PWM Power Supply Control IC "FA8B00 Series" Capable of Handling Peak Loads

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ABSTRACT

In recent years, the notebook computer and inkjet printer market requires increasing the maximum output power for new CPUs and motor drive loads. To meet these requirements, Fuji Electric has developed the "FA8B00 Series" of pulse width modulation (PWM) power supply control IC capable of handling Peak loads. This IC can increase the switching frequency up to 130 kHz in accordance with rise in FB terminal voltage, allowing it to increase the maximum output power of a power supply without increasing the volume of a transformer. Furthermore, the IC comes equipped with an expansion function for switching frequency jitter that enables it to achieve low EMI noise characteristics even against varying loads.

1. Introduction

In recent years, it has become increasingly important to work toward the creation of a low-carbon society in order to mitigate the severity of global warming. There is currently a need for the various electronic equipment that support our modern society to operate at high efficiency, low standby power and low noise levels from the view point of increased energy savings and electromagnetic compatibility (EMC). Fuji Electric has been working to meet these social needs by developing and releasing into the market a number of high efficiency current-mode power supply control ICs that come equipped with built-in low standby power functions. At the same time, the notebook computer and inkjet printer industries have been requiring a peak power output capable of corresponding to new CPUs and motor drive loads.

Fuji Electric has developed the peak-power compatible "FA8B00 Series" pulse width modulation (PWM) power supply control IC as a current-mode PWM control IC capable of meeting these social and industrial needs.

2. Product Overview

Figure 1 shows the external appearance of the FA8B00 Series. This IC is characterized by a 3-stage switching frequency that is compatible with the peak loads of power supplies, and it has made it possible to increase the maximum output power without changing the size of power supply components. Moreover, it ensures power supply safety because it comes equipped with various protective functions optimized for power supply systems. Furthermore, the IC has an expansion function for switching frequency jitter*1 that enables it to achieve low electro-magnetic interference

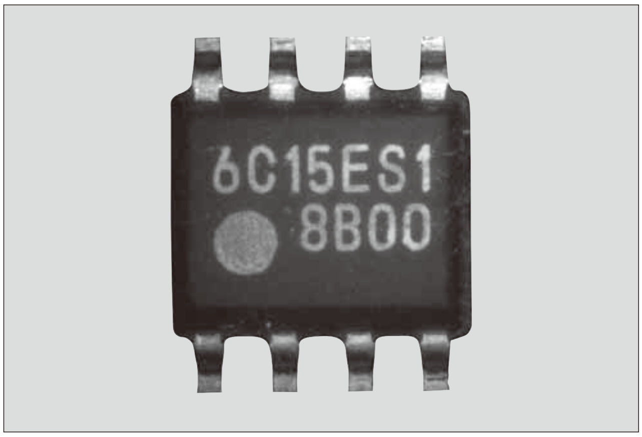

Fig. 1 "FA8B00 Series"

Table 1 Function overview of "FA8B00 Series"

Item	FA8B00 Series		FA8A00 Series (conventional model)	
Switching frequency characteristics	3-stage frequency characteristics (25 kHz - 65 kHz - 130 kHz)		2-stage frequency characteristics (25 kHz - 65 kHz)	
OCP line correction	±3.7%		±6.5%	
IC output voltage	With output voltage clamp		Without output voltage clamp	
Switching frequency jitter	With expansion function		Fixed	
Standby power	25.7 mW		29.0 mW	
Power supply average efficiency	90.0% (V_i = 115V AC)	90.7% (V_i = 230V AC)	89.7% (V_i = 115V AC)	90.5% (V_i = 230V AC)

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*1: Switching frequency jitter: It refers to an IC function for reducing EMI noise, especially conduction noise, by changing the switching frequency via a fixed interval and width.

