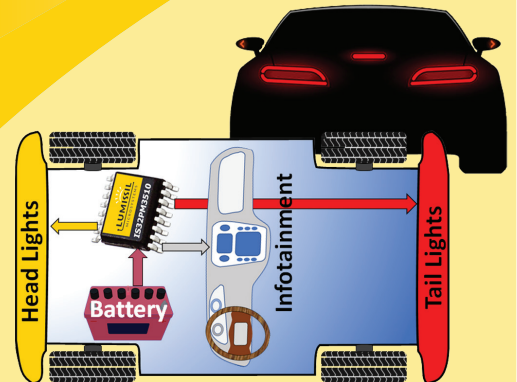


IS32PM3510 DC/DC Converter Uses



A DC-to-DC converter is an electronic circuit that converts a voltage source from one voltage level to another at a certain current level. Therefore, it can also be considered a type of electric power converter since power is simply (Voltage) X (Current).

A power converter's efficiency is determined by comparing its input power to its output power. Since all power converters have inherent conversion losses, the output power is always less than the input power. The output voltage (V_{OUT}) can be higher or lower than the input voltage (V_{IN}) therefore, the input and output currents (I_{IN} and I_{OUT}) will provide a balance and compensate for the efficiency loss (P_{LOSS}) which is converted to heat energy under full load conditions. The Greek symbol Eta " η " is usually used to represent "efficiency." Considering the efficiency (η) and desired output power (P_{OUT}), the end-user can determine how much input power (V_{IN} , I_{IN}) will be required from the input power supply to guarantee stable converter operation.

$$\eta = P_{OUT} / P_{IN} = (V_{OUT} \times I_{OUT}) / (V_{IN} \times I_{IN})$$

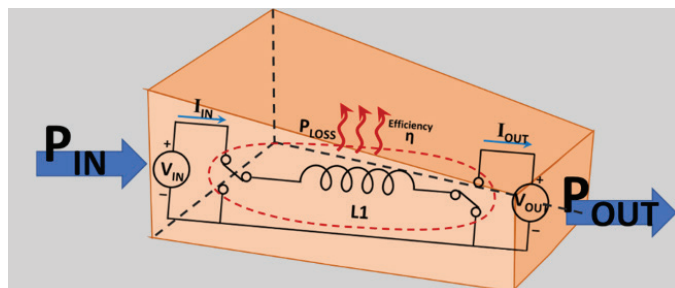


FIGURE 1. EFFICIENCY LOSSES IN POWER CONVERSION

DC-to-DC converters are often required since rarely does the available voltage supply match the operating circuit requirements. In many applications there are several sub-circuits, each with its own voltage level requirement different from what is provided by the external supply which could be

higher or lower than the required voltage. Note that even with battery supplies the voltage is rarely stable since the battery voltage could be high during charging or declining as the battery is used. A switching DC-to-DC converter offers a stable output voltage under all battery conditions.

There are two categories of DC-to-DC converters, linear (LR) and switch mode (SM) regulators. They both have inherent efficiency losses but typically the linear regulator losses are greater with the additional requirement that the input voltage must always be higher than the output voltage. The advantages of a switch mode regulator are the input voltage is independent (higher or lower) of the output voltage and the conversion efficiency (η) is much better (lower power loss) than a linear regulator.

Note that most DC-to-DC converter circuits regulate the output voltage; the exception is the LED driver which is a kind of DC-to-DC converter that regulates the LED current. Lumissil's IC portfolio includes both Voltage and Current DC-to-DC converters.

CAR BATTERY SUPPLY

A car battery is rated for 12V but depending on its state of charge or operating condition the voltage can be anywhere from 9V to 16V. A fully charged battery will typically measure at 12.6V, about 13~16V when the engine is running, and down to 9V when the engine is off. For this and other reasons a DC-to-DC converter is always required in automotive applications. Some other reasons are that automotive sub-circuits require a stable operating voltage which could be lower or higher than can be provided by the car battery. During normal automotive operating conditions, the battery voltage rail can experience voltage peaks and valleys which need to

be smoothed out by a DC-to-DC converter. An upstream DC-to-DC converter is recommended to supply a stable voltage for downstream sub-circuits such as linear LED drivers.

EMI AND EMC

As previously discussed, a switch mode DC-to-DC converter offers the advantages of higher conversion efficiency and a wide input to output voltage range. However, one disadvantage with a switching solution is the generation of EMI (Electromagnetic Interference) noise which needs to be managed. The automotive industry set a variety of electromagnetic compatibility (EMC) requirements. For example, one requirement states that electronic systems must not emit excessive electromagnetic interference (EMI) noise which could affect nearby systems such as radio or other telemetry applications.

Therefore, it is advantageous to minimize the number of switching DC-to-DC converters since a single EMI source is easier and less costly to manage than many. Having multiple DC-to-DC converters can not only cause havoc with automotive EMC compliance but can be costly to manage since additional precautions such as EMI shields or extra components would be required.

EXAMPLE USE OF DC-DC CONVERTERS

A good compromise between power efficiency and EMC compliance is to use a hybrid mix of switching and linear DC-to-DC converters. For example, a single switching converter directly connected to the car's battery can provide a stable voltage rail for other downstream linear sub-circuits. In this way the advantages of a switching converter are leveraged while introducing only a single EMI noise source. The linear DC-to-DC converters downstream benefit from a well-regulated voltage source set for minimal linear power loss. Since device power loss is calculated by $(V \times I)$, having a minimal voltage across the linear converter helps minimize its power loss. The added benefit of using a downstream linear LED driver is that besides the switching converter, there are no additional EMI sources to mitigate.

