# Introduction to Constant-On-Time Control Topology of Buck Converter

The DCDC regulator of the buck topology is commonly used in the step-down power management design of general electronic products. In recent years, many silicon chip manufacturers have successively introduced some buck converters that adopt the constant-on-time (COT) control mode. The following will focus on the features and applications of DCDC products that adopted COT control mode.

The COT mode adopts a double closed-loop control system. The feedback has two loops: the voltage outer loop and the current inner loop, as shown in Figure 1. The voltage outer loop consists of an error amplifier, a feedback resistor divider, and a feedback compensation network. The output of the error amplifier is connected to the non-inverting terminal of the current comparator. The current loop detects the current on the freewheeling side, and the current amplified signal is connected to the inverting terminal of the current comparator.

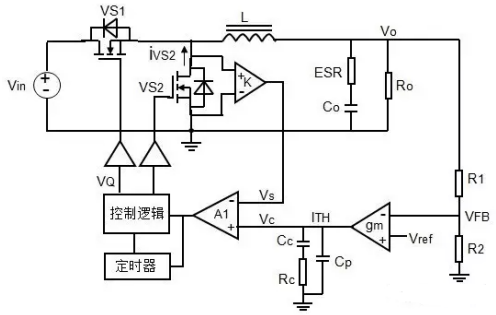


Figure 1

### 1.1 The COT mode works as follows:

(1) When the initial state is that the high-side power switch is turned on, the inductor is magnetized, and the current rises linearly. The high-side switch is on for a fixed period, which is set by an internal timer.

(2) When the high-side switch is turned off, the low-side switch is turned on, and the inductor begins to demagnetize, and the inductor current decreases linearly. Similarly, the current of the low-side switch also decreases linearly with time. The current detection resistor is the on-resistance of the low-side switch, so the voltage signal of the current detection signal also decreases linearly. At this time, since Vc is lower than Vs, the current comparator output is low. The high-side switch remains off, while the low-side switch remains on.

(3) When the voltage signal of the current detection resistor continues to decrease until Vc equals Vs, the output of the current comparator is reversed from low level to high level. The logic control circuit works. The low-side freewheeling switch is turned off, while the high-side power switch is turned on, meanwhile, a trigger signal is sent to the timer to start the timer. After the high-side switch is turned on, the inductor starts to be magnetized, and the current rises linearly. The whole process enters the next cycle, and so on repeatedly. As shown in Figure 2.

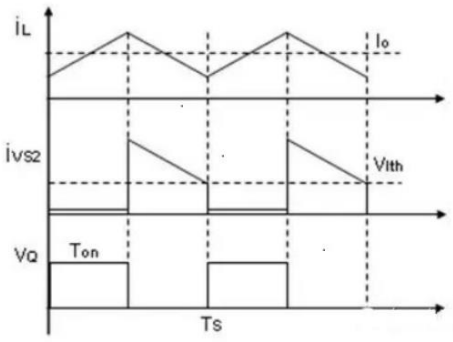


Figure 2

**1.2 The working principle of the regulator is as follows:**

(1) When the output load increases and the output voltage decreases, Vc increases. The linearly decreased inductor current is equal to Vc at a higher value, causing the current comparator to be reversed. Therefore, the freewheeling switch remains on for a shorter time, and the high-end switch remains on for the same time, which means that the switching period is shortened, the switching frequency increases, and the input power increases. Then the output voltage increases. When the output voltage increases to a value within the regulated range, the system maintains balance.

(2) When the output load decreases and the output voltage increases, Vc decreases. The linearly decreased inductor current can only be equal to Vc at a lower value, causing the current comparator to be reversed. Therefore, the freewheeling switch remains on for a longer time, and the high-side switch remains on for the same time, which means that the switching period is lengthened, the switching frequency decreases, and the input power decreases. Then the output voltage decreases. When the output voltage decreases to a value within the regulated range, the system maintains balance.

In the COT mode, the on-resistance of the low-side switch can be used as the current sense resistor, or a current detection resistor can be connected in series under the source of the switch. Using the on-resistance of the low-side switch as the current detection resistor can improve the efficiency of the system and eliminate the need for an additional expensive current detection resistor, but the accuracy is relatively poor.

# 2. Advantages and Disadvantages of COT mode

**2.1 Advantages of COT mode:**

(1) Can work in a wide input voltage range.

(2) Can work under lower duty ratio conditions.

(3) Easy to detect current.

(4) Fast load response

**2.2 Disadvantages of COT Mode:**

The switching frequency and the peak value of the inductor current vary with the changes in input and output voltages, making it difficult to select an optimized inductor.

When operating in variable frequency mode, the conduction time of the high-side MOSFET remains constant and unchanged as the input and output voltage change. This causes the system to operate over a wide frequency range, which is not conducive to optimizing the inductor.

Usually, a feedforward circuit is needed inside the controller to make the conduction time of the high-side MOSFET inversely proportional to the input voltage and directly proportional to the output voltage. Therefore, the converter works approximately in a fixed frequency mode when the input voltage changes and the load changes.