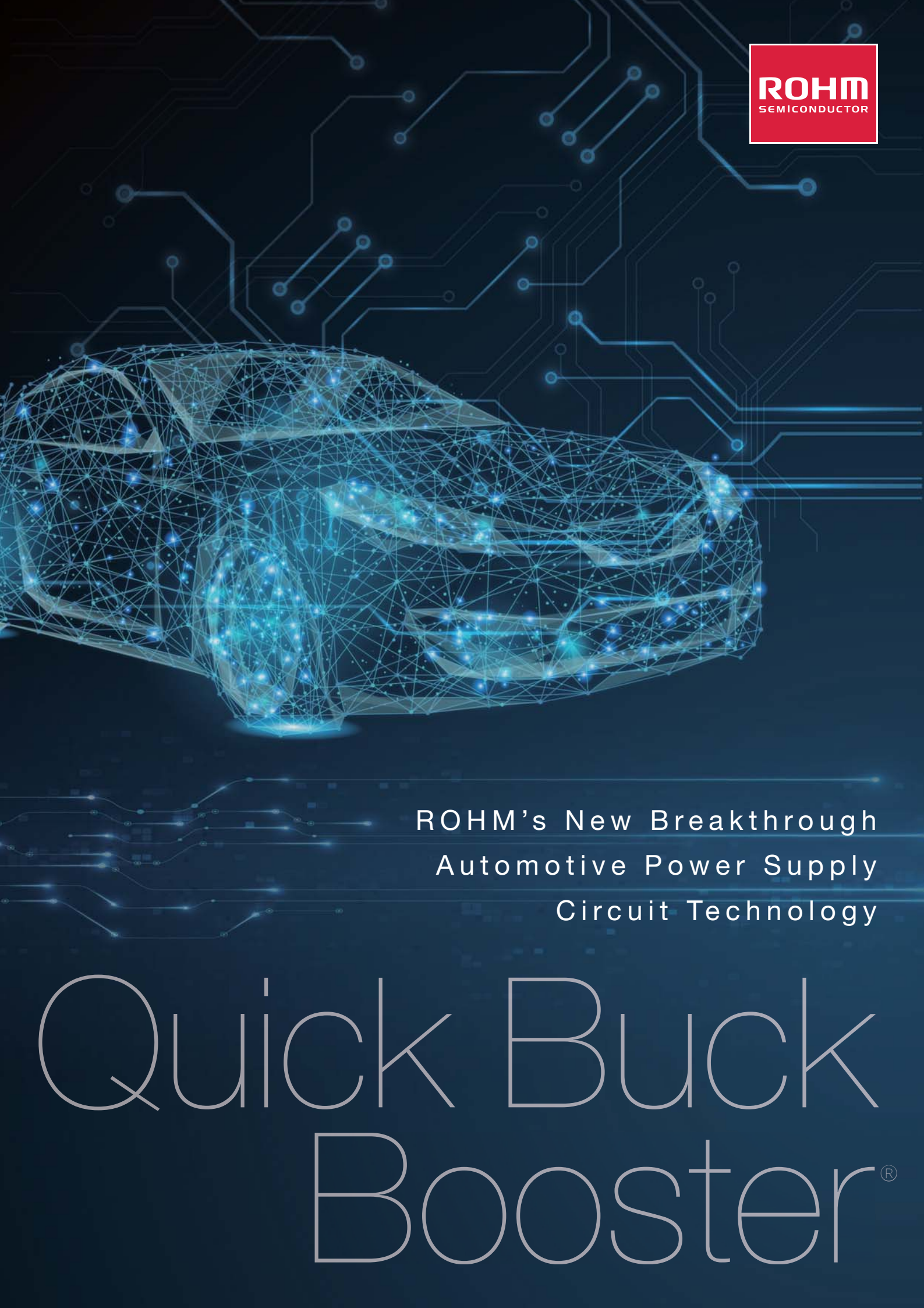


ROHM SEMICONDUCTOR

ROHM's New Breakthrough
Automotive Power Supply
Circuit Technology

Quick Buck Booster®

A new approach to solving problems inherent in stop-start systems

ROHM took a novel approach for buck-boost DC/DC converters, in which it has been difficult to achieve stable control, by developing Quick Buck Booster® technology that delivers fast response, industry-low* current consumption, and stable performance. Utilizing this technology in our automotive buck-boost power supply chipset contributes to greater design efficiency and stable operation in ECUs used stop-start vehicle systems.

