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Designing DC-DC Power Supplies with the LM3477 LM3478 / LM3488

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Switching Regulator Controllers

- LM3477 High side n-channel (Buck)
- LM3478 Low side n-channel (Boost)
- LM3488 Low side n-channel (Boost)

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Buck
Buck-Boost (Invert)
ZETA
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LM3488
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LM3477
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LM3478
SEPIC
CUK
Flyback
Boost

Features

- Vin 2.95 to 40V
- Current mode control
- Adjustable current limit
- Adjustable Slope Compensation
- Adjustable Frequency (100KHz to 1MHz)

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LM347x Controllers versus SIMPLE SWITCHERS DC-DC Converters

- Load current capability
- Degree of control
- Customization

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Flexibility

- LM3477
  - Buck
  - Buck-Boost
  - Zeta
- LM3478 or LM3488
  - Boost
  - SEPIC

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Design Limitations

- Duty-Cycle Limitation (LM3478 / LM3488)
- Minimum On-time
- FET Selection
- Current Sinking Capability

Design Aids

- LM3478/88
  - AN-1204 Application Note
  - Boost Evaluation Board
  - WebSim **POWER.NATIONAL.COM**
- LM3477
  - AN-1193 Application Note
  - Buck Evaluation Board

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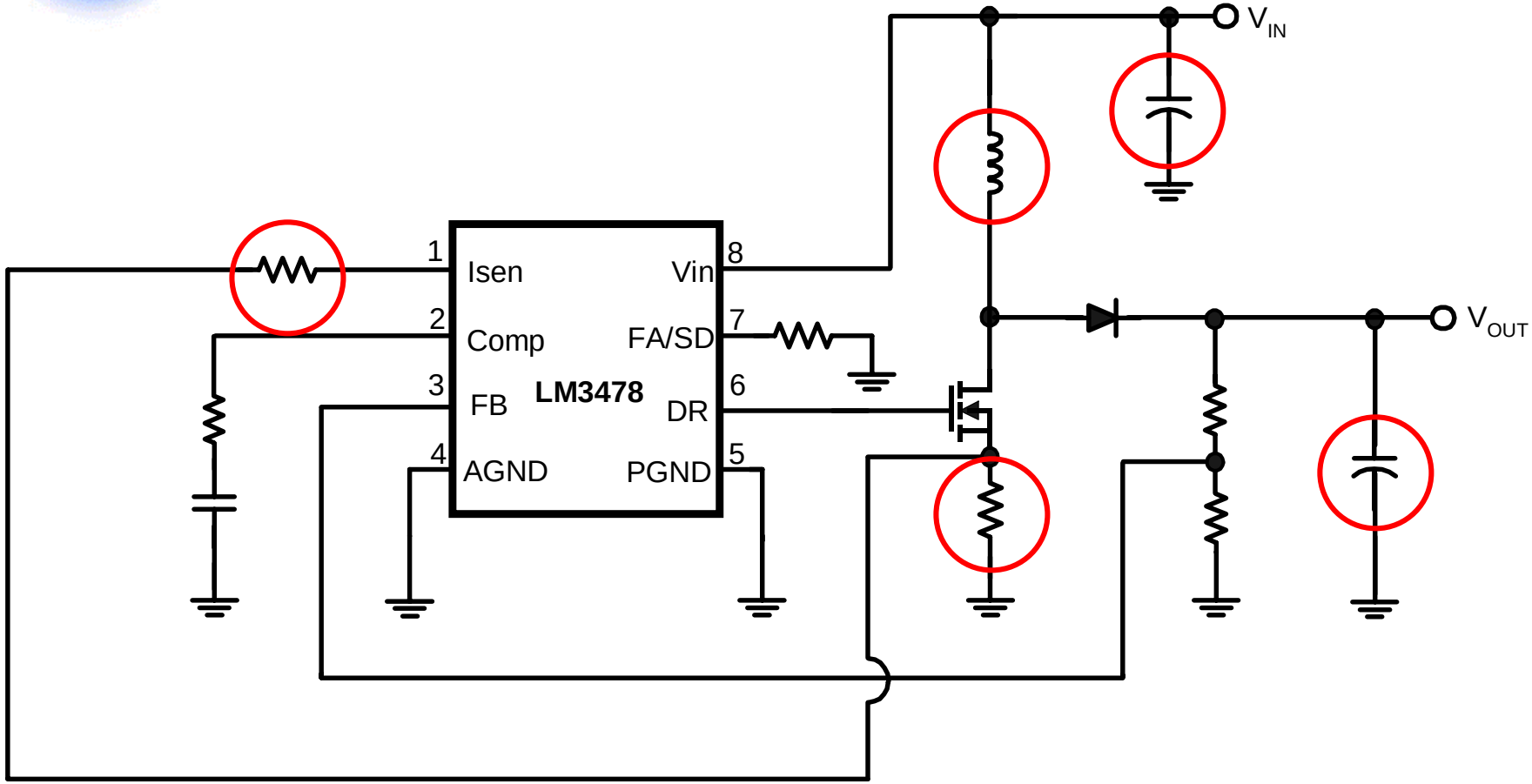
Designing a Boost

- Slope Compensation
- Current Limit
- Inductor Selection
- Capacitor Selection

Highlighted Schematic



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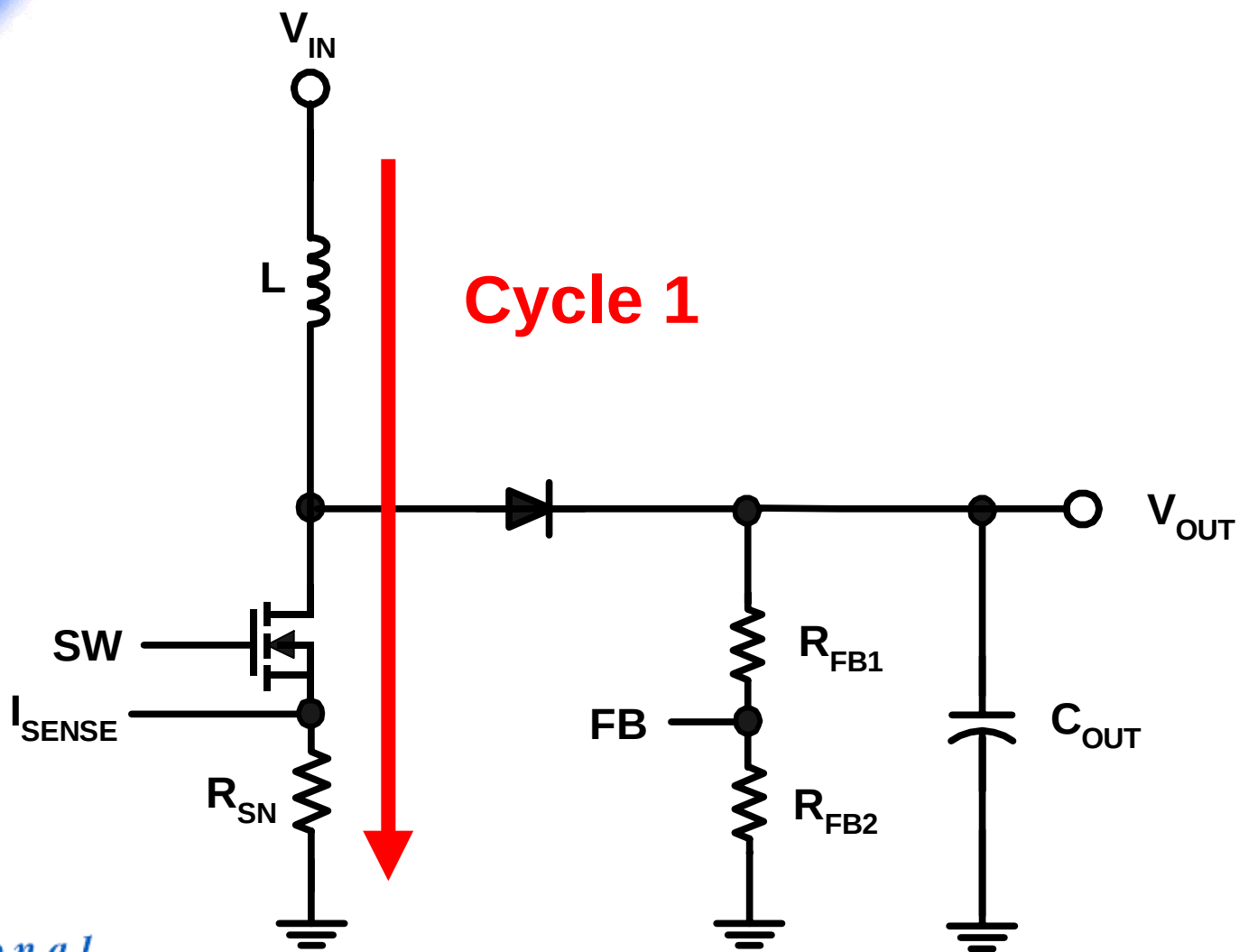
Boost Operation: Switch ON



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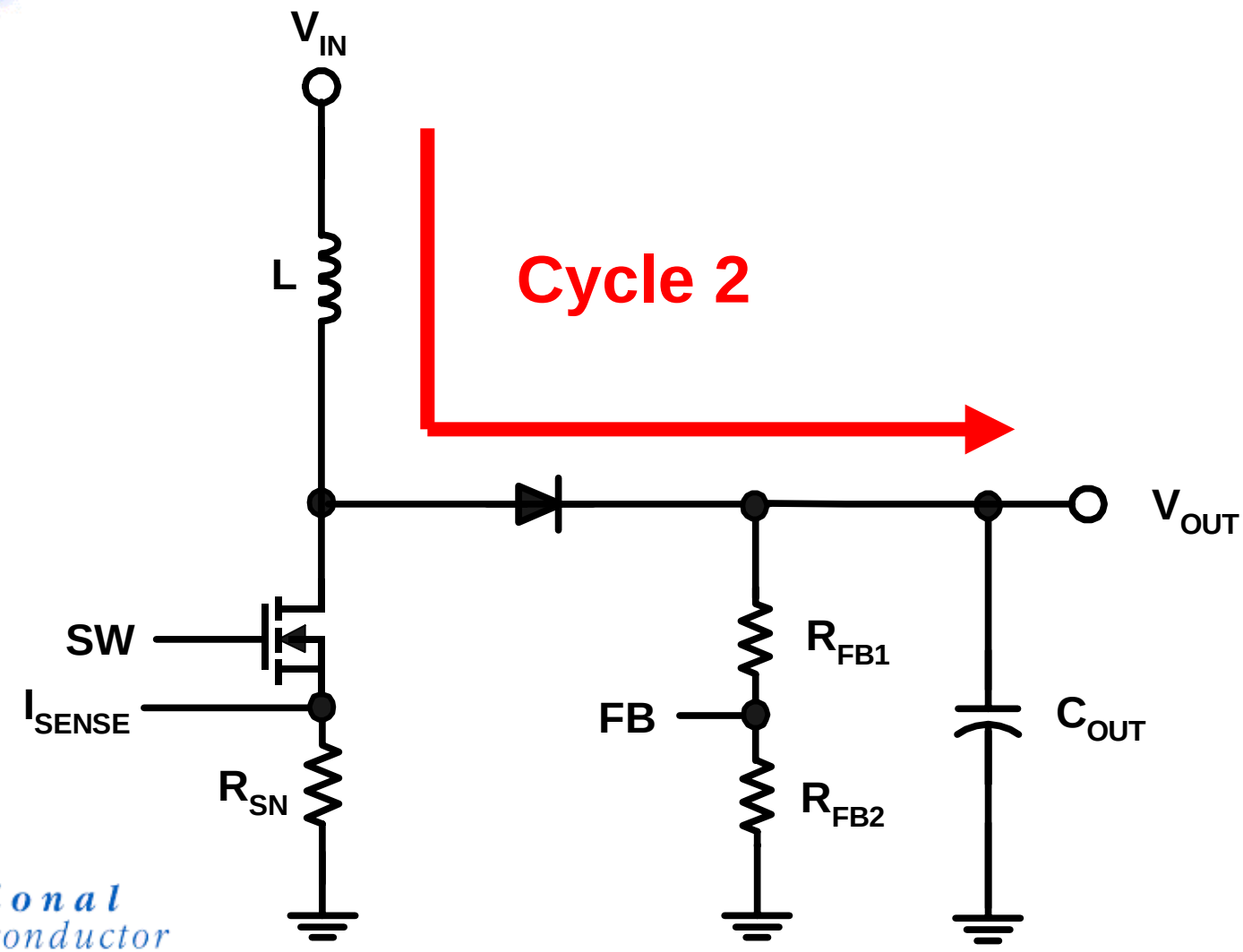
Boost Operation: Switch OFF



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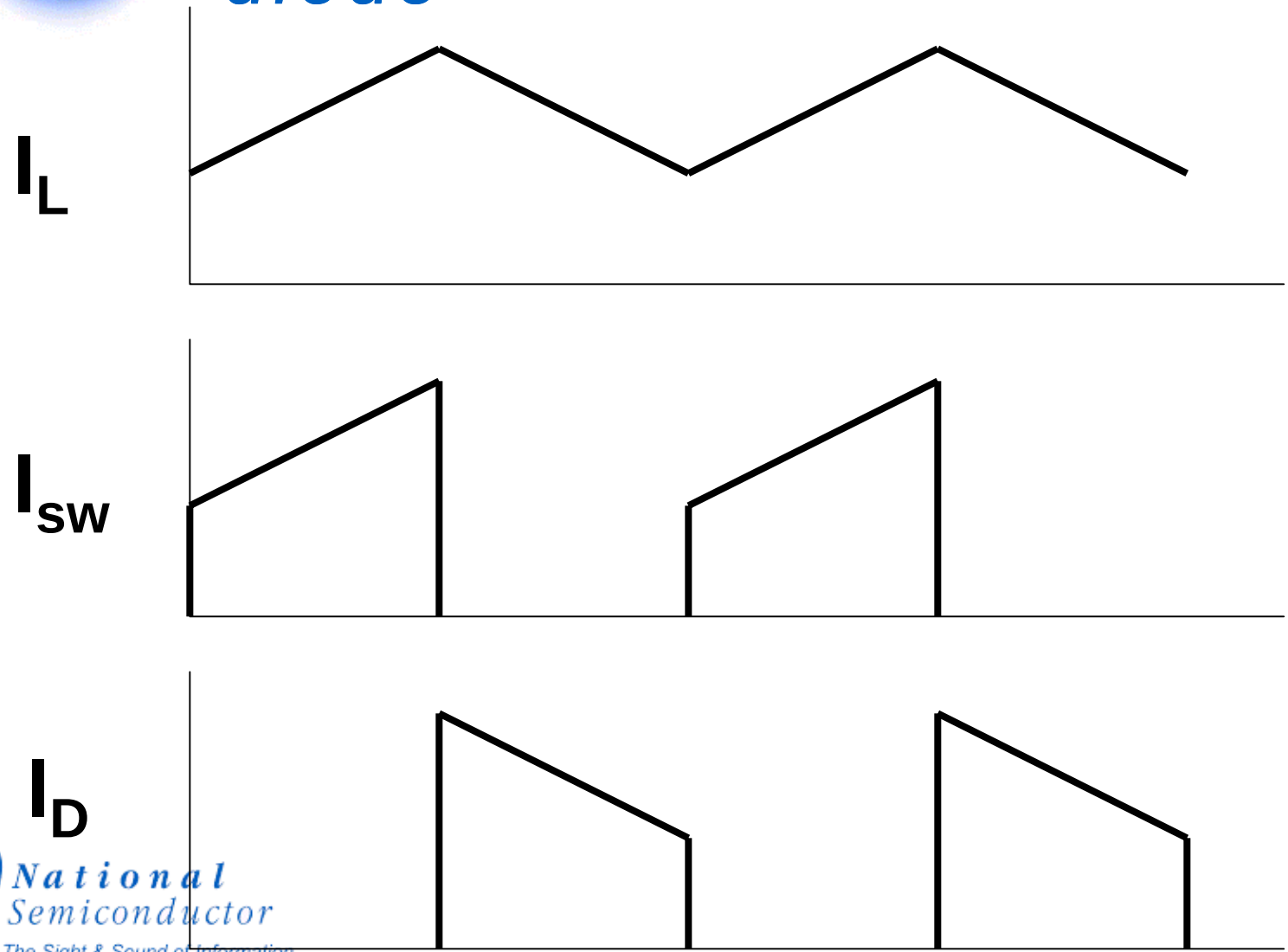
Boost Current waveforms through inductor, switch and diode



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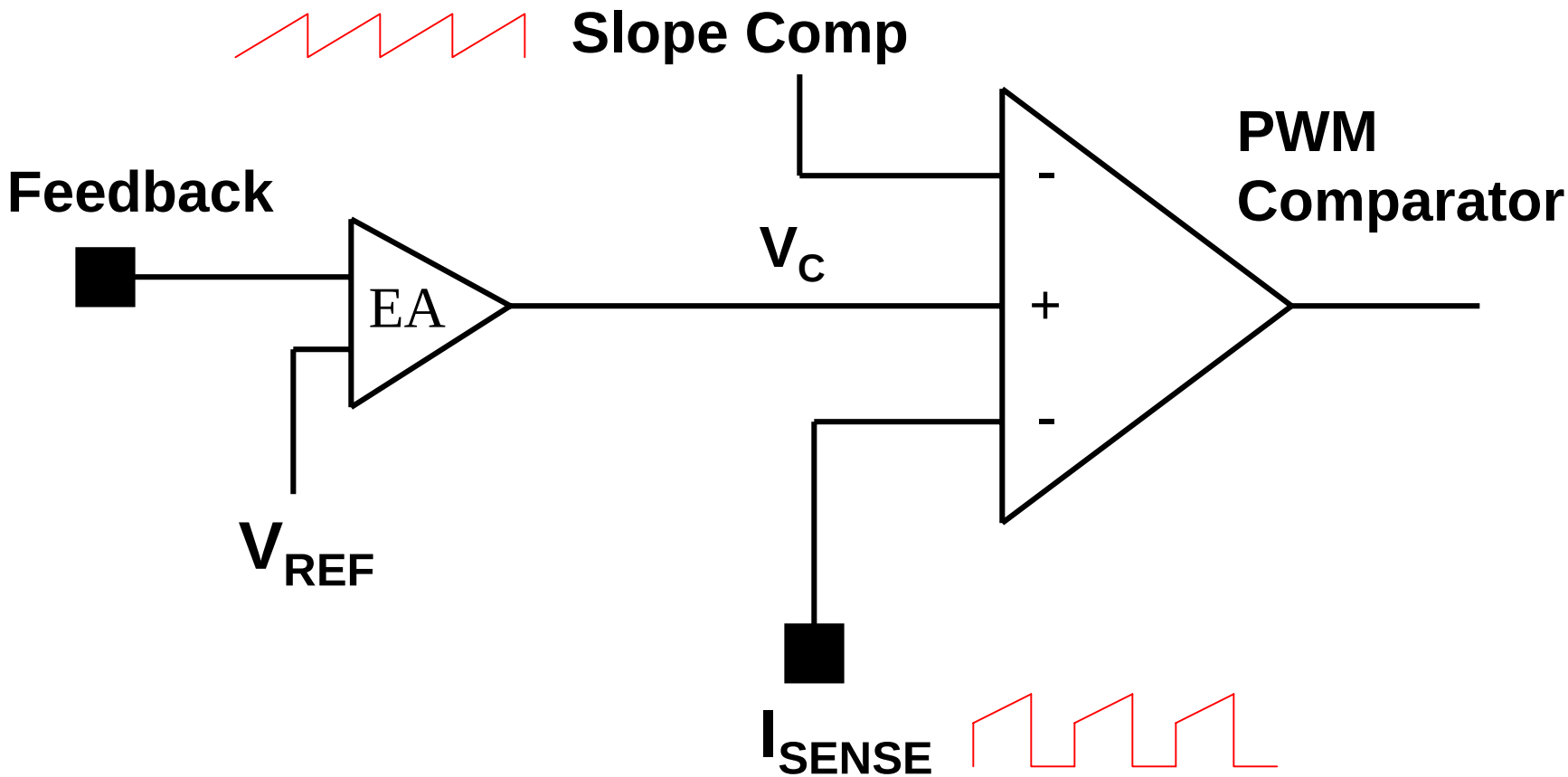
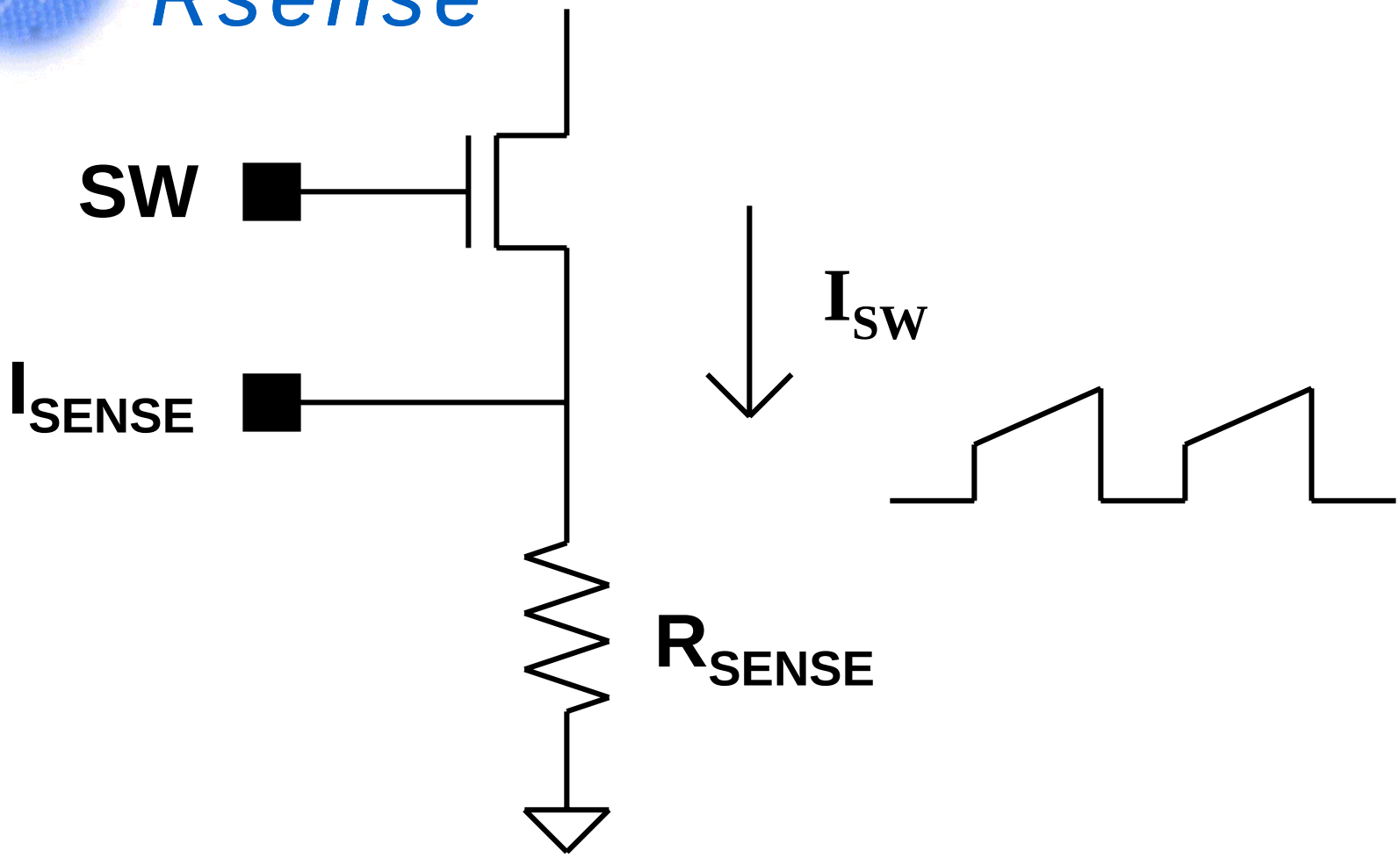
Current Mode Control



Current sense adjusted by Rsense



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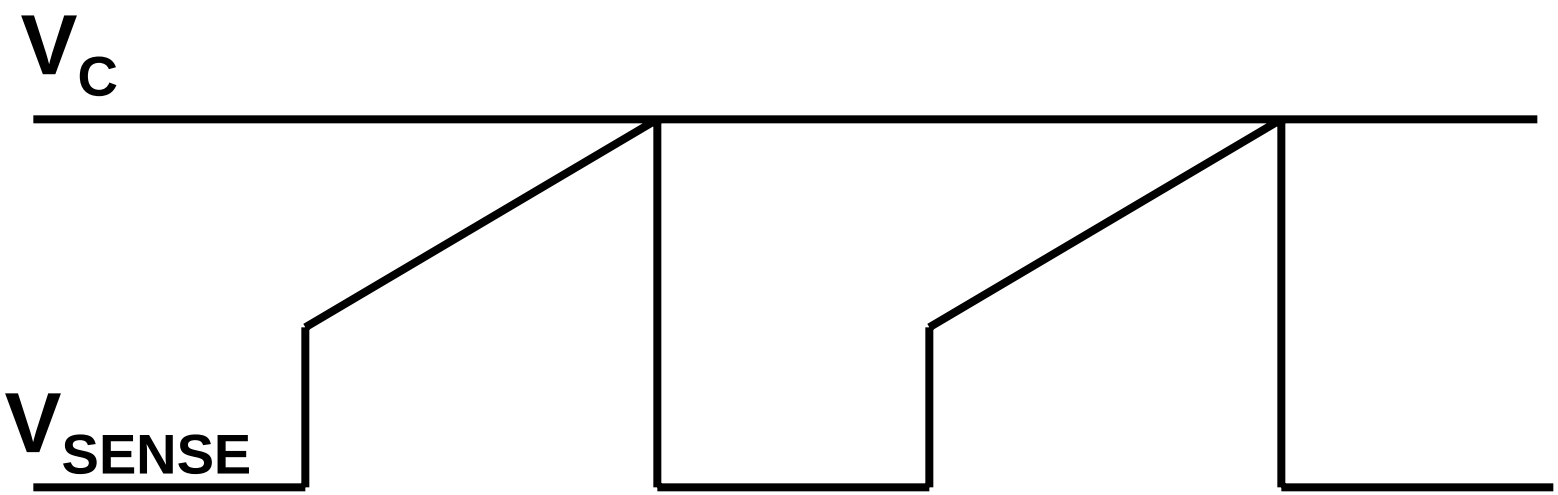
Comparison of Command Voltage and Vsense



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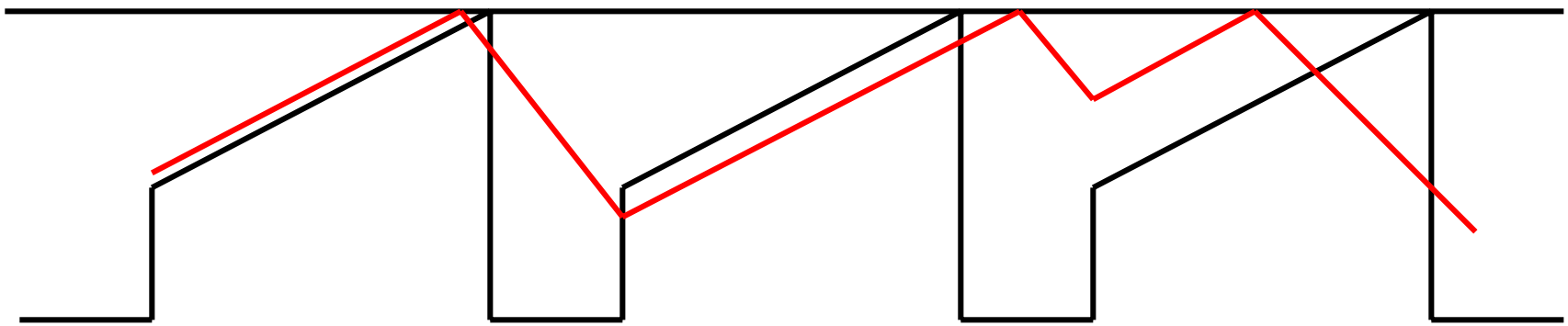
Subharmonic Oscillation



Perturbation causes divergent current waveform

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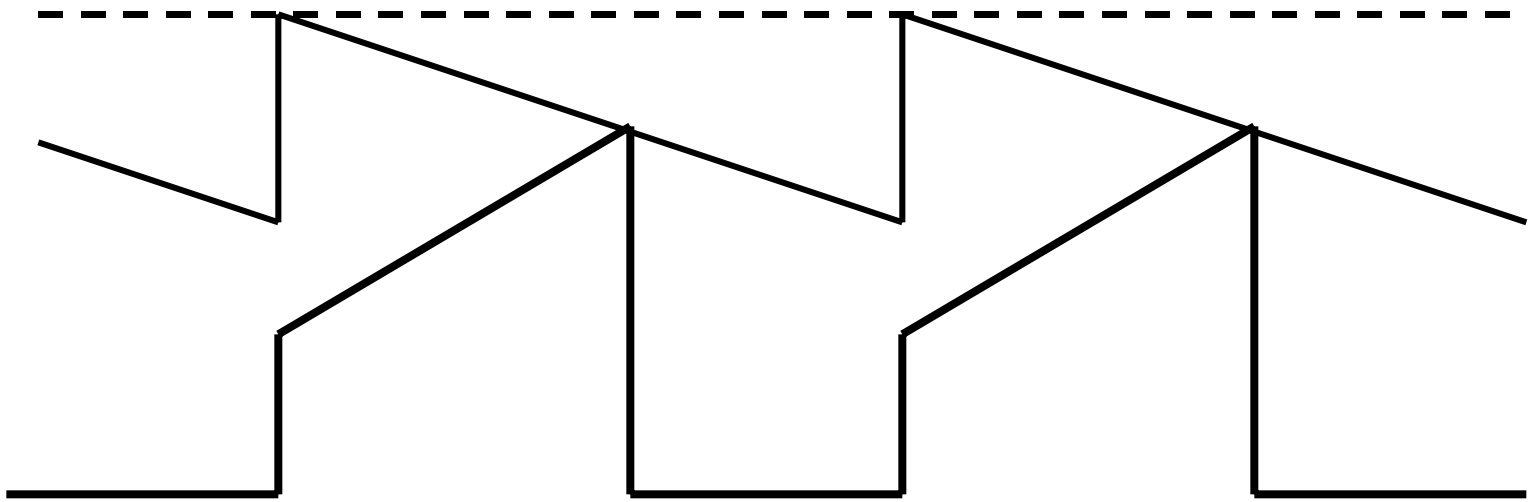
Slope Compensation



Subharmonic Oscillation is prevented by the addition of slope compensation

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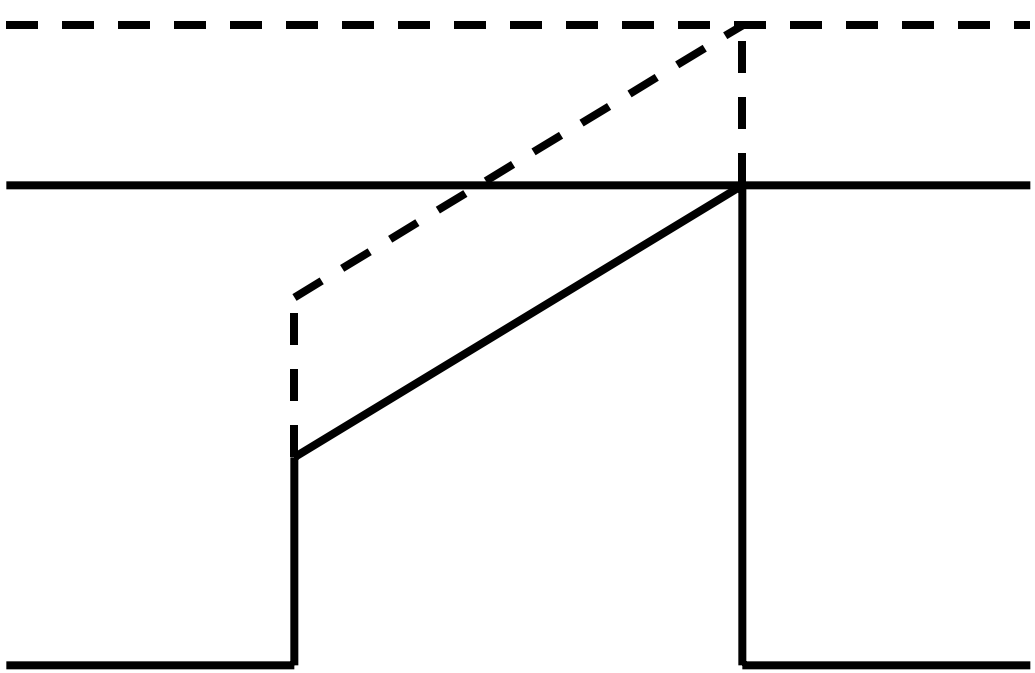
Slope Compensation

- Current Limit
  - Causes a reduction in current limit dependant on duty-cycle
- Inductor Selection
  - Allows smaller inductors to be used

