Small-package 5-channel Output DC-DC Converter Control IC

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1. Introduction

The market for portable electronic devices, which is centered on digital still cameras, has grown rapidly in recent years. Such types of electronic devices have trended toward higher performance and multi-functionality, while at the same time achieving remarkably smaller and thinner dimensions, lighter weight, and lower cost. A diverse range of components is used to configure the electronic devices internally, and those components require many different voltages. Accordingly, the power supply unit of an electronic device accounts for a rather large percentage of space on the circuit board, and demands to reduce this percentage are steadily growing.

Fuji Electric, having previously developed many PWM (pulse width modulation) type multi-channel output DC-DC converter control ICs for portable electronic devices, has recently developed the FA7716R, a 36-pin small-package 5-channel output DC-DC converter control IC that enables a drastic reduction in externally attached components. An overview of the FA7716R is presented herein.

2. Features

In addition to maintaining the equivalent functionality as power supply circuits built with Fuji Electric's previous 5-channel output DC-DC converter control ICs, the internal integration of components that had formerly been attached as discrete external components and the adoption of a small package enable the FA7716R to achieve a drastic reduction in size compared to conventional PWM-type 5-channel output ICs. Moreover, use of Fuji Electric's characteristic CMOS (complementary metal oxide semiconductor) technology enables the realization of low current consumption.

Each of the five output channels is capable of directly driving a MOSFET (metal oxide semiconductor field effect transistor), and is suitable for driving circuits such as boost converters or buck converters that use inductors, or flyback converters that use transformers. In addition, each channel can independently be turned on or off (although some channels are controlled commonly) and such control provides the capability for supporting all types of power supply sequences.

Table 1 FA7716R main characteristics

Item	Condition	Minimum	Standard	Maximum	Unit
Power supply voltage		2.5		10	V
Oscillation frequency		200	500	1,200	kHz
Reference voltage (error amplifier)		0.09	1.00	1.01	V
Soft start time	0 to 100 %		25		ms
Internal maximum duty limit	When DT = GND	80	85	90	%
	When DT = VREG	65	70	75	%
Undervoltage lockout operating voltage		1.9	2.1	2.3	V
OUT H-level ON-resistance	I_{out} = 10 mA		15	23	Ω
OUT L-level ON-resistance	I_{out} = −10 mA		7	11	Ω
Standby current			2	10	μA
Supply current	f_{osc} = 500 kHz		4	6	mA

Note : Unless otherwise specified, rated values are for the conditions of 3.3 V power supply voltage and room temperature (25°C)

Main characteristics of the FA7716R are shown in Table 1, and other features are listed below:

(1) 36-pin QFN (quad flat non-lead) package

(2) Operating voltage: 2.5 to 10 V

Compatible with lithium ion batteries (1 cell, 2 cells), nickel hydrogen batteries (4 cells), alkali dry cells (4 cells)

(3) Oscillation frequency: 200 kHz to 1.2 MHz

High frequency operation enables reduction of inductor size

(4) Internal reference voltage: 1.00 V ±1 %

(5) Built-in 5-channel PWM controlled outputs

Channels 1, 2 and 3 are for n-channel driving, channel 4 is for p-channel driving, channel 5 is selectable for either n or p-channel driving

(6) Built-in timer and latch-type short circuit protection, undervoltage lockout circuit

(7) Independent on/off control for each channel,

(channels 4 and 5 are controlled commonly)

(8) Built-in soft start circuit (fixed internally within IC)

(9) Channel 5 startup delay time in relation to channel 4 can be set

(10) Built-in maximum duty limits

Channels 1, 3, 5 (during n channel driving) can be set as either 85 % or 70 %. Arbitrary maximum duty limit may also be set. Channel 2 is internally fixed at 85 %.

3. Product Overview

Figure 1 shows an internal block diagram of the FA7716R and an example circuit application. An overview of the various functional sections is presented below.

3.1 PWM control blocks

Except for channel 3, the non-inverted inputs to the error amplifier are internally connected to a reference voltage. The channel 3 error amplifier input can be set externally as either non-inverted or inverted input.

The outputs of channels 1, 2 and 3 are for n-channel driving, the output of channel 4 is for p-channel driving, and the output of channel 5 can be switched for either n or p-channel driving.

Because its error amplifier is provided with a non-inverted input, channel 3 can be used to drive a LED backlight such as used in a digital still camera.

3.2 Maximum duty limit circuit

The maximum duty limit can be set for n-channel driving by channels 1, 3 and 5. This IC is provided internally with two maximum duty limit settings, 85 % and 70 %, which can be switched by affixing the DT pin voltage to either GND or VREG (See Fig. 2.). An arbitrary maximum duty limit may also be set by applying an external voltage to the DT pin. During p-channel driving by channel 5, the maximum duty limit is completely disabled.

