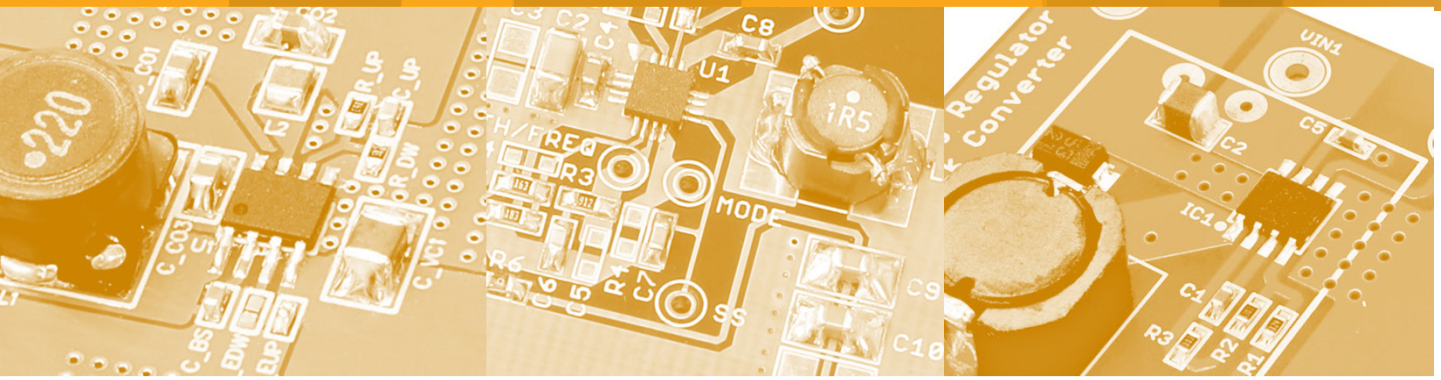
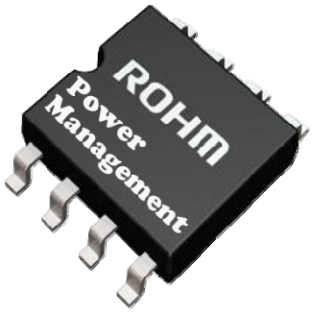
Buck DC/DC Converter Selection Guide

Rev. 1.4





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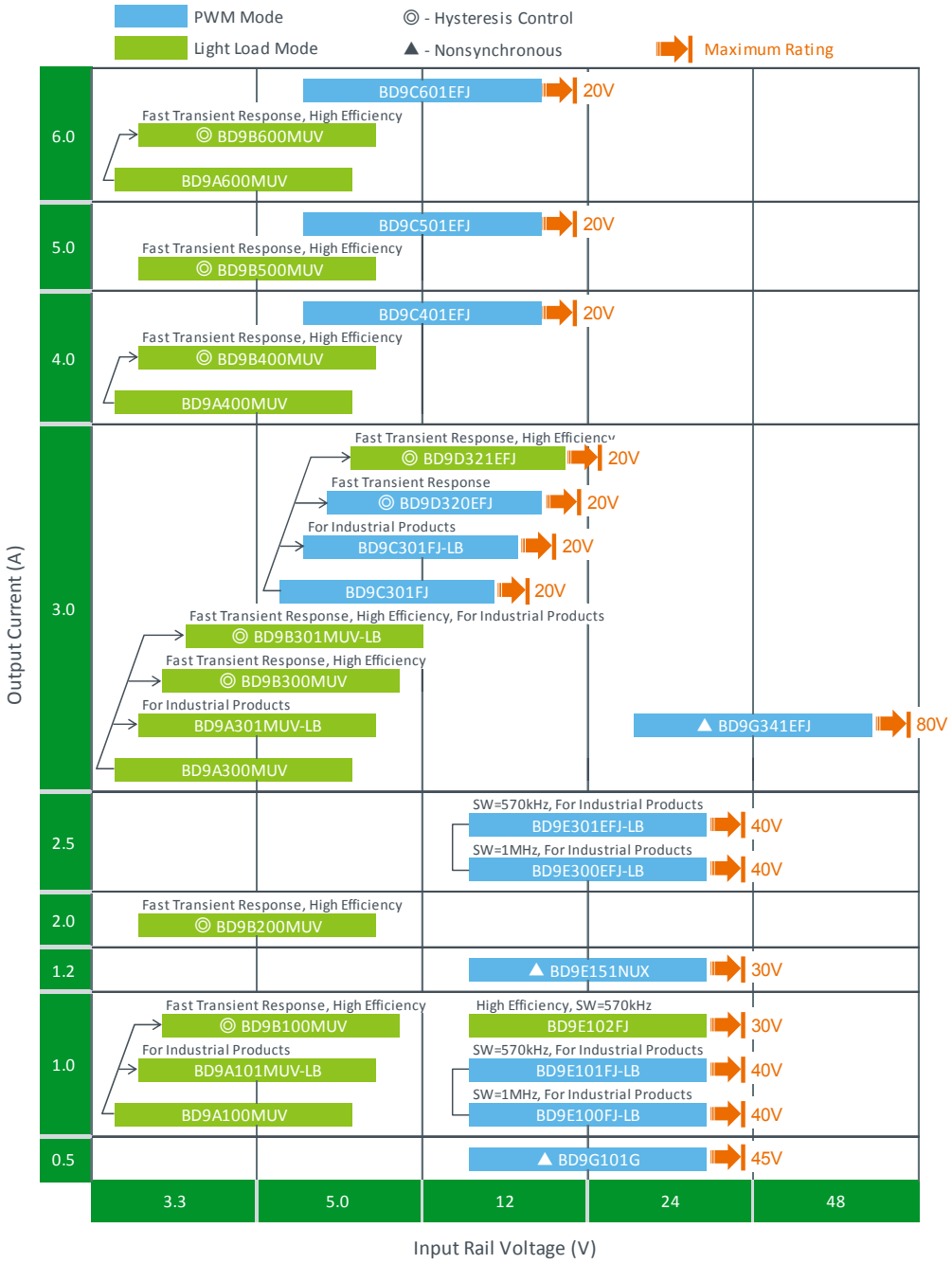
ROHM SEMICONDUCTOR

New Series of High Efficiency DC/DC Buck Converter

BD9x series Product family



ROHM offers high-efficiency power supply solutions to suit customer's requirements. Latest DC/DC converter series “BD9x family”, where "BD9" stands for "buck-type" and subsequent alphabet-letter represents maximum input-voltage rating, and the number following represents output-current. The “BD9x series” can be used for 3.3V, 5V, 12V, 24V, and 48V power supply, and provides better efficiency by decreased ON-resistance of built-in power MOSFET.

Part No. Description

Note : Some cases are not based on this rule.

B D 9 A 3 0 0

Topology
9 : Buck
8 : Boost, Buck-Boost, Inverting

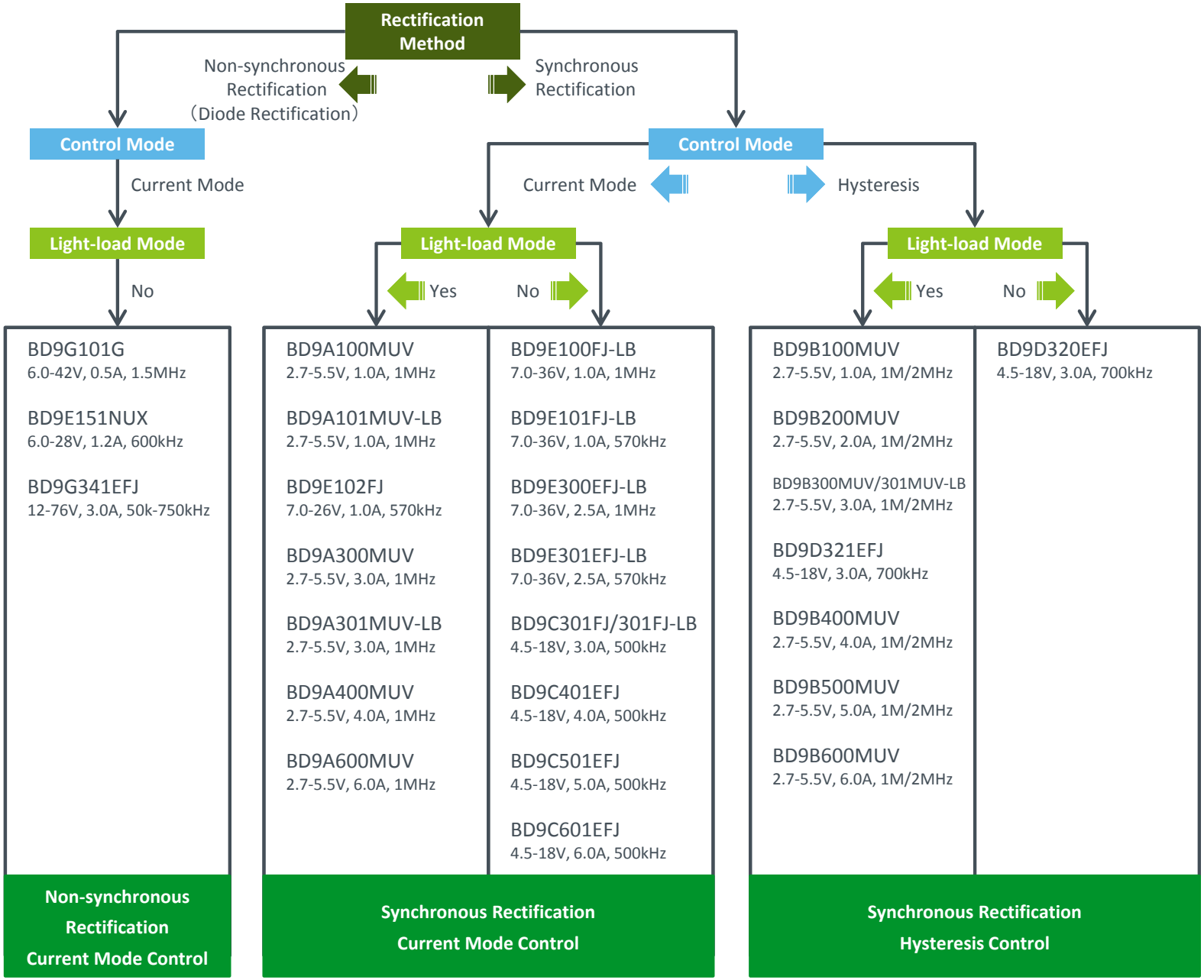
Maximum Input Voltage Ratings and Control Mode
A : ≤ 7V Current Mode
B : ≤ 7V Hysteresis
C : ≤ 20V Current Mode
D : ≤ 20V Hysteresis
E : ≤ 40V Current Mode
F : ≤ 40V Hysteresis
G : ≤ 80V Current Mode

Output Current
1 : ≤ 1A
2 : ≤ 2A
3 : ≤ 3A
4 : ≤ 4A
5 : ≤ 5A
6 : ≤ 6A
·
·
·
A : ≤ 10A

Serial No. 00, 01, 02, ···

BD9x series are designed with the combination of various rectification-methods, control-method s and efficiency enhancement operation during the light-load. Rectification method has non-synchronous rectification (Diode Rectification) and synchronous one. Non-synchronous rectification can achieve smaller IC footprint area, since the diode is externally used for low-side switch, but efficiency reduces if the output-voltage is low. If the output-voltage is high, the efficiency is similar to that of synchronous rectification. At all output-voltage ratings, synchronous rectification could minimize the decrease in efficiency. The stable consecutive operations could be continued even if load current decreases. Two types of rectification control methods are available: Current-mode and Hysteresis control method. Current-mode has a faster transient response than the former Voltage-mode control, can be easily set phase-compensation, and also output ripple-voltage is smaller.

