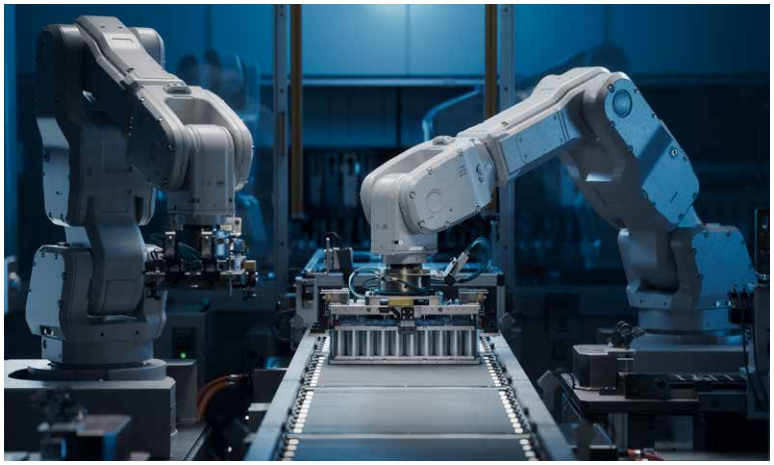
Switching converters (DC-DC) Quick reference guide



DC-DC switching regulators are a family of power conversion circuits that efficiently transfer from a source to a load at different voltages and current levels. These converters enable devices to operate with optimal power levels despite varying power sources and load conditions. Switching converters are favored over linear regulators due to their higher efficiency, especially in applications where the difference between input and output voltages is significant.

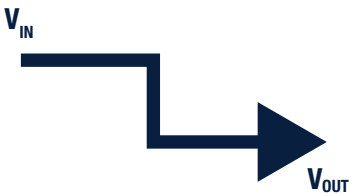
Switching regulators key points

- Higher efficiency: it can exceed 95%, reducing energy loss and heat dissipation.
- Minimal power loss: losses in switching converters are limited to biasing currents and imperfections in components, unlike linear regulators, which dissipate excess power as heat.

Switching regulators main topologies

Buck regulators (step-down)

- Used when the input is higher than the output.
- They maintain optimal performance across a range of load conditions.



Boost regulators (step-up)

- Convert low input voltage to a higher output voltage.
- They can be combined with other power conversion topologies for complex systems.

Buck-boost regulators

- Voltage flexibility: steps up or steps down input voltage as required, ensuring stable output.
- Inverted output: delivers an output voltage that is inverted relative to the input, beneficial for specific applications.
- A wide input range is ideal for variable power sources in several applications.

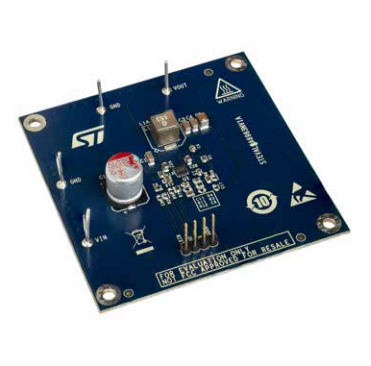
Learn more about these main DC-DC topologies by visiting the following webpages:

- Buck regulators
- Boost regulators
- Buck-boost regulator

Comprehensive DC-DC power solutions and design

ST'S EVALUATION BOARDS

Quick overview: STMicroelectronics offers an array of evaluations boards to support the development of DC-DC converters across various applications.

