DC POWER SUPPLY

DC POWER SUPPLY

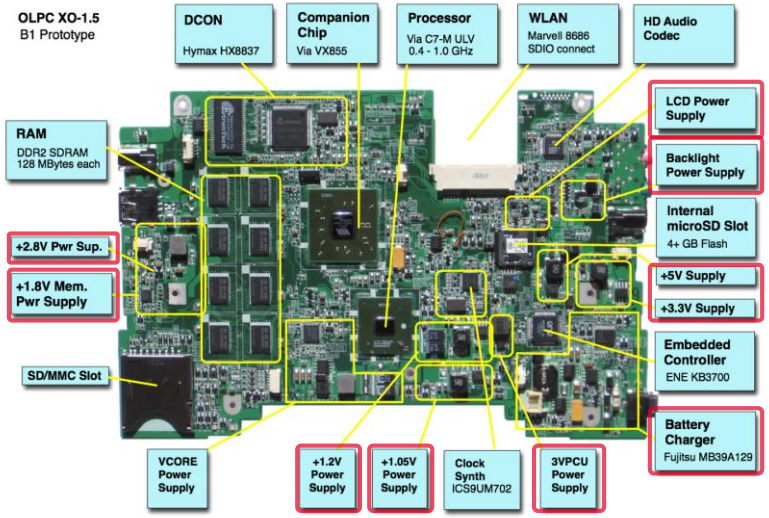
The applications

Cellphone charger

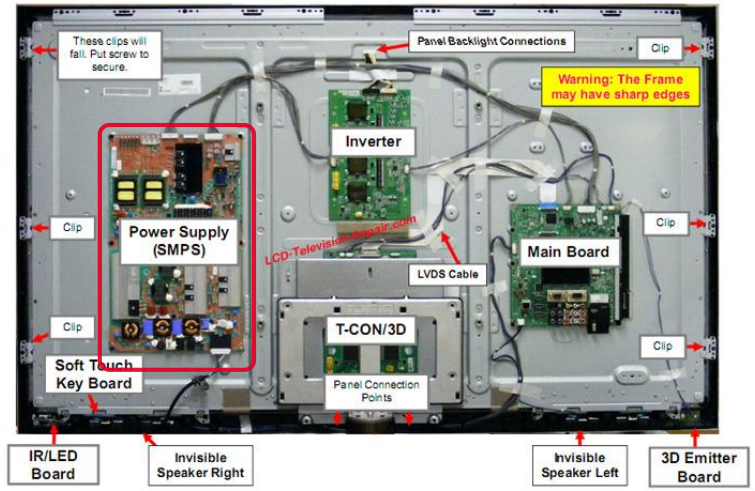
Laptop charger

PC power supply

PLC power supply



DC power supplies in portable devices



DC power supply in a TV

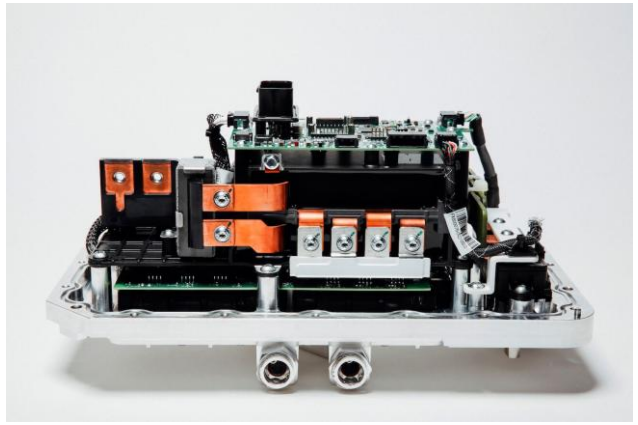
- DC/DC power conversion
- Generate voltage having small ripple