BD9x series Family Chart

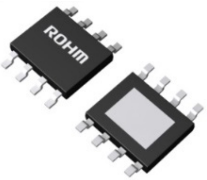


Hysteresis control has a faster transient response than current-mode, and doesn't requires phase-compensation.
This document describes On-time control or H^{3}Reg^{TM} control mode as Hysteresis control. ICs with an improved efficiency mode for light-load could save power while on stand-by. When load-current decreases, the switching frequency changes to low and hence operating current decreases, which improves the efficiency. Signal interference in the device should be considered, because switching frequency changes with respect to load-current. At this time, output ripple-voltage also increases, and it should be also considered whether it is suitable as per the specification.

Compact and Thin Packages

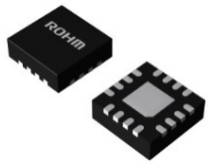
The Exposed-pad enables efficient heat dissipation from the bottom of the package to the PCB. This enables to implement 6A DC/DC solution with a compact package.

Under 6A



HTSOP-J8
4.90mm × 6.00mm
h: 1.00mm

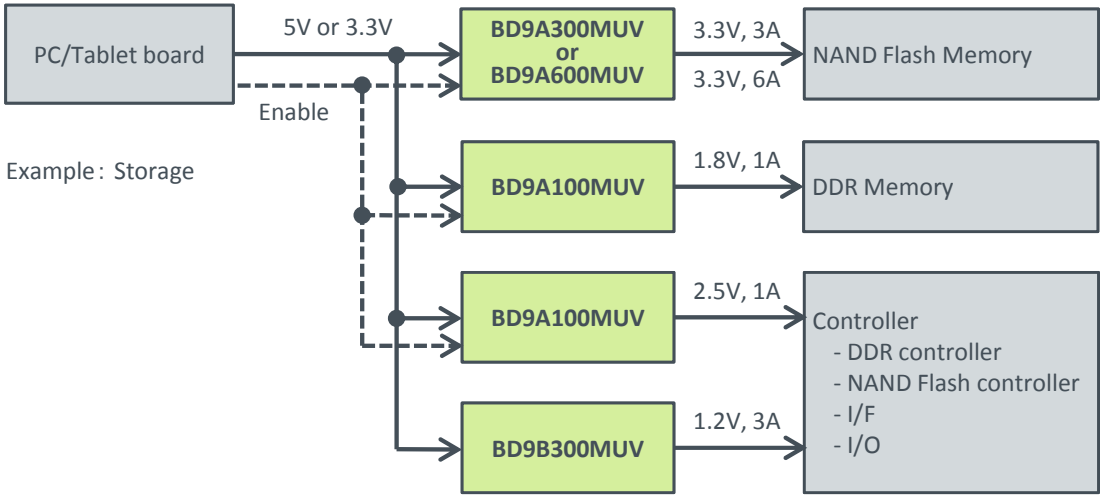
Under 6A

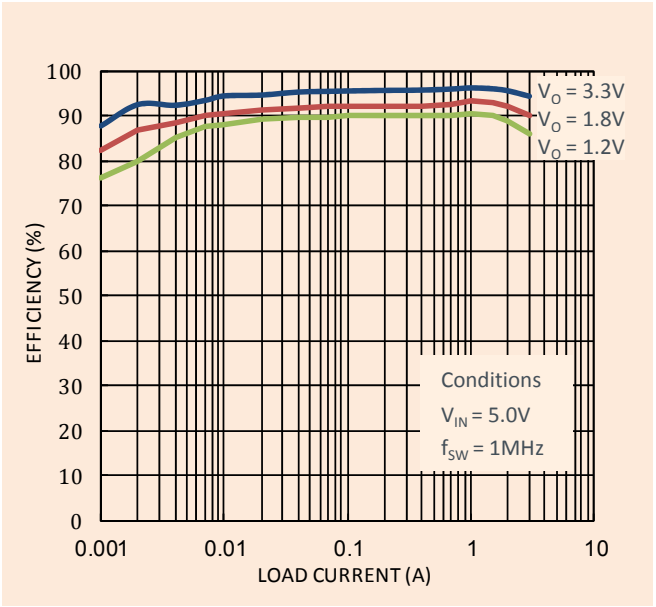


VQFN016V3030
3.00mm × 3.00mm
h: 1.00mm

The Power Supply Solution for Consumers' Products

BD9A100MUV, BD9A300MUV, BD9A600MUV, and BD9B300MUV generate low voltages such as 1.8V, from 5V or 3.3V power supply.

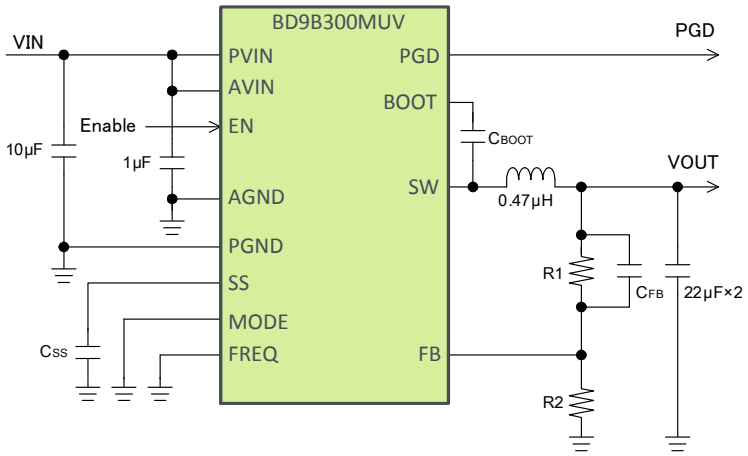




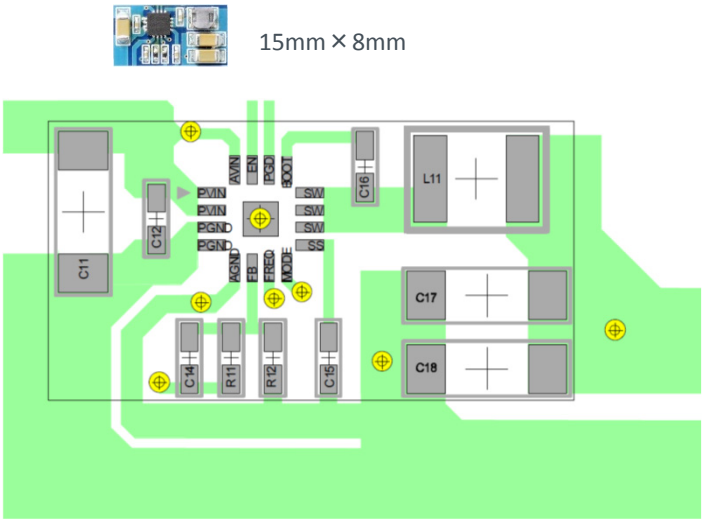
BD9B300MUV Efficiency vs. Load Current

Product Example: BD9B300MUV

- Input Voltage Range : 2.7V to 5.5V
- Output Voltage Range : 0.8V to (V_{IN}×0.8)V
- Standard Voltage : 0.8V±1.0%
- Output Current : 3A
- Switching Frequency : 1MHz / 2MHz
- Built-in Switching FET : 35mΩ
- Circuit Current : 35μA
- Fast Transient Response Characteristics by the constant-on-time control
- High Efficiency mode for light-load
- Selectable from Light-load Automatic Switching mode and PWM Fixed mode
- Adjustable Soft-Start
- Power Good Output
- Various Protection Functions
  Over Current Protection (OCP), Short Circuit Protection (SCP)
  Thermal Shutdown Protection(TSD), Under-Voltage Protection (UVLO)



BD9B300MUV Application Circuit



BD9B300MUV PCB layout

Selectable from Two Series

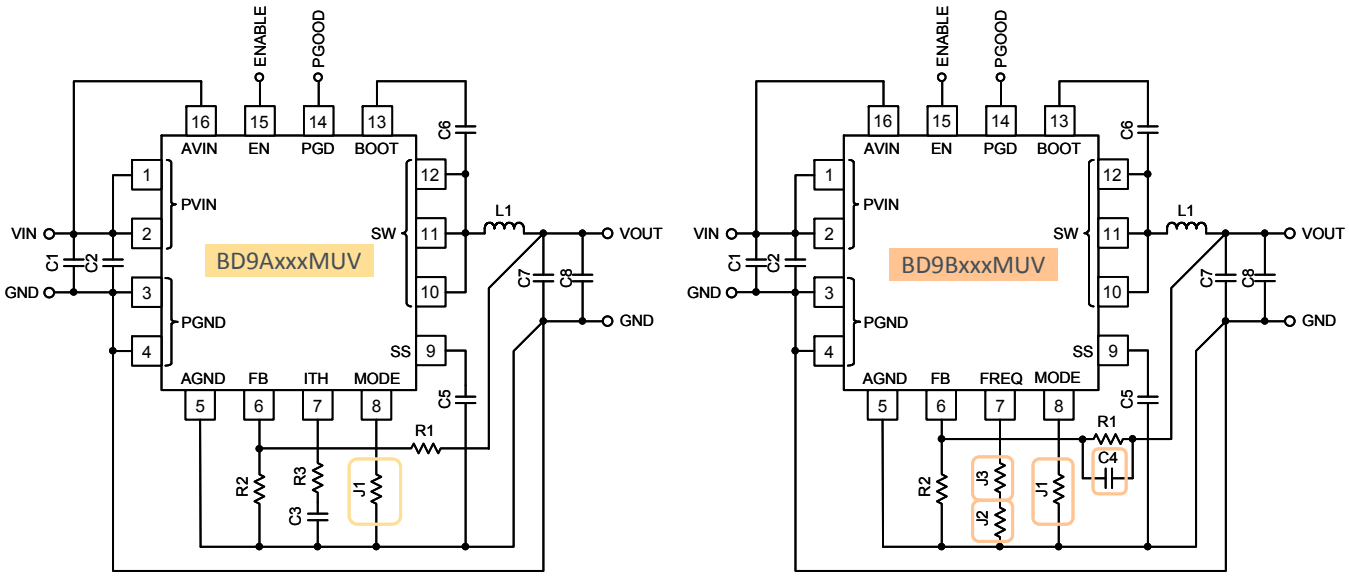
BD9AxxxMUV and BD9BxxxMUV series are configured pin-compatible from 1A to 6A, and can select suitable IC to suit for various application. It operates at high-speed PWM mode, when higher load-current is needed, and when load current is smaller, it changes to power-saving operation in SLLM™(PFM) mode. BD9BxxxMUV is a upper compatible series than BD9AxxxMUV, and are replaceable with each other by minor changes to the PCB layout.

