

CURRENT SOURCES WITH OPAMP AND T

I. OBJECTIVES

- Analyzing current sources with OpAmp and MOSFET, OpAmp and BJT.
- Determining the output current.
- Determining the effect of the fixed/adjustable resistance in the emitter/source on the value of the output current.

II. COMPONENTS AND INSTRUMENTATION

Use the breadboard, an LM741 OpAmp, a 2N2222 BJT, an IRFZ24N MOSFET, some resistors, a potentiometer. The supply and input voltages are obtained from the dc regulated voltage supply. The output current is measured using the milliammeter.

The terminals of the LM741 OpAmp, 2N2222 BJT, IRFZ24N MOSFET are shown in Fig. 1.

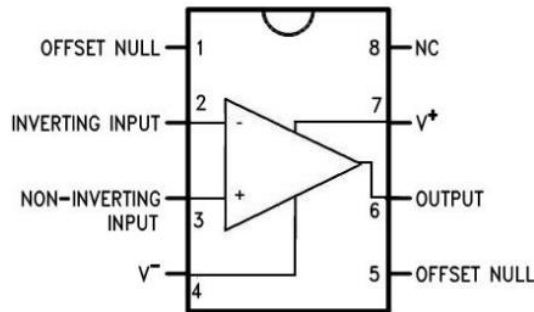


Fig. 1 a) LM741 pinout diagram

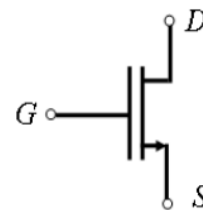
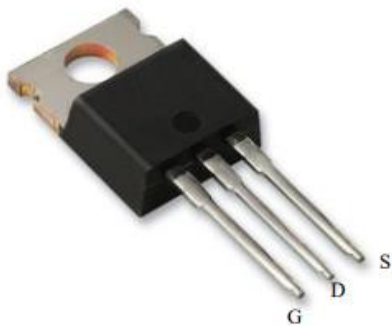


Fig. 1 b) IRFZ24N MOSFET – pinout diagram



1. Emitter 2. Base 3. Collector
TO-92 Plastic Package

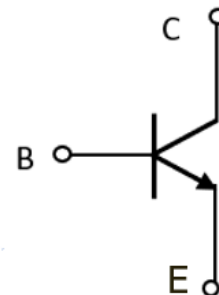


Fig. 1 c) 2N2222 BJT – pinout diagram

III. PREPARATION

1.P. Current source with OpAmp and MOSFET

For the circuits in Fig. 2, assume OpAmp – rail to rail, $V_{Th}=3V$; $\beta=5mA/V^2$. The milliammeter is used to measure the output current.

For the circuit in Fig. 2 a):

- What is the expression and value of the output current, I_O ?
- Compute the value of v_{GS} , assuming T is in (a_F).
- What is the range for R_L , so that the transistor works in the active forward region (a_F)?

For the circuit in Fig. 2 b):

- What is the expression of the output current, I_O ? What are the minimum and maximum values of this current?
- Is it possible to switch the places for P and R? Explain.

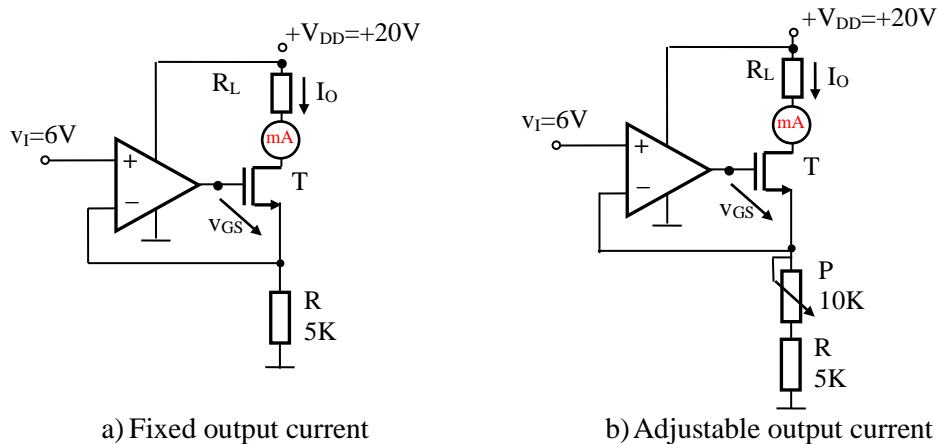


Fig. 2. Current source with OpAmp and MOSFET

2.P. Current source with OpAmp and BJT

For the circuits in Fig. 3, assume OpAmp – rail to rail, $\beta=75$, $V_{BE, on}=0.6V$. The milliammeter is used to measure the output current.

For the circuit in Fig. 3 a):

- What is the expression and value of the output current, I_O ?
- What is the range for R_L , so that the transistor works in the active forward region (a_F)?

For the circuit in Fig. 3 b):

- What is the expression of the output current, I_O ? What are the minimum and maximum values of this current?
- Is it possible to switch the places for P and R? Explain.

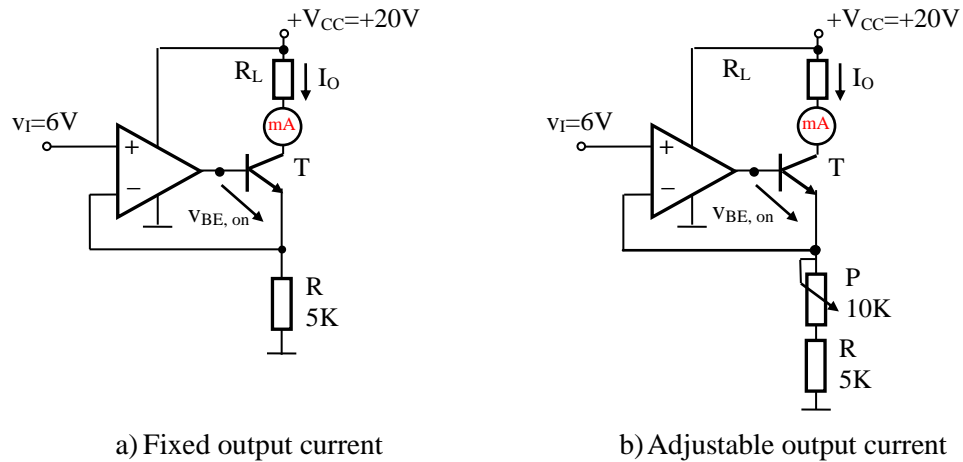


Fig. 3. Current source with OpAmp and BJT

IV. EXPLORATION AND RESULTS

1. Current source with OpAmp and MOSFET

Exploration

- Build the circuit in Fig. 2 a), using $R_L = 5K\Omega$.
- The millimeter is set to the 6mA range, with the two measurement wires connected to “mA” and “COM” inputs.
- Measure the output current.
- Repeat the measurements for $R_L = 10K\Omega$ and $R_L = 15K\Omega$.
- Write the values in Table 1.
- Come back to $R_L = 5K\Omega$. Increase the input voltage until the output current no longer increases. What is the first value of the input voltage for which the output current is maximum, $V_{I_{max}}$? What is the maximum value for the output current? What is the operating region of T in this case?
- Fill in Table 2.
- Build the circuit in Fig. 2 b), using $R_L = 5K\Omega$. Determine the minimum and maximum values for the output current.

Results

- Table 1 and Table 2 for MOSFET.
- The minimum and maximum values for the output current, for the circuit in Fig. 2 b).

Table 1. Comparison for current sources with OpAmp and MOSFET, OpAmp and BJT, variable load resistance

		Output current I_o [mA]	
		MOSFET	BJT
$V_I = 6\text{ V}$	$R_L = 5K\Omega$		
	$R_L = 10K\Omega$		
	$R_L = 15K\Omega$		

Table 2. Comparison for current sources with OpAmp and MOSFET, OpAmp and BJT, variable input voltage

		Output current I_o [mA] and operating region	
		MOSFET	BJT
$R_L = 5K\Omega$	$V_I = 6\text{ V}$		
	$V_{I_{max}}$		

2. Current source with OpAmp and BJT

Exploration

- Build the circuit in Fig. 3 a), using $R_L = 5K\Omega$.
- The milliammeter is set to the 6mA range, with the two measurement wires connected to “mA” and “COM” inputs.
- Measure the output current.
- Repeat the measurements for $R_L = 10K\Omega$ and $R_L = 15K\Omega$.
- Write the values in Table 1.
- Come back to $R_L = 5K\Omega$. Increase the input voltage until the output current no longer increases. What is the first value of the input voltage for which the output current is maximum, $V_{I_{max}}$? What is the maximum value for the output current? What is the operating region of T in this case?
- Fill in Table 2.
- Build the circuit in Fig. 3 b), using $R_L = 5K\Omega$. Determine the minimum and maximum values for the output current.

Results

- Table 1 and Table 2 for BJT.
- The minimum and maximum values for the output current, for the circuit in Fig. 3 b).
- Compare the two types of current sources from the point of view of the maximum output current.

REFERENCES

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