

RVB019 Current-mode Buck Converter

5-40VIN ◇ 2A ◇ 0.1Ω Power MOSFET



FEATURES

- Input voltage range: 5V to 40V
- 2A continuous output current
- 500μA operating quiescent current
- Integrated high-side 0.1Ω LDMOS
- 100ns minimum on-time
- Peak current-mode control
- Operating frequency: up to 1MHz
- Built-in input undervoltage protection
- Built-in overcurrent, short-circuit, and overtemperature protection
- Frequency foldback under light-load conditions to optimize efficiency
- Integrated soft-start and slope compensation
- Accurate EN threshold with hysteresis
- 97% maximum duty cycle
- Integrated loop compensation
- ESOP8 package with enhanced thermal performance

APPLICATIONS

- Automotive battery voltage regulation
- Industrial power conversion
- Auxiliary power supply for BMS
- Telecommunications and data communication systems
- PoE (Power over Ethernet) power supplies
- Electric bicycles

DESCRIPTION

The RVB019 is a 40V, 2 A buck regulator with an integrated high-side MOSFET. Utilizing advanced IC process technology, the device integrates a high-side power MOSFET and PWM control circuitry on a single die. It is designed for non-synchronous buck converter applications with input voltages up to 40V and absolute max VIN voltage is 50V, making it suitable for non-isolated power regulation in a wide range of industrial and automotive applications.

The RVB019 integrates multiple control functions and requires only minimal external components, allowing peripheral parameters to be flexibly designed according to application requirements. Its adjustable switching frequency range enables optimization of either efficiency or external component size. Integrated loop compensation simplifies the design process by eliminating the need for external compensation design. The built-in loop compensation also minimizes the number of external components required, while integrated slope compensation prevents subharmonic oscillation. In addition, the analog frequency foldback function under light-load conditions improves light-load efficiency. Under ultra-light-load or no-load conditions, the device operates in burst mode to reduce no-load power consumption.

The RVB019 also integrates cycle-by-cycle overcurrent protection, output short-circuit protection, overtemperature protection, and input undervoltage lockout (UVLO). All protection mechanisms support automatic recovery once abnormal conditions are removed, maximizing the reliability of the switching power supply system.

DEVICE INFORMATION

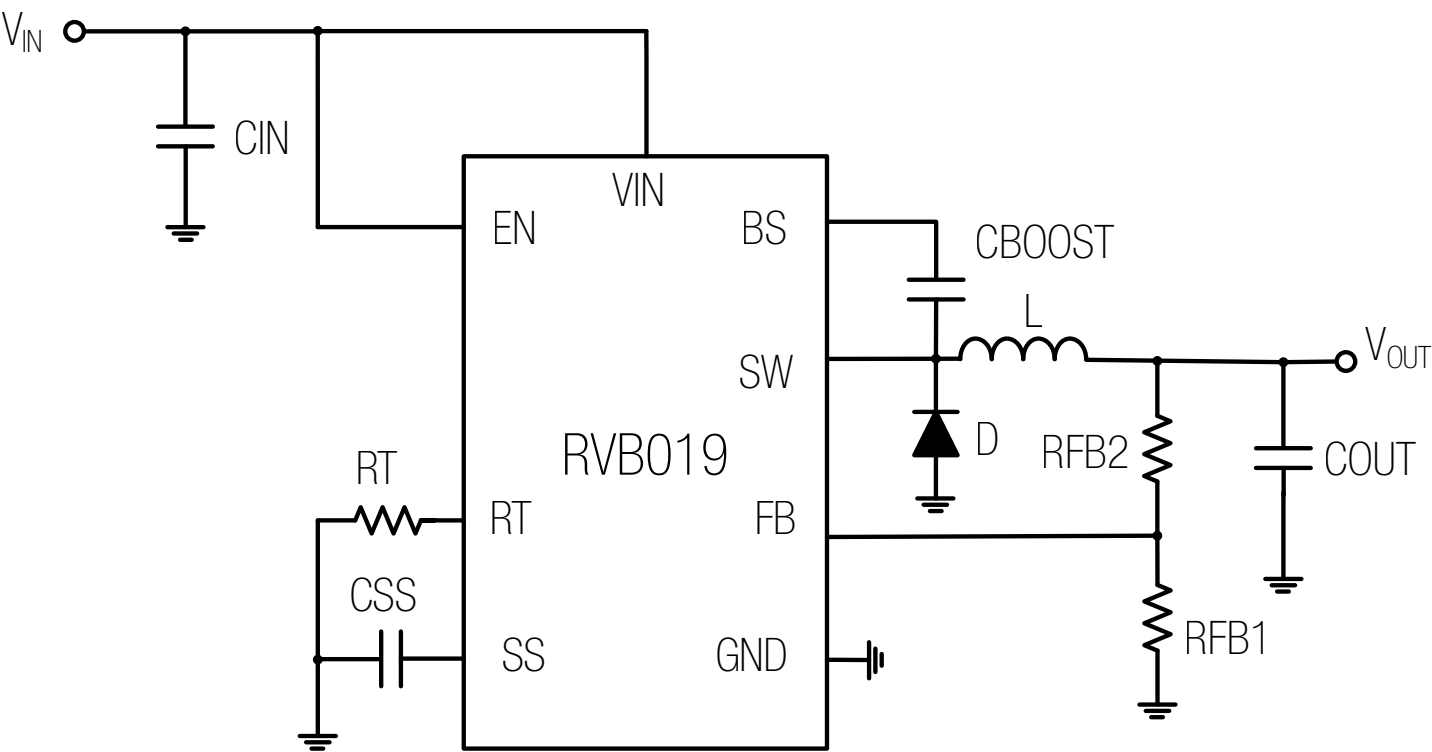
Part number	Package type	Dimension	SPQ
RVB019	ESOP8	5mm×6mm	4000

RVB019 Current-mode Buck Converter

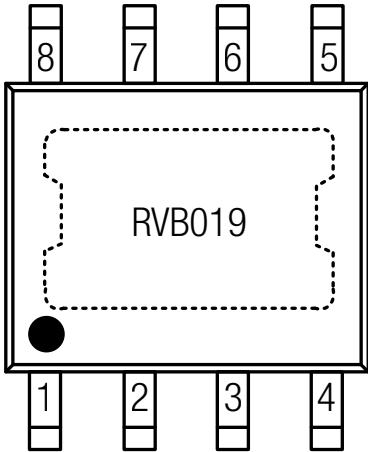
5-40VIN ◇ 2A ◇ 0.1Ω Power MOSFET



SIMPLIFIED APPLICATION SCHEMATIC



PIN CONFIGURATION AND FUNCTIONS



Name	No.	Type	Description
BS	1	I	Bootstrap capacitor connection for the high-side MOSFET driver: connect a 0.1μF ceramic capacitor between BS and SW.
VIN	2	P	Power supply pin: VIN is regulated by an internal low-dropout regulator (LDO) to generate the internal supply voltage VCC for the control circuitry. The VIN pin should be connected to the input power supply and bypass capacitor C _{IN} . The connection path between VIN, the high-frequency bypass capacitor C _{IN} , and GND should be kept as short as possible to minimize parasitic inductance and noise.
EN	3	I	Enable pin: An internal pull-up current source is integrated. Pulling the EN voltage below 1.2V disables the device. Connecting EN to VIN or leaving it open enables the device. The input undervoltage lockout (UVLO) threshold can also be programmed using an external resistor divider.

