電子電路實驗 3: VTC of CMOS Amplifier Circuits

實驗預報

B02901178 江誠敏

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1 Objectives

1. To familiarize with the measurement of VTC (Voltage Transfer Curve) for CMOS amplifier circuits.
2. The effects of resistance between gate and source terminal for the VTC of CMOS inverter.
3. Application of CMOS inverter and amplifier.

2 Procedures

a. CMOS amplifier as an inverter

(1) In Fig. 1, supply voltage source $V_{DD} = +8\,\mathrm{V}$ to the circuit.

(2) Use function generator to generate $v_i = V_{i(dc)} + v_{i(ac)} \sin(2\pi f t), V_{i(dc)} = 4\,\mathrm{V}, v_{i(ac)} = 4\,\mathrm{V}, f = 1\,\mathrm{kHz}$. Provide the input small signal V_i to the breadboard.

(3) Make sure that the v_i is measured from the breadboard by using the Function generator ▷Press the `FUNC` button ▷Set `FREQ` $= 1\,\mathrm{kHz}$, `SIN wave` ▷`ATTN 0dB` ▷`SUB FUNC` ▷`OFFSET ON` ▷`Adjust DC/OFFSET` and set dc offset value $V_{i(dc)} = 4\,\mathrm{V}$.

(4) `Oscilloscope` ▷Press the `CH1` and `CH2 MENU` ▷`Coupling` ▷DC .

(5) `Oscilloscope` ▷Press the `DISPLAY` button ▷`Format` ▷`XY mode` , the diagram will be the same as that shown in Fig. 2.

(6) Adjust the $\texttt{VOLTS/DIV}_{\texttt{in}}$ `CH1` and `CH2` so that the transition region of the diagram is obvious enough to determine the voltage gain.

(7) Record the voltage gain (Reference value = $-20\,\mathrm{V/V}$) by observing the slope of the VTC in the transition region (the differentiation of input and output voltage value) shown in the curve at `XY mode`.

(8) Change the input voltage signal, and observe whether the shape of the diagram in `XY mode` is consistent.

(9) Record the value of input voltage source as it change.

b. CMOS analog circuit experiment

(1) In Fig. 3, use $R = 20\,\mathrm{k\Omega}, 510\,\mathrm{k\Omega}, 1\,\mathrm{M\Omega}, 3.9\,\mathrm{k\Omega},$ and $10\,\mathrm{M\Omega}$, respectively.

(2) Supply voltage source $V_{DD} = +8\,\mathrm{V}$ to the circuit.

(3) Use function generator to generate $v_i = V_{i(dc)} + v_{i(ac)} \sin(2\pi ft), V_{i(dc)} = 4\,\mathrm{V}, v_{i(ac)} = 4\,\mathrm{V}, f = 1\,\mathrm{kHz}$. Provide the input small signal V_i to the breadboard.

(4) Make sure that the v_i is measured from the breadboard by using the probe from CH1 in oscilloscope.

(5) Function generator ▷Press the `FUNC` button ▷`FREQ` = 1 kHz, `SIN` wave ▷`ATTN 0dB` ▷`SUB FUNC` ▷`OFFSET ON` ▷Adjust `DC/OFFSET` and set dc offset value $V_{i(dc)} = 4\,\mathrm{V}$. Push the `DISPLAY` button ▷`Format` ▷`XY mode` , the diagram will be the same as that shown in Fig. 2.

(6) Adjust the `VOLTS/DIV` in `CH1` and `CH2` so that the transition region of the diagram is obvious enough to determine the voltage gain.

(7) Record the voltage gain A_v in the follow table by observing the differentiation of input and output voltage value shown in the curve at `XY mode`. (Referent value = constantly $-20\,\mathrm{V/V}$)

(8) Change the input voltage source V_{DD} , and observe whether the shape of the diagram in XY mode is consistent.

(9) Record the value of input voltage source as it change:

c. CMOS analog amplifier circuit experiment

(1) Supply voltage source $V_{DD} = +8\,\mathrm{V}$ to the circuit.

(2) Use function generator to generate $v_i = V_{i(dc)} + v_{i(ac)} sin(2\pi ft), v_{i(ac)} = 4\,\mathrm{V}, f = 1kHz$. Provide the input small signal V_i to the breadboard.

(3) Function generator ▷`SUB FUNC` ▷`OFFSET OFF`.

(4) Make sure that the v_i is measured from the breadboard by using the probe from CH1 in oscilloscope.

(5) Use voltage power supplier to supply DC voltage $V_{i(dc)} = 4\,\mathrm{V}$.

(6) Please beware whether the DC voltage and Small-Signal Voltage (SSV) supplement are properly connected in the circuit. (DC → SSV → ground. Do you know why?)

(7) Adjust the $v_{i(ac)}$ and $V_{i(dc)}$ so that $v_{o(ac)}$ can be achieved to the highest value and not be curtailed.

(8) Push the `DISPLAY` button ▷`Format` ▷`YT mode` ▷Press `MEASURE` button.

(9) Record the value in the table as follow.

(10) Make sure that the output amplitude achieves to the maximum and the $V_{i(dc)}$ is well selected so that the output waveform is symmetry between positive half cycle and the negative half cycle.