

## Biopotential Amplifier (3/20/2006 Speaker:孫士育 )

### Design Requirement:

1. Large Rin, Small Rout  
Amp 設計基本，並能 drive the next stage.
- 2.要考慮 Frequency Response.  
相當重要，必須視不同生理信號之特性作調整
- 3.Gain 要夠大，voltage level of bio-signal usually small.
- 4.保護電路，Not only for human body, but also the circuit itself.
- 5.Differential Amplifier and high CMRR (Ad/Acm).
- 6.Calibration.

### In the Block diagram of ECG

Preamplifier – Need Baseline restoration

Isolation – Power supply isolated, esp. other instruments in the hospital

Usually circuits connected to GND need isolation.

To Driver Amp

### Problems

#### **Frequency Distortion**

**Saturation / cutoff distortion** due to circuit design restriction

**Ground loop** ( two site with different potential as GND, and this may cause electricity flow or low-frequency noise in the system. Need Isolation to prevent damaging the system)

**Artifact – large electric transient**, (causes: Defibrillation, electrodes' motion, accumulated static electric charge. )

**Interference** (From Power system, or Magnetic induction, EM and EMG, See the voltage and freq. range for common biopotential, 0.1~100Hz, milli-volt to  $10^{-5}$  range observable.)

Derivation of Interference form electric power systems:

In the Model, consider all the path from Power supply to ECG equipment, both two hands have coupled capacitance. → 120uV potential difference between right and left hand.

Then Consider the effect from head, (其他部位 common) → cause 40uV

Reduce Magnetic induction: 除了 shielding, 盡可能遠離干擾磁場之外, very interesting way to reduce the effective area of single turn coil.

Amp for various biopotential signal, remember that different spectram and amplitude

constraints in different type of signal.

另對 EMG amplifier Design 來說，其量測信號之振幅受使用 electrode 和 Spectrum 特性，必要考慮高頻帶產生雜訊如 EMG 信號。

通常量 intracellular 要求 BW 要寬以配合不同細胞生理活動，因膜電位已經有 50~100Mv 之振幅，Gain 較不須要求太高；but Geometry cause a large shunting capacitance → Compensation: Use positive feedback to introduce a negative capacitance.

(Derivation result  $C_{eq} = (1-A_v)C_f$ , some problems such as frequency-dependent gain, noise, and instability of positive feedback.)

EEG 的信號較弱，約  $10^{-4}$  等級，需要 high gain, high CMRR 及 Low noise amp. 另使用 electrode smaller and higher input impedance.