LM 7805 VOLTAGE REGULATOR

I. OBJECTIVES

a) to determine the parameters of the *IC 7805* voltage regulators.
b) to identify a method for increasing the output current and the short circuit protection for the IC 7805 voltage regulators.

II. COMPONENTS AND INSTRUMENTATION

We use the experimental assembly in Fig. 6. The input voltage is applied from a regulated dc power supply or a signal generator. We measure the dc voltages with a digital multimeter, and we use the dual channel oscilloscope to visualize the voltages in the circuit.

III. PREPARATION

P1. Fixed output voltage regulator

P1.1. DC Parameters

- From the *IC 7805* datasheet, write down the minimum, typical and maximum values of the output voltage V_O and then compute the value of the output current I_O, for the load resistance $R_L=47\Omega$.
- Determine the smallest value of the input voltage V_I for which *IC7805* can still work as a voltage regulator.
- Considering $V_I=8V$, compute the value of the output current I_{O1}, for a load resistance $R_{L1}=15\Omega$.
- From the *IC 7805* datasheet, write down the value of the short circuit current I_{SC}.

P1.2. Line regulation

- From the *IC 7805* datasheet, write down the typical and maximum values for the variation of the output voltage V_O, when the input voltage V_I varies between *8V* and *12V*.
- For the typical and maximum values of the output voltage variation, compute the line regulation coefficient, using the formula:

$$LineReg = \frac{\Delta v_O / V_O}{\Delta v_I / V_I}$$

P1.3. Load regulation

- From the *IC 7805* datasheet, write down the typical and maximum values for the variation of the output voltage V_O, when the output current varies.
- For the typical and maximum values of the output voltage variation, compute the load regulation coefficient, using the formula:

$$Load\ \mathrm{Re}\,g = \frac{\Delta v_O / V_O}{\Delta i_O / I_O}$$

- For the circuit in Fig. 3., compute the value of the load resistance, corresponding to both values (levels) of the *TTL* voltage.

P2. Adjustable output voltage regulator

- For the circuit in Fig. 4., compute the minimum and maximum values of the output voltage V_O.
- Compute V_O for the tap of the potentiometer *POT* in the middle position.

P3. Voltage regulator with external transistor and protection circuit

- For the circuit in Fig. 5., compute the value of the output current I_O for $V_I=8V$ and $R_L=47\Omega$.
- If $R_L=47\Omega$ is replaced with $R_{L1}=15\Omega$, recompute the value of the output current I_{O1}.

- Compute the value of the short circuit current $I_{O,SC}$ and compare it with the value of the short circuit current for the basic *IC 7805*, without the external transistor and protection circuit.

IV. EXPLORATIONS AND RESULTS

1. Fixed output voltage regulator

1.1. DC parameters

Explorations

- Supply the schematic in Fig. 1. with a DC input voltage, $V_I=8V$ and use the jumpers to connect *J1* with *J2*, *J11* with *J12* and *J14* with *J15*. Measure the output voltage V_O with a voltmeter and compute the value of the output current I_O ($R_L=47\Omega$). Write down these values.

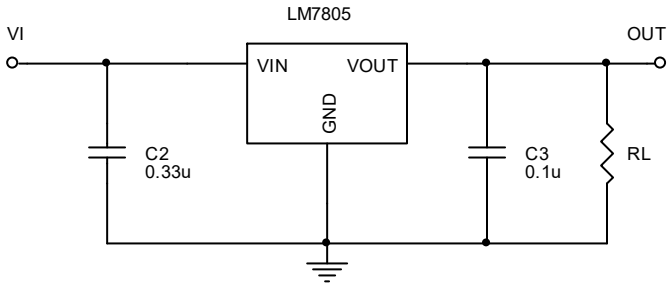

Fig.1. DC parameters determination

- Decrease the value of the input voltage V_I until the output voltage starts to decrease below *5V*. Write down the last value of V_I for which V_O remains constant.

$V_O(I_O)$ characteristic

The first values for V_O and I_O have already been determined in the previous experiment (for $V_I=8V$). Using the same input voltage, do the following:

- In order to obtain $R_{L1}=15\Omega$, connect $R_L=47\Omega$ in parallel with $R_{L2}=22\Omega$, by connecting *J9* with *J9*. Measure the output voltage V_{O1} once again and

determine the value of the output current I_{O1}. Write down the values for V_{O1} and I_{O1}.

- Connect a milliameter, set on the *20A* scale, between the output and the ground (in a short circuit connection). Write down the measured value of the current.

Results

- The minimum value of the input voltage for which the schematic works as a voltage regulator. (V_I - V_O) value.
- Fill in the table:

V_O			
R_L	*47Ω*	*15 Ω*	*0Ω*
I_O			

- Draw the $V_O(I_O)$ characteristic.

1.2. Line regulation

Explorations

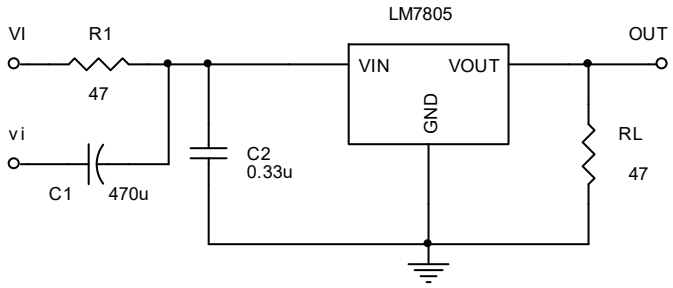

Fig.2. Line regulation

- Build the experimental schematic in Fig. 2., by supplying the V_I point with a DC voltage $V_I=14V$ and the v_i point with a sinusoidal voltage $v_i=2\sin 2\pi 120t$ *[V]*. To do this, disconnect *J1* from *J2, J9* from *J9*, and *J11* from *J12* and connect *J3* with *J4*, and *J14* with *J15.*

- Using the oscilloscope, visualize the input voltage of the integrated circuit $v_I(t)=(V_I+ v_i)$ and the output voltage $v_O(t)$. Pay attention when setting the oscilloscope to visualize the small variations of the output voltage!
- From the oscilloscope, read the ripple of the input and output voltages (Δv_I and Δv_O). Using these values, compute the line regulation coefficient:

$$LineReg = \frac{\Delta v_O / V_O}{\Delta v_I / V_I}$$

Results

- $v_I(t)$ and $v_O(t)$.
- The input and output voltage ripples Δv_I and Δv_O.
- Compare the voltage ripples from the datasheet with the one you measured.
- *LineReg* value.

1.3. Load regulation

Explorations

- Build the experimental schematic in Fig. 3. by applying $V_I=8V$ at the *VI* point and a *TTL* voltage with an amplitude of *5V* and a frequency of *500Hz*, at the control input of the Q_3 transistor. To do this, disconnect *J3* from *J4*, and *J14* from *J15* and connect *J1* with *J2*, and *J13* with *J14*.
- Using the oscilloscope, visualize the *TTL* voltage and the output voltage $v_O(t)$. Pay attention when setting the oscilloscope to visualize the small variations of the output voltage!
- From the oscilloscope, read the ripple of the output voltage Δv_O, for both *TTL* values (levels). Compute the ripple (variation) of the output current Δi_O, corresponding to the ripple of the output voltage.
- Compute the load regulation coefficient:

$$LoadReg = \frac{\Delta v_O / V_O}{\Delta i_O / I_O}$$

Results

- *TTL* and $v_O(t)$ voltages.
- Compare the voltage variation value from the datasheet with the one you measured, for load regulation.

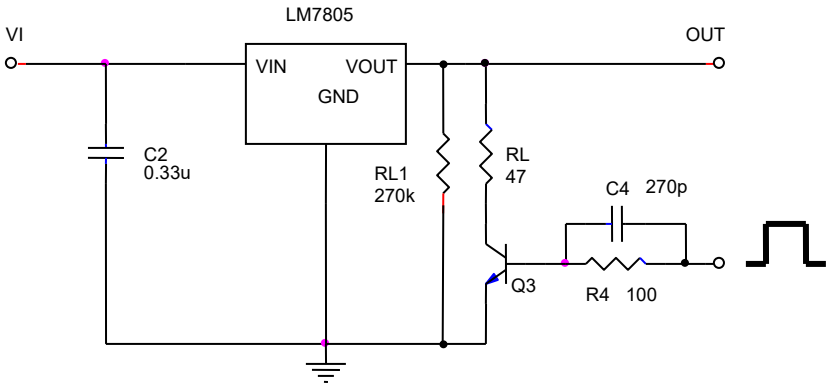

Fig. 3. Load regulation

- *LoadReg* value.

2. Adjustable output voltage regulator

Explorations

- Build the experimental schematic in Fig. 4. (in the upper right corner of the schematic) by applying the input voltage in the point *VI2*.

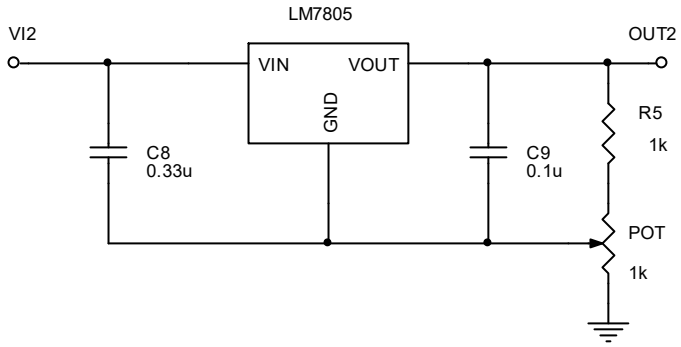

Fig.4. Voltage regulator with variable output

- For $V_I=8V$ measure and write down the minimum and maximum values of the output voltage (by modifying *P*).

- Check if for the tap of the potentiometer *POT* in the middle position you get a value of v_O in the interval you determined.

Results

- Minimum and maximum values of the output voltage. Compare the maximum value of V_O with V_I. Which one is higher and why?
- Output voltage value for the tap of the potentiometer *POT* in the middle position.

3. Voltage regulator with external transistor and protection circuit

Explorations

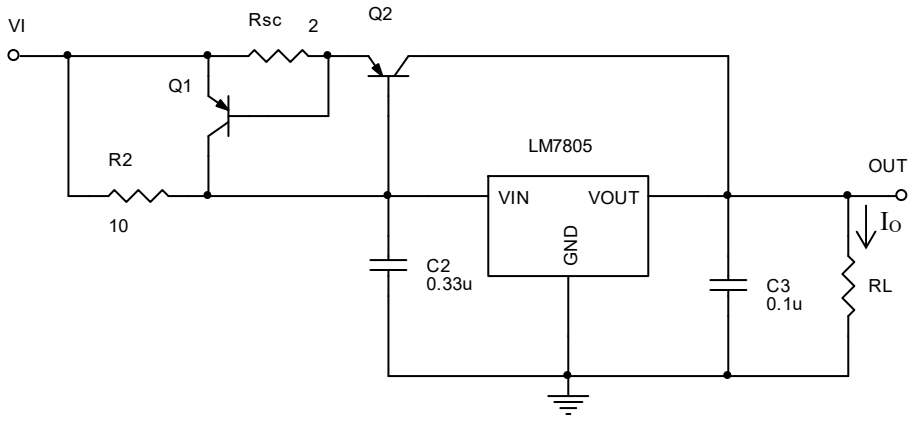

Fig. 5. Voltage regulator with external transistor and protection circuit

- Build the experimental scheme in Fig.5. by applying $V_I=8V$ at the *VI* point and connecting a load resistance $R_L=47\Omega$. To do this, disconnect *J1* from *J2* and connect *J5* to *J6*, *J7* to *J8*, *J9* to *J10*, *J 11* to *J12* and *J14* to *J15*.
- Measure the output voltage V_O using a voltmeter and determine the output current I_O. Write down these values.
- To obtain $R_{L1}=15\Omega$, connect $R_L=47\Omega$ in parallel with $R_{L2}=22\Omega$, by connecting *J9* with *J9*. Measure the output voltage V_{O1} and determine the output current I_{O1}. Write down these values.

- Connect a milliameter, set on the *20A* scale, between the output and the ground (in a short circuit connection). Write down the measured value of the current.

Results

- Output voltage V_O and output current I_O values for $R_L=47\Omega$. Compare these values with the ones you obtained in section 1.1. In which exploration did you obtain higher values for the output voltage and current and why?
- Output voltage V_{O1} and output current I_{O1} values for $R_{L1}=15\Omega$. Compare these values with the ones you obtained in section 1.1. In which exploration did you obtain higher values for the output voltage and current and why?
- Short circuit current value $I_{SC.}$ Compare this value with the one you obtained in section 1.1. In which exploration did you obtain a higher value for the output current and why?
- $V_O(I_O)$ characteristic.

REFERENCES

1. Oltean, G., Circuite Electronice, UT Pres, Cluj-Napoca, 2007, ISBN 978-973-662-300-4
2. http://www.datasheetcatalog.org/datasheets/228/390068_DS.pdf
3. http://www.bel.utcluj.ro/dce/didactic/fec/fec.htm

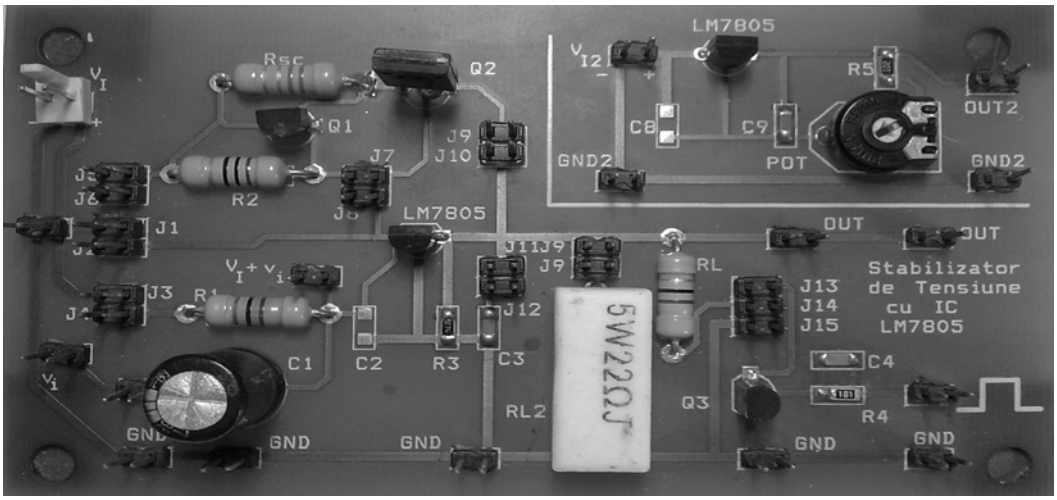

Fig. 5. Experimental assembly