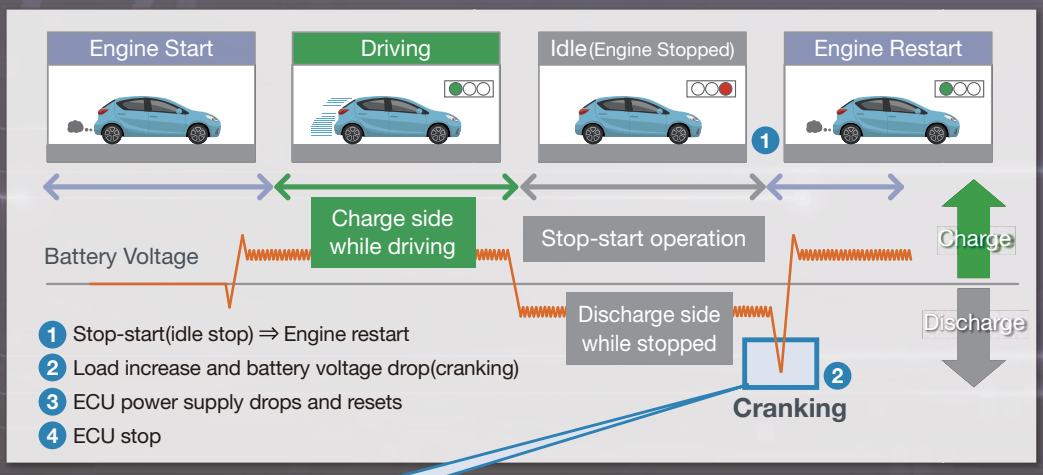
*ROHM October 2018 study

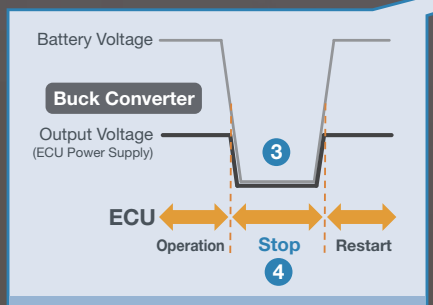
The challenges and necessity of buck-boost power supply in automotive stop-start applications

The growing concern in recent years regarding the global environment has increased the demand for start-stop vehicles that stops the motor or engine while idle.
However, this places a momentary large load on the system when restarting, requiring cranking which causes the battery voltage to drop. Therefore, a buck-boost converter is needed to prevent malfunctions and provide stable power to the ECU, but conventional buck-boost converters have been plagued with various problems in the past. Another issue is the need to restart the design process from the beginning when the power supply is initially designed for buck only operation but then suddenly must switch to buck-boost operation (i.e. during testing).

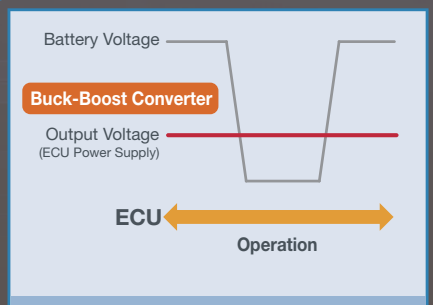
Problem	Slower response than buck converters, requiring a large capacitor for compensation
Problem	Buck and boost operations must be controlled separately based on input voltage, making control complicated
Problem	Growing demand for lower current consumption to accommodate the increasing number of ECUs adopted to handle the continued electrification of vehicle systems

Problems with stop-start vehicle systems : Battery voltage and ECUs (Electronic Control Units)

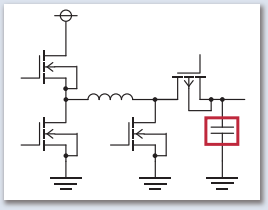




The buck converter stops the ECU during battery voltage cranking



Buck-boost converter required for stable ECU operation



BUT Buck-boost converters demand complex control and large capacitance capacitors

Flexible approach paves the way to a revolutionary new technology

Quick Buck Booster®

To solve these problems, ROHM leveraged analog design technology and power system processes to develop Quick Buck Booster®, a breakthrough buck-boost technology that utilizes original high-speed pulse control technology dubbed Nano Pulse Control®. As a result, responsiveness was dramatically improved, making it possible to provide a common design for both buck and buck-boost conversion while significantly reducing the capacitance of the output capacitor.

