Designing a flyback DC/DC converter

Video 1
Guidelines for topology selection

Brigitte Hauke – Boost and Buck-Boost Controller Application Manager

Youhao Xi – Boost and Buck-Boost Controller Application Manager

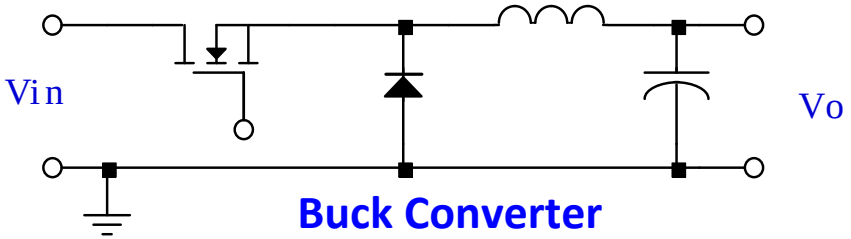
June 2023

Outline of video series

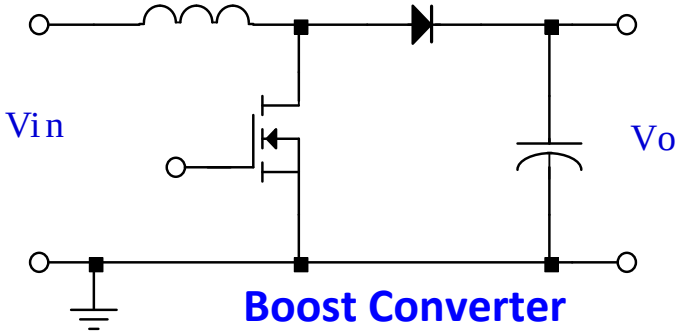
1. Guidelines for topology selection
2. Fundamentals of flyback converters
3. Flyback converter design procedure I
4. Flyback converter design procedure II
5. Flyback transformer basics
6. Practical issues experienced with flyback converters

TOPOLOGY SELECTION

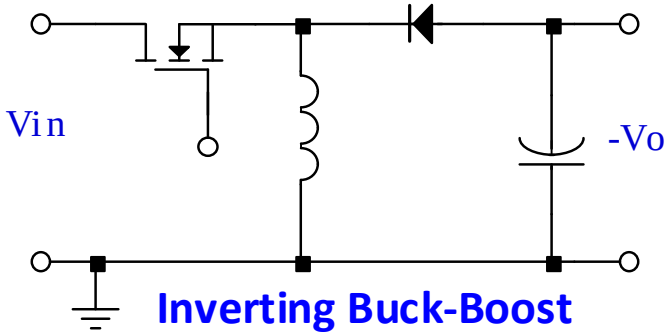
Fundamental DC-DC power converter topologies



Buck Converter



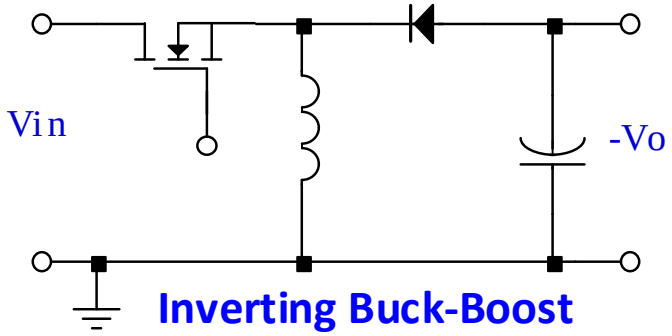
Boost Converter



Inverting Buck-Boost Converter

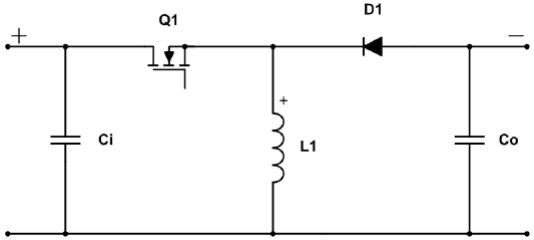
Fundamental DC-DC power converter topologies

When V_{IN} can vary from $<V_{OUT}$ to $>V_{OUT}$ during operation, the buck-boost topology is the right choice.