  $\Delta U_{out} \ll U_{out}$

- Main or auxiliary power supply

DC POWER SUPPLY

The applications



Machine drives

Lighting

UPS devices

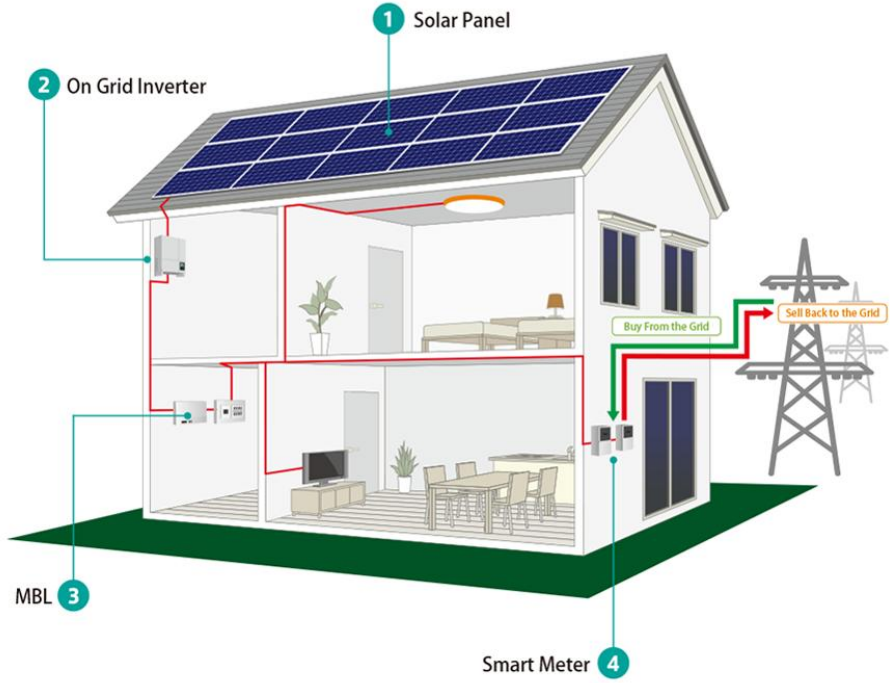
Welding machine

Laboratory equipment

DC POWER SUPPLY

The applications

EV battery charger



DC household installation

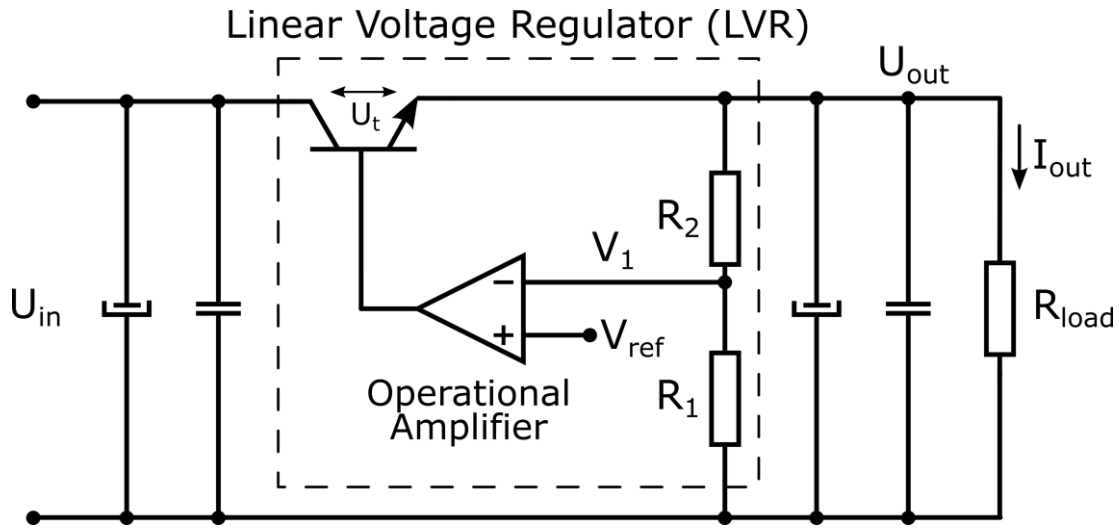
PV power plant

DC POWER SUPPLY

Types of DC power supplies

- Linear DC power supplies
- Switching DC power supplies

Outline of the basic linear DC power supply circuit



- Negative feedback loop

  $\Rightarrow V_1 = V_{ref}$

  $\Rightarrow U_{out} = \frac{R_1 + R_2}{R_1} \cdot V_{ref}$

- LVR voltage limitations

  $U_t = U_{in} - U_{out} > U_{t(mn)}$

  $U_{t(mn)} \approx 1{,}5V$ Transistor voltage in active (amplifier) region

DC POWER SUPPLY

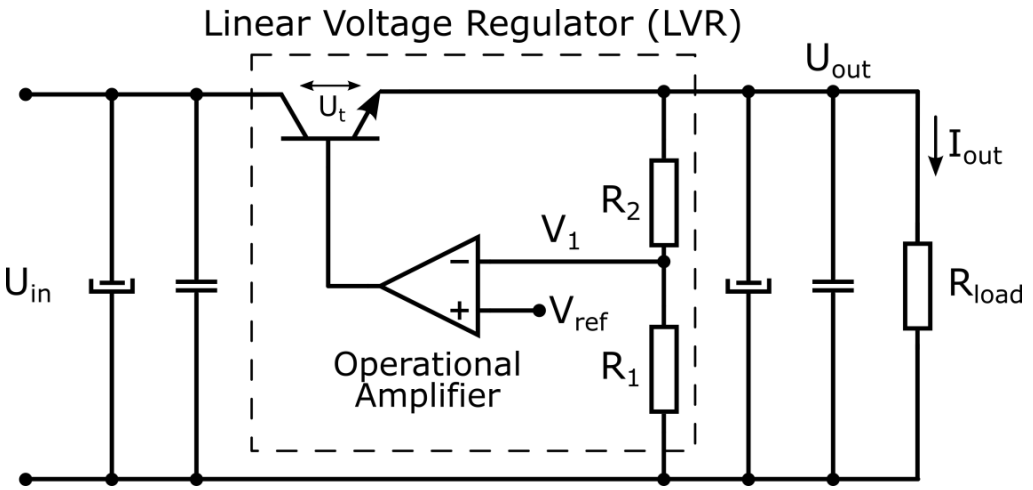
Linear DC power supplies

- Properties
  - Fast response to disturbances in input voltage and load current
  - Does not introduce noise (contrary to switching power supplies).
  - Small efficiency (high transistor losses), hence used in small power application.