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PIN CONFIGURATION AND FUNCTIONS

Name	No.	Type	Description
RT	4	I	Fixed-frequency oscillator setting pin. Connect a timing resistor RT from this pin to ground to set the switching frequency. An internal amplifier maintains this pin at a constant voltage. The oscillator frequency can be approximated by the following simplified equation: $f_{OSC} = 23900/RT$, where f_{OSC} is in kHz and RT is in kΩ.
FB	5	I	Inverting input of the internal error amplifier. Connect to the feedback resistor divider to set V_{OUT} .
SS	6	I	Soft-start pin. Connect a capacitor from this pin to GND to set the soft-start time. If this pin is left floating, the IC provides a built-in soft-start time of 1 ms.
GND	7	P	Ground reference pin of the IC. This pin serves as the signal ground for the internal control logic and is also the source terminal of the integrated LDMOS power MOSFET.
SW	8	O	Switching output of the converter. Internally connected to the high-side power MOSFET.
Thermal pad	-	P	The thermal pad is electrically connected to the GND node. Connect to the GND plane for improved thermal performance.

TECHNICAL SPECIFICATION

Absolute maximum ratings

		Min.	Max.	Unit
VIN, EN to GND voltage range	V_{IN}, V_{EN}	-0.3	50	V
BS to GND voltage range	V_{BS}	-0.3	55	V
SW to GND voltage range	V_{SW}	-1	$V_{IN}+0.3$	V
RT, SS, FB to GND voltage range	V_{RT}, V_{SS}, V_{FB}	-0.3	6	V
Peak power MOSFET current	I_{PEAK}		4.5	A
Maximum operating junction temperature	T_{JMAX}		150	°C

Stress levels exceeding the absolute maximum ratings may cause permanent damage to the device. These are stress ratings only and do not imply functional operation of the device at these or any other conditions beyond those indicated under Recommended Operating Conditions. Prolonged exposure to absolute maximum rating conditions may affect device reliability. All voltages are referenced to ground. Currents are positive into and negative out of the specified terminal.

ESD ratings

		Value	Unit
$V_{(ESD)}$	Human Body Model (HBM), per ESDA/JEDEC JS-001-2017, (Zap 1 pulse, Interval: $\geq 0.1s$) ⁽¹⁾	±2000	V
	Charged Device Model (CDM), per ESDA/JEDEC JS-002-2014 ⁽²⁾	±1000	V

Note (1): JEDEC document JEP155 states that 500-V HBM allows safe manufacturing in standard ESD control processes.

Note (2): JEDEC document JEP157 states that 250-V CDM allows safe manufacturing in standard ESD control processes.

Recommended operations conditions

		Min.	Typ.	Max.	Unit
Power MOSFET drain voltage	V_{IN}	5		40	V
EN voltage	V_{EN}	1.2		40	V
Operating frequency	f_{SW}	200		1000	kHz
Operating junction temperature	T_J	-40		125	°C

Thermal resistance information

Package	Parameter	Value	Unit
ESOP8	Junction-to-ambient thermal resistance $R_{\theta JA}$	52	°C/W
	Junction-to-case thermal resistance Ψ_{JT}	6.5	

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TECHNICAL SPECIFICATION**Electrical characteristics**(the following parameters are measured under the conditions of V_{EN} and $V_{IN} = 12V$ and $T_{AMB} = 25^{\circ}C$, unless otherwise stated)

Symbol	Parameter	Test condition	Min.	Typ.	Max.	Unit
Input Pin VIN						
V _{IN}	VIN input voltage range		5		40	V
V _{IN(ON)}	VIN startup voltage	During VIN rising	4.2	4.7	5	V
V _{IN(OFF)}	VIN undervoltage lockout threshold	During V _{IN} falling	4	4.3	4.5	V
I _Q	Operating quiescent current	V _{FB} = 1.4 V		0.4	0.6	mA
I _{VIN(UVP)}	Operating current under input undervoltage condition	EN = 0 V		200	230	μA
Enable pin EN						
V _{EN(UVP)}	EN threshold voltage		1.05	1.2	1.38	V
I _{EN(PING)}	EN pin current	V _{EN} =1.21V		-6.2		μA
		V _{EN} =1.19V		-2		μA
I _{EN_HYS}	EN hysteresis current			-4.2		μA
Soft-start setting pin SS						
I _{SS}	SS pin current			16		μA
T _{SS}	Built-in soft-start time	SS pin left floating		1		mS
Oscillator frequency setting pin RT						
V _{RT}	RT pin voltage		1.28	1.3	1.32	V
f _{OSC}	Frequency	T _A =25°C, R _T =50kΩ	460	500	540	kHz
		T _A =25°C, R _T =22kΩ	0.95	1	1.05	MHz
Feedback voltage reference pin FB						
V _{FB(REG)}	EA non-inverting input reference voltage		1.18	1.2	1.22	V
A _V	EA low-frequency gain			1400		V/V
Bootstrap voltage pin BS						
V _{BS}	BS pin operating voltage range		5		45	V
V _{BS(REG)}	BS pin output voltage	Connect a capacitor between BS and SW	5	5.3	5.6	V
Source terminal of the high-side MOSFET pin SW						
R _{DS(ON)}	Power MOSFET on-resistance	V _{IN} =12V		100	170	mΩ
I _{SCP}	Overcurrent protection threshold		3	3.1	3.2	A
f _{OSC}	Maximum operating frequency	Frequency before analog frequency foldback		1		MHz
f _{short}	Short-circuit frequency			80		kHz
D _{MAX}	Maximum duty cycle	F _{SW} =300kHz		97		%
t _{ON(MIN)}	Minimum on-time			100		nS
Other protection features						
T _{SHDN}	Overtemperature protection threshold		148	167	178	°C
T _{SHDN(HYS)}	Overtemperature protection hysteresis			15		°C

