Linear electronics vs. switch mode power electronics

### Linear Electronics Approach

- **Input voltage**: 10V to 14V DC
- **Output voltage**: 5V DC +/- 0.1%
- **Output current**: 1A max.
- **Efficiency**: Theoretically 100% (with ideal components)
- **Pros**:
  - Excellent regulation, control
  - Low noise, ripple at the output

### Switch Mode Approach

- **Input voltage**: 1.5V to 2V DC
- **Output voltage**: 5V DC +/- 0.1%
- **Output current**: 0.1A max.
- **Efficiency**: Theoretically 100% (with ideal components)
- **Pros**:
  - Zero voltage when switch is ON
  - Zero current when switch is OFF
  - Practical efficiency > 95% in many applications

### Problems with Switch Mode Approach

- **Low-pass Filter at the Output**
  - High frequency content in \( v_A \), filtered using LC filter
  - Filter size and cost very small with high frequency

### Simple Step-down Converter

- Uses a bi-positional switch
- **Switch in position 1** \( v_A = V_{IN} \)
- **Switch in position 2** \( v_A = 0 \)
- **Efficiency**

\[
\text{Efficiency} = \frac{P_{OUT}}{P_{IN}} = \frac{5 \times 1}{14 \times 1} = 35.7\
\]
## Power supply problem example #3

### Isolated Power Supplies

<table>
<thead>
<tr>
<th>Input Voltage</th>
<th>120V AC +/-20%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output Voltage</td>
<td>5V DC +/- 0.1%</td>
</tr>
<tr>
<td>Output Current</td>
<td>20A max.</td>
</tr>
</tbody>
</table>

#### Linear Approach

- 120 V
- 60 Hz
- Bulky, costly
- Large C
- High power loss

#### Line-Commutated Approach

- 60 Hz transformer
- Bulky filter
- Thyristor

### Switch mode isolated power supply

#### Full-Bridge DC-DC Converter

- High-frequency transformer
- Typically smaller by a factor of 50–100
- Smaller filter
- Higher efficiency
- EMI problems