Fujitsu’s High-Efficiency Power Management ICs Improve the Global Environment

This article discusses how the “MB39C308,” a new category of system power management LSIs that Fujitsu has developed and provides, has achieved miniaturization and efficiency improvement.

Introduction

There are two aspects to the “environmental friendliness” of ICs. The first is to either not contain any chemical substances that are hazardous to the environment or to reduce the amount of such substances. The second is to provide the public with ICs that effectively reduce the power consumption of devices so as to lower the amount of CO₂ generated by power plants, thereby lessening global warming.

Developing and providing ICs for small devices also involves promoting the miniaturization and power consumption reduction of devices and contributing to energy saving.

In the PC field, UMPC (Ultra Mobile PC), a new category of mobile devices that were smaller than conventional ones, was proposed about three years ago. Fujitsu has developed and has been providing a new category of system power management LSI (MB39C308) based on LPIA (Low-Power Intel Architecture) proposed by Intel as the low power consumption platform for UMPCs. We are currently providing it for PCs in the category of even smaller MID (Mobile Internet Device).

In the UMPC and MID PC categories that utilize MB39C308, significantly smaller sizes than conventional Notebook PCs, such as those that fit in the palm of your hand, are assumed. As such, ultrasmall, high-efficiency, and high-performance power management systems are required to enable a long battery operation period. This article discusses how MB39C308 has realized miniaturization and high efficiency.

Miniaturization Efforts

6 channels of DC/DC converters necessary for the Intel UMPC chipset, DDR memory, and peripherals (applications such as wireless LAN) are monolithically integrated (Figure 1). FETs for power supply rails that the load currents have been pre-determined such as chipset and memory rails are integrated to reduce the chip size.

In addition, flexibility in current capacity has been increased for power management systems in which the specification may change with the set (such as external systems) by specifying the external connection to switching FET.

The DC/DC converter power management size must take into consideration the peripheral parts. The major peripheral parts that occupy large areas are the coil and capacitor. Their

Photo 1 0.5mm ball pitch, 208-pin “MB39C308” using plastic BGA
sizes are, in general, inversely proportional to the switching frequency of the DC/DC converter. Therefore, the switching frequency must be increased to realize miniaturization. There is a problem of increased switching loss (the energy required for turning ON/OFF) for the switching FET, which leads to reduced efficiency when the switching frequency is increased. MB39C308 specifies a frequency of 700kHz as optimal for balancing these factors. It was possible to realize both a reduction of external parts and miniaturization by integrating the resistor/capacitance filter of the feedback system, thanks to the large gain/phase margin in feedback loop achieved by the adoption of current mode as the DC/DC converter control method.

A 0.5mm ball pitch, 208-pin plastic BGA package was adopted for miniaturization (9mm×9mm) and the central thermal balls (52) enabled low thermal resistance (34°C/W) (Photo 1).

As a result of the aforementioned measures, the package area of 555mm² (4-layer board) is possible. It can thus construct a power management system that is one-third or smaller in size than the conventional products of other manufacturers (Figure 2).

**Efforts to Achieve High Performance and High Efficiency**

As the target devices for this product are further miniaturized compared to conventional Notebook PCs with 3 to 4 series of lithium ion batteries, their specification comprises 2 series of lithium ion batteries. The input voltage range is therefore 5.5V to 12.6V, which increases the input/output voltage ratio when output voltage is close to 1.0V. Based on the earlier standpoint of miniaturization, the switching frequency needs to be increased. However, the switching FET on-duty is reduced when the input/output voltage ratio is large. To address both issues, the ON time must be minimized. As such, we enabled high-speed and high-efficiency switching even under large current operation of 1.5A to 3.5A by adopting LDMOS (Lateral Double Diffusion MOS) with low ON resistance and small gate input capacity for the power management of memories and chip set systems requiring low output voltage and realized a high-speed response property with current mode.

In addition, high efficiency was achieved by adopting the synchronous rectification method for all 6 channels of DC/DC converter. Both high-side and low-side switching FETs were operated with N-channel LDMOS to achieve extremely short ON time as well as high efficiency.

Figure 3 presents the conversion efficiency properties against the input voltage. Efficiency of 93% has been realized in the standard current area.
As part of the comprehensive safety design of the power management system, we have included a built-in function to enable output voltage startup and shutdown with no output current dependency by the soft-start/-stop method; various protective functions including undervoltage lockout, overcurrent protection, output overvoltage protection, over-temperature protection, short-circuit protection, and input overvoltage protection; and a POWERGOOD function to ensure that the output voltage is in the proper range.

**Figure 3** Conversion Efficiency Properties

*Conversion efficiency—input voltage properties*

- **Condition:** \( V_{IN} = 7.2\, \text{V (Typ.)}, \, V_{O1} = 5.0\, \text{V}, \, V_{O2} = 3.3\, \text{V}, \, V_{O3} = 1.8\, \text{V}, \, V_{O4} = 0.9\, \text{V}, \, V_{O5} = 1.5\, \text{V}, \, V_{O6} = 1.05\, \text{V}, \, f_{osc} = 700\, \text{kHz} \)