ROHM's Expanded Lineup of High Noise Tolerance EMARMOUR™ Comparators Enables to Greater Reliability and Simpler Designs in Automotive Systems

White Paper

Introduction

In recent years, the trend towards greater electrification following technical innovation in the automotive sector has dramatically increased the number of electronic components used per vehicle. At the same time, high reliability is required for mounted components to ensure vehicle safety. For example, EVs are driven by electric motors, with current to the motors supplied from the main inverter. And as the main inverter is not only responsible for converting DC into AC, but also plays a major role as a safety device to prevent motor damage, its importance in EVs cannot be understated, necessitating extremely high reliability components.

High reliability is also demanded by Engine Control Units(ECUs) as well as MCUs that act as the core for processing input from sensors and, in some cases, carry out powertrain control. In addition, in terms of safety, Advanced Driver Assistance Systems (ADAS: various systems that assist the driver such as automatic braking and cruise control) utilizing multiple sensors and MCUs are seeing greater adoption. And from the standpoint of convenience, the number of built-in functions including Bluetooth functionality, car navigation systems, and ETC also continues to rise.

But one drawback to the continuing electrification of vehicles is the increasing number of devices that generate noise, worsening the noise environment. As a result, noise countermeasures that prevent malfunctions in small-signal devices have become a major challenge. However, it is extremely difficult to perform noise evaluation of the in-vehicle (interior) electrical system alone, making it necessary to conduct testing after assembly. Consequently, at this time if the noise evaluation results in NG, the process of Design → Assembly → Evaluation must be repeated many times, significantly increasing design load.

In response, ROHM developed the EMARMOUR™ lineup featuring superior noise tolerance. The first products in this lineup, a series of op amps released in 2017, has been well-received in the automotive industry. This time we introduce the second series in the lineup - comparators developed to meet strong market demands.

Automotive noise environment

Automotive noise can come from a variety of sources (Fig. 1). These range from batteries, engines, and peripheral circuits on PCBs to motors, inverters, and switching power supplies. In addition, as communication devices such as car navigation and audio systems along with smartphones continuously emit radio waves, they are considered sources of noise. This noise can cause system malfunctions by entering the signal and/or power supply lines. It is imperative that no malfunctions occur in areas related to the basic performance of vehicles such as ‘run’, ‘turn’, and ‘stop’, so designers are required to take countermeasures against all types of noise.

Figure 1. Sources of Automotive Noise

Noise countermeasures can roughly be divided into two types. One is EMI or emission measures that suppress generated noise to prevent it from affecting other devices. The other is EMS or immunity measures intended to minimize the effects of noise generated by other devices. Designs that combine both EMI and EMS measures are referred to as EMC design or EMC countermeasures. International standards to measure noise and verify EMC countermeasures have been established by organizations such as International Electrotechnical Commission (IEC) and International Special Committee on Radio Interference (CISPR).

Relationship between automotive and comparator noise tolerance

Comparators and op amps are essential electronic components used in virtually all analog circuits, including those in automotive applications (Fig. 2). Op amps amplify signals before converting them to a voltage level the MCU can process, while comparators output a digital signal (High/Low) after performing threshold judgment of the signal. One example is ECUs that comprise the core of automotive systems, which receive information from multiple sensors (i.e. position, temperature, voltage, humidity) then use comparators to perform threshold judgment of the sensor signals. (Fig.3) The MCU needs this information to oversee and control the entire system and optimize vehicle operation. Other application examples include combining with op amps in motor control units and resistors in current detection circuits. In these cases, circuit control is achieved by first amplifying voltage converted by the current detection resistor using an op amp, then performing threshold judgment with a comparator.

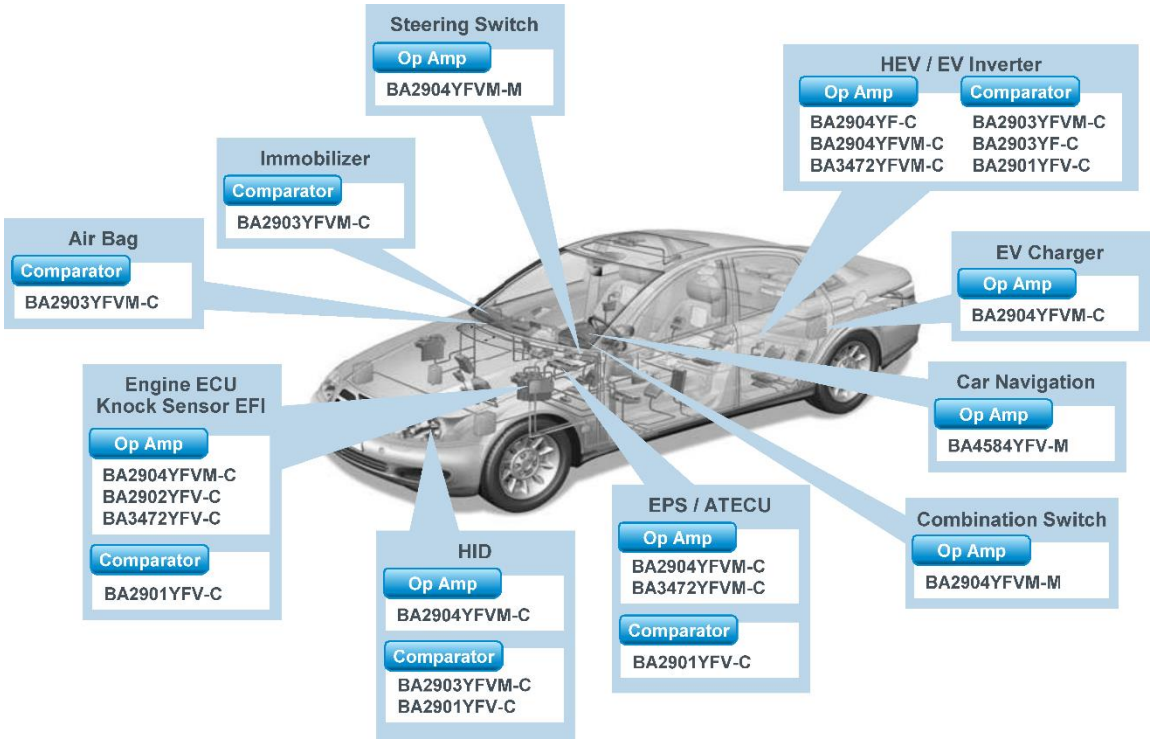

Figure 2. Application Examples of Op Amps and Comparators in Automotive Systems

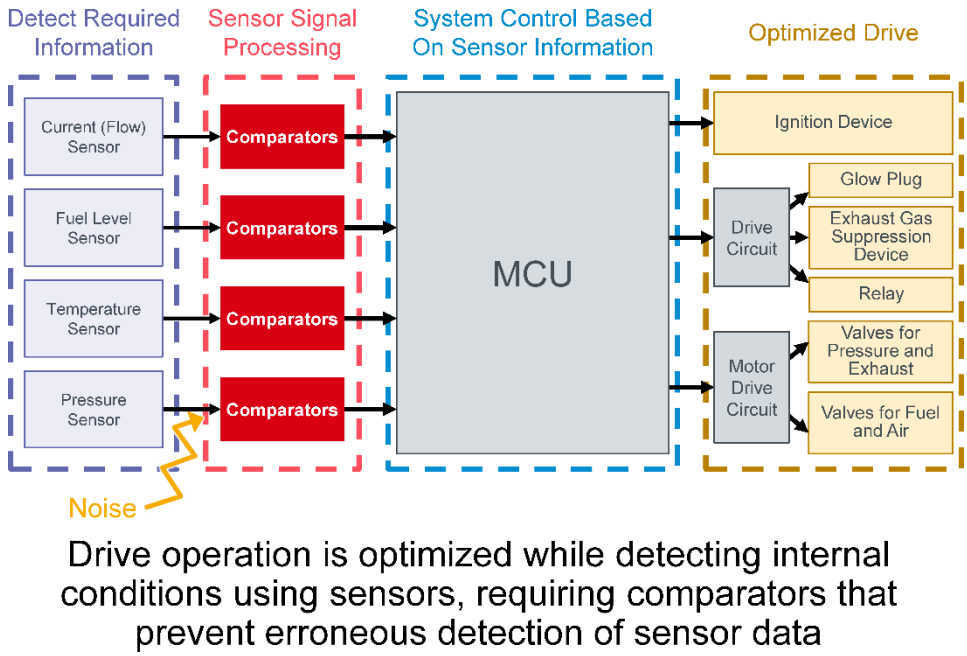

Figure 3. Comparators Used in an ECU

The main consideration for threshold judgment is the noise tolerance of the comparator itself. External noise introduced into the sensor output signal or comparator can cause erroneous judgment if the noise tolerance of the comparator is low. (Fig.4) This can lead to malfunction of the MCU and subsequently, the entire

system. On the other hand, if the noise tolerance of the comparator is high, noise can be removed and the sensor signal accurately judged and sent to the MCU, ensuring normal system operation. For this reason, highly integrated ECUs and inverters require electronic components with robust noise tolerance.

