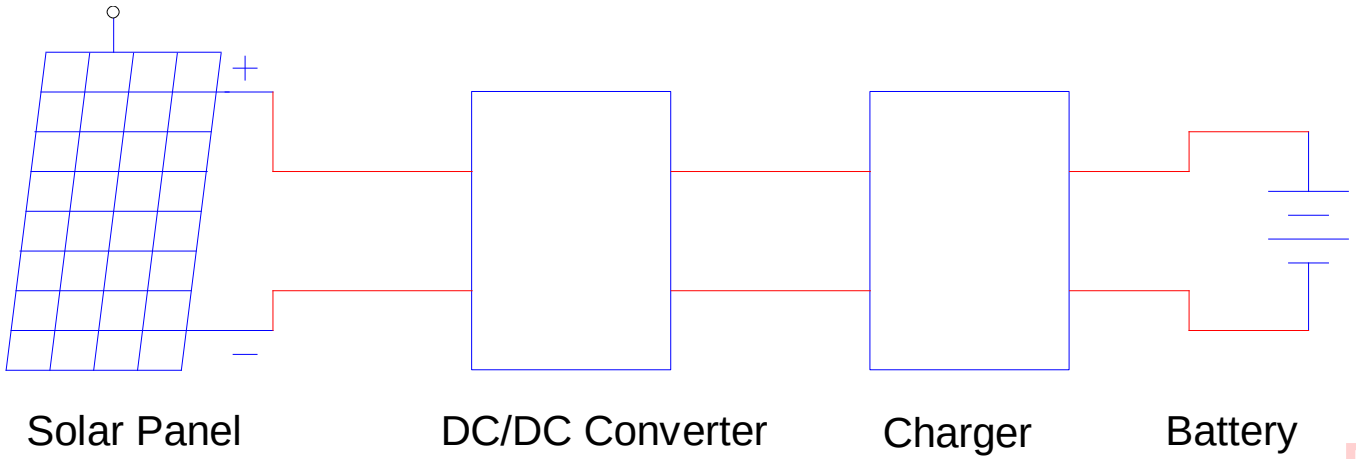
Detailed Design

- DC/DC Converter

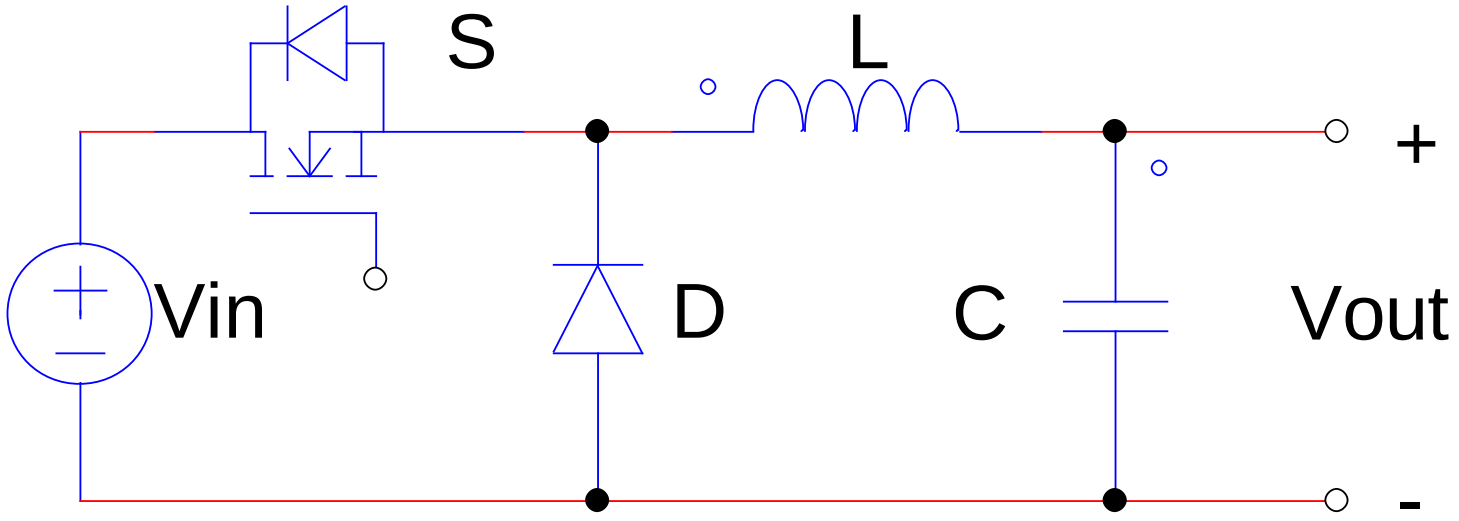
Example Design – Power Supply for Charger

- Input: 20V - 28V DC
- Output: 17V DC
- Maximum Output Current: 2A
- Isolation not required
- Operating temperature



