



Murata's Multilayer Power Coils Extend Battery Life of Mobile Devices

Remarkable progress has been made lately on mobile equipment and various products like mobile phones, smart phones, digital cameras and mobile audio equipment are being commercially developed in the market. As these products have built-in power supply, their portability increases. It is quite clear, however, that the duration of continuous operation of their power supply will significantly affect the ease of use of these products.

One possible and favorable way to extend the continuous operation is to increase the battery capacity while reducing the power consumption of the product itself. Therefore, various designs have been introduced for reducing power consumption.

One recently applied technique is changing the voltage conversion method of power supply to reduce power losses. Today's trend is to replace the series power supply, which has poor power conversion efficiency, with a switching type power supply, which on the other hand has superior power conversion efficiency.

Using a switching type DC/DC converter can significantly improve the power supply conversion efficiency. To realize a power supply with even higher efficiency, it is necessary to focus on the performance of devices that are used to con-

figure a power supply circuit. For example, a chopper type switching power supply uses a voltage conversion coil, and its power supply efficiency varies depending on the performance of this coil.

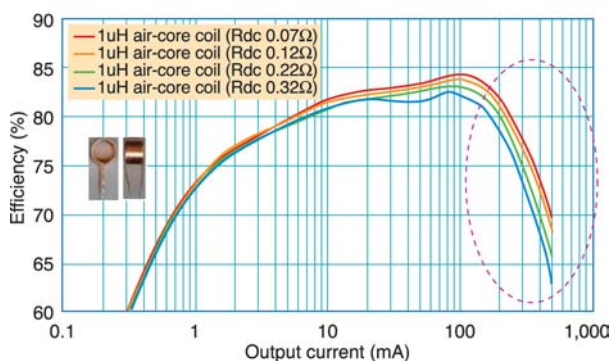
In relation to this, Murata Manufacturing Co., Ltd. recently commercialized a power coil that contributes in achieving high power supply conversion efficiency.

Reducing Power Loss From Coil

One possible solution in improving the power supply conversion efficiency is reducing the power losses attributed to coils. These losses are due to the direct current (DC) resistance of a coil or to the high-frequency losses like iron loss or eddy current loss under high frequencies.

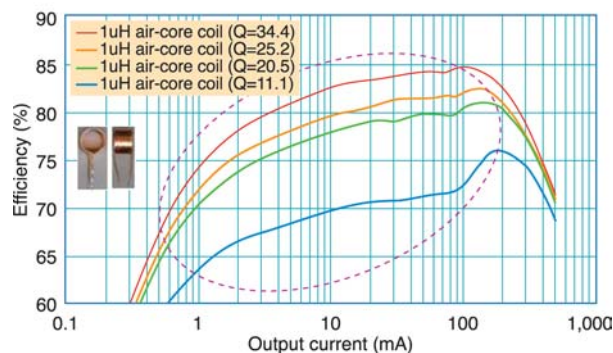
Fig. 1 shows how the power supply conversion efficiency changes by connecting fixed resistors in series with air core coils of the same configuration and inductance, and using different DC resistance values for the power supply. A study on the elements that affect power supply conversion efficiency shows that the efficiency improves when a high load is applied as the DC resistance decreases.

On the other hand, Fig. 2 shows the effect of core losses by connecting fixed resistors in parallel with the coil and simulating changes in the high-frequency loss (Q) of the coil. This study also shows that the efficiency improves when a low load is applied as Q of the coil increases. Based on these studies, the DC resistance of a coil affects the power supply conversion efficiency during high load, while the Q of a coil affects the power supply conver-



The effect of Rdc (DC resistance) on efficiency is larger in the high output current region.

Fig. 1: Effect of DC resistance



The effect of core loss on efficiency is larger in the low output current region.

Fig. 2: Effect of core loss

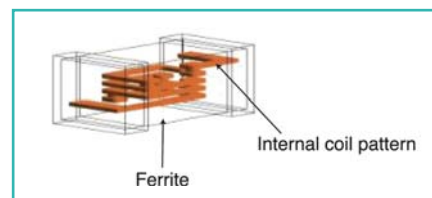


Fig. 3: Internal structure of multilayer coil

sion efficiency during low load. Therefore, both DC resistance and high-frequency losses of the coil must be reduced in order to improve the coil characteristics during low load and also during high load.

What is necessary to develop a coil with reduced losses? Fig. 3 shows an example of a multilayer coil structure. A multilayer coil is constructed using laminated ferrite sheets that contain coil patterns inside. To reduce the DC resistance of the coil, the cross-sectional area of an internal conductor must be made larger. In the case of a multilayer coil, the internal conductor must be either wider or thicker to reduce DC resistance. When the internal conductor becomes thicker, it will affect the sheet lamination and an advanced manufacturing technology is required for this task. On the other hand, to reduce the high-frequency losses, it is necessary to reduce the hysteresis loss produced by the ferrite portion and eddy current loss produced by the electrodes. Because the entire circumference of the multilayer coil is sur-

