Electronic circuit

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電子回路論11

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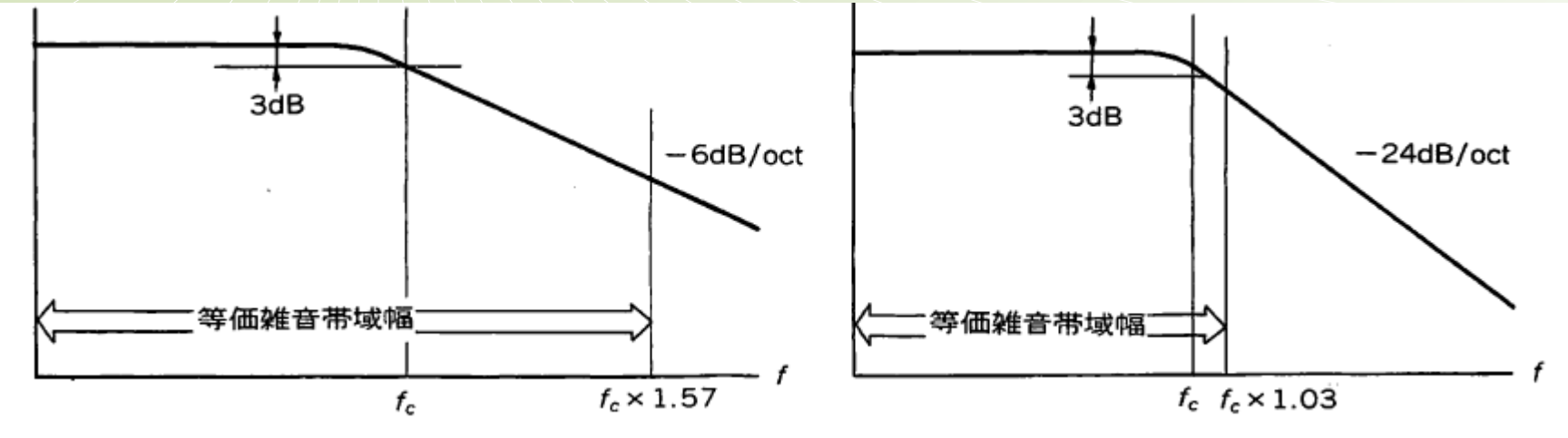
増幅回路と雑音

等価雑音帯域幅 (equivalent noise band width)



