

■ DEFINITION OF A DC/DC CONVERTER

Direct current (DC) can be found in such power supplies as a dry cell battery or a car battery. One other hand, alternating current (AC) could be said to be for domestic use. A converter is a machine, which converts electric current from one kind to another. Therefore, a "DC/DC converter" converts, for example, 3.0V direct current to 1.5V or 5.0V direct current. The DC/DC converter is also called as a switching power supply or a switching regulator. (AC value by countries : Japan = 100V, USA = 110V, UK = 240V, Hong Kong = 220V, Korea = 110V/220V, Singapore = 230V)

1. Structure of a DC/DC converter

A DC/DC converter circuit generally consists of the IC, coils, diodes, transistors, and capacitors. The relative merits of a DC/DC converter cannot be easily understood by just looking at the electrical characteristics. Stability or performance of the power supply circuit are influenced by the characteristics of the external components and PCB's copper foil pattern layouts. When you examine the performance of a DC/DC converter, please consider all the various factors concerning the circuit together.

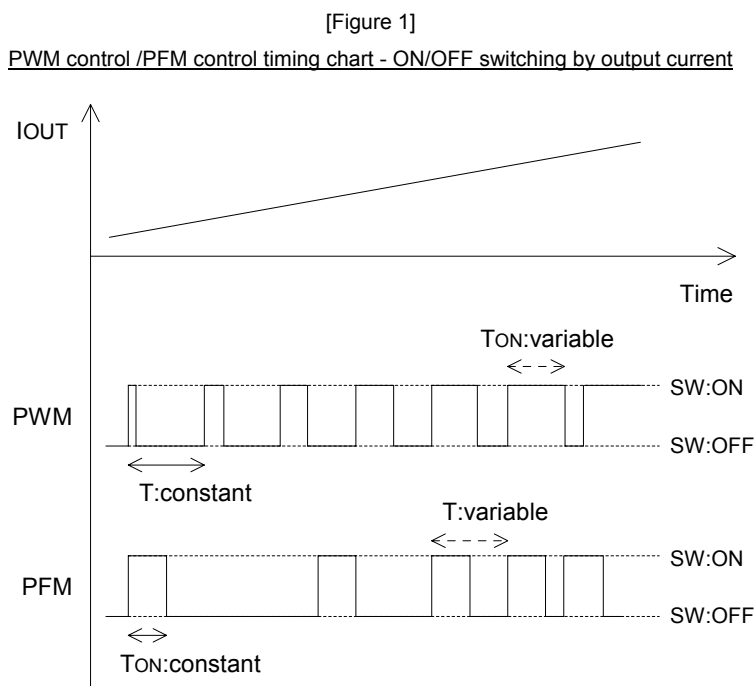
2. Control method

a) PWM (Pulse Width Modulation)

PWM control is a control method to stabilize output voltage by modulating pulse width while switching pulse output frequency is constant.

b) PFM (Pulse Frequency Modulation)

PFM control is a control method to stabilize output voltage by modulating switching pulse frequency while pulse width is constant.



c) General differences of DC/DC converter characteristics between PWM control and PFM control.

ITEM	PFM CONTROL	PWM CONTROL
Structure of Circuit	Easy	Difficult
Supply Current	Small	Large
Ripple Voltage	Large	Small
Response Time against Load Fluctuation	Slow	Fast

■ OPERATING OSCILLATION FREQUENCY WITH PWM CONTROL AND DUTY RATIO WITH PFM CONTROL

○ PWM Control

A. With high oscillation frequency (ex. 500kHz)

- (1) Low efficiency at light load
- (2) Low ripple voltage of output voltage

If output ripple voltage needs to be reduced, efficiency becomes lower when operating oscillation frequency is high (500kHz).