3.3 Soft start circuit

Because each channel generally starts up at its own arbitrary timing, the soft start circuit must be

Fig.1 FA7716R internal block diagram and example circuit application

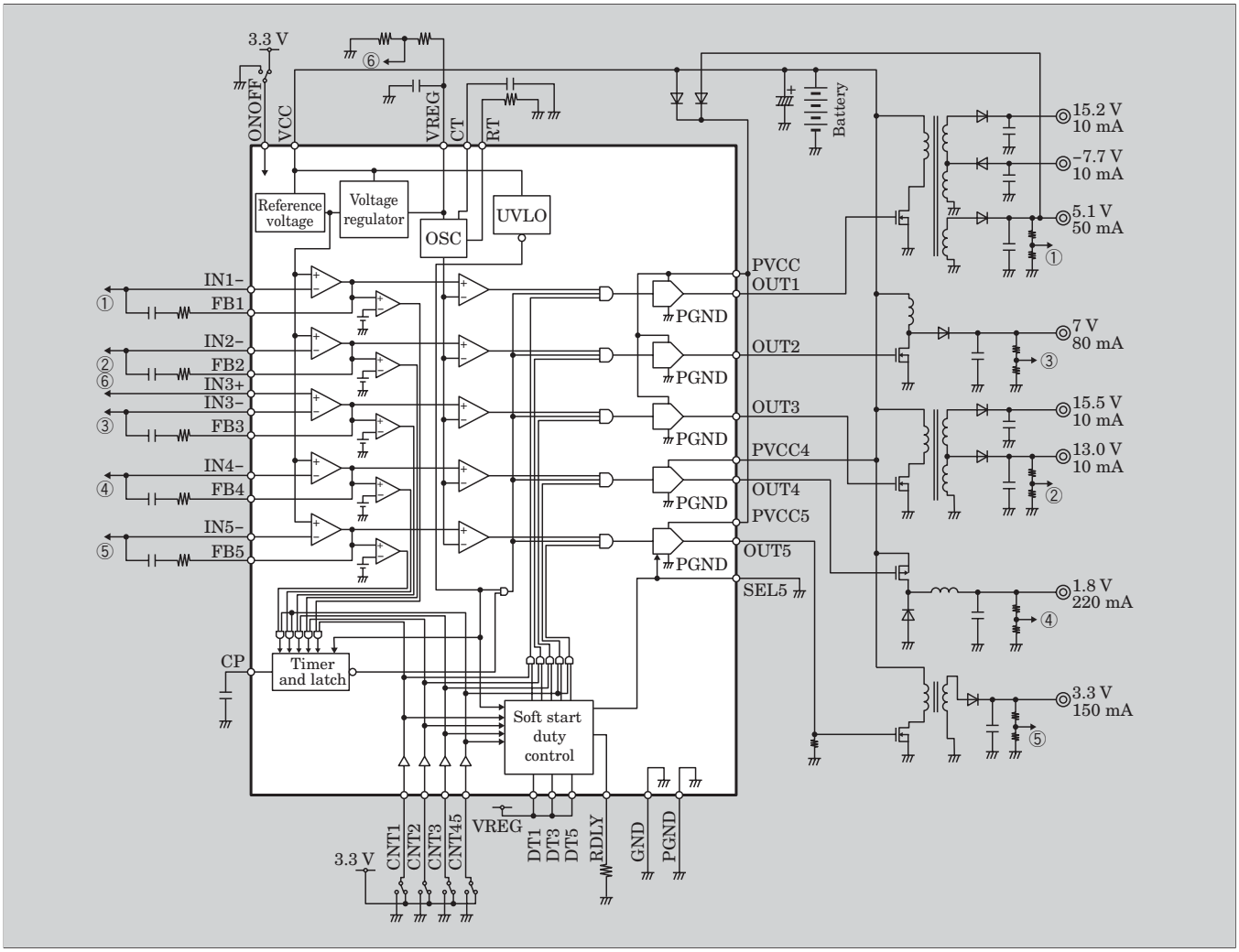


Fig.2 DT pin voltage vs. maximum duty limit

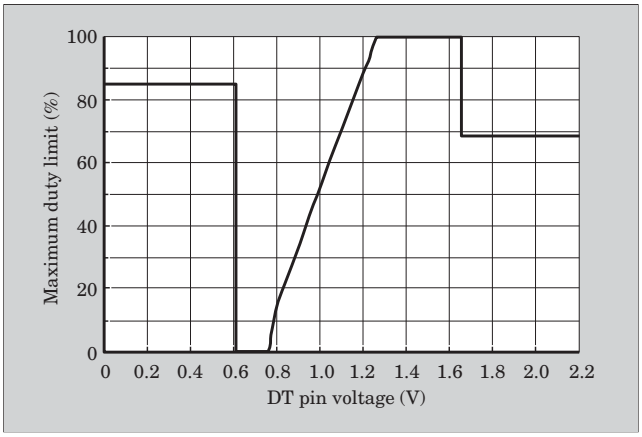


Fig.3 Soft start signals

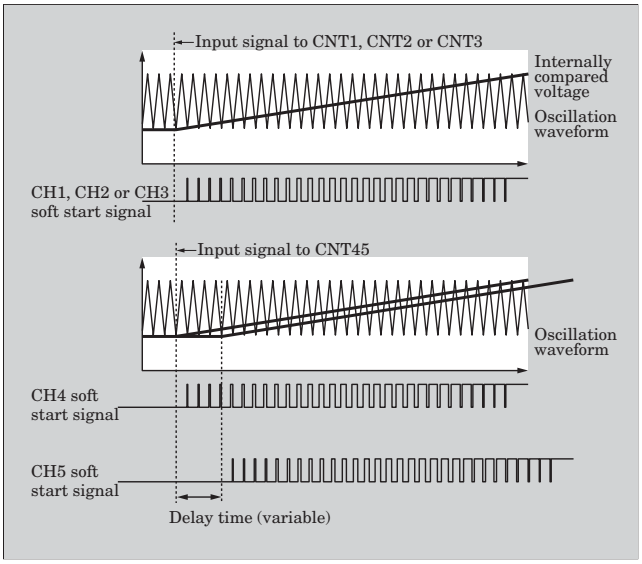
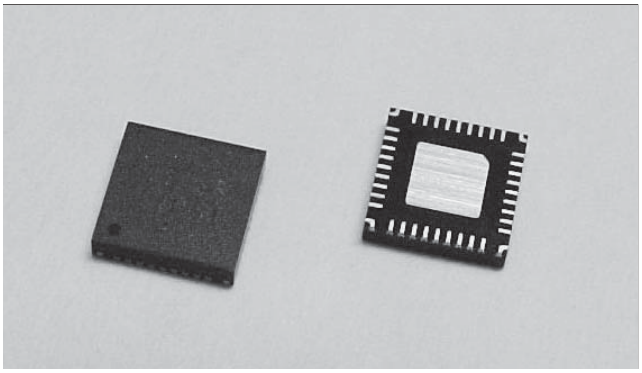


Fig.4 External view of package



independently settable for each channel, and this has typically required external components to be attached to each channel. The FA7716R, however, has a fully self-contained soft start function that does not require any externally attached components, thereby enabling the FA7716R to realize a reduction in its pin count.

The internal soft start signals are obtained by inputting an oscillating waveform and comparison voltage into a comparator. The comparison voltage has a gradual time slope of several millisecond and is generated by an oscillator, counter and D-A converter. Each channel has its own counter and D-A converter, and a soft start signal is generated when a signal is applied to the CNT pin of each channel. The CNT pin turns each channel on or off (See Fig. 3.).

Channels 4 and 5 are both controlled by the same CNT45 pin. Individual soft start signals can be generated for each using the delay circuit described below.

3.4 Channel 5 delay circuit

Channels 4 and 5 are intended for use in supplying voltage to a digital system, and a common CNT45 pin controls both of these channels. Two types of voltage signals typically determine the sequencing of a digital system, and at startup, one voltage signal must never overtake the other voltage signal.

Accordingly, the FA7716R enables the startup of channel 5 to be delayed with respect to the startup of channel 4, and this delay time is settable. Because the time required for startup of each channel differs depending on the input voltage range used and the load conditions, when using these channels 4 and 5 in combination, an external resistor can be attached to vary the delay time and adjust to optimal conditions.