TECHNICAL SPECIFICATION

Typical characteristic curve

Figure 1. Efficiency vs Load, $V_{OUT}=5V$, $f_{SW}=500kHz$

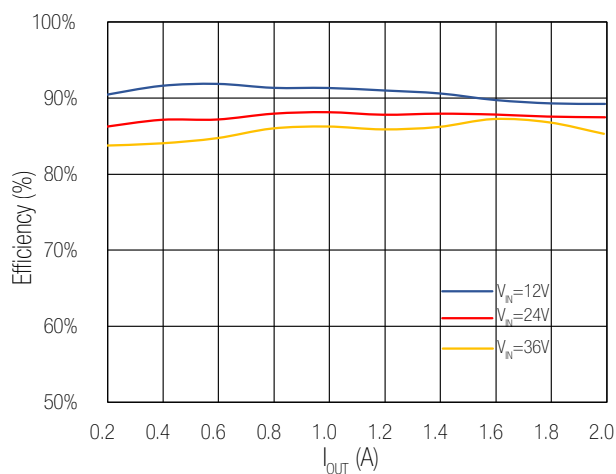


Figure 2. Efficiency vs Load, $V_{OUT}=5V$, $f_{SW}=1MHz$

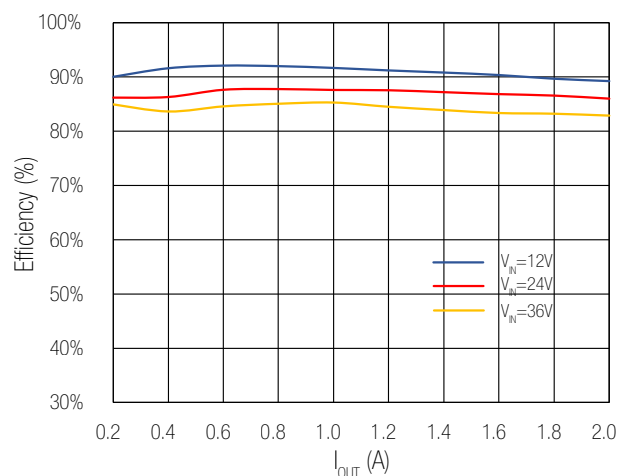


Figure 3. Efficiency vs Load, $V_{OUT}=3.3V$, $f_{SW}=500kHz$

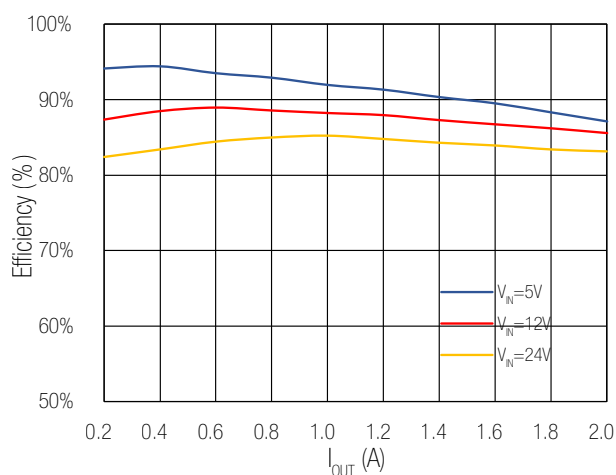


Figure 4. Efficiency vs Load, $V_{OUT}=3.3V$, $f_{SW}=1MHz$

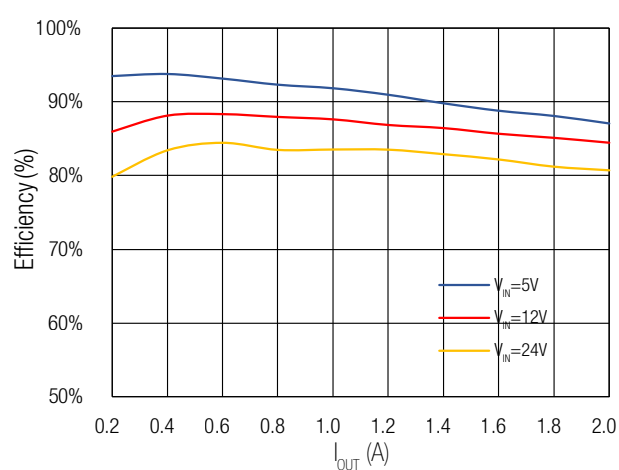


Figure 5. EN threshold voltage vs Temperature, $V_{IN}=12V$

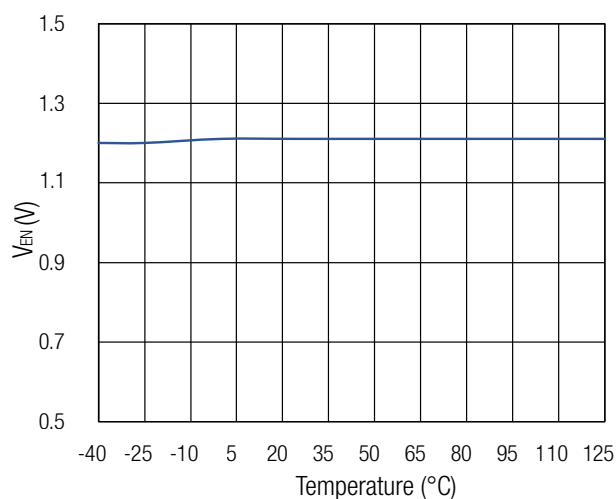
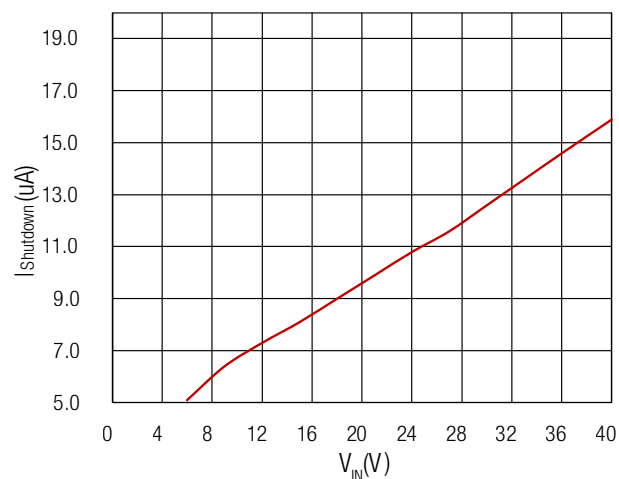


Figure 6. V_{IN} vs $I_{shut\downarrow}$, $V_{OUT}=5V$



TECHNICAL SPECIFICATION

Typical characteristic curve

Figure 7. UVLO vs Temperature, $f_{sw}=500kHz$, $V_{out}=5V$

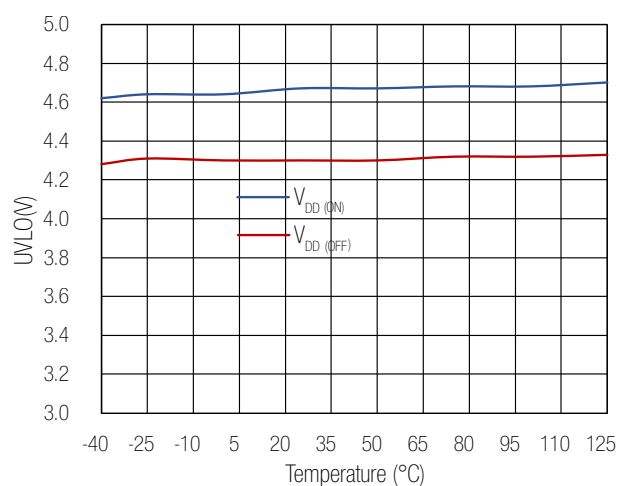


Figure 8. Frequency setting, $V_{in}=12V$, $V_{out}=5V$, $I_{load}=1A$

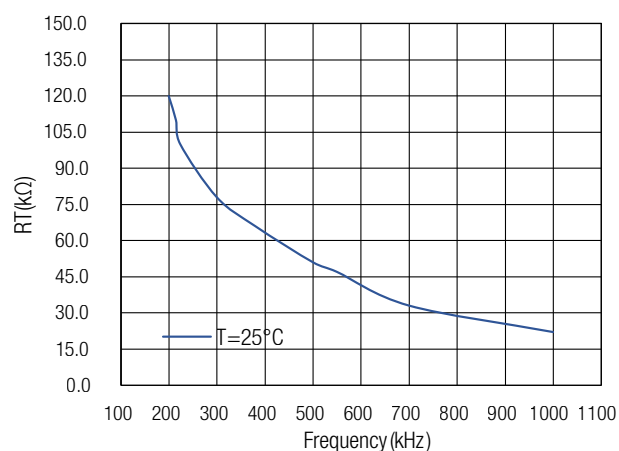


Figure 9. EN Enable waveform

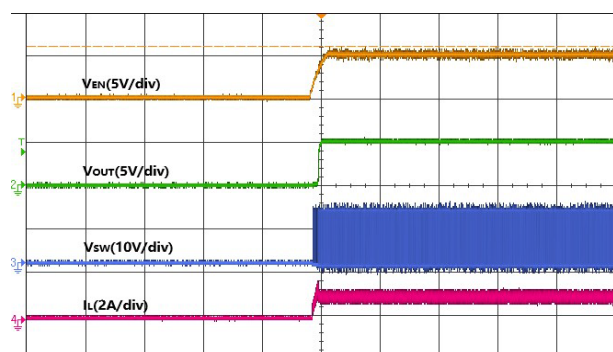


Figure 10. EN Shutdown waveform

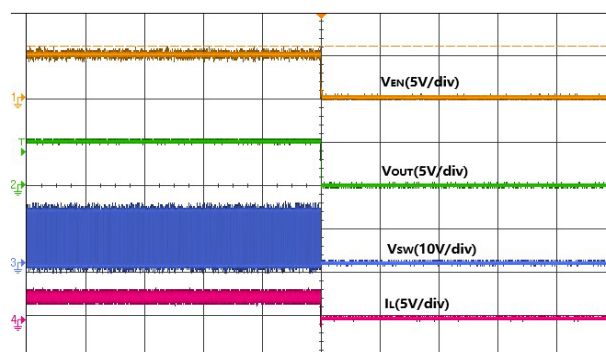


Figure 11. Full-load ripple and SW waveform

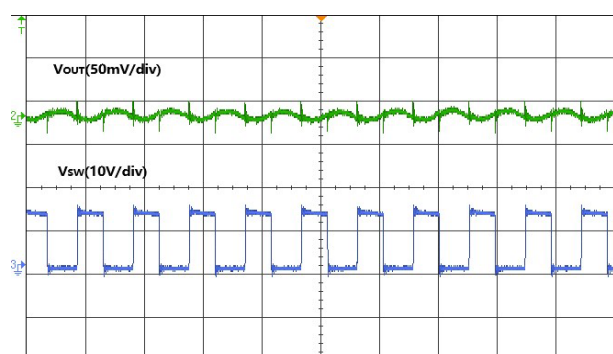
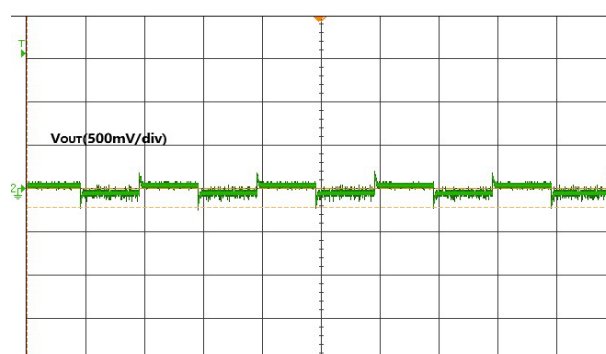