減衰傾度	k
-6 db/oct	1.57
-12 db/oct	1.11
-18 db/oct	1.05
-24 db/oct	1.03

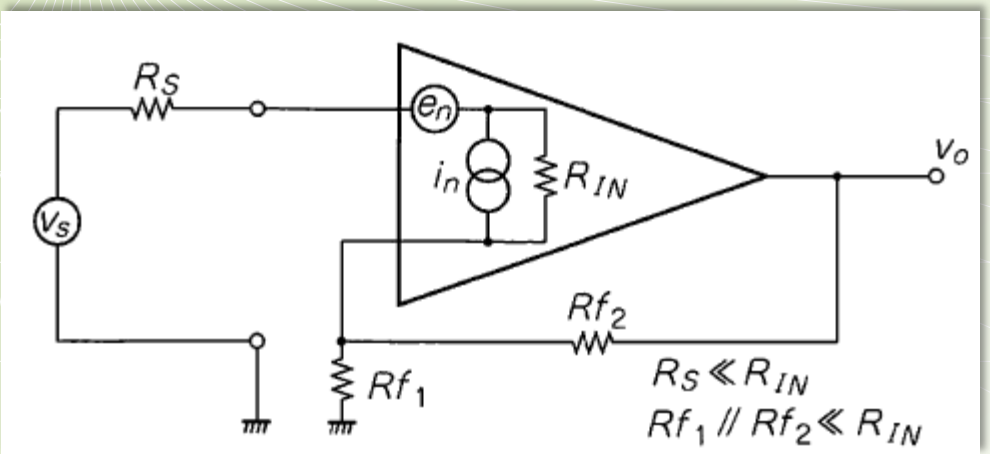
gain band width GBW

$=A$ (open loop gain)$\times f_c$

OP ampの規格表などに出ているもの

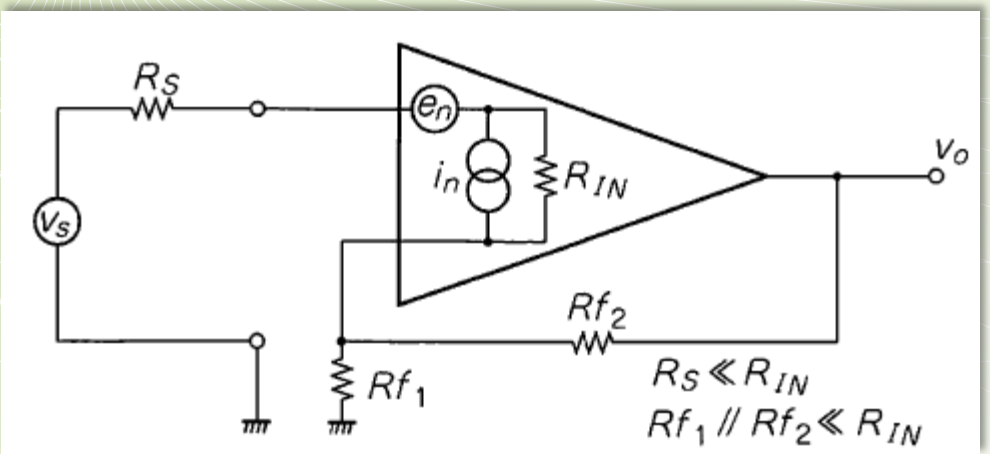
f_cは，帰還回路により変化する．

非反転増幅回路と雑音



1. R_Sの熱雑音 $= \sqrt{4kTR_S}$
2. $Rf_1 \parallel Rf_2$で発生する熱雑音 $= \sqrt{4kT(Rf_1 \parallel Rf_2)}$
3. 入力換算雑音電圧 e_n, 入力換算雑音電流 i_n
4. 入力換算雑音電流と信号源抵抗による雑音 $= i_n \times R_S$
5. 入力換算雑音電流と帰還抵抗による雑音 $= i_n \times (Rf_1 \parallel Rf_2)$

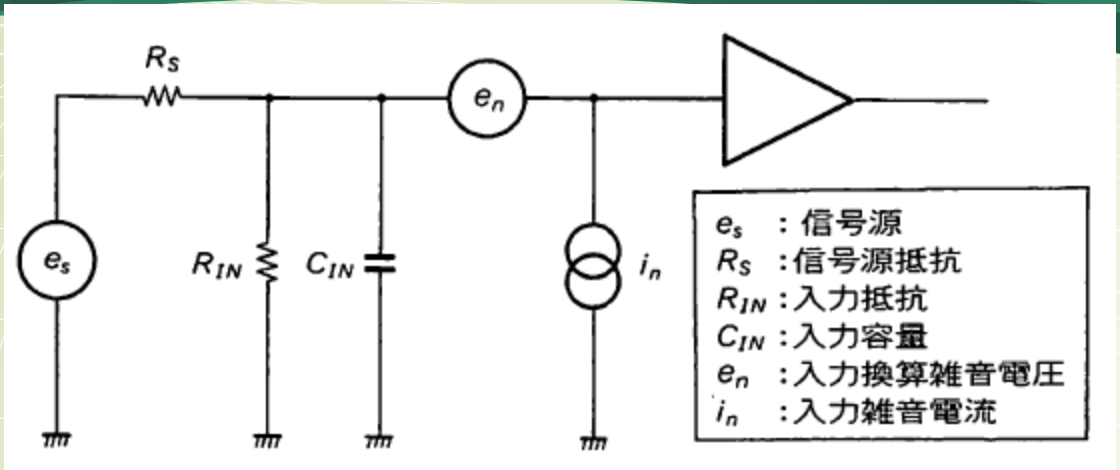
非反転増幅回路と雑音



(出力雑音)

$$= \sqrt{{e_1}^2 + {e_2}^2 + {e_3}^2 + {e_4}^2 + {e_5}^2} \times G \times \sqrt{\text{等価雑音帯域幅}}$$

