

Lab 06

Charge Steering FF

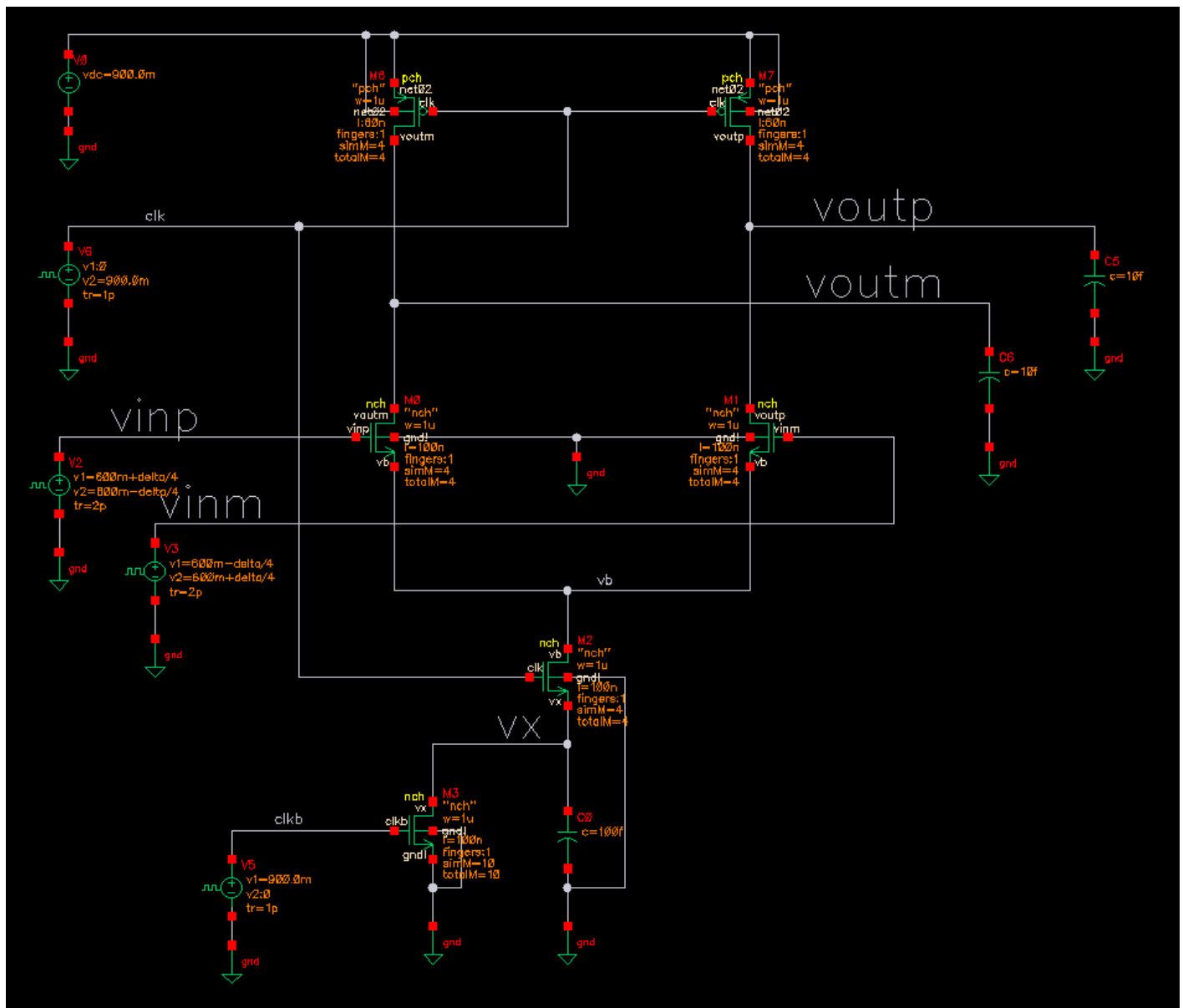
Intended Learning Objectives

- Learn about CS Concept (small input)
- Learn about CS Concept (large input)

Part one

1. Schematic of charge steering circuit:

- create the schematic shown below for the charge steering circuit with small input swing (50 mVpp) and ($v_{dd}=900$ mV).



