電子回路論 第7回

2014.11.13

物性研究所

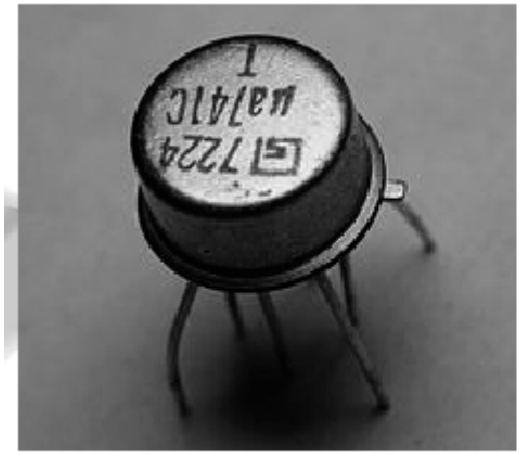
勝本信吾

OPampのパッケージング

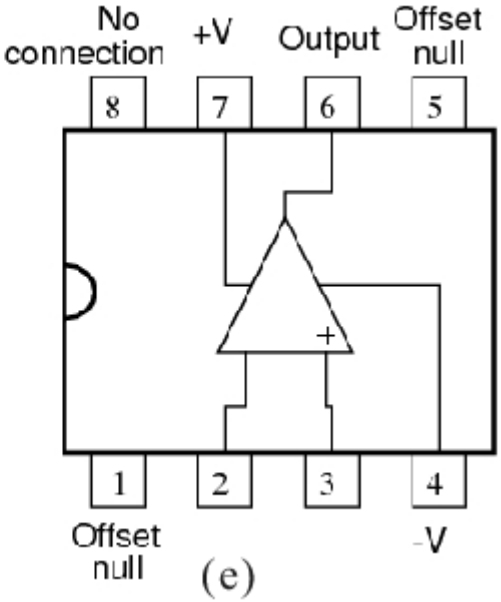
(a)

(b)

(c)



(d)



(e)

Opamp data sheet

ANALOG DEVICES

Ultralow Offset Voltage Operational Amplifier

Data Sheet **OP07**

FEATURES

- Low V_{OS}: 75 µV maximum
- Low V_{OS} drift: 1.3 µV/°C maximum
- Ultrastable vs. time: 1.5 µV per month maximum
- Low noise: 0.6 µV p-p maximum
- Wide input voltage range: ±14 V typical
- Wide supply voltage range: ±3 V to ±18 V
- 125°C temperature-tested dice

PIN CONFIGURATION

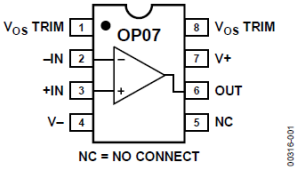
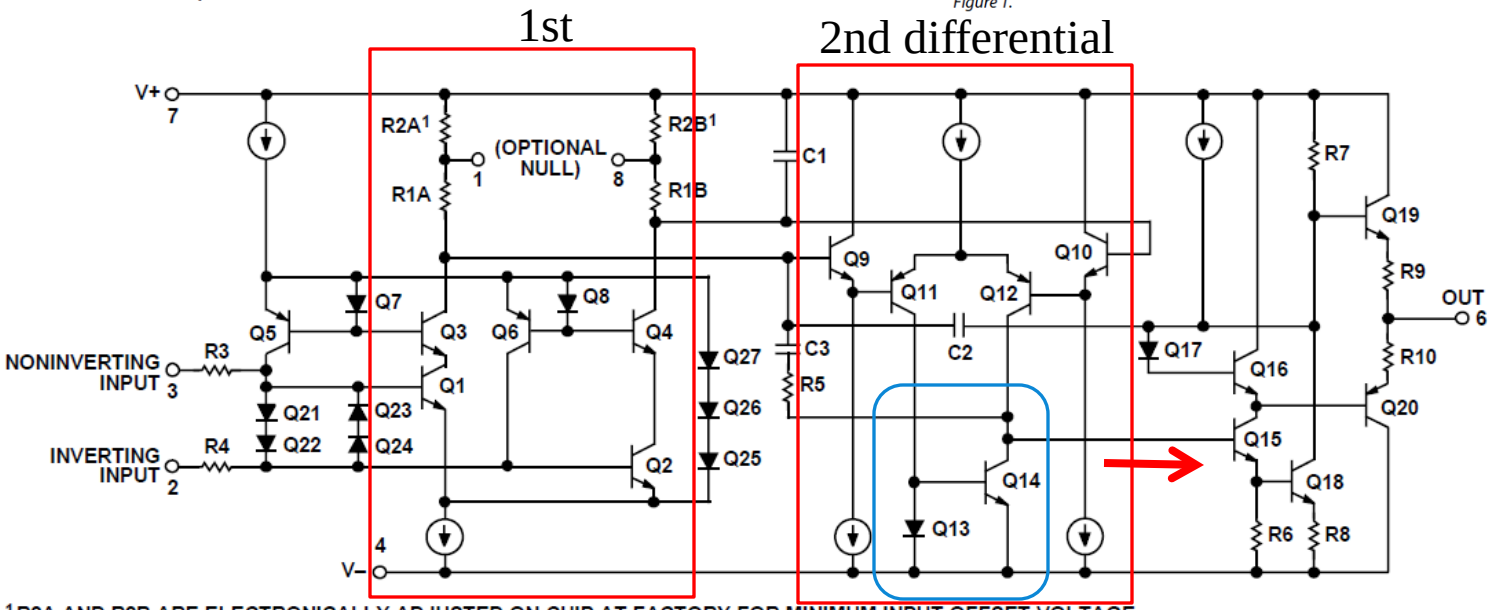


Figure 1.



[1] R2A AND R2B ARE ELECTRONICALLY ADJUSTED ON CHIP AT FACTORY FOR MINIMUM INPUT OFFSET VOLTAGE.

