Séance 1

SÉANCE 1 / BASES ET AMPLIFICATEUR LINÉAIRE

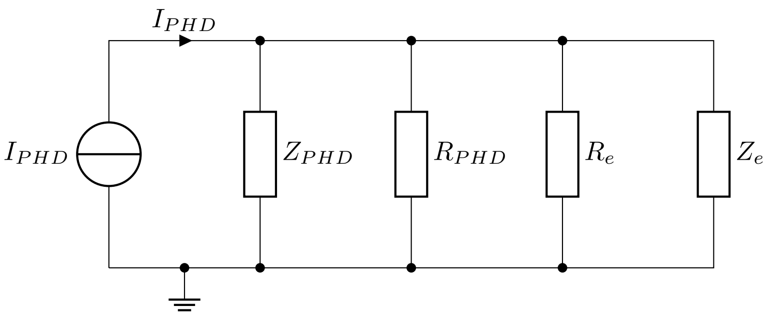
Pour ce TD, on pourra s'appuyer sur les fiches résumées : Fondamentaux et Ampli Linéaire Intégré.

Mission 1.1 - Abaisser une tension

Proposez un circuit permettant d'abaisser une tension d'un facteur k.
$0 < k < 1$

Mission 1.2 - Courants et tensions

Soit le circuit suivant :



1. Donnez l'expression de V_S en fonction de I_{PHD}.
2. Que devient cette expression si $R_e \longrightarrow +\infty$, $Z_e \longrightarrow +\infty$ et $Z_{PHD} \longrightarrow +\infty$?

   On se place à présent en régime harmonique.

   Z_{PHD} est une capacité C_{PHD} et Z_e est une capacité C_e.
3. Que devient l'expression de V_S en fonction de I_{PHD} ?
4. A quoi peuvent correspondre l'ensemble des éléments du montage ?

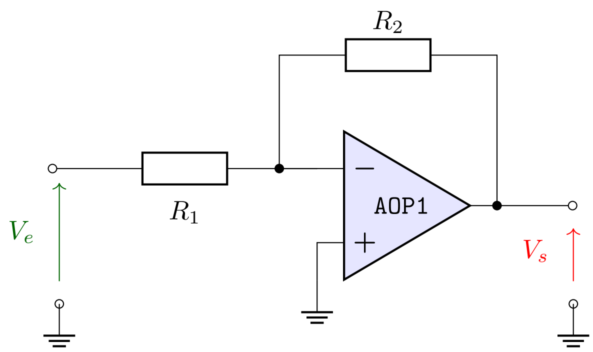
Mission 1.3 - Amplificateur linéaire intégré

On fournit en annexe une partie de la documentation technique de l'amplificateur linéaire intégré (ALI) **TL081**.

1. Cherchez dans la documentation les valeurs des paramètres électriques suivants :
   (a) Tension d'alimentation (Supply Voltage)
   (b) Tension d'entrée différentielle maximale
   (c) Amplification différentielle
   (d) Gain unitaire ou produit gain-bande-passante
   (e) Impédance d'entrée
   (f) Slew Rate
2. Précisez à quoi corresponde chacun de ces paramètres.
3. Rappelez la relation entre les entrées V^+, V^- et la sortie V_S d'un ALI.
4. Tracez la caractéristique $V_S = f(\varepsilon)$ où $\varepsilon = (V^+ - V^-)$ pour cet ALI avec $V_{CC} = 15\,\text{V}$.
5. Est-ce un bon amplificateur ? Quelle est sa bande-passante ?

Mission 1.4 - Amplificateur inverseur

On se propose d'étudier à présent le montage suivant :



1. Donnez la relation entre V_S et V_E du circuit précédent en utilisant la relation d'entrées-sortie de l'exercice 1.
2. Quelle hypothèse fait-on souvent lorsqu'on utilise des ALI avec une rétroaction négative ?
3. Quelle relation trouve-t-on alors entre V_S et V_E en partant de cette hypothèse ?
4. Cette hypothèse est-elle justifiée ?

TL08xx JFET-Input Operational Amplifiers

1 Features

- Low Power Consumption: 1.4 mA/ch Typical
- Wide Common-Mode and Differential Voltage Ranges
- Low Input Bias Current: 30 pA Typical
- Low Input Offset Current: 5 pA Typical
- Output Short-Circuit Protection
- Low Total Harmonic Distortion: 0.003% Typical
- High Input Impedance: JFET Input Stage
- Latch-Up-Free Operation
- High Slew Rate: 13 V/μs Typical
- Common-Mode Input Voltage Range Includes V_{CC+}

2 Applications

- Tablets
- White goods
- Personal electronics
- Computers

3 Description

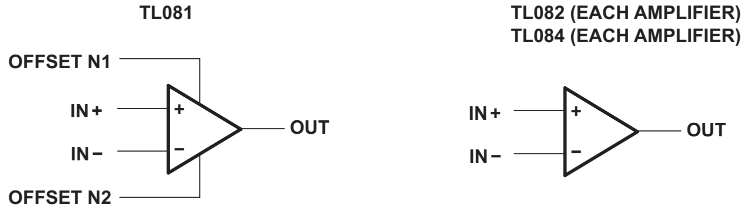
The TL08xx JFET-input operational amplifier family is designed to offer a wider selection than any previously developed operational amplifier family. Each of these JFET-input operational amplifiers incorporates well-matched, high-voltage JFET and bipolar transistors in a monolithic integrated circuit. The devices feature high slew rates, low input bias and offset currents, and low offset-voltage temperature coefficient.