Problem ❶

Buck-boost converter response → Slower than buck converters (Large capacitance output capacitors required)

With Quick Buck Booster®

Fast response equivalent to buck converters (**Lower capacitance** output capacitors)

Problem ❷

Difficult to selectively achieve buck and buck-boost operation → The minimum battery voltage will vary depending on the type of vehicle (IC selection, phase design, board modifications)

With Quick Buck Booster®

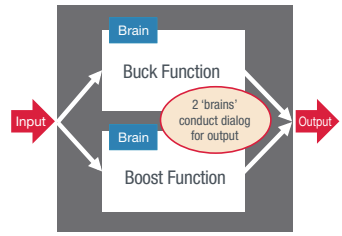
Allows for a common design for buck and buck-boost converters

New method for maintaining a fixed boost ratio

Conventional buck-boost converters typically use a four-switch configuration that combines 2 switches each for buck and boost operation, requiring complicated control that utilizes individual PWM (Pulse Width Modulation) signals for driving the buck and boost switches based on input voltage. As a result, because the 2 'brains' for buck and boost must constantly carry out dialog, it becomes impossible to improve response. In response, ROHM introduced a new approach that controls only the buck side while fixing the boost ratio without controlling the boost side. Eliminating the need to control the boost side results in only one 'brain' left for control, making it possible to significantly improve response to input voltage fluctuations.

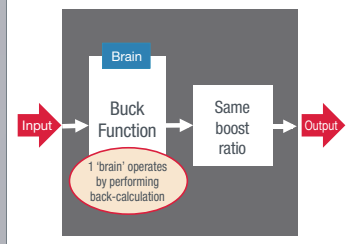
Moving away from the trend towards single-chip solutions allowed ROHM to provide a common design utilizing 2 chips to provide buck-boost operation by adding an optional boost IC to a buck converter topology.

Conventional Buck-Boost Converter



2 'brains' complicate control

Buck-Boost Converter Utilizing Quick Buck Booster® Technology



1 'brain' enables simple control, improving response

Technology using an unprecedented new approach that solves all problems with buck-boost power supplies

Technology that leverages the performance of buck converters for buck-boost operation

Quick Buck Booster® makes it possible to switch to buck-boost power supply while maintaining the characteristics of buck topologies that provide superior performance over conventional buck-boost converters. In other words, the characteristics of ROHM's high performance buck converters can be used for buck-boost operation, reducing current consumption along with the size and number of capacitors.

Advantages of ROHM's Quick Buck Booster® Control Technology*1

	Buck Converter **BD8P250MUF-C**	Buck-Boost Chipset **BD8P250MUF-C + BD90302NUF-C**	Conventional Product Buck-Boost Converter
No-Load Current Consumption	8μA (Low Consumption)	**8μA** (Industry-leading* performance)	Approx. 30μA
Shutdown Current	3μA	3μA	Equivalent
Min. Input Voltage	3.5V	2.7V	Equivalent
Operating Switching Frequency	2.2MHz (High Frequency Operation)	2.2MHz	Equivalent
Efficiency	88% (High efficiency)	87%	85%
Max. Output Current	2A	0.8A	Equivalent
Output Capacitance	44μF (Fast Response)	**44μF**	88μF or more
External Parts	5pcs (Few Parts)	5pcs	5pcs or more
Spread Spectrum Function	Available (Low Noise)	**Available** (Industry-leading* performance)	None

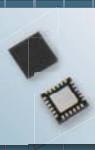
ROHM's technology achieves buck-boost operation while maintaining buck performance, which was not previously possible

*1 : When using a chipset equipped with the BD8P250MUF-C

*ROHM October 2018 study

Automotive Buck-Boost Power Supply Chipset Utilizing Quick Buck Booster® Technology