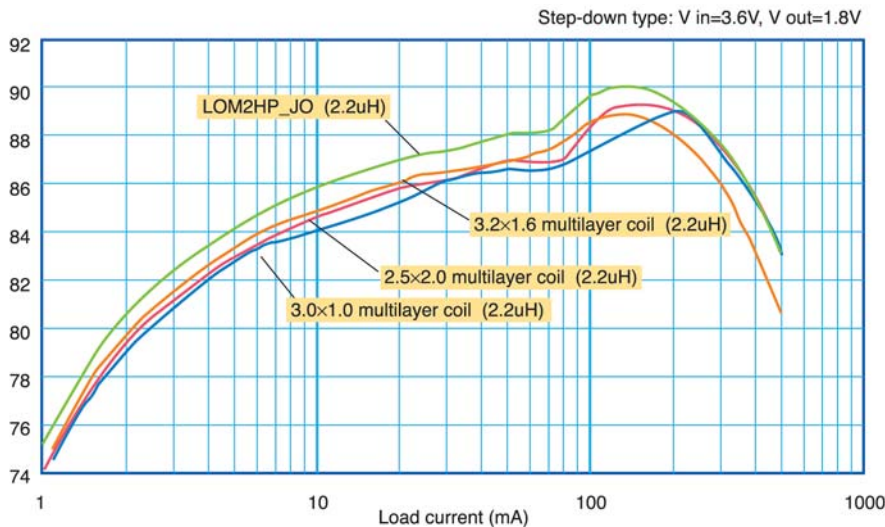


Fig. 4: Differences in power supply conversion efficiency depending on the coils used

Table 1: New lineup of monolithic type power supply power coils

Picture	Series name	LW size typ. (mm)	Height Max. (mm)	Inductance (uH)	Rated current (A)	DC resistance typ. (ohm)
	LQM31P_OO	3.2x1.6 (EIA1206)	0.95	0.47-4.7	1.2 @1.0uH	0.12 @1.0uH
	LQM31P_CO	3.2x1.6 (EIA1206)	0.55	0.47-2.2	1.1 @1.0uH	0.14 @1.0uH
	LQM2HP_JO	2.5x2.0 (EIA1008)	1.2	1.0-3.3	1.5 @1.0uH	0.09 @1.0uH
	LQM21P_CO	2.0x1.25 (EIA0805)	0.55	0.47-2.2	0.8 @1.0uH	0.19 @1.0uH

rounded by ferrite, the magnetic flux density in ferrite becomes high, which makes it difficult to reduce losses. Therefore, it has been conventionally difficult to reduce losses in multilayer coils, which led to the common belief that multilayer coils are unsuitable for use as voltage conversion coils.

Copes With Large Current, Suits Low Profile

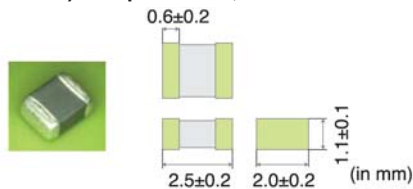
Multilayer coils are thought to be unsuitable for voltage conversion applications. On the contrary, but there are many advantages like their suitability for down scaling as well as low cost. For this rea-

son, there have been efforts to resolve the shortcomings of multilayer coils.

Under these circumstances, Murata Manufacturing has developed a technology to laminate a thick internal coil pattern with high precision. Also it came up with a technology to prevent an excess increase in magnetic flux density by optimizing the magnetic flux distribution in ferrite in order to use multilayer coils for power supply conversion. Consequently, Murata has introduced in the market, the LQM21P, LQM2HP, and LQM31P series monolithic type chip coils for voltage conversion.

Among these products, the LQM2HP_J0 series uses a number of cutting-edge technologies, including the technology to reduce the losses on power coils. Thus, the LQM2HP_J0 series has the specifications to cope with a large current of up to 1.5A, in the case of the 1uH model, despite its small size measuring 2.5 x 2.0mm. It also offers a low DC resistance and high-Q coil, which can be used to configure a

Table 2: 2520 (EIA1008) size power coil, LQM2HP_J0 Series



Part Number	Inductance (uH)	Inductance measurement frequency (MHz)	Rated current (mA)	DC resistance (Ω)
LQM2HPN1R0MJ0	1.0±20%		1,500	0.09±25%
LQM2HPN2R2MJ0	2.2±20%	MHz	1,000	0.13±25%
LQM2HPN3R3MJ0	3.3±20%		1,000	0.12±25%

high-efficiency power supply. Fig. 4 shows examples of using various coils for the power supply IC. This graph indicates that when the LQM2HP_J0 series coil is used, a high-efficiency power supply conversion is achieved during both low and high loads.

Table 1 gives the list of monolithic type power coils for power supply conversion manufactured by Murata Manufacturing. The company offers a wide range of monolithic power coils from the 2012 (EIA0805) size to the 3216 (EIA1206) size that can be selected in accordance with the allowable dimensions, required allowable current and inductance.

One of the major features of these monolithic power coils is that they are available in many low-profile models with heights of under 1.0mm. The shortest product is about 0.55mm in height. Murata has the most suitable products to meet the latest requirements in a market that demands low-profile devices.

Contributes to Power Supply Efficiency

One of the most important factors regarding the performance of mobile equipment is the length of continuous operation of the power supply. The coils used in switching type power supplies are a key component that has a significant effect on battery life.

The LQM2HP_J0 series has been developed by considerably improving the DC resistance and magnetic losses, which are the drawbacks of conventional multilayer coils. This series is a small size power coil that can contribute to improving power supply efficiency at both high and low loads.

Murata also has expanded its lineup of monolithic power coils besides the LQM2HP_J0 series to enable a wider selection of products to meet equipment requirements. Murata intends to provide a product lineup that takes maximum advantage of both wire-wound and monolithic power coils focusing on low-profile models that are most suitable for today's mobile equipment.

Murata hopes that its products can contribute to making better mobile equipment in the future.

About This Article:

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