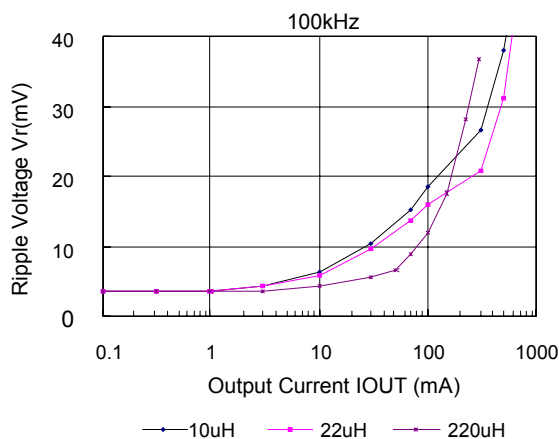
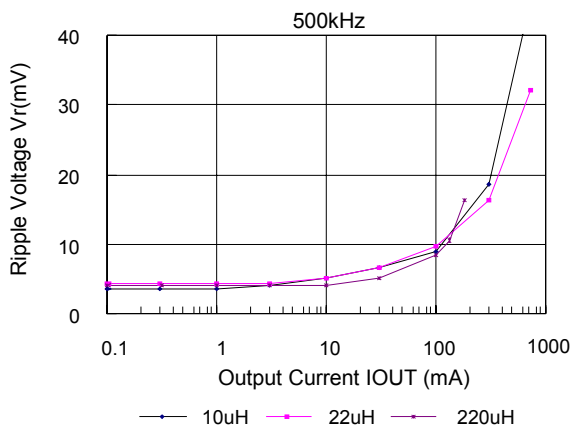
B. With low oscillation frequency (ex. 100kHz)

- (1) High efficiency at light load
- (2) High ripple voltage of output voltage

If a suspension time used at the time of light load is long, efficiency becomes higher when operating oscillation frequency is low (100kHz).

[Figure 2]

Comparison of ripple voltage when differing operating oscillation frequency but using the same coil (XC6367A Series, VOUT=5V, VIN=3.3V)



* For efficiency, please refer to TIP No. 22 - How to select DC/DC converter, item 2-1.

○ PFM Control

A. With high duty ratio (75% duty)

- (1) Low efficiency at light load
- (2) High current can be pulled in

75% duty should be chosen if the application needs high current

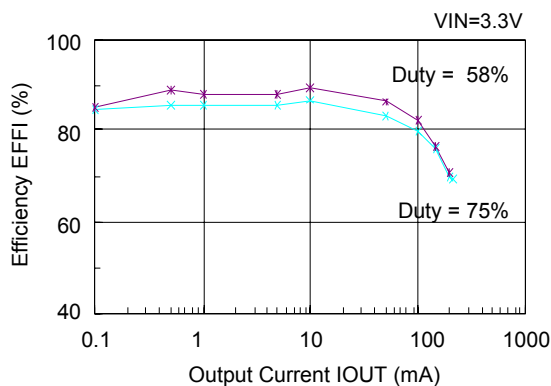
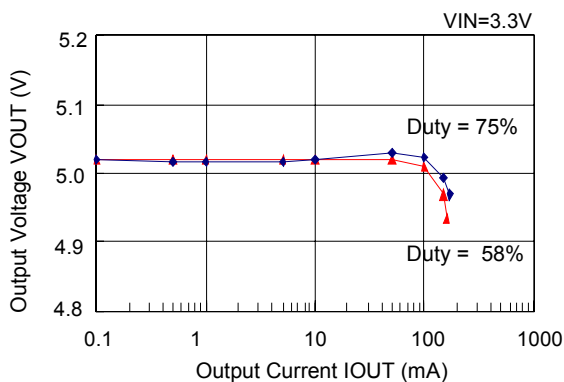
B. With low duty ratio (58% duty)

- (1) High efficiency at light load
- (2) High current cannot be pulled in

58% duty should be chosen if efficiency needs to be high at light load.

[Figure 3]

Comparison of output voltage vs. ripple voltage when differing the duty ratio but using the same coil (XC6381A501MR, Duty=58%, L=100μH) (XC6382A501MR, Duty=75%, L=100μH)



○ Fluctuation of efficiency when alternating external transistor from a bipolar transistor to a power MOSFET

When a transistor is changed from a bipolar to a power MOSFET, efficiency will increase. Because a bipolar transistor is a current drive element, a base current should be input. Therefore, excessive electric power is consumed. On the other hand, because a MOSFET is a voltage drive element, it operates by applying voltage to gate. Therefore, a MOSFET does not need a supply of current. Since other external components have a large effect on efficiency, please check with the actual parts.

■ SPIKE NOISE OF A DC/DC CONVERTER (SWITCHING REGULATOR)

A switching regulator switches a transistor ON and OFF in order to generate step-up and step-down operation. Spike noise (switching noise) and electromagnetic noise occurs especially when the transistor switches ON and OFF rapidly.

* Please also refer to TIP No. 6 - How to reduce the spike noise.