Device Information(1)

PART NUMBER	PACKAGE	BODY SIZE (NOM)
TL084xD	SOIC (14)	8.65 mm × 3.91 mm
TL08xxFK	LCCC (20)	8.89 mm × 8.89 mm
TL084xJ	CDIP (14)	19.56 mm × 6.92 mm
TL084xN	PDIP (14)	19.3 mm × 6.35 mm
TL084xNS	SO (14)	10.3 mm × 5.3 mm
TL084xPW	TSSOP (14)	5.0 mm × 4.4 mm

(1) For all available packages, see the orderable addendum at the end of the data sheet.

Schematic Symbol



6 Specifications

6.1 Absolute Maximum Ratings

over operating free-air temperature range (unless otherwise noted)(1)

				MIN	MAX	UNIT
V_{CC+}	Supply voltage(2)				18	V
V_{CC-}					–18	
V_{ID}	Differential input voltage(3)				±30	V
V_I	Input voltage(2)(4)				±15	V
	Duration of output short circuit(5)			Unlimited		
	Continuous total power dissipation			See *Dissipation Rating Table*		
T_A	Operating free-air temperature		TL08_C TL08_AC TL08_BC	0	70	°C
			TL08_I	–40	85	
			TL084Q	–40	125	
			TL08_M	–55	125	
	Operating virtual junction temperature				150	°C
T_C	Case temperature for 60 seconds	FK package	TL08_M		260	°C
	Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds	J or JG package	TL08_M		300	°C
T_{stg}	Storage temperature			–65	150	°C

(1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions* is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
(2) All voltage values, except differential voltages, are with respect to the midpoint between V_{CC+} and V_{CC-}.
(3) Differential voltages are at IN+, with respect to IN−.
(4) The magnitude of the input voltage must never exceed the magnitude of the supply voltage or 15 V, whichever is less.
(5) The output may be shorted to ground or to either supply. Temperature and/or supply voltages must be limited to ensure that the dissipation rating is not exceeded.

6.2 ESD Ratings

			VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human body model (HBM), per ANSI/ESDA/JEDEC JS-001(1)	1000	V
		Charged-device model (CDM), per JEDEC specification JESD22-C101(2)	1500	

(1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.
(2) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process.

6.3 Recommended Operating Conditions

over operating free-air temperature range (unless otherwise noted)

			MIN	MAX	UNIT
V_{CC+}	Supply voltage		5	15	V
V_{CC-}	Supply voltage		–5	–15	V
V_{CM}	Common-mode voltage		V_{CC-} + 4	V_{CC+} – 4	V
T_A	Ambient temperature	TL08xM	–55	125	°C
		TL08xQ	–40	125	
		TL08xI	–40	85	
		TL08xC	0	70	

Electrical Characteristics for TL08xC, TL08xxC, and TL08xI (continued)

$V_{CC\pm}$ = ±15 V (unless otherwise noted)

PARAMETER		TEST CONDITIONS	T_A (1)	TL081C, TL082C, TL084C			TL081AC, TL082AC, TL084AC			TL081BC, TL082BC, TL084BC			TL081I, TL082I, TL084I			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
I_{CC}	Supply current (each amplifier)	V_O = 0, No load	25°C		1.4	2.8		1.4	2.8		1.4	2.8		1.4	2.8	mA
V_{O1}/V_{O2}	Crosstalk attenuation	A_{VD} = 100	25°C		120			120			120			120		dB

6.6 Electrical Characteristics for TL08xM and TL084x

$V_{CC\pm}$ = ±15 V (unless otherwise noted)