Figure 2. Simplified Schematic

Opamp data sheet

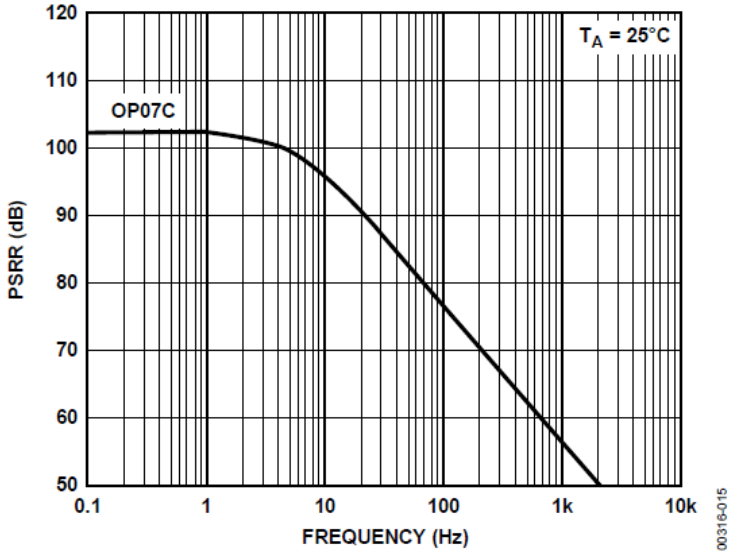


Figure 15. PSRR vs. Frequency

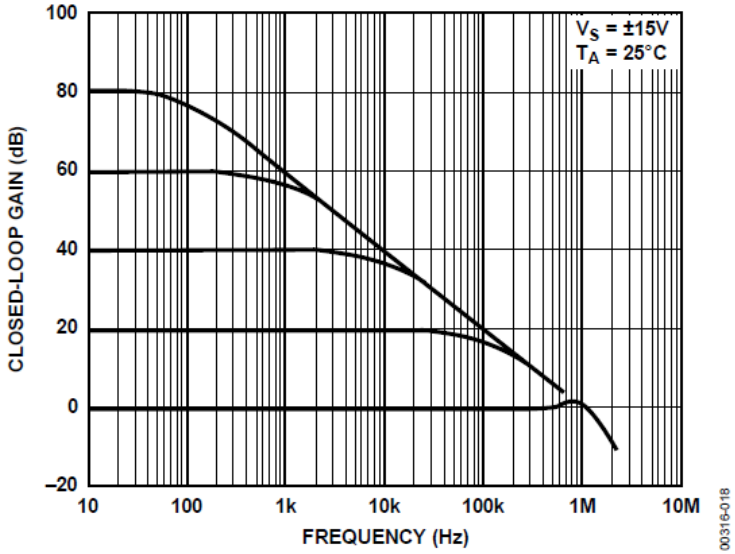


Figure 18. Closed-Loop Frequency Response for Various Gain Configurations

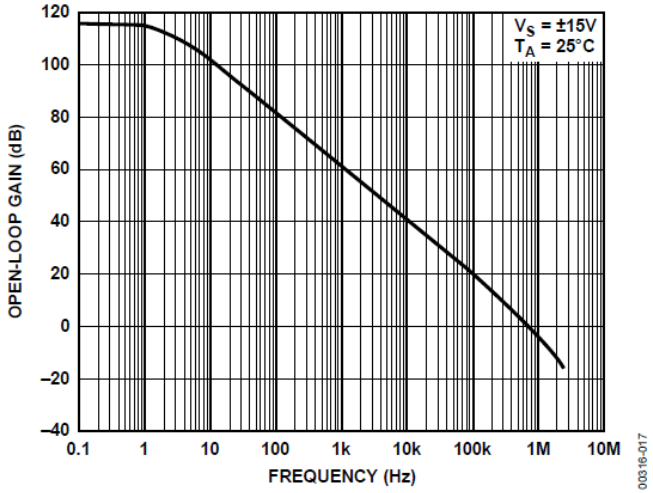
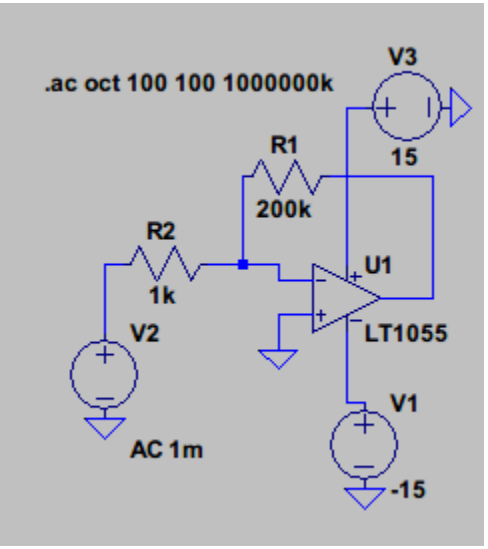
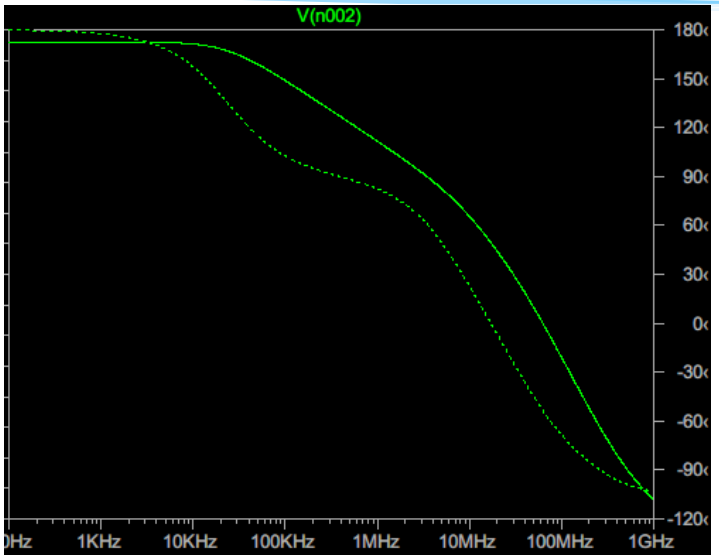


