Power Supply IC for Low Power AC Adapters

Yasushi Katayama

1. Introduction

The AC adapter is a kind of AC-to-DC converter and is mostly used for supplying power to portable electronics equipment or for charging batteries. Required features of the AC adapter have been small size, light weight and low price. Recently, however, low standby power has also come to be required due to the trend toward energy saving in response to global environmental problems.

To satisfy such requirements for the AC adapter, Fuji Electric developed and produced a power IC (integrated circuit) for switch-mode power supply control. The IC integrates a PWM (pulse width modulation) control circuit containing high accuracy analog CMOS (complementary metal oxide semiconductor) devices with a 700 V power MOSFET (metal oxide semiconductor field effect transistor). This construction achieves small-sized and low priced AC adapters with low power dissipation and high reliability.

This paper presents an overview of the "FA5702P" power IC for switch-mode power supply control, developed for application to 5 W-class low-power AC adapters.

2. Characteristics

Figure 1 shows a block diagram of the FA5702P and Table 1 shows its primary electrical characteristics.

For decreasing standby power consumption of the AC adapter, reduction of the power dissipation of its control circuit is a crucial issue. The FA5702P has achieved a low supply current of 200 μA at MOSFET switching due to significantly reduced current consumption and optimized configuration of the circuit.

Primary advantages of the FA5702P are as follows:

(1) A power MOSFET and its control circuit are integrated into a single chip.

(2) A low supply current of 200 μA at MOSFET switching is achieved with a newly designed control circuit.

(3) The supply current for the internal circuit is fed from the rectified AC input directly. A bootstrap circuit, consisting of a transformer auxiliary winding, diodes, and capacitors, becomes unnecessary for supplying power to the IC, and thus the circuit configuration of the AC adapter can be simplified.

(4) The IC accommodates input from any universal AC power supply ranging from 100 V to 240 V, since the supply voltage is 500 V maximum and the breakdown voltage of the power MOSFET is 700 V maximum.

(5) Peak current mode PWM control is utilized, which is superior in stability and frequency response and suppresses the generation of audible transformer

Fig.1 Block diagram

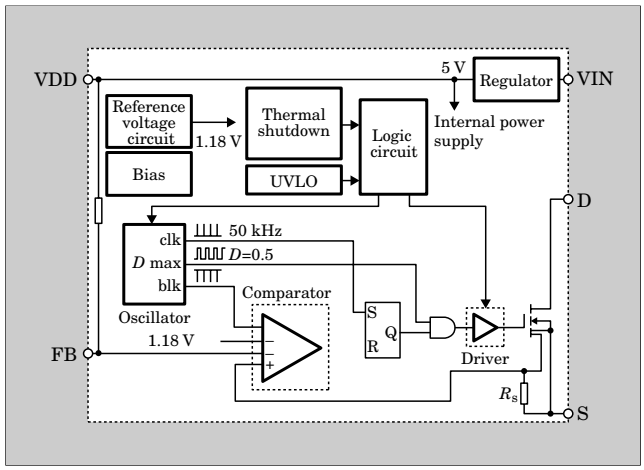


Table 1 Primary electrical characteristics

Item		Characteristic
Power MOSFET	Breakdown voltage	700 V (Minimum)
	On-resistance	20 Ω (Typical)
Control circuit	Supply voltage	500 V (Maximum)
	VDD terminal voltage	5 V (Typical)
	Oscillator frequency	50 kHz (Typical)
	Maximum duty cycle	50 % (Typical)
	Current limit	350 mA (Typical)
	Supply current at MOSFET switching	200 μA (Typical)
	Supply current at latched off	60 μA (Typical)

noise under light load conditions.

(6) It contains internal protection functions such as overcurrent limiting, thermal shutdown, and undervoltage lockout (UVLO).

Figure 2 shows a top view of the FA5702P chip and Fig. 3 shows external views of the IC packages.

In Fig. 2, the 700 V power MOSFET is shown in the upper half of the figure and the control circuit is shown in the lower half. The IC is constructed with a standard DIP (dual in-line package).

Fig.2 Top view of FA5702P chip

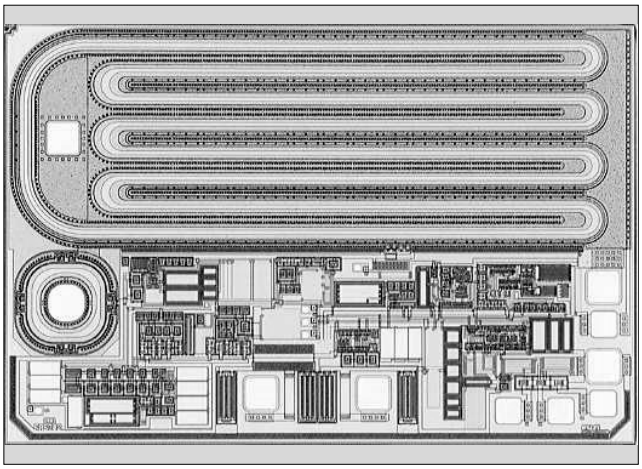
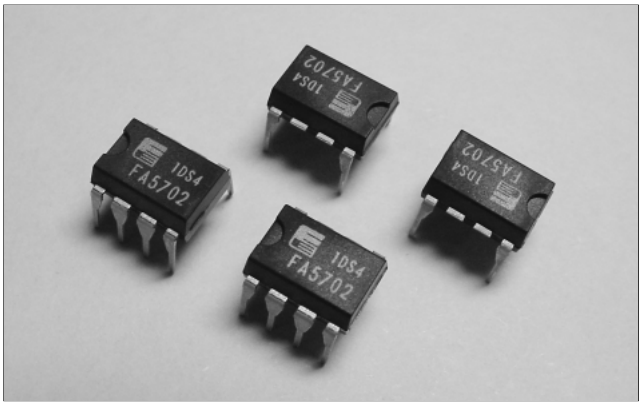


Fig.3 External view of FA5702P packages



3. Example of Application Circuit

Figure 4 illustrates an example of an AC adapter circuit that utilizes the FA5702P chip. The circuit is configured as a flyback converter, which is used in most low-power AC adapters, and the input range is from 90 V to 264 V AC and the output is 5.8 V/800 mA DC .

The FA5702P contains an internal power MOSFET for the main switch, and the FA5702P can be directly powered from the rectified AC input as shown in Fig. 4. Therefore, in contrast to the usual ICs for switch-mode power supply control which require the use of additional power MOSFETs and bootstrap and startup circuits consisting of a transformer auxiliary winding, diodes, and capacitors, the FA5702P eliminates the need for those additional components. This allows an AC adapter that uses the FA5702P to be configured with