Detailed Design

1. Topology Selection



Buck Converter

Step Down

20-28V --> 17V

$$V_{out} = V_{in}D$$

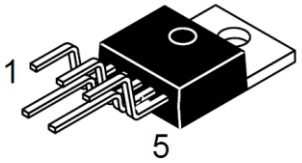
For Continuous Conduction Mode

D - Duty Cycle

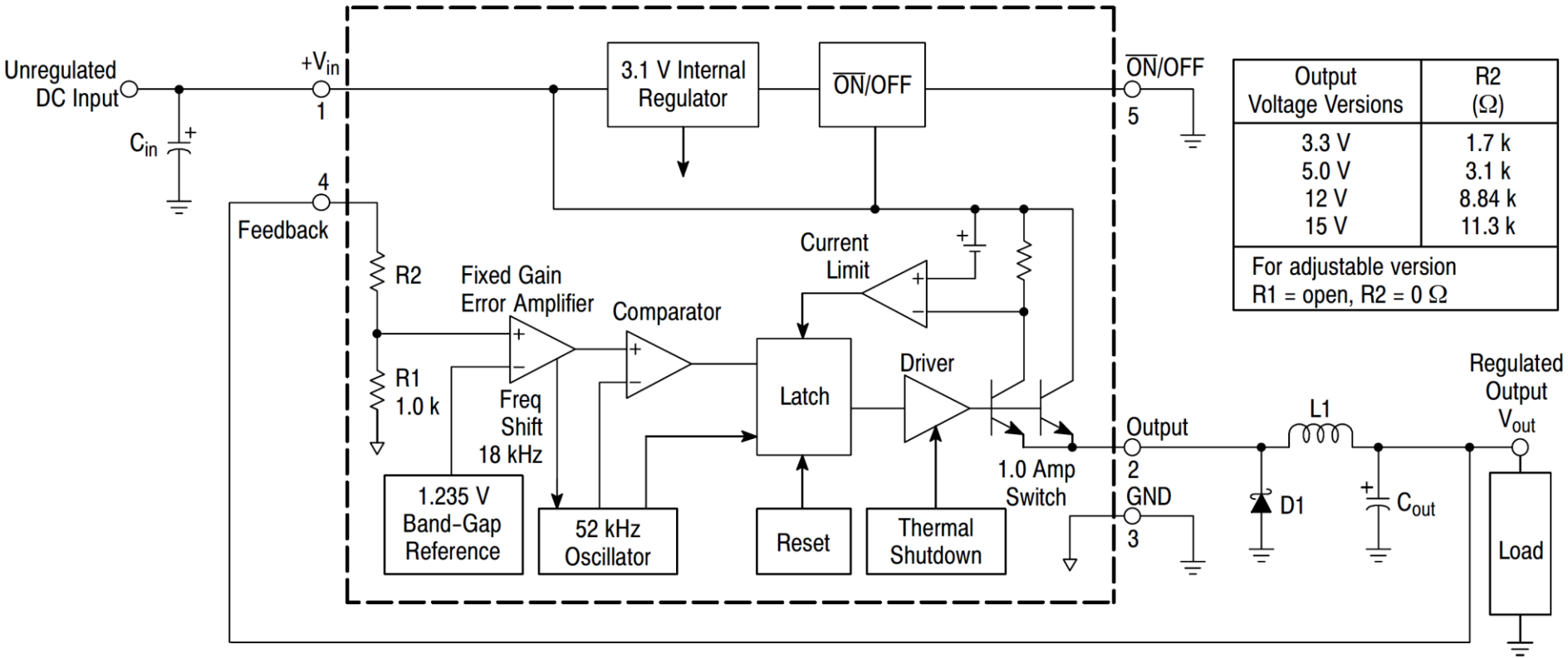
Detailed Design

2. Controller IC

LM2576TV-ADJG



TO−220
TV SUFFIX
CASE 314B

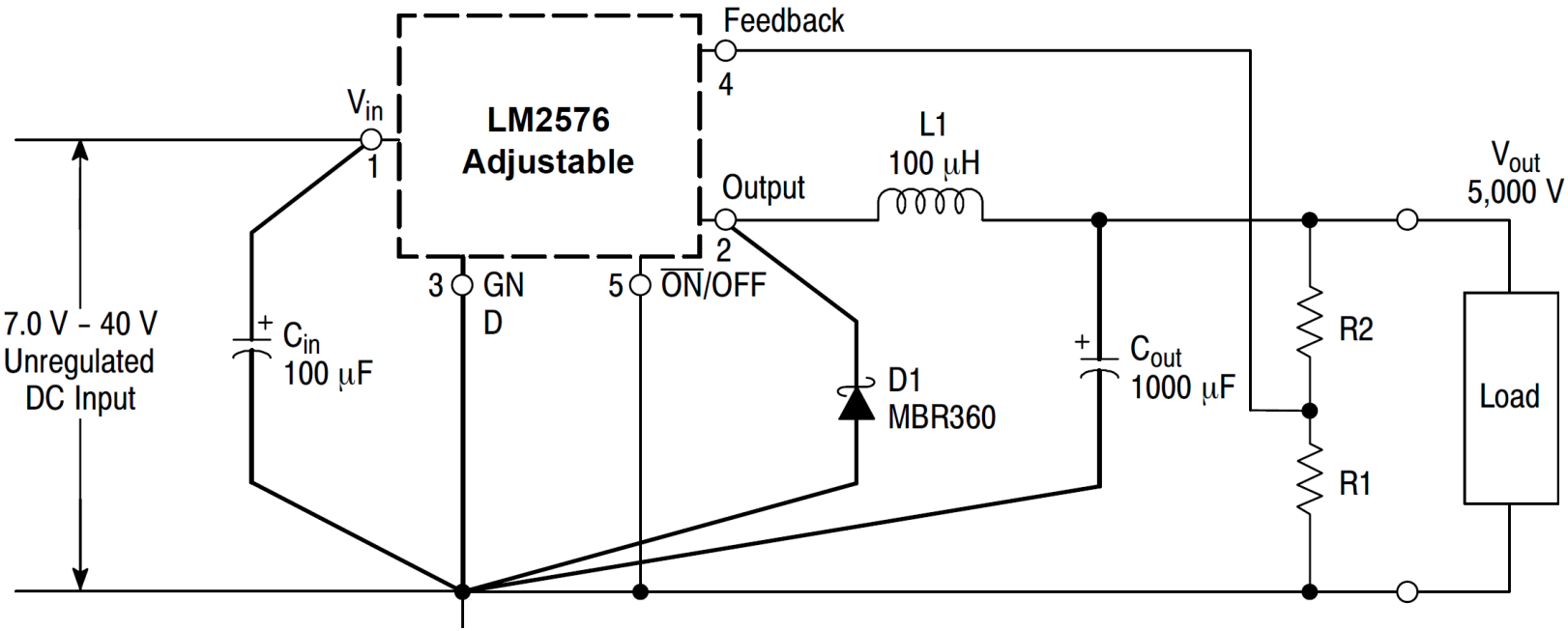


Output Voltage Versions	R2 (Ω)
3.3 V	1.7 k
5.0 V	3.1 k
12 V	8.84 k
15 V	11.3 k
For adjustable version R1 = open, R2 = 0 Ω	

http://www.onsemi.com/pub/Collateral/LM2576-D.PDF

Detailed Design

3. Example Circuit



$$V_{out} = V_{ref}\left(1.0 + \frac{R2}{R1}\right)$$

$$R2 = R1\left(\frac{V_{out}}{V_{ref}} - 1.0\right)$$

Where V_{ref} = 1.23 V, R1 between 1.0 k and 5.0 k

Adjustable Output

Use voltage divider for feedback

Online tool of voltage divider calculator

http://www.ti.com/download/kbase/volt/volt_div3.htm

Detailed Design

4. Input Capacitor (Cin) Selection

- At least 100 uF
- Electrolytic capacitor
- Low ESR
- Voltage/Current ratings
- Temperature rating
- Place the capacitor close to the regulator
- Keep the leads as short as possible

5. Catch Diode (D1) Selection

- Consider maximum load current
  - 1.5-2.5 safety factor
- Consider maximum input voltage
  - 1.5-2.0 safety factor
- Prefer Schottky diode (fast speed and low forward voltage drop)
- Or fast recovery diode
- Standard 60-Hz diodes (general purpose) not suitable
