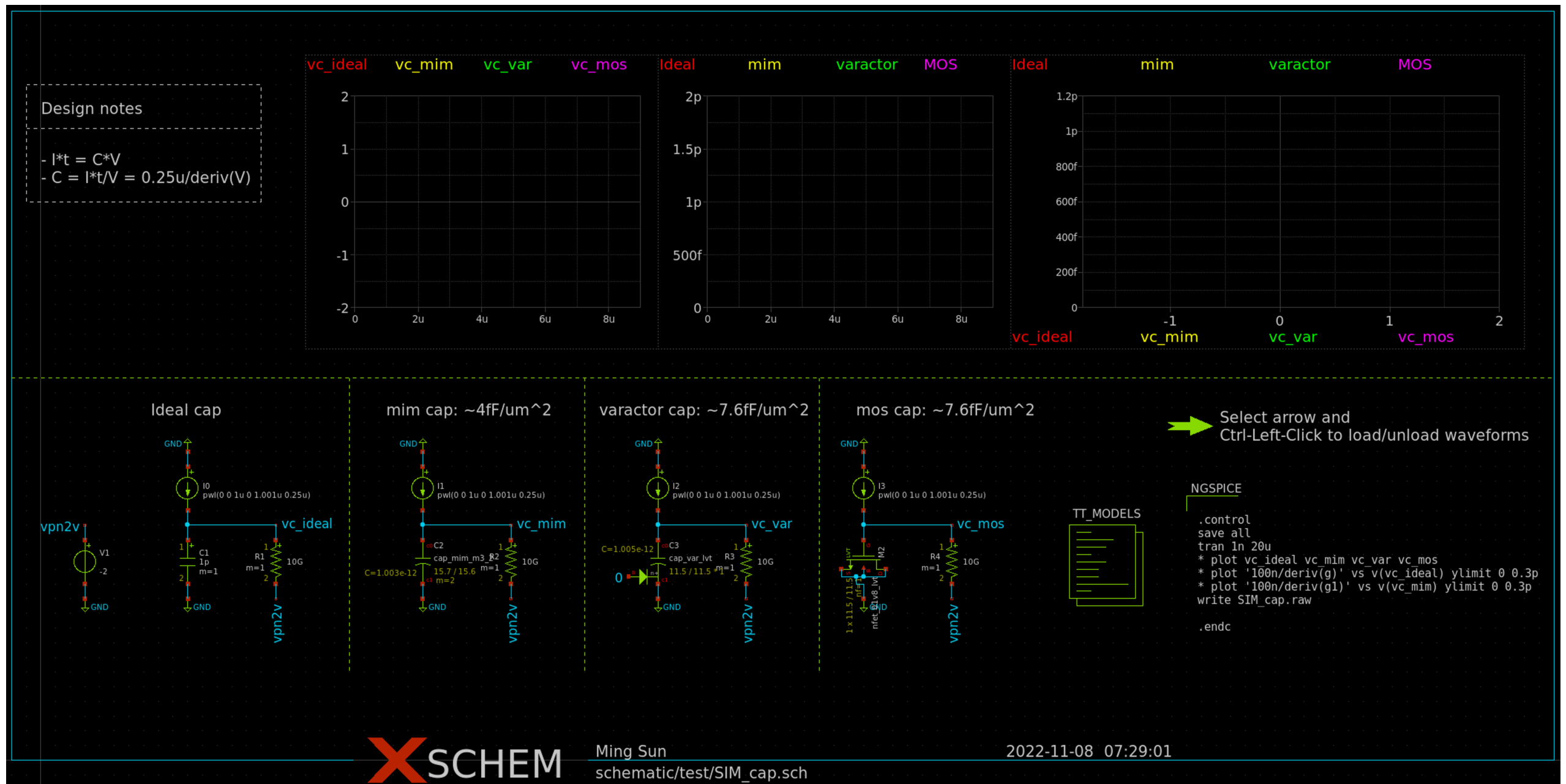


Capacitors

- PDK: Skywater130
- Schematic capture tool: Xschem
- Simulator: Ngspice
- Waveform viewer: Xschem built-in waveform graph

Test bench



Devices used in the schematic

Symbol	Library	Descriptions	Properties
vsource.sym	/home/parallels/share/xschem/ xschem_library/devices	Voltage source	name=V1 value=-2
isource.sym	/home/parallels/share/xschem/ xschem_library/devices	Current pwl	name=I0 value="pwl(0 0 1u 0 1.001u 0.25u)"
cap_mim_m3_2.sym	/usr/share/pdk/sky130A/libs.tech/ xschem/sky130_fd_pr	mim cap	name=C2 model=cap_mim_m3_2 W=15.7 L=15.6 MF=2 spiceprefix=X
cap_var_lvt.sym	/usr/share/pdk/sky130A/libs.tech/ xschem/sky130_fd_pr	Varactor cap	name=C3 model=cap_var_lvt W=11.5 L=11.5 VM=1 spiceprefix=X
nfet_01v8_lvt.sym*	/usr/share/pdk/sky130A/libs.tech/ xschem/sky130_fd_pr	1.8V LVT NMOS	name=M2 L=11.5 W=11.5 nf=1 mult=1 ad="'int((nf+1)/2) * W/nf * 0.29'" pd="'2*int((nf+1)/2) * (W/nf + 0.29)'" as="'int((nf+2)/2) * W/nf * 0.29'" ps="'2*int((nf+2)/2) * (W/nf + 0.29)'" nrd="'0.29 / W'" nrs="'0.29 / W'" sa=0 sb=0 sd=0 model=nfet_01v8_lvt spiceprefix=X

