ADAS Camera Systems
Power supply and Data Interface Solutions

White Paper

・ ADAS Market Trends and ROHM Initiatives

On the way to autonomous driving, more and more safety assistance systems have been introduced in the automotive environment in the past and will do so in the future. This movement has affected Europe and North America, which created the trend toward their widespread use, as well as East Asia, including China and Japan, and more recently India, among other areas.

In conjunction with this shift, there has also been a significant acceleration in the development of equipment required to configure advanced driver assistance systems (ADAS), including in-vehicle camera systems, radar, LiDAR and sensor fusion systems that integrate multiple sensing technologies. For this equipment, camera systems play a particularly important role in sensing the surrounding environment and have been widely used in conventional surround-view type systems. Today cameras and radar systems, they are the most frequently installed sensing systems in vehicles.

With the market for camera systems expected for further growth, various related issues are becoming apparent. The challenging topics are the need to install additional cameras, the increased data transmission rate and to ensure stable operation against external factors such as noise. An additional point to be considered is the power consumption, which needs to be as low as possible to reduce the overall cost and finally the CO2 emission. Additionally, to construct safer systems, it is necessary to clarify malfunction-related risks and deliver “functional safety” that ensures acceptable levels if a failure does occur.

In an effort to address these issues, ROHM has been pursuing product development that incorporates the idea of functional safety and also targeting performance enhancements that reduce both power consumption and noise, two areas that we have been working on for some time. More specifically, we have released BD868xxMUF-C, a power management IC (PMIC) for camera modules complies with ASIL-B of ISO 26262, a set of guidelines created to standardize development processes for achieving functional safety.

BD868xxMUF-C ranks as the industry’s smallest package device* among PMICs equipped with reporting functions as safety mechanism. It is able to provide optimal power supply functions for camera modules, which have increasingly high requirements for miniaturized components.

* Based on ROHM research, as of April 2022.

・ Overview of ROHM Solutions for ADAS Camera Systems

Camera systems are installed in almost every part of a vehicle, however, each one is composed of a camera module that captures the images and an electronic control unit (ECU) that processes the received imager data and controls the camera module. A block diagram of a basic camera system is shown in Figure 1.