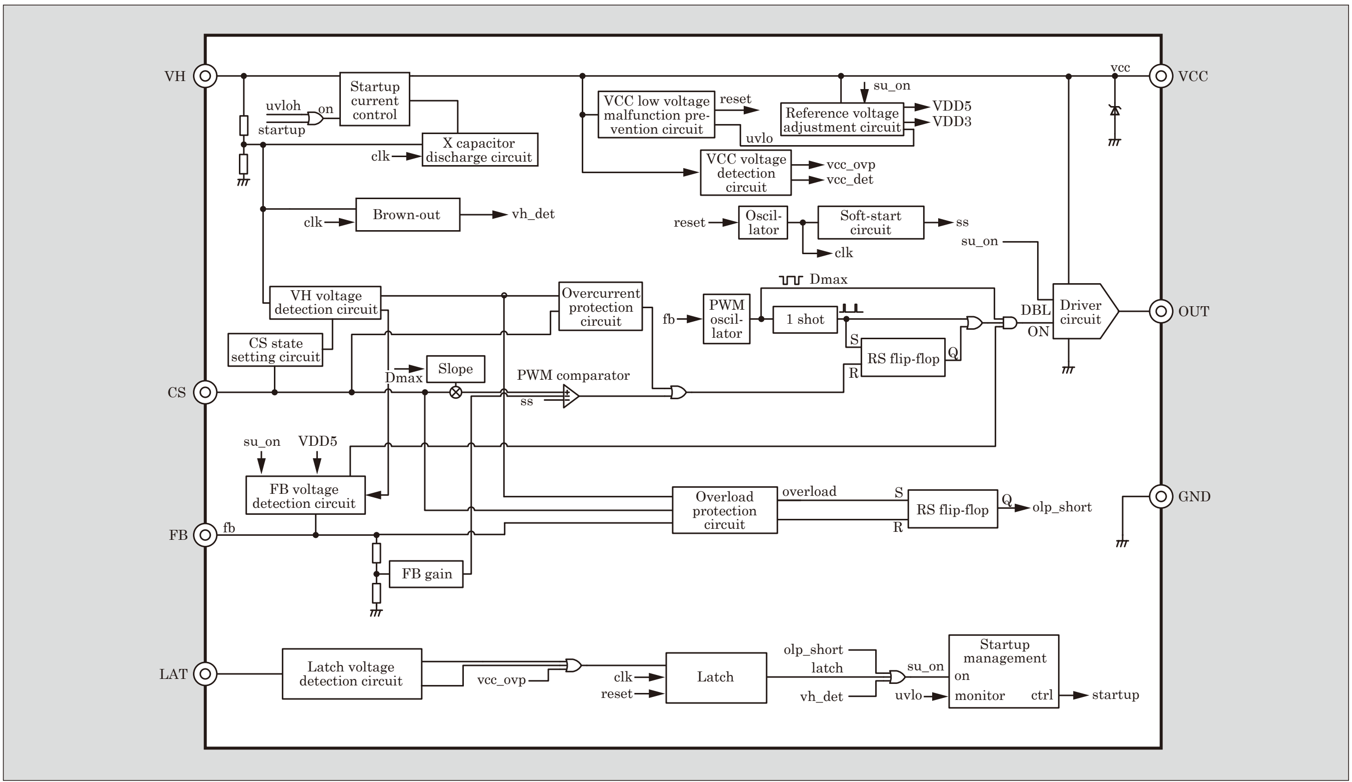

Fig. 2 Block diagram of "FA8B00 Series"

(EMI) noise characteristics even against fluctuating loads.

Table 1 provides a function overview of the FA8B00 Series, and Fig. 2 shows the block diagram.

3. Main Features

3.1 Switching frequency characteristics compatible with peak loads

The FA8B00 Series comes equipped with a new 3-stage switching frequency characteristic (25 kHz to 65 kHz to 130 kHz) that is compatible with the-peak loads of power supplies, and in accordance with increasing FB terminal voltage, switching frequency has also been increased to a maximum of 130 kHz (see Fig. 3). Since conventional models of the "FA8A00 Series" could only support a switching frequency up to 65 kHz, a larger-volume transformer was needed to obtain a larger maximum output, and this resulted in extra costs. In contrast, the FA8B00 Series is capable of providing higher switching frequencies, and it can increase maximum output without needing to change the volume of the transformer.

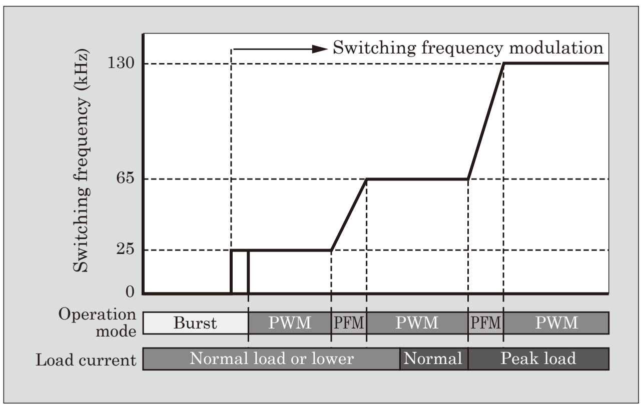

Fig. 3 3-stage switching frequency characteristics

3.2 High-precision OCP line correction

The output current during overload has the property that it increases in proportion to AC input voltage. As a result, power supply has a large difference in the detecting current of over load between low input voltage (approximately 100 V AC) and high input voltage (approximately 230 V AC). The conventional model came built-in with an over current protection (OCP) line correction function for adjusting the threshold voltage of the CS terminal changed by the AC input voltage, allowing it to reduce the output current fluctuation width to ±6.5% during overload within an AC input voltage range of 90 to 265 V.

The FA8B00 Series is designed to achieve high-precision control so that this function has more flat characteristics versus AC input voltage. Figure 4 shows a comparison with the conventional model regarding output current during overload. The FA8B00 Series has reduced the output current fluctuation width to ±3.7%. In addition, it is enabled to select between 3 correction levels (Weak, Middle, Strong) for OCP line correction, thus improving design flexibility.

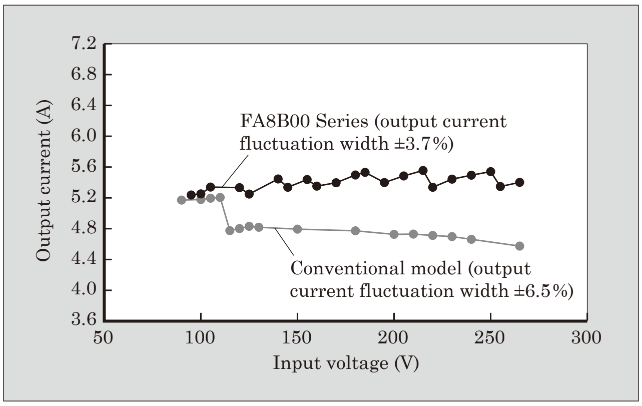

Fig. 4 Comparison of output current during overload

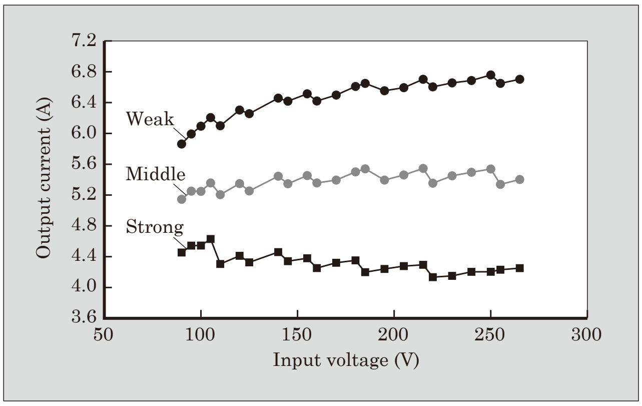

Fig. 5 Selection of OCP line correction

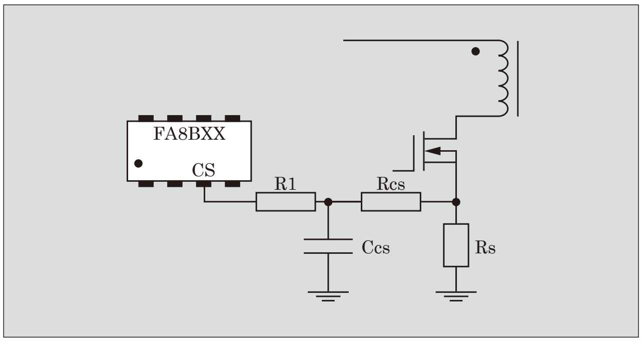

Fig. 6 Circuit configuration example for CS terminal

Table 2 Adjustment of correction amount

Input voltage dependence correction amount	Resistance value
Strong(correction amount: large)	0.3 kΩ ≤ Rcs or R1 + Rcs ≤ 0.5 kΩ
Middle(correction amount: medium)	1.4 kΩ ≤ Rcs or R1 + Rcs ≤ 2.1 kΩ
Weak(correction amount: small)	3.9 kΩ ≤ Rcs or R1 + Rcs ≤ 5.2 kΩ

Correction levels can be selected via the value of the external resistor connected to the CS terminal (see Fig. 5, Fig. 6, Table 2).