High Function

Upper Compatible

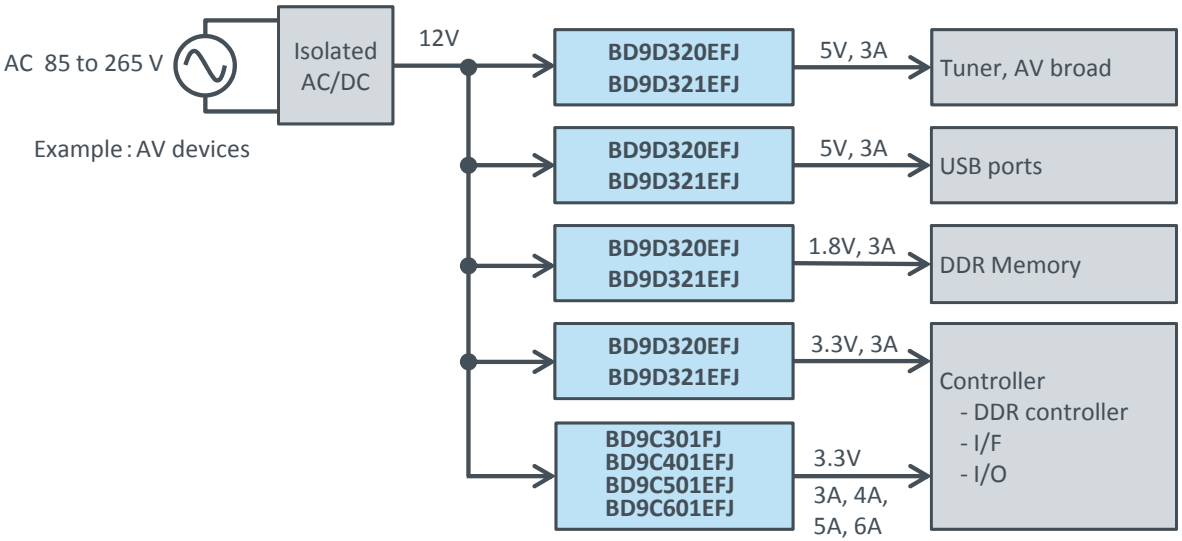
Product	Control Method	Light Load Operation	Function Differences
BD9B100MUV BD9B200MUV BD9B300MUV BD9B301MUV-LB BD9B400MUV BD9B500MUV BD9B600MUV	Constant-on-time	Deep SLLM	• Faster transient response than BD9AxxxMUV • No need of phase compensation • Improved efficiency for all load ranges, wider than BD9AxxxMUV • When MODE terminal turns Low, it operates with automatic switching of light-load. When MODE terminal turns High, it operates with PWM fixed mode. • When FREQ terminal turns Low, it operates at 2MHz. When FREQ terminal turns High, it operates at 1MHz.
BD9A100MUV BD9A101MUV-LB BD9A300MUV BD9A301MUV-LB BD9A400MUV BD9A600MUV	Current mode	SLLM™	• When MODE terminal turns Low, it operates with PWM fixed mode. When MODE terminal turns High, it operates with automatic switching mode of light load.

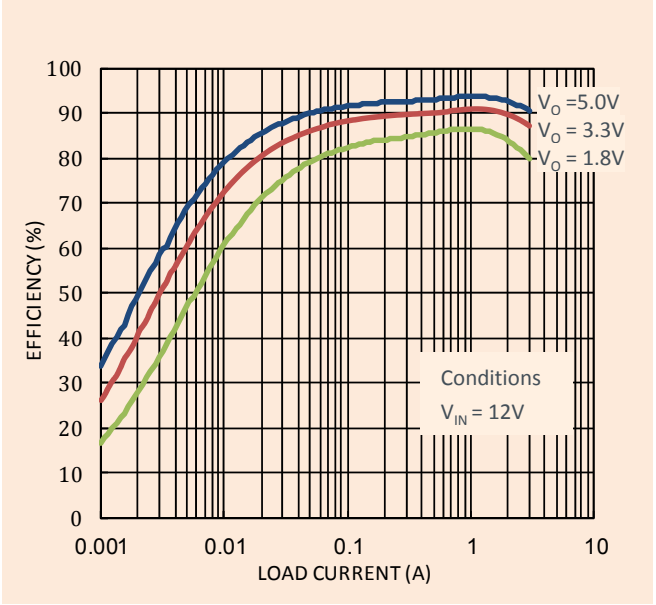
SLLM™ : Simple Light Load Mode (PFM operation)



Power Supply Solution for Consumers' Products

BD9D320EFJ, BD9D321EFJ, BD9C301FJ, BD9C401EFJ, BD9C501EFJ, and BD9C601EFJ generate voltages 5V or 3.3V from 12V power supply.

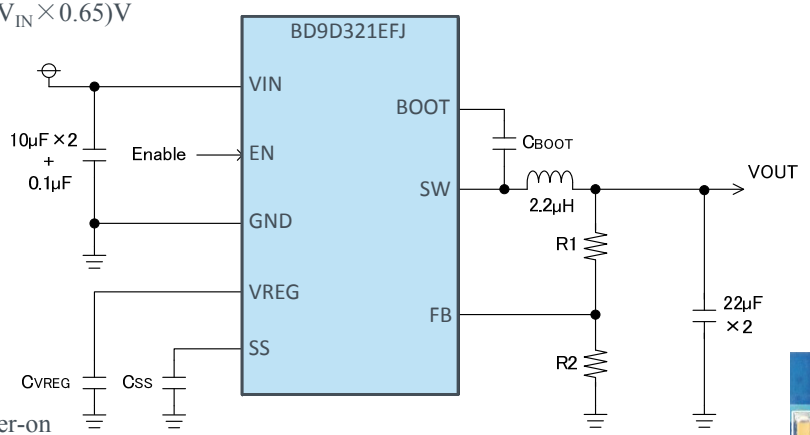




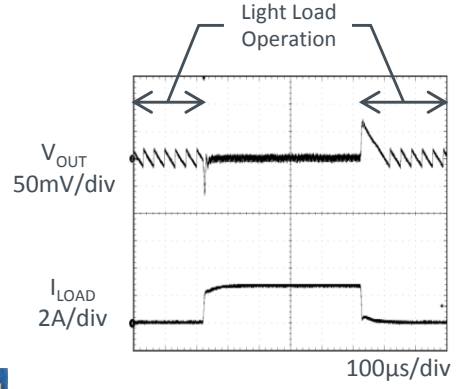
BD9D321EFJ Efficiency vs. Load Current

Product Example: BD9D321FEJ

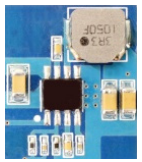
- Input Voltage Range : 4.5V to 18V
- Output Voltage Range : 0.765V to 7.0V, (V_{IN}×0.07)V to (V_{IN}×0.65)V
- Standard Voltage : 0.765V±1.5%
- Output Current : 3A
- Switching Frequency : 700kHz
- Built-in Switching FET : 100mΩ, 70mΩ
- Fast Transient Response Characteristics by the constant-on-time control
- No phase-compensating components required
- Ceramic Capacitor for output
- Synchronous Rectification Type
- High efficiency mode for light-load
- Adjustable soft-start function prevents inrush current on power-on
- Various Protective Functions
  Over-Current Protection(OCP), Short Circuit Protection(SCP)
  Thermal Shutdown Protection(TSD), Under-Voltage Protection(UVLO)



BD9D321EFJ Application Circuit



BD9D321EFJ Transient Response

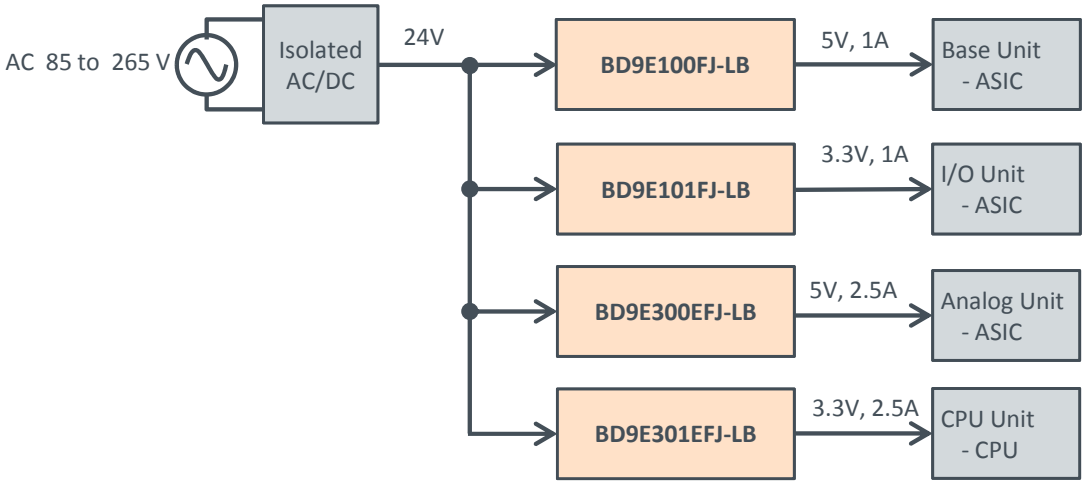


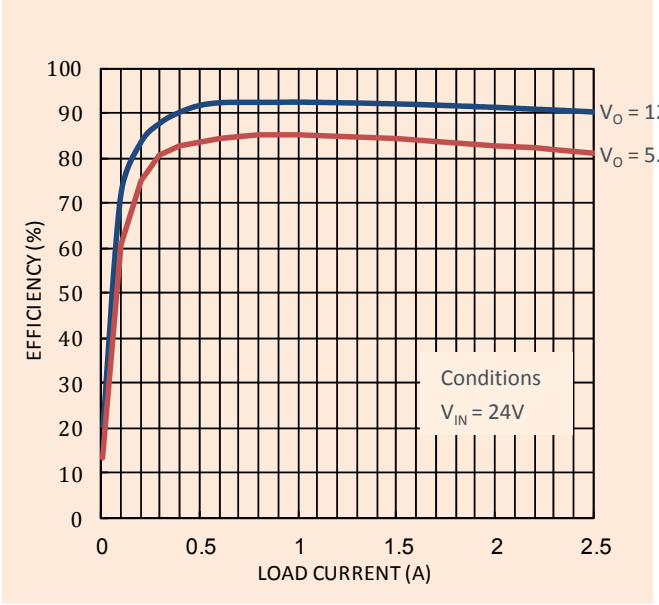
17mm × 20mm

BD9D320EFJ PCB-size

Power Supply Solution for Industrial Products

BD9E100FJ, BD9E101FJ, BD9E300EFJ, and BD9E301EFJ generate 5V or 3.3V from 24V or 12V power supply.