Figure 12. 0.2A to 2A load transient waveform



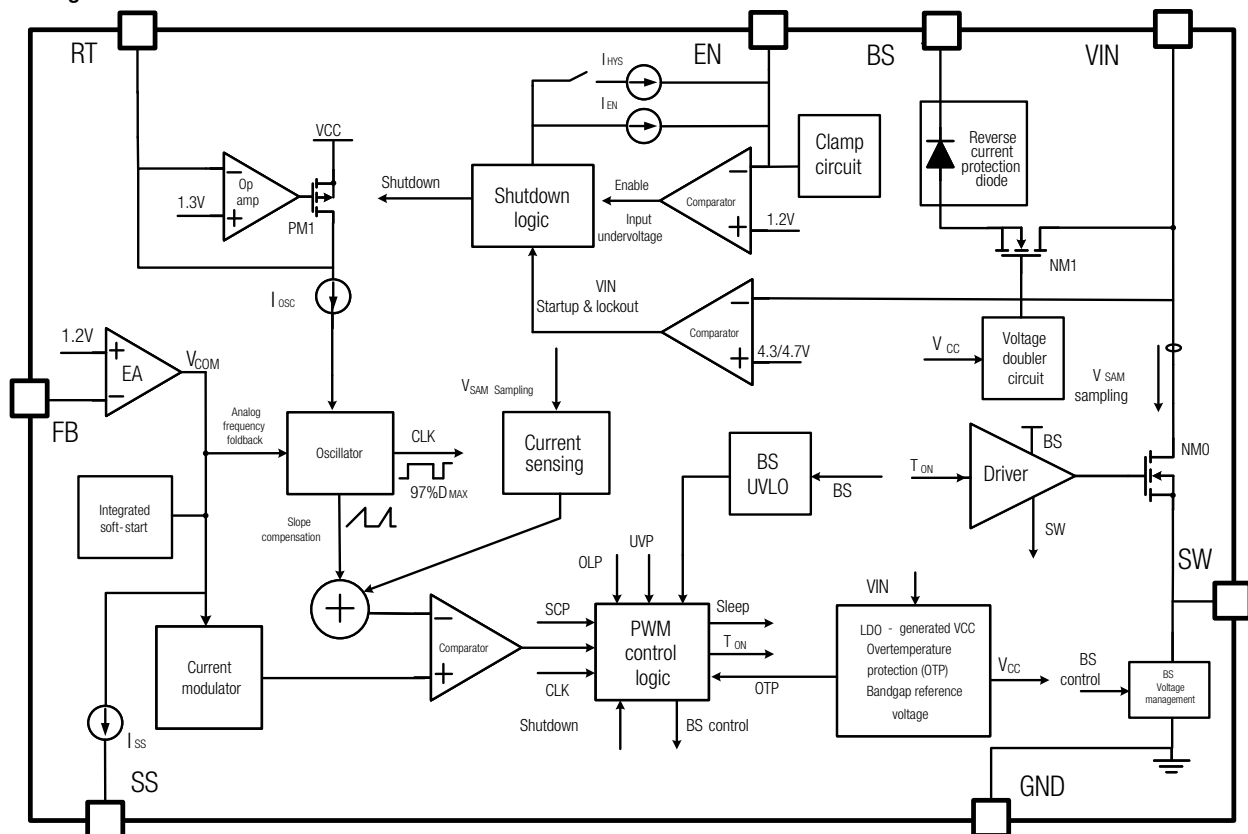
FUNCTIONS AND PRINCIPLES

Overview

The RVB019 is a current-mode power converter that integrates the control circuitry and power MOSFET on a single die using advanced BCD process technology. It is an easy-to-use non-synchronous DC/DC buck converter operating from a 5V to 40V input supply range. The device integrates a 100 m Ω (typ.) high-side MOSFET and is capable of delivering up to 2A of continuous load current with a very compact solution size, while providing excellent efficiency and thermal performance.

The RVB019 also integrates cycle-by-cycle overcurrent protection, output short-circuit protection, overtemperature protection, and input undervoltage lockout (UVLO). All protection functions support automatic recovery once fault conditions are removed, maximizing the reliability of the switching power supply system.

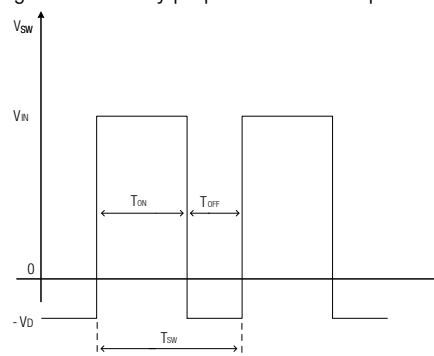
Functional diagram

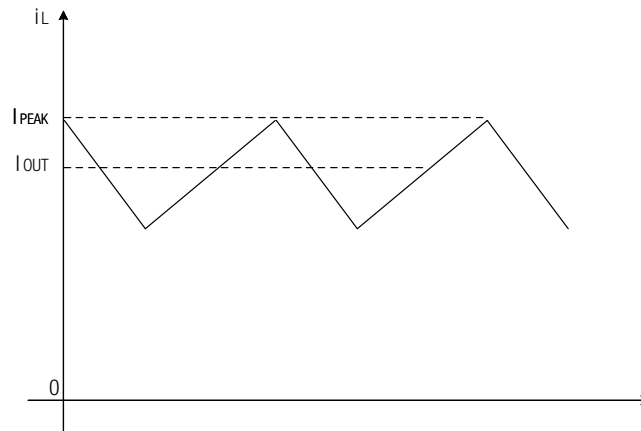


Feature descriptions

Peak current-mode control

As shown in the figure below, the RVB019 regulates the output voltage by turning on the high-side N-channel MOSFET during a controlled on-time interval. During the high-side switch conduction period, the SW pin voltage rises to approximately V_{IN} , and the inductor current i_L increases linearly with a slope of $(V_{IN} - V_{OUT}) / L$. When the high-side switch turns off, the inductor current freewheels through the external diode and decreases with a slope of $-V_{OUT} / L$. The control parameter of the buck converter is defined as the duty cycle $D = t_{ON} / T_{SW}$, where t_{ON} is the high-side switch on-time and T_{SW} is the switching period. The regulator control loop maintains a constant output voltage by adjusting the duty cycle D . For an ideal buck converter with negligible losses, the duty cycle is proportional to the output voltage and inversely proportional to the input voltage, as shown below: $D = V_{OUT} / V_{IN}$.



FUNCTIONS AND PRINCIPLES**Feature descriptions****Peak current-mode control****Figure 13. SW waveform and inductor current waveform in CCM mode**

The RVB019 employs peak current-mode control to provide accurate DC output voltage regulation. It uses a voltage feedback loop that adjusts the peak inductor current reference according to the error amplifier output, ensuring precise output voltage regulation. During each switching cycle, the controller monitors the peak current of the high-side switch and turns it off when the sensed current reaches the reference level determined by the feedback voltage. The voltage feedback loop incorporates internal compensation, minimizing the number of required external components and simplifying the overall circuit design. Under normal load conditions, the regulator operates in fixed-frequency PWM mode, providing stable output regulation and predictable switching behavior. As the load decreases, the device automatically transitions to PFM (Pulse Frequency Modulation) mode to improve efficiency by reducing switching losses. Under ultra-light-load conditions, the RVB019 enters Burst Mode, where switching occurs only as needed to maintain the output voltage. In this mode, the effective switching frequency decreases with decreasing load current, maximizing efficiency and minimizing quiescent power consumption.

Enable function with adjustable undervoltage lockout (UVLO)

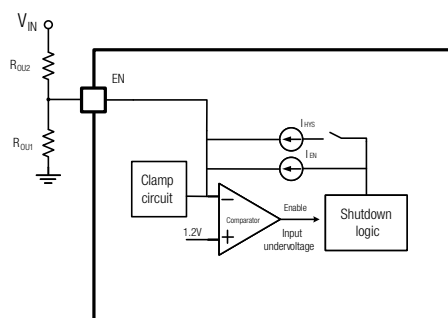
As shown in the figure below, the adjustable undervoltage lockout (UVLO) function of the RVB019 is implemented through the EN pin, and the lockout threshold voltages can be programmed according to actual application requirements. The operating principle is as follows:

When the voltage at the VIN pin rises above 4.7V (typ.) and the EN pin voltage exceeds the enable threshold of 1.2V (typ.), the RVB019 is enabled. When the VIN pin voltage falls below 4.3V (typ.) or the EN pin voltage drops below 1.2V, the RVB019 is disabled. When the EN pin voltage exceeds 1.2V, the EN pin provides an additional hysteresis current (typically $I_{HYS} = 4.2 \mu A$). When the EN pin voltage is pulled below 1.2V, the IHYS current disappears and only the IEN current remains (typically $I_{EN} = 2 \mu A$). This additional current helps implement adjustable input-voltage UVLO hysteresis. The enable threshold voltage and disable threshold voltage of the VIN undervoltage protection can therefore be calculated as follows:

$$R_{OU1} = \frac{V_{EN(UVP)}}{\frac{V_{INON(UVP)} - V_{EN(UVP)}}{R_{OU2}} + I_{EN}}$$

$$R_{OU2} = \frac{V_{INON(UVP)} - V_{INOFF(UVP)}}{I_{HYS}}$$

VINON(UVP) is the voltage threshold required to enable the RVB019, VINOFF(UVP) is the voltage threshold required to disable the device, and VEN(UVP) is the EN pin undervoltage lockout threshold voltage.

**Figure 14. EN enable operation block diagram**

FUNCTIONS AND PRINCIPLES

Feature descriptions

Slope compensation

The RVB019 adds a compensation ramp to the MOSFET switching current sensing signal. This slope compensation prevents subharmonic oscillation when the duty cycle exceeds 50%. The peak current limit of the high-side switch is not affected by the slope compensation and remains constant over the entire duty-cycle range.

Frequency foldback under light-load conditions and Burst mode operation under ultra-light-load conditions

Frequency foldback under light-load conditions: To improve light-load efficiency and reduce no-load power consumption, the RVB019 features an analog frequency foldback function. As the converter load decreases, the modulation voltage V_{COM} or V_{EA} also decreases gradually. When the load falls to approximately 30% of the maximum output power, the operating frequency begins to decrease along with the reduction of V_{COM} or V_{EA} . The minimum operating frequency is $f_{MIN} = 40 \text{ kHz}$.

Burst mode operation under ultra-light-load conditions: When the switching converter operates under ultra-light-load conditions, the RVB019 works at the minimum operating frequency and minimum on-time. In this condition, the energy delivered to the converter output V_{OUT} may not be fully consumed, causing V_{OUT} to rise above the regulation target. The RVB019 then enters an intermittent idle state, stopping the switching operation until V_{OUT} drops to the recovery threshold, at which point the device resumes switching pulses. As a result, the RVB019 maintains stable output regulation through intermittent hiccup-style Burst mode operation.

Bootstrap regulator driver

The RVB019 provides an integrated bootstrap regulator. A small capacitor connected between the BS and SW pins supplies the gate-drive voltage for the high-side MOSFET. The BS capacitor is refreshed when the high-side MOSFET is turned off and the external low-side diode is conducting. The recommended BS capacitor value is $0.1 \mu\text{F}$. It is recommended to use a ceramic capacitor with X7R or X5R dielectric material and a rated voltage of 16 V or higher to ensure stable performance over temperature and voltage variations.

Bootstrap charging is implemented through an external bootstrap capacitor that powers the high-side power MOSFET driver. A dedicated internal regulator charges and regulates the bootstrap capacitor voltage to approximately 5V above the SW node. When the voltage between the BS and SW nodes drops below the regulated value, the PMOS transistor connected from VIN to BS turns on. The charging current path flows from VIN to BS and then to SW. The external circuit should provide sufficient voltage headroom to support charging. As long as VIN is significantly higher than SW, the bootstrap capacitor remains charged.

When the high-side power MOSFET is turned on, $V_{IN} \approx V_{SW}$, making it impossible to charge the bootstrap capacitor. When the high-side power MOSFET is turned off, $V_{IN} - V_{SW}$ reaches its maximum value, enabling fast charging. When there is no inductor current, $V_{SW} = V_{OUT}$, allowing the voltage difference between VIN and VOUT to charge the bootstrap capacitor. The bootstrap regulator includes its own UVLO protection with a rising threshold of 3.2V and 400mV hysteresis. A 10Ω resistor is recommended between the BS pin and the bootstrap capacitor to reduce SW spike voltage.

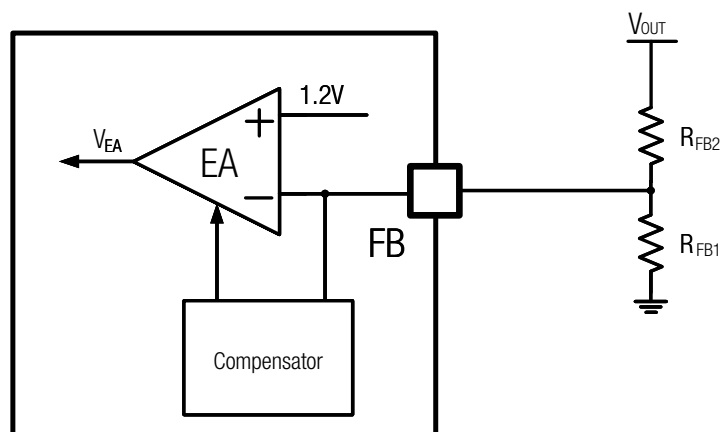
Since the gate-drive current supplied by the BS capacitor is very small, the high-side MOSFET can remain on for many switching cycles before it must turn off to refresh the capacitor. Therefore, the effective duty cycle of the switching regulator can reach up to 97%. During dropout operation, the effective duty cycle of the converter is mainly limited by the voltage drop across the power MOSFET, inductor resistance, low-side diode forward voltage, and PCB trace resistance.

Output voltage setting

The output voltage of the RVB019 is set by an external resistor divider connected to the FB (feedback) pin. The divided output voltage is applied to the inverting input of the internal error amplifier (EA), where it is compared with the internal reference voltage, $V_{FB(REF)} = 1.2 \text{ V}$, applied to the non-inverting input. The resulting error signal generates the control voltage (V_{EA}), which adjusts the converter duty cycle to regulate the output voltage, as illustrated in the figure below. Under steady-state operating conditions, the feedback voltage at the FB pin is regulated to match the internal reference voltage of 1.2 V, thereby maintaining the desired output voltage. Therefore, the output voltage can be calculated as follows:

$$V_{FB(REF)} = V_{OUT} \cdot \frac{R_{FB1}}{R_{FB1} + R_{FB2}} = 1.2V$$

$$V_{OUT} = \frac{R_{FB1} + R_{FB2}}{R_{FB1}} \cdot 1.2V$$

FUNCTIONS AND PRINCIPLES**Feature descriptions****Output voltage setting****Figure 15. FB resistor divider****Soft-start**

The purpose of soft-start is to allow the output voltage and inductor current of the switching power supply to gradually reach their initial steady-state values during startup, thereby reducing startup stress and input inrush current. During FB regulation, an internal 16μA (I_{SS}) current source charges the external soft-start capacitor C_{SS} through the SS pin. The rising rate of the C_{SS} voltage controls the ramp-up speed of the V_{COM} voltage, thereby gradually increasing the duty cycle. The soft-start time can be configured by selecting the value of the external soft-start capacitor. The soft-start equation is:

$$T_{SS} = C_{SS} \cdot \frac{V_{COM(MAX)}}{I_{SS}}$$

where V_{COM(MAX)} = 2V.

Oscillator frequency setting

The oscillator frequency can be programmed through the external resistor R_T connected between the RT and GND pin. The RT pin maintains a static operating voltage of 1.3V. The reference current generated through resistor R_T is proportional to the charge and discharge current of the internal relaxation oscillator. The frequency setting equation is:

$$F_{osc} = \frac{23900}{R_T(k\Omega)} \text{ (kHz)}$$

f _{sw} (kHz)	R _T (kΩ)
200	120
300	78
500	50
700	33
1000	22

Table 16. Typical R_T values for a given switching frequency f_{sw}**Overcurrent and short-circuit protection**

The RVB019 provides cycle-by-cycle overcurrent protection by limiting the peak current of the high-side MOSFET during each switching cycle. As part of its peak current-mode control architecture, the high-side switch current is continuously monitored and compared with the control signal from the error amplifier (EA), adjusted by the slope compensation signal (refer to the functional block diagram for details). To prevent excessive current, the peak current of the high-side MOSFET is clamped to a fixed maximum threshold. As a result, the overcurrent limit is independent of the slope compensation signal and remains constant over the entire duty-cycle range, ensuring reliable protection under all operating conditions.

Thermal shutdown

When the junction temperature exceeds 167°C (typ.), the RVB019 triggers the internal thermal shutdown circuit to protect the device. When thermal shutdown is activated, the high-side MOSFET stops switching. After the junction temperature falls below 152°C (typ.), the device automatically restarts with a power-up sequence controlled by the internal soft-start circuit.

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FUNCTIONS AND PRINCIPLES

Operating modes

Operating in undervoltage lockout (UVLO) mode

The EN pin provides the RVB019 with an electrical on/off control function. When V_{EN} is below 1.2V, the device enters shutdown mode. The switching regulator is disabled, and the quiescent current is typically reduced to 2.0μA. The RVB019 also features undervoltage lockout (UVLO) protection. If the VIN voltage falls below the UVLO threshold, the switching regulator will be turned off.

Normal operating condition

When V_{EN} is higher than the precision enable threshold and VIN is above its UVLO level, the RVB019 enters normal operating mode. The simplest way to enable the RVB019 is to connect the EN pin directly to the VIN pin. This configuration enables automatic startup when the input voltage is within the operating range of 5V to 40V. Under normal operating conditions, the RVB019 operates in one of the following three modes depending on the load current:

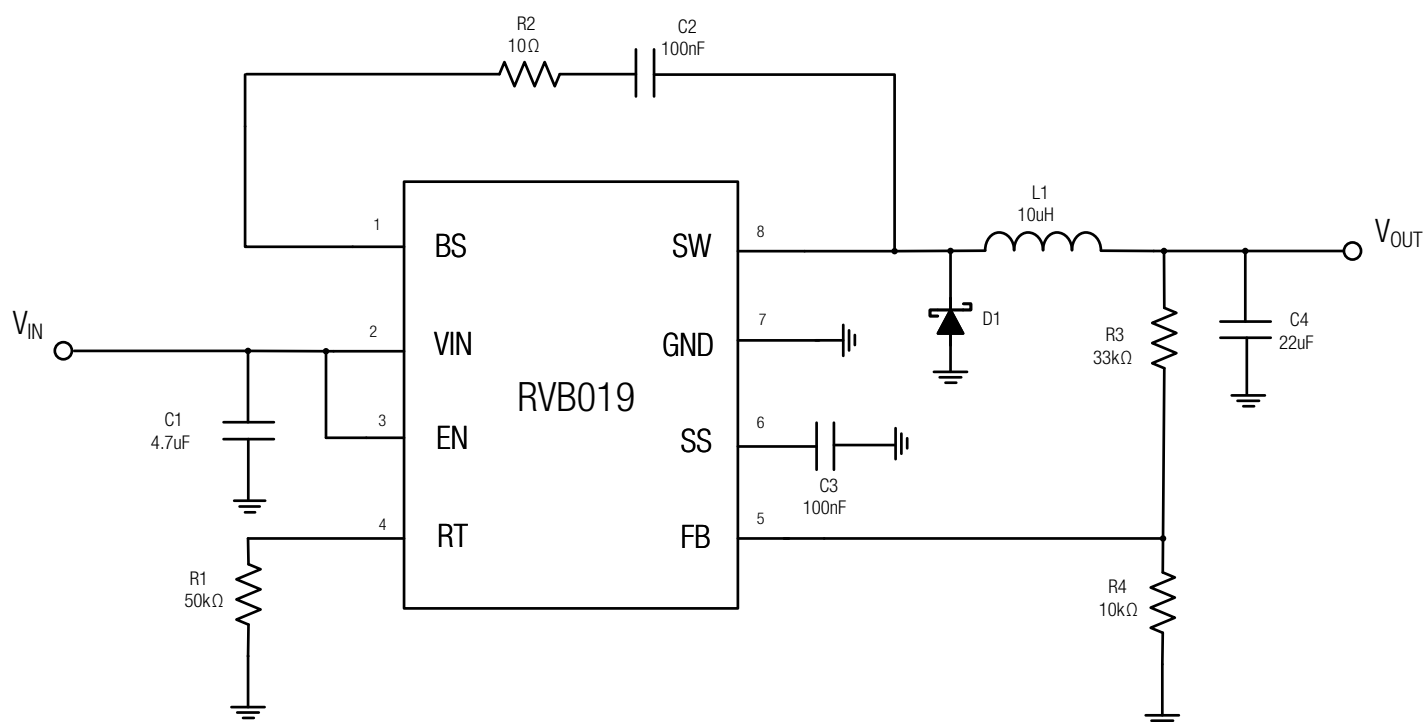
Continuous Conduction Mode (CCM): The switching frequency is fixed, and the load current is greater than half of the peak-to-peak inductor current ripple.