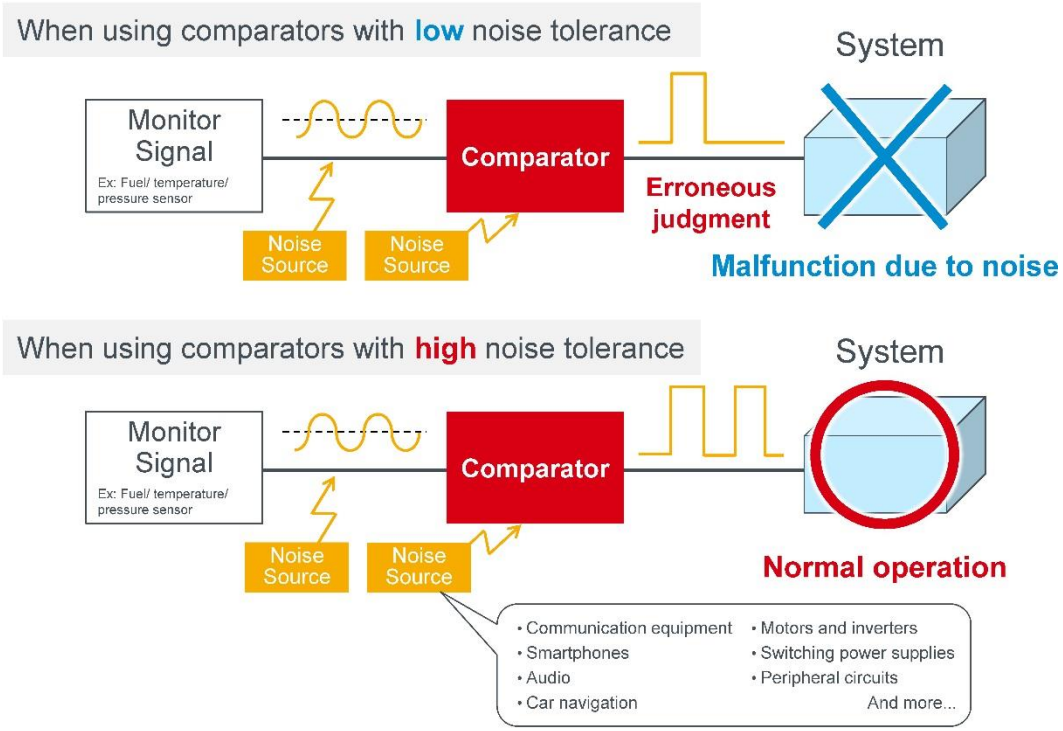

Figure 4. The Effects of Comparator Noise Tolerance on System Operation

When carrying out noise countermeasures in a comparator, not only the circuit design but the power supply and ground lines must also be considered as elements with resistance, capacitance, and inductance components. Recently, however, although the development of high performance high frequency simulators is progressing, it is still not possible to cover detailed characteristics such as process-specific parasitic capacitances and inductances, leaving it up to the knowledge, intuition and experience of the designer to determine the strength of noise tolerance. All of these factors add to the difficulty of noise design.

ROHM's EMARMOUR™ Series Achieves Breakthrough Noise Tolerance

In response to these challenges, ROHM developed the EMARMOUR™ series. EMARMOUR™ is the brand name given to ROHM products leveraging proprietary technologies covering layout, processes, and circuit design to achieve ultra-high noise tolerance that limits output fluctuation to less than ±3% across the entire noise frequency band during evaluation testing under the international ISO11452-2 standard.