- the setting of the input sources and input clock (10GHz) is shown below:

Vinm

Edit Object Properties

Cell Name: off

View Name: off

Instance Name: off

Add Delete Modify

User Property Master Value Local Value Display

lvignore: off

CDF Parameter	Value	Display
Frequency name for 1/period		off
Noise file name		off
Number of noise/freq pairs	0	off
DC voltage		off
AC magnitude		off
AC phase		off
XF magnitude		off
PAC magnitude		off
PAC phase		off
Voltage 1	587.5m V	off
Voltage 2	612.5m V	off
Period	300p s	off
Delay time		off
Rise time	2p s	off
Fall time	2p s	off
Pulse width	100p s	off
Temperature coefficient 1		off
Temperature coefficient 2		off
Nominal temperature		off
Type of rising & falling edge		off

OK Cancel Apply Defaults Previous Next Help

Vinp

Edit Object Properties

Cell Name: off

View Name: off

Instance Name: off

Add Delete Modify

User Property Master Value Local Value Display

lvignore: off

CDF Parameter	Value	Display
Frequency name for 1/period		off
Noise file name		off
Number of noise/freq pairs	0	off
DC voltage		off
AC magnitude		off
AC phase		off
XF magnitude		off
PAC magnitude		off
PAC phase		off
Voltage 1	612.5m V	off
Voltage 2	587.5m V	off
Period	300p s	off
Delay time		off
Rise time	2p s	off
Fall time	2p s	off
Pulse width	100p s	off
Temperature coefficient 1		off
Temperature coefficient 2		off
Nominal temperature		off
Type of rising & falling edge		off

OK Cancel Apply Defaults Previous Next Help

clk

Edit Object Properties

Cell Name: off

View Name: off

Instance Name: off

Add Delete Modify

User Property Master Value Local Value Display

lvignore: off

CDF Parameter	Value	Display
Frequency name for 1/period		off
Noise file name		off
Number of noise/freq pairs	0	off
DC voltage		off
AC magnitude		off
AC phase		off
XF magnitude		off
PAC magnitude		off
PAC phase		off
Voltage 1	0 V	off
Voltage 2	900.0m V	off
Period	100p s	off
Delay time		off
Rise time	1p s	off
Fall time	1p s	off
Pulse width	50p s	off
Temperature coefficient 1		off
Temperature coefficient 2		off
Nominal temperature		off
Type of rising & falling edge		off

OK Cancel Apply Defaults Previous Next Help

clkb

Edit Object Properties

Cell Name: off

View Name: off

Instance Name: off

Add Delete Modify

User Property Master Value Local Value Display

lvignore: off

CDF Parameter	Value	Display
Frequency name for 1/period		off
Noise file name		off
Number of noise/freq pairs	0	off
DC voltage		off
AC magnitude		off
AC phase		off
XF magnitude		off
PAC magnitude		off
PAC phase		off
Voltage 1	900.0m V	off
Voltage 2	0 V	off
Period	100p s	off
Delay time		off
Rise time	1p s	off
Fall time	1p s	off
Pulse width	50p s	off
Temperature coefficient 1		off
Temperature coefficient 2		off
Nominal temperature		off
Type of rising & falling edge		off

OK Cancel Apply Defaults Previous Next Help

c. The setting of the transistors and CT, CD: CT=100fF , CD=10fF (Modes the external loading)

M6&M7:

Property	Value	Display
Library Name	tsmcN65	off
Cell Name	pch	value
View Name	symbol	off
Instance Name	M7	off

CDF Parameter	Value	Display
Model name	pch	off
description	dard VT PMOS transistor	off
I (M)	60n M	off
w (M)	1u M	off
total_width(M)	1u M	off
Number of Fingers	1	off
Multiplier	4	off
total_m	4	off

M0&M1:

Property	Value	Display
Library Name	tsmcN65	off
Cell Name	nch	value
View Name	symbol	off
Instance Name	M0	off

CDF Parameter	Value	Display
Model name	nch	off
description	dard VT NMOS transistor	off
I (M)	100n M	off
w (M)	1u M	off
total_width(M)	1u M	off
Number of Fingers	1	off
Multiplier	4	off
total_m	4	off

M2:

Property	Value	Display
Library Name	tsmcN65	off
Cell Name	nch	value
View Name	symbol	off
Instance Name	M2	off

Add Delete Modify

CDF Parameter	Value	Display
Model name	nch	off
description	dard VT NMOS transistor	off
I (M)	100n M	off
w (M)	1u M	off
total_width(M)	1u M	off
Number of Fingers	1	off
Multiplier	4	off
total_m	4	off

M3:

Property	Value	Display
Library Name	tsmcN65	off
Cell Name	nch	value
View Name	symbol	off
Instance Name	M3	off

Add Delete Modify

CDF Parameter	Value	Display
Model name	nch	off
description	dard VT NMOS transistor	off
I (M)	100n M	off
w (M)	1u M	off
total_width(M)	1u M	off
Number of Fingers	1	off
Multiplier	10	off
total_m	10	off

Q1: comment on the size of M6&M7 and the trade off with the gain?

2- Transient simulation:

Run transient simulation for 500ps and plot the following:

a. $V_{inp-diff}$:

b. V_X :

Q2: comment on the swing at V_x node?

c. Plot V_{outp} & V_{outm} :

Q3: comment on the behavior of the two signals?

d. Plot $V_{out-diff}$:

e. Calculate Power consumption:

Q4: Mention the effect of increasing C_T on the power consumption and the reason for that?

Part two

1- Same schematic but with large input swing (500mVpp):

a. Plot $V_{inp-diff}$:

b. Plot V_X :

c. Plot V_{outp} & V_{outm} :

Q5: For the V_{outp} & V_{outm} , make a comparison between the low swing and large swing inputs "compare with part one"?

d. Plot $V_{out-diff}$:

e. Calculate Power consumption :

Part three

- Plot Vout VS Vin for different values of the input swing and plot the Gain:

first we need to add samplers to remove the reset phase effect to calculate the gain

Veriloga code for the sampler:

```
// VerilogA for charge_steering_lab, low_input_swing, veriloga
```

```
`include "constants.vams"
```

```
`include "disciplines.vams"
```

```
module low_input_swing_sampler(vinp,vinn,clk,vout);
```

```
input vinn,vinp,clk;
```

```
output vout;
```

```
electrical vinn, vinp, vout, clk;
```

```
real vdiff =0;
```

```
parameter trise = 1p;
```

```
analog begin
```

```
@(initial_step("tran", "pss")) begin
```

```
vdiff = 0;
```

```
end
```

```
@(cross(V(clk) - 0.45, -1))
```