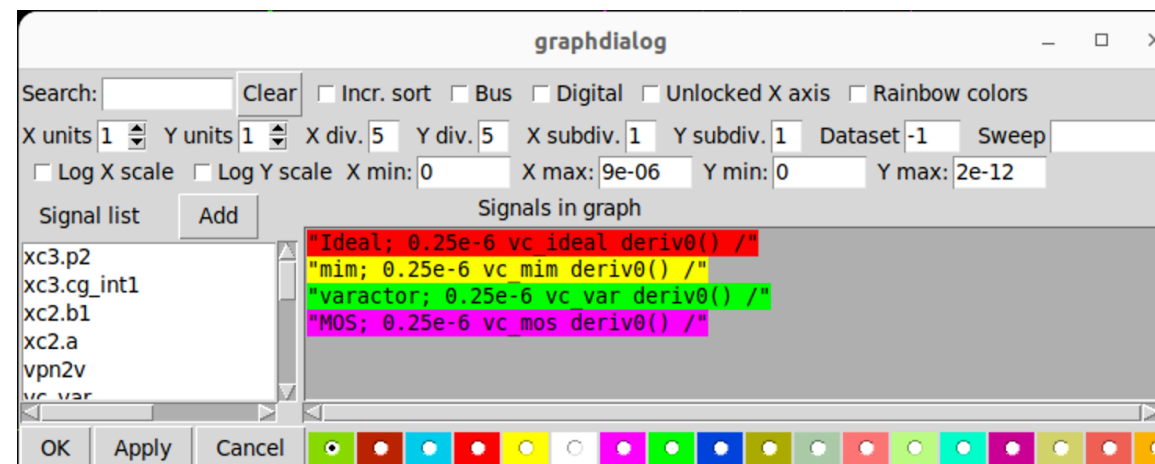
* You can replace any type of MOSFET you would like on the test bench to find out its corresponding capacitance

Devices used in the schematic

Symbol	Library	Descriptions	Properties
code.sym	/home/parallels/share/xschem/ xschem_library/devices	TT corner	<pre> name=TT_MODELS only_toplevel=true format="tclevel(@value)" value=" ** opencircuitdesign pdks install .lib \$::SKYWATER_MODELS/sky130.lib.spice tt " spice_ignore=false </pre>
code_shown.sym	/home/parallels/share/xschem/ xschem_library/devices	Stimulus	<pre> name=NGSPICE only_toplevel=true value=" .control save all tran 1n 20u * plot vc_ideal vc_mim vc_var vc_mos * plot '100n/deriv(g)' vs v(vc_ideal) ylimit 0 0.3p * plot '100n/deriv(g1)' vs v(vc_mim) ylimit 0 0.3p write SIM_cap.raw .endc " </pre>
launcher.sym	/home/parallels/share/xschem/ xschem_library/devices	Load/unload waveform	<pre> name=h1 descr="Select arrow and Ctrl-Left-Click to load/unload waveforms" tclcommand=" xschem raw_read \$netlist_dir/[file tail [file rootname [xschem get current_name]]].raw tran " </pre>

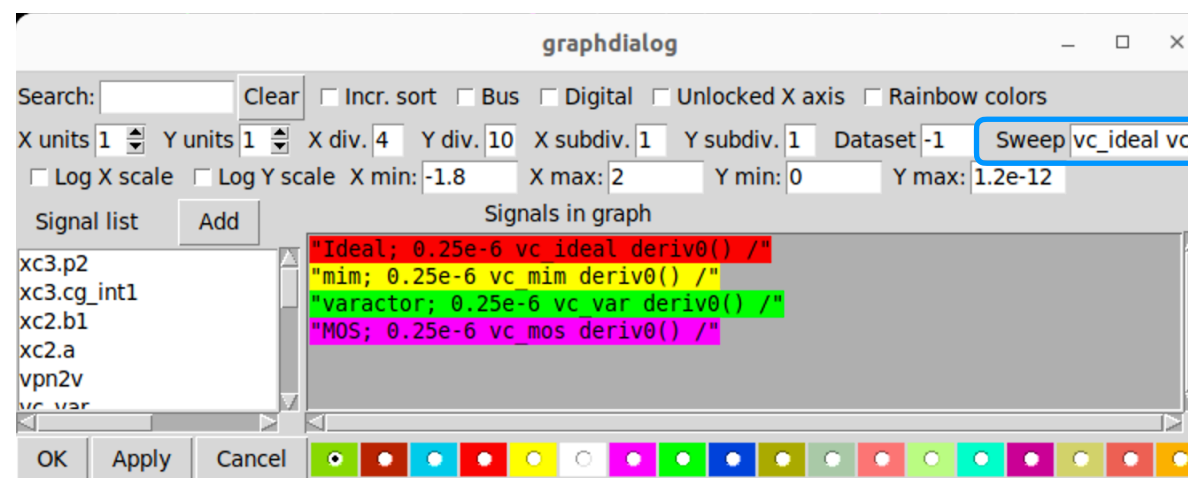
Waveform graph properties in the schematic