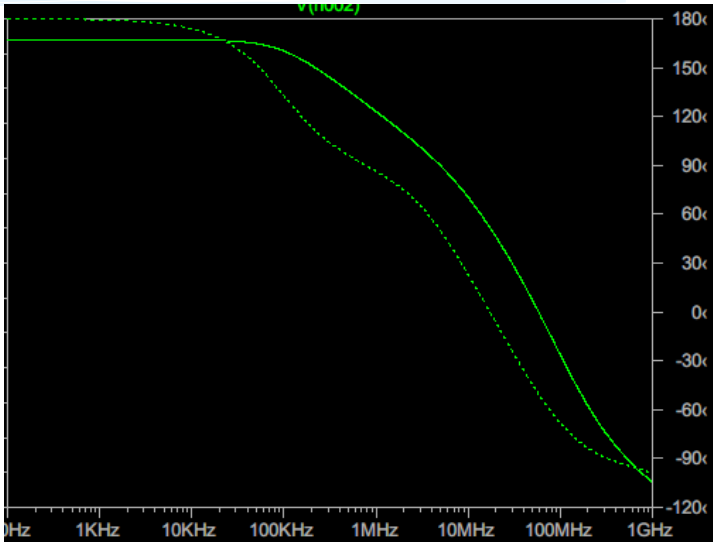
Figure 17. Open-Loop Frequency Response

反転増幅回路と遮断周波数

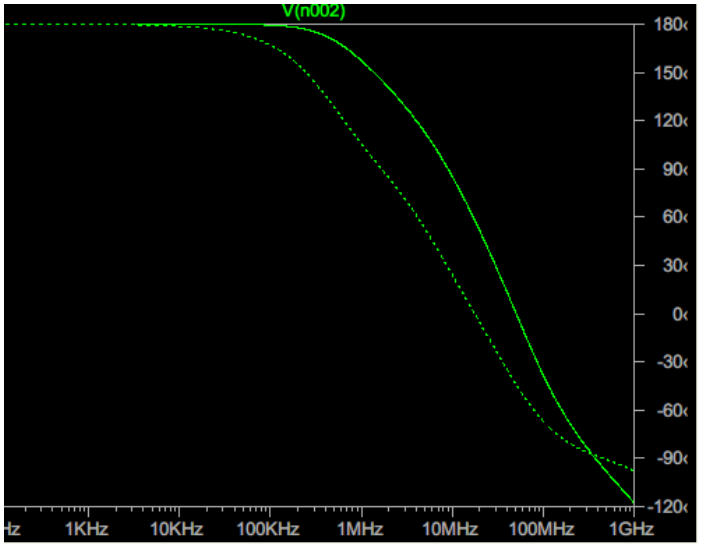




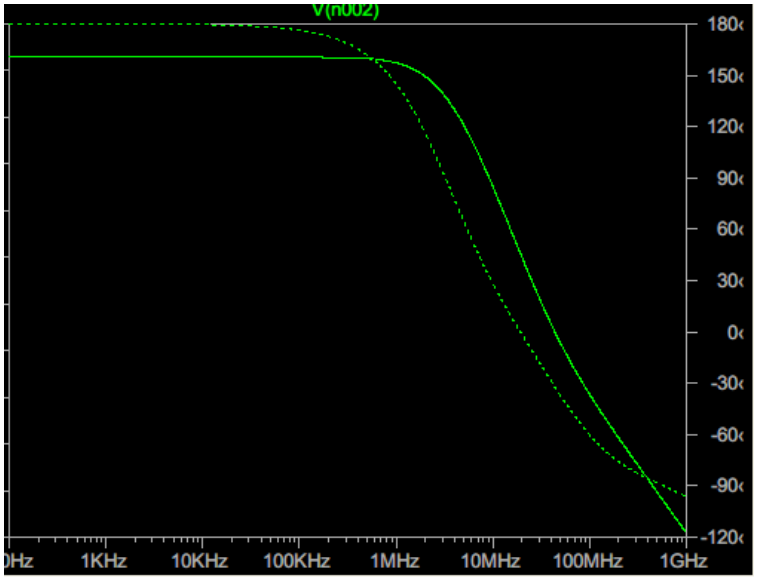
G =200 f_T =30kHz



G =50 f_T =90kHz

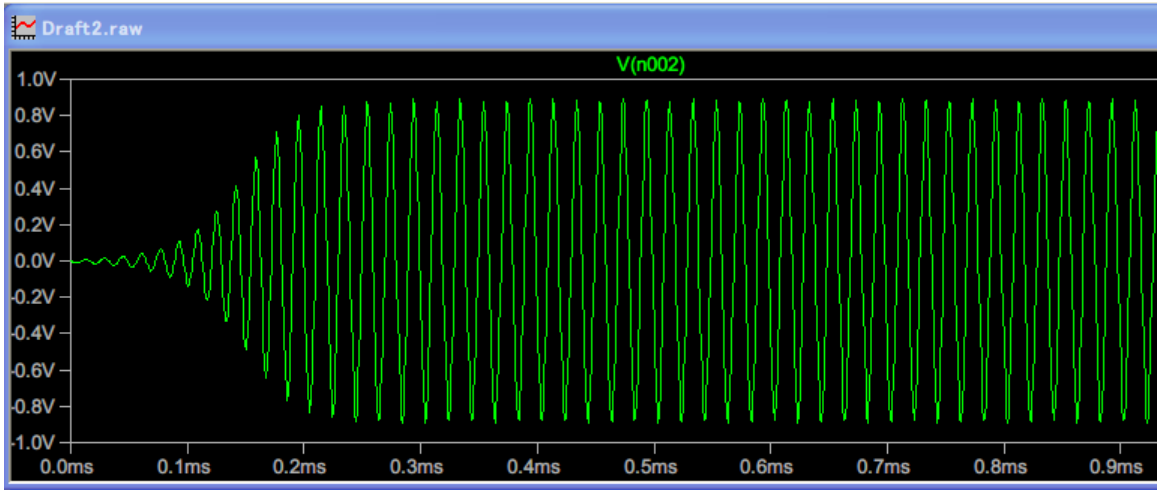


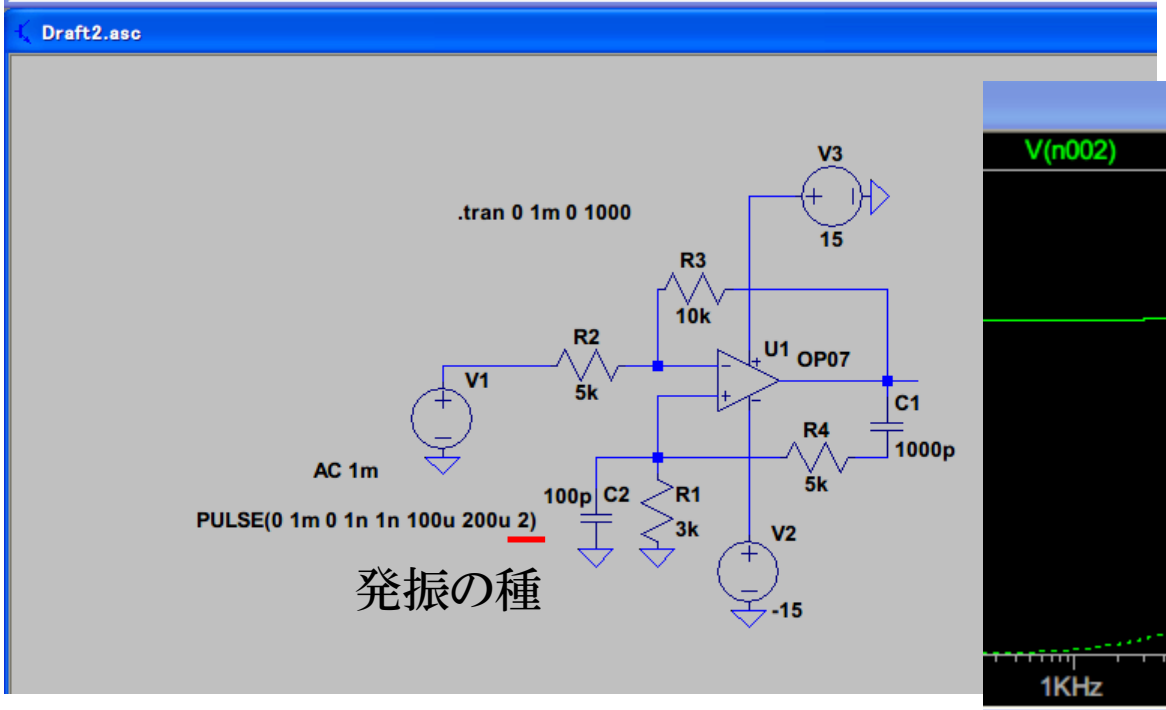
G =10 f_T =300kHz

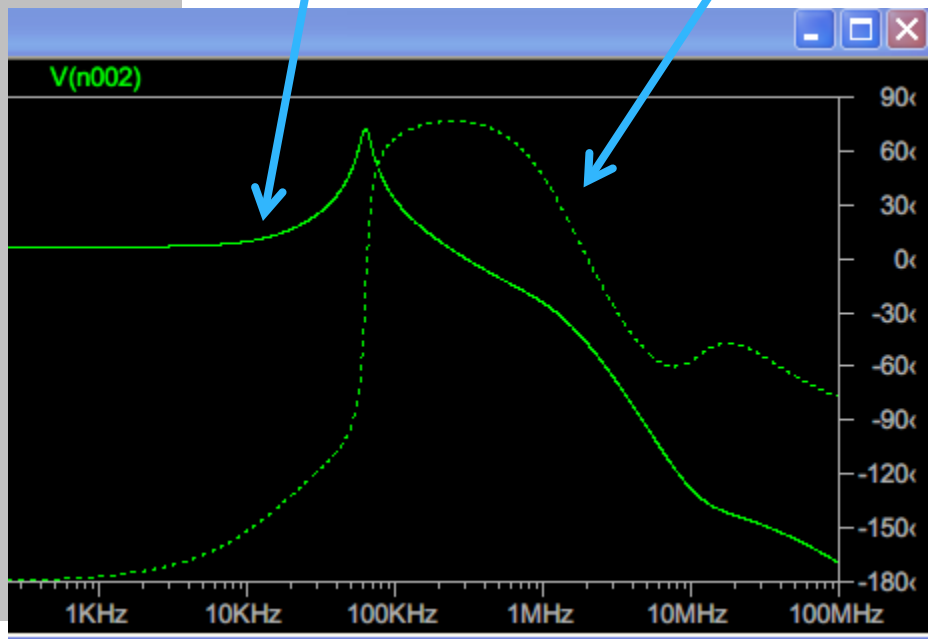


G =2 f_T =2MHz

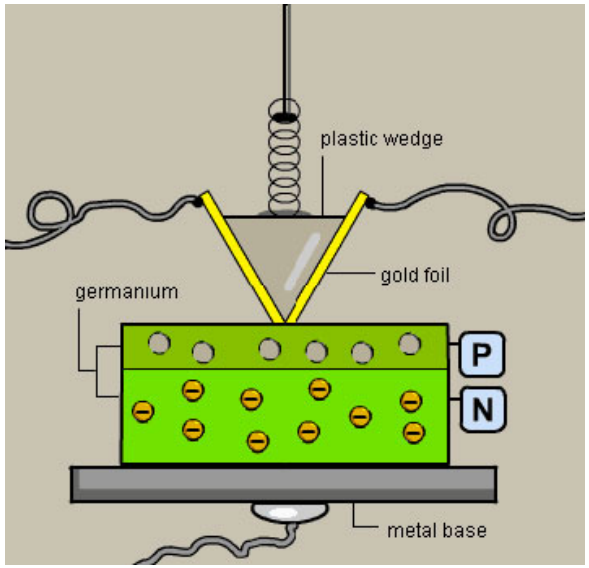
OPamp回路の発振


Draft2.raw
V(n002)
1.0V
0.8V
0.6V
0.4V
0.2V
0.0V
-0.2V
-0.4V
-0.6V
-0.8V
-1.0V
0.0ms
0.1ms
0.2ms
0.3ms
0.4ms
0.5ms
0.6ms
0.7ms
0.8ms
0.9ms


