Analog Electronics

Unit 3

Unit 3. Static features of analog processing systems

Table of contents

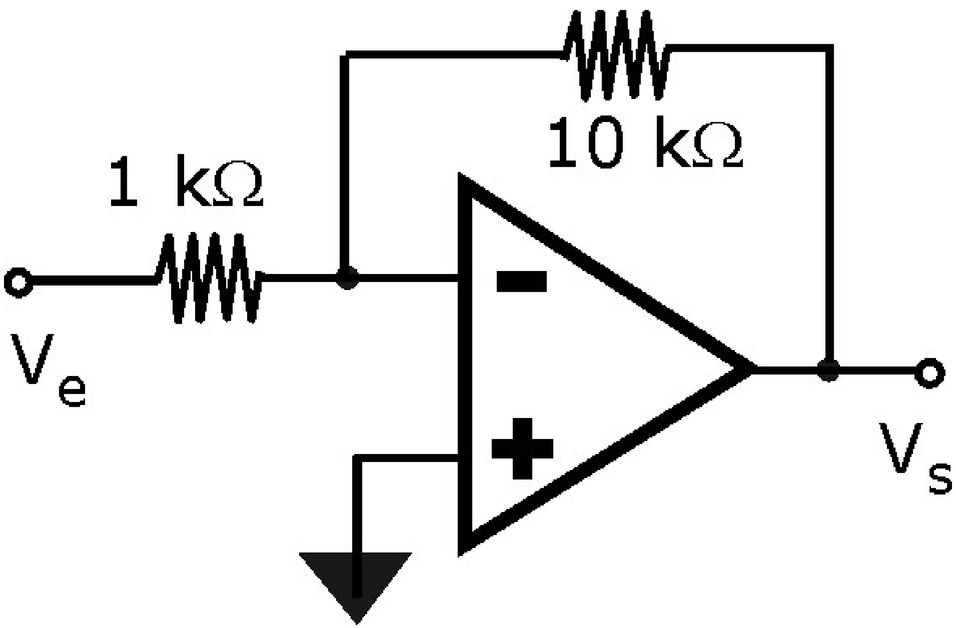
3.1 Introduction. Output Input ratio

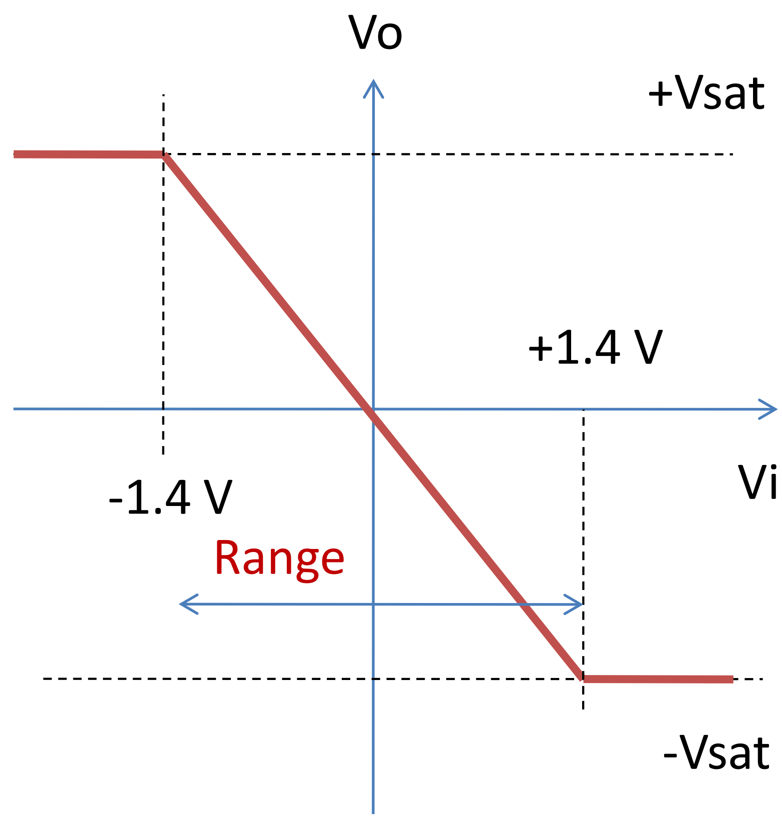
Every analog processing system can be described by a MATHEMATICAL MODEL (linear or non-linear).

- Amplification: $u_o(t) = K \cdot u_i(t)$ with $|K|>1$
- Atenuation: $u_o(t) = K \cdot u_i(t)$ with $|K|<1$
- Level shift: $u_o(t) = u_i(t) + D$

3.2 Transfer function

Input range and saturation





Vsat = Vcc – (1 ó 2 V)