3.3 Various protective functions

The FA8B00 Series comes with built-in protective functions especially suited for power supply systems, and with fewer external components, it is capable of achieving safe and stable power supply.

(1) Load short-circuit protective function

The IC comes with a built-in load short-circuit protective function for preventing metal-oxide-semiconductor field-effect transistor (MOSFET) damage from occurring at the time of power supply output short circuit. This function can be used according to application need because it has 2 types of methods for detecting load short circuit. In a type using a method of detection based on VCC terminal voltage, it instantly terminates switching when the VCC terminal voltage falls to a certain threshold in the overload state. In another type using a method of detection based on FB terminal voltage, it terminates switching when voltage continuously exceeds the FB load short-circuit protection detection voltage for longer than a certain fixed period of time.

(2) Brown-in/brown-out function

It is also equipped with a built-in brown-in/brown-out function for preventing power circuit malfunction when there is some drop in AC input voltage. This function terminates the output pulse from the OUT terminal when AC input voltage drops to the VH brown-out threshold voltage for longer than a certain fixed period of time. Moreover, it starts switching once the AC input voltage reaches the VH brown-in threshold voltage.

(3) Overvoltage protective function

It comes with a built-in overvoltage protective function for monitoring VCC terminal voltage. This function terminates switching when the VCC terminal voltage continuously exceeds the overvoltage protection threshold voltage for longer than a certain fixed period of time.

(4) Low voltage malfunction prevention function

It also comes with a built-in low voltage malfunction prevention function for preventing IC malfunction when there is some drop in VCC terminal voltage, i.e. the power supply voltage of the IC. It terminates operation when the VCC terminal voltage drops to the OFF threshold voltage, and starts operation when the VCC terminal voltage reaches the ON threshold voltage.

4. Application Effect on the Power Circuit

4.1 EMI countermeasures

The conventional model came equipped with a built-in jitter function as an EMI countermeasure for implementing a frequency variation of ±7% for a switching frequency of 65 kHz. This function made it possible to reduce conduction noise because switching noise energy was dispersed more efficiently comparing with a fixed frequency system. However, the real jitter width would fall below 7% when the switching frequency was changing from 130 kHz to 65 kHz or from 65 kHz to 25 kHz (frequency reduction region), and this, in turn, would create the problem of a weakened noise reduction effect. This was the result of the jitter amplitude width decreasing due to the FB terminal voltage based frequency variation offsetting the jitter based frequency variation. Therefore, the FA8B00 Series newly comes equipped with a built-in switching frequency jitter expansion function for expanding the jitter width in the frequency reduction region from 7% to 14%. An overview of the switching frequency jitter expansion function is shown in Fig. 7, the evaluation results of the switching frequency jitter expansion function in Fig. 8 and the evaluation results of the conduction noise generating power supply in Fig. 9. We verified that the jitter effect can be maintained in the frequency reduction region and that a standard compliant noise margin can be secured at approximately 10 dB and above.