Fig.5 Waveforms at rated output

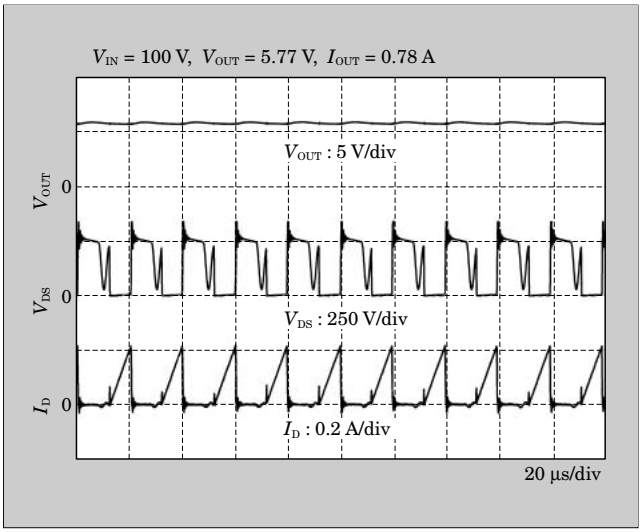


Fig.4 Example of application circuit

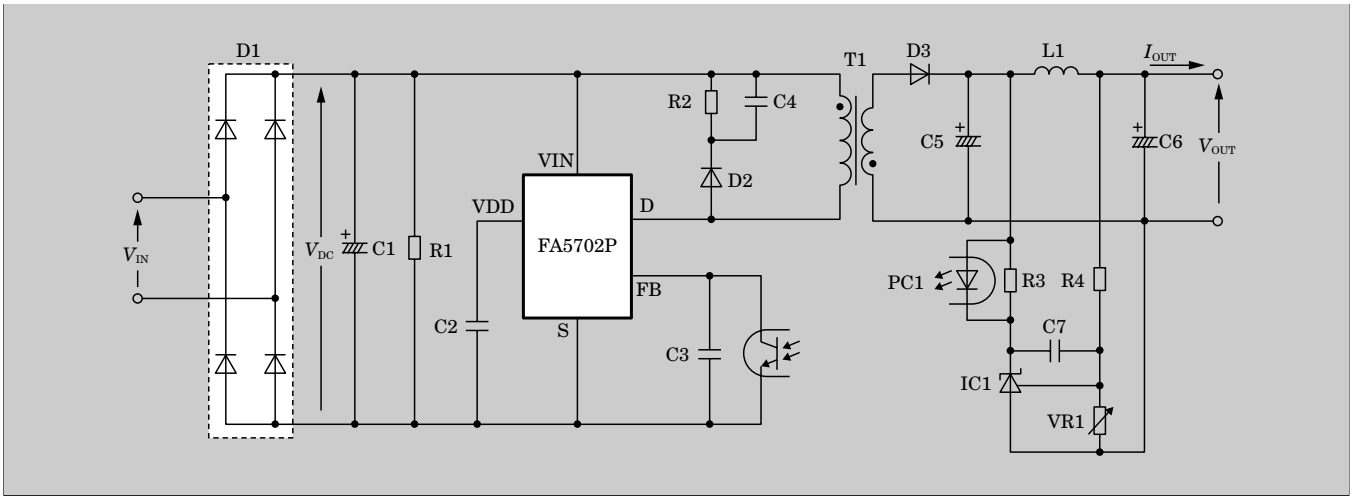


Fig.6 Waveforms at no load

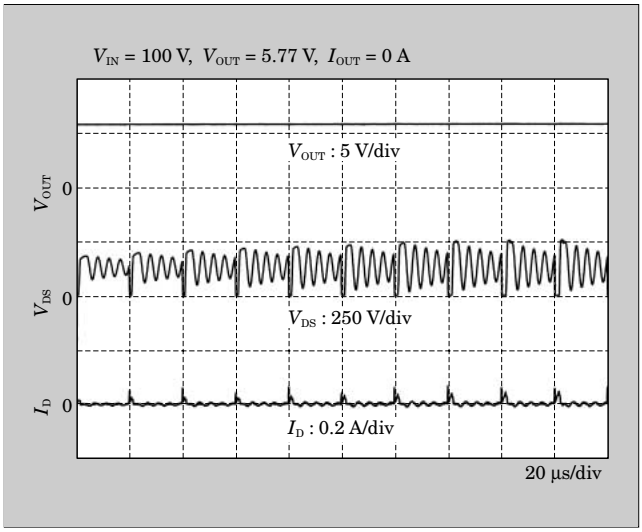
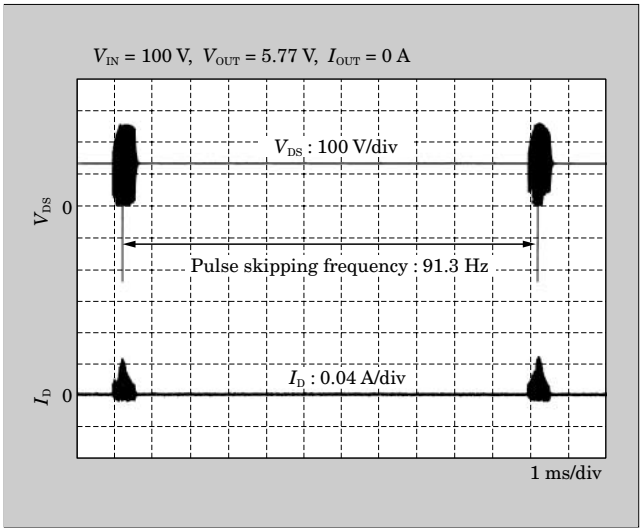


Fig.7 Pulse skipping operation at no load



fewer components than in the case when conventional type ICs are used.