As mentioned earlier, in 2017 ROHM released the first products in this lineup, a series of ground sense op amps ideal for sensor-equipped automotive systems exposed to harsh environments such as ECUs and powertrain. This same technology was applied to the BA8290xxYxx-C series of comparators. Both products under the EMARMOUR™ lineup feature improved noise tolerance by integrating an EMI filter

circuit that cuts noise over a wide frequency band along with an optimized layout (i.e. configuration of elements, power supply/ground lines) and adoption of new chip layout and bipolar processes strong against noise. (Fig. 5)

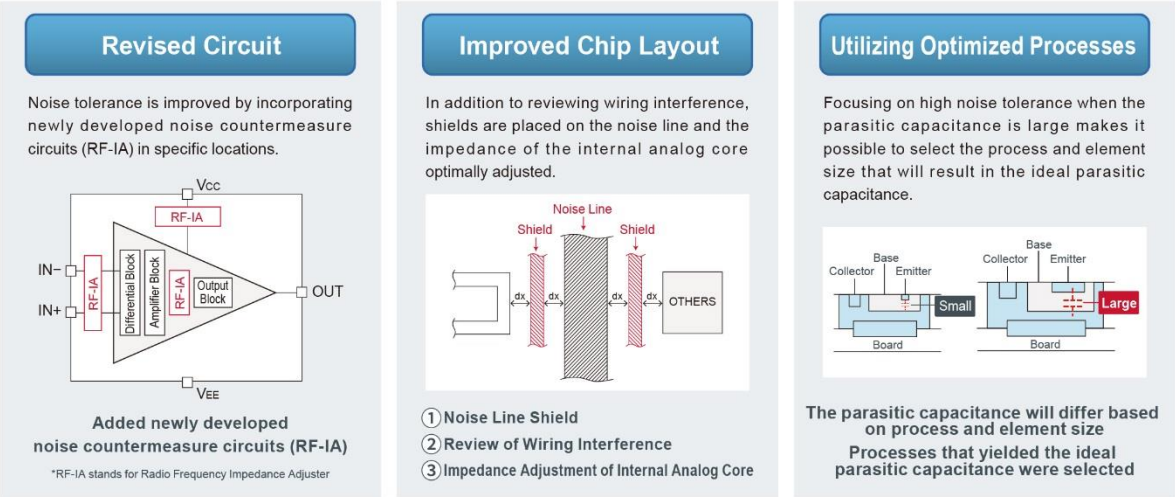

Figure 5. ROHM Utilizes Proprietary Analog Technologies to Achieve High Noise Tolerance

As a result, unlike conventional products whose output voltage fluctuation can exceed ±20% which can lead to malfunction (inverted High/Low), the BA829xYxx-C series has been proven to suppress noise to less than ±1% across the entire frequency range (200Mz to 1GHz) during evaluation testing under the automotive ISO11452-2 standard. (Fig. 6)

Conventionally, to compensate for comparator noise tolerance, it was necessary to utilize an external filter for attenuating the specific frequency band susceptible to noise along with shielding (metal plates), but these can be eliminated by providing ultra-high noise tolerance that significantly decreases the time and costs required for noise countermeasures, reducing noise design load considerably.

