

Lab. 01

INSTALLATION OF CIRCUIT SIMULATOR

Installation

1. LTspice

- Download LTspice at "<http://www.analog.com/>" and install it.

2. Model parameters of MOSFET

- <http://cmosedu.com/cmos1/book.htm>
- Right click and save the file `cmosedu_models.txt`
- Rename the saved file from `cmosedu_models.txt` to `cmos.lib`
- The file `cmos.lib` should be located in the same folder as the circuit file (`name.asc`) or `C:\Users\{User_Name}\Documents\LTspiceXVII\lib\cmp\`.

3. Symbols of MOSFET

- The symbol `nmos4`, and `pmos4` provided by Linear Technology.

[Note] Files of schematic and symbol

- Use the menu [File] - [Save As] to save the file of the schematic and symbol data for the first time.
 - Do not use [File] - [Save], because the default name is used.
 - The extension is automatically added.
 - Schematic filename = *.asc
 - Symbol filename = *.asy

DC analysis of MOSFET

1. Refer to next page and simulate the $I_{dsn} - V_{dsn}$ characteristic and the $I_{dsn} - V_{gsn}$ characteristic with the LTspice.
2. Simulate the $I_{dsp} - V_{dsp}$ characteristic and the $I_{dsp} - V_{gsp}$ characteristic of p-ch MOSFET as well as the n-ch MOSFET.

Reference URL of LTspice

<http://jaco.ec.t.kanazawa-u.ac.jp/edu/ec2/ltspice/>

Reference Book of LTspice

<https://www.kohgakusha.co.jp/books/detail/978-4-7775-1936-1>

Example -1 (Schematic)

File path of the model parameters

Comment out

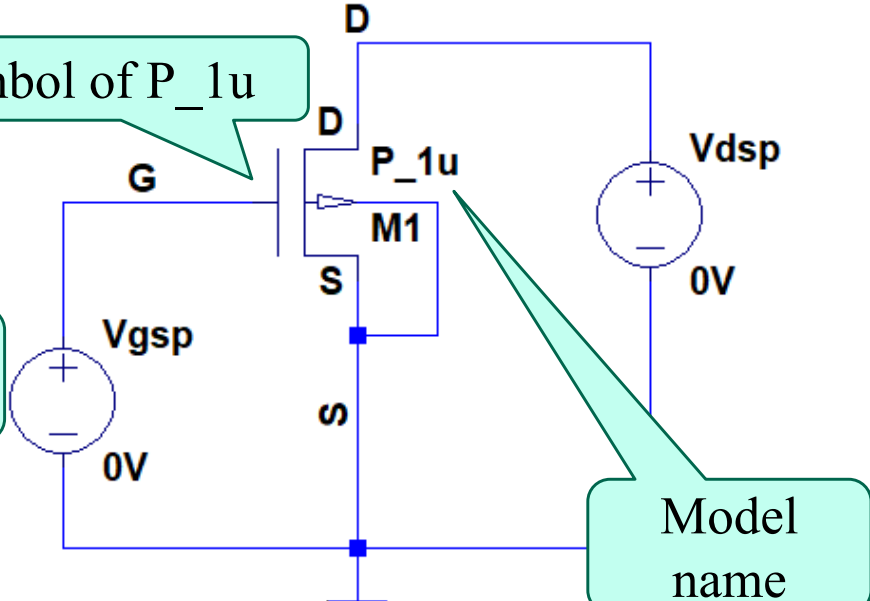
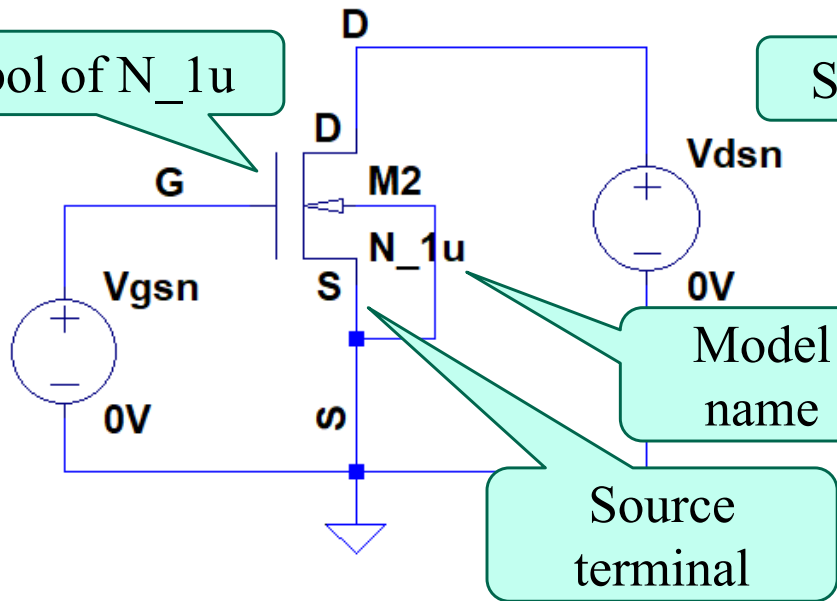
Nesting of the voltage sweep

```
.lib cmos.lib
;dc Vdsn 0V 5V 0.01V Vgsn 0V 5V 0.5V
.dc Vgsn 0V 5V 0.01V Vdsn 0V 5V 0.5V
```

```
o cmos.lib
.dc Vdsp 0V -5V -0.01V Vgsp 0V -5V -0.5V
;dc Vgsp 0V -5V -0.01V Vdsp 0V -5V -0.5V
```

