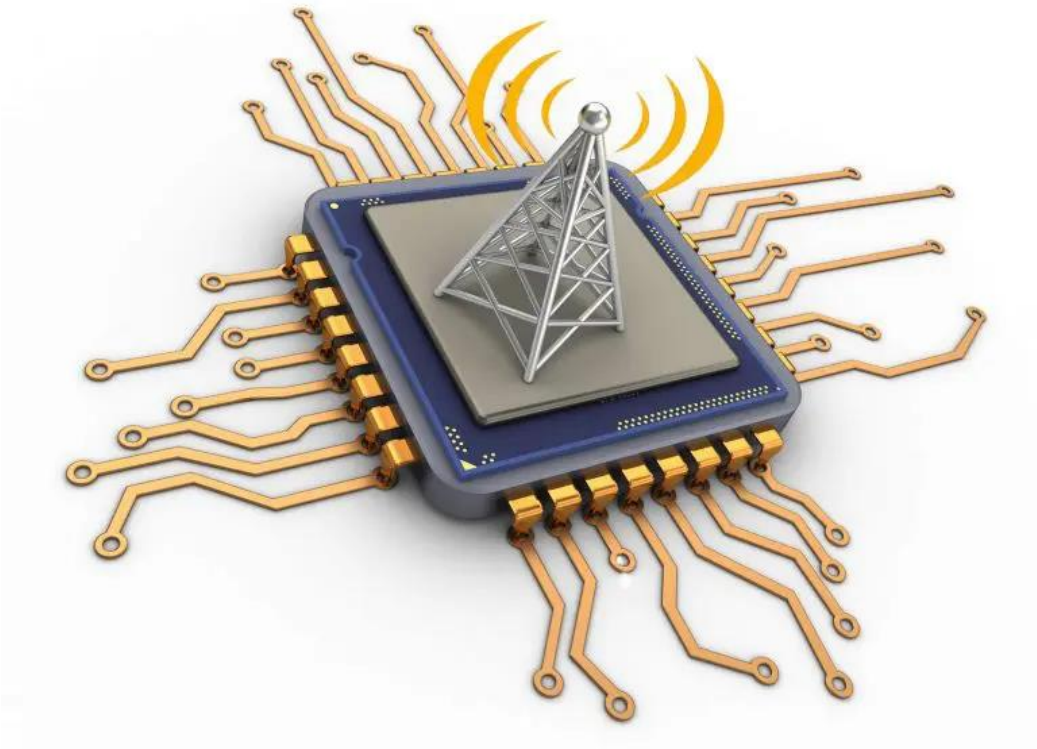
COOK-BOOK OF Bandgap Voltage Reference



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1. Motivation:

This Cook-Book present the design conduct that is to be followed for the designing of the Bandgap Voltage reference (BGR). It is a major building block of Integrated circuit as it is very essential for a circuit to be immune to effect of temperature change. The functionality of BGR is to give a constant reference voltage which is independent of temperature and supply voltage.

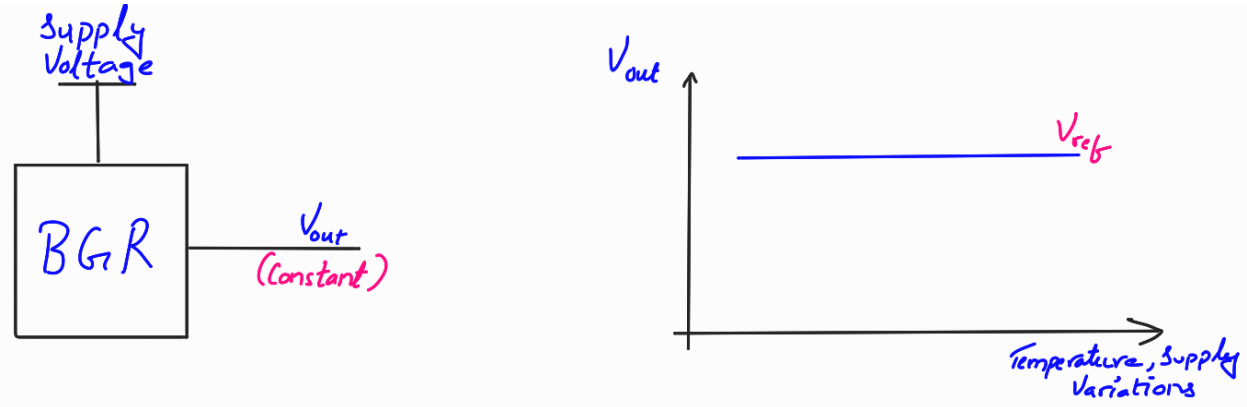


Figure 1: Bandgap reference functionality

Process variations is also one of the parameters which effect $V_{ref.}$

Applications: IN LDO, Buck, Boost Converter, Regulator, ADC, DAC or any of analog or RFIC circuits.

The standard temperature variation an integrated circuit is expected to withstand is: -40℃ to 125℃

Hence, Bandgap reference is a circuit which will give constant output voltage (V_{ref}) with respect to temperature and supply variations.

Important Parameters of BGR:

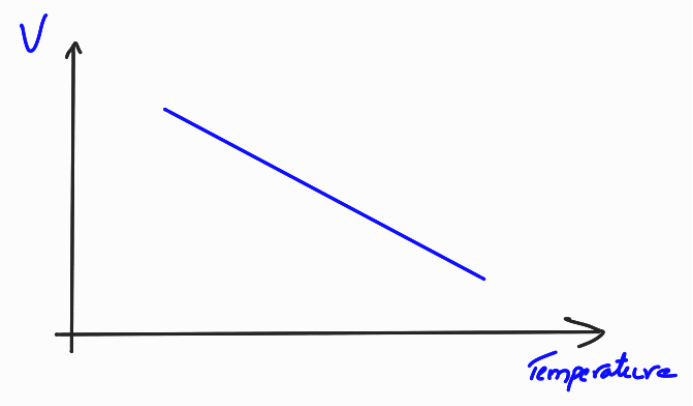
A) Temperature variations: More prevailing than others

B) Supply variations

2. Temperature Variations:

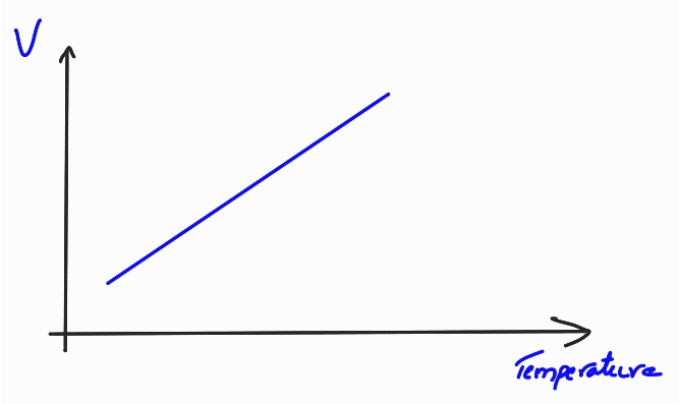
Generally, a circuit behaves in two ways under the effect of temperature:

A) CTAT (Complementary to absolute temperature):



Circuit whose voltage or current decreases with the increase in temperature are called CTAT circuits.

B) PTAT (Proportional to absolute temperature):



Circuit whose voltage or current increases with the increase in temperature are called PTAT circuits.

Now, we can make a constant voltage reference, cancelling the effect of temperature by combining CTAT and PTAT circuits.

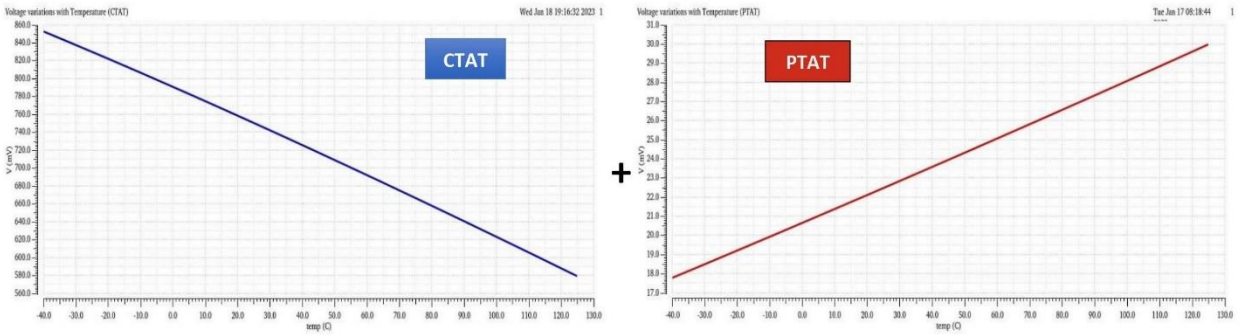


Figure 2: Combining CTAT and PTAT together

But it is not applicable to any PTAT or CTAT since the slope of CTAT and PTAT differs and adding them up will not cancel their nature.

Thus, we need to scale the CTAT and PTAT so that they cancel each other as depicted in given block diagram representation.

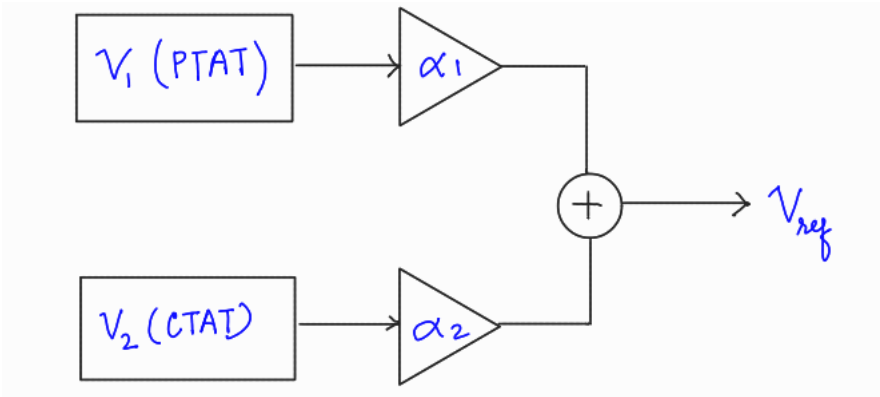


Figure 3: Block diagram of BGR

Hence, Bandgap reference can be mathematically represented as;

$$\alpha_1 . PTAT + \alpha_2 . CTAT = Constant\ Voltage \qquad (1)$$

Where, α_1 and α_2 are scaling factors.

3. CTAT Design: