D1: Boost Converter Project

Mark French & Klaus-Peter Zauner

ELEC1200/1201: Circuits & Programming

Project Topic

You will build a computer controlled power supply:

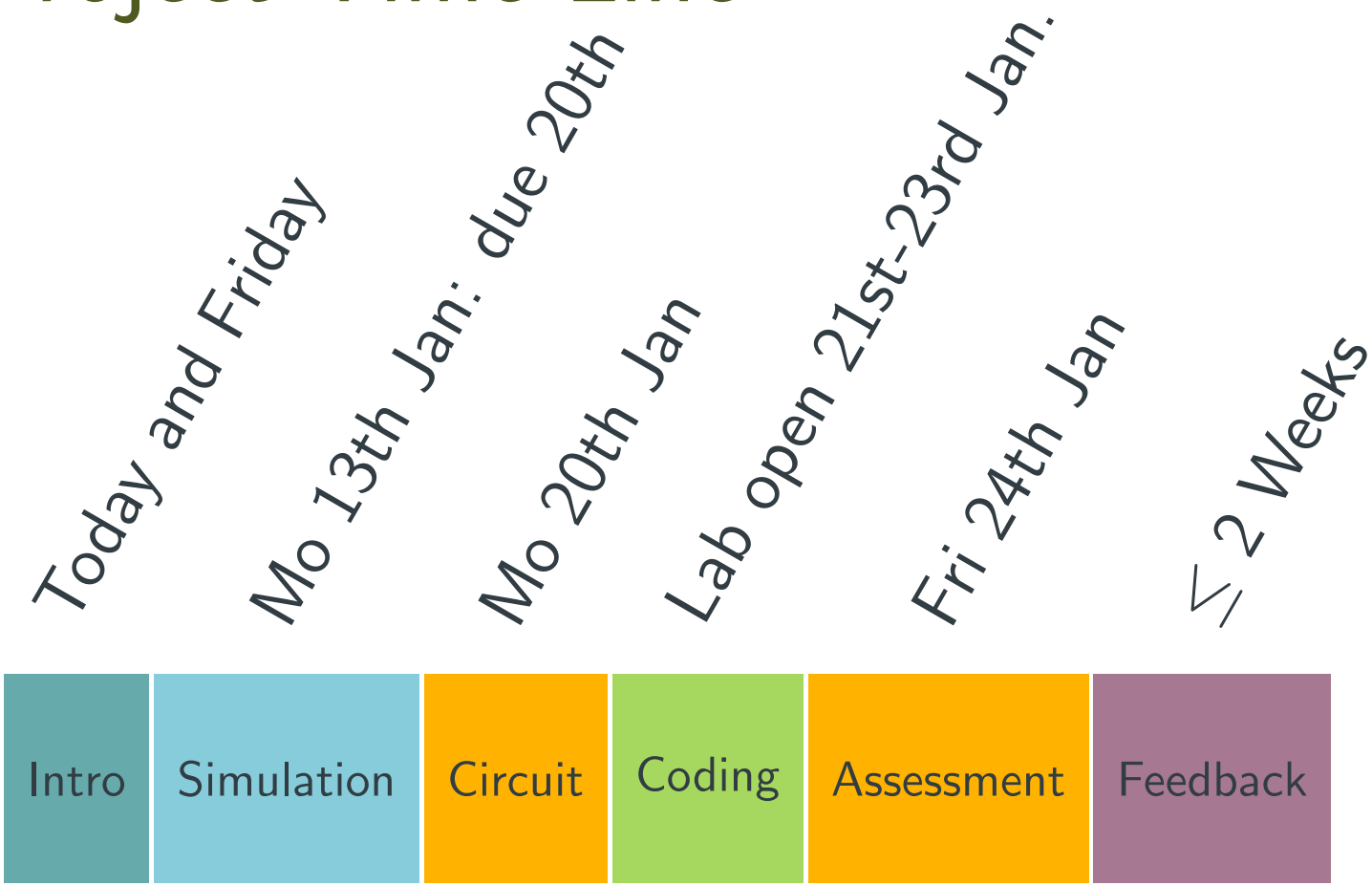
- Use a 1.5 V source (e.g., an AA battery)
- Generate output voltage up to 12 V
- Circuit Simulation
- Host Programming
- Embedded Programming
- Serial Communication (Host $\leftrightarrow$ IIMatto)
- PWM control
- Analouge Input
- TFT Display

Project Topic

You will build a computer controlled power supply:

- Use a 1.5 V source (e.g., an AA battery)
- Generate output voltage up to 12 V
- Circuit Simulation
- Host Programming
- Embedded Programming
- Serial Communication (Host $\leftrightarrow$ IIMatto)
- PWM control
- Analouge Input
- TFT Display

Project Time Line



You will have lab access either AM or PM every day from 20th–24th Jan. You are expected to work on your code the other half of the day.

Boost Converter: Applications I

1. Energy Harvesting

- Solar
- Wind
- Thermo-Couple

2. Reduce Battery Cell Number

- LED Lights
- Laptops
- Cars
- Run 5V devices of LiPol Cell (3 V–4.2 V)
- Rechargeables (1.2V) instead of Alkaline (1.5V)

Boost Converter: Applications I

1. Energy Harvesting

- Solar
- Wind
- Thermo-Couple

2. Reduce Battery Cell Number

- LED Lights
- Laptops
- Cars
- Run 5V devices of LiPol Cell (3 V–4.2 V)
- Rechargeables (1.2V) instead of Alkaline (1.5V)

Boost Converter: Applications I

1. Energy Harvesting

- Solar
- Wind
- Thermo-Couple

2. Reduce Battery Cell Number

- LED Lights
- Laptops
- Cars
- Run 5V devices of LiPol Cell (3 V–4.2 V)
- Rechargeables (1.2V) instead of Alkaline (1.5V)

Boost Converter: Applications II

3. Higher Voltage Components

- Nixi Tubes
- Xenon Stroboscobes

4. Subgroup Supply

- Symmetric Supply for an OP Amp
- More "Headroom" for Amplifier
- Unstable supply

Boost Converter: Applications II

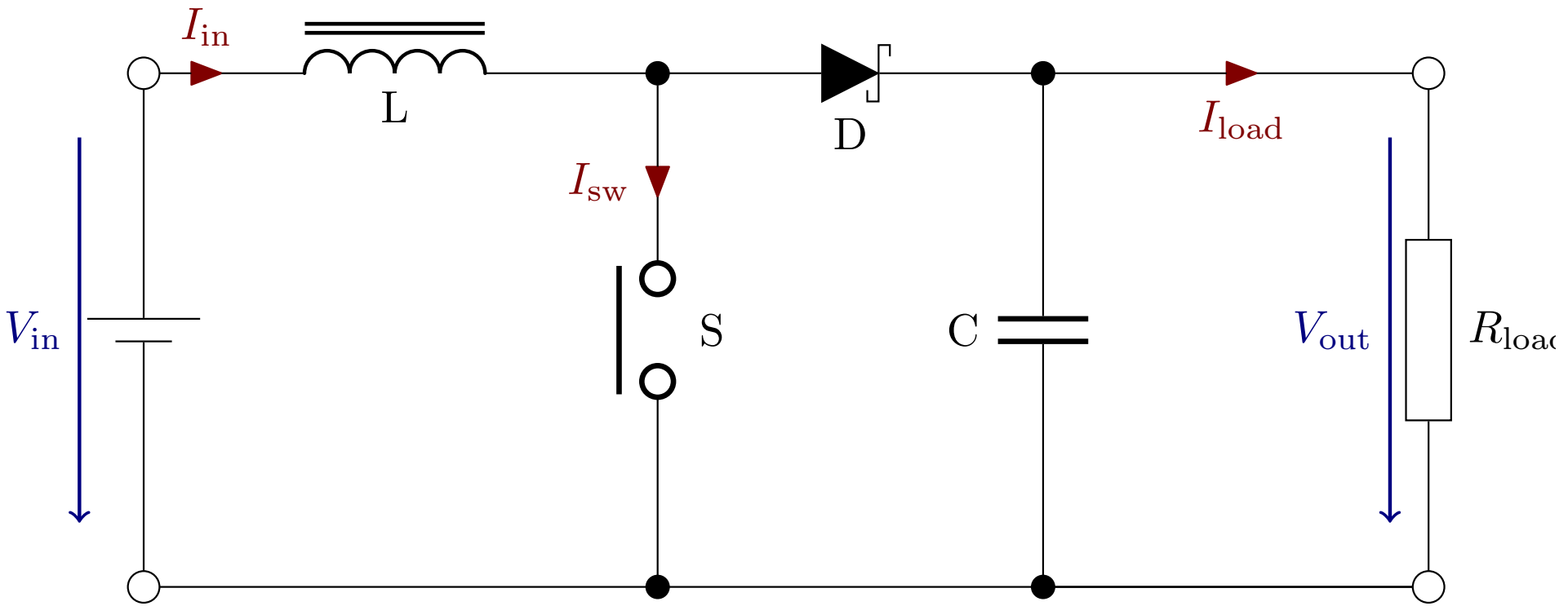
3. Higher Voltage Components

- Nixi Tubes
- Xenon Stroboscobes

4. Subgroup Supply

- Symmetric Supply for an OP Amp
- More "Headroom" for Amplifier
- Unstable supply

