Voltage Regulation Calculator

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Using our voltage regulation calculator, you can **find the voltage ratio**, i.e., the voltage difference between no-load and full-load, and the percentage change of that voltage ratio on the secondary voltage terminals of your regulator.

In the following article, we share:

What voltage regulation is;

Diagrams of voltage regulators;

How to calculate power dissipation in voltage regulators; and

How to calculate voltage regulation in linear and switching regulators.

What is voltage regulation?

Voltage regulation maintains a constant output voltage to match the needs of the components of an electrical device, even when the input voltage or load conditions change.

We measure the voltage regulation in two parameters:

1. **Line regulation**

   It is the ratio of change in micro voltage output per unit change in the input voltage, i.e.,

   $\Delta V_{\text{output}}/\Delta V_{\text{input}}$

   where:

   ΔV_{output} – Change in the output voltage; and

   ΔV_{input} – Change in the input voltage.

2. **Load regulations**

   It is the ratio of change in the output voltage when going from no-load to full-load:

   $\Delta V_{\text{output}}/\Delta I_{\text{load}}$

   or

   $V_{\text{no-load}} - V_{\text{full-load}}/\Delta I_{\text{load}}$

   $\because$ $\Delta V_{output} = V_{\text{no-load}} - V_{\text{full-load}}$

   where:

   ΔI_{load} – Change in the load current;

   $V_{\text{no-load}}$ – Voltage when there is no load; and

   $V_{\text{full-load}}$ – Voltage when there is full load.

💡 In an ideal case scenario, the output voltage remains **constant** with and without the load. Thus, the line and load regulation are always zero.

Types of voltage regulators

There are two types of voltage regulators:

1. **Linear type regulators**

   They are **buck (step-down) regulators**. These linear-type regulators are less efficient, with basic integrated circuits and voltage dividers to drop the voltage at the desired level while shedding the rest as heat.

   Benefits of linear regulators:

   Low resistor noise;

   Cost efficient;

   Easy to design;

   Simple to add to circuit;

   Fast response time; and

   Low output voltage ripple.

   The output of a linear regulator is always lower than the input and drops out if the input voltage is too low.

   $$V_{\text{input}} > V_{\text{output}} + V_{\text{drop-out}}$$

2. **Switching type regulators**

   Switching type regulators can be **buck (step-down), boost (step-up), or buck-boost** (mixture of both). They are more advanced and challenging to design with the arrangement of capacitors, diodes, and inductors to determine whether the output voltage should increase or decrease.

   They rapidly switch the input voltage on and off to produce desirable changes in voltage and current. And this switching of frequency creates a possibility to obtain a wide range of voltages from the same input source.

   Benefits of switching type regulators:

   Very efficient;

Handling large voltage spikes;

Reverse polarity protection; and

Remove unwanted signal noise.

🙋 Every device in an electrical system can have a different voltage regulator based on its needs. We commonly use switching regulators for conversion from DC to DC electrical power of different voltages.

How to use the voltage regulation calculator

Our voltage regulation calculator helps you calculate the voltage regulation of linear and switching regulators as follows:

1. In the **V NO-LOAD** field, enter the measured voltage when there is no load on the regulator, e.g., **230 V**.
2. Then, in the **V FULL-LOAD** field, enter the voltage when there is a full load on the regulator, e.g., **220 V**.
3. Once you've entered your voltage in both fields, the calculator will present:

   Your **step-down voltage regulation** is **0.0435**.

   With its **percentage change** value is **4.3%**.

   And,

   Your **step-up voltage regulation** is **0.0454**.

   Along with its **percentage change** value is **4.5%**.

Calculate voltage regulation of linear and switching regulators

Linear regulators are only step-down, i.e., buck regulators. Switching regulators can be step-down, step-up, or both, i.e., buck, boost, or buck-boost.

We use the following formula to calculate **step-down voltage regulation**:

$$VR = \frac{V_{\text{no-load}} - V_{\text{full-load}}}{V_{\text{no-load}}}$$

And the following formula to calculate **step-up voltage regulation**:

$$VR = \frac{V_{\text{no-load}} - V_{\text{full-load}}}{V_{\text{full-load}}}$$

And when we multiply **voltage regulation** by **100**, we get its **percentage change**:

$$PC = VR \times 100$$

where:

VR – Voltage regulation; and

PC - Percentage change from no-load to full-load.

For example, let's find a buck regulator's voltage regulation and percentage change, with the voltage on no-load being **140 V**, and on full-load, **120 V**.

Placing the values in the formula, we get:

$$VR = \frac{140 - 120}{140} = 0.143$$

$$PC = 0.143 \times 100 = 14.3$$

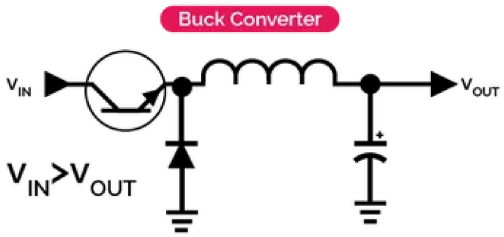
Thus, our step-down voltage regulation is **0.143**, and the percentage change is **14.3%**.

Linear and switching voltage regulator diagrams

The following diagrams help us better perceive step-up and step-down converters.

Buck converters: Reduce voltage.

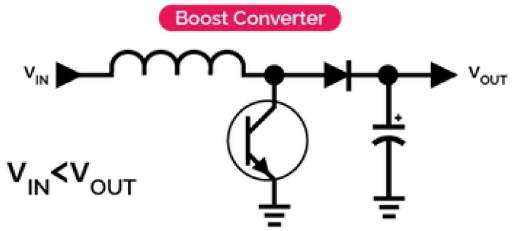
$V_{\text{input}} > V_{\text{output}}$



Buck converter

Boost converters: Increase voltage.

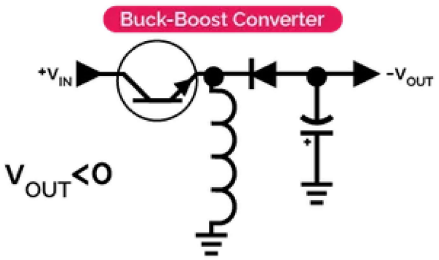
$$V_{\text{input}} < V_{\text{output}}$$



Boost converter

Buck-boost converters: Increase or decrease voltage but reverse the polarity.

$$V_{\text{output}} < 0$$



Buck-boost converter

What is power dissipation in a voltage regulator?

The efficiency of a regulator depends on the difference between its input and output voltages and how much the circuit draws current. The greater the difference, or the more the current, the more the heat or power dissipation by the regulator.

We can obtain this value using the following formula:

$$PD = (V_{\text{input}} - V_{\text{output}}) \times I_{\text{output}}$$

where:

PD – Power dissipation from the regulator;

V_{input} – Regulator voltage input;

V_{output} – Regulator voltage output; and

I_{output} – Regulator current output.

FAQ

What is an adjustable voltage regulator?

An adjustable voltage regulator is a **variable or buck-boost switching regulator** that can be adjusted to increase or reduce its output voltage to meet the electrical system requirements.

They are generally DC to DC power converters.

What is the purpose of a DC voltage regulator?

The purpose of a DC voltage regulator is to function as a **power supply** and provide a stable input voltage for the devices to operate. A DC voltage regulator can also stabilize the output voltage, avoiding input voltage and current fluctuations.

How many types of voltage regulators are there?

There are two main types of voltage regulators:

Linear regulators; and

Switching regulators

Both regulate the voltage, but **linear regulators have low efficiency**, thus dissipating more power as heat. In comparison, switching regulators are highly efficient, as most of their input power transfers as output with minimum dissipation.

How do I calculate power dissipation in a voltage regulator?

To calculate the power dissipation in a voltage regulator:

1. **Subtract** the output voltage from the input voltage.
2. **Multiply** the result with the output current.
3. That is the **power dissipation** of your voltage regulator.

We can represent this as:

```
PD = ( Vi - Vo ) × Io
```

where:

`PD` – Power dissipation from the regulator;

`Vi` – Regulator voltage input;

`Vo` – Regulator voltage output; and

`Io` – Regulator current output.