BOOST CONVERTER CLOSED LOOP
Description of Boost Converter

- In a boost converter, the output voltage is greater than the input voltage, hence the name “boost”.

- The function of boost converter can be divided into two modes, Mode 1 and Mode 2.

- Mode 1 begins when Switch “ S ” is ON at time t=0. The input current rises and flows through inductor L and Switch.

- Mode 2 begins when Switch “ S ” is OFF at time t = t1. The input current now flows through L, C, load, and diode. The inductor current falls until the next cycle. The energy stored in inductor L flows through the load.

- By the proper design of the inductor and the capacitor values and the duty cycle of the triggering pulse with the suitable switching frequency, gives the output from the converter.
Closed Loop Control

- The purpose of a switching regulator is to maintain its output under load disturbances and input voltage variations.

- This can only be achieved via feedback control scheme. There are two basic approaches to achieve the closed loop control of a switching converter.

- One is the voltage-mode control via the output feedback only, the other is Current-mode control by adding an inner current control loop to regulate the inductor current.

- The schematics of voltage-mode buck switching regulator is designed using the SolidThinking Activate tool.
PID Theory

- There are many types of the feedback controller, such as PID, phase-lead, 2nd-order filter, or a specifically designed frequency compensator, can be used as the loop compensator for the closed-loop voltage regulation of the buck converter.

- In order to reduce the steady-state effect of the disturbance, we analyze PID control, namely proportional + integral + derivative, with inner loop rate feedback.

- According to the Obtained PI Controller, design or tuning a set of the controller parameters to improve the dynamic response under input voltage variations and load disturbances.
PI Controller is a special case of PID controller, but with no use of derivative (D) part of the error. So control signal U for PI controller is given below:

\[ U = K_p + K_i \int \Delta \, dt \]

Where \( K_p, K_i \) is proportional, integral gain, \( \Delta \) is the error or deviation of actual measured value (PV) from the set point (SP)

\[ \Delta = SP - PV \]

The PI controller transfer function \( C(s) \) is given as \( C(s) = K_p + K_i / s \)

General approach to PI tuning:

1. Firstly set \( K_i \) = zero.
2. Increase \( K_p \) until desired response has been obtained
3. Add integral gain and modify \( K_i \) until the removed steady state error.
Pulse Width Modulation

- The Saturation Dc value from the Voltage sensor is fed to the PID control.
- The Obtained DC voltage from the PID controller is fed to the one terminal of the Comparator, the other terminal is fed with the Triangular waveform.
- The comparator compares the Voltage value from the PID control and the Triangular waveform.
- The reference voltage cuts the Triangular wave at certain level of the waveform, thereby obtaining the PWM pulse from the comparator block.
- For different Voltage levels from the PID control, the pulse width of the obtained waveform is adjusted, thereby the duty cycle to the switching device is adjusted
- By controlling the Duty cycle the output voltage of the converter is controlled
PWM Control in Closed Loop

Voltage

Triangular wave

\( V_{\text{ref}1} \)

\begin{align*}
\text{ON} & \quad \text{OFF} & \quad \text{ON} & \quad \text{OFF} & \quad \text{ON} & \quad \text{OFF} & \quad \text{ON} \\
\text{ON} & \quad \text{OFF} & \quad \text{ON} & \quad \text{OFF} & \quad \text{ON} & \quad \text{OFF} & \quad \text{ON}
\end{align*}

\( V_{\text{ref}2} \)

Time

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Circuit Topology
Output Voltage Waveform
Conclusion

- Boost converter is used in the SMPS topologies, used to boost up the voltage from lower level to the higher level without change in the power level.

- Boost converters are used in the solar inverters and many step-up dc voltage as a source input.

- Thus by using the Activate the boost Converter topology is implemented.