Draft2.asc
.tran 0 1m 0 1000
V3
15
R3
10k
R2
5k
V1
U1
OP07
C1
1000p
R4
5k
AC 1m
100p
C2
R1
3k
PULSE(0 1m 0 1n 1n 100u 200u 2)
V2
-15
発振の種

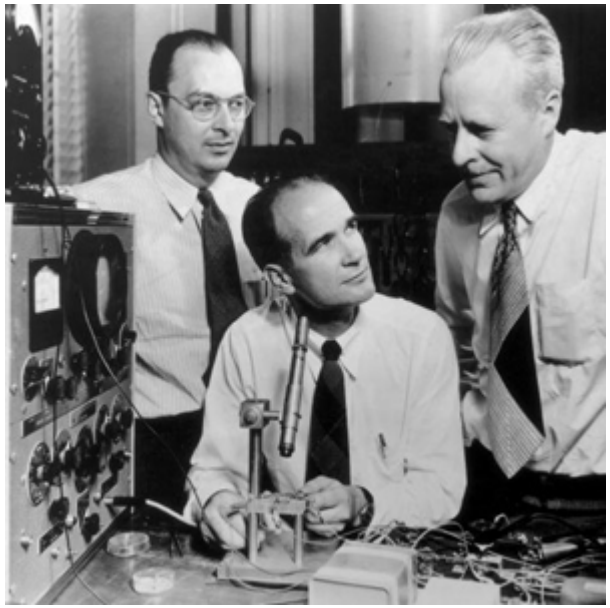

ゲイン
位相
V(n002)
90
60
30
0
-30
-60
-90
-120
-150
-180
1KHz
10KHz
100KHz
1MHz
10MHz
100MHz

トランジスタの発見・発明



最初の点接触トランジスタ

(1947年12月．論文は
1948年6月)

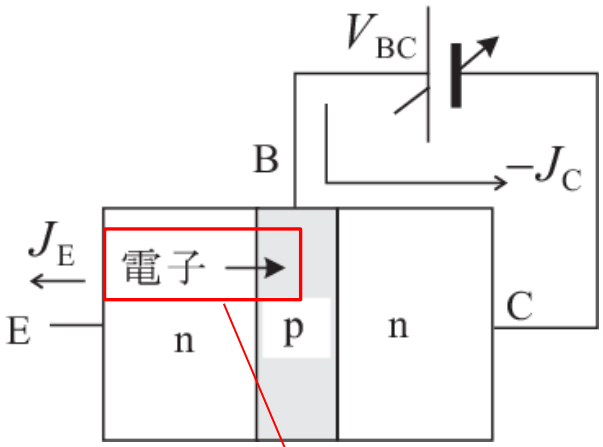


John Bardeen

William Shockley

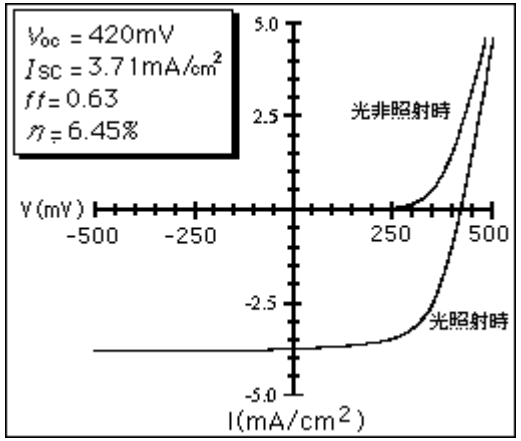
Walter Brattain

動作原理

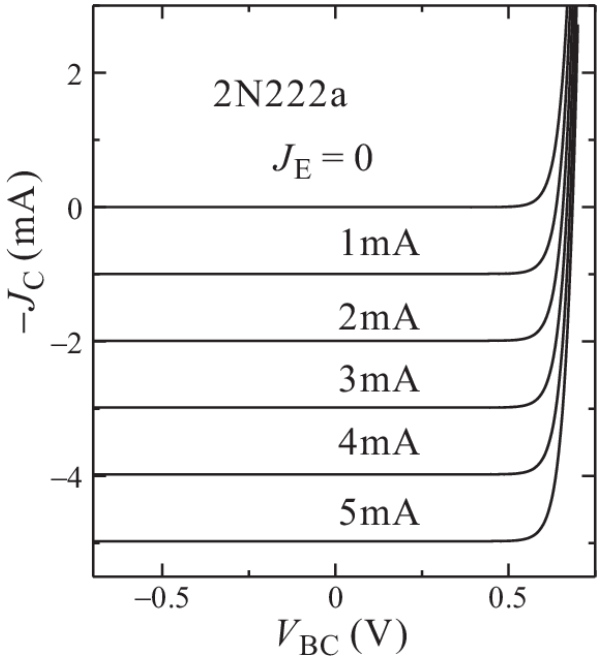


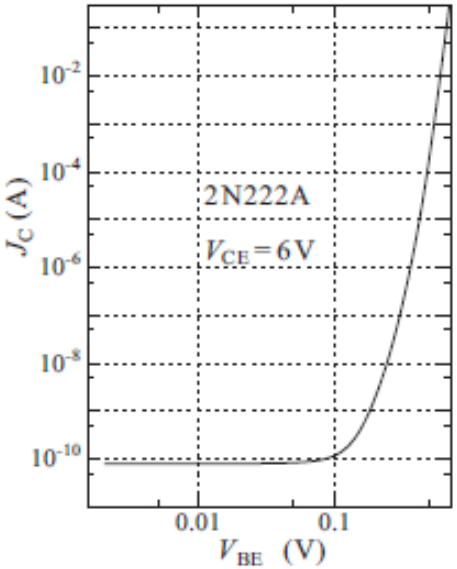
少数キャリア注入

cf. 太陽電池：光照射による少数キャリア注入



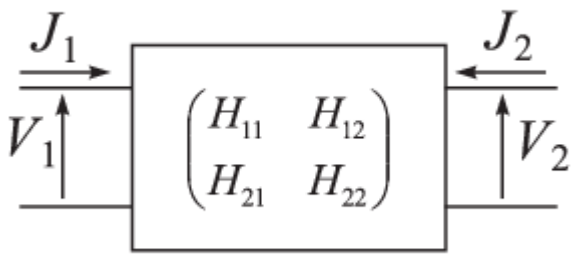
拡散伝導 → 大部分コレクタに吸収される



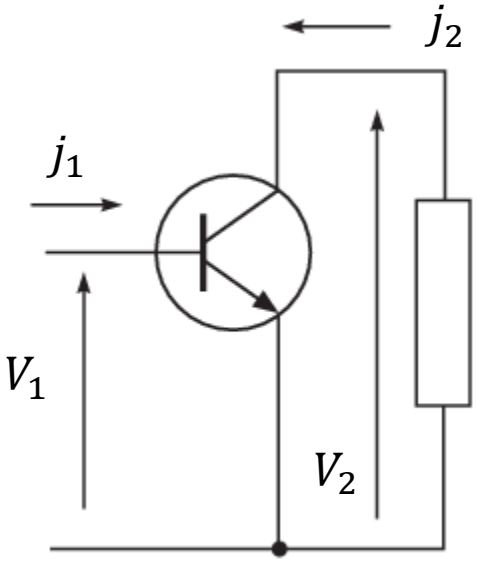


$$J_C = h_{FE} J_B$$

BJTの線形近似

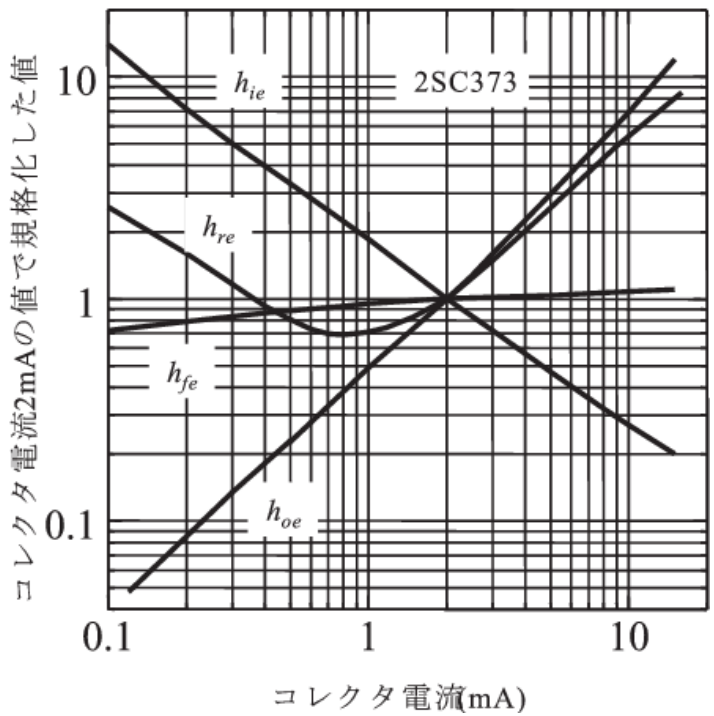


$$\begin{pmatrix} V_1 \\ J_2 \end{pmatrix} = \begin{pmatrix} H_{11} & H_{12} \\ H_{21} & H_{22} \end{pmatrix} \begin{pmatrix} J_1 \\ V_2 \end{pmatrix}.$$



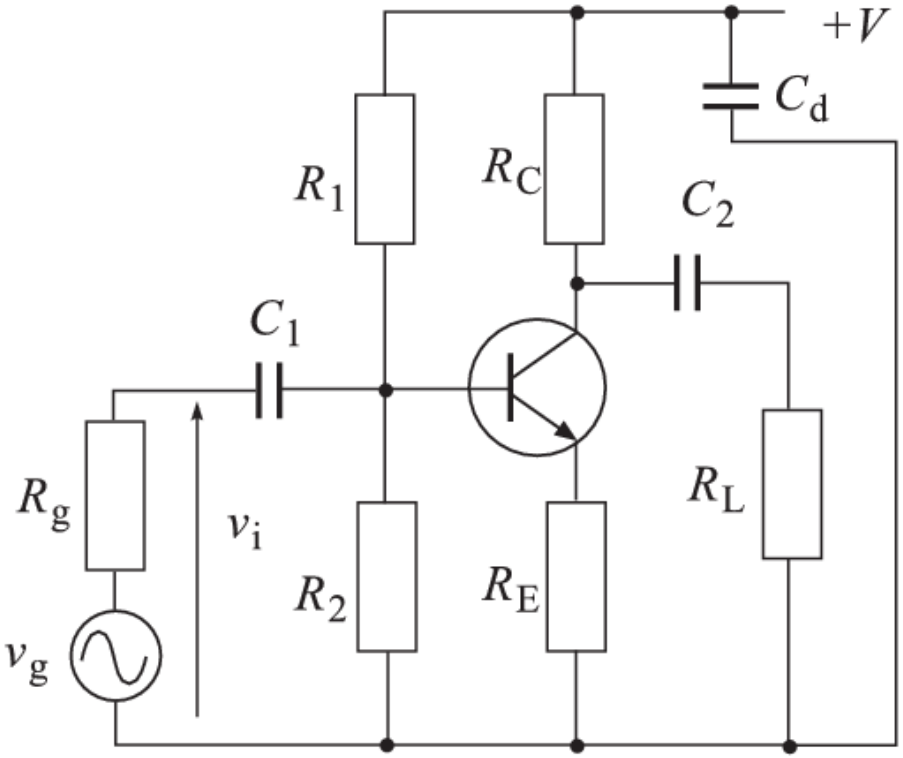
$$\begin{pmatrix} v_1 \\ j_2 \end{pmatrix} = \begin{pmatrix} h_{11} & h_{12} \\ h_{21} & h_{22} \end{pmatrix} \begin{pmatrix} j_1 \\ v_2 \end{pmatrix} = \begin{pmatrix} h_i & h_r \\ h_f & h_o \end{pmatrix} \begin{pmatrix} j_1 \\ v_2 \end{pmatrix}$$

(小文字：
小振幅線形近似を表す)