Figure 5 shows electrical waveforms of the operation of this circuit at the rated output. As can be seen, the circuit operates stably while regulating the output voltage with PWM control.

Figures 6 and 7 show electrical waveforms of the operation of this circuit under the condition of no load. In this condition, the circuit status shifts to pulse skipping operation, as shown in the figures. At that time, the pulse skipping frequency has decreased to an audible frequency level. The FA5702, however, generates no audible noise from the transformer core. This is because the IC controls the peak current at a low level with the current mode PWM control and thus the variation in the magnetic flux density excited in the core is also suppressed.

Figures 8 and 9 respectively show the efficiency and the total loss measured in the application circuit

Fig.8 Efficiency in application circuit

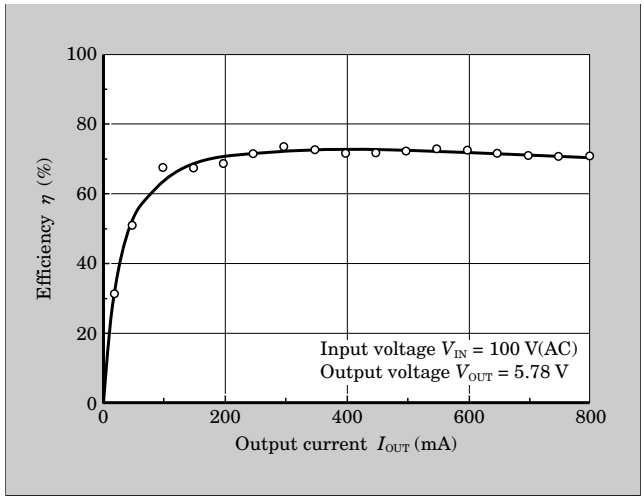
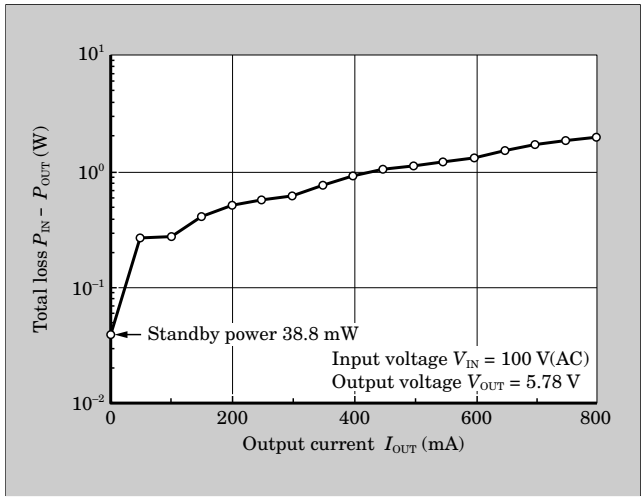


Fig.9 Total loss in application circuit



in Fig. 4. The selection of components in the transformer and feedback circuit greatly effects the efficiency and total loss of the circuit, but this circuit has achieved low standby power of 38.8 mW.

4. Conclusion

This paper has introduced an overview of the FA5702P power IC for switch-mode power supply control, developed for the application to 5 W-class low-power AC adapters.

This IC contains an internal power MOSFET and has the advantage of low current consumption. Therefore, it helps to reduce the standby power consumption of AC adapters and the number of their circuit components.

Fuji Electric will respond further to market needs by expanding the product line of power ICs for switch-mode power supply control to provide devices suitable for application to a variety of applications and output requirements.