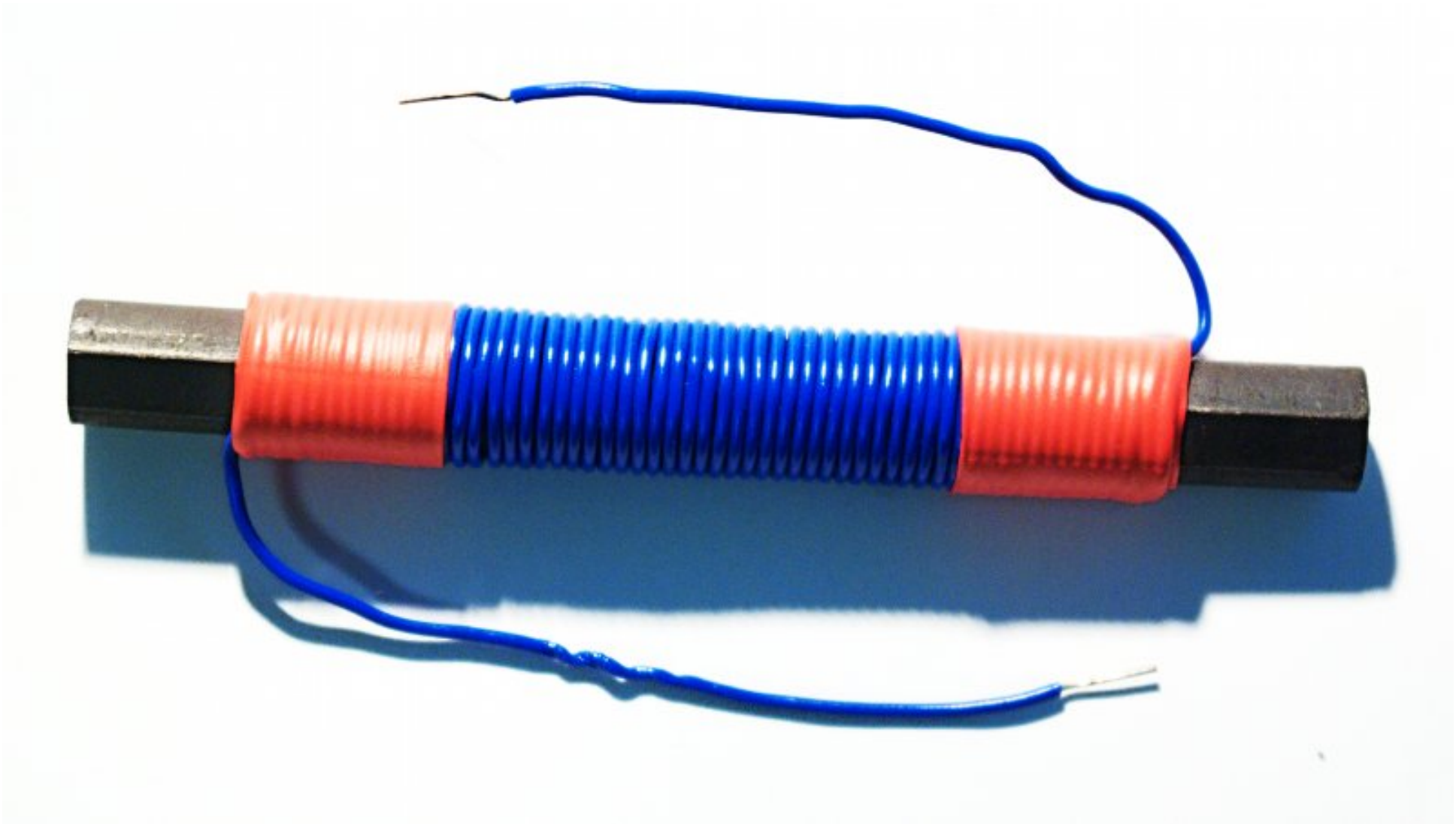
Boost Circuit



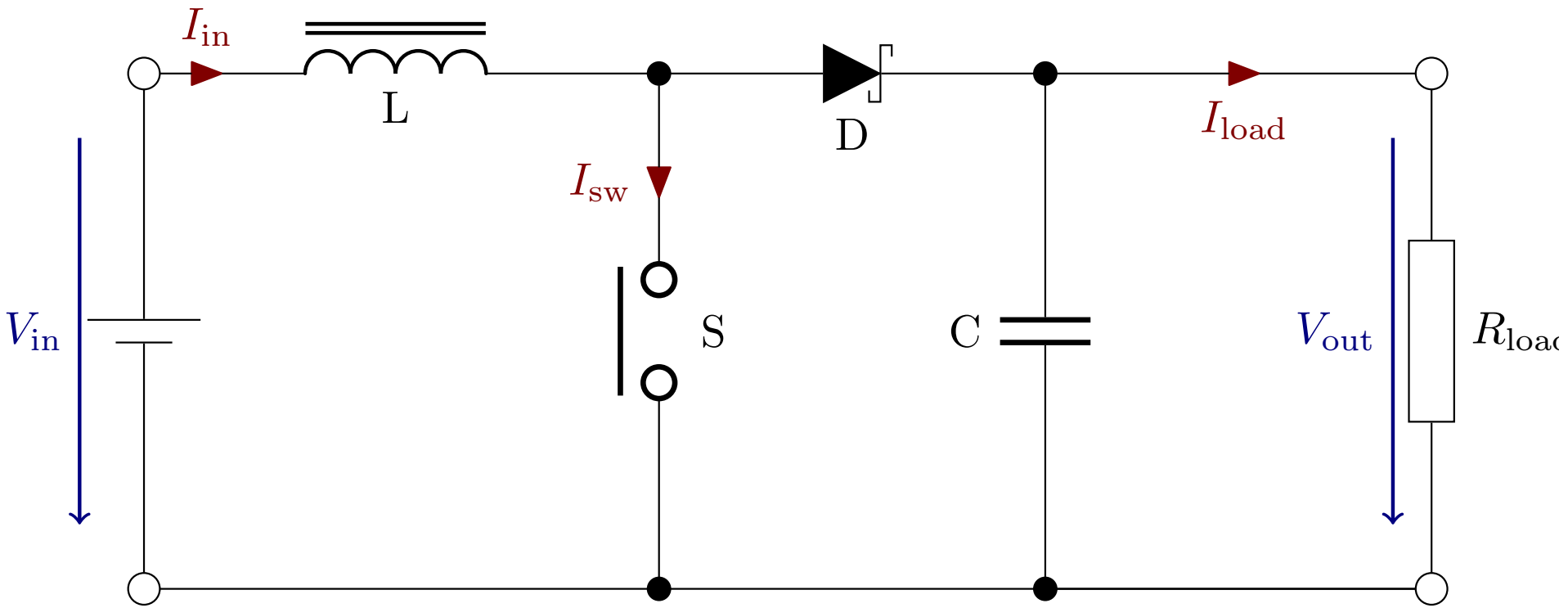
As a switch we will use an n-MOSFET that can be controlled with the 3.3 V IIMatto board.