NF マッピング



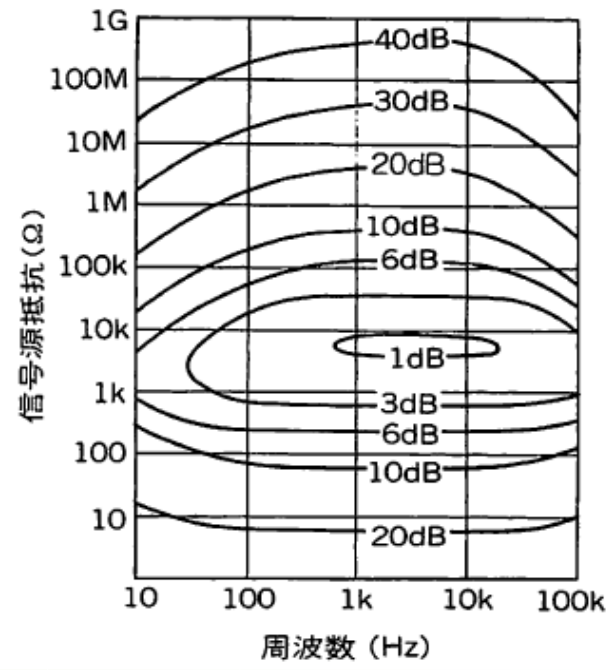
$$\text{ノイズ・フィギュア(dB)} = 20\log\left(\frac{\sqrt{R_S /\!/ R_{IN}\text{の熱雑音}^2 + e_n{}^2 + (i_n \cdot R_{ZIN})^2}}{R_S\text{の熱雑音} \cdot T_f}\right)$$

$$R_S\text{の熱雑音} = \sqrt{4\,kTR_S}$$

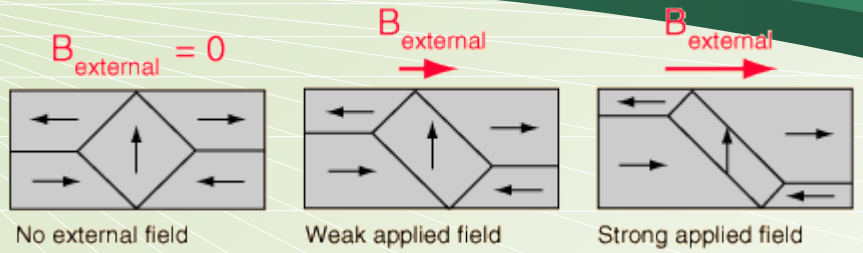
$$R_S /\!/ R_{IN}\text{の熱雑音} = \sqrt{4\,kT\,\frac{R_S \cdot R_{IN}}{R_S + R_{IN}}}$$

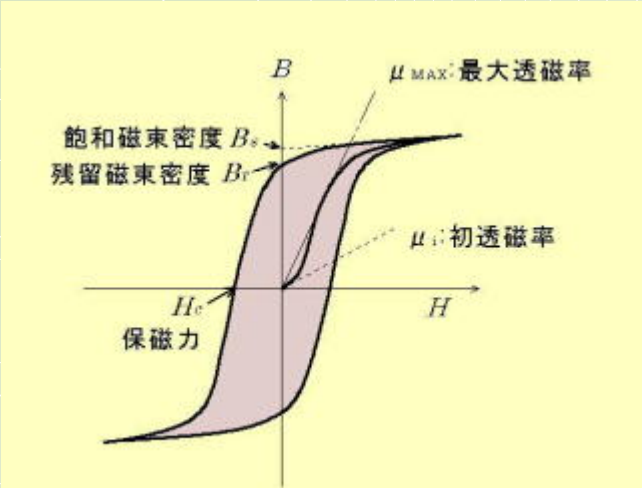
$$\text{信号源に対する入力伝達関数 } T_f = \frac{R_{IN}}{R_S + R_{IN}} \cdot \frac{1}{\sqrt{1 + \left(2\,\pi f \cdot C_{IN} \cdot \frac{R_S \cdot R_{IN}}{R_S + R_{IN}}\right)^2}}$$

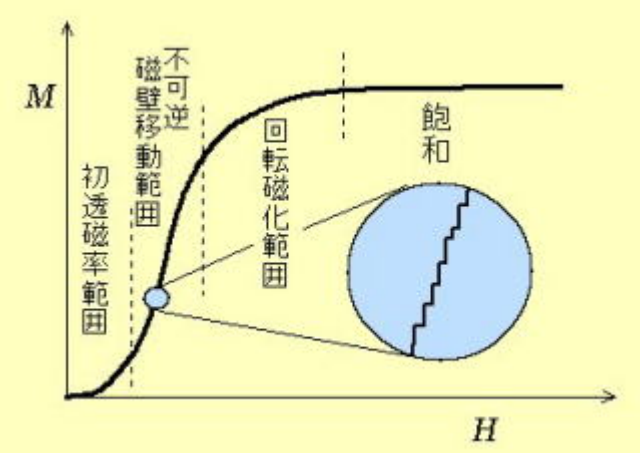
$$\text{増幅器から見た入力部インピーダンス}(R_{ZIN})\text{の実部} = \frac{\frac{R_S \cdot R_{IN}}{R_S + R_{IN}}}{1 + \left(2\,\pi f \cdot C_{IN} \cdot \frac{R_S \cdot R_{IN}}{R_S + R_{IN}}\right)^2}$$

