

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  $I_{\text{dsn}} - V_{\text{dsn}}$  characteristic and the  $I_{\text{dsn}} - V_{\text{gsn}}$  characteristic with the LTspice.
2. Simulate the  $I_{\text{dsp}} - V_{\text{dsp}}$  characteristic and the  $I_{\text{dsp}} - V_{\text{gsp}}$  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)

```

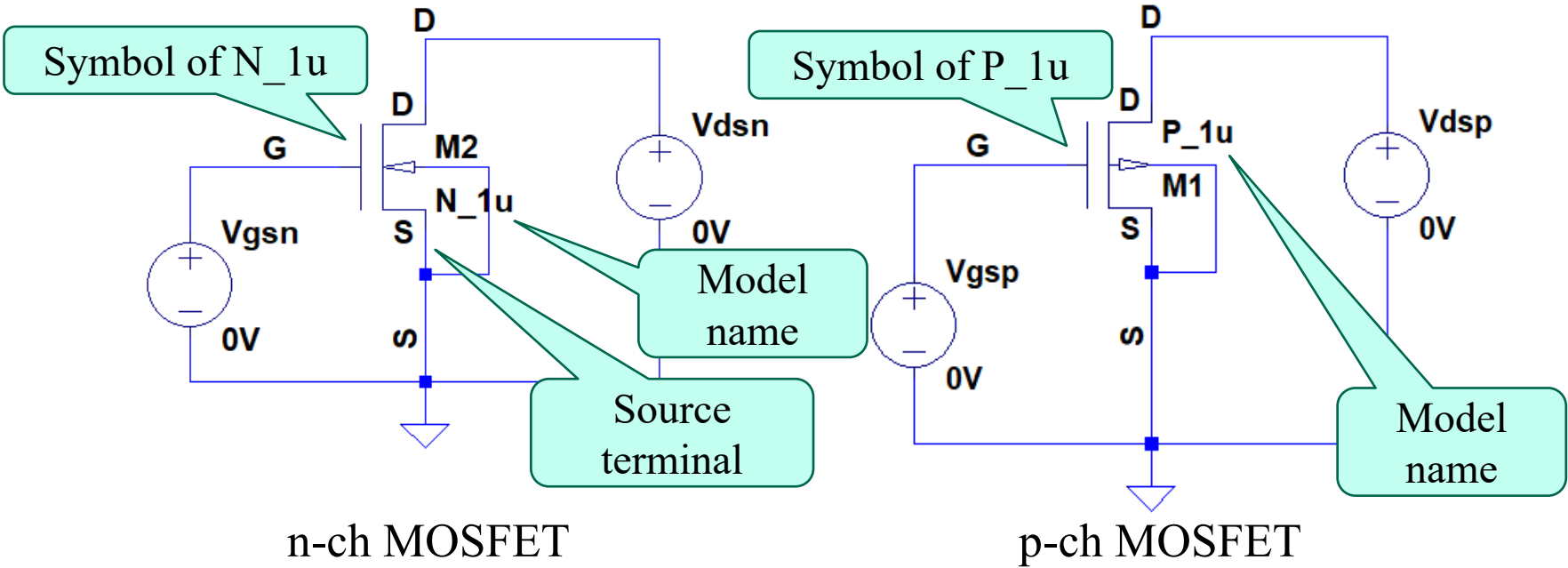
.lib cmos.lib
;dc Vdsn 0V 5V 0.01V Vgsn 0V 5V 0.5V
.dc Vgsn 0V 5V 0.01V Vdsn 0V 5V 0.5V

;dc Vdsp 0V -5V -0.01V Vgsp 0V -5V -0.5V
;dc Vgsp 0V -5V -0.01V Vdsp 0V -5V -0.5V
    
```