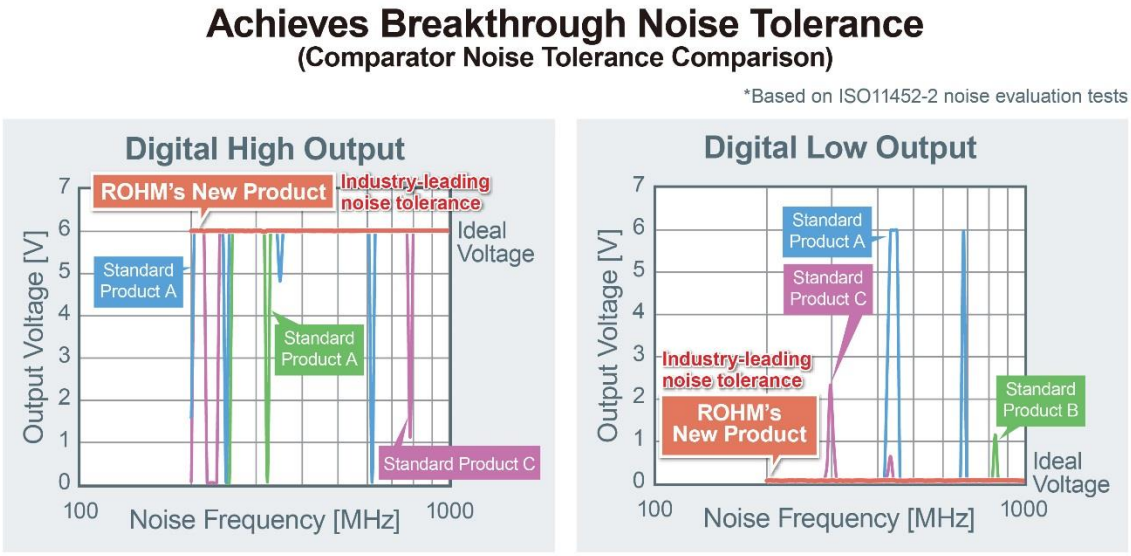

Figure 6. Noise Evaluation Comparison

What's more, the BA8290xYxx-C series is qualified under the automotive AEC-Q100 standard. And stable long-term supply is ensured while universal compatibility makes it easy to replace conventional products. A wide supply voltage range of 2.0 to 36V is also provided. Additional features include an input offset voltage of ±2mV (typ., ±5mV max.), input range between VEE and VCC-1.5V, and operating temperature range from -40°C to +125°C. Current consumption is 0.6mA for 2ch products and 0.8mA for 4ch models. These characteristics allow the BA8290xYxx-C series to meet the needs of the automotive market by delivering improved noise tolerance while maintaining conventional performance.

Future Developments

The BA8290xYxx-C series of comparators together with the high noise tolerance op amps released in 2017 are part of the EMARMOUR™ lineup that is expected to be adopted in a variety of applications where noise-induced malfunctions cannot be allowed, including automotive systems, FA (Factory Automation) equipment, industrial robots, and medical equipment.

Improved vehicle safety and convenience is accelerating the electrification and proliferation of EVs/HEVs, making EMARMOUR™ the de facto standard as noise countermeasure become increasingly important. And going forward, ROHM will continue to contribute to even simpler designs and greater reliability in automotive systems by expanding its lineup of power supply ICs (linear regulators) and high-speed op amps that leverage industry-leading noise tolerance technology.

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