4.2 Effect of reducing power supply components

In order to reduce the conduction noise generated from the power supply, common mode choke coils and capacitors are inserted as noise filters into power supply input portion. The FA8B00 Series newly comes equipped with a built-in switching frequency jitter expansion function as described in Section 4.1, and thus it is capable of reducing the capacity and number of input filters since it can reduce conduction noise more

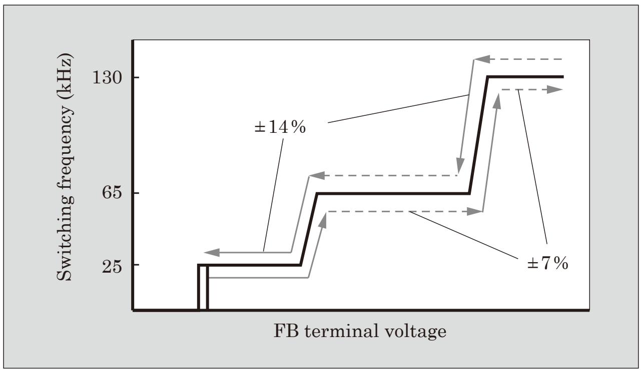

Fig. 7 Overview of switching frequency jitter expansion function

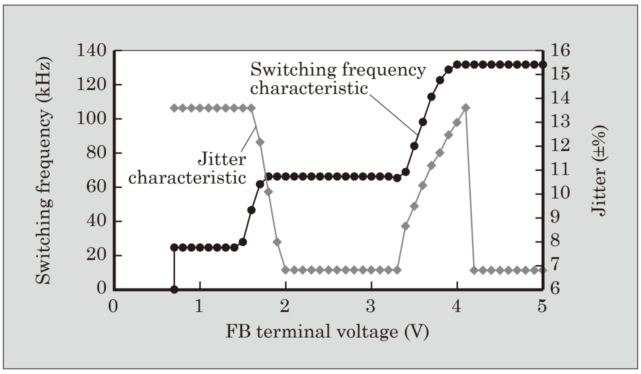

Fig. 8 Evaluation results for switching frequency jitter expansion function

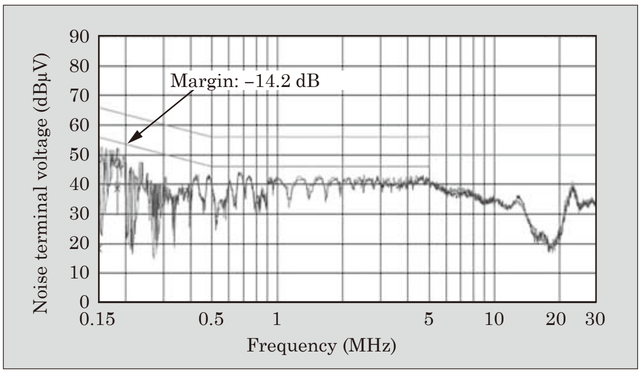

Fig. 9 Evaluation results for power supply conduction noise

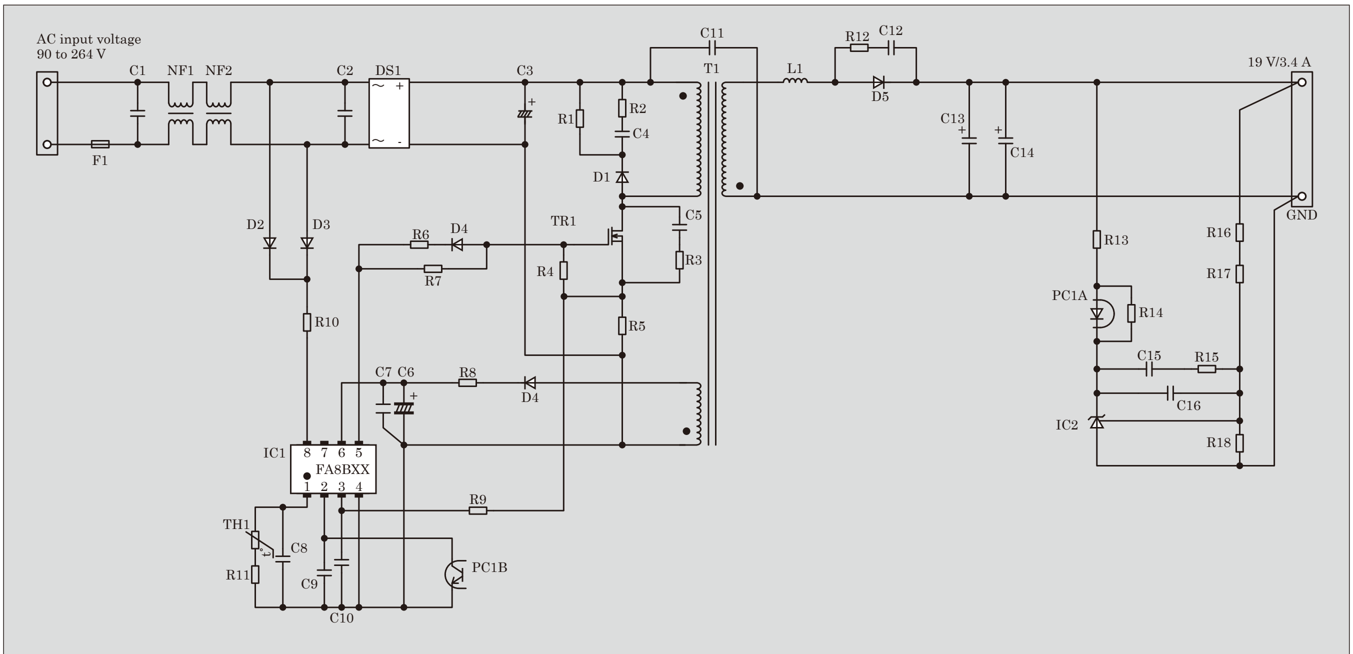

Fig. 10 Circuit of evaluation-use power supply board

than the conventional model

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4.3 Improvement in power supply safety

The FA8B00 Series comes with a built-in OUT terminal voltage clamp function for the IC, and is capable of clamping the output voltage of the IC at approximately 18 V to prevent the OUT terminal voltage from rising any further even when a VCC terminal