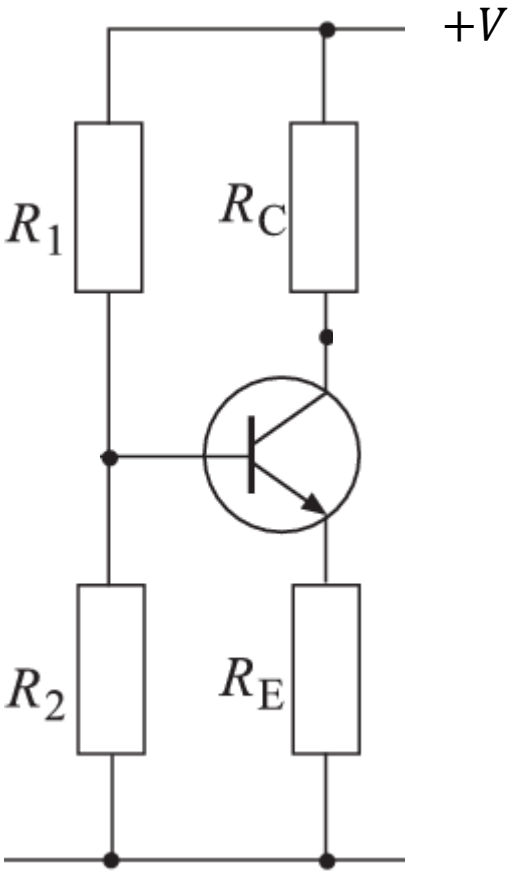
BJTのバイアス回路

エミッタ接地増幅回路



バイアス回路を見る時

キャパシタはすべて切れている

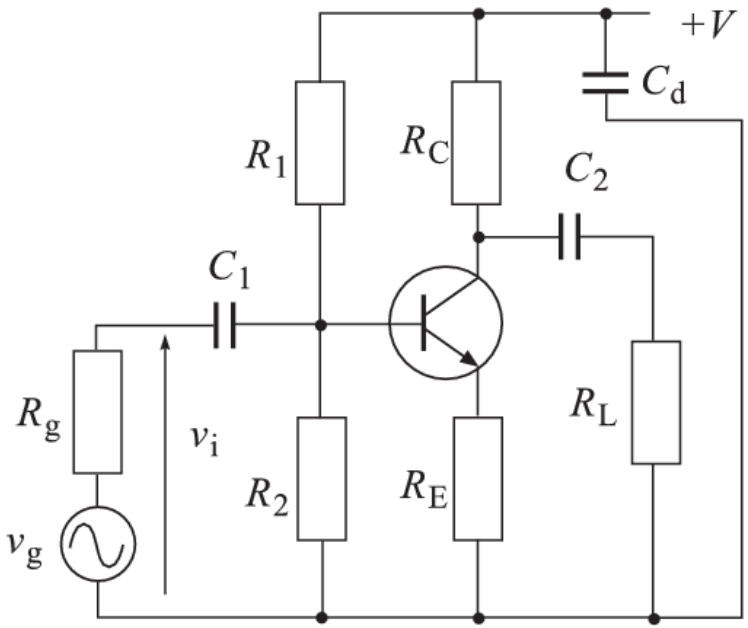


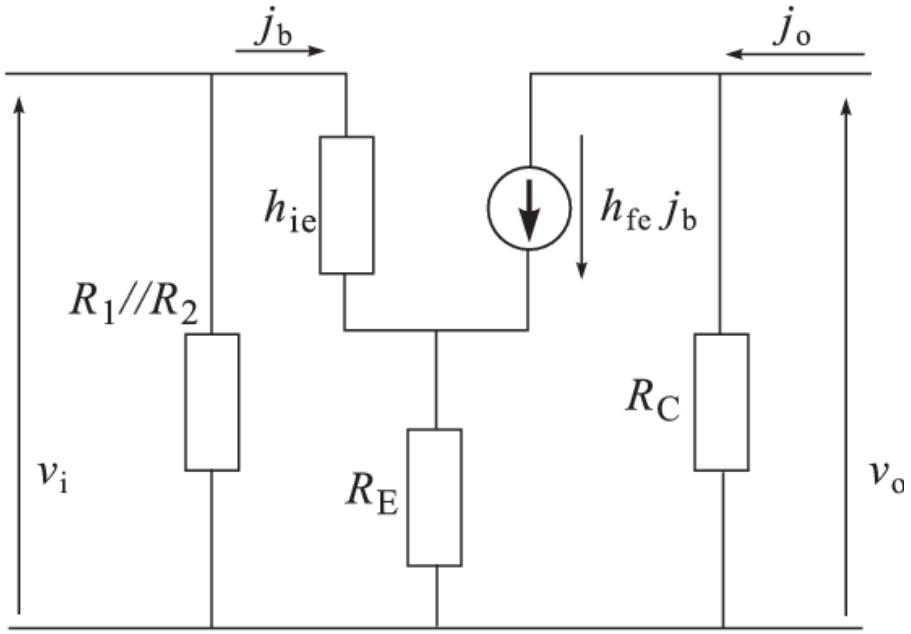
BTJの小振幅線形回路

小振幅回路を見る時

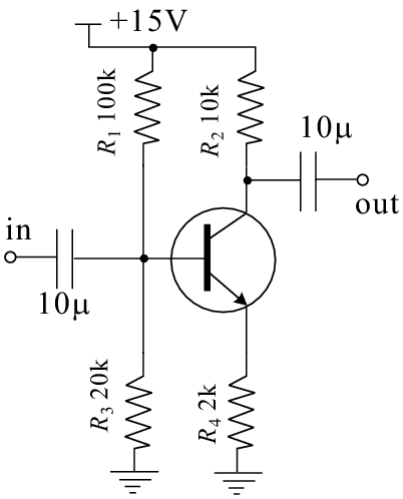
キャパシタはすべてショート

エミッタ接地増幅回路

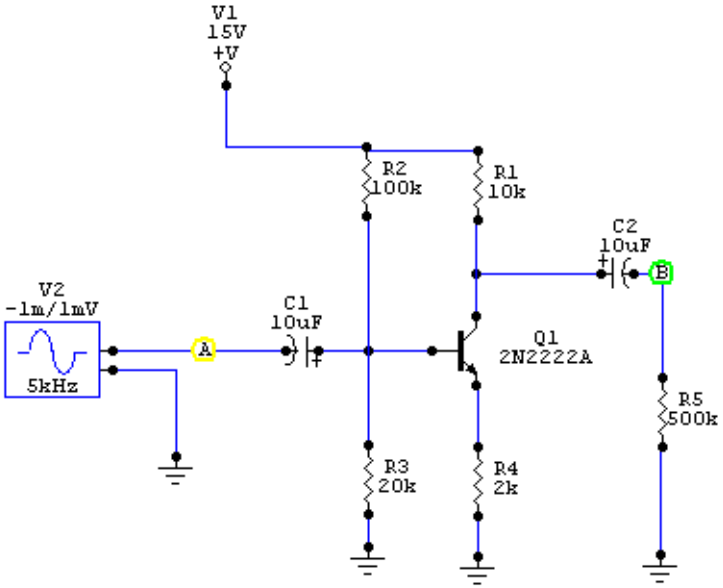


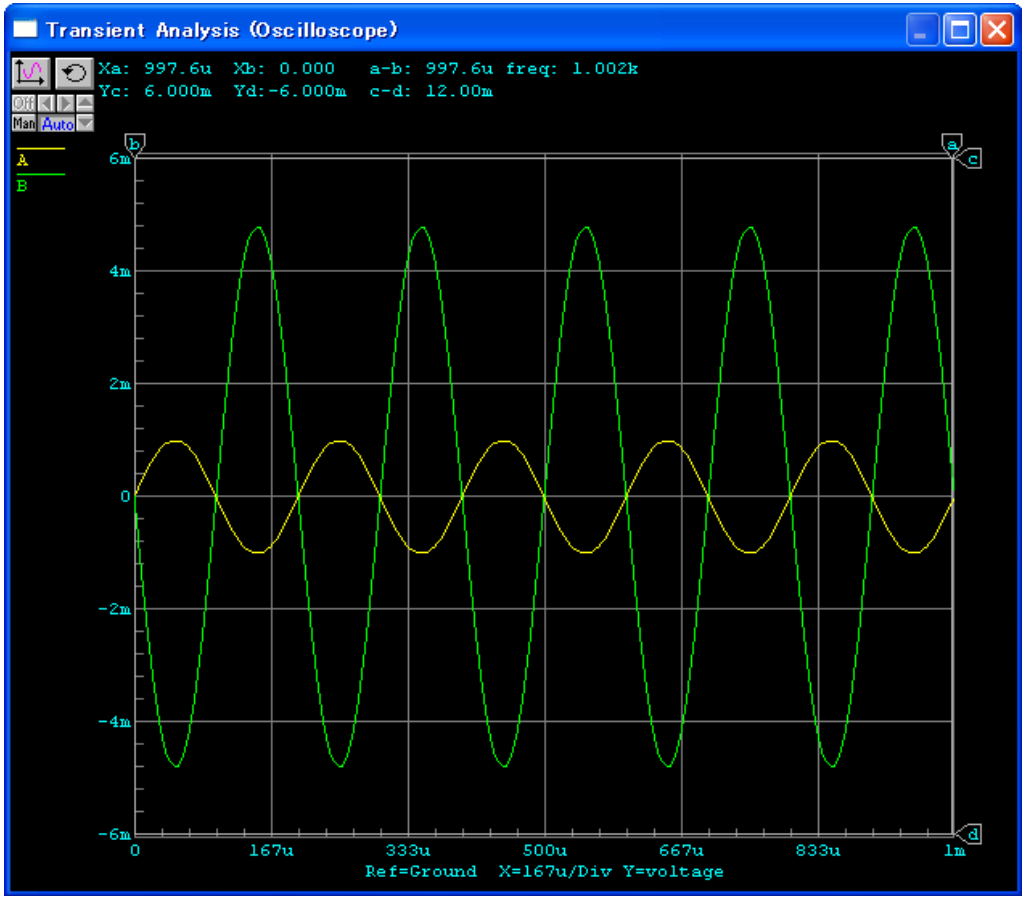


エミッタ接地増幅回路



$$\Delta V_{\mathrm{C}} = R_2 \Delta J_{\mathrm{C}} \approx R_2 \Delta J_{\mathrm{E}} = R_2 \frac{\Delta V_{\mathrm{E}}}{R_4} = \frac{R_2}{R_4} \Delta V$$