Coil

You will wind and characterise your own coil:

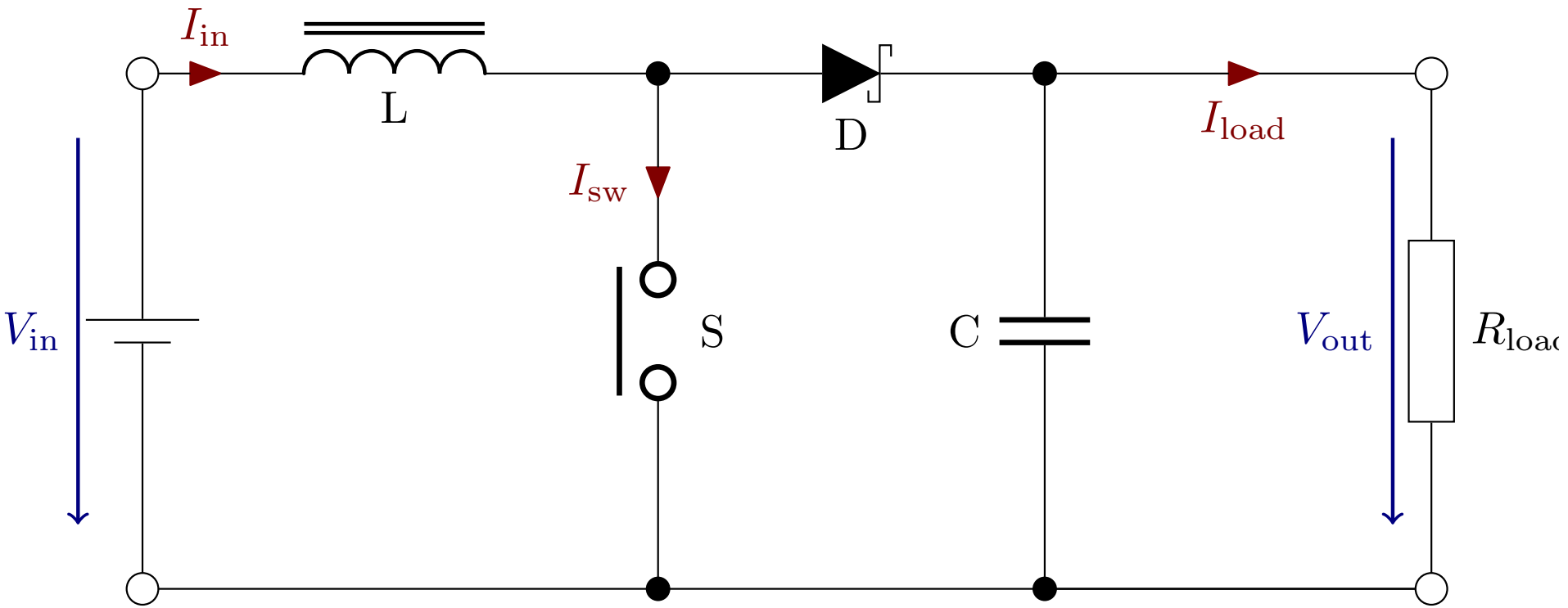


Boost Converter: Properties



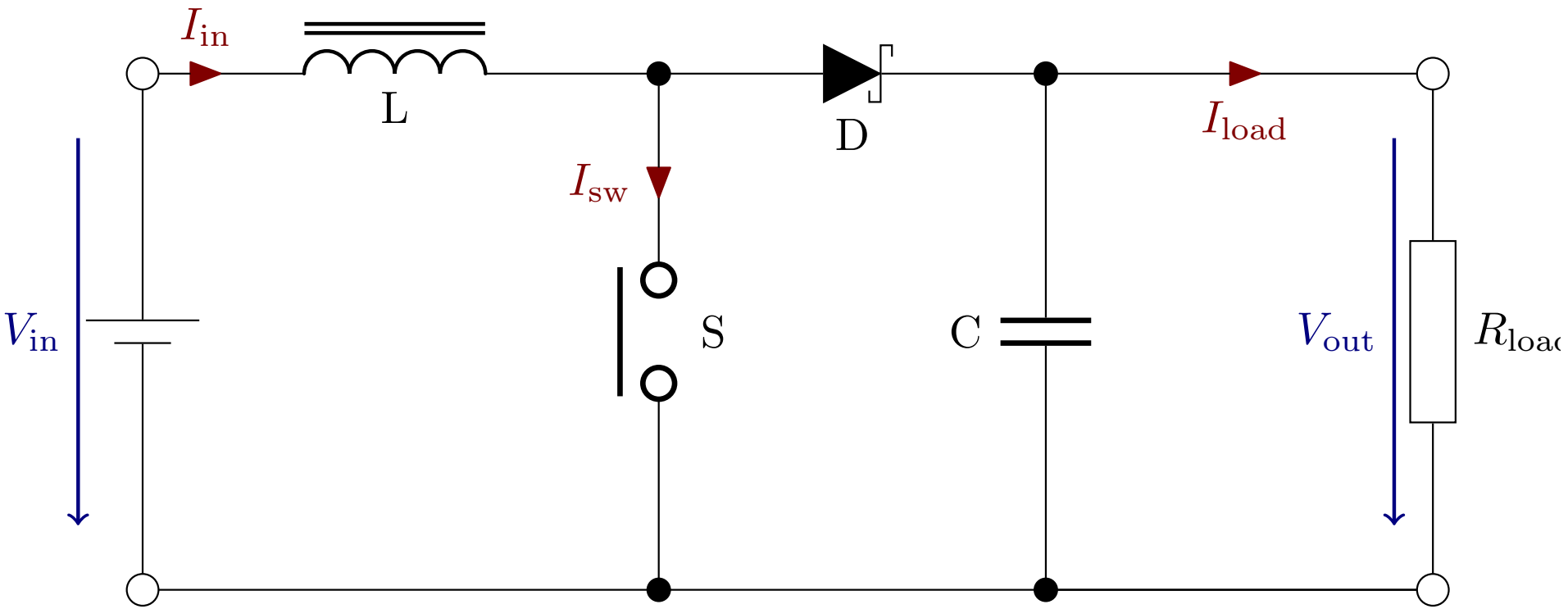
- No isolation between input and output
- Typically common ground

Boost Converter: Properties



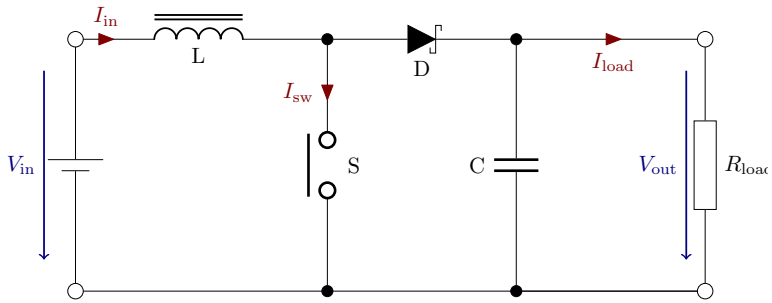
- No isolation between input and output
- Typically common ground

Boost Converter: Properties



- No isolation between input and output
- Typically common ground

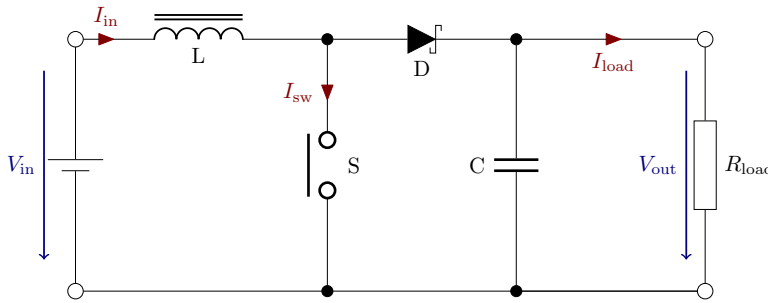
Boost Converter: Considerations