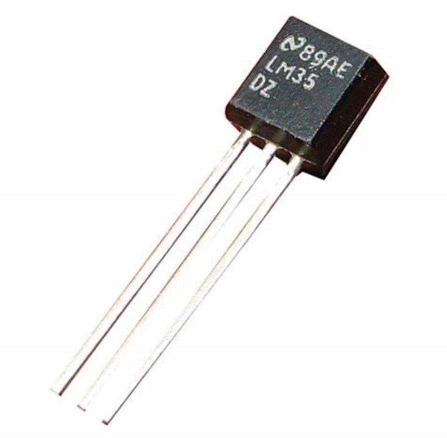
Vcc = 15 V → Vsat = 14 V

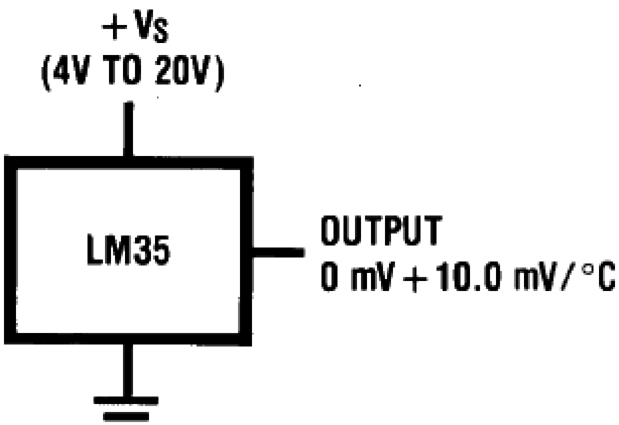
Saturation = ± 14 V

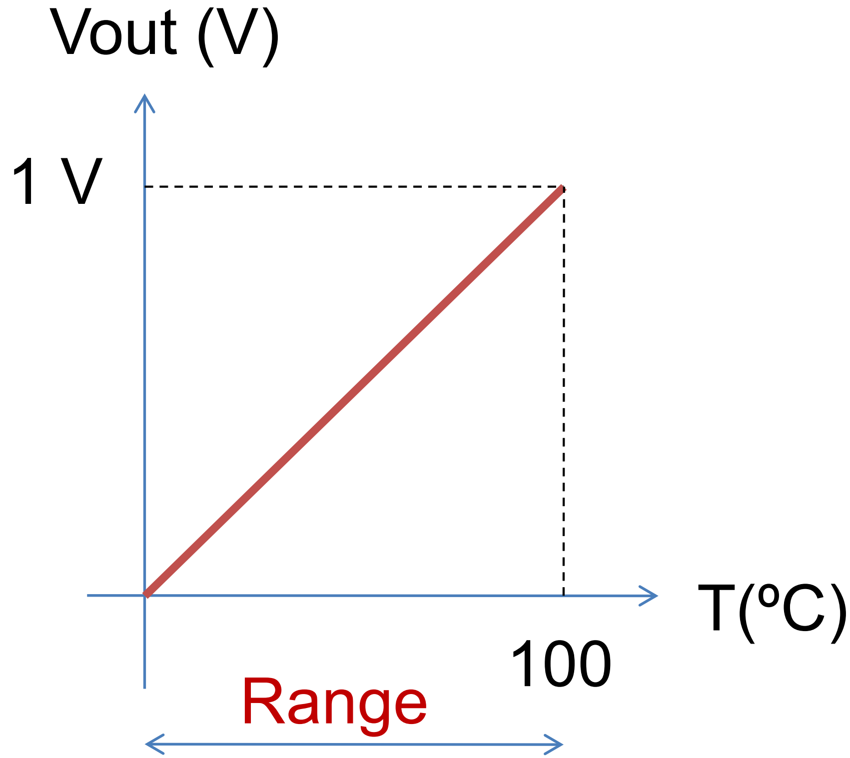
Input range = 1.4 – (-1.4) = 2.8 V

Transfer function also for sensors

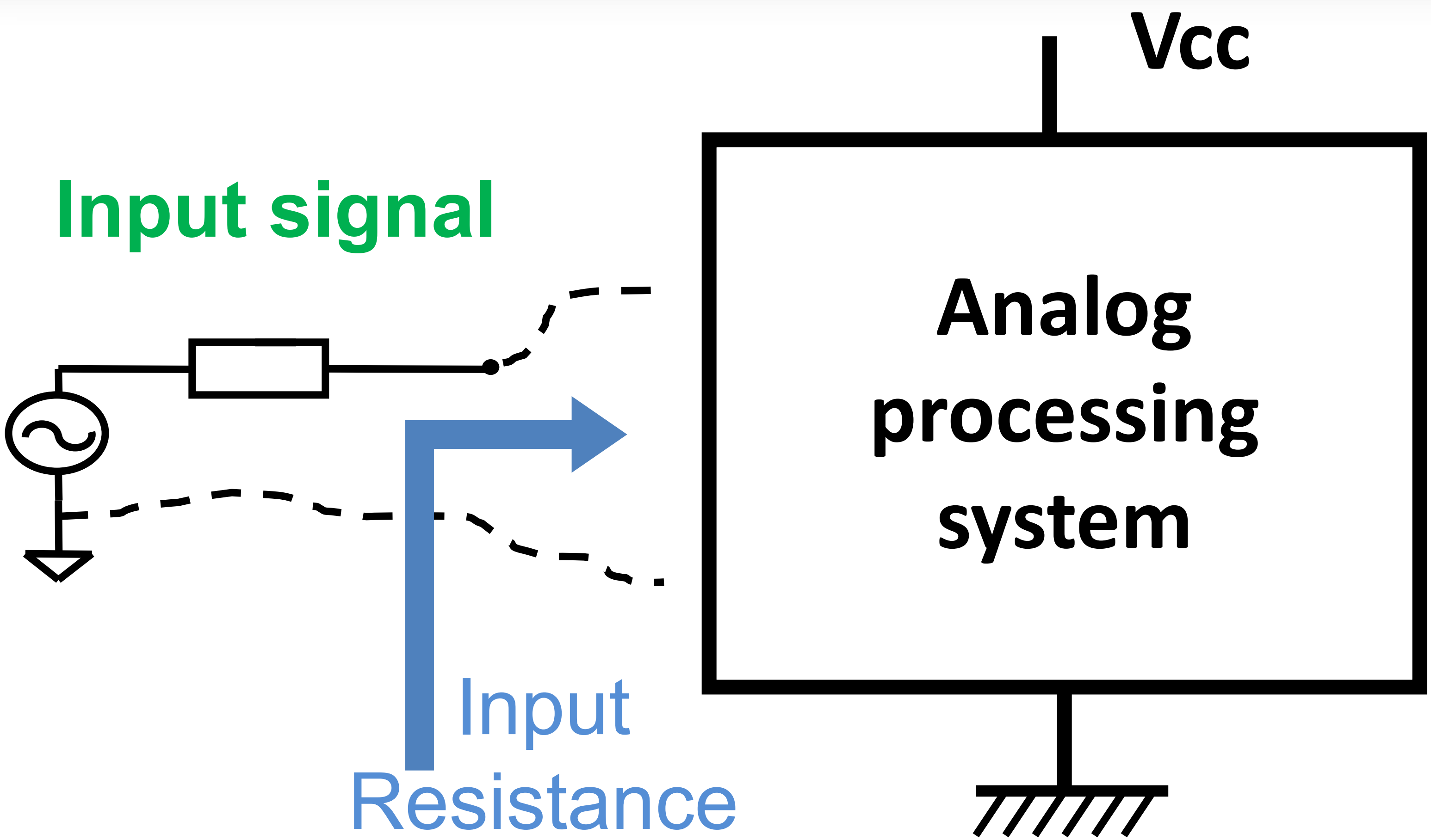
Ej: LM35







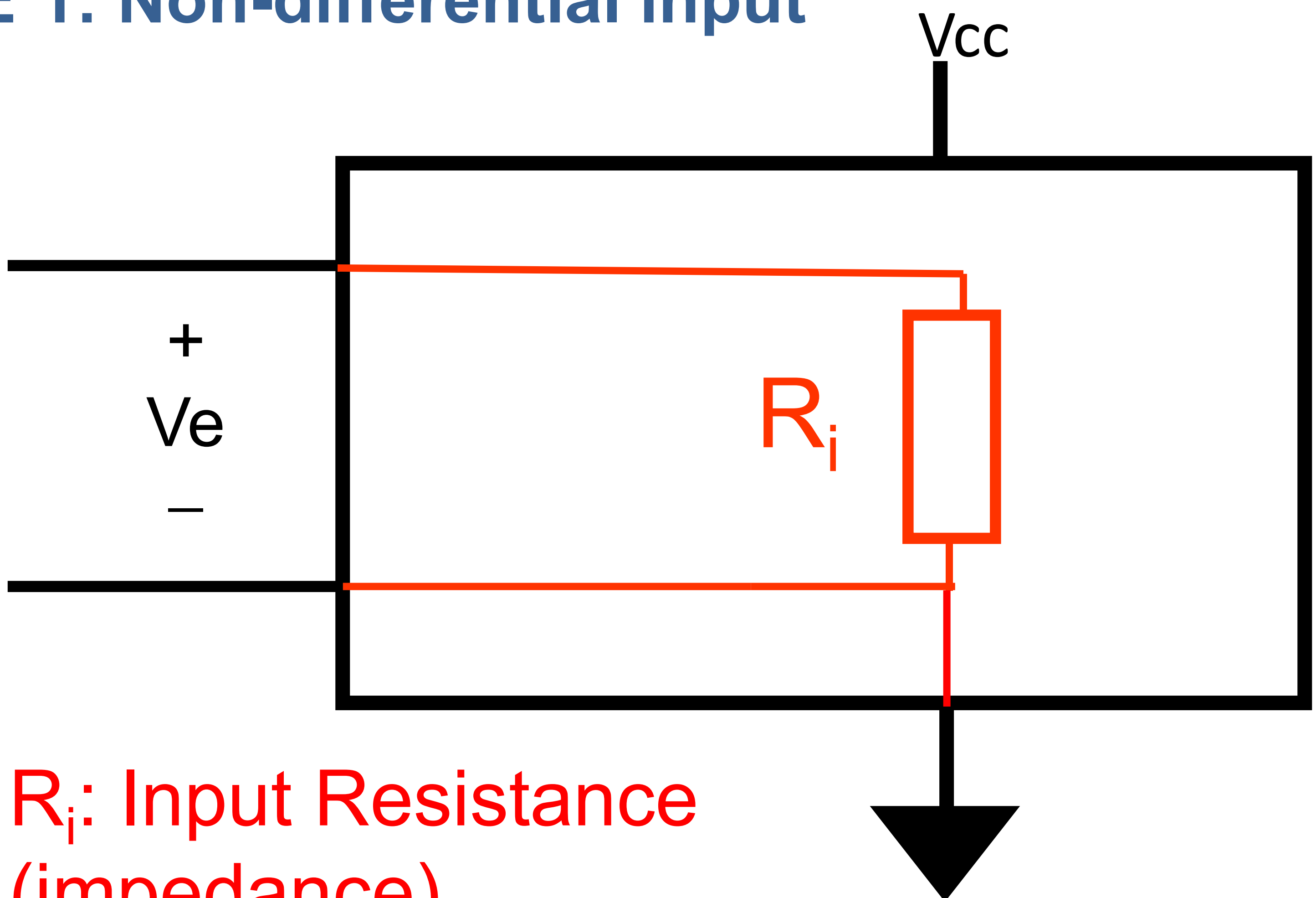
3.3 Differential and non-differential input



Symetric power supply: intermediate potential point.
Non-symetrical power supply: lower potential point.

3.3 Differential and non-differential input

CASE 1: Non-differential input

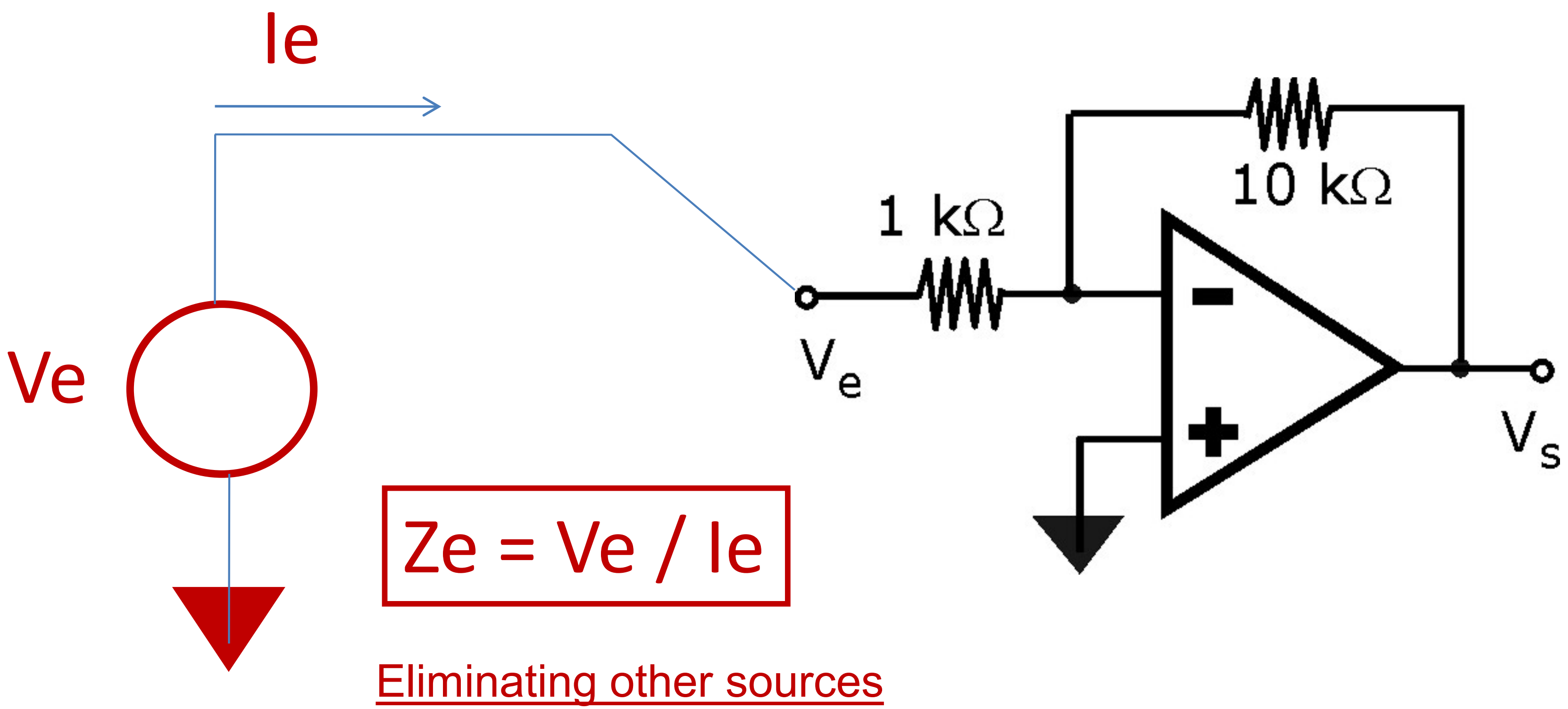


R_i: Input Resistance (impedance)

