

- **Design of Band- gap Reference Circuit**

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## Band-Gap Reference Circuit

- A bandgap reference is a circuit widely used in analog and mixed-signal integrated circuits to generate a stable voltage that is largely independent of temperature, power supply variations, and manufacturing process changes.
- The concept is based on combining two voltages with opposite temperature coefficients.
- It is a vital analog building block used in many applications like Low Dropout voltage regulators, Analog to digital converter, Digital to analog converter, Buck converters etc. Compared to a voltage regulator, reference circuit lack current driving capability.
- As per industry standards, range of variation in temperature is considered as from  $-40^{\circ}\text{C}$  to  $125^{\circ}\text{C}$ . Range of supply variation depends on applications, typically 10% to 20% from the typical value of voltage supply.
- Basically 2 important variations are discussed in this report
  - i) Supply variations
  - ii) Temperature variations

## Effect of Temperature

- All electronic devices are sensitive to temperature variations.
- If voltage across a device increases with the increase in temperature, then such devices are called PTAT [Proportional to Absolute Temperature].
- If voltage decreases with the increase in temperature, then such devices are called CTAT [Complementary to Absolute Temperature]

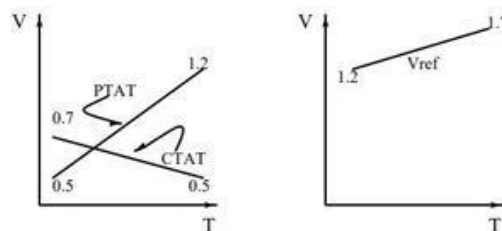


Fig. 1: (a) PTAT and CTAT responses (b) Response of voltage reference

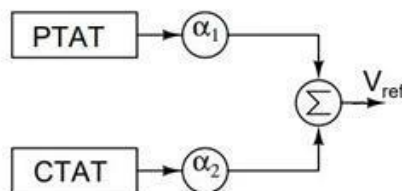


Fig. 2: Generation of  $V_{ref}$  voltage

## CTAT and PTAT Design

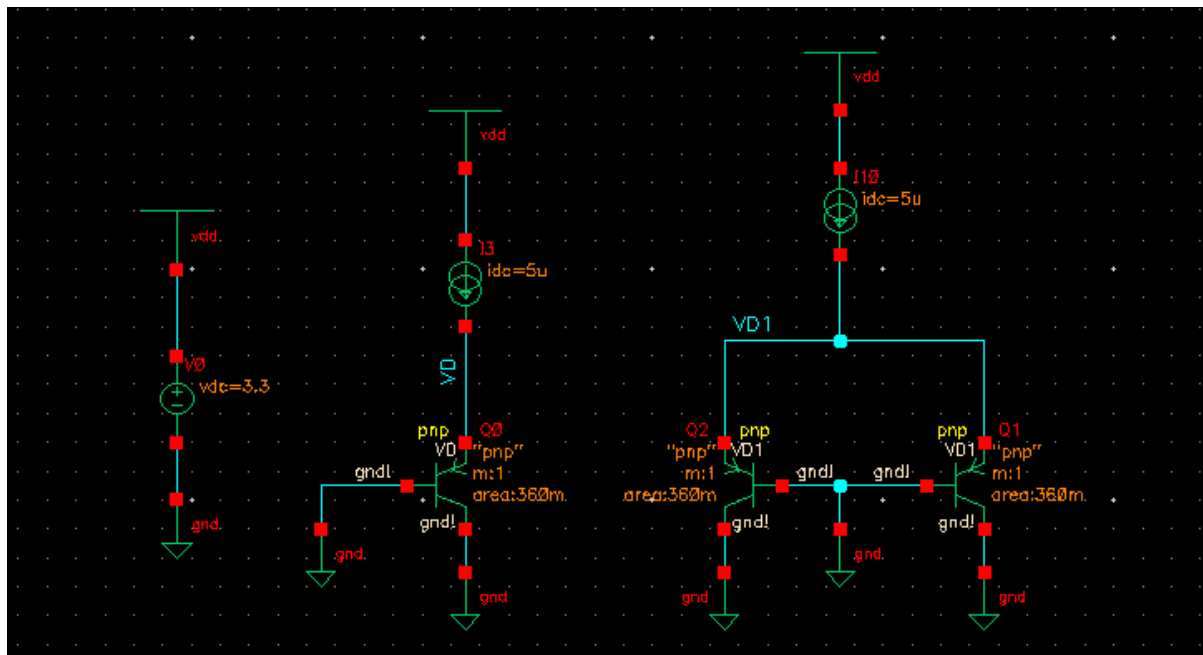


Fig3: Schematic of CTAT and PTAT design

### Final Circuit

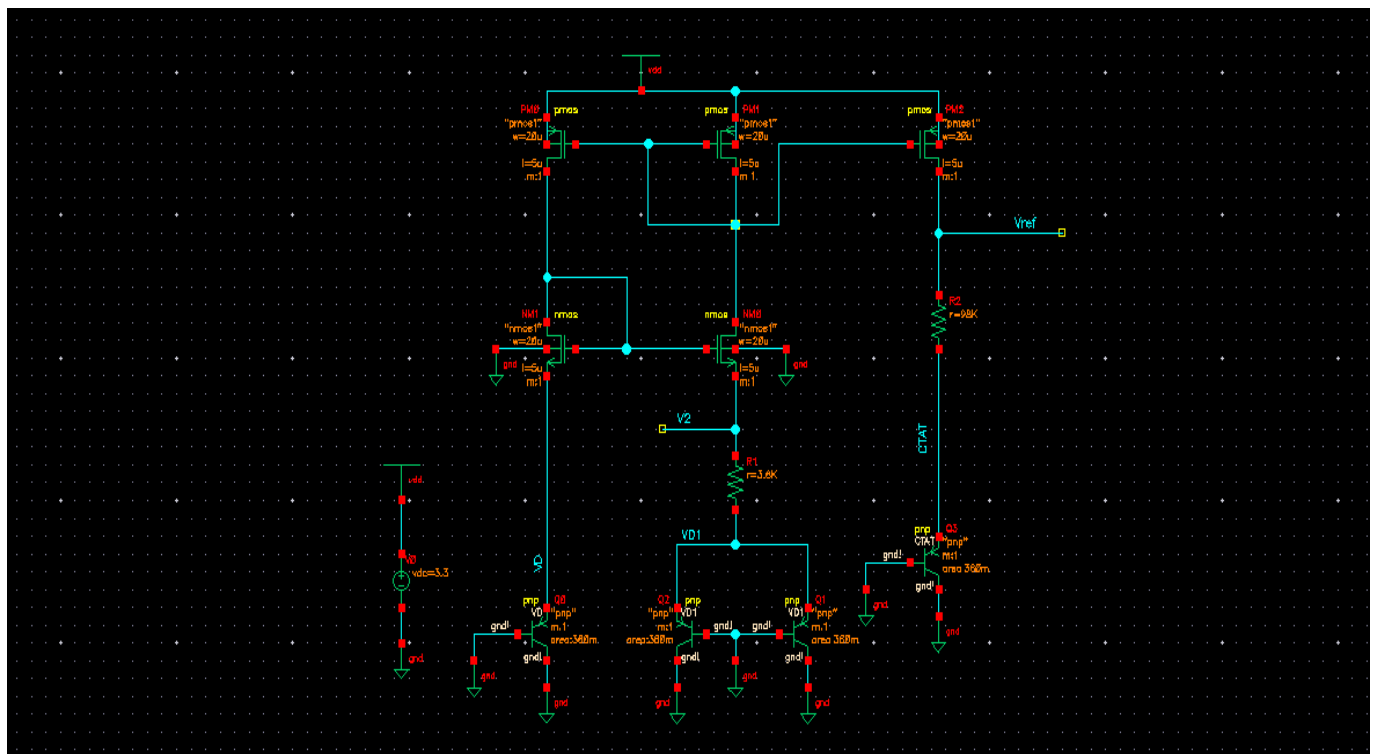


Fig 4: Schematic of the final circuit implementation

## Results:

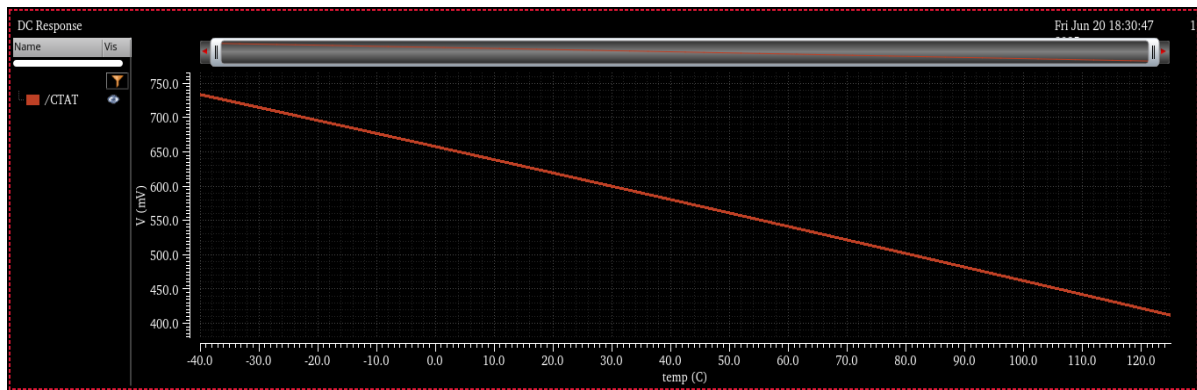


Fig5: CTAT graph

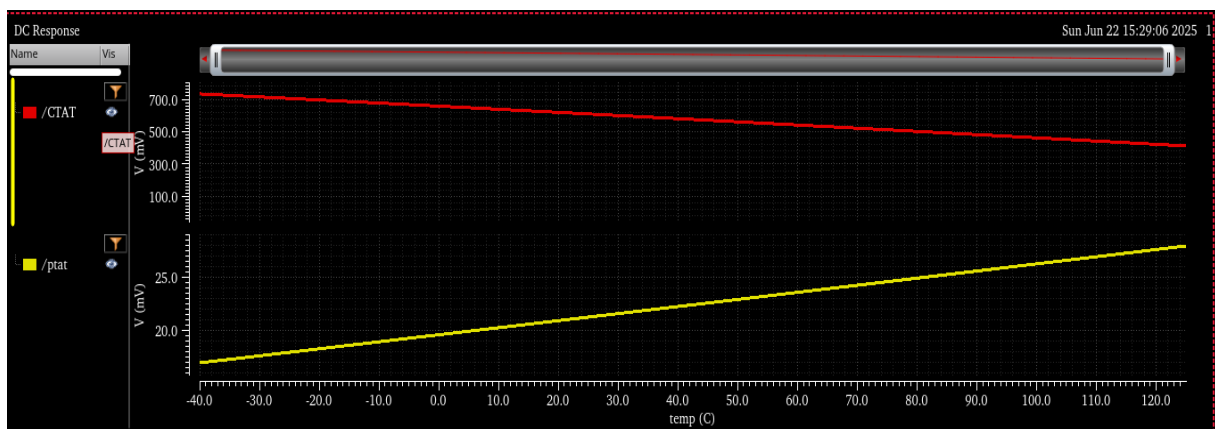


Fig5: CTAT and PTAT graph

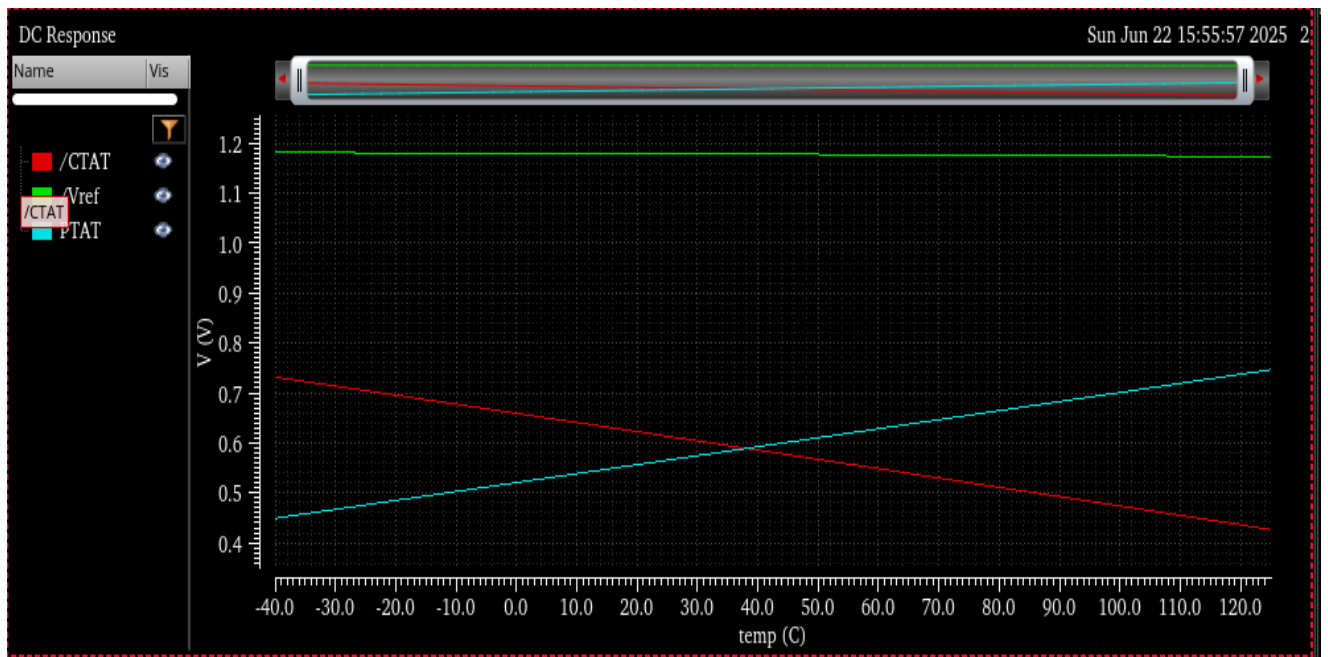


Fig 6: Final V reference voltage variation with Temperature

### Variation with supply voltage:

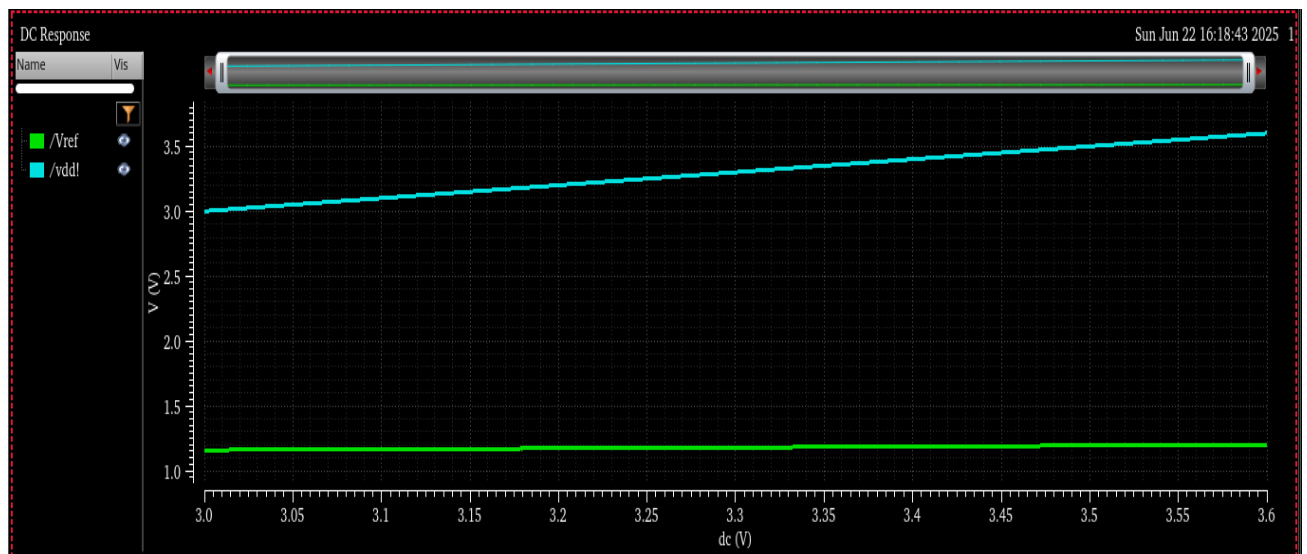


Fig 7: Variation with supply voltage