- Connect the diode near the IC

6. Inductor (L1) Selection

- Peak-to-peak inductor ripple current
  20%-30% maximum load current
- Ripple frequency 52kHz (switching frequency)
- Refer to the selection guide in the data sheet
- Check the inductor maximum current (< inductor saturation current)

7. Output Capacitor (Cout) Selection

- Minimum capacitance (see data sheet)

$$C_{out} \geq 13,300 \frac{V_{in(max)}}{V_{out} \times L\ [\mu H]}\ [\mu F]$$

- Higher capacitance lower ripple voltage

  several times larger

- Voltage rating

  1.5-2.0 safety factor

- Connect the capacitor near the IC
- Recommend low ESR capacitor

  however, very low ESR could lead to instability

8. Thermal Design

The following formula is to calculate the approximate total power dissipated by the LM2576:

$$P_D = (V_{in} \times I_Q) + d \times I_{Load} \times V_{sat}$$

where d is the duty cycle and for buck converter

$$d = \frac{t_{on}}{T} = \frac{V_O}{V_{in}},$$

I_Q (quiescent current) and V_{sat} can be found in the LM2576 data sheet,

V_{in} is minimum input voltage applied,

V_O is the regulator output voltage,

I_{Load} is the load current.

The dynamic switching losses during turn−on and turn−off can be neglected if proper type catch diode is used.

Detailed Design

Some WebDesign Tools

- TI WEBENCH Designer

http://www.ti.com/design-tools/webench-power-design/power-designer.html

- Power Supply WebDesigner

http://www.onsemi.com/