3.3 Differential and non-differential input

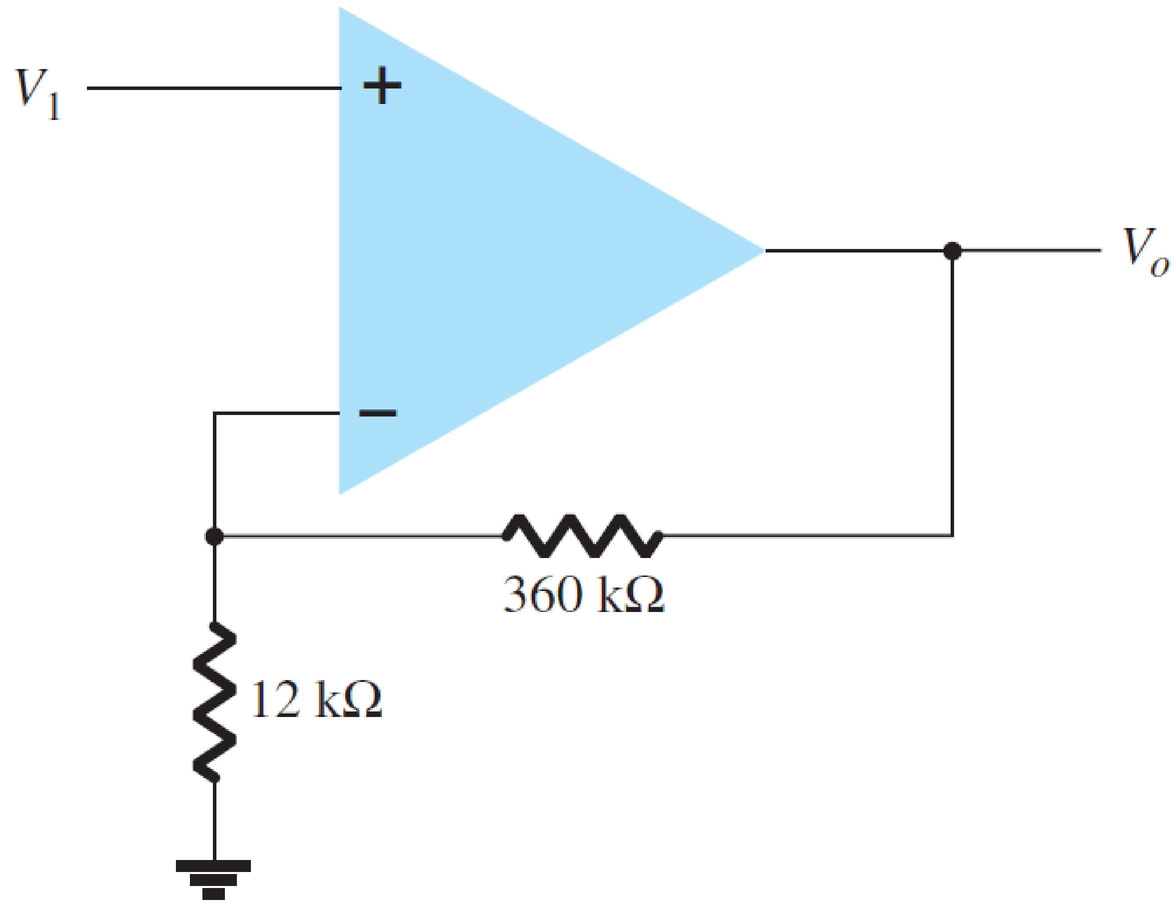
Non Differential Impedance

Analitical calculation of the input impedance



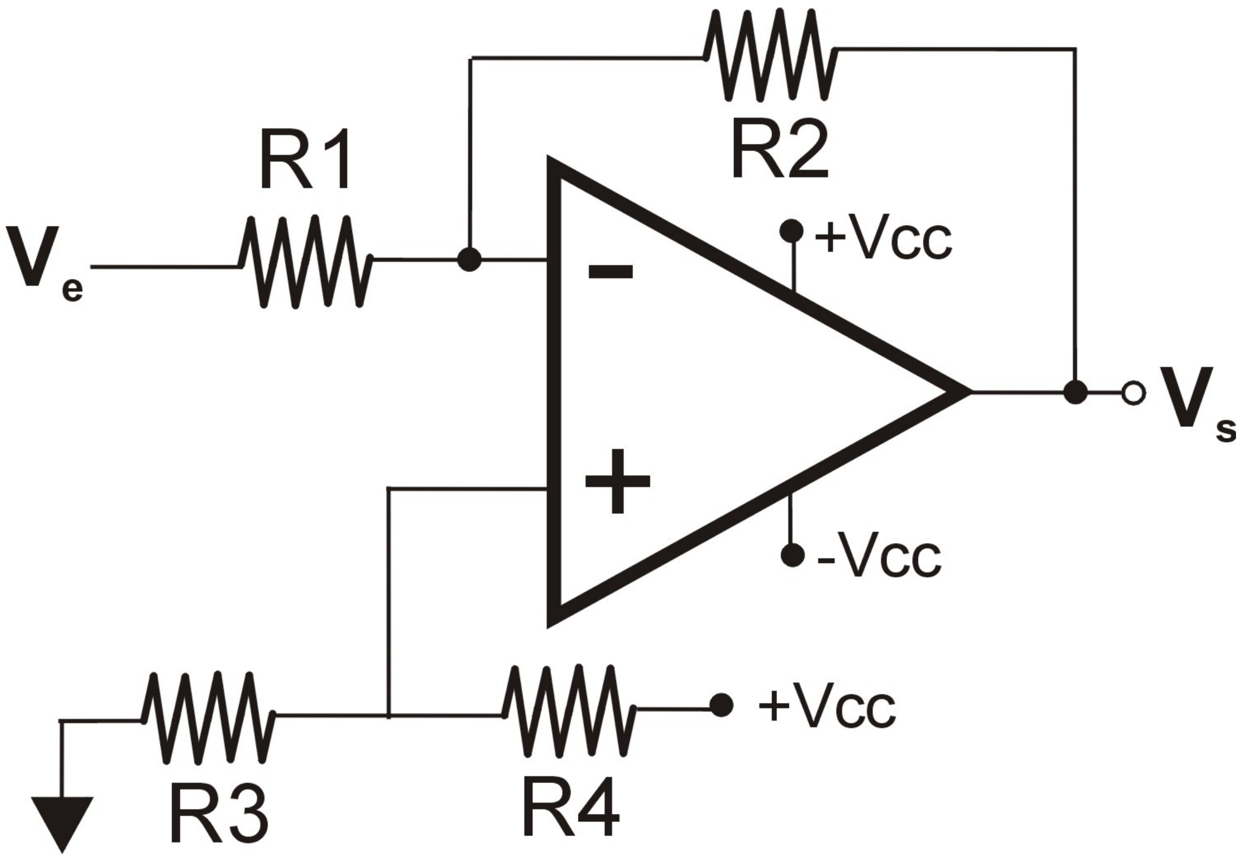
3.3 Differential and non-differential input

Calculate analytically the input impedance of the circuit



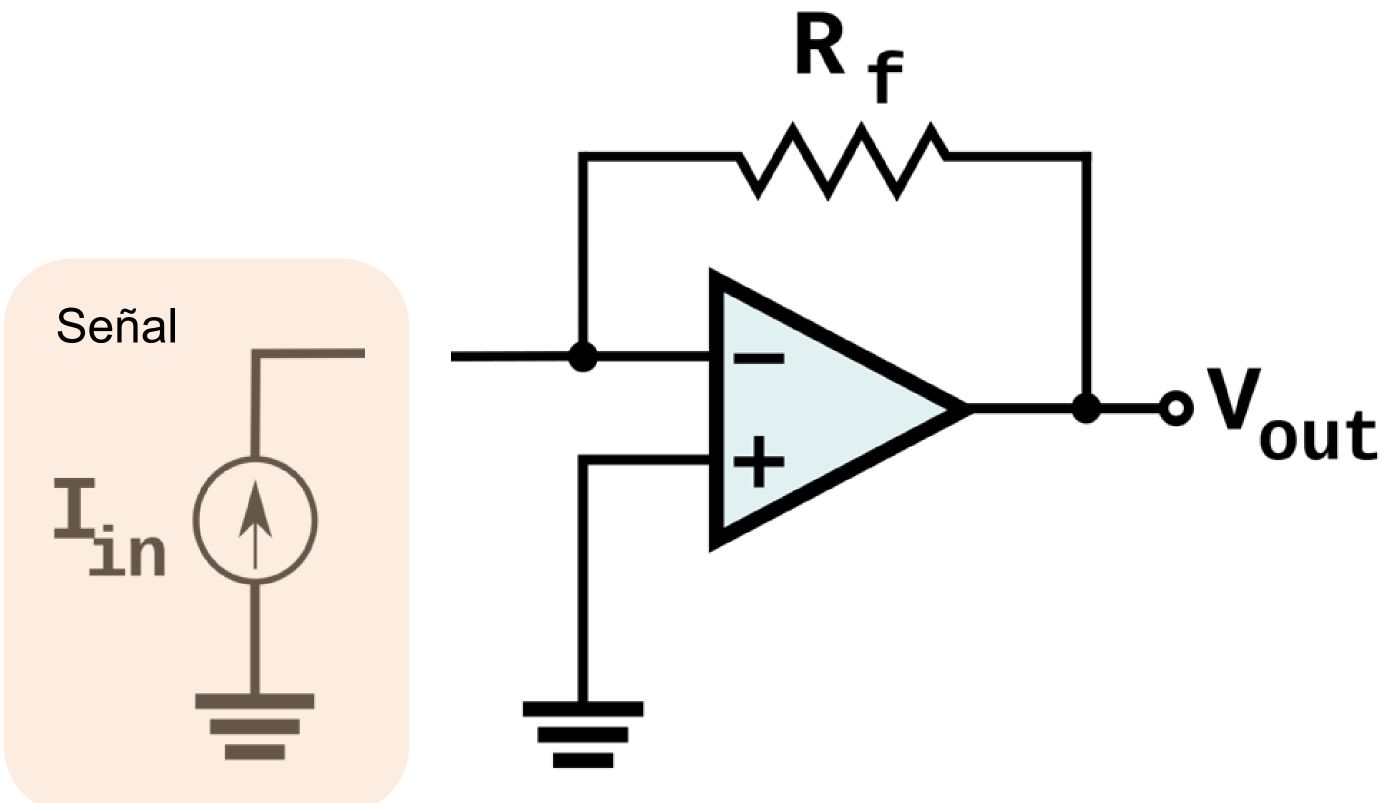
3.3 Differential and non-differential input