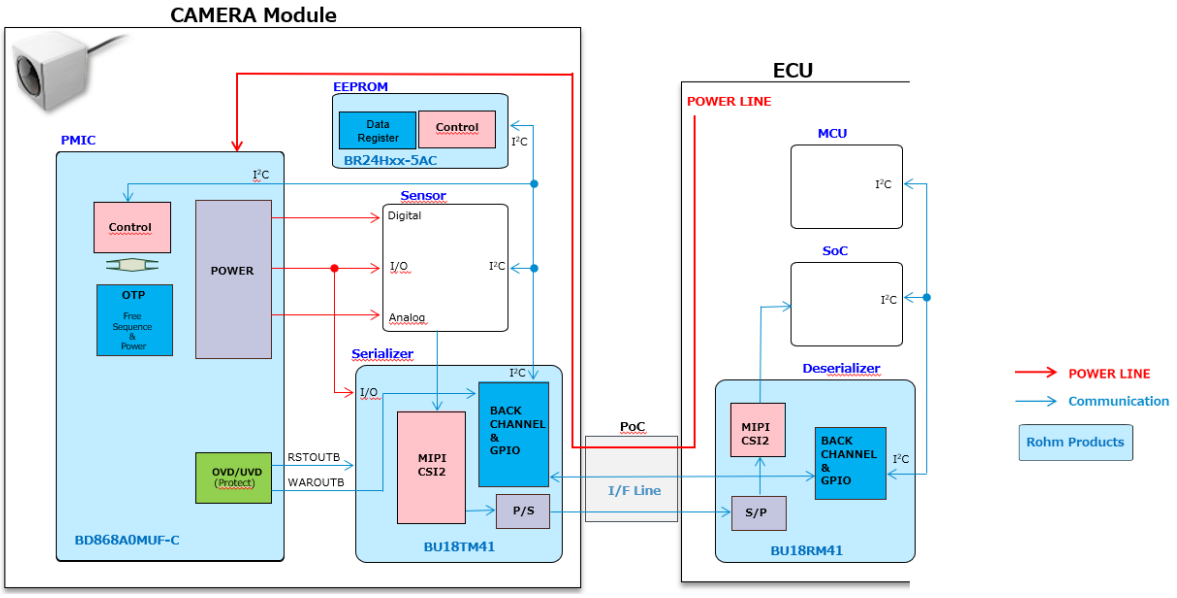

Figure 1. Block Diagram of Camera System and ROHM Products

In Figure 1, shows the principle connection diagram of an ADAS camera module connected via power over coax (PoC) to an ECU. The camera system uses BU18xMxx-M series as communication IC (a serializer and deserializer, hereafter SerDes), responsible for transmitting image data captured by the camera module to the ECU, and the BD868xxMUF-C PMIC, which supplies power to the CMOS image sensor, the SerDes, the EEPROM and optionally the lens heating. The system also includes the BR24Hxx-5AC EEPROM, for holding the image correction data of the image sensor. ROHM offers all necessary active components for camera systems except the CMOS image sensor.

・ Specifications of BD868xxMUF-C PMIC and BU18xMxx-C Series SerDes

BD868xxMUF-C is a PMIC specifically developed for in-vehicle camera modules and incorporates three switching regulators and one LDO. The product lineup includes both ASIL-B-compliant and non-compliant models. The product portfolio includes a variant family including lens heating or ultrasonic cleaning control. Each model uses one time programmable (OTP) memory, enabling the output voltage value and startup sequence to be changed at the time of product shipment. This allows to support the power supply specifications of almost all camera sensors.

Part Number	Supply Voltage [V]	Switching Frequency [MHz]	Operating Temperature [°C]	Output Voltage Accuracy [%]	Output								Function				Package
					DC/DC1 buck		DC/DC2 buck		DC/DC3 buck		LDO		I^2C	Spread Spectrum for EMC	Safety	Heater Driver	
BD868xxMUF-C series	4.0V to 18.0V	2.25MHz	-40°C to 125°C	2	3.0V to 5.0V	2.0A Max	0.95 to 1.5V or 1.8V	1.2A Max	0.95 to 1.5V or 1.8V	1A Max	2.7V to 3.5V	0.3A Max	✓	✓	ASIL-B	-	VQFN20FV3535 3.5 mm x 3.5 mm x 1.0 mm
						2.0A Max		1.2A Max		1A Max		0.3A Max			-	-	
						2.0A Max		1.2A Max		0.4A Max		0.3A Max			ASIL-B	✓	

Table 1. Characteristics of BD868xxMUF-C PMIC

The BU18xMxx-M series SerDes pairs the BU18TM41-M serializer and BU18RM41-M deserializer to create a unit specifically for camera systems. The lineup also includes the four channel BU18RM84-M deserializer, enabling the construction of a more compact SerDes when multiple communications are received on the ECU side. Communication speeds of up to 3.6 Gbps are supported, as are all types of STP, coax and POC communication cables. These features mean the series can be used in a wide range of ADAS camera systems.

Part Number	Function	Transmission Standard	Supply Voltage [V]	Input Signal Type	Output Signal Type	Operating Temperature [°C]	Applicable communication cable			Package
							STP (Shielded Twisted Pair Cable)	Coax (Coaxial Cable)	POC (Power Over Coaxial)	
BU18TMA41-C	Serializer	CLL-BD***	1.8	MIPI-CSI2 (1.5Gbps×4)	CLL-BD*** (3.6Gbps×1)	-40°C to 105°C	✓	✓	✓	VQFN32FBV050 5.0 mm x 5.0 mm x 1.0 mm
BU18RM41-C	Deserializer	CLL-BD***	1.8	CLL-BD*** (3.6Gbps×1)	MIPI-CSI2 (1.5Gbps×4)					VQFN32FBV050 5.0 mm x 5.0 mm x 1.0 mm
BU18RM84-C	Deserializer (4in1**)	CLL-BD***	1.2/1.8	CLL-BD*** (3.6Gbps× 4)	MIPI-CSI2 (1.7Gbps×8)					HTQFP64BV 12.0mm x 12.0 mm x 1.0 mm

**BU18RM84-M can convert 4 camera images into MIPI signals and output them.

***CLL-BD = Clockless Link™-BD. Clockless Link™ is a trademark or registered trademark of ROHM Co.,Ltd.

Table 2. Characteristics of BU18xMxx-M Series SerDes

・ Numerous Advantages Delivered by ROHM Solutions

Manufacturers experience a wide range of benefits, including functional safety, versatility, low power consumption and low noise, while using ROHM BD868xxMUF-C PMIC and BU18xMxx-M series SerDes units in their camera systems (Fig. 2).

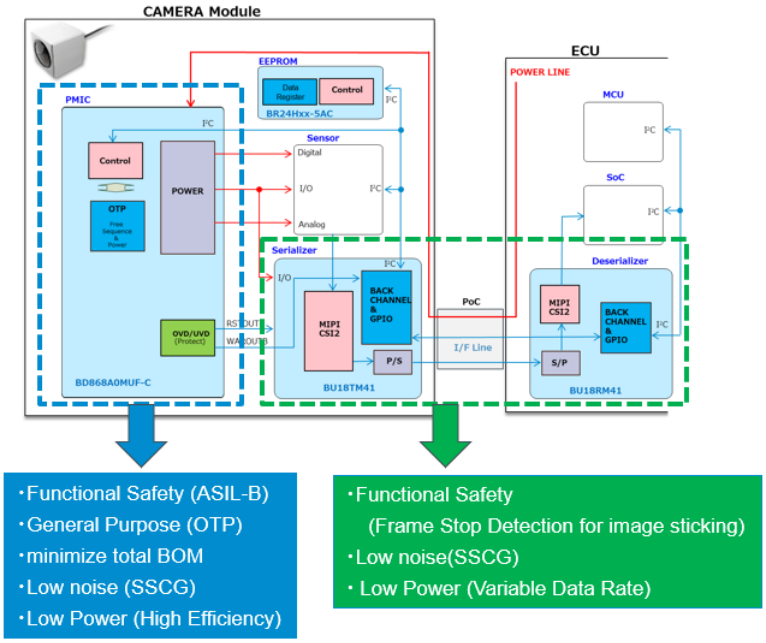

Figure 2. Benefits of ROHM Solutions for ADAS Camera Systems

1. Safety

In order to achieve highest safety levels for ADAS systems, not just redundant hardware and software needs to be taken into account, also redundancy on IC level is requested.

ROHM has achieved development process certification as stipulated by ISO 26262, the international standard covering functional safety for vehicles. In 2021, we launched the ComfySIL™ brand for better visibility of our safety and security products. This primarily serves to provide both customers and systems with information about functional safety.

The BD868xxMUF-C PMIC for camera modules; mentioned above; also belongs to our “FS process compliant” functional safety category, which is the highest for ComfySIL™, and we can provide a range of documentation including ISO 26262-related materials such as an FMEDA guide and safety manual (Fig. 3). It additionally complies with ASIL-B thanks to the incorporation of various safety functions in the IC, including voltage monitoring, BIST (self-diagnosis) and reference voltage isolation.

ComfySIL™ dedicated Website: https://www.rohm.com/functional-safety

The following are ROHM's functional safety categories (as of October 2021, for the automotive sector only).

- **FS process compliant** : Indicates that the IC was developed using ISO 26262-compliant processes conforming to the ASIL level.
- **FS mechanism implemented** : Denotes that the IC is equipped with functional safety required by the ASIL level.
- **FS supportive** : Indicates the automotive IC is able to support functional analysis related to functional safety.

List of Materials Provided by Category BD868A0MUF-C

	FS process compliant	FS mechanism implemented	FS supportive
IATF16949 Process Compliant	✓	✓	✓
ISO 26262 Process Compliant	✓	–	–
FMEA	✓	✓	✓
FIT	✓	✓	✓
FMEDA	✓	✓	✓ FS supportive FMEDA does not include analysis such as hardware architecture metrics.
Safety manual	✓	✓	–

Figure 3. Functional Safety Categories for ComfySIL™ and Available Documentation

To enhance the safety of camera systems, the BU18TM41-M serializer is equipped with a function called frame cyclic redundancy check (CRC) for detecting freezing of images. In a CRC, a standard calculation is performed on the color data of an image and the result is then output as a data string consisting of several bits. This result serves as a code that can be applied to the frame of an individual image. The same calculation is performed for each image on both the transmitting and receiving sides and the resulting CRC values are compared. This makes it possible to check the integrity of the image data and confirm that no loss or other error has occurred during transmission and reception.

While the above describes the general operation of a CRC, the frame CRC performed by BU18TM41-M is able to detect image freezing, an important requirement for ADAS camera systems, in addition to normal CRC errors. For example, when a camera system is capturing the area around a moving vehicle, the image data it sends is constantly changing and should not be the same for any fixed period. In other words, if the same CRC value is detected for a fixed period or longer, it means the image has frozen due to some problem. BU18TM41-M detects image freezing by comparing the CRC values for each frame before and after an image in a sequence of transmitted and received data (Fig. 4).

The BU18xMxx-M series SerDes also belongs to the "FS mechanism implemented" category for ComfySIL™, indicating it is equipped with relevant safety mechanisms required by ASIL. With the frame CRC function, the series supports the introduction of various functional safety features for camera systems.

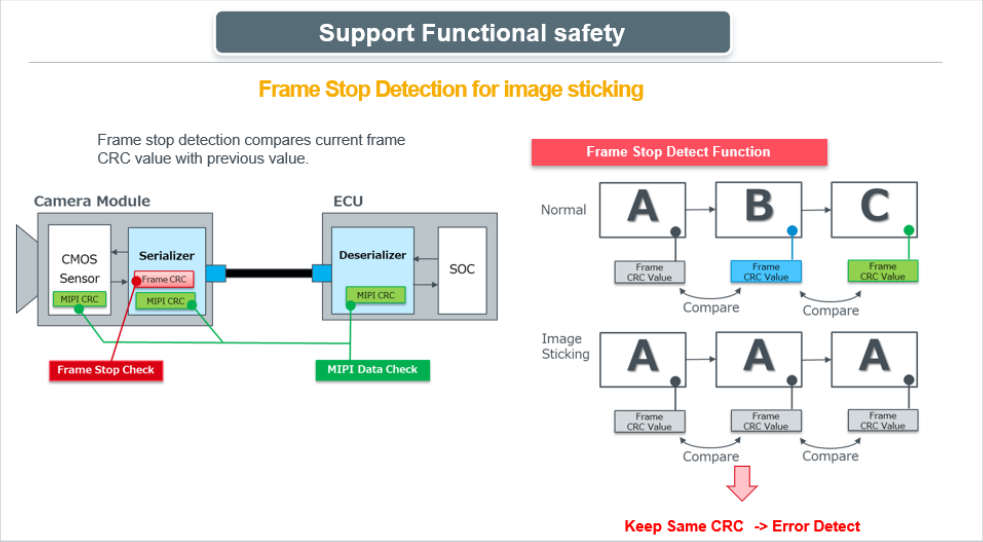

Figure 4. Detection of Image Freezing with Frame CRC of SerDes

2. Versatility

The BD868xxMUF-C PMIC incorporates a big variety of functions that simplify the design process for manufacturers. The most distinctive feature is the ability to, as described above, customize the electrical and functional PMIC behavior to the requirements of almost all CMOS image sensors using OTP memory. In short, instead of re-designing the power tree and adapting the power sequence control due to a CMOS sensor change, an updated OTP version with the same PMIC would be sufficient. Regulator output voltages, power sequencing, regulator detection and protection thresholds and failure behavior can be adapted to the updated imager. The above mentioned feature set are manifested in the BD868xxMUF-C OTP which will be programmed at the end of product testing process.

As a result, even when a change is made to the CMOS image sensor, manufacturers can handle this without altering the layout of the PCB.

In addition, BD868xxMUF-C offers a 25% reduction in its mounting area compared to conventional products. This has been achieved through the adoption of a more compact package and greater miniaturization of peripheral components enabled by the use of high frequency switching operation. As illustrated below, BD868xxMUF-C also reduces thermal issues by delivering higher efficiency during power conversion (Fig. 6). These advantages allow it to support next-generation further miniaturized camera modules.

Output	OTP setting①	OTP setting②	OTP setting③
VO1	3.7V	3.7V	3.3V
VO2	1.1V	1.1V	1.2V
VO3	1.8V	1.8V	1.8V
VO4	3.3V	3.3V	2.8V
Startup sequence	VO1->VO2->VO3->VO4	VO1->VO4->VO3->VO2	VO1->VO4->VO3->VO2
Sensor type	Sensor [A]	Sensor [B]	Sensor [C]

Figure 5. Example of Voltage/Startup Sequence Settings Enabled by OTP Memory

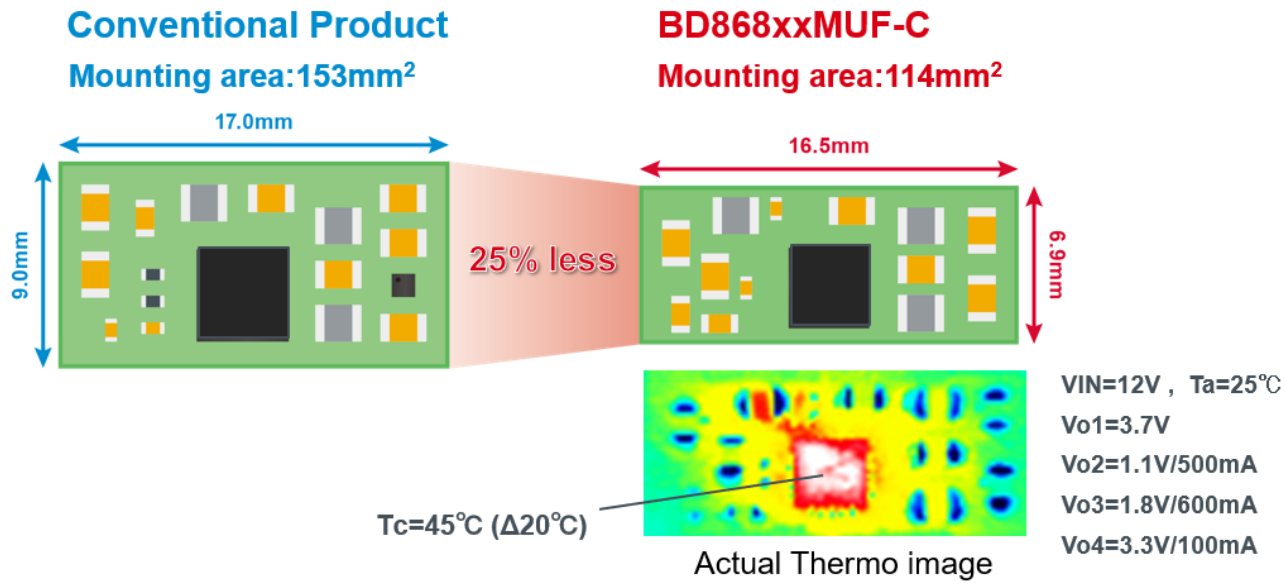

Figure 6. Mounting Area of PMIC and Heat Generation

3. Low Noise

The BD868xxMUF-C PMIC and BU18xMxx-M series SerDes incorporate several measures targeting lower electromagnetic interference (EMI), an important area in addressing the noise created by in-vehicle applications. One of such measure shared by both products is the spread spectrum clock generator (SSCG). This function reduces the intensity of noise in a specific spectrum by intentionally adding fluctuation (jitter) to the communication clock of the IC and to the switching frequency of the regulators.

The BU18xMxx-M series' serializer and deserializer are both equipped with the SSCG function, enabling them to achieve 10 dB reductions in EMI, as well as various other functions designed to lower EMI. Thanks to these features, both the BU18xMxx-M series SerDes and BD868xxMUF-C PMIC meet the class 5 standard of Limits and methods of measurement for the protection of on-board receivers (CISPR25), one of the various standards published by the International Special Committee on Radio Interference (CISPR).

In addition, the BU18xMxx-M series utilizes the variable transmission rate function introduced in Figure 3, allowing a SerDes to intentionally change individual transmission rates using very slight adjustments (0.1% steps) when multiple communication lanes exist. Similarly to the SSCG, this function delivers a 10 dB reduction in EMI (Figs. 7 and 8).

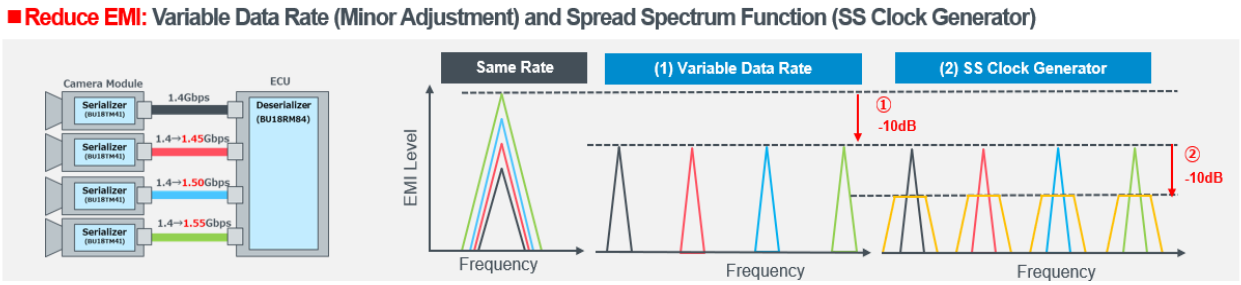

Figure 7. Noise Level Reductions Achieved by SSCG Function of SerDes and Variable Transmission Rate Function

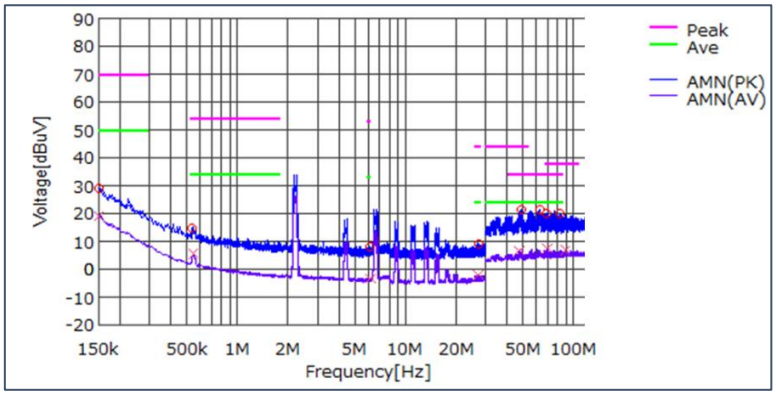

Figure 8. Measurement Results for Conducted Emissions of PMIC

4. Low Power Consumption

The BD868xxMUF-C PMIC achieves a total power conversion efficiency of 82%* for the load range required by in-vehicle camera modules. This high conversion efficiency allows the PMIC to handle both the interior and exterior temperature environments of a vehicle without problem (Fig. 9).

Additionally, the BU18xMxx-M series SerDes has the function enabling the use of variable transmission rates. With this function, the rate can be optimized according to the application, delivering reductions in power consumption of around 27% compared to standard products. These features allow manufacturers to construct a communication system that consumes the minimum power necessary (Fig. 10).

* Based on results obtained in a test environment designed by ROHM.

