

Modulated Constant Off-Time Control Mechanism



Application Note

INTRODUCTION

Linfinity's LX166x family of programmable switching regulators utilize a modulated constant off-time control mechanism, which results in fast transient response and no external compensation network. This application note describes the control mechanism.

MODULATED CONSTANT OFF TIME CONTROL

The purpose of modulating the off time is to maintain the switching frequency constant, so minimizing noise. For a buck converter, the duty ratio, defined as the on time of the MOSFET over the whole switching period, is equal to the voltage conversion ratio, defined as the ratio of output to input voltages.

$$D = T_{ON} / T_S = V_{OUT} / V_{IN} \dots\dots\dots(1)$$

where D is the duty ratio, T_{ON} is the on time, T_S is the switching period, V_{OUT} is the output voltage and V_{IN} is the input voltage. The off time for the buck converter is

$$T_{OFF} = (T_S - T_{ON}) = T_S \left(1 - \frac{V_{OUT}}{V_{IN}} \right)$$

$$T_{OFF} = \frac{T_S (V_{IN} - V_{OUT})}{V_{IN}} \dots\dots\dots(2)$$

Now if we fix the off time T_{OFF} at, say, 2μs, the switching period T_S will vary for different V_{IN} and V_{OUT}. On the

other hand, one can control T_{OFF} to be proportional to (V_{IN} - V_{OUT})/V_{IN}, then T_S will be constant regardless of the values of V_{IN} and V_{OUT}.

The off time control block in LX1668 is shown in Figure 1. The current source has a current of V_{CC}/R, the threshold voltage for the comparator is V_{CC} - V_{SET}, where V_{SET} is the output of the VID DAC (which is approximately the output voltage). During the on time of the top FET, the NPN transistor is turned on and the voltage of the timing capacitor is pulled to zero volts. When the PWM flip-flop is reset and the top FET is turned off, so is the NPN transistor and the capacitor start being charged up by the current source.

The voltage on the capacitor when t < T_{OFF} is

$$V_C(t) = \frac{1}{C_T} \int_0^t I dt = \frac{1}{C_T} \int_0^t \frac{V_{CC}}{R} dt = \frac{V_{CC}}{C_T R} t \dots\dots\dots(3)$$

When t = T_{OFF}, V_C = (V_{CC} - V_{SET}), therefore,

$$T_{Off} = \frac{V_{CC} - V_{set}}{V_{CC}} C_T R \dots\dots\dots(4)$$

The V_{CC} of the IC is connected to the input voltage, i.e. V_{CC} = V_{IN}. Combining (4) and (2) yields

$$T_S = C_T R \dots\dots\dots(5)$$

Thus, the switching period, or the switching frequency, is determined by the timing capacitance, independent of the input and output voltage of the power supply. In LX1668, the internal C_T and R result in a switching period of 5μs (switching frequency 200kHz). The under-voltage lock-out (UVLO) input disables the timer during UVLO state.

CONCLUSION

The LX1668 device modulates the off-time in order to maintain constant frequency for different input and output voltages, so reducing noise while giving optimal performance.

FURTHER INFORMATION

For datasheets and other application notes, please visit Linfinity's web site at <http://www.linfinity.com> or use Linfinity's Fax Back service at 1 (714) 372-3848. Evaluation kits for the LX1668 and other devices are available upon request from Linfinity's representatives and distributors.

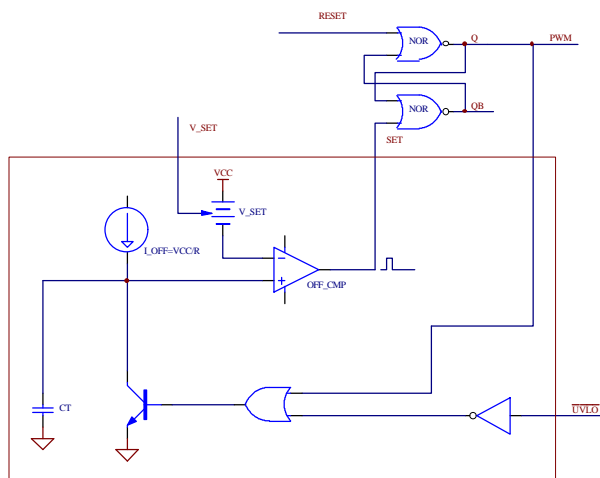


Figure 1: Off-Time Control Block, LX1668