

# Foundational Support for Progress in Automotive Electronic Control Releasing a String of Unique Passive Components

## Panasonic Contributes to Downsizing, Environmental Resistance, and Electromechanical Integration

The presence of Panasonic's passive components is on the rise in the electronic component market for automotive electronic control units (ECU). This is because the company's string of new products meets the future needs of ECU designers, who are faced with even more demanding requirements due to the progress in automotive electrification. Here, I'd like to introduce hybrid aluminum electrolytic capacitors, Low DCR Resistors for current sensing, automotive power inductors, and some other products that particularly attract attention, among their numerous passive components for automotive electronic control devices.

The demand for automotive ECU designs is getting more sophisticated. In addition to higher functions and performance, downsizing is required to maximize the utilization of limited space. ECU mounting methods are also diversifying with the increasingly common notion of electromechanical integration, which allows the direct attachment of ECUs to mechanical components. Panasonic is releasing passive components with unique features to meet the needs of designers encountering this situation.

Panasonic is one of few suppliers who provide numerous passive components. Furthermore, the company has several models of each device. Being able to provide combined products using these components is a significant edge. Panasonic's hybrid aluminum electrolytic capacitors, Low DCR Resistors for current sensing, and automotive power inductors indicate their excellent technologies.

### "Cherry Picking" the Advantages of Conventional Products

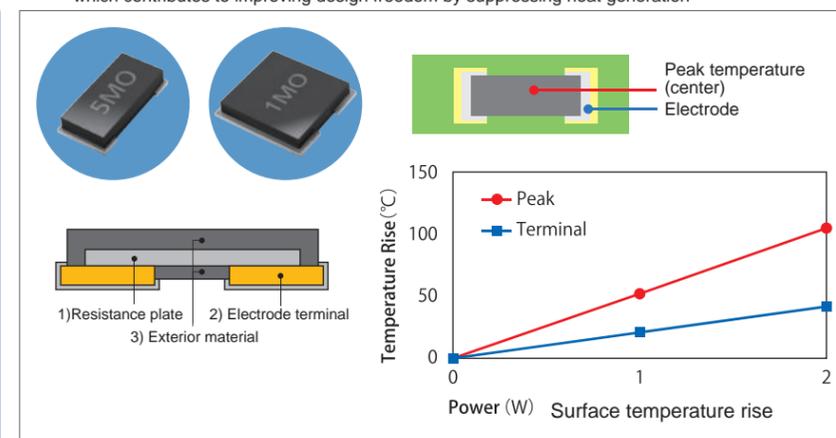
Hybrid aluminum electrolytic capacitors have advantages of coming in both liquid and solid electrolysis types (liquid and solid systems) (Fig. 1). Aluminum electrolytic capacitors have a large capacity and high voltage resistance. However, liquid system aluminum electrolytic capacitors have high equivalent series resistance (ESR) and high frequency impedance. The solid system that uses conductive polymer material as electrolyte solved this problem. Compared with the liquid system, it has lower ESR and better high frequency characteristics. Its conductivity is also more than 10,000 times higher. However, while internal failures occur in open-circuit mode in the liquid system, they can occur in short-circuit mode in the solid system.

The hybrid type has conductivity equivalent to the solid system, low ESR, and low high frequency impedance. It therefore works well on ripple management. It is also safe since failures occur in open-circuit mode. Unlike conventional aluminum electrolytic capacitors whose ESR rapidly rises at temperature below 0°C, the hybrid type's ESR remains nearly the same as a normal temperature. These characteristics are all advantageous for automotive devices that are used in various environments. It also contributes to the downsizing of ECUs because it can secure a large capacity despite its small size. Through early commercialization, Panasonic has taken the indus-

Fig. 1. Features of hybrid aluminum electrolytic capacitors

Internal structure	Liquid system	Solid system	Hybrid
	Film	Film	Film
	Organic electrolyte (liquid)	Conductive polymer (solid)	Hybrid (Liquid + Solid)
Conductivity	0.1	1,000	1,000
Safety	○	×	○
Current loss	○	×	○
Resistance (ESR)	×	○	○
Service life	○	△	○
Temperature characteristics	×	○	○
High frequency capacity	×	○	○

Fig. 2. Low resistor for current sensing (metal plate type), which contributes to improving design freedom by suppressing heat generation



try's lead in the market of hybrid-type products that offer such benefits to designers. Major electric system manufacturers have already started employing Panasonic's products.