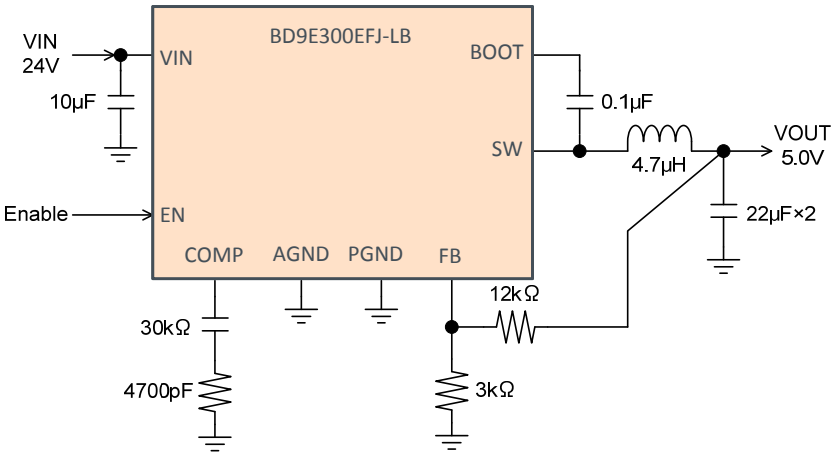




BD9E300EFJ-LB Efficiency vs. Load Currents

Product Example: BD9E300EFJ-LB

- Long Time Supporting Product for Industrial Applications
- Input Voltage Maximum Rating : 40V
- Input Voltage Range : 7.0V to 36V
- Output Voltage Range : (V_{IN}×0.15)V to (V_{IN}×0.7)V
  (V_{IN}×0.15) ≥ 1.0V
- Reference Voltage : 1.0V±2.0%
- Output Current : 2.5A
- Small-size Inductor by high switching frequency as 1MHz
- Built-in Switching FET : 170mΩ, 140mΩ
- Fast Transient Response Characteristics by current mode control
- No external diode required (For synchronous rectification)
- Soft start prevents inrush current during power-on
- Various Protective Functions
  Over Current Protection (OCP), Short Circuit Protection(SCP)
  Thermal Shutdown Protection(TSD), Under Voltage Protection(UVLO)



BD9E300EFJ-LB Application Circuit

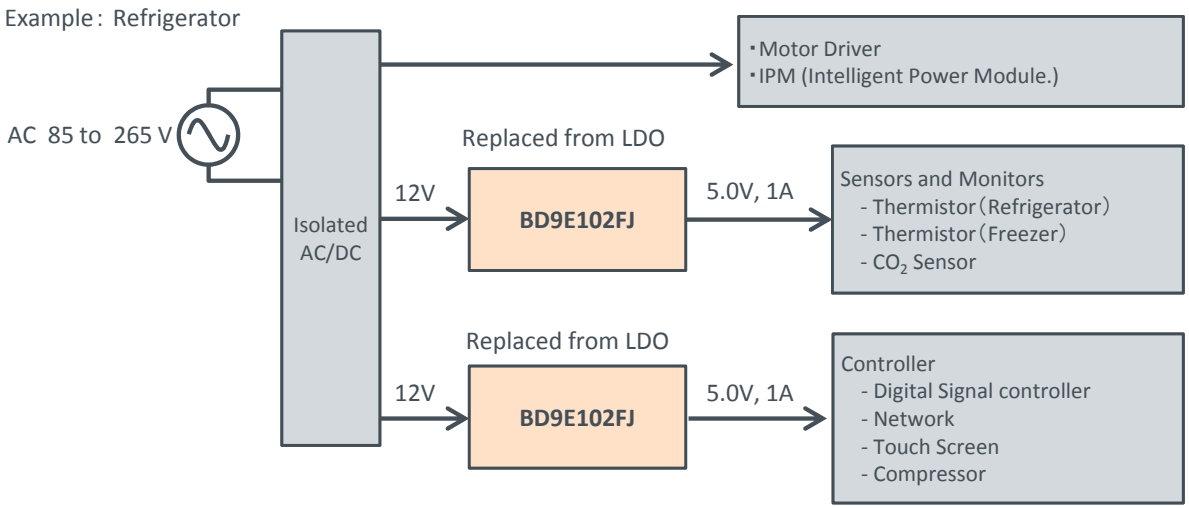
29mm × 12mm

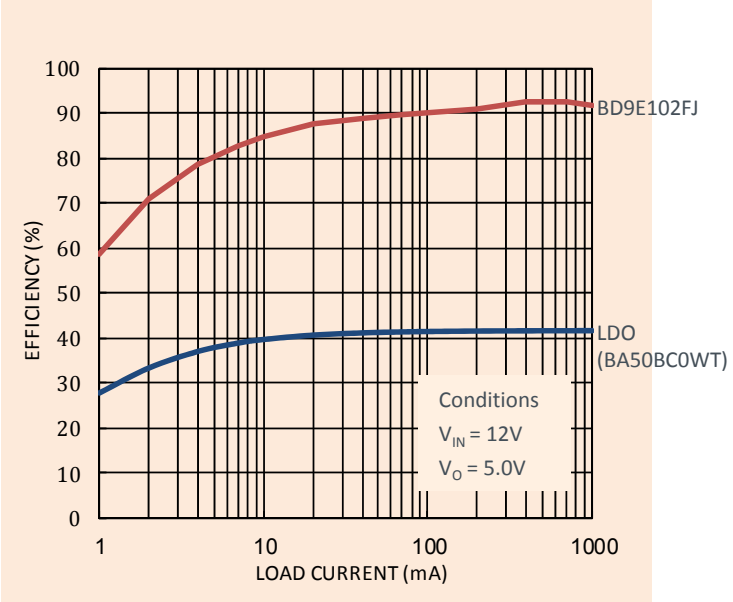
BD9E300EFJ PCB-size

Efficient heat-radiation by the Exposed Heat-pad

Power Solution for Home Appliances

BD9E102FJ generates voltage as 5V or 3.3V from 24V or 12V power supply. Replacing LDO enables power-saving.

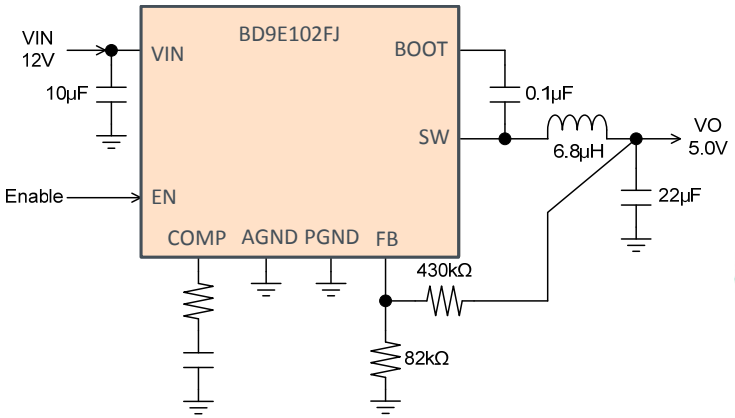




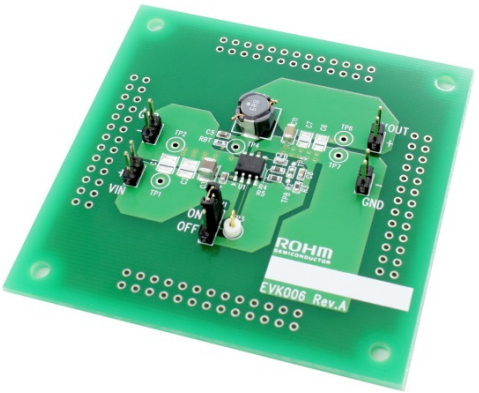
BD9E102FJ Efficiency vs. Load Current

Product Example: BD9E102FJ

- Input Voltage Range : 7.0V to 26V
- Output Voltage Range : $(V_{IN} \times 0.143)$V to $(V_{IN} \times 0.7)$V
  $(V_{IN} \times 0.143) \geq 1.0$V
- Reference Voltage : 0.8V±2.0%
- Output Current : 1.0A
- Input Voltage Max. Rating : 28V for Home Appliances
- High efficiency for light-load and power-saving while stand-by
- Built-in Switching FET : 250mΩ, 200mΩ
- Fast Transient Response Characteristics by current mode control
- Easy to set phase-compensation
- No external diode required (For synchronous rectification)
- Soft-start prevents inrush current during power-on
- Various Protection Functions:
  Over Current Protection(OCP), Short Circuit Protection (SCP),
  Thermal Shutdown Protection(TSD), Under-Voltage Protection(UVLO)



BD9E102FJ Application Circuits

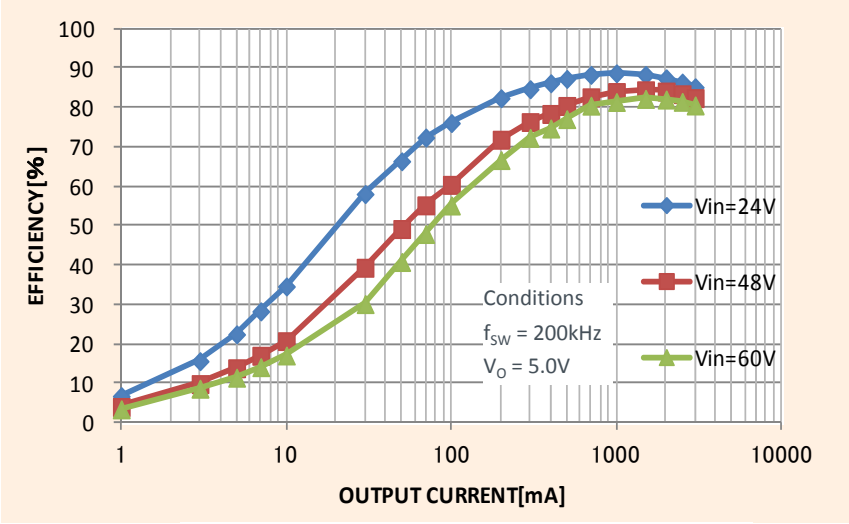


BD9E102FJ Evaluation Board

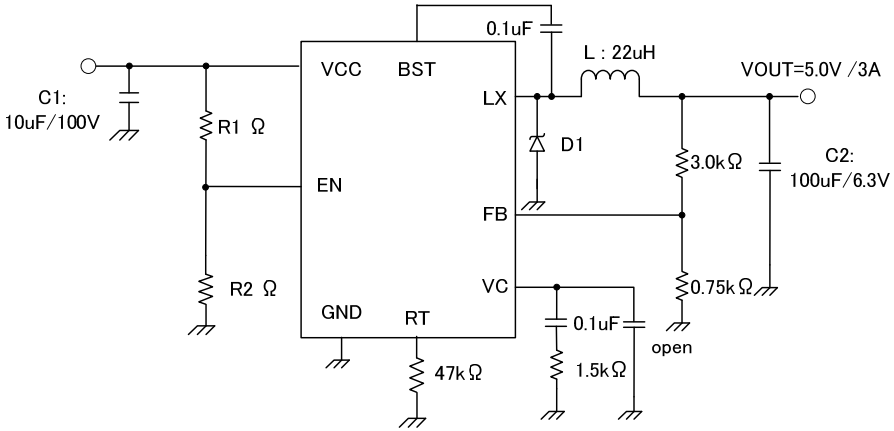
Product Example: BD9G341EFJ（Under Development ）

- Input Voltage Range : 12V to 76V
- Output Voltage Range : 1.0V to (V_{IN}×0.7)V
- Standard Voltage : 1.0V±1.5%
- Output Current : 3.0A
- Built-in Switching MOSFET 80V withstanding voltage
- Fast Transient Response Characteristics by current mode control
  Easy to set phase-compensation
- Soft-start prevents inrush current during power-on
- Operating Frequency 50kHz to 750kHz configurable
- UVLO value configurable by an external component
- Various Protective Functions
  Over-Current Protection(OCP), Short Circuit Protection(SCP)
  Thermal Shutdown Protection(TSD), Under-Voltage Protection(UVLO)

※The above specifications may be change at the time of release.



BD9G341EFJ Efficiency vs. Load Current

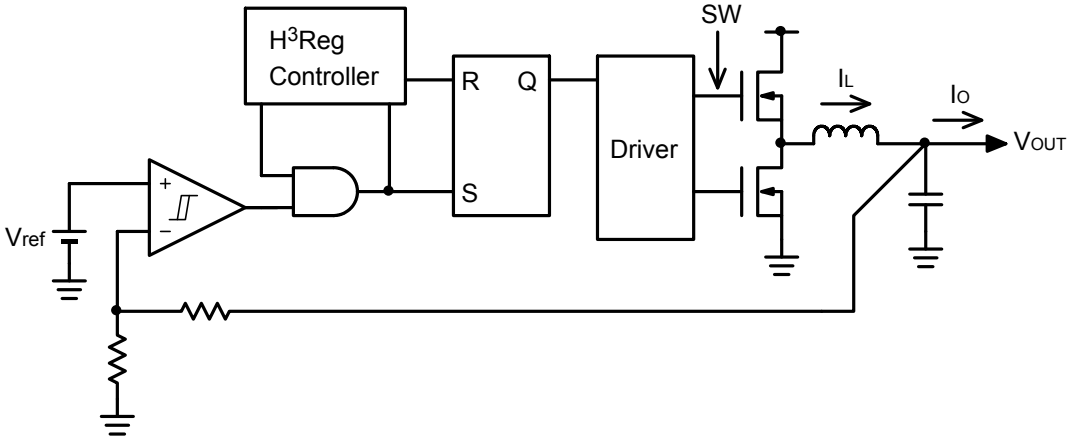


BD9G341EFJ Application Circuit

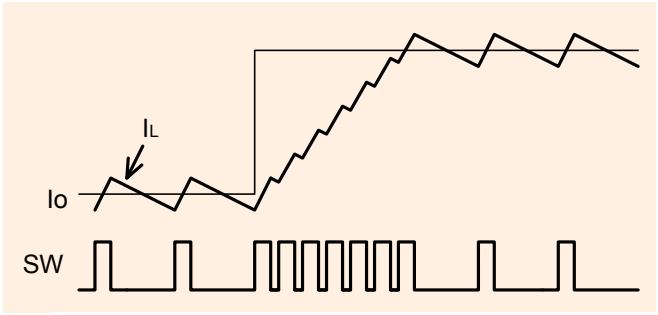
High efficient heat-radiation characteristics by Exposed-pad

H³Reg™ Control – Quick Response to Load changes

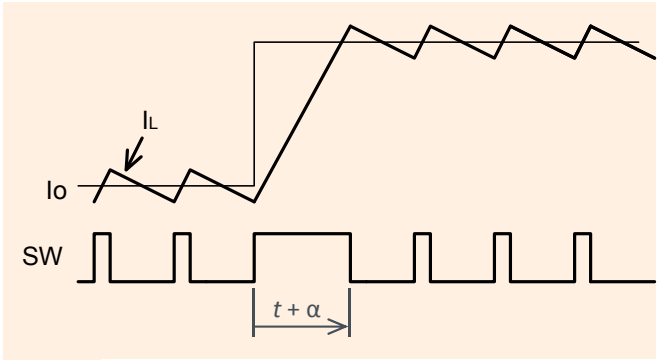
Current-mode control is a popular control method for switching regulators, but some applications are not satisfied with the transient response characteristics, due to change in the load currents. Switching regulators of hysteresis-control mode could solve this problem. Constant-on-time control, which is one of the hysteresis control method, which feedbacks ripple-voltage waveform generated at the output-voltage, and maintains the output-voltage constant by switching control, by comparing voltage bottom of the ripple-voltage and reference-voltage. When the feedback-voltage goes below the reference-voltage, one shot pulse occurs and currents are supplied from input to output by turning on the high-side switch. As switching control is done by simple comparison, there is not much delay-time for the feed back control, and can obtain faster transient response than current-mode control method. H³Reg™ control is the evolved version of Constant-on-time control, and ROHM's original control method. When load current increases sharply, the output voltage falls and even after the predetermined on-time if the feedback voltage does not rise higher than reference voltage, on-time of the high-side switch is extended by supplying more power and thereby accelerating the return of the output voltage. Hence, faster transient response would be obtained than constant-on-time control method, and the noise could be made smaller because of fewer switching times for load changes.



H³Reg™ Block Diagram



Constant-on-time Controlled Operating Wave Form

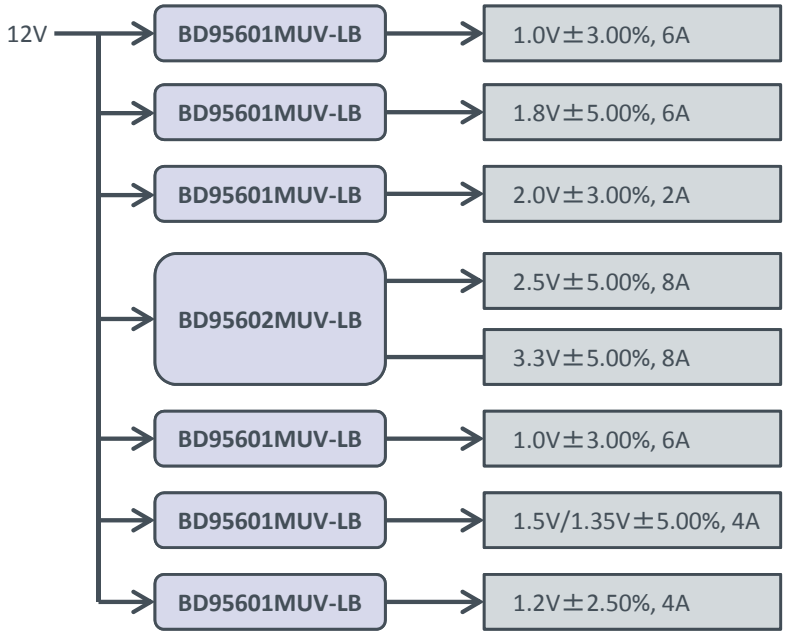


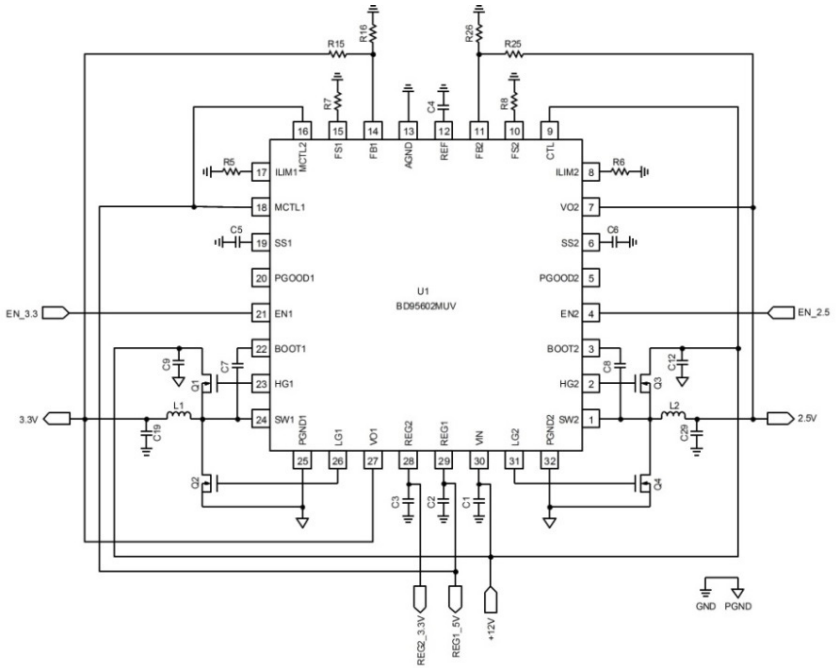
H³Reg™ Controlled Operating Wave Form

Power Supply Solution for FPGA

BD95601MUV-LB and BD95602MUV-LB are power supply ICs suited for FPGA having fast transient response using H³Reg™ Technology. These ICs generate power supply voltages with higher accuracy specifications needed for FPGA from the 12V input voltage, and also usable for power supply sequence on start-up.

FPGA Power Tree Board

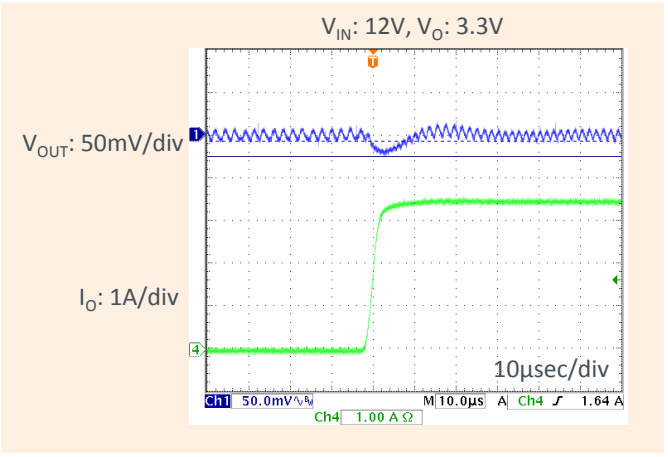




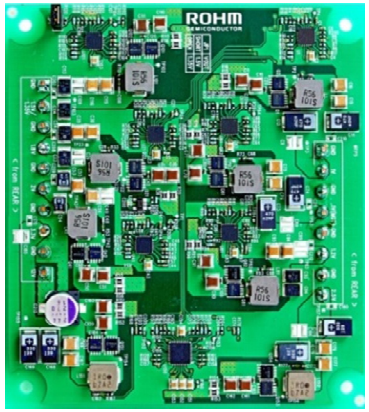
BD95602MUV-LB application Circuit

Product Example: BD95602MUV-LB

- H³Reg™ dual DC/DC controller to enable fast transient response
- Selectable from light-load mode, continuous PWM mode, and Quiet light-load mode
- Soft-start prevents inrush current on power-on
- Power Good Output
- Input Voltage Range : 5.5V to 28V
- Output Voltage Range: 1.0V to 5.5V
- Standard Voltage : 0.7V±1.0%
- Switching Frequency : 150kHz to 500kHz
- Various Protective Functions
  - Over-Current Protection(OCP)
  - Over-Voltage Protection(OVP)
  - Thermal Shutdown Protection(TSD)
  - Under-Voltage Protection (UVLO)



BD95602MUV-LB Fast Transient Response characteristics



Avnet Internix Corporation
Power Module Board
For 'Mini module plus 'developing system
(Kintex-7)

3.3V, 5V Rail Input Selection Guide

	Part No.	Input Voltage Maximum Rating (V)	Output Current (A)	Input Voltage Range (V)	Output Voltage (V)	Switching Frequency (MHz)	Control Mode	Features							Description	Operating Temperature (°C)	Package (mm)
								Power Good	Externally Synchronizable	Adjustable Soft Start	Synchronous Rectifier	Light-Load Efficiency	Over-Current Protection	Thermal Protection			
	BD9122GUL	7	0.3	2.5～5.5	1.0～2.0	1	Current	-	-	-	✔	✔	Latch	Latch		-25～+85	VCSP50L2 (2.5×1.1)
	BD9161FVM BD9161FVM-LB	7	0.6	2.5～4.5	1.0～3.3	1	Current	-	-	-	✔	✔	Latch	Latch		-25～+85	MSOP8
New	BU9B001G	7	0.6	2.3～5.5	2.5	1.2	Hysteresis	-	-	-	✔	Deep	Feed back	Feed back		-40～+85	SSOP6
	BU9006GUZ	7	0.75	2.5～4.5	1.0～V_{IN}	2	Current	-	-	-	✔	-	Feed back	Feed back	Incorporates in/output bias switch, 100% Duty	-35～+85	VCSP35L1 (1.6×1.6)
	BD9109FVM BD9109FVM-LB	7	0.8	4.5～5.5	3.3	1	Current	-	-	-	✔	✔	Latch	Latch		-25～+85	MSOP8
	BD9102FVM	7	0.8	4.0～5.5	1.24	1	Current	-	-	-	✔	✔	Latch	Latch		-25～+85	MSOP8
	BD8966FVM	7	0.8	4.0～5.5	1.0～2.5	1	Current	-	-	-	✔	-	Latch	Latch		-25～+85	MSOP8
	BD9106FVM BD9106FVM-LB	7	0.8	4.0～5.5	1.0～2.5	1	Current	-	-	-	✔	✔	Latch	Latch		-25～+85	MSOP8
	BD9120HFN	7	0.8	2.7～5.5	1.0～1.5	1	Current	-	-	-	✔	✔	Latch	Latch		-25～+85	HSON8
	BD8967FVM	7	0.9	4.5～5.5	3.3	1	Current	-	-	-	✔	-	Latch	Latch		-25～+85	MSOP8
	BD9104FVM	7	0.9	4.5～5.5	3.3	1	Current	-	-	-	✔	✔	Latch	Latch		-25～+85	MSOP8
New	BU90002GWZ	7	1	4.0～5.5	3.3	6	Hysteresis	-	-	-	✔	✔	Feed back	Feed back		-40～+85	UCSP35L1 (1.3×0.9)
New	BU90003GWZ	7	1	2.3～5.5	1.2	4	Hysteresis	-	-	-	✔	✔	Feed back	Feed back		-40～+85	UCSP35L1 (1.3×0.9)
New	BU90004GWZ	7	1	2.3～5.5	1.8	5.4	Hysteresis	-	-	-	✔	✔	Feed back	Feed back		-40～+85	UCSP35L1 (1.3×0.9)
New	BU90005GWZ	7	1	2.3～5.5	2.5	6	Hysteresis	-	-	-	✔	✔	Feed back	Feed back		-40～+85	UCSP35L1 (1.3×0.9)
New	BU90006GWZ	7	1	2.3～5.5	3.0	6	Hysteresis	-	-	-	✔	✔	Feed back	Feed back		-40～+85	UCSP35L1 (1.3×0.9)
New	BU90007GWZ	7	1	2.3～5.5	1.25	4	Hysteresis	-	-	-	✔	✔	Feed back	Feed back		-40～+85	UCSP35L1 (1.3×0.9)

	Part No.	Input Voltage Maximum Rating (V)	Output Current (A)	Input Voltage Range (V)	Output Voltage (V)	Switching Frequency (MHz)	Control Mode	Features							Description	Operating Temperature (℃)	Package (mm)
								Power Good	Externally Synchronizable	Adjustable Soft Start	Synchronous Rectifier	Light-Load Efficiency	Over-Current Protection	Thermal Protection			
New	BD9A100MUV	7	1	2.7～5.5	0.8～(V_{IN}×0.7)	1	Current	✔	-	✔	✔	✔	Feed back	Feed back		-40～+85	VQFN016V3030
Under Development	BD9A101MUV-LB	7	1	2.7～5.5	0.8～(V_{IN}×0.7)	1	Current	✔	-	✔	✔	✔	Feed back	Feed back		-40～+125	VQFN016V3030
Under Development	BD9B100MUV	7	1	2.7～5.5	0.8～(V_{IN}×0.8)	1 / 2	Hysteresis	✔	-	✔	✔	Deep	Feed back	Feed back		-40～+85	VQFN016V3030
	BD8964FVM	7	1.2	4.0～5.5	1.0～1.8	1	Current	-	-	-	✔	-	Latch	Latch		-25～+85	MSOP8
	BD9107FVM	7	1.2	4.0～5.5	1.0～1.8	1	Current	-	-	-	✔	✔	Latch	Latch		-25～+85	MSOP8
	BD9123MUV	7	1.2	2.7～5.5	0.85～1.2	1	Current	✔	-	-	✔	✔	Latch	Latch	Output voltage setting by 3-bit parallel control	-40～+95	VQFN016V3030
New	BU90023NUX	7	1.5	2.3～5.5	1.23	1	Hysteresis	-	-	-	✔	✔	Feed back	Feed back		-40～+85	VSON008X2030
New	BU90028NUX	7	1.5	2.3～5.5	1.175	1	Hysteresis	-	-	-	✔	✔	Feed back	Feed back		-40～+85	VSON008X2030
	BD8961NV	7	2	4.5～5.5	3.3	1	Current	-	-	-	✔	-	Latch	Latch		-25～+105	SON008V5060
	BD9111NV	7	2	4.5～5.5	3.3	1	Current	-	-	-	✔	✔	Latch	Latch		-25～+105	SON008V5060
	BD9110NV	7	2	4.5～5.5	1.0～2.5	1	Current	-	-	-	✔	✔	Latch	Latch		-25～+105	SON008V5060
	BD89630EFJ	7	2	2.7～5.5	1.0～2.5 *1	1	Current	-	-	-	✔	-	Latch	Latch		-25～+85	HTSOP-J8
	BD8960NV	7	2	2.7～5.5	1.0～2.5 *1	1	Current	-	-	-	✔	-	Latch	Latch		-25～+105	SON008V5060
	BD9130EFJ	7	2	2.7～5.5	1.0～2.5 *1	1	Current	-	-	-	✔	✔	Latch	Latch		-25～+105	HTSOP-J8
	BD9130NV	7	2	2.7～5.5	1.0～2.5 *1	1	Current	-	-	-	✔	✔	Latch	Latch		-25～+105	SON008V5060
	BD91370MUV	7	2	2.7～5.5	0.8～3.3 *1	1	Current	-	-	-	✔	✔	Feed back	Feed back		-40～+105	VQFN020V4040
Planning	BD9B200MUV	7	2	2.7～5.5	0.8～(V_{IN}×0.8)	1 / 2	Hysteresis	✔	-	✔	✔	Deep	Feed back	Feed back		-40～+85	VQFN016V3030

*1 Restrictions depend on input/output voltage conditions.

3.3V, 5V Rail Input Selection Guide (Continued)

	Part No.	Input Voltage Maximum Rating (V)	Output Current (A)	Input Voltage Range (V)	Output Voltage (V)	Switching Frequency (MHz)	Control Mode	Features							Description	Operating Temperature (℃)	Package (mm)
								Power Good	Externally Synchronizable	Adjustable Soft Start	Synchronous Rectifier	Light-Load Efficiency	Over-Current Protection	Thermal Protection			
	BD8962MUV	7	3	2.7～5.5	0.8～2.5 *1	1	Current	-	-	-	✔	-	Latch	Latch		-40～+105	VQFN020V4040
	BD9132MUV	7	3	2.7～5.5	0.8～3.3 *1	1	Current	-	-	-	✔	✔	Latch	Latch		-40～+105	VQFN020V4040
	BD8963EFJ	7	3	2.7～5.5	1.0～2.5 *1	1	Current	-	-	-	✔	-	Latch	Latch		-25～+85	HTSOP-J8
	BD9134MUV	7	3	4.5～5.5	3.3	1	Current	-	-	-	✔	✔	Latch	Latch		-40～+105	VQFN020V4040
	BD9139MUV	7	3	2.7～5.5	0.8～3.3 *1	1	Current	-	-	-	✔	✔	Latch	Latch		-40～+105	VQFN016V3030
New	BD9A300MUV	7	3	2.7～5.5	0.8～(V_{IN}×0.7)	1	Current	✔	-	✔	✔	✔	Feed back	Feed back		-40～+85	VQFN016V3030
Under Development	BD9A301MUV-LB	7	3	2.7～5.5	0.8～(V_{IN}×0.7)	1	Current	✔	-	✔	✔	✔	Feed back	Feed back		-40～+125	VQFN016V3030
Under Development	BD9B300MUV	7	3	2.7～5.5	0.8～(V_{IN}×0.8)	1 / 2	Hysteresis	✔	-	✔	✔	Deep	Feed back	Feed back		-40～+85	VQFN016V3030
Under Development	BD9B301MUV-LB	7	3	2.7～5.5	0.8～(V_{IN}×0.8)	1 / 2	Hysteresis	✔	-	✔	✔	Deep	Feed back	Feed back		-40～+85	VQFN016V3030
	BD9137MUV	7	4	2.7～5.5	0.8～3.3 *1	1	Current	-	-	-	✔	✔	Feed back	Feed back		-40～+105	VQFN020V4040
	BD91361MUV	7	4	2.7～5.5	0.8～3.3 *1	1	Current	-	-	-	✔	✔	Latch	Latch	Output voltage setting by 2-bit parallel control	-40～+105	VQFN020V4040
Under Development	BD9A400MUV	7	4	2.7～5.5	0.8～(V_{IN}×0.7)	1	Current	✔	-	✔	✔	✔	Feed back	Feed back		-40～+85	VQFN016-V3030
Planning	BD9B400MUV	7	4	2.7～5.5	0.8～(V_{IN}×0.8)	1 / 2	Hysteresis	✔	-	✔	✔	Deep	Feed back	Feed back		-40～+85	VQFN016V3030
	BD91363AMUV	7	4.8	2.7～5.5	0.9～3.3 *1	1.5	Current	-	-	-	✔	✔	Latch	Latch	Output voltage setting by 3-bit parallel control	-40～+105	VQFN020V4040
New	BD91364AMUU	7	5	2.9～5.5	0.8～(V_{IN}×0.8)	1.7	Current	✔	-	✔	✔	✔	Latch	Feed back		-40～+105	VQFN20U4040M
Planning	BD9B500MUV	7	5	2.7～5.5	0.8～(V_{IN}×0.8)	1 / 2	Hysteresis	✔	-	✔	✔	Deep	Feed back	Feed back		-40～+85	VQFN016V3030
Under Development	BD9A600MUV	7	6	2.7～5.5	0.8～(V_{IN}×0.7)	1	Current	✔	-	✔	✔	✔	Feed back	Feed back		-40～+85	VQFN016-V3030
Under Development	BD9B600MUV	7	6	2.7～5.5	0.8～(V_{IN}×0.8)	1 / 2	Hysteresis	✔	-	✔	✔	Deep	Feed back	Feed back		-40～+85	VQFN016V3030

*1 Restrictions depend on input/output voltage conditions.

12V Rail Input Selection Guide

	Part No.	Input Voltage Maximum Rating (V)	Output Current (A)	Input Voltage Range (V)	Output Voltage (V)	Switching Frequency (MHz)	Control Mode	Features								Description	Operating Temperature (°C)	Package (mm)
								Power Good	Externally Synchronizable	Adjustable Soft Start	Synchronous Rectifier	Light-Load Efficiency	Over-Current Protection	Thermal Protection	Over-Voltage Protection			
	BD8312HFN	15	1	3.5～14	1.2～12 *1	1.5	Current	-	-	-	✔	-	-	Feed back	-		-25～+85	HSON8
	BD8313HFN	15	1.2	3.5～14	1.2～12 *1	1	Current	-	-	-	✔	-	-	Feed back	-		-40～+85	HSON8
New	BD1482EFJ	20	2	4.2～18	0.923～(V_{IN}×0.7)	0.38	Current	-	-	✔	✔	-	Feed back	Feed back	-		-40～+85	HTSOP-J8
	BD9328EFJ BD9328EFJ-LB	20	2	4.2～18	0.9～(V_{IN}×0.7)	0.38	Current	-	-	✔	✔	-	Feed back	Feed back	-	Matrix pin short protection	-40～+85	HTSOP-J8
	BD9141MUV	15	2	4.5～13.2	2.5～6.0 *1	0.5	Current	-	-	-	✔	✔	Latch	Latch	-		-40～+105	VQFN020V4040
New	BD95821MUV	15.2	2	7.5～15	0.8～(V_{IN} × 0.5) (V_{IN} × 0.5)≦5.5V	0.5～0.8	H^3Reg	✔	-	-	✔	-	Latch	Feed back	✔		-20～+100	VQFN020V4040
	BD9325FJ BD9325FJ-LB	20	2	4.75～18	0.9～(V_{IN}×0.8)	0.38	Current	-	-	✔	-	-	Feed back	Feed back	-		-40～+85	SOP-J8
	BD93290EFJ	20	3	4.2～18	0.9～(V_{IN}×0.7)	0.3	Current	-	-	✔	✔	-	Feed back	Feed back	-	Matrix pin short protection	-40～+85	HTSOP-J8
New	BD1484EFJ	20	3	4.2～18	0.925～(V_{IN}×0.7)	0.38	Current	-	-	✔	✔	-	Feed back	Feed back	-		-40～+85	HTSOP-J8
	BD9329AEFJ BD9329AEFJ-LB	20	3	4.2～18	0.9～(V_{IN}×0.7)	0.38	Current	-	-	✔	✔	-	Feed back	Feed back	-	Matrix pin short protection	-40～+85	HTSOP-J8
New	BD9C301FJ	20	3	4.5～18	(V_{IN}×0.125)～(V_{IN}×0.7) (V_{IN}×0.125)≧ 0.8	0.5	Current	-	-	-	✔	-	Latch	Feed back	-		-40～+85	SOP-J8
New	BD9C301FJ-LB	20	3	4.5～18	(V_{IN}×0.125)～(V_{IN}×0.7) (V_{IN}×0.125)≧ 0.8	0.5	Current	-	-	-	✔	-	Latch	Feed back	-		-40～+125	SOP-J8
New	BD95831MUV	15.2	3	7.5～15	0.8～(V_{IN} × 0.5) (V_{IN} × 0.5)≦5.5V	0.5～0.8	H^3Reg	✔	-	-	✔	-	Latch	Feed back	✔		-20～+100	VQFN016V3030
New	BD95835EFJ	20	3	4.5～18	0.9～(V_{IN}×0.6)	0.2～0.8	Hysteresis	-	-	✔	✔	-	Feed back	Feed back	✔		-40～+85	HTSOP-J8
New	BD9D320EFJ	20	3	4.5～18	0.765～(V_{IN}×0.7) (V_{IN}×0.7)≦7	0.7	Hysteresis	-	-	✔	✔	-	Feed back	Feed back	-		-40～+85	HTSOP-J8
New	BD9D321EFJ	20	3	4.5～18	0.9～7.0 (V_{IN}×0.06)～(V_{IN}×0.65)	0.7	Hysteresis	-	-	✔	✔	✔	Feed back	Feed back	-		-40～+85	HTSOP-J8
	BD9859EFJ	15	3	5.0～14	1.0～(V_{IN}×0.7)	0.75	Current	-	-	-	-	-	Feed back	Feed back	-		-40～+85	HTSOP-J8
	BD9326EFJ BD9326EFJ-LB	20	3	4.75～18	0.9～(V_{IN}×0.8)	0.38	Current	-	-	✔	-	-	Feed back	Feed back	-		-40～+85	HTSOP-J8

*1 Restrictions depend on input/output voltage conditions.

12V Rail Input Selection Guide（Continued）

	Part No.	Input Voltage Maximum Rating (V)	Output Current (A)	Input Voltage Range (V)	Output Voltage (V)	Switching Frequency (MHz)	Control Mode	Features								Description	Operating Temperature (℃)	Package (mm)
								Power Good	Externally Synchronizable	Adjustable Soft Start	Synchronous Rectifier	Light-Load Efficiency	Over-Current Protection	Thermal Protection	Over-Voltage Protection			
New	BD9C401EFJ	20	4	4.5～18	(V_{IN}×0.125)～(V_{IN}×0.7) (V_{IN}×0.125)≧ 0.8	0.5	Current	-	-	-	✔	-	Latch	Feed back	-		-40～+85	HTSOP-J8
New	BD95841MUV	15.2	4	7.5～15	0.8～(V_{IN} × 0.5) (V_{IN} × 0.5)≦5.5V	0.5～0.8	H^3Reg	✔	-	-	✔	-	Latch	Feed back	✔		-20～+100	VQFN016V3030
	BD9327EFJ BD9327EFJ-LB	20	4	4.75～18	0.9～(V_{IN}×0.8)	0.38	Current	-	-	✔	-	-	Feed back	Feed back	-		-40～+85	HTSOP-J8
New	BD9C501EFJ	20	5	4.5～18	(V_{IN}×0.075)～(V_{IN}×0.7) (V_{IN}×0.075)≧ 0.8	0.5	Current	-	-	-	✔	-	Latch	Feed back	-		-40～+85	HTSOP-J8
New	BD95861MUV	20	6	7.5～18	0.8～(V_{IN} × 0.5) (V_{IN} × 0.5)≦5.5V	0.5～0.8	H^3Reg	✔	-	-	✔	-	Latch	Feed back	✔		-20～+100	VQFN024V4040
New	BD9C601EFJ	20	6	4.5～18	(V_{IN}×0.075)～(V_{IN}×0.7) (V_{IN}×0.075)≧ 0.8	0.5	Current	-	-	-	✔	-	Latch	Feed back	-		-40～+85	HTSOP-J8
	BD95500MUV	24	6	3.0～20	0.7～5.0	0.2～1.0	H^3Reg	✔	-	✔	✔	✔	Latch	Feed back	✔	Output Discharge	-10～+100	VQFN040V6060

24V Rail Input Selection Guide

	Part No.	Input Voltage Maximum Rating (V)	Output Current (A)	Input Voltage Range (V)	Output Voltage (V)	Switching Frequency (MHz)	Control Mode	Features								Description	Operating Temperature (℃)	Package (mm)
								Power Good	Externally Synchronizable	Adjustable Soft Start	Synchronous Rectifier	Light-Load Efficiency	Over-Current Protection	Thermal Protection	Over-Voltage Protection			
New	BD9G101G	45	0.5	6.0～42	(V_{IN}×0.15)～(V_{IN}×0.7) (V_{IN}×0.15)≧ 1.0	1.5	Current	-	-	-	-	-	Feed back	Feed back	-		-40～+105	SSOP6
New	BD9E100FJ-LB	40	1	7.0～36	(V_{IN}×0.15)～(V_{IN}×0.7) (V_{IN}×0.15)≧ 1.0	1	Current	-	-	-	✔	-	Feed back	Feed back	✔		-40～+150	SOP-J8
New	BD9E101FJ-LB	40	1	7.0～36	(V_{IN}×0.0855)～(V_{IN}×0.7) (V_{IN}×0.0855)≧ 1.0	0.57	Current	-	-	-	✔	-	Feed back	Feed back	✔		-40～+150	SOP-J8
New	BD9E102FJ	30	1	7.0～26	(V_{IN}×0.143)～(V_{IN}×0.7) (V_{IN}×0.1425)≧ 1.0	0.57	Current	-	-	-	✔	✔	Feed back	Feed back	✔		-40～+85	SOP-J8
New	BD9E151NUX	30	1.2	6.0～28	1.0～(V_{IN}×0.7)	0.6	Current	-	-	✔	-	-	Feed back	Feed back	✔		-55～+125	VSON008X2030

	Part No.	Input Voltage Maximum Rating (V)	Output Current (A)	Input Voltage Range (V)	Output Voltage (V)	Switching Frequency (MHz)	Control Mode	Features								Description	Operating Temperature (℃)	Package (mm)
								Power Good	Externally Synchronizable	Adjustable Soft Start	Synchronous Rectifier	Light-Load Efficiency	Over-Current Protection	Thermal Protection	Over-Voltage Protection			
	BD9701CP-V5	36	1.5	8.0～35	1.0～(V_{IN}-3.0)	0.1	Voltage	-	-	-	-	-	Feed back	Feed back	-	100% Duty	-40～+85	TO220CP-V5
	BD9701FP	36	1.5	8.0～35	1.0～(V_{IN}-3.0)	0.1	Voltage	-	-	-	-	-	Feed back	Feed back	-	100% Duty	-40～+85	TO252-5
	BD9703CP-V5	36	1.5	8.0～35	1.0～(V_{IN}-3.0)	0.3	Voltage	-	-	-	-	-	Feed back	Feed back	-	100% Duty	-40～+85	TO220CP-V5
	BD9703FP	36	1.5	8.0～35	1.0～(V_{IN}-3.0)	0.3	Voltage	-	-	-	-	-	Feed back	Feed back	-	100% Duty	-40～+85	TO252-5
	BD9870FPS	36	1.5	8.0～35	1.0～(0.8×(V_{IN}-I_O×R_{ON})	0.9	Voltage	-	-	-	-	-	Feed back	Feed back	-	100% Duty	-40～+85	TO252S-5
	BD9873CP-V5	36	1.5	8.0～35	1.0～(0.8×(V_{IN}-I_O×R_{ON})	0.11	Voltage	-	-	-	-	-	Feed back	Feed back	-	100% Duty	-40～+85	TO220CP-V5
New	BD9E300EFJ-LB	40	2.5	7.0～36	(V_{IN}×0.15)～(V_{IN}×0.7) (V_{IN}×0.15)≧ 1.0	1	Current	-	-	-	✔	-	Feed back	Feed back	✔		-40～+150	HTSOP-J8
New	BD9E301EFJ-LB	40	2.5	7.0～36	(V_{IN}×0.0855)～(V_{IN}×0.7) (V_{IN}×0.0855)≧ 1.0	0.57	Current	-	-	-	✔	-	Feed back	Feed back	✔		-40～+150	HTSOP-J8
	BD95513MUV	30	3	4.5～28	0.7～5.0	0.2～1.0	H^3Reg	✔	-	✔	✔	✔	Latch	Feed back	✔	Output Discharge	-10～+100	VQFN032V5050
	BD9702CP-V5	36	3	8.0～35	1.0～(V_{IN}-3.0)	0.11	Voltage	-	-	-	-	-	Feed back	Feed back	-		-40～+85	TO220CP-V5
	BD9874CP-V5	36	3	8.0～35	1.0～(0.8×(V_{IN}-I_O×R_{ON})	0.11	Voltage	-	-	-	-	-	Feed back	Feed back	-		-40～+85	TO220CP-V5
	BD95514MUV	30	4	4.5～28	0.7～5.0	0.2～1.0	H^3Reg	✔	-	✔	✔	✔	Latch	Feed back	✔	Output Discharge	-10～+100	VQFN032V5050

48V Rail Input Selection Guide

	Part No.	Input Voltage Maximum Rating (V)	Output Current (A)	Input Voltage Range (V)	Output Voltage (V)	Switching Frequency (MHz)	Control Mode	Features								Description	Operating Temperature (℃)	Package (mm)
								Power Good	Externally Synchronizable	Adjustable Soft Start	Synchronous Rectifier	Light-Load Efficiency	Over-Current Protection	Thermal Protection	Over-Voltage Protection			
Under Development	BD9G341EFJ	80	3	12～76	1.0～(V_{IN}×0.7) *1	0.05～0.75	Current	✔	-	-	-	-	Feed back	Feed back	✔		-40～+85	HTSOP-J8

*1 Restrictions depend on input/output voltage conditions.