File path of the model parameters

Comment out

Nesting of the voltage sweep

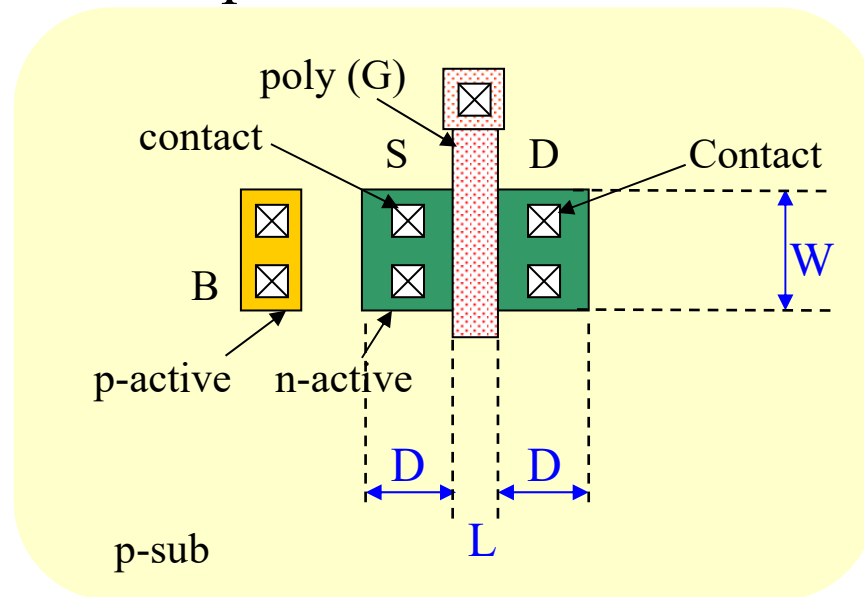


n-ch MOSFET

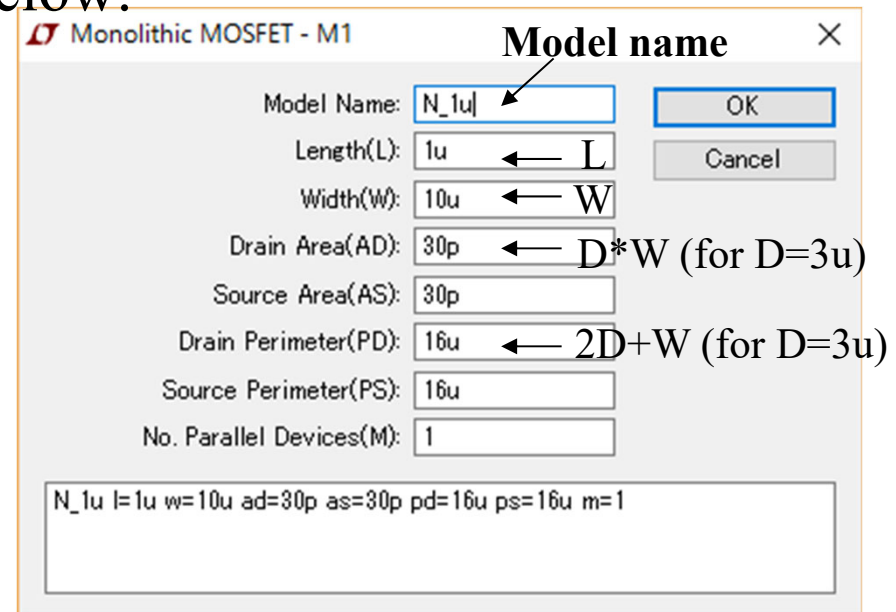
p-ch MOSFET

# 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 list 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.

The diagram shows a code snippet for a MOSFET model with four callout boxes pointing to specific parts of the code:

- Model name:** Points to `N_1u` in `.model N_1u`
- Device model of n-ch MOSFET:** Points to `nmos` in `nmos level = 3`
- Type of the device model:** Points to `level = 3`
- Model parameters:** Points to `GAMMA = 0.5`

```
.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                 |