design FAQs

Voltage Regulator ICs

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FREQUENTLY ASKED QUESTIONS

What is the function of a voltage regulator IC?

A voltage regulator generates a fixed output voltage of a preset magnitude that remains constant regardless of changes to its input voltage or load conditions. There are two types of voltage regulators: linear and switching.

What is a linear voltage regulator?

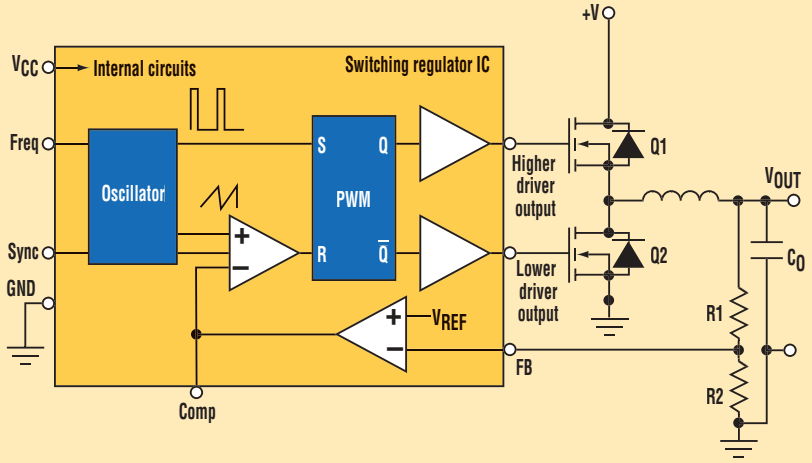
A linear regulator employs an active (bipolar junction transistor (BJT) or MOSFET) pass device (series or shunt) controlled by a high-gain differential amplifier. It compares the output voltage with a precise reference voltage and adjusts the pass device to maintain a constant output voltage.

What is a switching regulator?

In a switching regulator, the input voltage is applied to an LC filter and is controlled by a power switch (MOSFET or BJT). The output voltage is fed back to the switching regulator controller that varies the length of time the power switch is on (duty cycle) to keep the output voltage constant.

What are some of the switching regulator topologies?

There are three main topologies: buck (step-down), boost (step-up), and buck-boost (step-up/step-down). Other topologies include flyback, SEPIC, Cuk, push-pull, forward, full-bridge, and half-bridge.



This step-down switching regulator circuit drives external MOSFETs configured as a synchronous rectifier (Q1 and Q2) whose output is applied to an LC low-pass filter to produce a dc output (V_{OUT}). The switching frequency is set by pulling the "Freq" pin high or low. External sync is available using the "Sync" pin. The R1-R2 network sets the circuit's output voltage, and the frequency compensation network is applied to the "Comp" pin.

How does switching frequency impact regulator designs?

Higher switching frequencies mean the voltage regulator can use smaller inductors and capacitors. They also mean higher switching losses and greater noise in the circuit.

What losses occur with the switching regulator?

Power losses occur as a result of the power needed to turn on and off the MOSFET. The MOSFET driver must bear this loss. Also, the MOSFET takes a finite time to switch to/from a conduction state to non-conduction state. Hence, power loss will be associated with this activity in the MOSFET itself. These losses are dominated by the MOSFET gate charge and the capability of the drive, in effect the energy needed to charge and discharge the capacitance of the MOSFET gate between the threshold voltage and gate voltage.

What are the usual applications for linear and switching regulators?

The linear regulator's power dissipation is directly proportional to its output current for a given input and output voltage, so typical efficiencies can be 50% or even lower. Using the optimum components, a switching regulator can achieve efficiencies in the 90% range. However, the noise output from a linear regulator is much lower than a switching regulator with the same output voltage and current requirements. Typically, the switching regulator can drive higher current loads than a linear regulator.

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How does a switching regulator control its output?

Switching regulators require a means to vary their output voltage in response to input and output voltage changes. One approach is to use pulse-width modulation (PWM) that controls the input to the associated power switch, which controls its on and off time (duty cycle). In operation, the regulator's filtered output voltage is fed back to the PWM controller to control the duty cycle. If the filtered output tends to change, the feedback applied to the PWM controller varies the duty cycle to maintain a constant output voltage.

What design specifications are important for a voltage regulator IC?

The basic parameters include input voltage, output voltage, and output current. Depending on the application, other parameters may be important, such as output ripple voltage, load transient response, output noise, and efficiency. Important parameters for the linear regulator are dropout voltage, power-supply rejection ratio (PSRR), and output noise.

Are there additional voltage regulator IC features?

Some voltage regulator ICs have a margining feature that changes the output voltage of the associated power supply up or down, which provides a way to see the effect of power-supply output variations on a system.

Another voltage regulator IC feature is output voltage tracking, which forces the output voltage of one power supply to track the output of another power supply after startup.

Can a voltage regulator IC control its input current on startup?

The soft-start feature reduces input current transients and prevents output voltage overshoot when powering up or resuming operation after shutdown, overload, short-circuit, or overload conditions. **ED ONLINE 14405**