Descriptions	Properties
Capacitance vs. time	"Ideal; 0.25e-6 vc_ideal deriv0() /" "mim; 0.25e-6 vc_mim deriv0() /" "varactor; 0.25e-6 vc_var deriv0() /" "MOS; 0.25e-6 vc_mos deriv0() /"



Waveform graph properties in the schematic

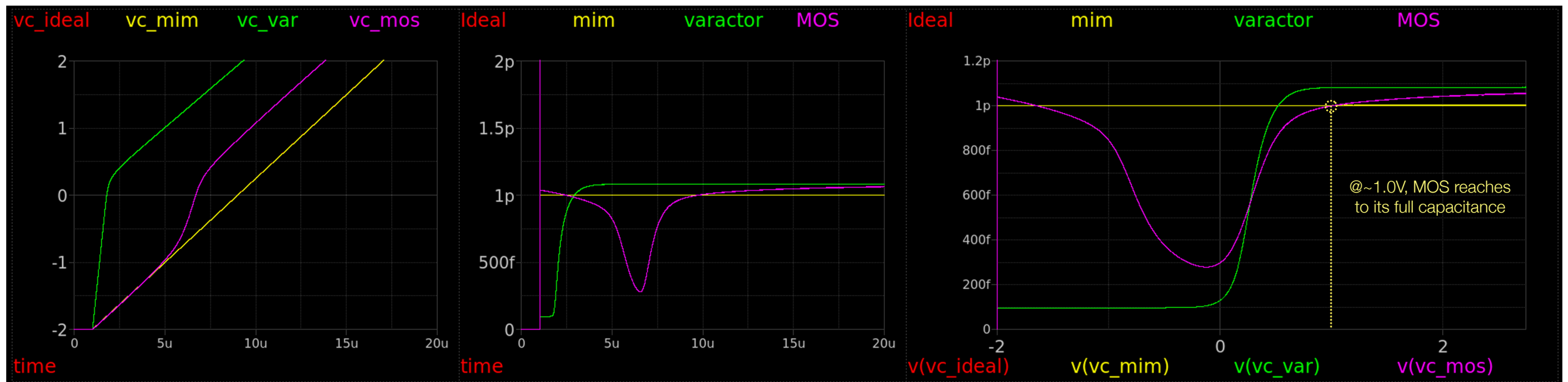
Descriptions	Properties
Capacitance vs. voltage	"Ideal; 0.25e-6 vc_ideal deriv0() /" "mim; 0.25e-6 vc_mim deriv0() /" "varactor; 0.25e-6 vc_var deriv0() /" "MOS; 0.25e-6 vc_mos deriv0() /"



Sweep property needs to be modified as:
vc_ideal vc_mim vc_var vc_mos

Simulation results

Type	Dimensions			Capacitance	Density
	W [μm]	L [μm]	m		
mim	15.7	15.6	1	1.0 pF	4.1fF/ μm^2
varactor	11.5	11.5	1	1.08 pF	8.2fF/ μm^2
1.8V LVT NMOS	11.5	11.5	1	1.04 pF	7.9fF/ μm^2



Summary table

Type	Dimensions			Capacitance	Density
	W [μm]	L [μm]	m		
mim	15.7	15.6	1	1.0 pF	4.1fF/ μm^2
varactor	11.5	11.5	1	1.08 pF	8.2fF/ μm^2
1.8V LVT NMOS	11.5	11.5	1	1.04 pF	7.9fF/ μm^2
1.8V NMOS	11.5	11.5	1	1.04 pF	7.9fF/ μm^2
3.0V native NMOS	10	0.5	10	0.17 pF	3.5fF/ μm^2
10V NMOS	40	0.5	2	0.14 pF	3.5fF/ μm^2
16V NMOS	20	0.7	2	0.11 pF	4.1fF/ μm^2
1.8V PMOS	11.5	11.5	1	1.0 pF	7.6fF/ μm^2
1.8V LVT PMOS	11.5	11.5	1	1.02 pF	7.7fF/ μm^2
10V PMOS	40	0.5	2	0.12 pF	3.1fF/ μm^2
16V PMOS	20	0.66	2	0.11 pF	4.3fF/ μm^2