

ISOLATION

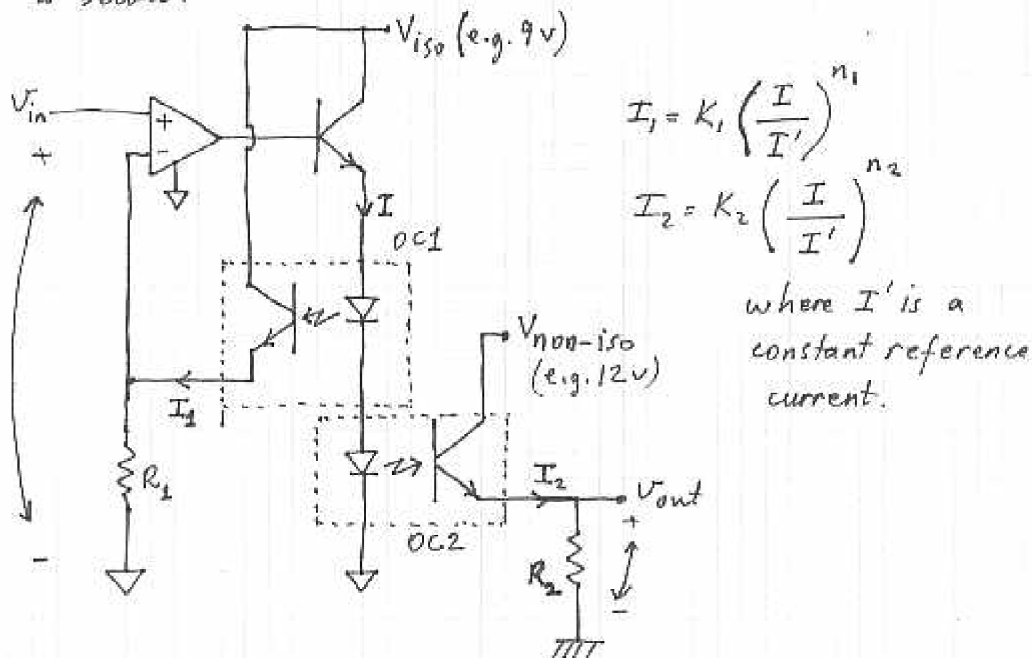
In order to protect the patient from dangerous current flow, biopotential amplifiers must be isolated from earth. Isolation must be achieved for both power and signals. Isolation, as we have seen before, also helps reduce 50Hz common mode interference.

Signal Isolation:

(i) Optical: Optocouplers or optical fibers can be used.

These components have non-linearities and therefore precautions for linearization must be taken.

Example for a low frequency linear optocoupler isolation is below:



$$I_1 = K_1 \left(\frac{I}{I'} \right)^{n_1}$$

$$I_2 = K_2 \left(\frac{I}{I'} \right)^{n_2}$$

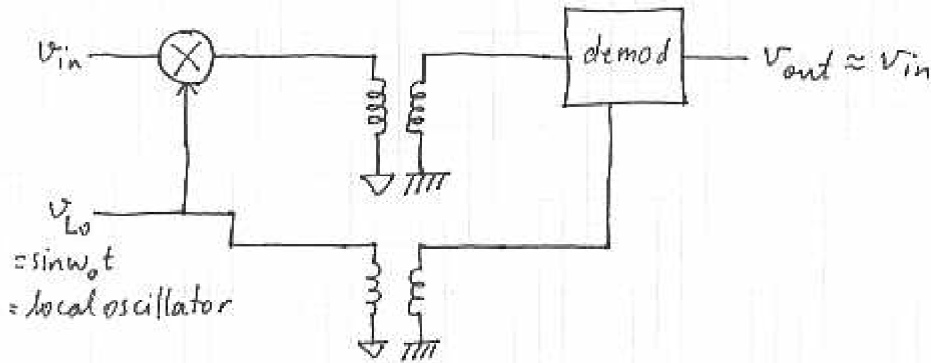
where I' is a constant reference current.

Because the optocouplers, OC1 and OC2, may not be matched, i.e. $K_1 \neq K_2$ and $n_1 \neq n_2$, the relation between V_{in} and V_{out} will not be linear. However if they are matched (or nearly matched) we will get a linear relation. Assume they are matched i.e. $K_1 = K_2$, $n_1 = n_2$. Then, $I_1 = I_2$, $I_1 = \frac{V_{in}}{R_1}$, $I_2 = \frac{V_{out}}{R_2}$ and $V_{out} = \frac{R_2}{R_1} V_{in}$.

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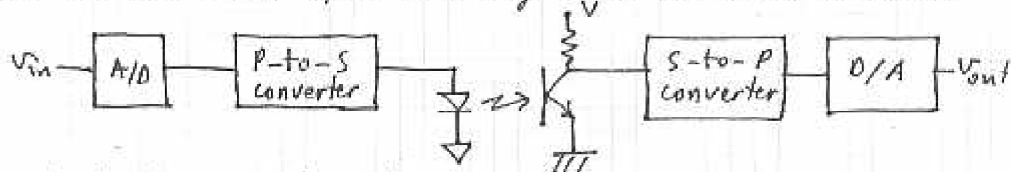
(ii) Magnetic Isolation:

This is achieved using transformers. Since most bioelectric signals have DC (or very low frequency) components, transformers must be used after shifting the signal from baseband to at least few KHz up.



Digitization before isolation:

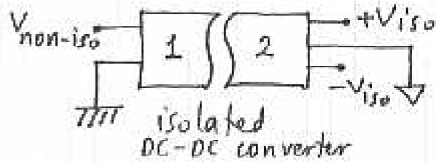
Because of the distortions due to non-ideal (and non-linear) analog isolators, one may digitize the signal beforehand using an A/D converter. After encoding a bit stream is obtained.



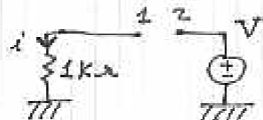
Instead of an optocoupler, a pulse transformer can also be used.

Power Isolation:

Power isolation is usually magnetic (using transformers) if of course a battery does not simply meet the power requirement. Isolated DC-DC converters are readily available (for < 50 \$).



Testing of an isolated DC-DC converter!



V is either a large DC voltage (5000v) or 220v (50Hz). 1 and 2 are any conductive parts on the non-iso and iso sections of the converter.

For V = 220v (50Hz) i must be less than 100 uA
 For V = 5000v (DC), breakdown must not occur.