In the example below, the IS32PM3510 is configured to provide a regulated 15V to the IS32LT3140B linear LED driver sub-circuits. The required 15V rail was calculated by summing the LED string voltage drop of 14V with the minimum LED driver operating voltage of 1V. Having a

fixed 15V rail guarantees the LED driver will operate with a minimal $(V \times I_{LED})$ thermal loss. Without the upstream IS32PM3510, the IS32LT3140B voltage can increase to $>2V$ resulting in a doubling of its thermal loss.

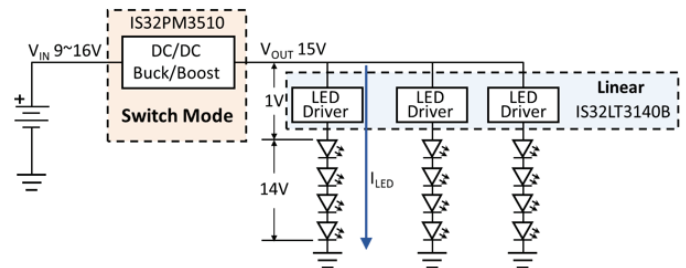


FIGURE 2. HYBRID DC-TO-DC CONVERSION SCHEME

IS32PM3510

The IS32PM3510 is an asynchronous multi-topology COT PWM controller that employs a single inductor to provide excellent voltage regulation. In a Buck-Boost topology regulated output voltage is maintained when the input voltage is either less or greater than the desired output voltage, making it especially suitable for automotive applications, where this wide input voltage variation is expected. With a 150kHz to 650kHz programmable operating frequency that can be either adjusted with an external resistor or synchronized with an external clock, optimum inductor and capacitor(s) size can be achieved while maintaining high efficiency. The controller integrates spread spectrum function that effectively reduces overall EMI profile.

Typical applications are as a general automotive voltage regulator used in lighting and infotainment systems.

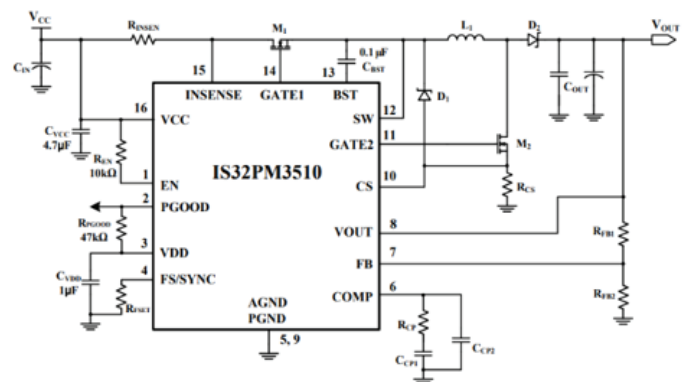


FIGURE 3. IS32PM3510 TYPICAL APPLICATION CIRCUIT (BUCK-BOOST TOPOLOGY)

IS32LT3140B

The IS32LT3140B is an automotive-grade high-side programmable current regulator consisting of a single output channel capable of 450mA. An external resistor

sets the current level for the single-channel current source. An optional thermal shunt resistor can be used to significantly optimize IC power dissipation. It features an EN pin to enable or shutdown the device. It supports either PWM dimming via a PWM pin or power supply modulation (PSM). A resistor divider circuit can be used on the UV pin to set an external VCC under-voltage lockout threshold for LED string open fault detection. In addition, the IS32LT3140B integrates fault protection for LED string open/short, output overcurrent (not reported), and over-temperature condition for robust operation. Detection of these failures is reported by the FAULTB pin. When a fault is detected the device will disable itself and output an active low open drain signal. Multiple devices can have their FAULTB pins connected to create a “one-fail-all-fail” condition.

Typical applications are in automotive interior/exterior lighting such as turn signal, rear lamp and cabin dome light.

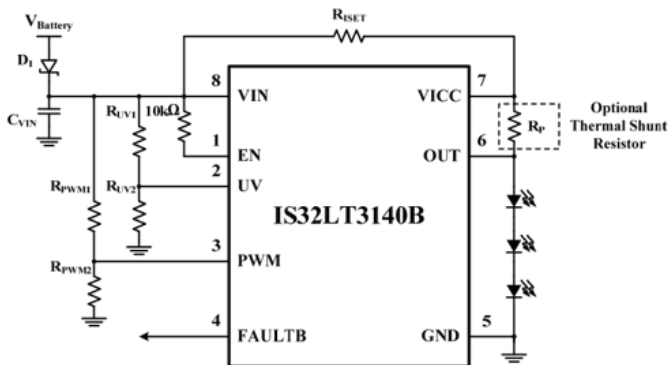


FIGURE 4. IS32LT3140B TYPICAL APPLICATION CIRCUIT

DC-TO-DC CONVERTER PORTFOLIO

Lumissil has an excellent portfolio of DC-to-DC converters for both voltage and current regulation. The IS32PM3510 is the latest offering for voltage regulation, it can be configured for various topologies such as ‘Buck’, ‘Boost’ or ‘Buck-Boost’. For current regulation, the portfolio covers all the switching topologies of ‘Buck’, ‘Boost’, ‘Buck-Boost’ as well as linear devices covering a wide range of LED currents. Visit Lumissil website to download the latest datasheets, spice models and evaluation board documentation, www.lumissil.com.

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