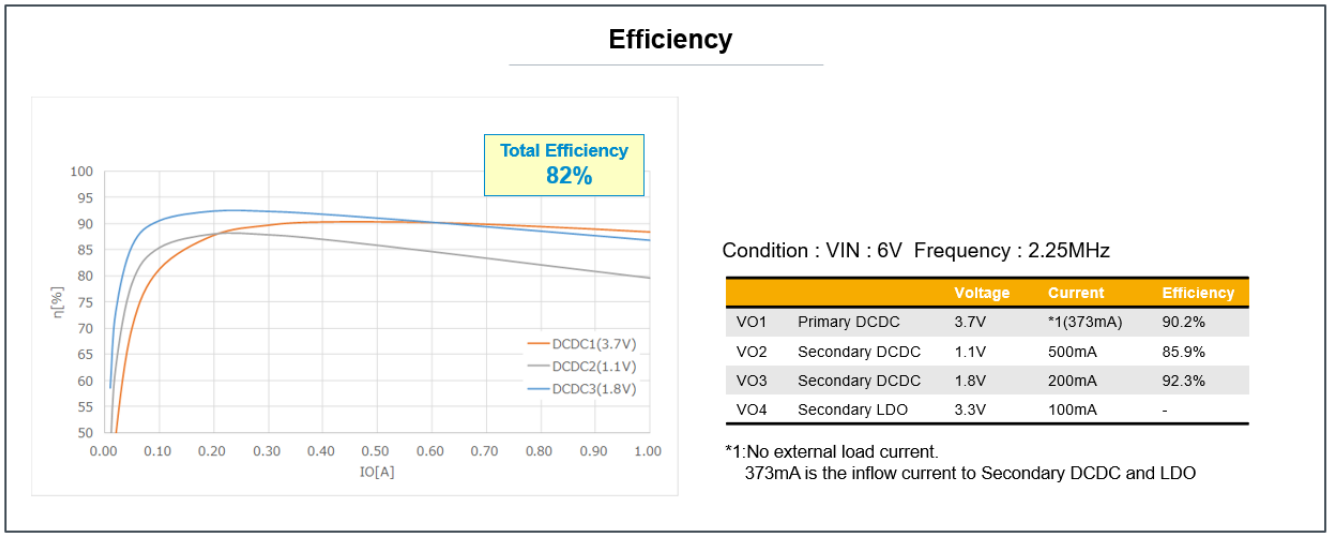

Figure 9. Power Conversion Efficiency of PMIC

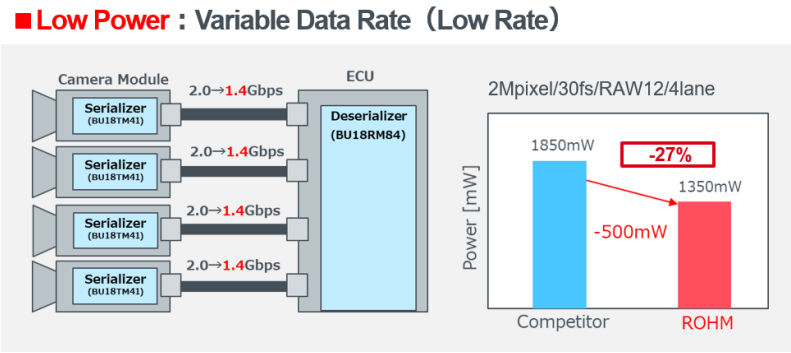

Figure 10. Variable Transmission Rate Function of SerDes

・ Summary and Future Development

ROHM has positioned the automotive field as an area of key focus and have already developed a large number of products for the ADAS market, including the PMICs and SerDes introduced in this white paper.

Going forward, we plan to target projects, supporting more advanced ADAS and autonomous driving systems. It will certainly be necessary to work on image sensors, which require improved resolution, and we are also considering the development of PMICs with additional power rails and lower output voltages as well as SerDes with even higher communication speeds.

Our overall goals remain, as ever, to deliver solutions that will help to resolve customer issues and through this, to contribute to greater safety and security in the automotive field.


ROHM
SEMICONDUCTOR
ROHM
ROHM
ComfySIL
Functional Safety

ROHM Co., Ltd.
2323 Owen Street,
Santa Clara, CA 95054 U.S.A
TEL : +1-408-720-1900
www.rohm.com