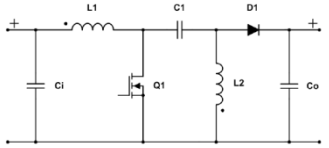
Inverting Buck-Boost Converter

Topologies derived from inverting buck-boost I

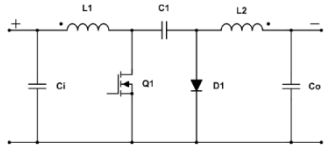


$$D = \frac{|V_{OUT}|}{V_{IN} + |V_{OUT}|}$$

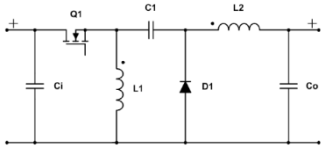
1. **SEPIC**



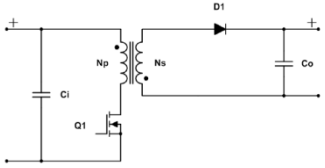
2. **Cuk**



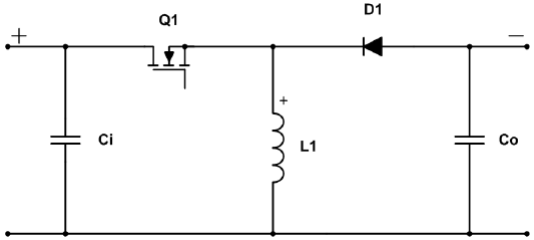
3. **Zeta**



4. **Flyback**

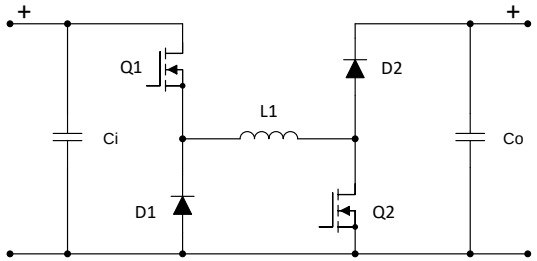


Topologies derived from inverting buck-boost II

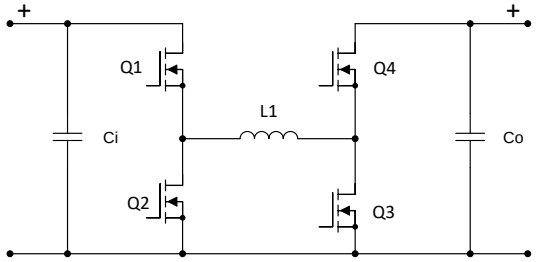


$$D = \frac{V_{OUT}}{V_{IN} + V_{OUT}}$$

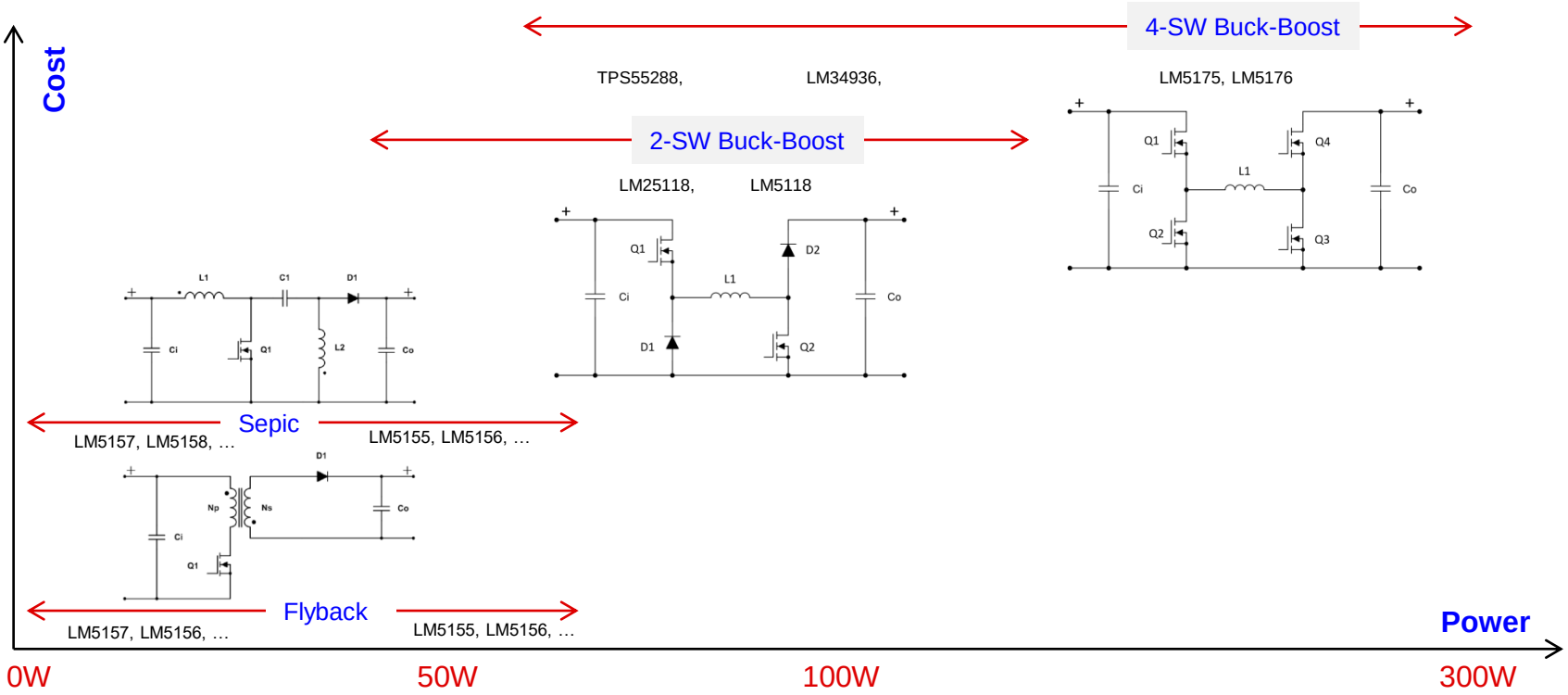
5. 2-SW Buck-Boost



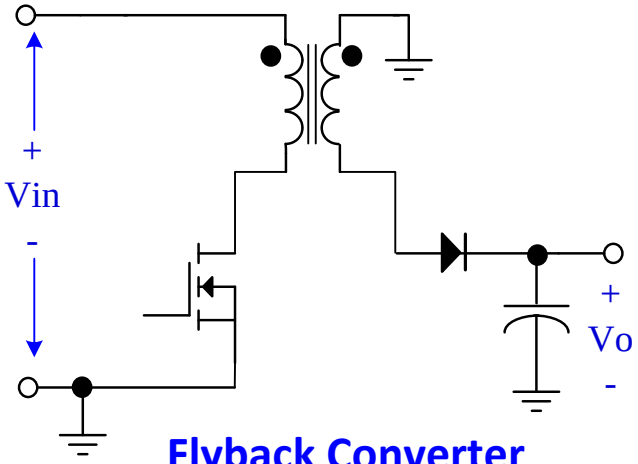
6. 4-SW Buck-Boost



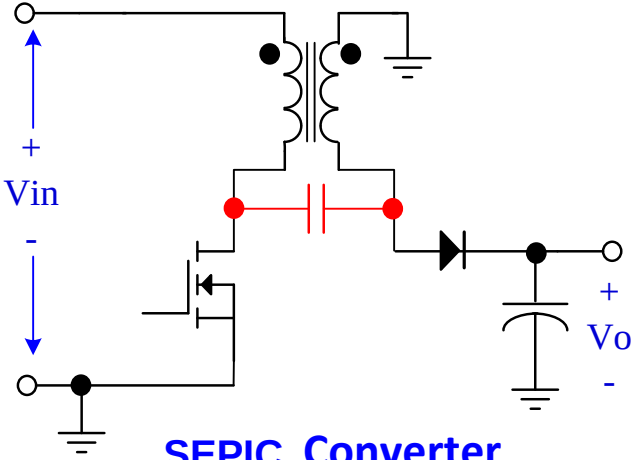
Guideline of topology selection



Flyback vs SEPIC



Flyback Converter



SEPIC Converter

Flyback vs SEPIC

	Flyback	SEPIC
Pros	• Supporting both isolated and non-isolated outputs • Able to support multiple outputs • Having freedom in duty cycle optimization • Auxiliary winding can save IC power dissipation • Popular, and well understood among engineers	• Lower conducted EMI emission • Clamped switch node ringing • Better availability for separate inductors solutions • Able to support low profile design when using separate inductors
Cons	• Higher conducted EMI emission • High switch node ringing • Transformer often needs custom design • Not easy to support low profile design	• Does not support isolated outputs • No freedom in duty cycle optimization • Slower dynamic response with separate inductors. • Coupled inductor has larger size, and is less available • Less understood among engineers