Current Limit



$$V_{C_{MAX}} = I_{SW} \times R_{SENSE}$$

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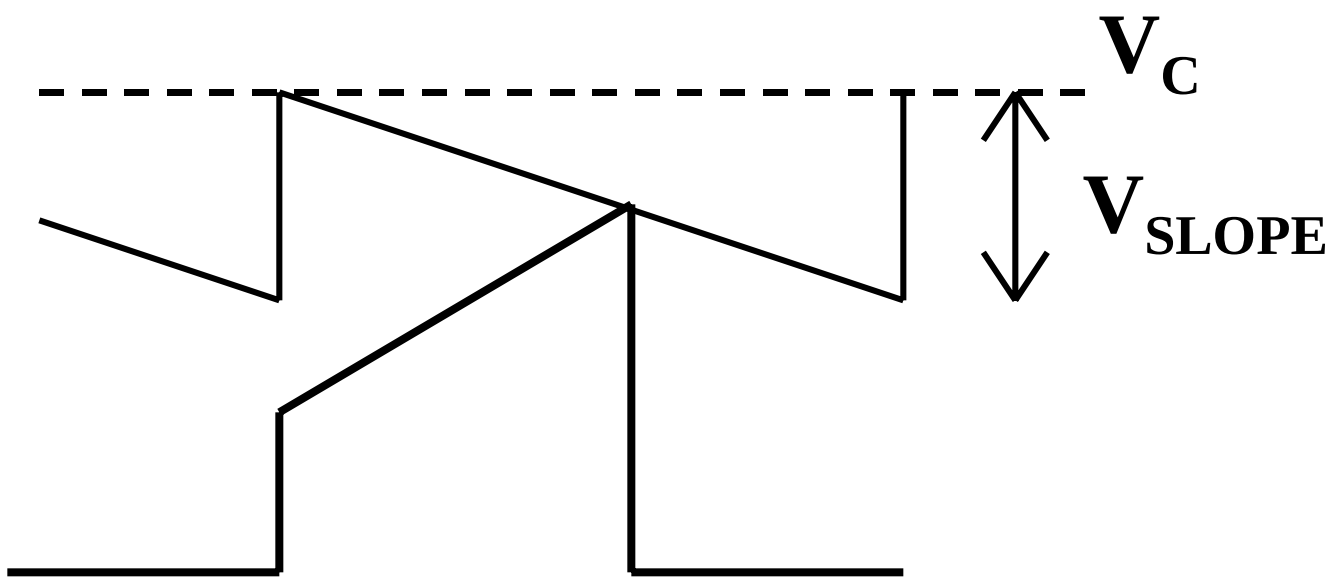
Slope Compensation reduces current limit



$$V_{C_{MAX}} - (V_{SLOPE} \times D) = I_{SW} \times R_{SENSE}$$

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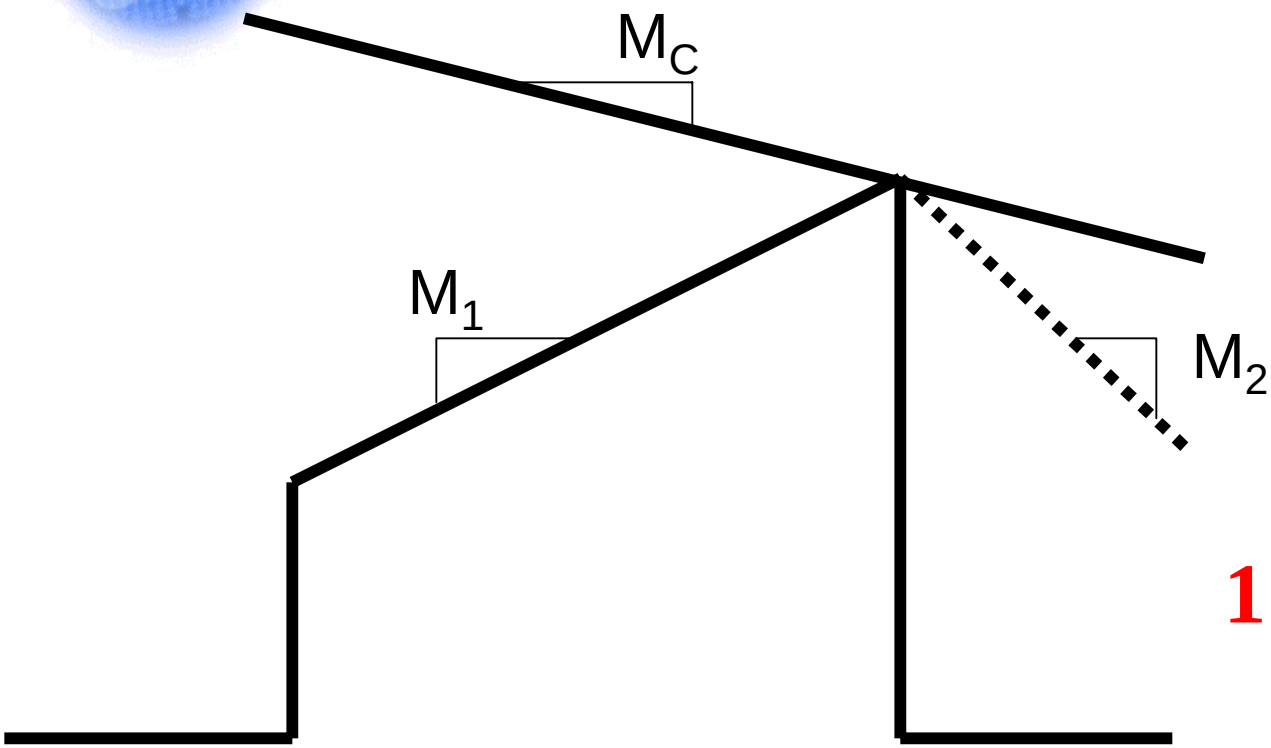
Determining Slope Compensation



