XC6219 Current Foldback Circuit

Introduction

The following document will give some insight about the XC6219 current foldback operation. Moreover, since the XC6219 current foldback circuit is sometimes used in conjunction with the XC6219 current limiter, we will talk as well about the latter.

1. Current limiting with the foldback and limiter circuits

1.1. Basic principles

The XC6219 includes two different current limit functions in order to protect against output short-circuits, over-current and –indirectly– against over-temperature:

- a current limiter circuit;
- a current foldback circuit.

By combining these 2 circuits, we obtain current limit graphs similar to those on Figure 1.

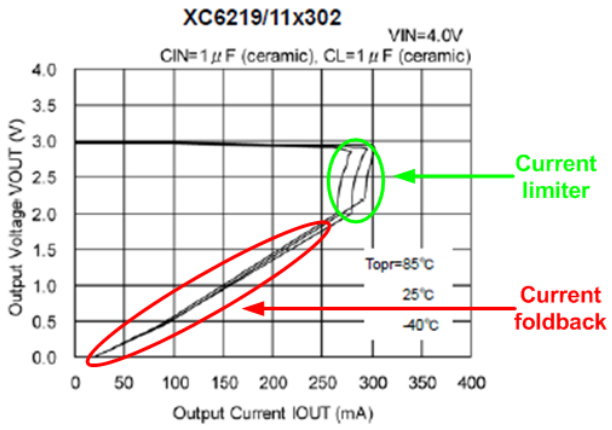

Figure 1: XC6219 V_{OUT} vs. I_{OUT} graph

1.2. The role of the current limiter circuit

Before explaining into details the behavior of the foldback circuit, let's see why the XC6219 requires a current limiter in addition to its current foldback circuit. For that matter, please refer to Figure 2.

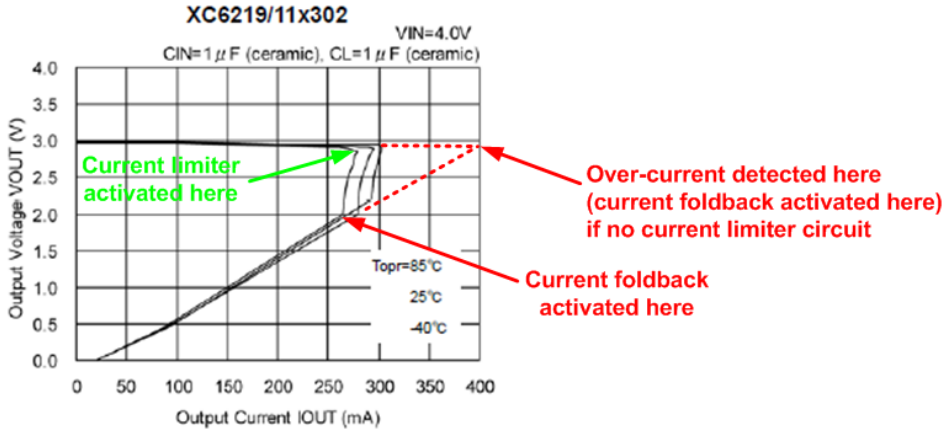

Figure 2: Importance of the current limiter for the XC6219

As you can see with the extrapolated red dotted curve, if the XC6219 didn't include a current limiter, the output current I_{OUT} could become very high before the foldback circuit gets activated. Moreover, this high output current would cause the temperature of the XC6219 to rise dangerously high and, since the XC6219 doesn't include a dedicated thermal shutdown circuit, the XC6219 could be permanently damaged by these high temperatures.

In order to avoid this problem –which would be caused by the lack of accuracy of the current foldback circuit–, when the output current becomes too high, the current limiter gets activated and forces the output voltage V_{OUT} to decrease. When V_{OUT} goes below a certain value, the current foldback takes over the current limiter and forces V_{OUT} to decrease further while decreasing I_{OUT} at the same time.

2. The role of the current foldback circuit at start-up

The previous section highlighted the response of the XC6219 current limiter and current foldback circuits to an excessive load current when the output voltage has already settled. However, there is another scenario when the current foldback circuit can be activated, and it is at start-up.

For that matter, we will refer to Figure 3, where the I-V characteristics (current consumption, input voltage) of an IC situated on the output side of the XC6219 have been superposed in red to the typical characteristics of the XC6219. This example will help understand how the current foldback circuit can prevent the output voltage to settle to its target value.

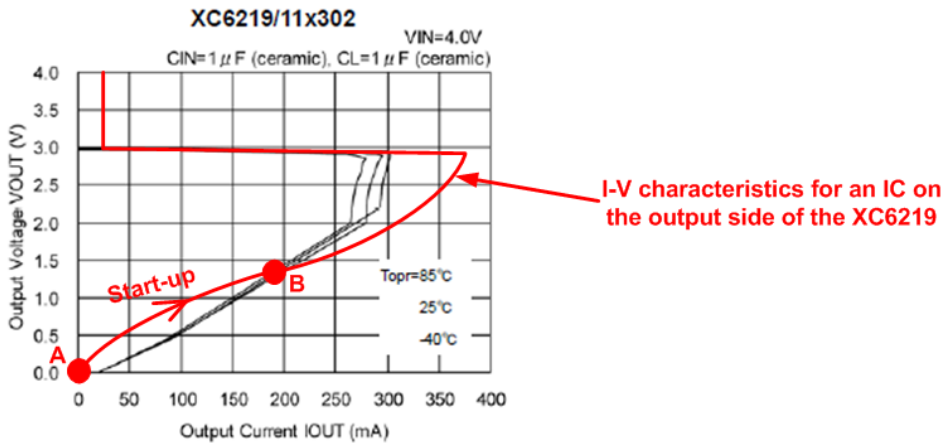

Figure 3: XC6219 behavior at start-up

At start-up, we are at point A. From A until B, the XC6219 can supply the current required by the IC, so its output voltage can start rising along the foldback curve (shown in black). However, after point B, the red curve of the IC passes below the foldback curve of the XC6219, which means that the output current requirement is higher than what the XC6219 permits. As a consequence, the foldback circuit gets activated and the output voltage stops increasing. Instead of it, the output voltage settles to the value when the I-V characteristics of the IC intersect the XC6219 foldback curve. In our example, this corresponds to an output voltage of 1.4V for point B.

The I-V characteristics of the IC on the output side of the XC6219 are equivalent to a variation of the load resistance seen by the XC6219. So, when the red curve goes below the foldback curve, this means that the load resistance is becoming too small.

It is important to note that the foldback circuit gets activated as soon as it detects that the load resistance is too small or, said

differently, the foldback circuit doesn't wait until the output current reaches the current limit value (380mA typ for the XC6219F) before latching. So, since the foldback circuit doesn't permit any high currents to flow during start-up, it performs a sort of inrush current protection. Although it is not as efficient as a dedicated inrush current protection circuit, this is another advantage of the foldback circuit that is worth knowing.

Conclusion

Thanks to the above explanation, we better understand the various roles played by the current foldback circuit, not only at start-up but also when the XC6219 is required to supply an excessive output current after its output voltage has settled to its set value. We realized as well that the foldback circuit can help reduce the inrush current at start-up.

Although many other LDO's (from Torex or competitors) combine the same "current foldback + current limiter" configuration as the XC6219, there are as well many LDO's whose configurations differ. In the future, we shall explain about such Torex LDO's in a more comprehensive document about protection circuits.