Suitable Applications	• **Multiple output rails** • **Isolated output(s)** • **Wider input voltage range** • **Possibly lower IC power dissipation**	• **Single output rail** • **Non-isolated output** • **Narrower input voltage range** • **Lower profile solution (separate inductors)**

Video 1 summary – video 2 to 6 outlook

- **We discussed**
  - **Topology selection guidelines** based on power level
    - Flyback and SEPIC topologies comparison and their suitable applications

- **We will discuss**
  - **Fundamentals of flyback:** operating modes and key parameters
  - **Design procedure** demonstrated with LM5155 example**, for non-isolated, PSR and isolated applications**
  - **Flyback transformer basics**, and the need of air gap
  - **Frequently asked questions** including multi rails, light load regulation, and high input voltage solutions, and **commonly seen mistakes**

Tools and application collaterals

Most important: E2E Forum https://e2e.ti.com/support/

All the following are available in the product folders on https://www.ti.com/

1. **Flyback EVMs and user's guides**
2. **Excel design calculators**
3. **WEBENCH™ Power Designer support**
4. **PSpice® models**
   - **Transient model supports flyback**
   - **We are adding more average models for flyback loop simulation**
5. **Application notes**
6. **Reference designs**
   - **You can find many flyback reference designs at: https://www.ti.com/reference-designs/index.html**