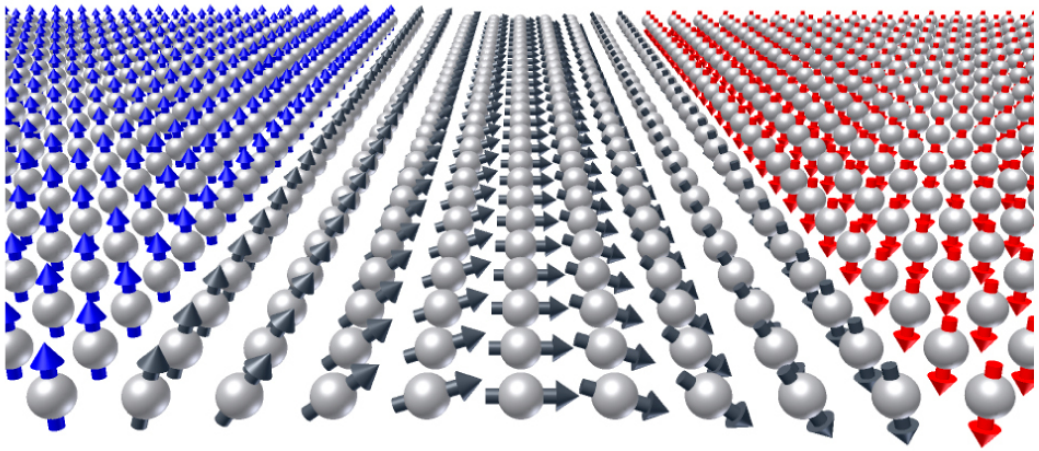


その他の雑音:バルクハウゼン雑音

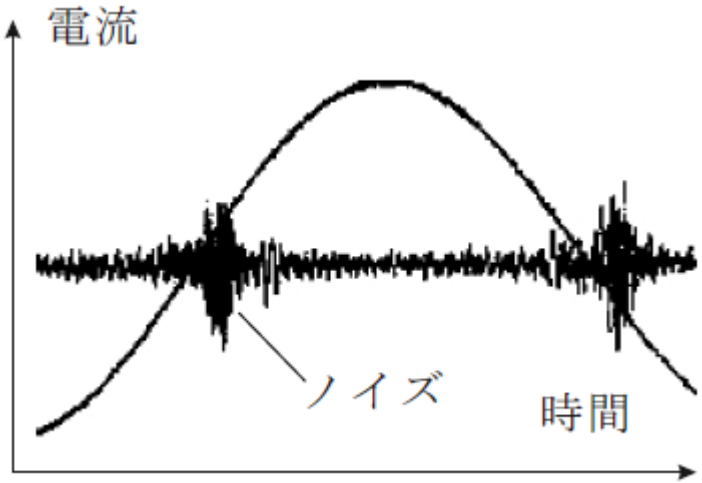






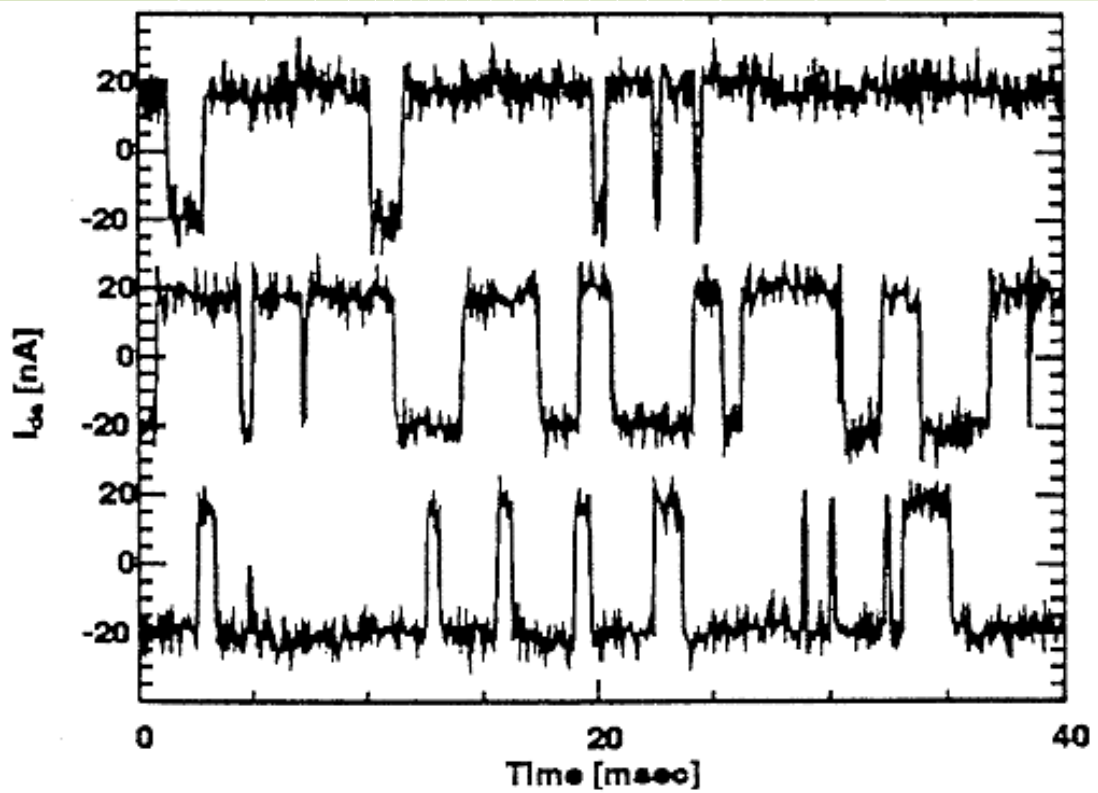


Domain 1 Domain wall Domain 2

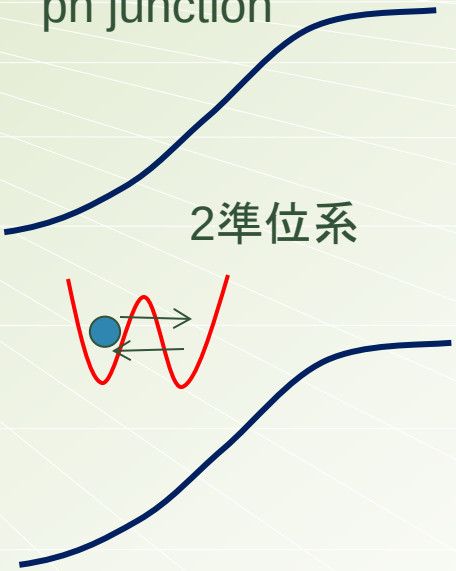