The relationship between the start up times of channels 4 and 5 is shown in Fig. 3.

3.5 Partitioned power supply pins of output drivers

To power a transformer or other such device, driving by means of a high-voltage MOSFET is sometimes necessary. In such a case, the MOSFET threshold voltage has a tendency to increase, and the battery voltage may be insufficient.

As a countermeasure, the voltage generated by a boost converter is fed back to the power supply pin of the driver, enabling the MOSFET to be driven at higher voltage. This countermeasure should also result in improved efficiency.

However, because it may be inconvenient to feedback this boosted voltage for some channels, the FA7716R is provided with a tri-partitioned driver power supply pin, enabling the design of power supply circuits with high flexibility.

3.6 Package

Miniaturization of the FA7716R contributed to both a reduction in the pin count and shrinking of the package itself.

The adoption of a 36-pin QFN package having 0.4 mm pin pitch enables the realization of a 5 mm × 5 mm body size. The package is a low-profile design having a maximum thickness of 0.95 mm.

Front and rear views of the package are shown in Fig. 4.

3.7 Circuit application example

An example circuit application is shown in Fig. 1. In addition to this example, various other combinations of power supply circuits can be configured.

4. Conclusion

An overview of Fuji Electric's newly developed small-package 5-channel DC-DC converter control IC has been presented.

The development of portable electronic devices, which center on digital still cameras, will undoubtedly continue. Two distinct trends have been observed for power supply circuits, either toward multi-channel functionality or toward fewer channels. At present, it is impossible to predict the future ratio of these trends.

Fuji Electric intends to monitor future trends and to work toward the rapid development of new and attractive products by striving for further internal integration of external components and higher efficiency of power supply circuits.