Calculate analytically the input impedance of the circuit (R1=1 kΩ, R2=10 kΩ, R3=2.2 kΩ, R4=2.2 kΩ)



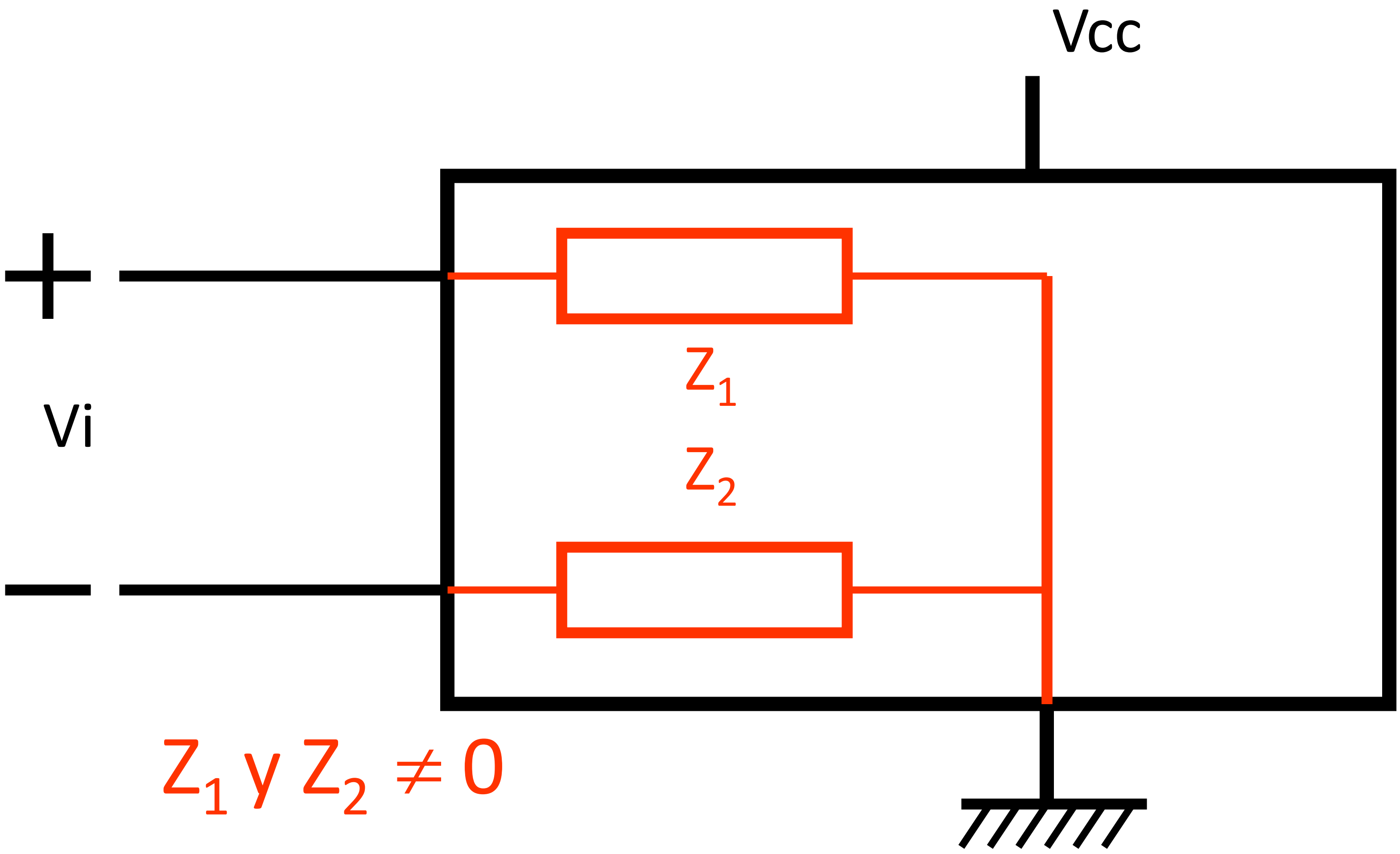
3.3 Differential and non-differential input

Determine the input topology and calculate the input impedance of the circuit (converter I → V)
Rf=1 MΩ



