Fig. 1. A typical voltage-mode PWM circuit uses a control voltage fed to a comparator to modulate the duty cycle of the regulator output stage.
Current-Mode Operation

For current-mode operation, the average current at the output of the power switch is given by the equation:

\[ I_{average} = \frac{V_{in}}{R} \]

where:
- \( I_{average} \) is the average current at the output of the power switch.
- \( V_{in} \) is the input voltage.
- \( R \) is the resistance.

This equation shows that the average current is directly proportional to the input voltage and inversely proportional to the resistance. In this mode, the output current is controlled by the input voltage, making it suitable for applications where precise current control is required.
Fig. 2. For fixed-frequency operation, an increase in the control voltage causes an increase in the duty cycle of the output of the Fig. 1 circuit.
TWO MAJOR APPLICATIONS OF POWER ELECTRONICS: INDUSTRIAL ELECTRONICS

A. Overview

POWER ELECTRONICS USES NEW SWITCHING CIRCUIT TOPOLOGIES TO MAKE SMALLER, LOWER WEIGHT AND HIGHER EFFICIENCY POWER SUPPLIES. These supplies for the first time are available at variable frequencies need for applications in motor drive and in lighting which together constitute over 75% of electricity use.

![Graph showing device current rating vs. blocking voltage rating]

Clearly, we have different applications that place specific requirements on the solid state switches. Only as advances in solid state switches occurred could these new applications become cost effective. Switch technology is an enabling one for new applications. Two issues are enabling: electrical performance and cost.

B. Improved Motor Control
Building-block Approach to Switching Power Supply Design

START

Design Specification Firm

Which Topology?

From general design requirements, choose a switching regulator topology

Black Box Calculations

Determine semiconductor parts and locate any trouble spots

Transformer Design

Design transformer, wire gauges, etc.

Output Filter & Rectifier Design

Design output indicators & select rectifiers and capacitors.

Power Switch & Driver Design

Design driver circuits

Controller Design

Choose control mode & IC. Design basic functions.

Output Feedback Design

Design Voltage feedback & cross-regulation circuits

From the above approach we need to pick a starting point. We will focus next of the output filter design in the remainder of this lecture and in lectures 5 and 6.

E. BASIC TOPOLOGIES OF PASSIVE L-C FILTERS

We will use L-C filters both to remove $v_{ac}$ signals lost to conversion and to avoid kvl and kil law violations from the switching.

1. DC OUTPUT REACTIVE FILTER (L-C). This places a series L between two voltages sources $v_{in}$ and $v_{out}$. It also removes or reduces the switch signal at $f_s$ and passes only dc if designed properly. Let's look at the two
Linear regulators enable fully regulated 2nd and 3rd auxiliary outputs.

Talk #1 Chip Choices
Talk #6 Details