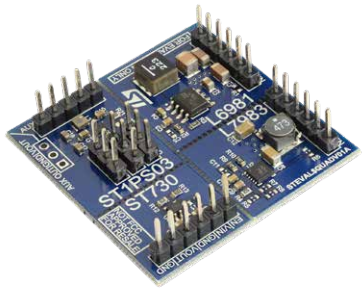


Evaluation boards	Applications	Input voltage range	Products
STEVAL-L3751V12	Industrial, light electric vehicles	6 to 75 V	L3751
STEVAL-L6981CDR, STEVAL-L6981NDR	Industrial, battery-powered devices	3.5 to 38 V	L6981
STEVAL-L6982CDR, STEVAL-L6982NDR			L6982
STEVAL-ISA208V1			L6983
STEVAL-A6983NV1	Automotive	3.5 to 38 V	A6983

Scan QR code for a complete visibility of ST boards

STEVAL-QUADV01: 4-IN-1 DC REGULATION SOLUTION

Quick overview: the STEVAL-QUADV01 is a multifunctional evaluation board for testing various DC-DC power supply configurations.



Features	Benefits
Multichannel output	Simulates different power supply scenario
Adjustable voltage and current	Offers testing flexibility for each channel
Integrated safety protections	Ensures operation safety with overvoltage, overcurrent, and thermal protection
User-friendly control panel	Allows for easy adjustments and real-time monitoring

Scan QR code for detailed information

eDesignSuite AND eDSim: DC-DC CONVERTER SIMULATION TOOL

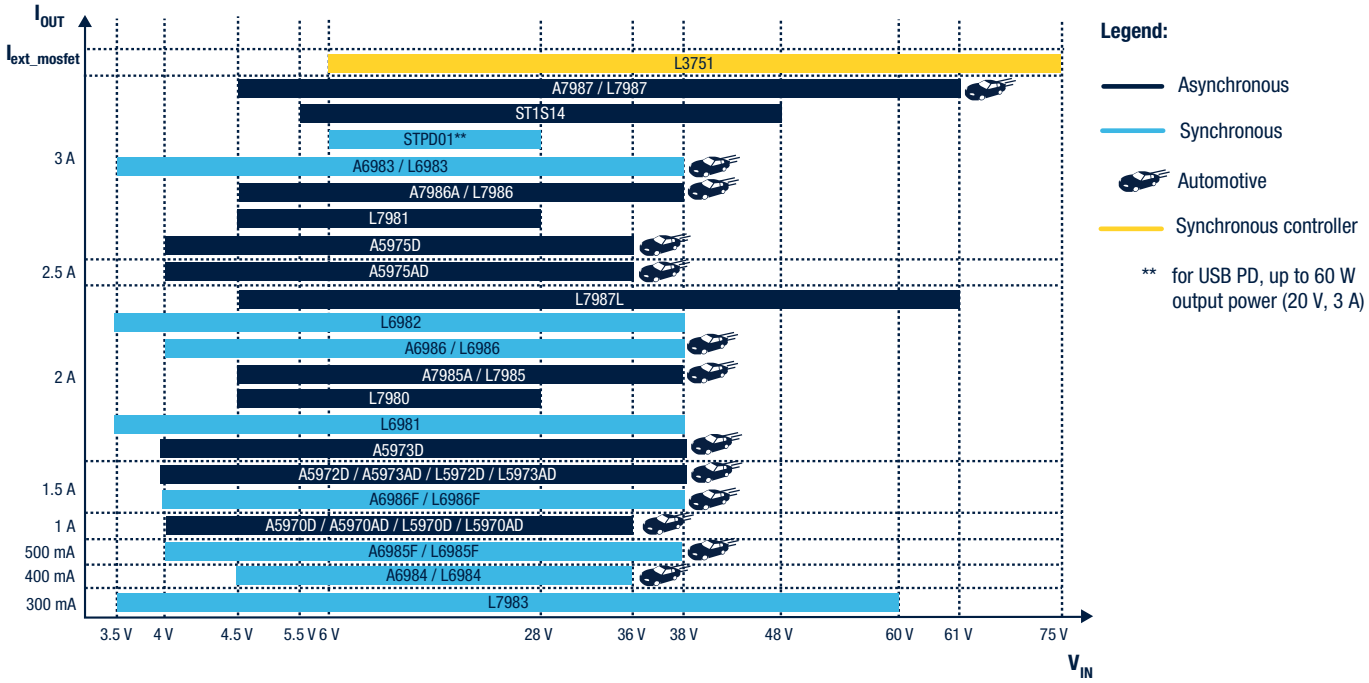
Quick overview: eDesignSuite is a design automation tool that simplifies the creation of electronic systems. By inputting basic parameters, users receive a tailored BOM, circuit schematics, and efficiency analyses. eDSim is an advanced online simulation tool for DC-DC converter design and analysis, streamlining the power supply development process.