3.3 Differential and non-differential input

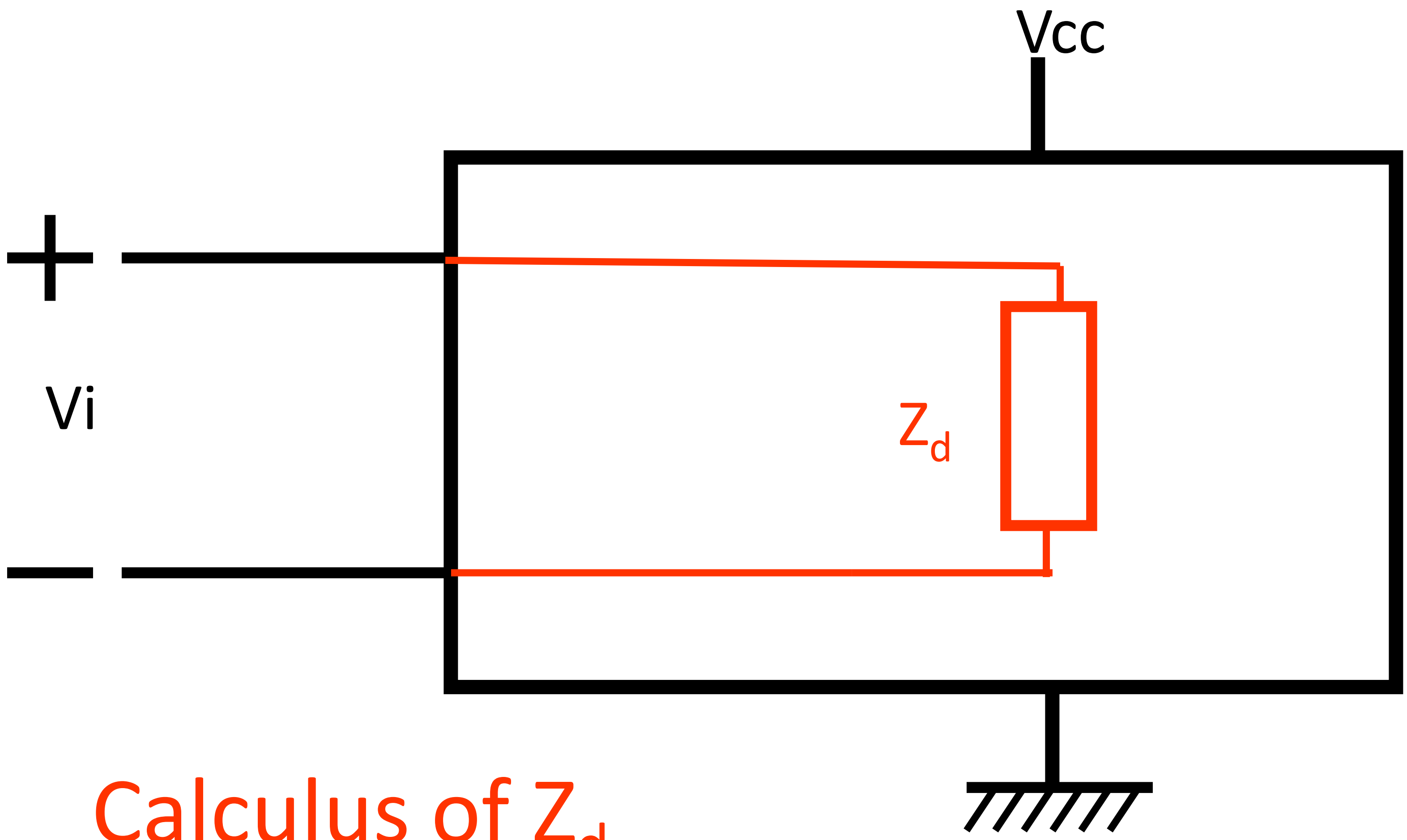
CASE 2: Input impedances. Differential



Z_1 y $Z_2 \neq 0$

3.3 Differential and non-differential input

CASE 2: Input impedances. Differential

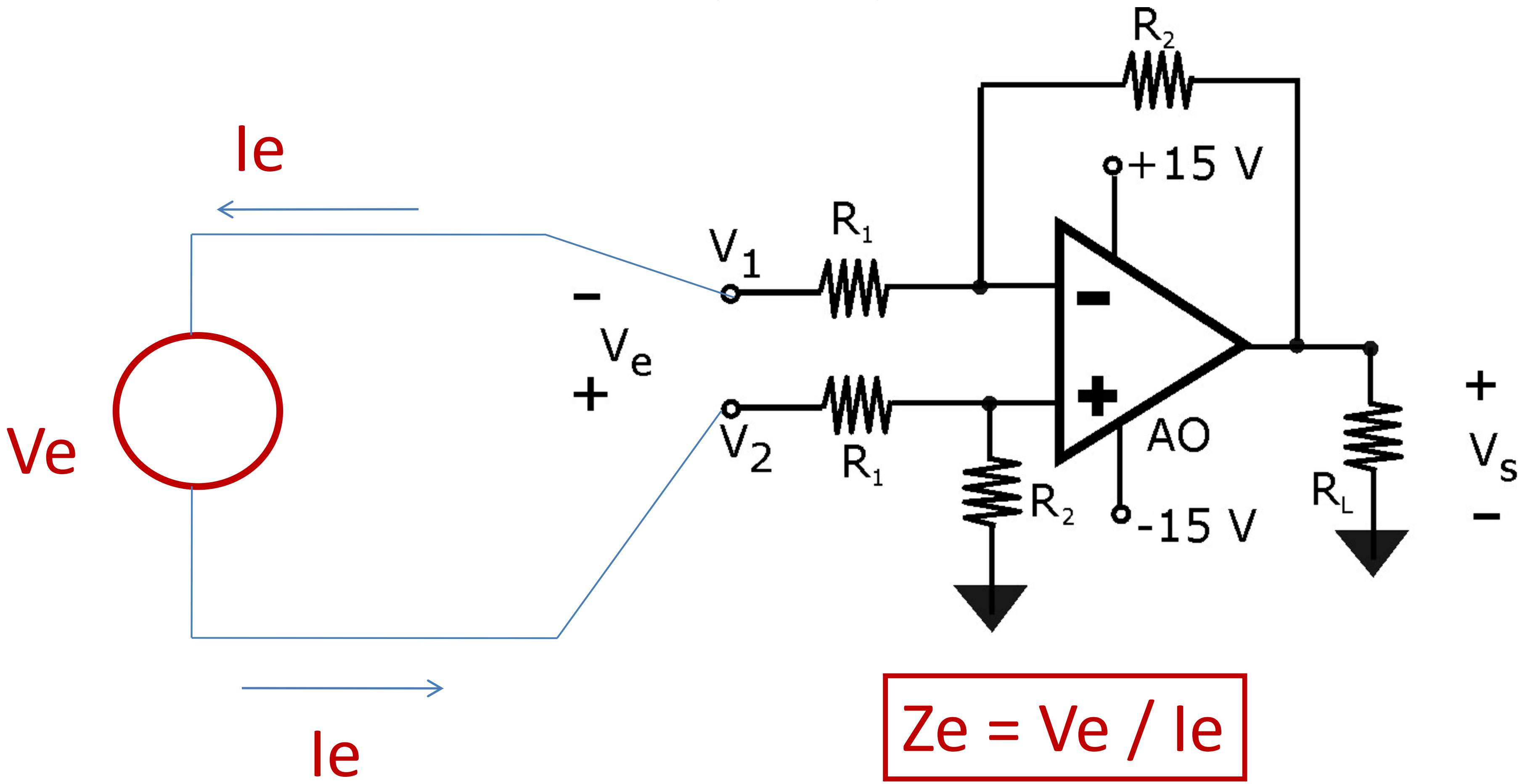


Calculus of Z_d

3.3 Differential and non-differential input

Differential Impedance

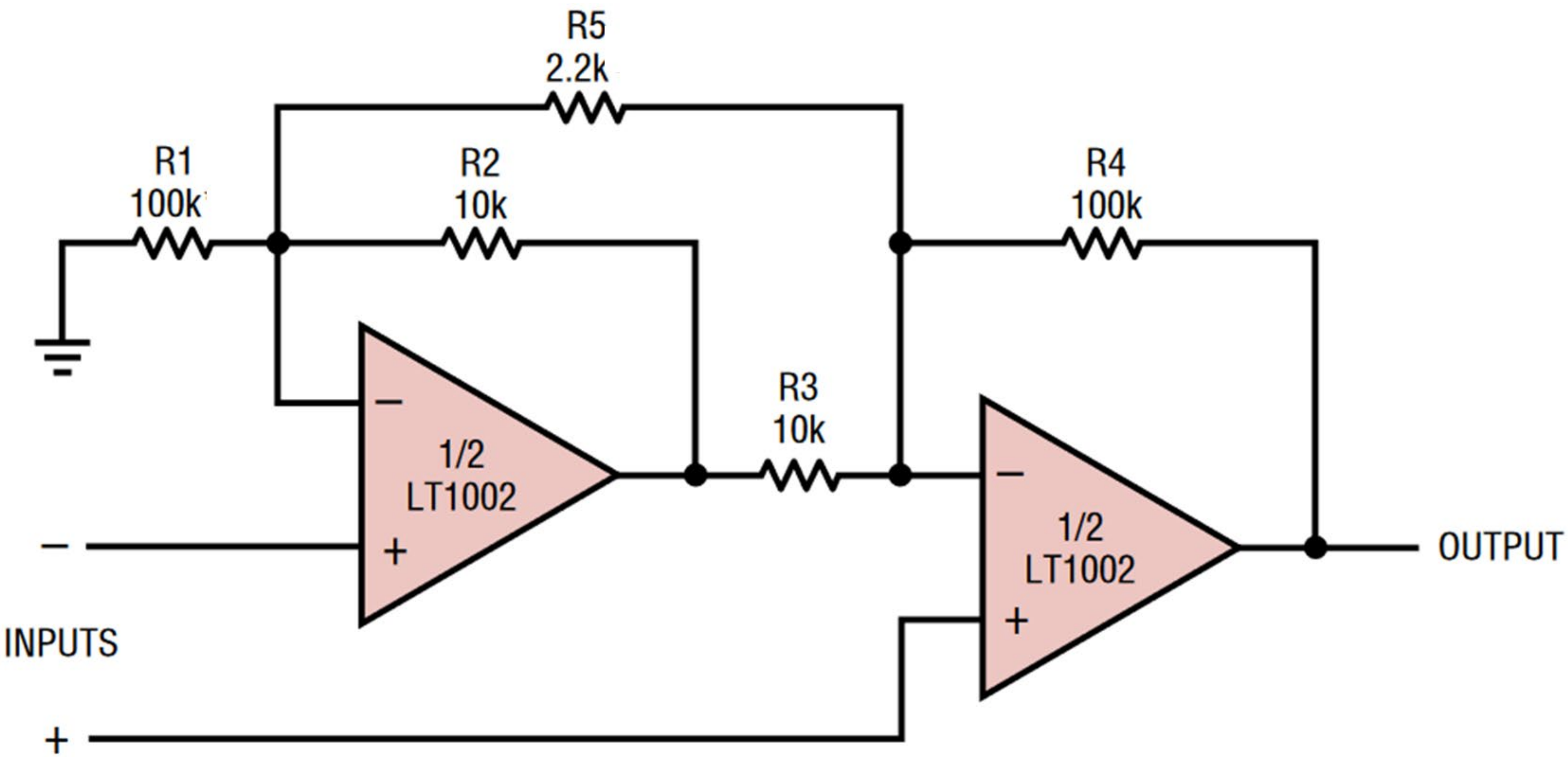
Analitical calculation of the input impedance



Ze = Ve / Ie

3.3 Differential and non-differential input

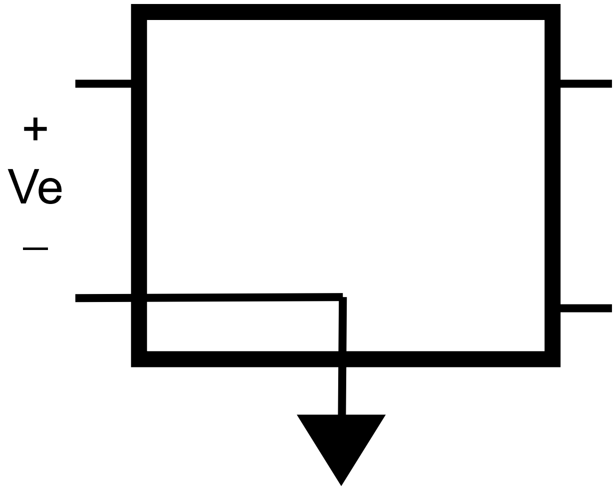
Calculate analytically the differential input impedance



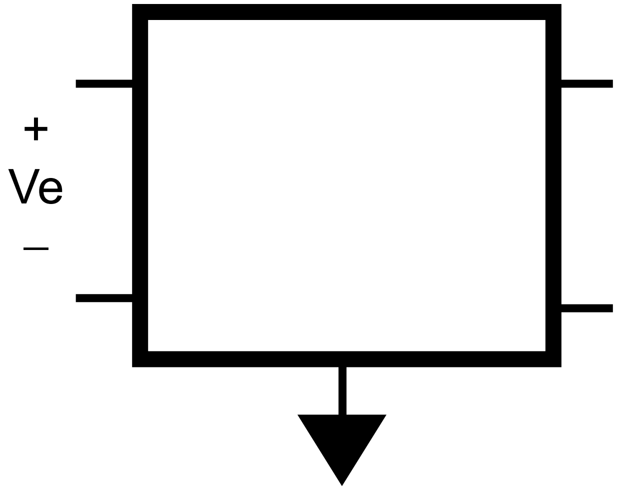
3.3 Differential and non-differential input

Relationship between input signal topology and input topology of the processing system