$$1 > \frac{(M_2 - M_c)}{(M_1 - M_c)}$$

$$M_1 = \frac{V_{IN}}{L} \qquad M_2 = \frac{V_{IN} - V_{OUT}}{L}$$

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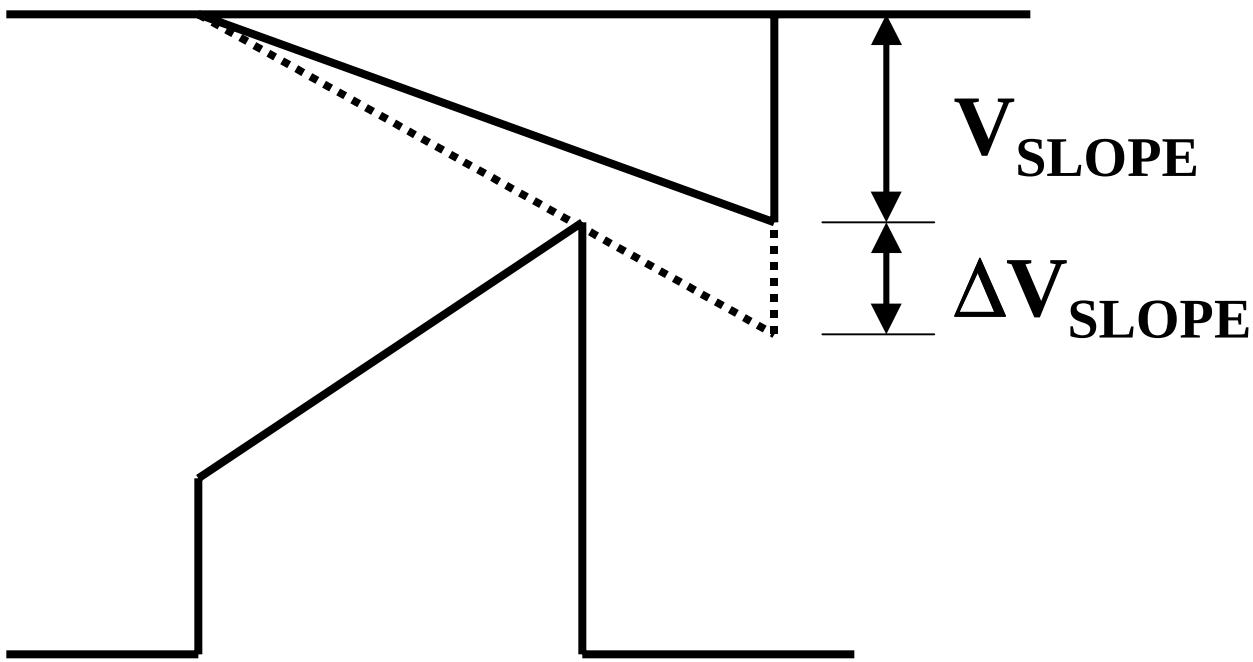
Adding Slope Compensation



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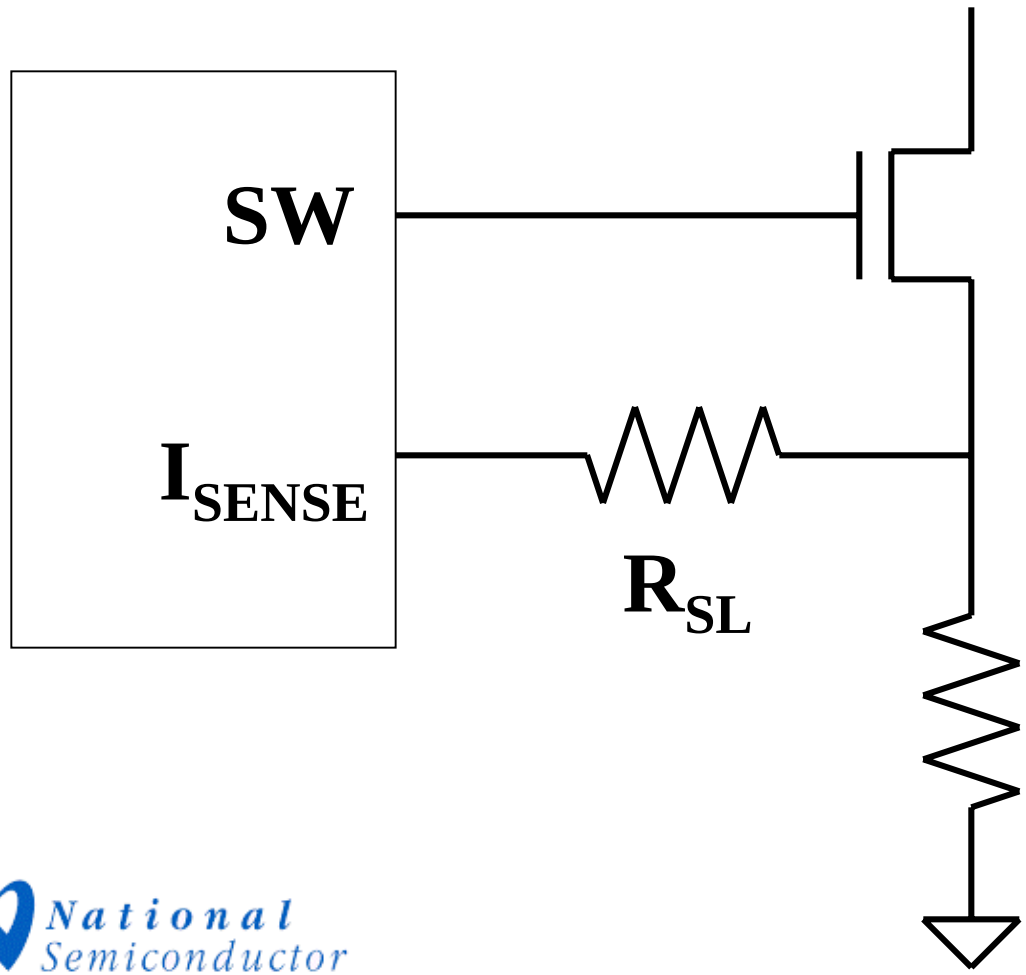
Slope compensation is adjusted by Rsl



Rsl is selected by table in datasheet

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Complete Current Limit

$$V_{C_{MAX}} - (V_{SLOPE} + \Delta V_{SLOPE}) \times D = I_{SW} \times R_{SENSE}$$

$$\downarrow$$

$$R_{SENSE} = \frac{V_{C_{MAX}} - (V_{SLOPE} + \Delta V_{SLOPE}) \times D}{\frac{I_{OUT}}{(1 - D)} + \frac{D \times V_{IN}}{2 \times f_S \times L}}$$

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Capacitor Selection

- Input Capacitor
  - Impedance Interaction
  - RMS Current
  - Peak Voltage
- Output Capacitor
  - RMS Current
  - Peak Voltage
  - ESR

FET Selection

- Peak Voltage
- Maximum Current
- Gate Charge
- R_{DSON}

Compensation

- Websim
  - **POWER.NATIONAL.COM**
- Application Notes
  - **WWW.NATIONAL.COM**

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