Features	Benefits
Optimized BOM	Streamlines material selection and procurement
Schematic output	Enhances understanding and accuracy of designs
Bode analysis	Provides insight into frequency stability
Flexible design	Accommodates changes with minimal redesign
Speedy simulation	Saves time with rapid simulation results
Efficiency metrics	Aids in predicting performance and energy usage
Comprehensive tests	Offers thorough analysis for reliability

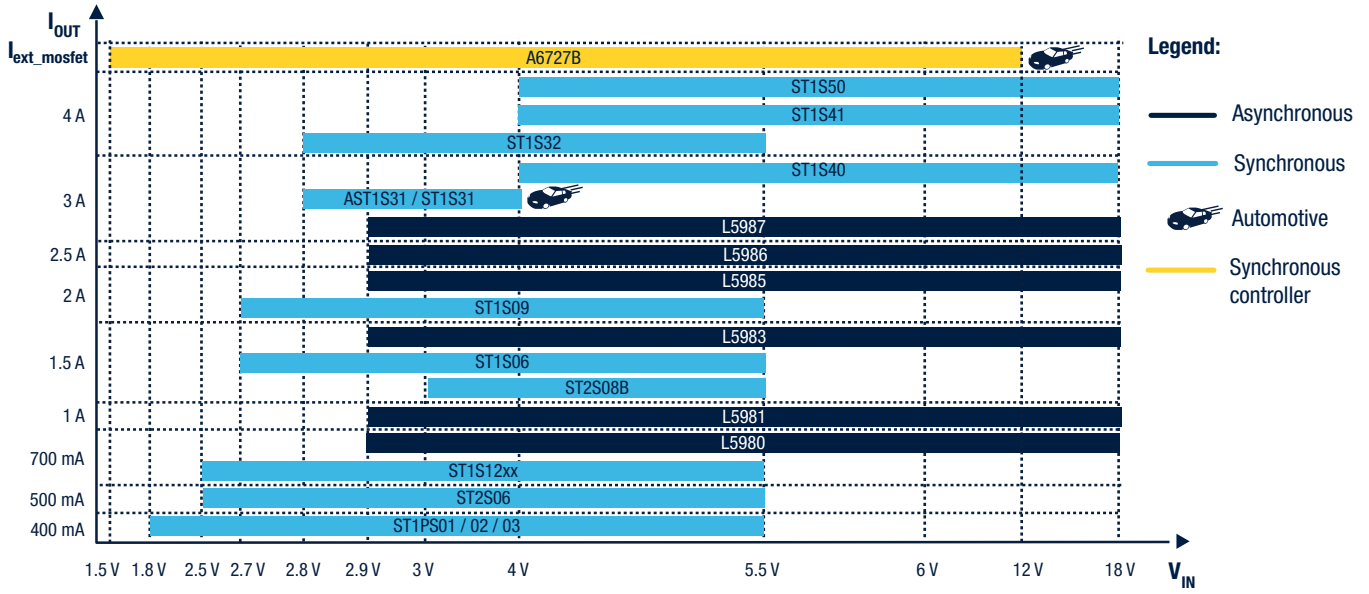
Scan QR code for an interactive simulation experience

Enhance your design experience: For a hands-on demonstration, click on the featured video section of the DC-DC webpage. Our comprehensive video tutorial guides you through comparing eDesignSuite and eDSim simulation data with bench measurements using the L6983 evaluation board.