Considering infinite input impedances



Non differential

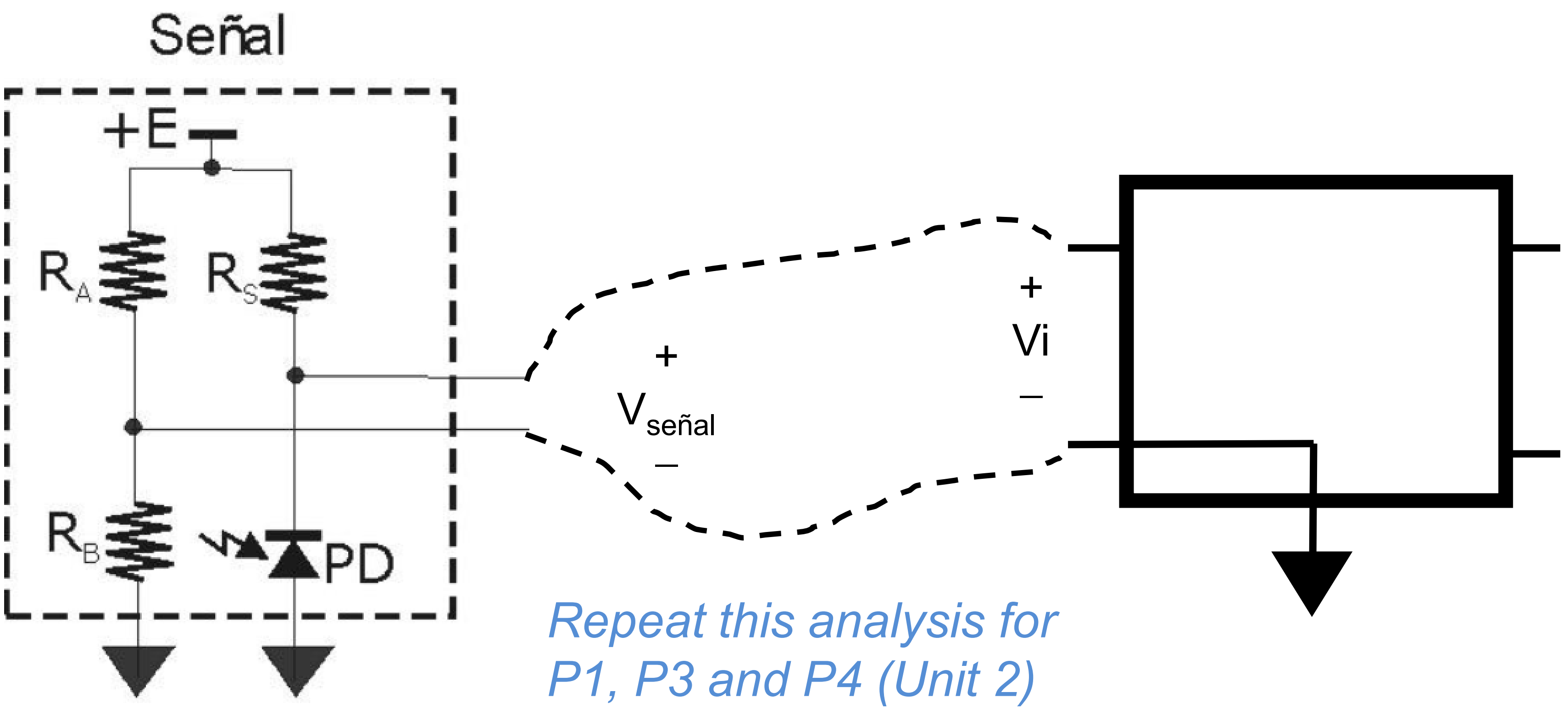


Differential

3.3 Differential and non-differential input

The processed input signal (Vi) should be equal to the signal ($V_{señal}$) before connecting it to the system

Is this condition fulfilled in this circuit? Why? How could this be achieved?



Repeat this analysis for P1, P3 and P4 (Unit 2)

3.3 Differential and non-differential input

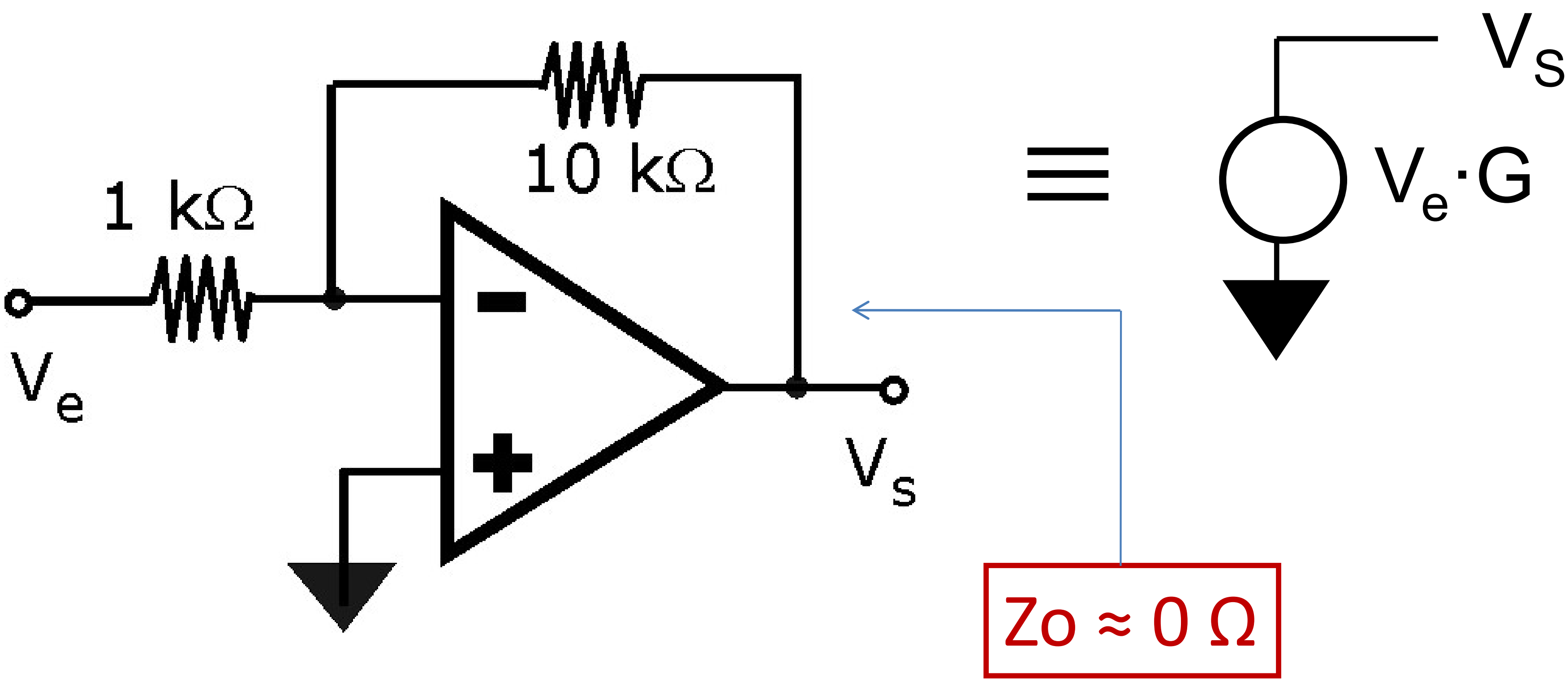
Adaptation to the topology of the signal

	Differential	Pseudo-differential	*Single-ended*
Floating	DIF/NO DIF	DIF/NO DIF	DIF/NO DIF
Grounded	Only DIF	Only DIF	DIF/ NO DIF