Switching Frequency:

- Ripple *vs.* Capacitor size
- Losses in switching transition
- Losses in inducter hysteresis
- Component size
- Resistance of coil $\rightarrow$ inductivity *vs.* size

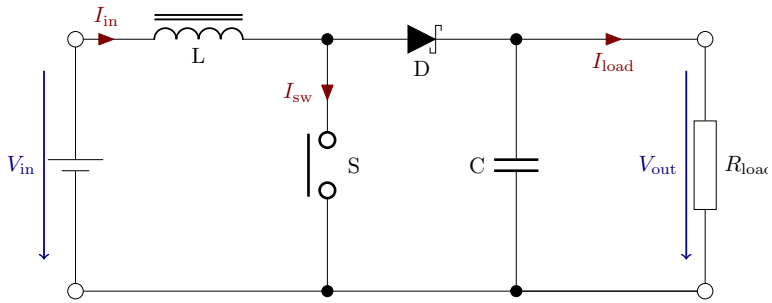
Boost Converter: Considerations



Switching Frequency:

- Ripple *vs.* Capacitor size
- Losses in switching transition
- Losses in inducter hysteresis
- Component size
- Resistance of coil $\rightarrow$ inductivity *vs.* size

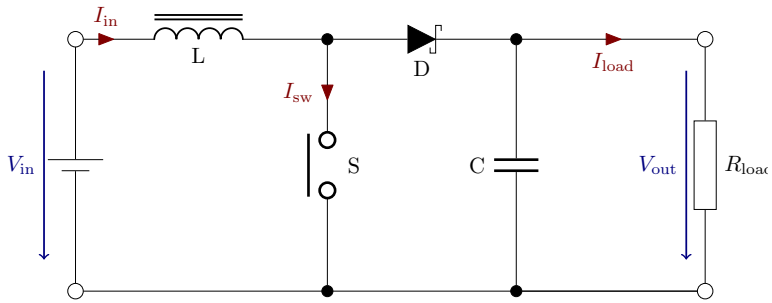
Boost Converter: Considerations



Switching Frequency:

- Ripple *vs.* Capacitor size
- Losses in switching transition
- Losses in inducter hysteresis
- Component size
- Resistance of coil $\rightarrow$ inductivity *vs.* size

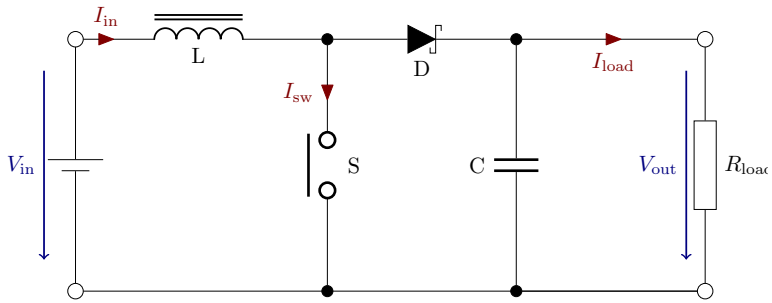
Boost Converter: Considerations



Switching Frequency:

- Ripple *vs.* Capacitor size
- Losses in switching transition
- Losses in inducter hysteresis
- Component size
- Resistance of coil $\rightarrow$ inductivity *vs.* size

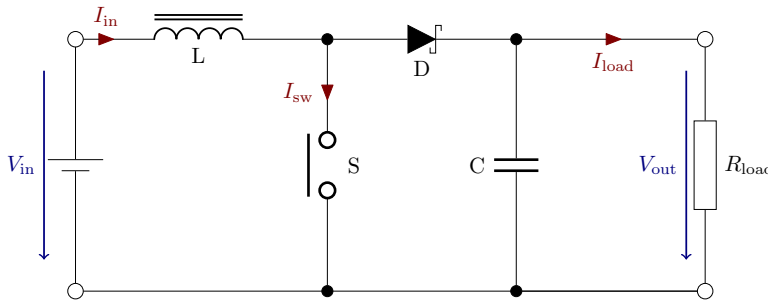
Boost Converter: Considerations



Switching Frequency:

- Ripple *vs.* Capacitor size
- Losses in switching transition
- Losses in inducter hysteresis
- Component size
- Resistance of coil $\rightarrow$ inductivity *vs.* size

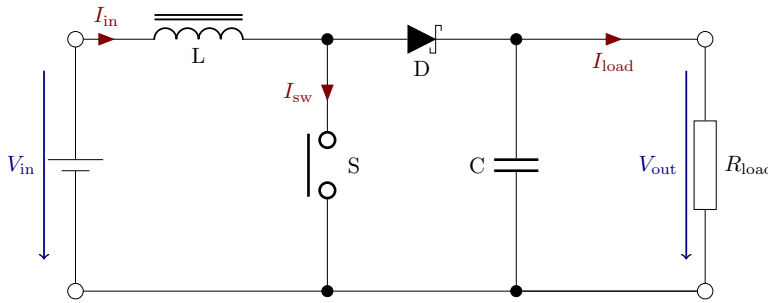
Boost Converter: Considerations



Switching Frequency:

- Ripple *vs.* Capacitor size
- Losses in switching transition
- Losses in inducter hysteresis
- Component size
- Resistance of coil $\rightarrow$ inductivity *vs.* size

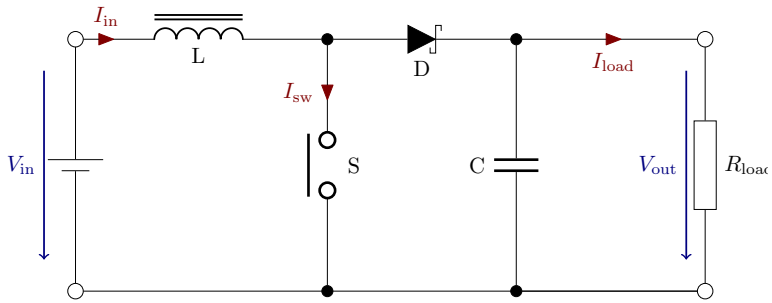
Boost Converter: Considerations



Feedback to IIMatto:

- What voltage is allowed?
- What voltage is ideal?
- Noise susceptibility *vs.* efficiency
- In your circuit: 22kΩ and 4.7kΩ

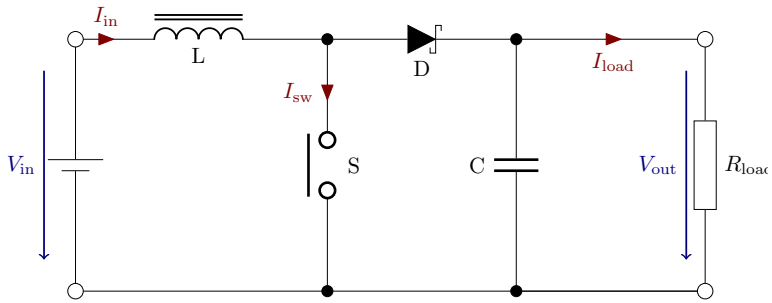
Boost Converter: Considerations



Feedback to IlMatto:

- What voltage is allowed?
- What voltage is ideal?
- Noise susceptibility *vs.* efficiency
- In your circuit: 22kΩ and 4.7kΩ

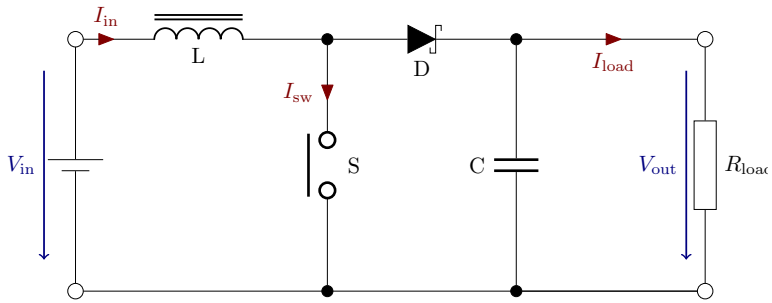
Boost Converter: Considerations



Feedback to IlMatto:

- What voltage is allowed?
- What voltage is ideal?
- Noise susceptibility *vs.* efficiency
- In your circuit: 22kΩ and 4.7kΩ

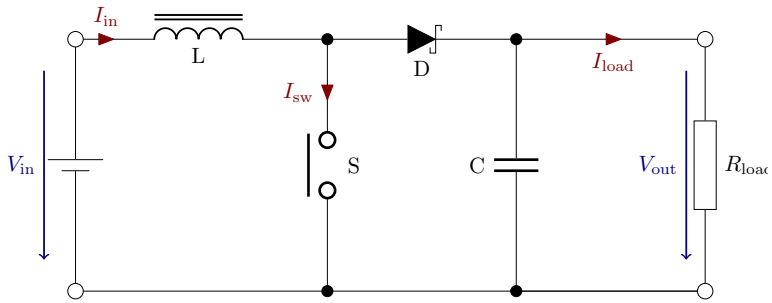
Boost Converter: Considerations



Feedback to IIMatto:

- What voltage is allowed?
- What voltage is ideal?
- Noise susceptibility *vs.* efficiency
- In your circuit: 22kΩ and 4.7kΩ

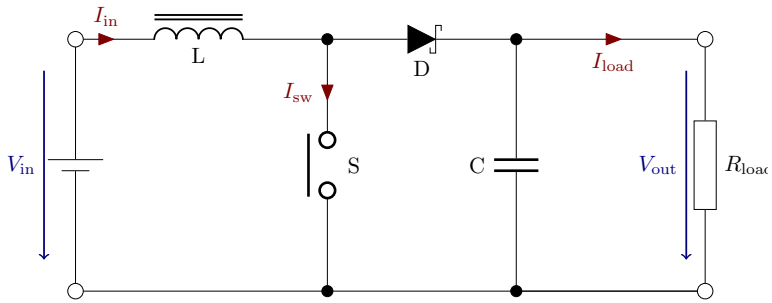
Boost Converter: Considerations



Feedback to IlMatto:

- What voltage is allowed?
- What voltage is ideal?
- Noise susceptibility *vs.* efficiency
- In your circuit: 22kΩ and 4.7kΩ

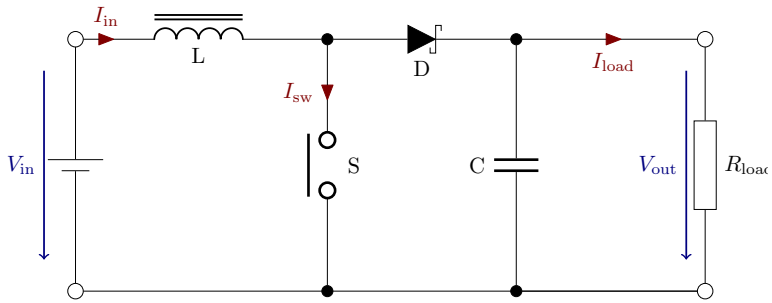
Boost Converter: Considerations



MOSFET selection:

- Gate Threshold Voltage
- R_{ON}
- Heat sink?
- Downrating of semiconductors

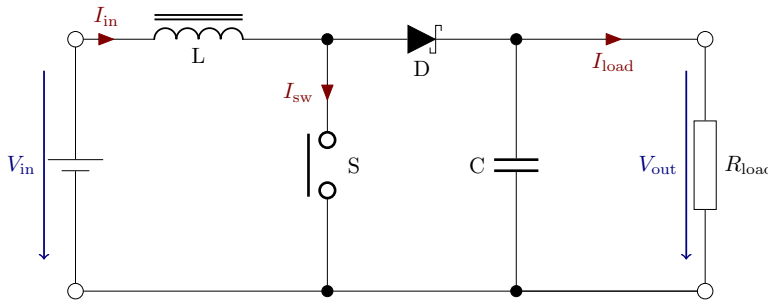
Boost Converter: Considerations



MOSFET selection:

- Gate Threshold Voltage
- R_{ON}
- Heat sink?
- Downrating of semiconductors

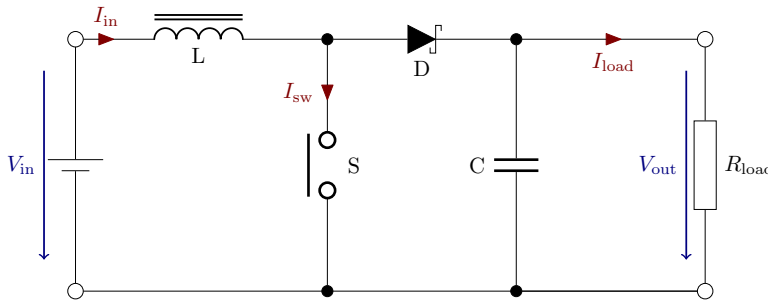
Boost Converter: Considerations



MOSFET selection:

- Gate Threshold Voltage
- R_{ON}
- Heat sink?
- Downrating of semiconductors

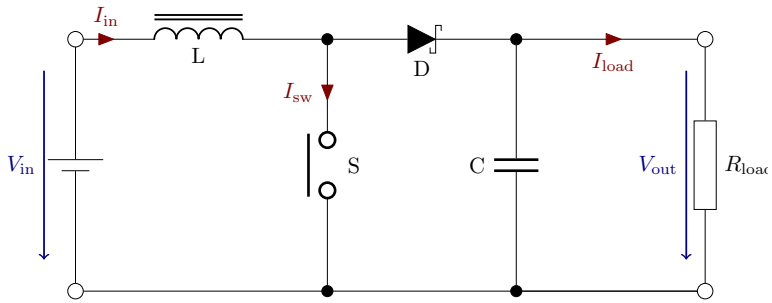
Boost Converter: Considerations



MOSFET selection:

- Gate Threshold Voltage
- R_{ON}
- Heat sink?
- Downrating of semiconductors

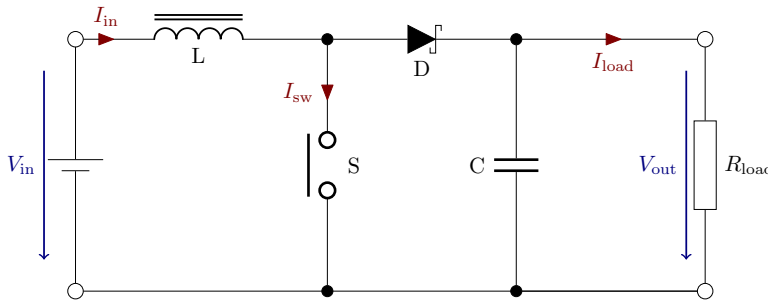
Boost Converter: Considerations



MOSFET selection:

- Gate Threshold Voltage
- R_{ON}
- Heat sink?
- Downrating of semiconductors

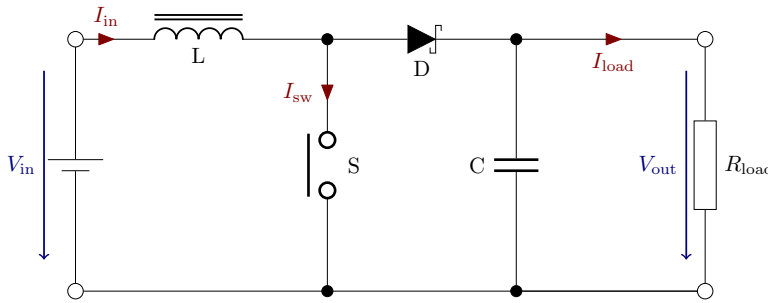
Boost Converter: Considerations



Other issues:

- Ringing?
- Short Circuit protection?

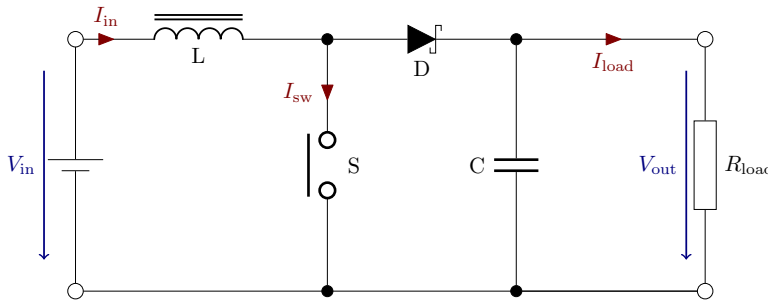
Boost Converter: Considerations



Other issues:

- Ringing?
- Short Circuit protection?

Boost Converter: Considerations



Other issues:

- Ringing?
- Short Circuit protection?

Duty Cycle

$$D = 1 - \frac{V_{IN(min)} * \eta}{V_{OUT(max)}}$$

$$\Delta I_L = \frac{V_{IN(min)} D_{max}}{f_S L}$$

Power IIMatto

We do not recommend this. . . but for the future:

IIMatto on boost converter?

- Use Zener-diode to protect from code errors
- Self-start with flashing LED
- Consider min gate threshold voltage for MOSFET

Power IIMatto

We do not recommend this. . . but for the future:

IIMatto on boost converter?

- Use Zener-diode to protect from code errors
- Self-start with flashing LED
- Consider min gate threshold voltage for MOSFET

Friday

- Assessment Details
- Skeleton Code Provided