PARAMETER		TEST CONDITIONS(1)	T_A	TL081M, TL082M			TL084Q, TL084M			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
V_{IO}	Input offset voltage	V_O = 0, R_S = 50 Ω	25°C		3	6		3	9	mV
			Full range			9			15	
α_{VIO}	Temperature coefficient of input offset voltage	V_O = 0, R_S = 50 Ω	Full range		18			18		μV/°C
I_{IO}	Input offset current(2)	V_O = 0	25°C		5	100		5	100	pA
			125°C			20			20	nA
I_{IB}	Input bias current(2)	V_O = 0	25°C		30	200		30	200	pA
			125°C			50			50	nA
V_{ICR}	Common-mode input voltage range		25°C	±11	–12 to 15		±11	–12 to 15		V
V_{OM}	Maximum peak output voltage swing	R_L = 10 kΩ	25°C	±12	±13.5		±12	±13.5		V
		R_L ≥ 10 kΩ	Full range	±12			±12			
		R_L ≥ 2 kΩ		±10	±12		±10	±12		
A_{VD}	Large-signal differential voltage amplification	V_O = ±10 V, R_L ≥ 2 kΩ	25°C	25	200		25	200		V/mV
			Full range	15			15			
B_1	Unity-gain bandwidth		25°C		3			3		MHz
r_i	Input resistance		25°C		10^{12}			10^{12}		Ω
CMRR	Common-mode rejection ratio	V_{IC} = V_{ICR}min, V_O = 0, R_S = 50 Ω	25°C	80	86		80	86		dB
k_{SVR}	Supply-voltage rejection ratio ($\Delta V_{CC\pm}/\Delta V_{IO}$)	V_{CC} = ±15 V to ±9 V, V_O = 0, R_S = 50 Ω	25°C	80	86		80	86		dB
I_{CC}	Supply current (each amplifier)	V_O = 0, No load	25°C		1.4	2.8		1.4	2.8	mA
V_{O1}/V_{O2}	Crosstalk attenuation	A_{VD} = 100	25°C		120			120		dB

(1) All characteristics are measured under open-loop conditions, with zero common-mode input voltage, unless otherwise specified.
(2) Input bias currents of a FET-input operational amplifier are normal junction reverse currents, which are temperature sensitive, as shown in Figure 13. Pulse techniques must be used that maintain the junction temperatures as close to the ambient temperature as possible.

6.7 Operating Characteristics

$V_{CC\pm}$ = ±15 V, T_A= 25°C (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
SR	Slew rate at unity gain	V_I = 10 V, R_L = 2 kΩ, C_L = 100 pF, See Figure 19	8(1)	13		V/μs
		V_I = 10 V, R_L = 2 kΩ, C_L = 100 pF, T_A = − 55°C to 125°C, See Figure 19	5(1)			

(1) On products compliant to MIL-PRF-38535, this parameter is not production tested.

6.9 Typical Characteristics

Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices. The Figure numbers referenced in the following graphs are located in *Parameter Measurement Information*.

Table 1. Table of Graphs

			Figure
V_{OM}	Maximum peak output voltage	versus Frequency versus Free-air temperature versus Load resistance versus Supply voltage	Figure 1, Figure 2, Figure 3 Figure 4 Figure 5 Figure 6
A_{VD}	Large-signal differential voltage amplification	versus Free-air temperature versus Load resistance	Figure 7 Figure 8
	Differential voltage amplification	versus Frequency with feed-forward compensation	Figure 9
P_D	Total power dissipation	versus Free-air temperature	Figure 10
I_{CC}	Supply current	versus Free-air temperature versus Supply voltage	Figure 11 Figure 12
I_{IB}	Input bias current	versus Free-air temperature	Figure 13
	Large-signal pulse response	versus Time	Figure 14
V_O	Output voltage	versus Elapsed time	Figure 15
CMRR	Common-mode rejection ratio	versus Free-air temperature	Figure 16
V_n	Equivalent input noise voltage	versus Frequency	Figure 17
THD	Total harmonic distortion	versus Frequency	Figure 18

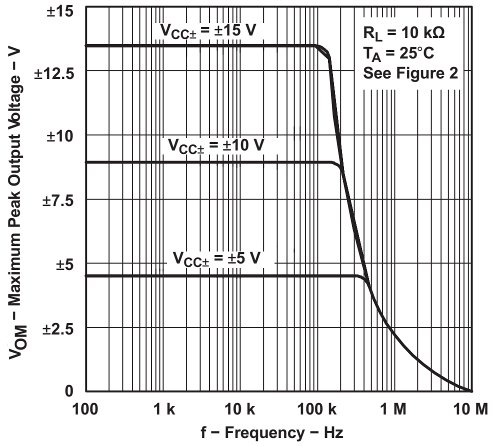


Figure 1. Maximum Peak Output Voltage vs Frequency

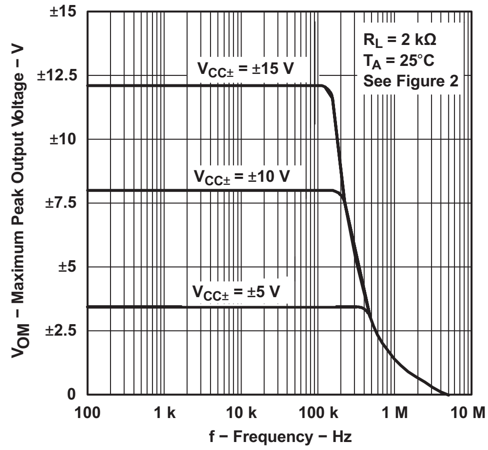


Figure 2. Maximum Peak Output Voltage vs Frequency