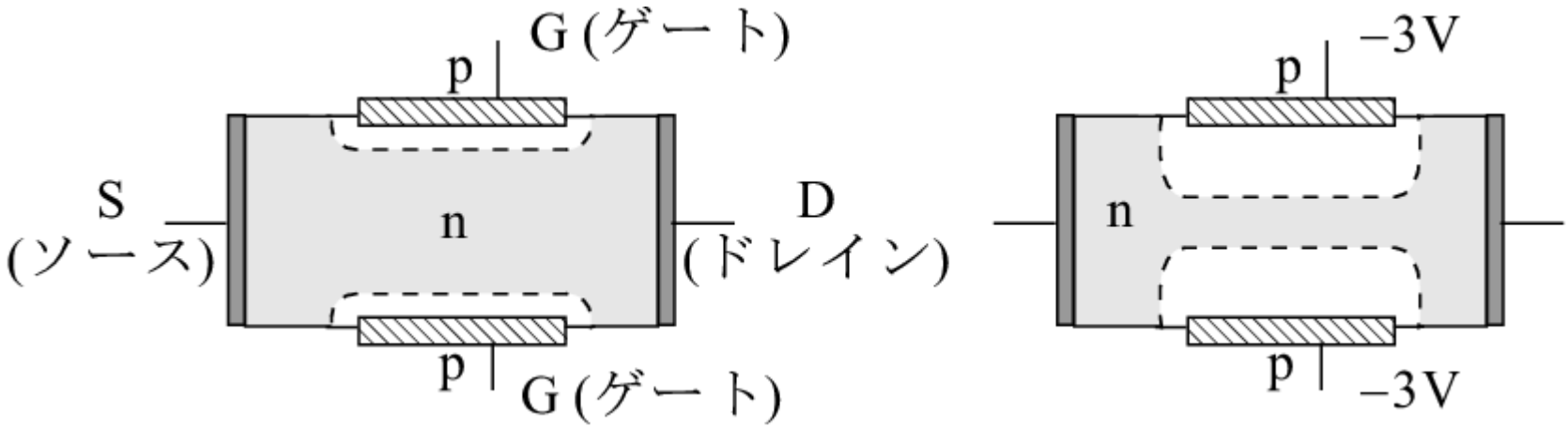


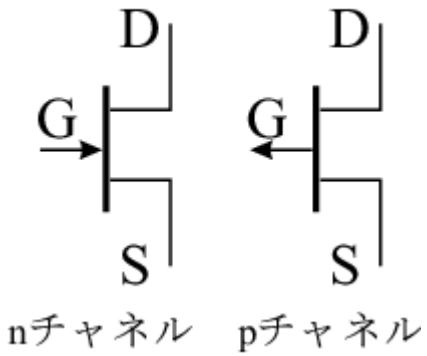


3.5 電場効果トランジスタ

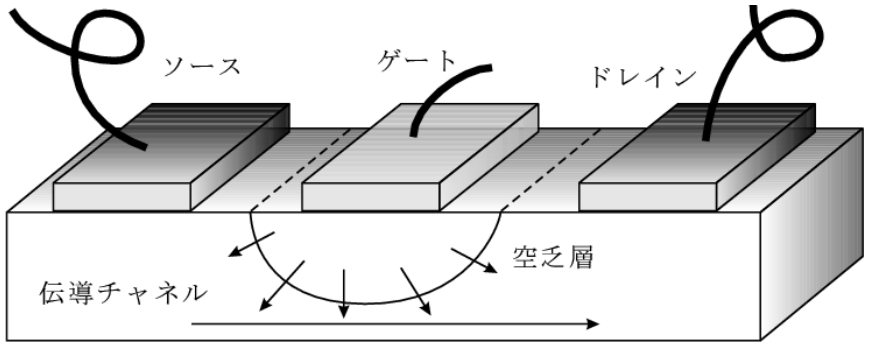
(field effect transistor, FET)

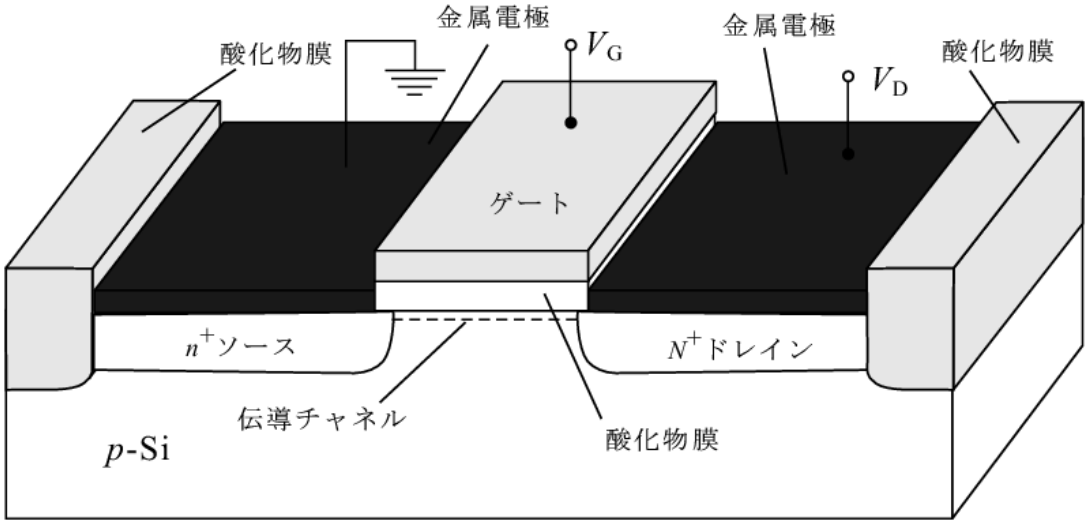
Junction FET (JFET)