voltage of 20 V or more has been applied. This function makes it possible to use a power MOSFET with a gate protection and gate voltage specification of 20 V or less, thus facilitating improvement in power supply safety and making it possible to reduce the cost of components. Figure 10 shows the circuit of an evaluation-use power supply board. In addition, the results of measuring standby power and power supply efficiency using the power supply board are compared with the conventional model in Fig. 11 and Fig. 12. The FA8B00 Series achieves a reduction in standby power of 3.3 mW compared with the conventional model, while also maintaining a power supply efficiency capability equal to or greater than the conventional model.

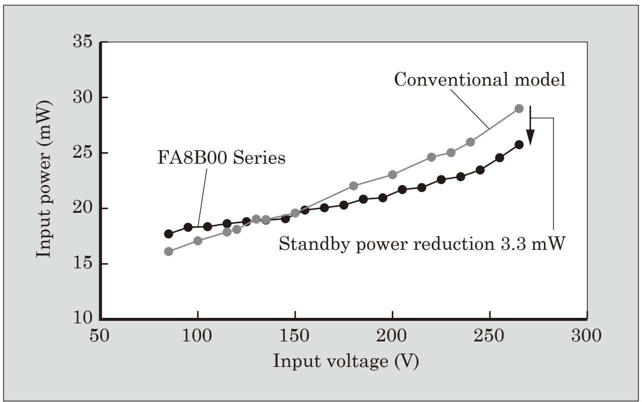

Fig. 11 Standby power

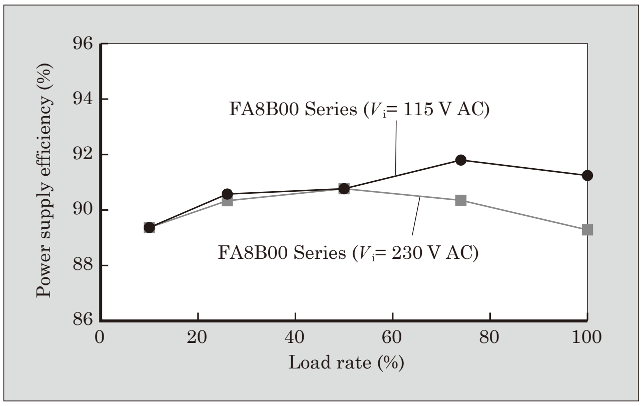

Fig. 12 Power supply efficiency

5. Postscript

This paper described the “FA8B00 Series” PWM power supply control IC, that is compatible with the peak power of switching power supply circuits.

In the future, we plan on advancing our efforts to establish new technologies for achieving even higher efficiency, lower standby power and lower noise so that we can continue to develop products that meet the needs of the market.