3.4 Output impedance

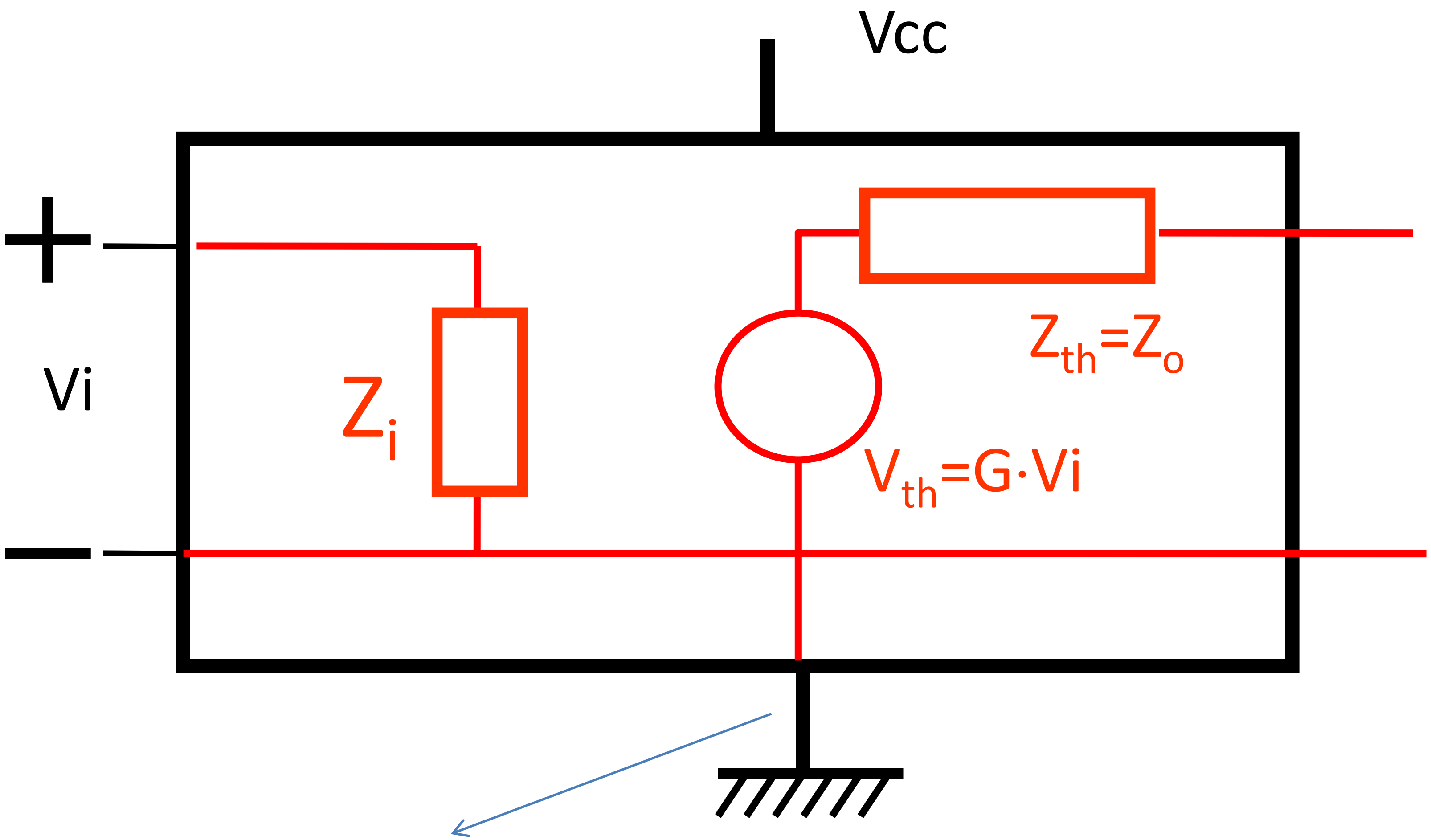
Output impedance

of a system based on an OA with negative feedback



3.5 Quadripole model

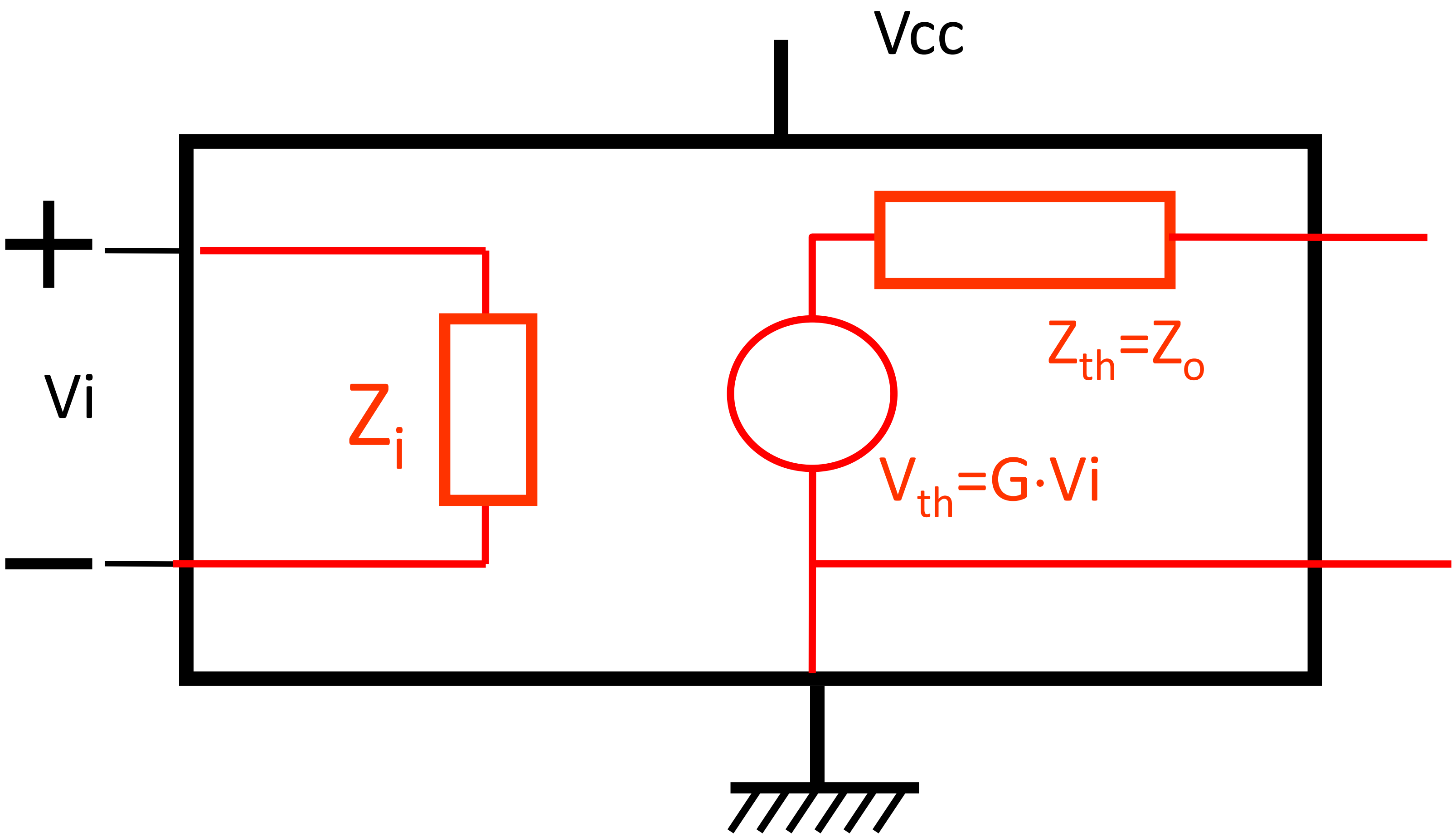
Non differential input-Thevenin output



Midpoint of the symetric supply or less potential point for the non symetric supply

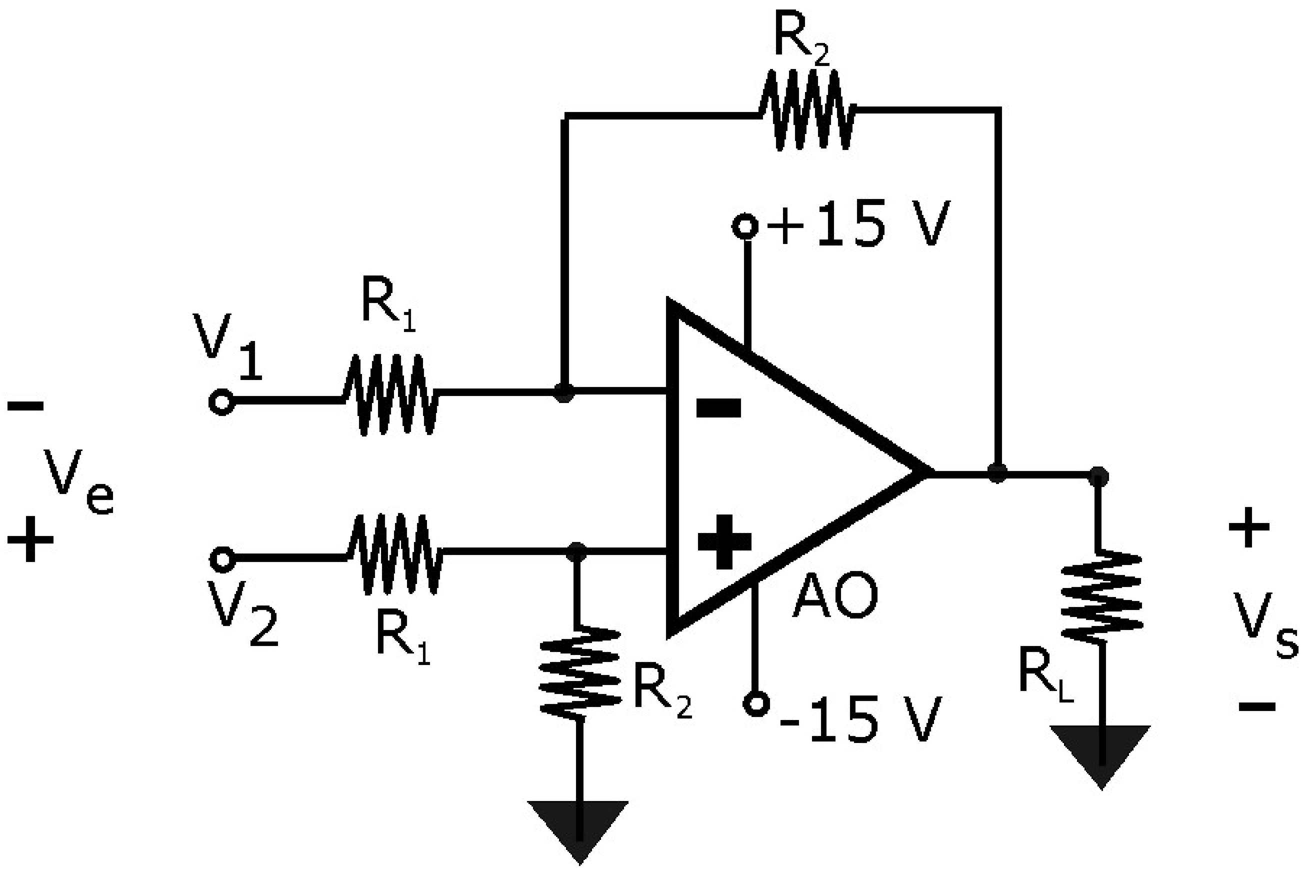
3.5 Quadripole model

Differential input-Thevenin output

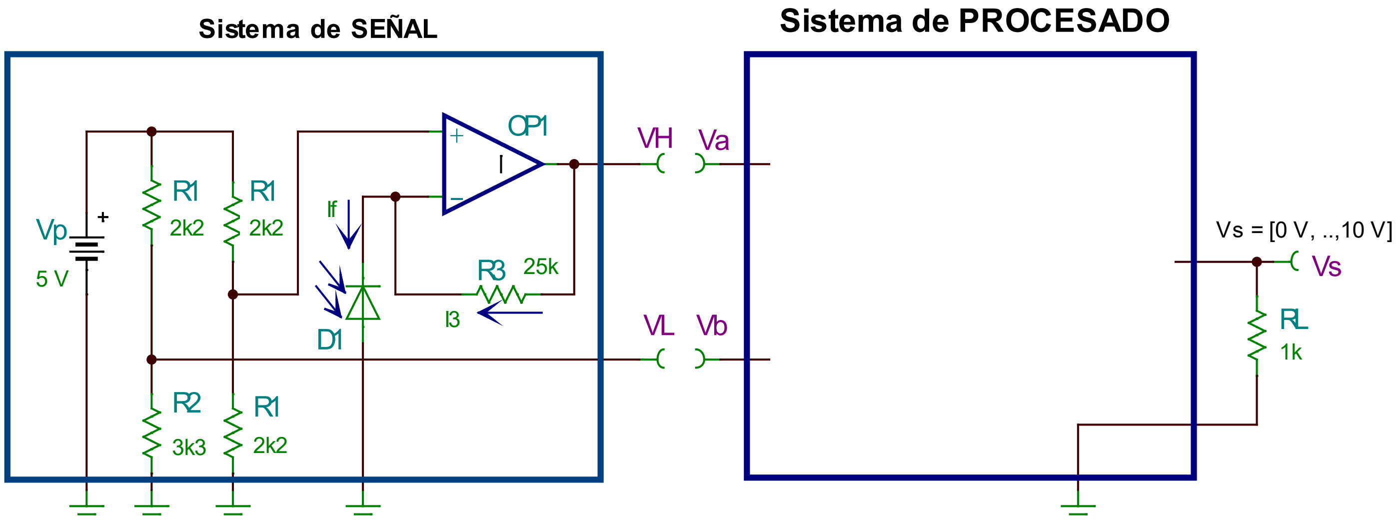


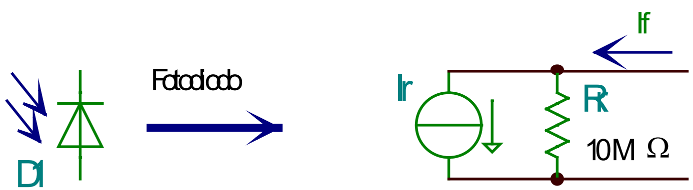
3.5 Quadripole model

Dibujar el modelo en cuadripolo del circuito de la figura
R_1= 25 kΩ, R_2 = 250 kΩ, R_L = 10 kΩ, 741C



P8. *El esquema adjunto permite detectar el nivel de iluminación de una sala mediante el empleo de un fotodiodo (D1).*





Rango de If está entre 20 μA y 50 μA.

