Diode series

Advantages of RBLQ Series: Compact and Highly Power Conversion Efficiency Schottky Barrier Diodes for Automotive

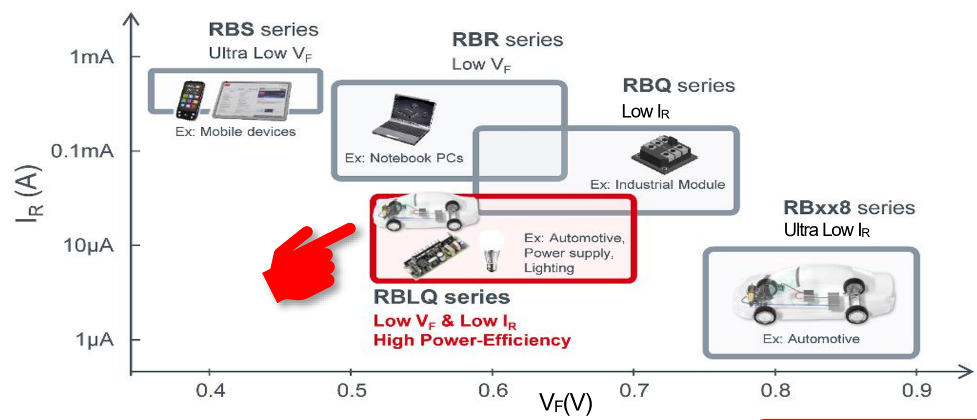
Schottky barrier diodes (SBDs) are semiconductor devices that feature low forward voltage (V_F) and low recovery loss compared with common PN junction diodes. They have significantly contributed to the improvement in power conversion efficiency of various power circuits, including PFC circuits and boost and buck converters, as well as reverse current protection circuits. Furthermore, demand for various automotive equipment including automotive LED lamps, in-vehicle infotainment, and ECU, solar power generation systems, and compact mobile devices represented by USB battery chargers has greatly increased in recent years.

To meet this demand, ROHM has developed the “RBLQ Series” as an addition to the previous RBS, RBR, RBQ, and RBxx8 series. Employing the latest Schottky process enables industry-leading low V_F and low capacitance characteristics, contributing to the improvement in power conversion efficiency of circuits. Furthermore, listing the compact and thin TO-277 package with high heat dissipation in its product lineup, the RBLQ series is also ideal for automotive equipment and compact mobile devices that have strict requirements for heat generation and mounting space.

This application note provides an easy-to understand explanation about the advantages of the RBLQ series with respect to its characteristics based on comparison with common competing products. It also explains its advantages in actual circuits based on results of comparative evaluation using an LED driver.

1. ROHM SBD roadmap

Figure 1 shows the SBD selection map developed by ROHM. The trade-off between V_F and I_R (reverse current) is significantly improved in the new products of the RBLQ series (red frame) compared with the previous RBS, RBR, RBQ, and RBxx8 series. While V_F is kept equivalent, I_R is reduced to approximately 1/10 compared with the previous series. Therefore, the new products can be conveniently applied and achieve a lower loss especially in the automotive equipment under a harsh temperature environment. Although the breakdown voltage V_{RM} setting is currently only 100 V, other settings will be added gradually.



Series	RBS *	RBR	RBQ	RBxx8	RBLQ
Automotive	-	Yes	Yes	Yes	Yes
Technology	Planer				Trench
Features	Ultra Low V_F	Low V_F	Low I_R	Ultra Low I_R	Low V_F / Low I_R Highly Power-efficiency
20V	✓				
30V		✓		✓	
40/45V		✓	✓	✓	✓ (Under development)
60/65V		✓	✓	✓	✓ (Under development)
100V			✓	✓	✓
150V				✓	
200V				✓	

* Automotive grade is unavailable for RBS series.

Figure 1. SBD selection map developed by ROHM

2. Application example using the RBLQ series (automotive LED headlamp)

As an application example using the RBLQ series, Figure 2 shows peripheral circuits of an automotive LED headlamp. SBDs (red frame) are generally used for rectification of the boost block.

Since these circuits are generally energized under a sealed condition for automotive LED headlamps, the temperature can be very high. Furthermore, with the increase in the number of bulbs in a headlamp and downsizing of circuit boards in recent years, the operating condition is increasingly harsher with respect to heat generation. Therefore, as the characteristics required for SBD, in addition to low V_F (low conduction loss), the low I_R characteristics and the heat dissipation performance of packages are very important in terms of reduction in the thermal runaway risk. Since the trade-off between V_F and I_R is significantly improved in the RBLQ series as described in Chapter 1, it has a huge advantage with respect to these points (when comparing products with similar V_F, I_R can be significantly reduced from the previous series). Furthermore, a wide range of packages with superior heat dissipation performance, including TO-252 and TO-277, is listed in its lineup (the lineup is described in detail in Chapter 5). This allows for flexible applications to various usages and mounting spaces.

In addition, since a recovery loss occurs if the boost circuit is operated in the continuous mode, the recovery characteristics of SBD also becomes very important. Since this recovery loss is superimposed over the switching cycle, it is more important at a higher operation frequency.

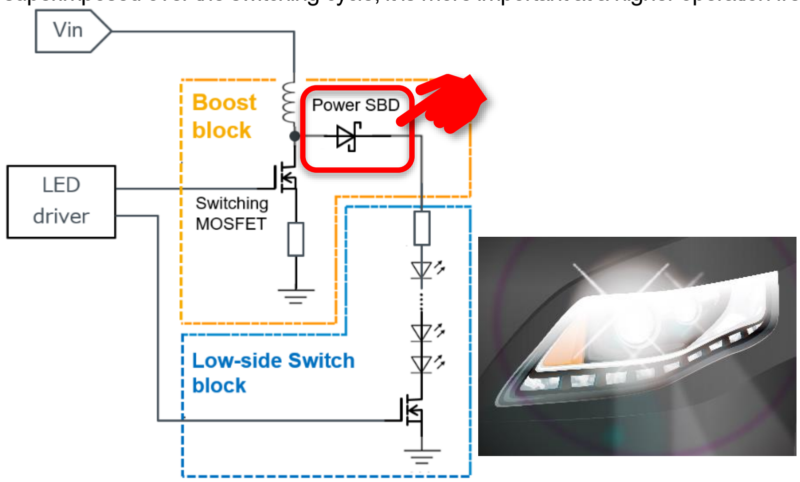


Figure 2. Peripheral circuits of automotive LED headlamps

3. Comparison of device characteristics with products from other companies

Figures 3 and 4 show the comparison results of the I_F-V_F and capacitance-V_R characteristics for the TO-277 package products in the 100 V/10 A class from other companies. ROHM RBLQ10RSM10 [1] has one of the lowest V_F characteristics, nearly equivalent to the Company-A product. Therefore, it can be predicted that ROHM RBLQ10RSM10 and the Company-A product have the lowest conduction loss when they are used in an actual circuit. In contrast, V_F of Companies-B and C products are higher by approximately 10 to 20%. Therefore, it can be expected that their conduction losses are higher compared with those of ROHM RBLQ10RSM10 and the Company-A product. Furthermore, based on the capacitance-V_R characteristics, it can be predicted that ROHM RBLQ10RSM10 has the lowest switching loss, because its capacitance is the smallest (approximately a half) compared with the competing products.

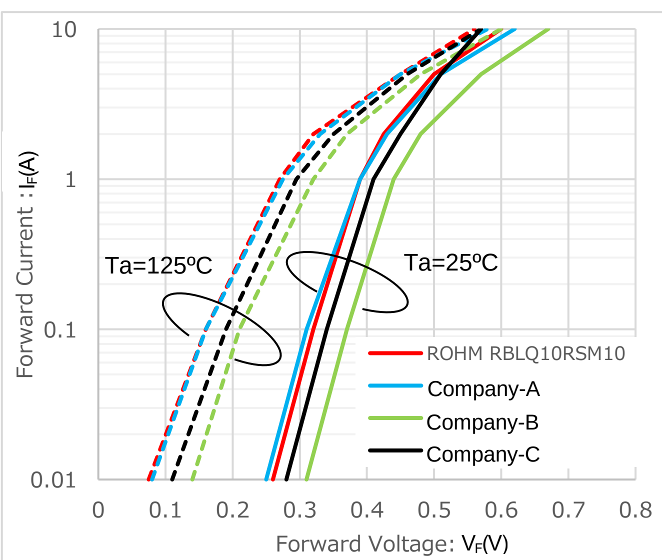


Figure 3. I_F-V_F characteristics

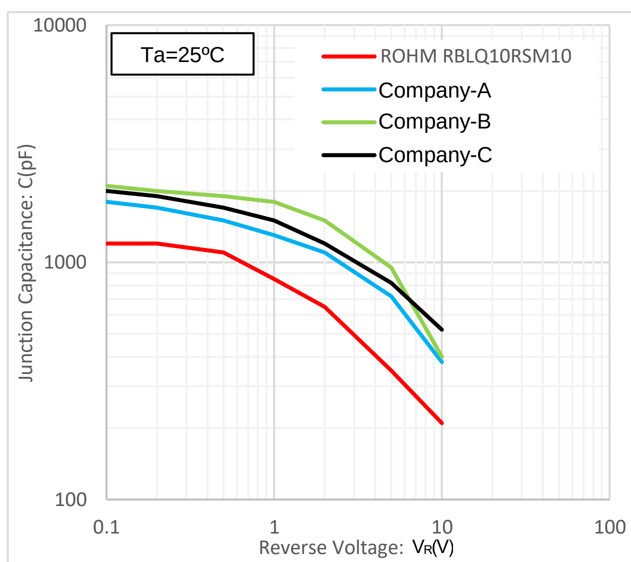


Figure 4. Capacitance-V_R characteristics

4. Comparative evaluation of competing products in actual equipment

Using ROHM automotive LED driver BD18353EFV-M [2] and its evaluation board, we compared the power conversion efficiency and heat generation of ROHM RLQ10RSM10 (100V/10A/TO-277) with similar products from other companies.

4-1. Evaluation board and circuit diagram

Figure 5 shows a full view of the evaluation board and its circuit diagram.

In this evaluation, a comparative evaluation was performed by exchanging the rectifier diode (red frame) in the boost block. For the switching MOSFET (blue frame), ROHM RD3P100SNFRA (100V/10A/TO-252) was used.

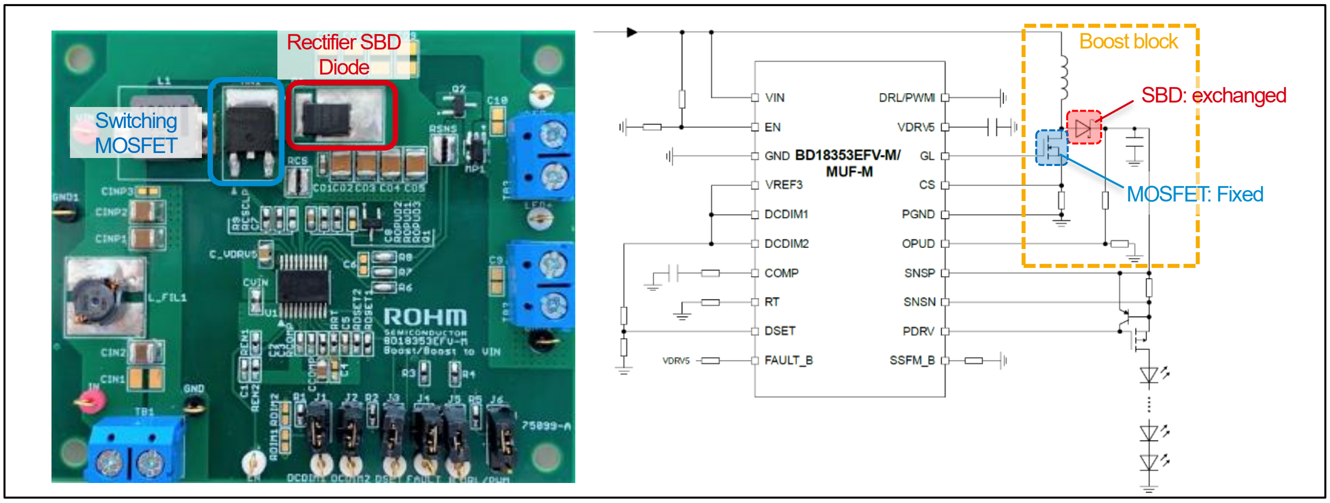


Figure 5. Picture of board and circuit diagram

4-2. Evaluation results

Figure 6 shows the comparison results of the efficiency and package surface temperature Tc.

As shown, it is confirmed that RBLQ10RSM10 with superior characteristics of both V_F and capacitance has the highest power conversion efficiency and can keep Tc the lowest even with the same package. The efficiency of products from Companies-B and C are specifically lower and their Tc is higher. This is because of their high V_F as described in Chapter 3. Furthermore, although the Company-A product has the V_F characteristics equivalent to ROHM RBLQ10RSM10, its efficiency is lower and Tc is higher because its switching loss is higher.

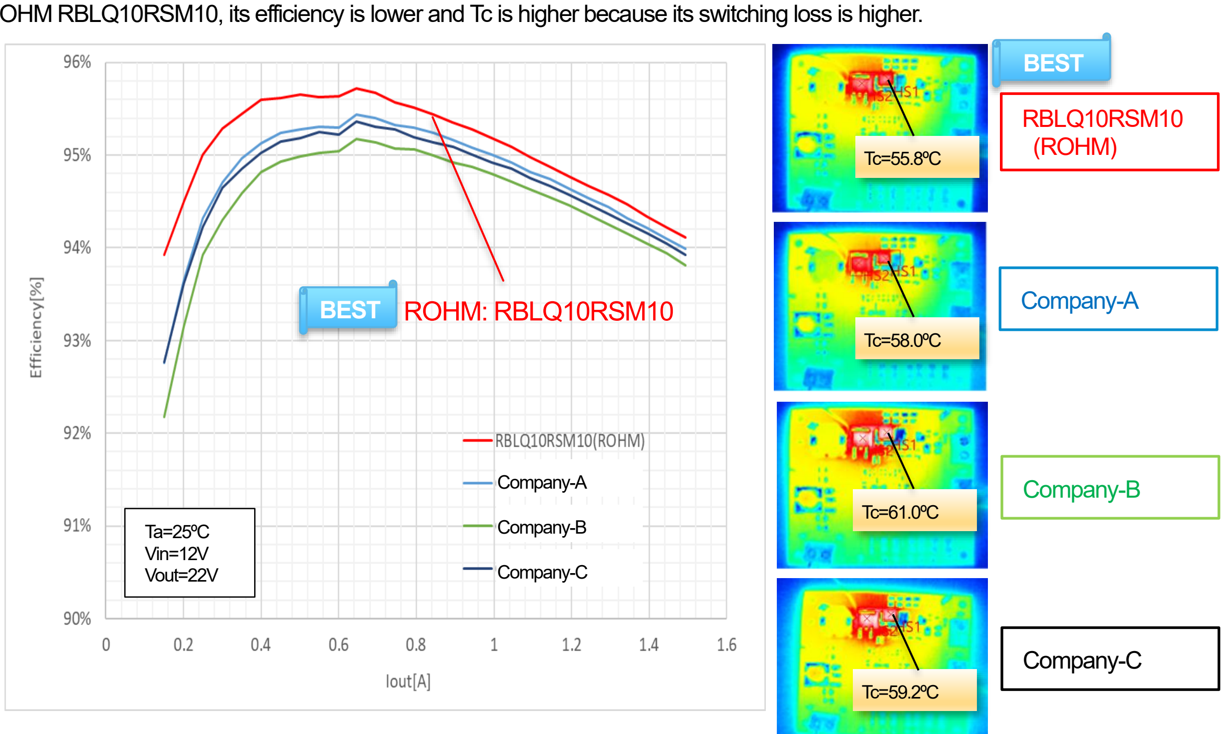
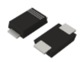


Figure 6. Comparison results of the efficiency and package surface temperature

5. Lineup

Figure 7 shows the lineup of the RBLQ series. A wide product lineup is prepared for various applications, including RBLQ10RSM10 which was used for the evaluation of the LED driver described above. Products other than the following will be gradually added to the product lineup. Please feel free to contact us.

Package	Part No.	code*	Configulation	V_{RM} (V)	I_O (A)	Tj max (°C)	Electrical characteristics (Tj=25°C)			
							V_F max. (V)	condition	I_R max. (µA)	condition
PMDE  2.5 × 1.3 × 0.95t (mm)	RBLQ2VWM10	TF	single	100	2	175	0.77	I_F=2A	10	V_R=100V
PMDU  3.5 × 1.6 × 0.8t (mm)	RBLQ2MM10	TF	single	100	2	175	0.77	I_F=2A	10	V_R=100V
PMDTM  4.7 × 2.5 × 0.95t (mm)	RBLQ3LAM10	TF	single	100	3	175	0.64	I_F=3A	15	V_R=100V
TO-277GE  6.65 × 4.75 × 1.2t (mm)	RBLQ10RSM10	TF	single	100	10	150	0.67	I_F=10A	80	V_R=100V
TO-252  10.0 × 6.6 × 2.2t (mm)	RBLQ20BM10	FH	single	100	20	150	0.86	I_F=20A	80	V_R=100V
TO-263L  15.1 × 10.1 × 4.5t (mm)	RBLQ20NL10S	FH	single	100	20	150	0.86	I_F=20A	80	V_R=100V
	RBLQ30NL10S	FH	single	100	30	150	0.86	I_F=30A	150	V_R=100V
	RBLQ20NL10C	FH	cathode common	100	20	150	0.71	I_F=10A	70	V_R=100V

* Automotive product code

Figure 7. RBLQ series lineup

6. Summary

- The products of the RBLQ series have lower V_F and lower I_R simultaneously compared with the previous RBS, RBR, RBQ, and RBxx8 series. Therefore, they can contribute to improved power conversion efficiency in various applications.
- The TO-252 and TO-277 packages with superior heat dissipation performance are also listed in the product lineup. Combination with low I_R dies can significantly contribute to reduction in the thermal runaway risk compared with previous products. This means they are especially useful for automotive equipment under harsh temperature environment.
- Compared with products in the same class from other companies, the RBLQ series has superior characteristics of V_F and capacitance. Therefore, it can be considered that it has a great advantage with respect to improvement in the power conversion efficiency and reduction in heat generation when it is used in an actual circuit such as automotive LED headlamps.

7. References

[1] Trench MOS Barrier Structure, 100V, 10A, TO-277A, Highly Efficient SBD for Automotive, RBLQ10RSM10TF
Data sheet (Rev.002) ROHM Co., Ltd., June 2021.

[2] 1ch High Current LED Controller for Automotive, BD18353EFV-M, BD18353MUF-M
Data sheet (No. TSZ02201-0T1T0B400330-1-1 Rev.002) ROHM Co., Ltd., February 2021.

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