LM2852 Typical application circuit

$V_{\text{IN}} = 3.3V$

$C_{\text{IN}} = 22\ \mu F$

$C_{\text{SS}} = 2.7 \text{ nF}$

$L_0 = 10\ \mu F$

$L_0 = 10\ \mu F$

$C_0 = 100\ \mu F$

$V_{\text{OUT}} = 2.5V$

$I_{\text{LOAD}} = 0A \text{ to } 2A$

few $\frac{1}{2}$ MHz

TA caps

CeX lowf

$L_{\text{EX}} x$

Internal switch at Y

$C_{\text{in(EXT)}}$
95% Efficient Synchronous Step-Down Regulators Draw Only 10μA

Low Standby Power

Linear Technology

meaning Need external C's R
Features

- No External FETs or Schottky Diode Required
- 10µA Quiescent Current
- Up To 95% Efficiency
- 2.65V to 10V Input Voltage (LTC1877)
- 600mA Output Current
- <1µA Shutdown Current
- Selectable Burst Mode™ Operation
- 550kHz Constant Frequency Operation Synchronizable from 400kHz to 700kHz
- Uses Ceramic or Tantalum Capacitors
- Small, Thin 8-Pin MSOP Package
Non-synchronous buck

Function: Step-down \((V_{OUT} < V_{IN})\)

When to use: Typically when \(V_{IN}\) is 3x to 5x \(V_{OUT}\) and \(I_{OUT}\) is > 0.5A and < 5A

Characteristics: Easy to design and good efficiency for the above-mentioned typical \(V_{IN}/V_{OUT}/I_{OUT}\) conditions

Devices to use: All buck integrated regulators and controllers

Cost of diode smart diode? Why are diode losses high? Which transition of diode has most loss?
\( i_L(t) \)

\[ I_Q \quad I_{\text{diode}} \]

2Di

\[ I_{DC} \quad t \]

\( h \) acts as a "flywheel"

\( 2 \Delta i_v = \frac{V_{in} - V_{out}}{L} \cdot \frac{D}{f_{SW}} \)

Choose desired \( \Delta i_v \)

Pick \( L f_{SW} \)

Pick \( D = \frac{V_o}{V_{in}} \)
Fig. 6. Power loss caused by the freewheeling diode should be eliminated to increase the converter’s efficiency.
Fig. 1. This synchronous buck converter is optimized for minimum switching and conduction losses.
For Designers: Power Converter Design

Synchronous Rectification in High-Power Converter

Figure 1. (a) Non-synchronous and (b) Synchronous Buck Converters

- Need: Vout = I * R (Parallel FETs)
- Always CIEC (no need for IC)
- Avoid short-throgh
- Replace LV power diode

By Robert Sandler Jr., Applications Engineer

— Performance Power Converter Design

Synchronous Rectification in High-Power Converter

LV Power
Figure 2: Step-down Configurations

Buck Integrated Regulator or Controller

Any "Synchronous Rectification" devices to use above mentioned above the diode in the basic buck topology, reducing losses.

Characteristics: A second switch replaces the

\[ V_{IN} < 5 \times V_{OUT} \text{ and/or } |V_{OUT} - V_{IN}| > 0.5A \]

When to use: When high efficiency is required with high output current (> 5A) with synchronous buck

Function: Step-down (V_{OUT} < V_{IN})
High-Efficiency LM1770 Synchronous Controller for Low-Voltage DC-DC Conversion

Application Circuit

Complementary Drivers

Synchronous operation enables higher efficiency

No external compensation required

Output voltage: 100 mV/div

Load step: 1 A/div

V_{IN} = 5V, V_{OUT} = 3.3V

2.8 to 5.5V

2A to 3A

Down to 0.3V

Transient Response
Ultrafast Transient Response

2% $\Delta V_{out}$ with a 5A Step

$V_{IN} = 12V$, $V_{OUT} = 1.5V$, 0A to 5A Load Step

$C_{OUT} = 3 \times 22\mu F$ CERAMICS, $470\mu F$ POS CAP
>90% Efficiency Over Load Current

$V_{\text{IN}} = 5\text{V}$

$V_{\text{OUT}} = 3.3\text{V}$
LM3370 Dual Buck Regulator Provides Highest Efficiency for FPGAs and Multimedia Processors

- **Automatic PFM-PWM mode switching provides high efficiency at all loads**
- **$V_{IN} = 2.7V$ to $5.5V$**
- **2 MHz operation enables smaller external components and minimizes footprint**
- **$V_{OUT1} = 1V$ to $2V$ Up to $600 \text{ mA}$**
- **$I^2C$ compatible interface scales power to match processor clock frequency**
- **$V_{OUT2} = 1.8V$ to $3.3V$ Up to $600 \text{ mA}$**
- **Lowest $I_q (<20 \mu\text{A})$ extends battery life**
- **Power-on-reset prevents fault condition in processors**
- **Spread spectrum reduces noise (ideal for RF systems)**

B0GO for low i Applications
Fig. 2. A simplified schematic of a multiphase uncoupled buck regulator (a) illustrates the two basic switching actions. In state one (b), S1H and S2L are closed while S1L and S2H are open. The input then sources energy to L1 and the output, and L2 sources energy to the output. In state two (c), S1L and S2L are closed, and S1H and S2H are open. Thus, both inductors source energy to the output. These operations are reversed for states three and four (not shown).
Fig. 1. Turn-on of the high-side MOSFET (not shown) produces a voltage transient \( \frac{dv}{dt} \) across the low-side (synchronous) MOSFET, which leads to the off-state current conduction shown here.

1. +V rail connected to D via \( \frac{dv}{dt} \)
2. Via \( C_{gs} \), lower FET on short
Figure 3. Synchronous Buck Converter

Figure 4. $dv/dt$ induced step on the low-side MOSFET
Ch 1 Switch node
Ch 2 Vgs _ low-side MOSFET