Sistema de señal:

1. Calcula y dibuja el circuito equivalente de Thévenin visto desde el terminal VH a masa y desde el terminal VL a masa, para el rango de trabajo especificado para el fotodiodo. Considerar el amplificador operacional (OP1) como ideal.

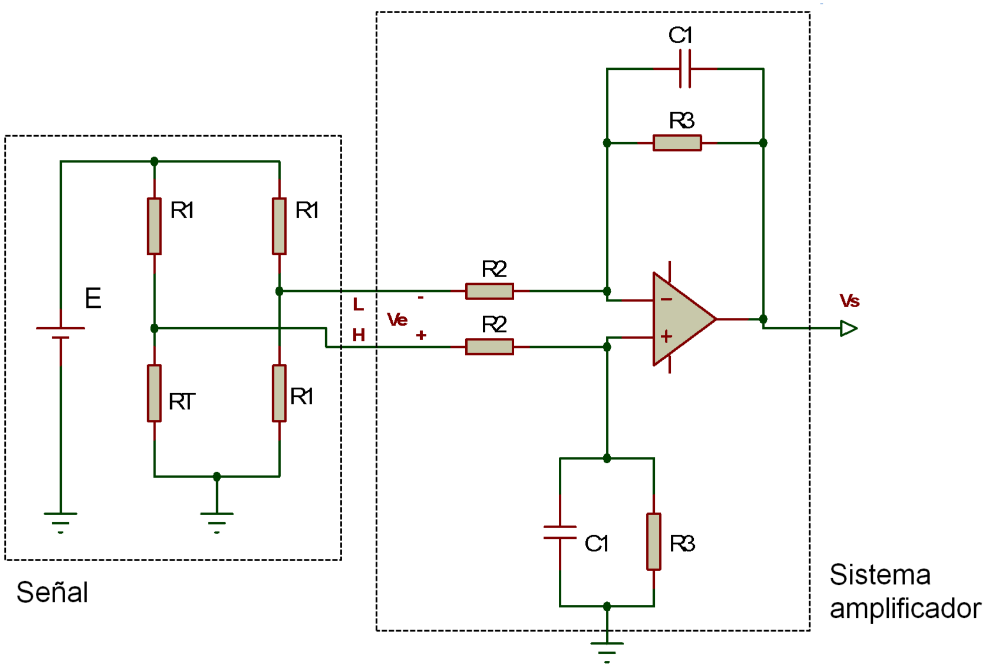
2. Razona e indica la topología del sistema de señal.

Sistema de procesado:

3. Dibuja el cuadripolo equivalente al sistema de procesado. Razona la topología del sistema de procesado.

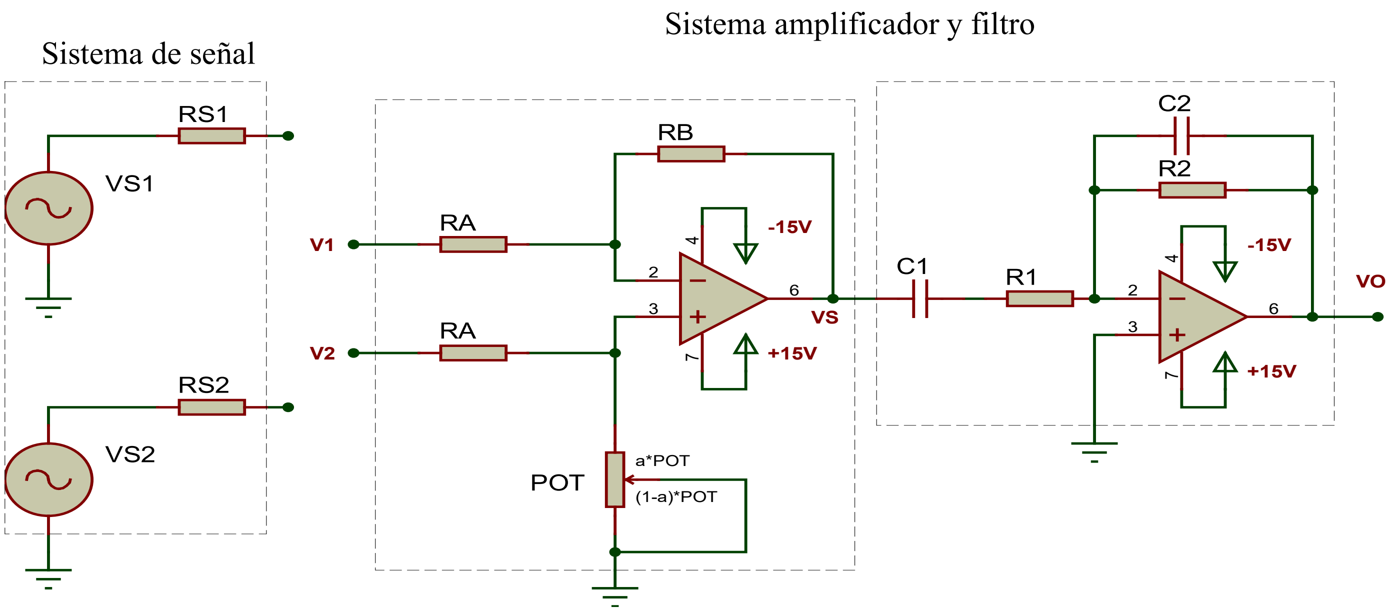
Ex Abril 2013. Pb1. *Sistema acondicionador de señal para un sensor térmico basado en una resistencia variable (RT). Además de un puente (sistema de señal), está compuesto por una sistema amplificador en cascada.*

1. Calcular el equivalente de Thevenin del sistema de señal visto desde el terminal H y el terminal L.
2. Determinar la topología del sistema de señal.
3. Calcular la impedancia de entrada diferencial del sistema amplificador.
4. Determinar la impedancia de salida del sistema amplificador.



Datos: VBAT: 5 V, ±Vcc= ±15 V, R1=100 Ω, RT=[100-250] Ω, R2 =1 kΩ, R3=3.3 kΩ, C1=0.1 nF, C2= 100 μF

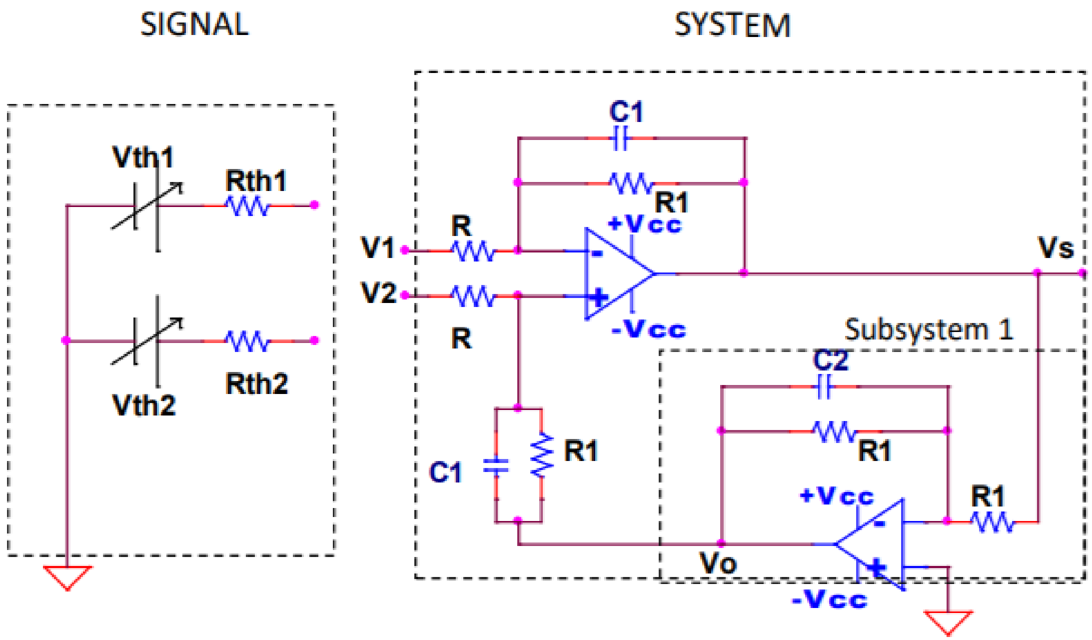
Ex Junio 2013. P1. *La figura representa un sistema de señal basado en dos electrodos para captar señales electrocardiográficas. Además se representa un sistema acondicionador de señal basado en una primera etapa de amplificación y una segunda etapa de*



Datos: VS1 y VS2: señales de amplitud máxima de 2 mV y un ancho de banda de de 150 Hz. Poseen una componente de continua de 1V. RS1=RS2=1 kΩ, RA=3.3 kΩ, RB=33 kΩ, POT=55 kΩ, a=0.6, C1=4.7 μF, C2= 0.33 μF, R1=330 Ω, R2=1 M Ω

1. Determinar la topología del sistema de señal.
2. Calcular la impedancia de entrada vista desde cada terminal V1 y V2 del sistema amplificador. Obtener la expresión algebraica de la función de transferencia del sistema amplificador Vs/(V2-V1).

Exercise. *The signal of the figure is provided by a temperature sensor and is composed by the interest signal (Vth2-Vth1) with a frequency spectrum lower than 10 Hz. The processing system is also shown in the figure.*



DATA:
Signal: Rth1=Rth2=50 Ω; (Vth2-Vth1) sinusoidal waveform with a frequency spectrum lower than 10 Hz.
System: Symmetric supply of the OA (Vcc=±15 V); C1=1 μF; C2=100 nF; R=800 Ω; R1=16 kΩ.
1) Describe and justify the topology of the signal.
2) Describe and justify the topology of the system.