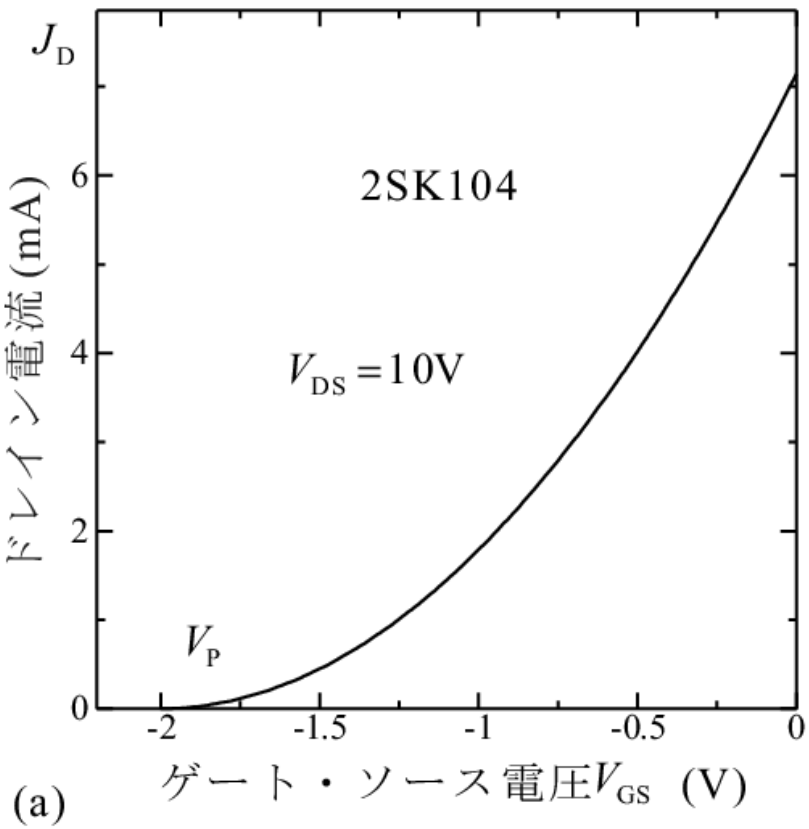


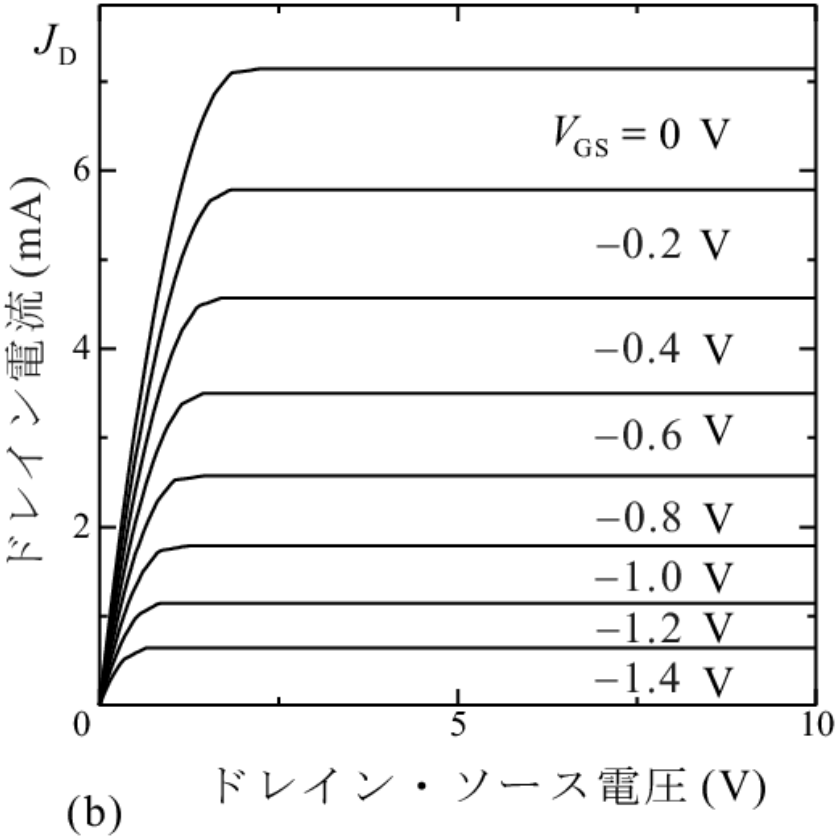
MESFET, MOSFET



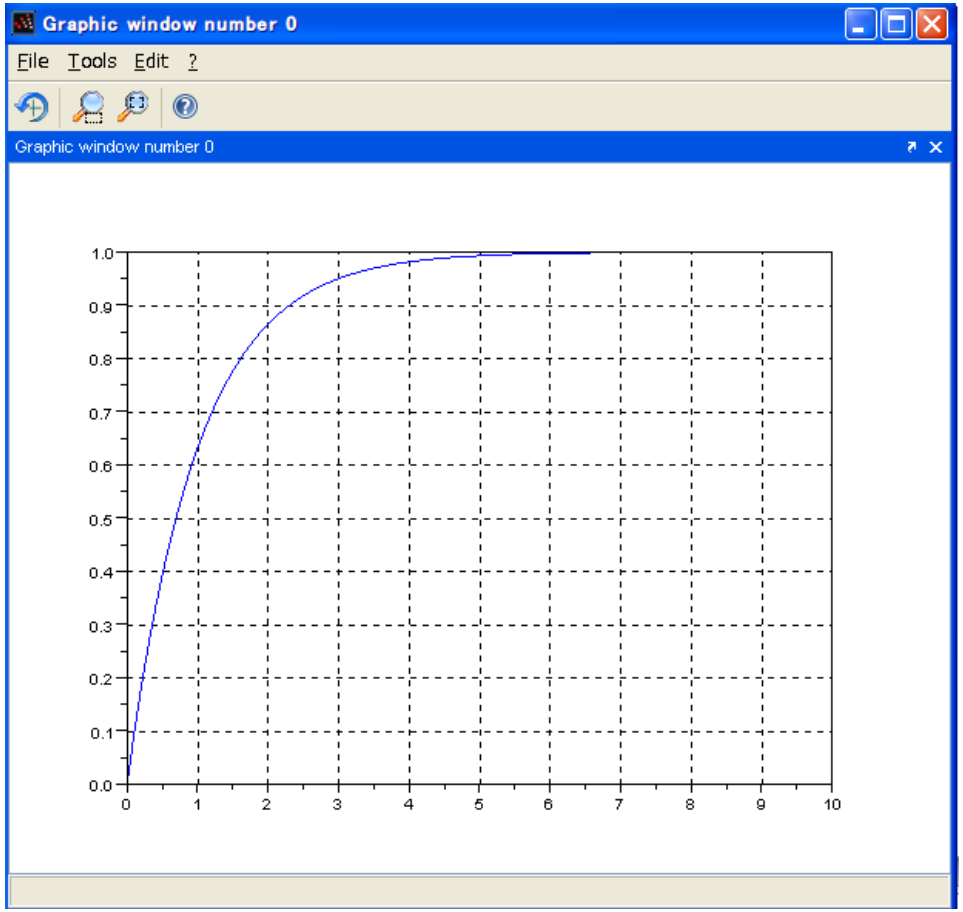


JFET静特性


J_D
2SK104
V_{DS} =10V
V_P
ドレイン電流 (mA)
0
2
4
6
-2
-1.5
-1
-0.5
0
ゲート・ソース電圧V_{GS} (V)
(a)

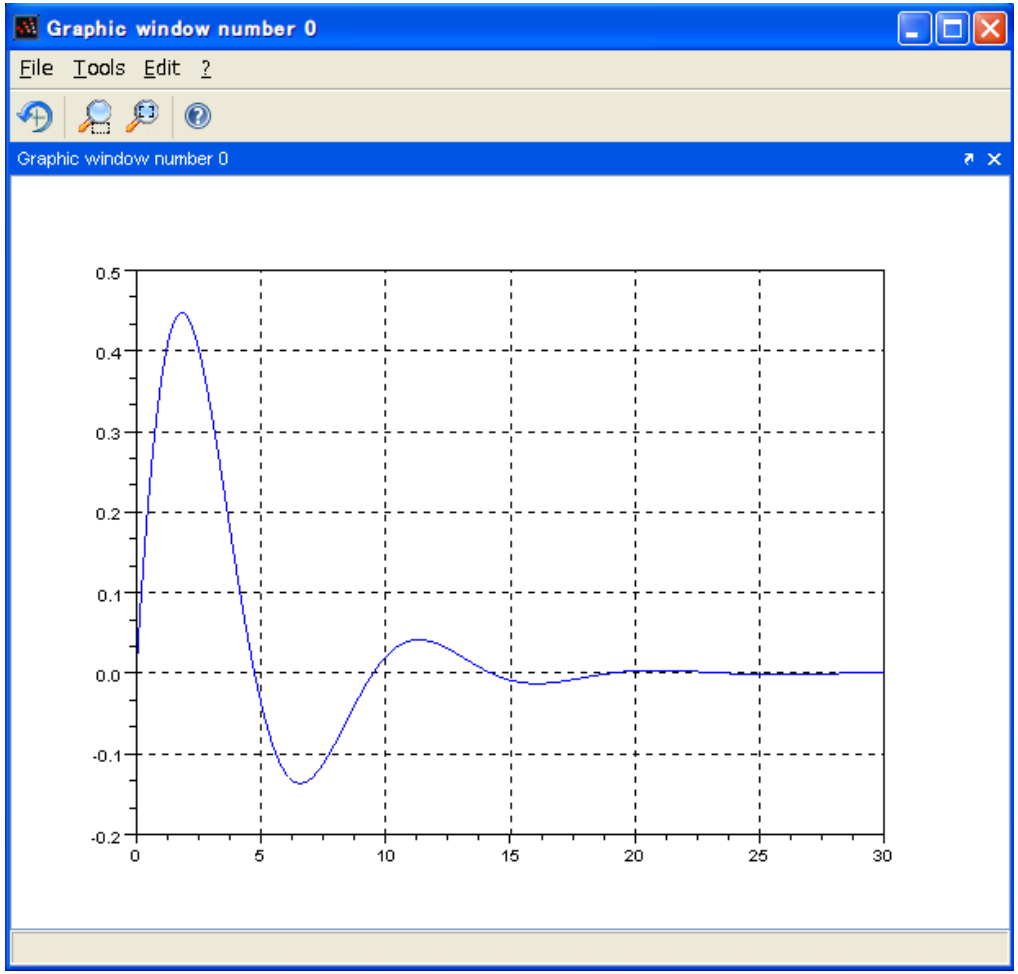

J_D
V_{GS} = 0 V
−0.2 V
−0.4 V
−0.6 V
−0.8 V
−1.0 V
−1.2 V
−1.4 V
ドレイン電流 (mA)
0
2
4
6
0
5
10
ドレイン・ソース電圧 (V)
(b)

過渡応答




```
-->s=poly(0,'s');

-->G=1/(1+s);

-->sys=syslin('c',G);

-->t=linspace(0,10,100);

-->y=csim('step',t,sys);

-->plot(t,y)

-->xgrid()
```

過渡応答2




```
-->G=s/(1+s+2*s*s);

-->sys=syslin('c',G);

-->y=csim('step',t,sys);

-->plot(t,y)
```