ポップコーン雑音

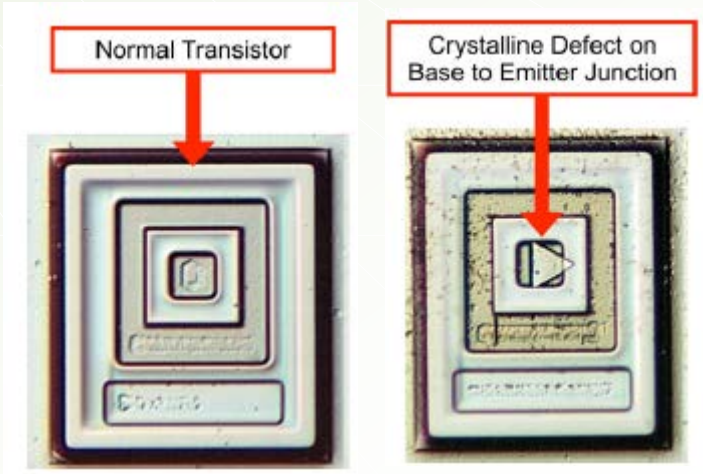
Popcorn noise, Burst noise



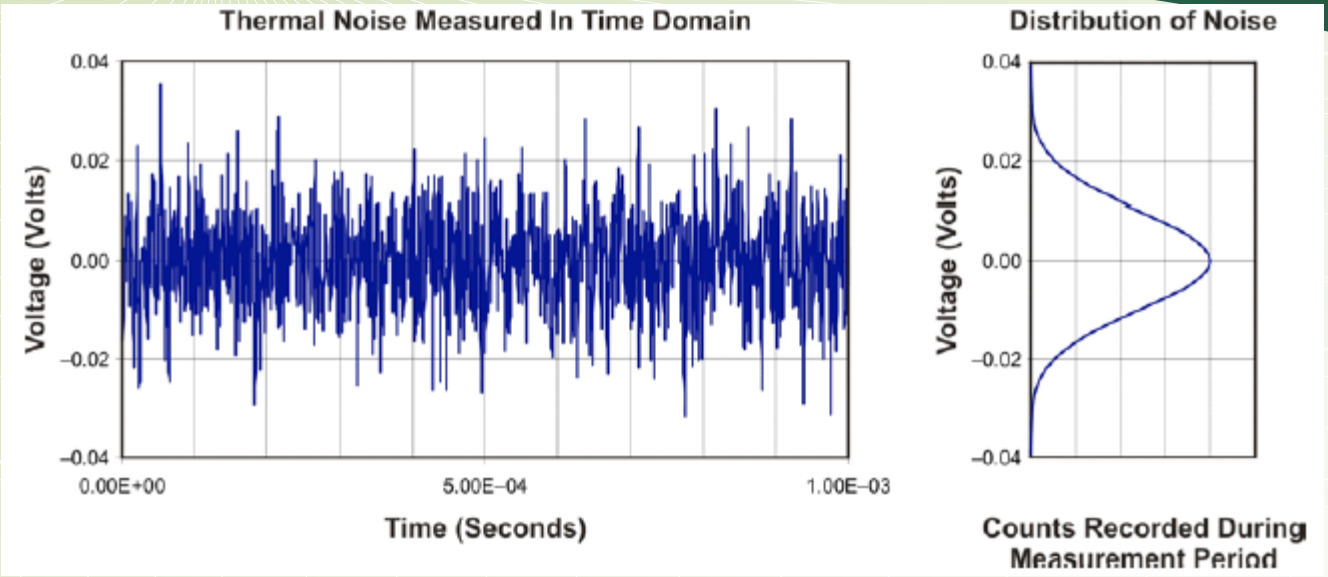
pn junction

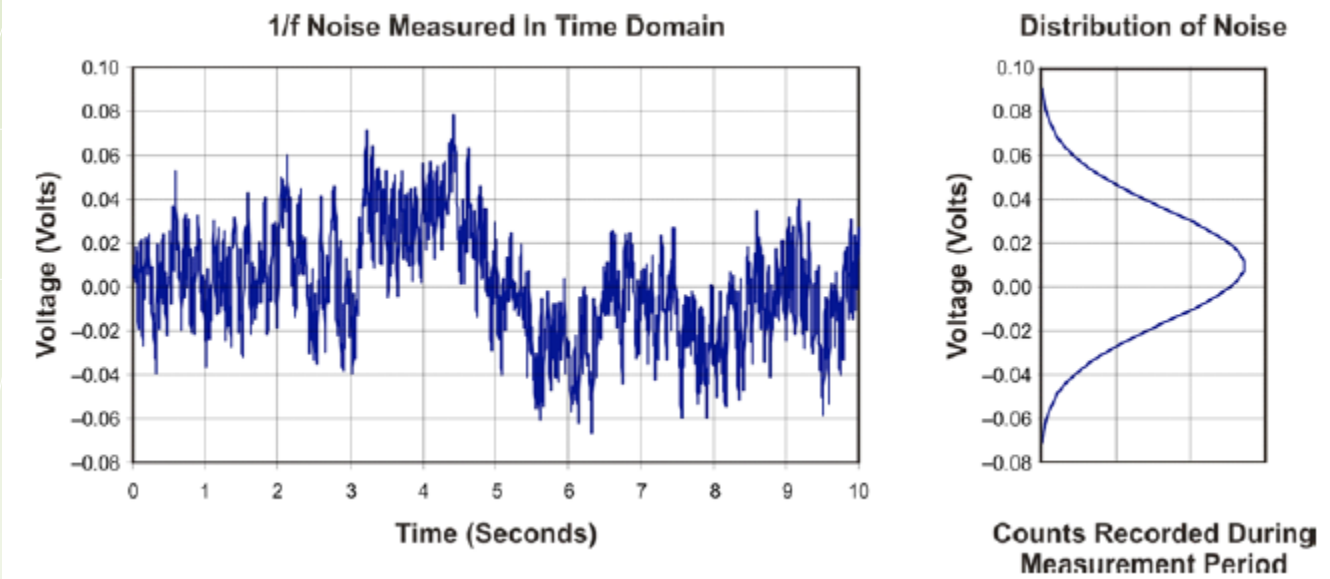


2準位系

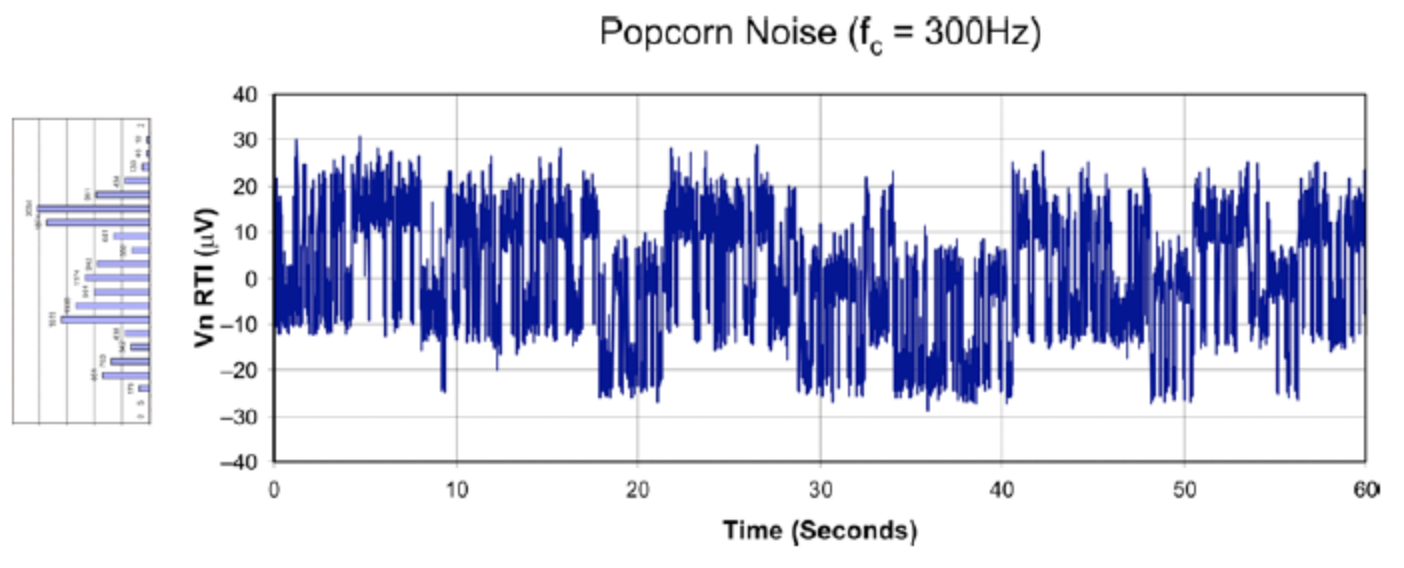