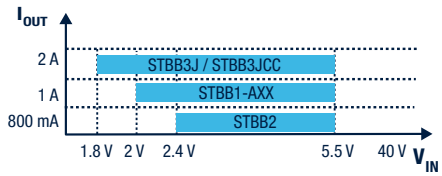
BUCK FOR PRE-REGULATION (>24 V)



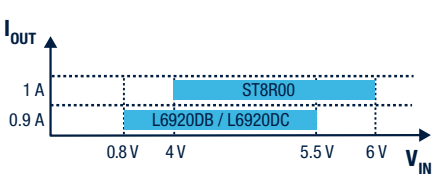
BUCK FOR POST-REGULATION (<24 V)



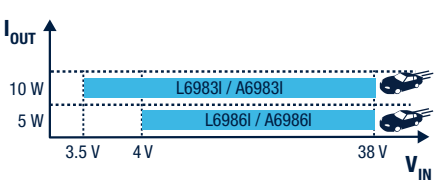
Buck-boost



Boost



Iso-buck



GLOSSARY

Accuracy – the maximum deviation from the specified output. Nominal accuracy can be affected by factors such as low tolerance resistors used in the feedback network. Commonly cited across temperature ranges, sometimes specified as tolerance.

AEC-Q100 – automotive industry standard test qualification for integrated circuits. A device must pass the failure mechanism-based stress test to be marked as automotive-grade compliant.

Buck-boost – a buck-boost regulator is like a buck and boost combined; it can both step down and step up an input voltage to reach the specified output voltage.

Continuous current mode (CCM) – during CCM, the current in the output inductor is always above zero. This mode of operation simplifies stability analysis and improves noise characteristics.

Discontinuous current mode (DCM) – during DCM, the current is allowed to drop to zero. This typically occurs when the output power is low, or the output inductor has low inductance.

Enable/Inhibit (EN/INH) – externally enabling (or disabling) the internal circuitry when the regulator is not required lowers the quiescent current and can prolong battery life.

Feedback network – resistors are used to set the desired output voltage. Often feedback networks also include capacitors to attenuate and amplify signals at specific frequencies (compensation).

Isolated buck topology – it is created by replacing the output inductor in a synchronous buck converter with a coupled inductor or transformer (no optocoupler needed) and rectifying the secondary winding voltage using a diode and a capacitor to generate an isolated output.

Line regulation – describes how well the regulator can maintain its intended output voltage given a change in the input voltage.

Noise – Good noise figures are critical in circuits for wireless communication or that rely on high-speed clock signals.

Package – while the most obvious effect of the package sizing is the board area required, it also has a direct influence on the thermal properties.

Pass element – the voltage regulation is performed by quickly switching a MOSFET fully on and off. This transistor is commonly referred to as the pass element.

Power dissipation – when a voltage is regulated, excess power is dissipated as heat. As heat can affect the regulator and surrounding components negatively, and eventually cause a thermal shutdown or functional failure, thermal management is important.

Power Good (PG) – this signal indicates that the output is within regulation. It is useful for power-sequencing, reset triggering, and more.

PSRR – power supply rejection ratio, or a measure of the regulator's ability to filter out noisy ripples in the input voltage. It is always specified in dB, and always over a range of frequencies.

Quiescent current – the current consumed by the regulator to operate. Lowering the quiescent current is especially important for battery-powered solutions.

Soft-start (SS) – soft-start is a controlled gradual increase of the throughput power, which prevents large inrush currents that can overload the power supply.

Step-down – a step-down regulator converts a higher input voltage to a lower output voltage and is commonly referred to as a buck regulator.

Step-up – a step-up regulator converts a lower input voltage to a higher output voltage and is commonly referred to as a boost regulator.

Switching frequency – a measure of how quickly the pass element is turned on and off. A higher switching frequency allows for smaller passive components, but also increases consumption and emissions.

Thermal shutdown – a protective function that shuts down the device to prevent damage from overheating.

Transient response – a description of the regulator's ability to resist changes in the input and output voltages. See line regulation and load regulation.

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