$$P_{loss} = U_t \cdot I_{out} = (U_{in} - U_{out}) \cdot I_{out}$$

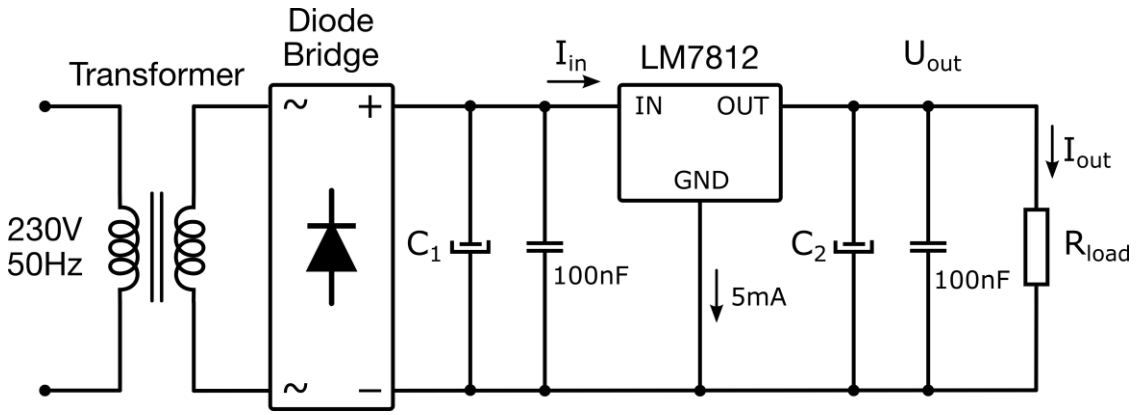
  - Positive and negative U_{out} possible, but the following must be satisfied:

$$|U_{out}| < |U_{in}| \quad \text{(regarding } U_{t(mn)})$$



DC POWER SUPPLY

Linear DC power supplies - design example



Linear DC power supply:
+12V, 5W

$$I_{out} = \frac{P_{out}}{U_{out}} = \frac{5}{12} = 0{,}42\text{A}$$

$$I_{in} = I_{out} + I_{gnd} \approx I_{out}$$

1. 12V output implies that the input voltage must be at least 13,5V ($U_{t(mn)}$).
2. Assume that the maximal allowed input voltage ripple is 10% (voltage ripple at the input of the LM7812, i.e. on capacitor C_1).
Hence, $\Delta U_{c1} = 1{,}35V$. The load current is $I_{out} = 0{,}42A$. The capacitance of C1 capacitor is: $C_1 = \frac{I_{out} \cdot 10_{ms}}{\Delta U_{C1}} = 3{,}1mF \ \ (3300\mu F/16V)$
3. The transformer secondary voltage must be higher than $U_s = 2 \cdot V_d + 1{,}35 + 13{,}5 = 16{,}85V$
4. Hence, secondary voltage RMS $U_s = 1{,}1 \cdot 16{,}85/1{,}41 = 13V$
5. Standard recommendation is for C_2 to be five times smaller than C_1.

