

# Adjust or Synchronize LM2586/88 Switching Frequency

## Introduction

Switching frequency is a very important parameter in switching power converters. As the switching frequency increases, the physical size of magnetic elements and other components in the circuit reduce significantly. Switching frequency also plays a great role in control loop gain and compensation design. Switching frequency determines the maximum allowable bandwidth of the control loop. Switching frequency is also important parameter for EMI and noise issues. The EMI spectrum is a direct function of the switching frequency.

From the above cited reasons, it can be deduced that a great advantage will be gained by having control over the switching frequency. Simple switcher boost converters are available in two flavors. While the LM2585 and LM2587 operate at a fixed switching frequency of 100 kHz, the LM2586 and LM2588 allows its switching frequency to be modified. Using either of two control methods, the switching frequency can be varied between 100 kHz (its base frequency) to 200 kHz. Figure 1 shows the LM2586 boost regulator with synchronization and frequency adjust pins.

Synchronization forces the LM2586/8 switching frequency to match that of an external source, such as another switching regulator or a system clock. This keeps the EMI generated within the system to a predictable set of frequencies. It also prevents similar (but not matching) switching frequencies from producing a beat frequency. Both of these results make it easier to filter out switching noise in the system. By synchronizing to a higher frequency (> 100 kHz) system clock or

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switching regulator, the LM2586/88 can be made to operate at higher frequencies, in order to reduce the size of the magnetic elements and other components.

The threshold voltage for the synchronization pin is typically around 0.75V. The voltage levels of the clock signal should be 0V and 2V. If the sync. Pin is not used, it should be left open.

The second frequency control method changes the switching frequency of an LM2586/8, using a single resistor (from the Frequency Adjust pin to ground). Once again, this allows a design to be customized for a smaller size, as the sizes of the transformer and output capacitor tend to go down as the switching frequency increases. Table 1 shows the resistor values corresponding to commonly used frequencies.

If the Frequency Adjust pin is not to be used, it should be left open. Pulling this pin above 3V will turn the regulator off.

TABLE 1. Frequency Settling Resistor Guide

R <sub>SET</sub> (kΩ)	Frequency (kHz)
Open	100
200	125
47	150
33	175
22	200

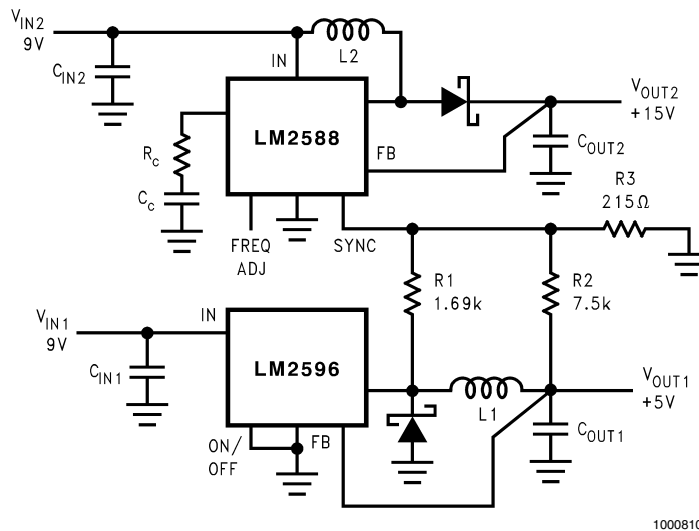


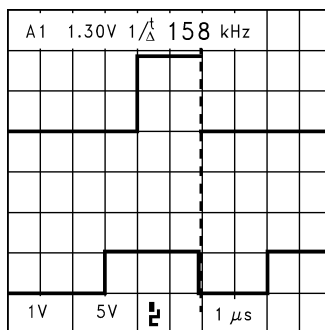
FIGURE 1. Synchronizing LM2588 Boost to LM2596 Buck Regulator

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## Example

In the example shown, the LM2588 has been synchronized to the 150 kHz LM2596. With the LM2596 output voltage of 5V, the resistor divider of R1, R2, and R3 sets the voltage applied to the LM2588 SYNC pin to swing between 0.1V and 1.5V. To assure correct operation, the regulator designated "master" (in this case, the LM2596) must be in continuous operation (i.e., the current in inductor L1 must be continually above 0A). In addition, to keep the sync voltage at the

designated levels, the input voltage to the master regulator ( $V_{IN1}$ ) should not vary more than  $\pm 10\%$ . Synchronization of the LM2588 (or LM2586) occurs on the falling edge of the sync signal. The LM2596 buck converter and LM2588 boost regulator are designed using the *Switchers Made Simple*<sup>®</sup> Software, SMS4.2.1. *Figure 2* shows the diode and switch voltage waveforms of the buck and boost regulators respectively.



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FIGURE 2. Waveforms (Top-Synchronization Signal, Bottom-LM2588 Switch Waveform)

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