### Low DCR Resistors for Current Sensing with Suppressed Heat Generation

Low DCR resistors for current sensing with a resistance value of 1 Ω or lower are essential devices for current sensing parts, etc. of motor control circuits, power supply control circuits, and battery control circuits. Here, the

required products need to be even smaller and with lower temperature coefficient of resistance (TCR) and resistance values. Panasonic responds to such needs with their "thick film wide terminal type", which has high solder-joint reliability using thick film resistance, and "metal plate type", which has a very low resistance value and low TCR. Of these, the metal plate type, which covers current sensing in the range of 100 A, is particularly drawing attention. Its unique metal plate joining achieves the long-term stability of the resistance value, and high heat dissipation exterior resin, adopted by taking heat dissipation into consideration, suppresses temperature rises (Fig. 2). The products alleviate heat-related restrictions, improving the design freedom of control circuits.

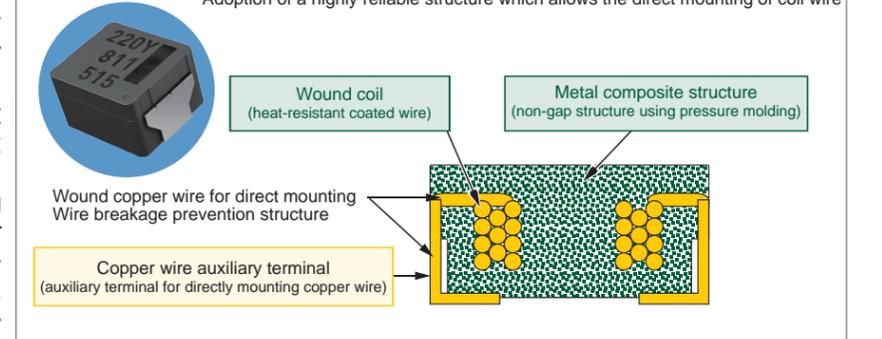
### Achieving Downsizing using Unique Materials

Power inductors for automotive applications are intended for ECU power supplies, noise filters of DC/DC converters, etc. (Fig. 3). One major characteristic is the high magnetic saturation, which is much higher than that of inductors using ferrite material, achieved by the adoption of uniquely developed metal composite material as a core material. This contributes to the downsizing of ECUs. That is, ECUs now require inductors that can handle larger currents to be compatible with, for example, faster CPUs. To be able to handle large currents, the core needs to be larger to prevent magnetic saturation. The adoption of composite material-type in place of ferrite material-type inductors can nearly eliminate the magnetic saturation characteristics and temperature dependency while maintaining the size. To put it the other way around, downsizing is also possible. In addition, the metal composite material made by mixing a binder, which uses highly thermostable silicone resin, and metal magnetic powder is highly heat-resistant, being able to maintain its quality even at temperatures over 200°C.

Another important feature of Panasonic's power inductors for automotive applications is its highly reliable structure. Both ends of a coil embedded in the core material are connected to the outside and allow direct soldering to the print substrate together with external terminals. This eliminates the welding sections in elements where wires are likely to break due to vibration.

Function and performance requirements for automotive control system such as ECUs are increasingly more sophisticated. New issues keep emerging at development sites. For designers who tackle such issues, Panasonic, who works on the advancement of basic components of control circuits such as capacitors, resistors, and inductors, must be a reliable partner.

Fig. 3. Power inductor for automotive applications that uses a metal composite having excellent magnetic saturation characteristics Adoption of a highly reliable structure which allows the direct mounting of coil wire



### Achieving Small Size and High Reliability through a Unique Electrode Formation Technology

Panasonic's automotive devices also draw attention for uses other than ECUs. Film capacitors are one example (Fig. 4). Panasonic uses very thin polypropylene film for its film capacitors for automotive applications and forms unique electrodes on their surface to achieve characteristics such as small size, light weight, large capacity, as well as long service life, high voltage resistance, high current resistance, and low ESR. These capacitors were commercialized for use in inverter circuits for motor drive, etc., and have been adopted in many electric vehicles (EV) and hybrid vehicles (HEV) since 2003. Their high voltage resistance and current resistance characteristics are also especially suitable for inverter circuits in trains, power generation / storage PCS, UPS, and industrial drive power sources. Panasonic intends to further improve their characteristics including the

Fig. 4. Film capacitor for automotive applications



small size, light weight, high voltage resistance, and high current resistance and at the same time launch factory production in China to strengthen support for global customers.