Symbol of N_1u

Symbol of P_1u

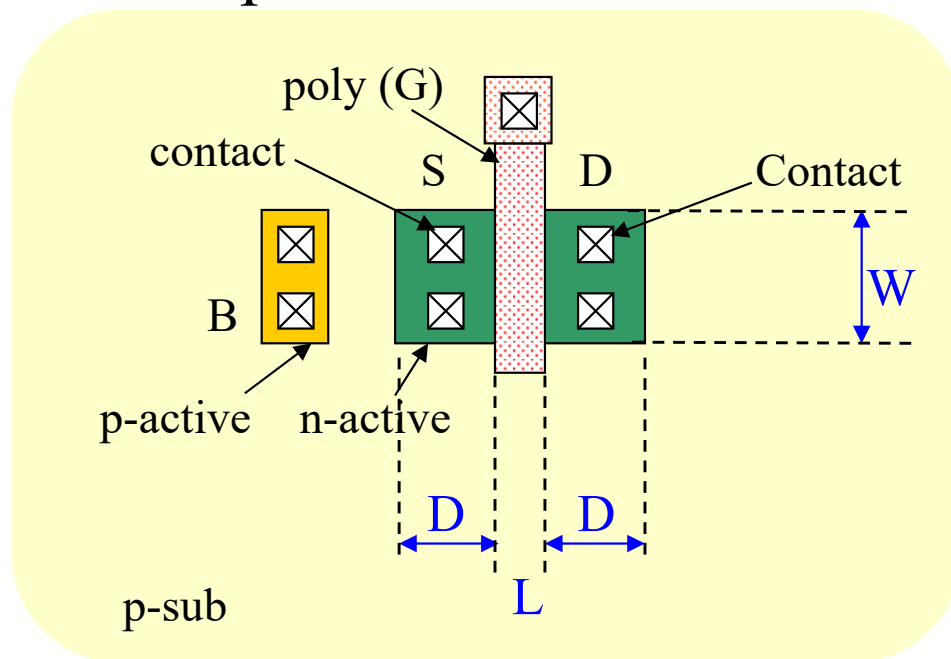


n-ch MOSFET

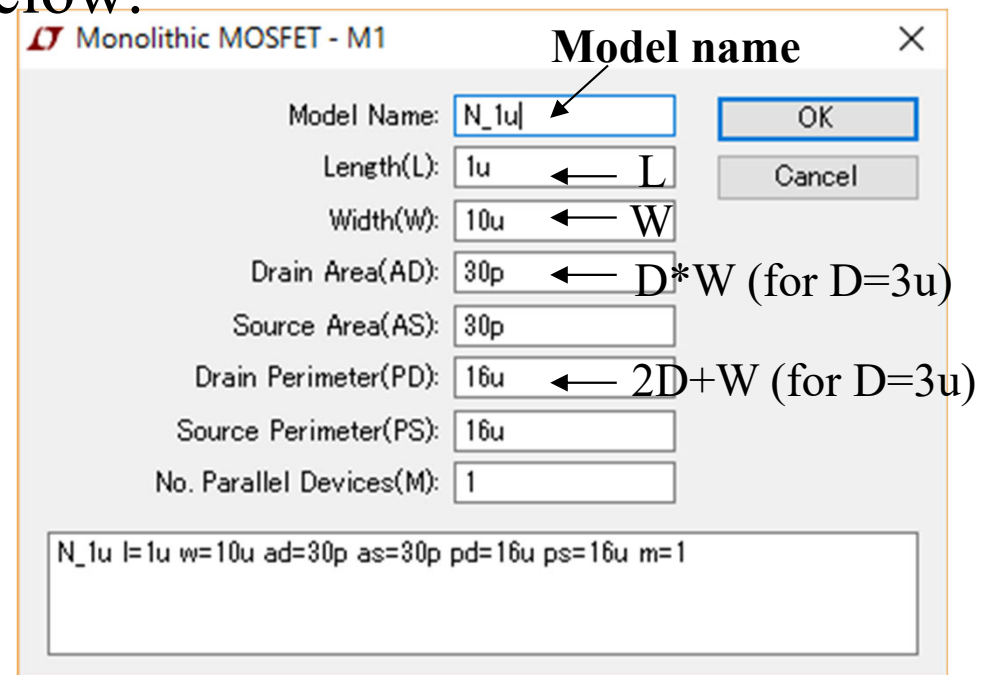
p-ch MOSFET

Example -2 (Size of MOSFET)

1. Right click the symbol of MOSFET
2. Input the values of the MOSFET parameters on the options window as stated below.



Layout of MOSFET



The image shows a dialog box titled "Monolithic MOSFET - M1" with a "Model name" field. The parameters are as follows:

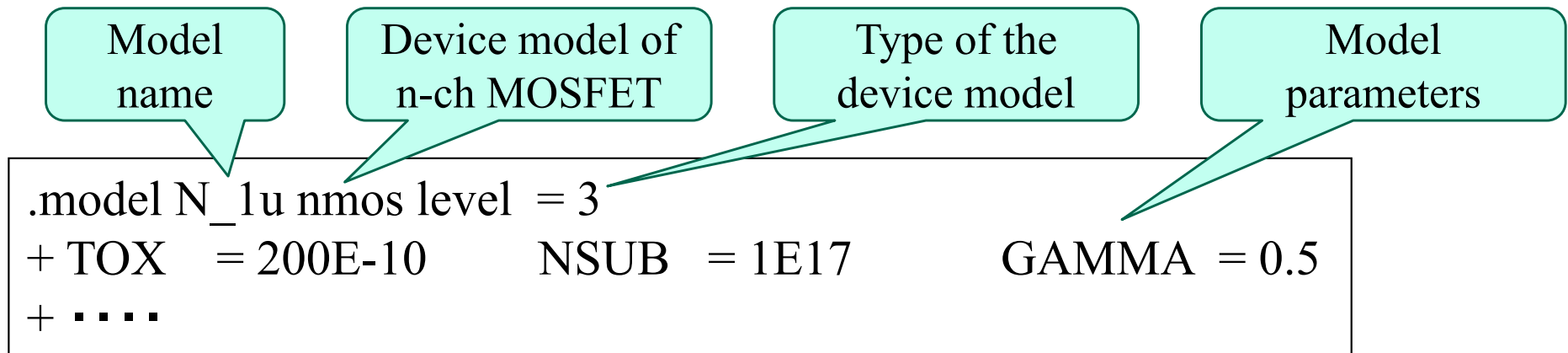
Parameter	Value	Formula
Model Name	N_1u	
Length(L)	1u	L
Width(W)	10u	W
Drain Area(AD)	30p	$D * W$ (for $D=3u$)
Source Area(AS)	30p	
Drain Perimeter(PD)	16u	$2D + W$ (for $D=3u$)
Source Perimeter(PS)	16u	
No. Parallel Devices(M)	1	

The parameter string at the bottom is: `N_1u |l=1u w=10u ad=30p as=30p pd=16u ps=16u m=1`

Parameters of MOSFET

Example -3 (Model parameters)

Open up the file of model parameters and confirm the model name.



Model name

Device model of n-ch MOSFET

Type of the device model

Model parameters

```
.model N_1u nmos level = 3
+ TOX = 200E-10 NSUB = 1E17 GAMMA = 0.5
+ .....
```

The four models are described in the file. The model names are N_1u, N_50n, P_1u, and P_50n.

Technology	n-ch MOSFET	p-ch MOSFET	Power supply voltage
1um (long channel)	N_1u	P_1u	5.0V
50nm (short channel)	N_50n	P_50n	1.0V