Dual-Output DC/DC Selection Guide

	Part No.	Number of Channels	Input Voltage Maximum Rating (V)	Output Current (A)	Input Voltage Range (V)	Output Voltage (V)	Switching Frequency (MHz)	Control Mode	Features								Description	Operating Temperature (℃)	Package (mm)
									Power Good	Externally Synchronizable	Adjustable Soft Start	Synchronous Rectifier	Light-Load Efficiency	Over-Current Protection	Thermal Protection	Over-Voltage Protection			
	BD91501MUV	2	7	Io1 : 0.4 Io2 : 0.3	2.55～5.5	Vo1 : 2.55 Vo2 : 1.80	1.65	Current	-	-	-	✔	✔	Latch	Feed back	-	100% Duty	-30～+105	VQFN016V3030
	BD9151MUV	2	7	Io1 : 0.4 Io2 : 0.8	2.8～5.5	Vo1 : 1.8 Vo2 : 1.2	1	Current	-	-	-	✔	✔	Latch	Feed back	-	Voltage Detector, High-side gate controller	-40～+85	VQFN020V4040
	BD9150MUV	2	7	Io1 : 1.5 Io2 : 1.5	4.75～5.5	Vo1 : 3.3 Vo2 : 0.8～2.5	1.5	Current	-	-	-	✔	✔	Latch	Feed back	-		-40～+85	VQFN020V4040
	BD9152MUV	2	7	Io1 : 1.5 Io2 : 1.5	4.5～5.5	Vo1 : 3.3 Vo2 : 0.8～2.5	1	Current	-	-	-	✔	✔	Latch	Feed back	-		-40～+85	VQFN020V4040
	BD9153MUV	2	7	Io1 : 1.5 Io2 : 1.5	4.5～5.5	Vo1 : 1.8～3.3 Vo2 : 0.8～2.5	1	Voltage	-	-	-	✔	✔	Latch	Feed back	-	LDO Controller, Voltage Detector	-40～+85	VQFN024V4040
New	BD93291EFJ	2	30	Io1 : 2.5 Io2 : 1.5	8.0～26	Vo1 : 5.0 Vo2 : 0.8～4.0	1.5～2.5	H^3Reg	-	-	-	✔	✔	Feed back	Feed back	-		-40～+85	HTSOP-J8
	BD91362MUV	2	7	Io1 : 3.0 Io2 : 1.0	2.7～5.5	Vo1 : 1.0～3.3 Vo2 : 1.0～3.3	1	Current	-	-	-	✔	✔	Latch	Feed back	-	8 bit Voltage setting by I^2C I/F	-40～+105	VQFN024V4040
	BD95830MUV	2	15.1	Io1 : 3.0 Io2 : 3.0	7.5～15	Vo1 : 0.8～5.5 Vo2 : 0.8～5.5	0.4～0.8	H^3Reg	-	-	-	✔	-	Latch	Feed back	Latch		-20～+100	VQFN032V5050

Controller-type DC/DC (External MOSFET) Selection Guide

	Part No.	Number of Channels	Input Voltage Maximum Rating (V)	Input Voltage Range (V)	Supply Voltage (V)	Output Voltage (V)	Switching Frequency (MHz)	Control Mode	Features								Description	Operating Temperature (℃)	Package (mm)
									Power Good	Externally Synchronizable	Adjustable Soft Start	Synchronous Rectifier	Light-Load Efficiency	Over-Current Protection	Thermal Protection	Over-Voltage Protection			
New	BD95601MUV-LB	1	28	4.5～25	4.5～5.5	0.75～2.0	0.2～0.5	H^3Reg	✔	-	✔	✔	✔	Latch	Feed back	Feed back	Tracking feature	-10～+85	VQFN020V4040
	BD9610AMUV	1	60	10～56	-	(V_{IN}×0.02)～(V_{IN}×0.97) *1 (VIN×0.02)≥0.8	0.05～0.5	Voltage	-	✔	✔	✔	-	Feed back	Feed back	-	Pre Bias	-40～+105	VQFN020V4040
New	BD9611MUV	1	60	10～56	-	(V_{IN}×0.02)～(V_{IN}×0.97) *1 (VIN×0.02)≥0.8	0.05～0.5	Voltage	-	✔	✔	✔	-	Feed back	Feed back	-	Pre Bias, Adjustable UVLO	-40～+105	VQFN020V4040
	BD63536FJ	1	32	3.0～30	-	1.25～V_{IN} *1	0.01～0.3	Voltage	-	-	-	-	-	Feed back	Feed back	Feed back		-25～+85	SOP-J8
	BD9845FV	1	36	3.6～35	-	1.0～V_{IN} *1	0.1～1.5	Voltage	-	-	✔	-	-	Feed back	Feed back	-		-40～+85	SSOP-B14
New	BD95602MUV-LB	2	30	5.5～28	-	1.0～5.5	0.15～0.5	H^3Reg	✔	-	✔	✔	✔	Latch	Feed back	Feed back	Output discharge, 3.3V LDO, 5V LDO	-20～+85	VQFN032V5050
	BD9848FV	2	36	3.6～35	-	1.0～V_{IN} *1	0.1～1.5	Voltage	-	-	✔	-	-	Feed back	Feed back	-		-40～+105	SSOP-B20

*1 Restrictions depend on input/output voltage conditions.

Notice

Precaution on using ROHM Products

1. If you intend to use our Products in devices requiring extremely high reliability (such as medical equipment (Note 1), aircraft/spacecraft, nuclear power controllers, etc.) and whose malfunction or failure may cause loss of human life, bodily injury or serious damage to property ("Specific Applications"), please consult with the ROHM sales representative in advance. Unless otherwise agreed in writing by ROHM in advance, ROHM shall not be in any way responsible or liable for any damages, expenses or losses incurred by you or third parties arising from the use of any ROHM's Products for Specific Applications.

(Note1) Medical Equipment Classification of the Specific Applications

JAPAN	USA	EU	CHINA
CLASSⅢ	CLASSⅢ	CLASSⅡb	CLASSⅢ
CLASSⅣ		CLASSⅢ	

2. ROHM designs and manufactures its Products subject to strict quality control system. However, semiconductor products can fail or malfunction at a certain rate. Please be sure to implement, at your own responsibilities, adequate safety measures including but not limited to fail-safe design against the physical injury, damage to any property, which a failure or malfunction of our Products may cause. The following are examples of safety measures:
   [a] Installation of protection circuits or other protective devices to improve system safety [b] Installation of redundant circuits to reduce the impact of single or multiple circuit failure

3. Our Products are not designed under any special or extraordinary environments or conditions, as exemplified below. Accordingly, ROHM shall not be in any way responsible or liable for any damages, expenses or losses arising from the use of any ROHM's Products under any special or extraordinary environments or conditions. If you intend to use our Products under any special or extraordinary environments or conditions (as exemplified below), your independent verification and confirmation of product performance, reliability, etc, prior to use, must be necessary:
   [a] Use of our Products in any types of liquid, including water, oils, chemicals, and organic solvents
   [b] Use of our Products outdoors or in places where the Products are exposed to direct sunlight or dust
   [c] Use of our Products in places where the Products are exposed to sea wind or corrosive gases, including Cl_2, H_2S, NH_3, SO_2, and NO_2
   [d] Use of our Products in places where the Products are exposed to static electricity or electromagnetic waves
   [e] Use of our Products in proximity to heat-producing components, plastic cords, or other flammable items
   [f] Sealing or coating our Products with resin or other coating materials
   [g] Use of our Products without cleaning residue of flux (even if you use no-clean type fluxes, cleaning residue of flux is recommended); or Washing our Products by using water or water-soluble cleaning agents for cleaning residue after soldering
   [h] Use of the Products in places subject to dew condensation

4. The Products are not subject to radiation-proof design.

5. Please verify and confirm characteristics of the final or mounted products in using the Products.

6. In particular, if a transient load (a large amount of load applied in a short period of time, such as pulse. is applied, confirmation of performance characteristics after on-board mounting is strongly recommended. Avoid applying power exceeding normal rated power; exceeding the power rating under steady-state loading condition may negatively affect product performance and reliability.

7. De-rate Power Dissipation (Pd) depending on Ambient temperature (Ta). When used in sealed area, confirm the actual ambient temperature.

8. Confirm that operation temperature is within the specified range described in the product specification.

9. ROHM shall not be in any way responsible or liable for failure induced under deviant condition from what is defined in this document.

Precaution for Mounting / Circuit board design

1. When a highly active halogenous (chlorine, bromine, etc.) flux is used, the residue of flux may negatively affect product performance and reliability.

2. In principle, the reflow soldering method must be used; if flow soldering method is preferred, please consult with the ROHM representative in advance.

For details, please refer to ROHM Mounting specification

Precautions Regarding Application Examples and External Circuits

1. If change is made to the constant of an external circuit, please allow a sufficient margin considering variations of the characteristics of the Products and external components, including transient characteristics, as well as static characteristics.

2. You agree that application notes, reference designs, and associated data and information contained in this document are presented only as guidance for Products use. Therefore, in case you use such information, you are solely responsible for it and you must exercise your own independent verification and judgment in the use of such information contained in this document. ROHM shall not be in any way responsible or liable for any damages, expenses or losses incurred by you or third parties arising from the use of such information.

Precaution for Electrostatic

This Product is electrostatic sensitive product, which may be damaged due to electrostatic discharge. Please take proper caution in your manufacturing process and storage so that voltage exceeding the Products maximum rating will not be applied to Products. Please take special care under dry condition (e.g. Grounding of human body / equipment / solder iron, isolation from charged objects, setting of Ionizer, friction prevention and temperature / humidity control).

Precaution for Storage / Transportation

1. Product performance and soldered connections may deteriorate if the Products are stored in the places where:
   [a] the Products are exposed to sea winds or corrosive gases, including Cl2, H2S, NH3, SO2, and NO2
   [b] the temperature or humidity exceeds those recommended by ROHM
   [c] the Products are exposed to direct sunshine or condensation
   [d] the Products are exposed to high Electrostatic

2. Even under ROHM recommended storage condition, solderability of products out of recommended storage time period may be degraded. It is strongly recommended to confirm solderability before using Products of which storage time is exceeding the recommended storage time period.

3. Store / transport cartons in the correct direction, which is indicated on a carton with a symbol. Otherwise bent leads may occur due to excessive stress applied when dropping of a carton.

4. Use Products within the specified time after opening a humidity barrier bag. Baking is required before using Products of which storage time is exceeding the recommended storage time period.

Precaution for Product Label

QR code printed on ROHM Products label is for ROHM's internal use only.

Precaution for Disposition

When disposing Products please dispose them properly using an authorized industry waste company.

Precaution for Foreign Exchange and Foreign Trade act

Since our Products might fall under controlled goods prescribed by the applicable foreign exchange and foreign trade act, please consult with ROHM representative in case of export.

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