ランダム性雑音の振幅分布

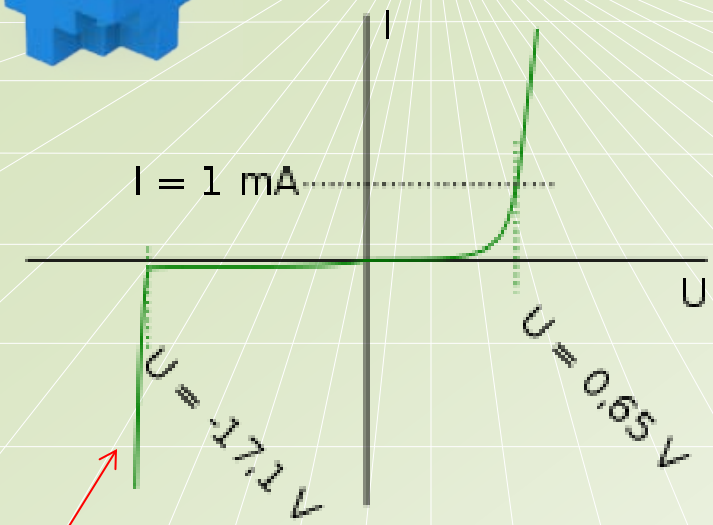




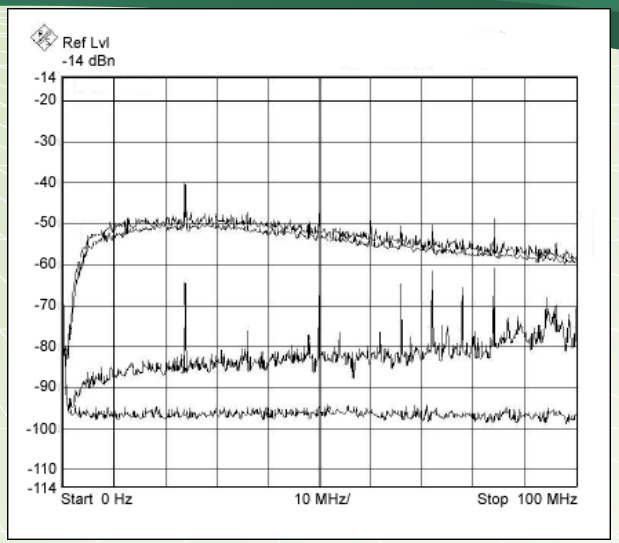
Popcorn noiseの振幅分布



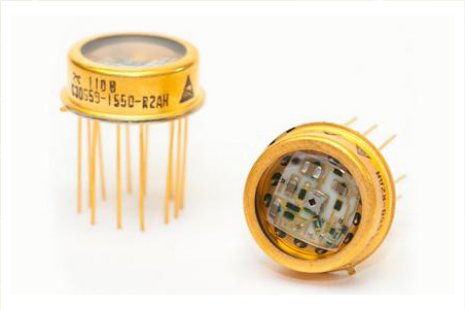
アバランシェ雑音



avalanche or Zener breakdown