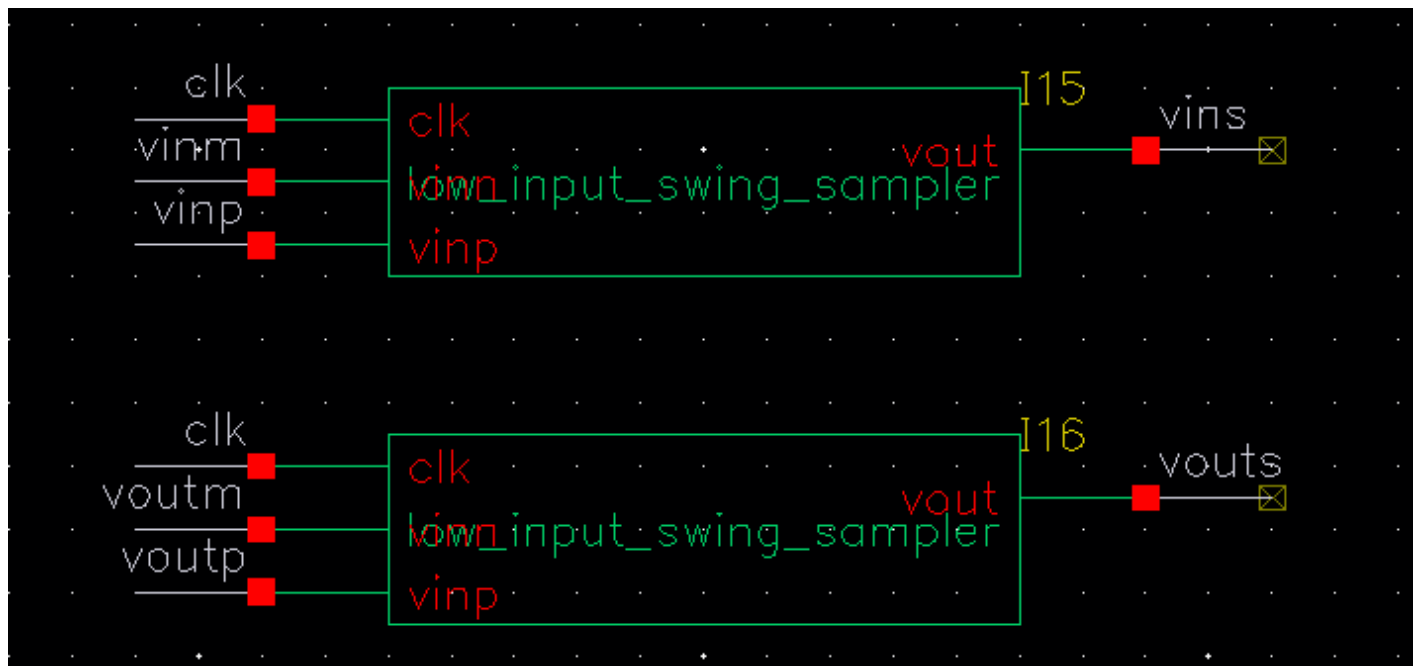
```
vdiff = V(vinp)-V(vinn);
```

```
V(vout) <+ transition (vdiff,0,trise);
```

```
end
```

```
endmodule
```

- symbol and the connection:



- setting of the input sources:

Voltage 1	<input type="text" value="600m+delta/4 V"/>	<input type="button" value="off"/> ▼	Voltage 1	<input type="text" value="600m-delta/4 V"/>	<input type="button" value="off"/> ▼
Voltage 2	<input type="text" value="600m-delta/4 V"/>	<input type="button" value="off"/> ▼	Voltage 2	<input type="text" value="600m+delta/4 V"/>	<input type="button" value="off"/> ▼
Period	<input type="text" value="300p s"/>	<input type="button" value="off"/> ▼	Period	<input type="text" value="300p s"/>	<input type="button" value="off"/> ▼
Delay time	<input type="text"/>	<input type="button" value="off"/> ▼	Delay time	<input type="text"/>	<input type="button" value="off"/> ▼
Rise time	<input type="text" value="2p s"/>	<input type="button" value="off"/> ▼	Rise time	<input type="text" value="2p s"/>	<input type="button" value="off"/> ▼
Fall time	<input type="text" value="2p s"/>	<input type="button" value="off"/> ▼	Fall time	<input type="text" value="2p s"/>	<input type="button" value="off"/> ▼
Pulse width	<input type="text" value="100p s"/>	<input type="button" value="off"/> ▼	Pulse width	<input type="text" value="100p s"/>	<input type="button" value="off"/> ▼
Temperature coefficient 1	<input type="text"/>	<input type="button" value="off"/> ▼	Temperature coefficient 1	<input type="text"/>	<input type="button" value="off"/> ▼
Temperature coefficient 2	<input type="text"/>	<input type="button" value="off"/> ▼	Temperature coefficient 2	<input type="text"/>	<input type="button" value="off"/> ▼
Nominal temperature	<input type="text"/>	<input type="button" value="off"/> ▼	Nominal temperature	<input type="text"/>	<input type="button" value="off"/> ▼
Type of rising & falling edge	<input type="button" value="off"/> ▼	<input type="button" value="off"/> ▼	Type of rising & falling edge	<input type="button" value="off"/> ▼	<input type="button" value="off"/> ▼

- sweep delta from 0 to 500mV with 50mV step.

a. Plot Vins:

b. Plot Vouts:

c. Plot V_{out} VS V_{in} @200ps:

d. Plot Gain @200ps: