Industrial Electronics
Practicum 0

Summary on linear regulator LM317

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Laboratory report

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Abstract

During this practicum we had to learn, design, implement, simulate, measure, and analyze a linear regulator model using the LM317 IC.
This practicum motivates the student to understand linear regulation systems, how to size it, and be critical of its characteristics.
Our observations in the report shows that ....

Table des matières

1 Introduction

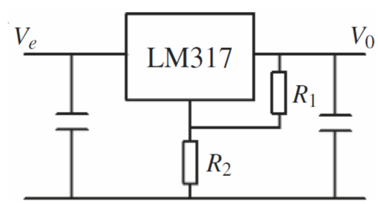
This practicum aims to study, dimension, simulate, and implement an LM317 linear regulator system, and analyze different aspects and parameters that impact the circuit's functionality.

The LM317 is a voltage regulator that is commonly used in electronic circuits. It is designed to provide a constant output voltage, regardless of variations in input voltage or load. It does this by using a reference voltage and an adjustable resistor to control the output voltage. The reference voltage is set using a pair of external resistors, and the output voltage can be adjusted by changing the resistance of the adjustable resistor. This allows the LM317 to be used in a wide range of applications, such as providing a stable power supply for a circuit or controlling the output voltage of a battery.

2 Preliminary task

Our goal is to implement an LM317 regulation system, which has an input of **5V** and an output of **3V3**. To accomplish that, we must scale different parameters, that we will develop in the subsection 2.1 to 2.4

2.1 Resistive bridge sizing



$$V_0 = 1,25 \times \left(1 + \frac{R_2}{R_1}\right)$$

FIGURE 1 – Resistive-bridge schematic and formula in the datasheet
Source:

The formula in the datasheet neglects the breakdown current of the internal Zener diode, we decided to take consideration of it in our calculations.

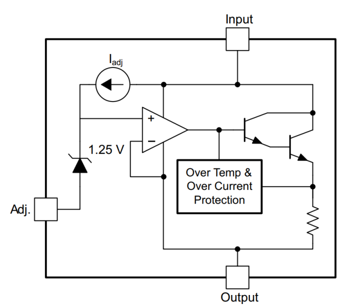


FIGURE 2 – Functional bloc diagram of LM317
Source:

The voltage of the internal zener diode is **1.25V**, this is the reference and minimum voltage of the regulator. To dimension the resistive bridge, we must take into account the breakdown current of the diode which is **50uA**, when this condition is met, we know that the voltage between the output and the ADJ pin is the same as the reference voltage. We can then set an arbitrary value for one of the resistors knowing that the total voltage at the output must be **3.3V**. We decided to have a current of **50uA** through R1, to reduce the power dissipation in the bridge.

2.1.1 Formulas

As described bellow, we have as parameters :
$I_{adj} = 50[uA]$
$I1 = 50[uA]$
Where I1 has been fixed by us to avoid having too much unnecessary current in the resistor bridge..
$U1 = 1.25[V]$

$$R1 = \frac{U1}{I1} \tag{1}$$

$$R2 = \frac{U2}{I2} = \frac{Uout - U1}{I_{adj} + I1} \tag{2}$$

As equation (1) and (2) state, in our application we found the values :
$R1 = 25\ k\Omega$
$R2 = 20.5\ k\Omega$

2.2 Maximum output power calculation

Since we have very few loss current in the resistive bridge, we decided to neglect it.
We have as parameters :
$U_{in} = 5[V]$
$U_{out} = 3.3[V]$
$I_{out} = 100[mA]$ (Specification)

$$P_{max} = (U_{out} - U_{in}) * I_{out} \tag{3}$$

By applying equation number (3) to our application, we found the value :
$P_{max} = 330\ mW$

2.3 Input provided power

In this subsection, we will continue to neglect the diode breakdown current. To have as an output current **100 mA** we sized an output resitor by applying this formula :

$$R_L = \frac{U_{out}}{I_{out}} \tag{4}$$

So our load resistor value is **33 Ω**.

We can now define our different powers in the systems :

$$P_{out} = \frac{U_{out}}{I_{out}} \tag{5}$$

$$P_{in} = \frac{{U_{out}}^2}{R_L} \tag{6}$$

$$P_{reg} = P_{in} - P_{out} \tag{7}$$

Calculated values for our application :
$P_{out} = 330\ mW$
$P_{in} = 500\ mW$
$P_{reg} = 170\ mW$

2.4 Temperature of the LM317 junction without cooling (Short-circuited)

3 Main task

3.1 Schematic proposal for limiting output current to 250mA

We were asked to design a proposed scheme to limit the output current to 250mA, to do this we decided to change the principle of the connections to create a current source using the LM317.

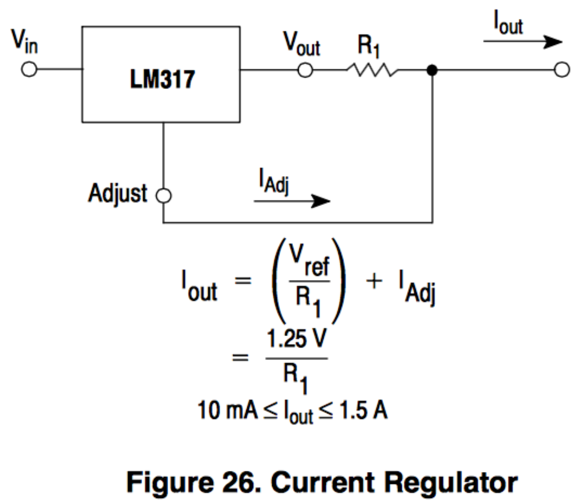


FIGURE 3 – Current source with LM317
Source: Stackexchange "lm317-μa-constant-current-source-possibility"

We use the reference voltage (**1.25V**) of the internal diode, so the output current depends on the resistance **R1** plus the leakage current of the diode.

By adding and changing a load resistor in the circuit, the induced output current will vary, as will the voltage, but the current will not exceed :
$\frac{Vref}{R1} + I_{ADJ}$

This

3.2 Plotting output tension depending on output current

3.3 Oscillogram of the output current depending on the input tension

3.4 Dissipated power calculation

3.5 Estimation of the junction's temperature without cooling

3.6 Short-circuited output - dissipated power calculation