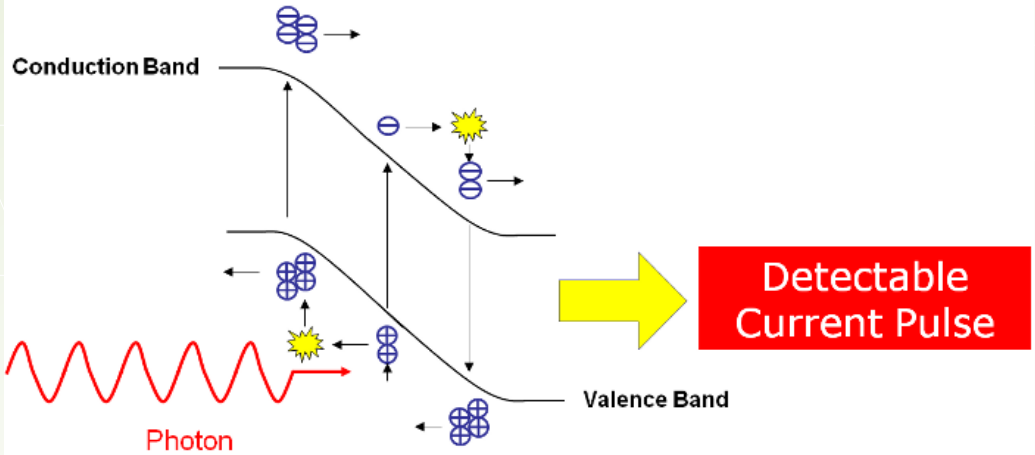


white noise



Avalanche Photo-Diode (APD)

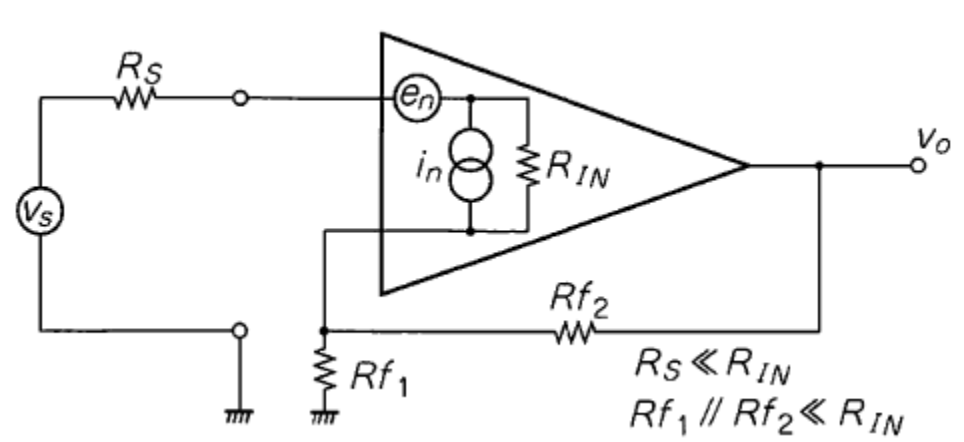
Zener voltage standard diode



練習問題 5-1

OP アンプ AD797 の特性は次のようになっている

パラメタ		単位
A	146	dB
GBW	110	MHz
e_n (1kHz)	0.9	nV/√Hz
i_n (1kHz)	2	pA/√Hz



上のような非反転増幅回路で，R_S= 100 Ω，R_{f1}=50 Ω，R_{f1}=49.95 kΩ，高周波の減衰傾度を– 6 dB/octとした時の，300Kでの出力雑音電圧を求めなさい．

ヒント：アンプの電圧ゲインは1000, これとAとGBWからf_cが求まる(1000倍に落としたことによるf_c の増加に注意)．–6 dB/octの場合の雑音帯域幅はこれに1.57をかける．