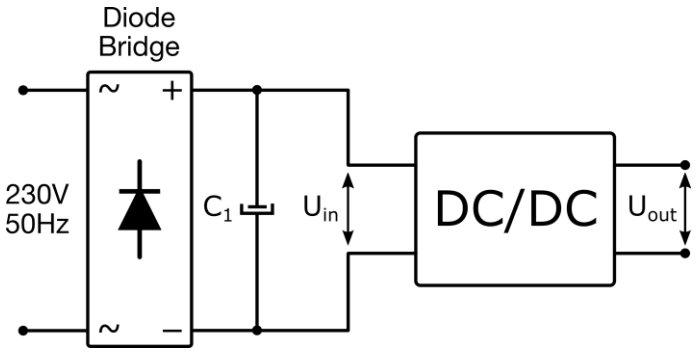
- Application:
  - Supply noise-sensitive circuitry (analog signal processing)
  - Small-power converters (price and simplicity, and not efficiency, crucial).

DC POWER SUPPLY

Switching DC power supplies

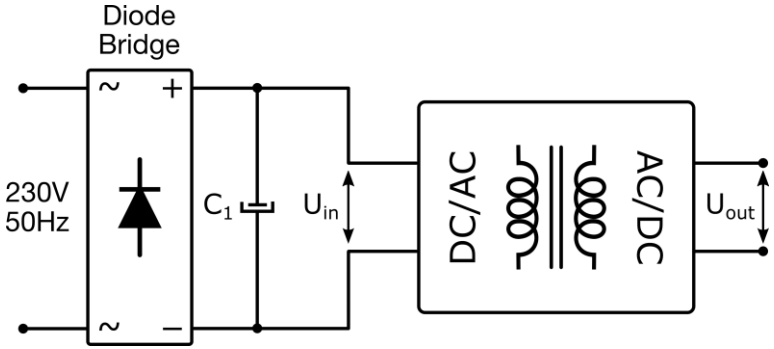
- Switching components - ON (saturation)/OFF states.
- The filters secure small output voltage ripple.

- Types (according to galvanic isolation):
  Non-isolated DC power supplies
  Isolated DC power supplies



- Without galvanic isolation

- Reduced user's safety
- High efficiency



- With galvanic isolation

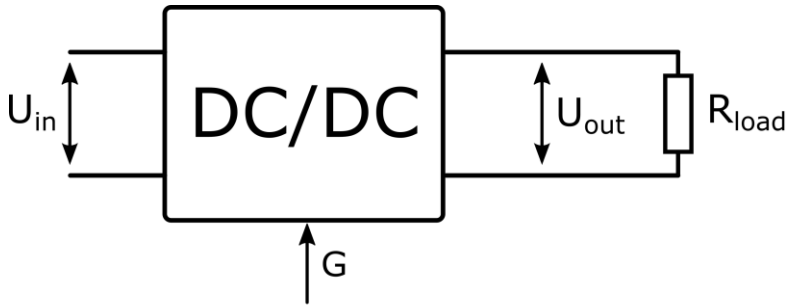
- HF transformer secures energy transfer (via magnetic coupling)
- Increased user's safety and equipment reliability
- Lower efficiency

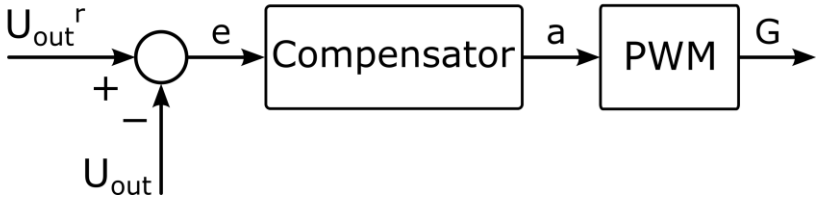
DC POWER SUPPLY

Switching DC power supplies

Non-isolated switching DC power supplies

- Basic outline:





- The most important non-isolated DC power supplies:

1. Buck converter (step-down converter)
2. Boost converter (step-up converter)
3. Buck-boost (step-up/down)
4. (more complex) Buck-boost converters (Sepic, Cuk...).