BD8P250MUF-C
+
BD90302NUF-C



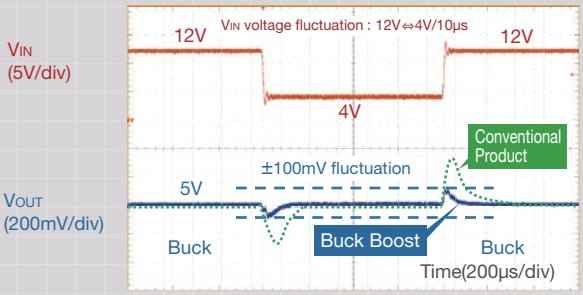
Buck Converter Featuring Quick Buck Booster® Technology
BD8P250MUF-C

Feature ❶ Fast Response

Improved buck-boost converter response reduces output capacitance by half

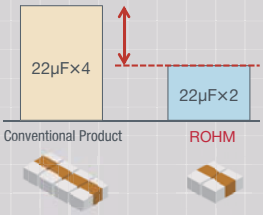
ROHM's buck-boost power supply chipset with Quick Buck Booster® technology suppresses output voltage fluctuations to ±100mV, **shortening fluctuation time considerably**.
This ensures stable ECU operation during cranking.
In addition, it is possible to halve the capacitance of the capacitor connected to the output side to improve response, contributing to **lower costs and greater space savings**.

The graph below shows the improved response characteristics, assuming a drop in battery voltage from 12V to 4V for 10µs.



Conditions : VIN=12V ⇔4V, VOUT=5V, IOUT=0.4A, Freq.=2.2MHz, VOUT=VCC_EX, L=3.3µH, COUT=22µF×2

Fast response maintains the output voltage even during cranking!



Capacitance reduced from 88µF(22µF×4) to 44µF(22µF×2)

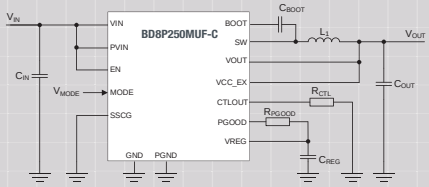
Reduces the number of output capacitors by half without sacrificing response

Feature ❷ Common Design①

Achieves a common design for buck and buck-boost, simplifying power supply design

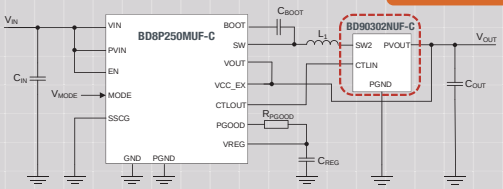
The BD8P250MUF-C can operate as a superior single-chip buck converter or as a buck-boost chipset by simply adding a dedicated boost IC. In keeping with the customer's perspective, as shown in the diagram below by simply adding a dedicated boost IC to the same board with same external parts, a common design for both buck and buck-boost operation is possible, regardless of the minimum value of the battery voltage, which can vary depending on vehicle model. In addition, phase compensation is built in to facilitate switching. This reduces the time and effort required for power supply design.

Buck Converter Configuration



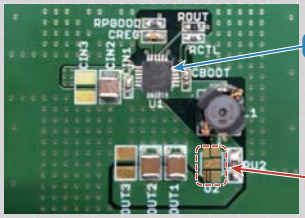
Buck-Boost Converter Configuration

Dedicated Boost IC
BD90302NUF-C



Easily switch between buck and buck-boost operation by using/not using ROHM's **BD90302NUF-C** dedicated boost IC
This allows for a common converter design, regardless of the minimum vehicle battery voltage

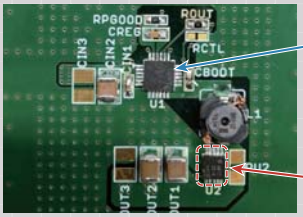
Easily switch from buck to buck-boost



BD8P250MUF-C

Unnecessary

Switchable on the same PCB



BD8P250MUF-C

Dedicated Boost IC
BD90302NUF-C

Achieves a common design for buck and buck-boost converters without the need for IC selection, phase design, or board modifications

Feature ❸

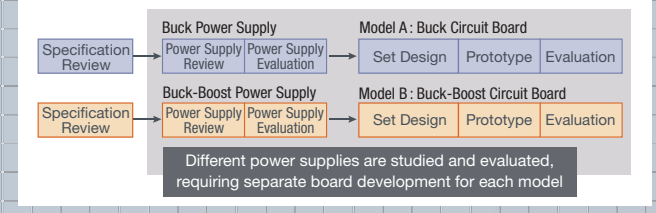
Common Design②

Providing a common board design reduces power supply development load by 50%

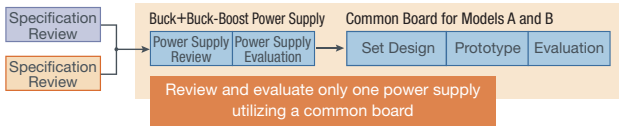
Utilizing a common board design reduces development load by 50% compared with conventional methods requiring separate designs for both buck-boost and buck power supplies, since only one power supply needs to be considered and evaluated.