Discontinuous Conduction Mode (DCM): The switching frequency is fixed, and the load current is less than half of the peak-to-peak inductor current ripple during DCM operation.

Burst Mode: Under ultra-light-load conditions, the switching frequency is reduced to optimize efficiency.

APPLICATION EXAMPLE

Typical application



V_{IN} range	8-36V
V_{OUT}	5V
I_{OUT}	1A
V_{RIPPLE} (target)	< 30mA
f_{SW}	500Khz
soft-start time	12.5ms
D1	60V/5A Schottky

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APPLICATION EXAMPLE

Typical application

Figure 16. Efficiency vs Load current

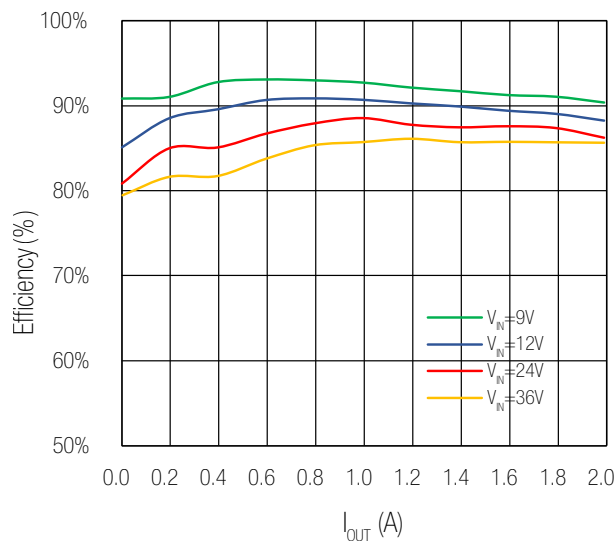
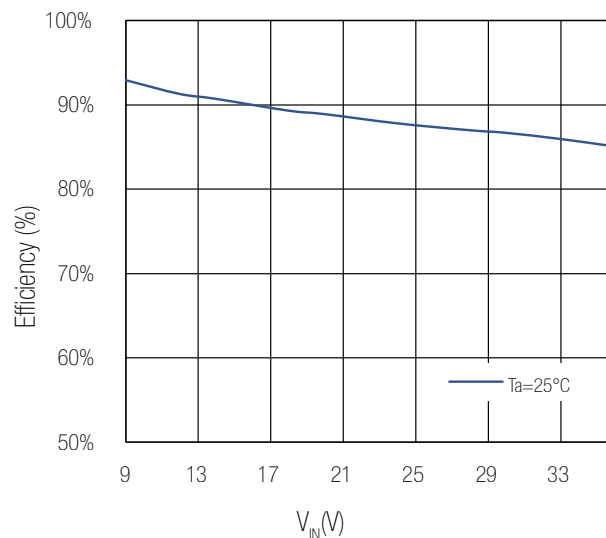
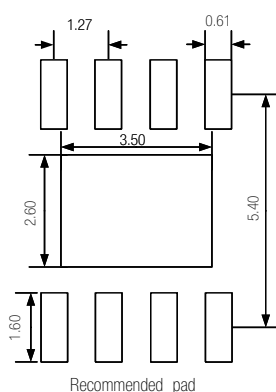
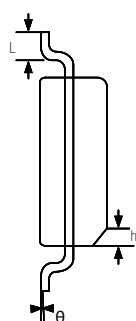
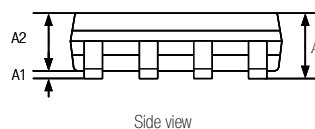
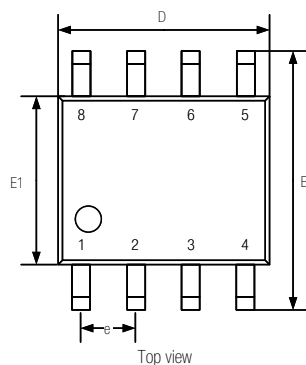


Figure 17. Efficiency vs Input voltage



PACKAGING INFORMATION

ESOP8



Dimension table

Symbol	Millimeter		
	Min.	Nom.	Max.
A	1.35	-	1.75
A1	0.1	-	0.25
A2	0.1	-	0.25
b	0.35	-	0.49
c	0.19	-	0.25
D	4.8	-	5
E	5.8	-	6.2
E1	3.8	-	4
e	1.27 BSC		
h	0.4	-	1.25
L	0.25	-	0.5
θ	0°	-	7°

ORDER INFORMATION

Part number	Package	PIN	Package type	SPQ	Marking code*	MSL
RVB019-BDWC-R	ESOP8	8	Tape and reel	4000	RVB019	MSL-3
RVB019-BDWC-CT	ESOP8	8	Moisture barrier bag	10	RVB019	MSL-3

*Marking code

RVB019 — Product code

The product information and specifications may be subject to changes even without prior written notice. The product has been designed for various applications; its suitability lies in the responsibility of each customer. The products are not authorized for use in safety-critical applications without RECOM's explicit written consent. A safety-critical application is an application where a failure may reasonably be expected to endanger or cause loss of life, inflict bodily harm or damage property. The applicant shall indemnify and hold harmless RECOM, its affiliated companies and its representatives against any damage claims in connection with the unauthorized use of RECOM products in such safety-critical applications.