No need to start from scratch **Enables flexible development**

Conventional



New Chipset

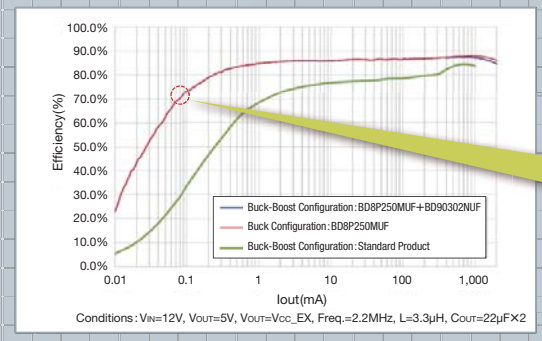


Feature ❹

High Efficiency

Reduces current consumption and significantly improves efficiency at light loads

Leveraging proprietary low current consumption technology allows ROHM to achieve an exceptionally low no-load current consumption of 8μA when obtaining 5V output from 12V battery voltage. As a result, efficiency under light and no loads has been significantly improved, achieving as much as 73% efficiency for both buck and buck-boost operation at an output load current of 0.1mA.



Conditions : V_{IN}=12V, V_{OUT}=5V, V_{OUT}=V_{CC}_EX, Freq.=2.2MHz, L=3.3μH, C_{OUT}=22μF×2

The growing number of ECUs increases **the demand for low current consumption**

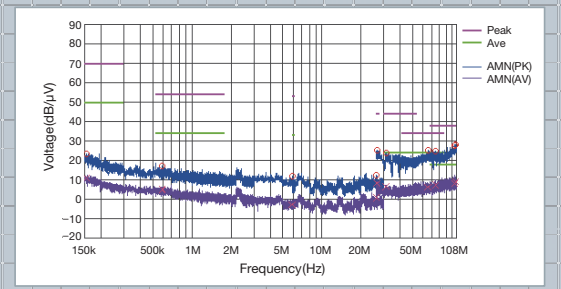
Quick Buck Booster® enables **high efficiency(73%) at an output load current of 0.1mA** for both buckand buck-boost converter configurations

Feature ❺

Low EMI

Low noise that easily clears stringent international standards

Low noise is a requirement for DC/DC converters. The below graph shows the average and peak values for EMI when obtaining 5V output from 12V input. As these products operate at 2.2MHz, noise peaks normally occur at 2.2MHz, 4.4MHz, etc., but the built-in spread spectrum function applies a slight variation to the clock frequency, suppressing these peaks and significantly reducing EMI. In addition, ROHM was able to sufficiently clear the stringent international CISPR 25 Class 5* standard.



Increasing **demand for low EMI** to meet stricter noise standards

Buck and buck-boost converter configurations equipped with Quick Buck Booster® technology **easily clears CISPR 25 Class 5* requirements**

*Specifies a method for evaluating noise generated from automotive electrical components for the purpose of protecting onboard receivers. The Class indicates the limits for the peak and average values of noise.

Automotive-Grade Low EMI Buck/Buck-Boost DC/DC Converters with Quick Buck Booster® Technology

	Part No.	Supply Voltage (V)	Output Voltage (V)	No-Load Current Consumption (μA)	Output Voltage Accuracy (%)	Operating Frequency (MHz)	Max. Output Current (A)	Operating Temperature (°C)	Package	Automotive Grade (AEC-Q100 Qualified)
Buck-Boost (Chipset)	New BD8P250MUF-C + New BD90302NUF-C (Dedicated Boost IC)	2.7 to 36	5	8	±2	2.2	0.8	−40 to +125	VQFN24FV4040	YES
									VSON10FV3030	YES
Buck	New BD8P250MUF-C	3.5 to 36	5	8	±2	2.2	2	−40 to +125	VQFN24FV4040	YES

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