AN-2220 Precision Current Limiting with the LMP8646 and LMZ12003

ABSTRACT

This application report discusses how to design the Texas Instruments LMP8646 with the LMZ12003 voltage regulator and a resistive load application.

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1 Overview

The LMP8646 is a precision current limiter used to improve the current limit accuracy of any switching or linear regulator with an available feedback node. Many regulators might have an internal current limiter, but its output accuracy is often as high as 30%. The output accuracy of the LMP8646 can be as low as 3%, making it a preferred current limiter for many regulator applications. The resistive load application with LMZ12003 regulator and LMP8646 precision current limiter is shown in Figure 1.

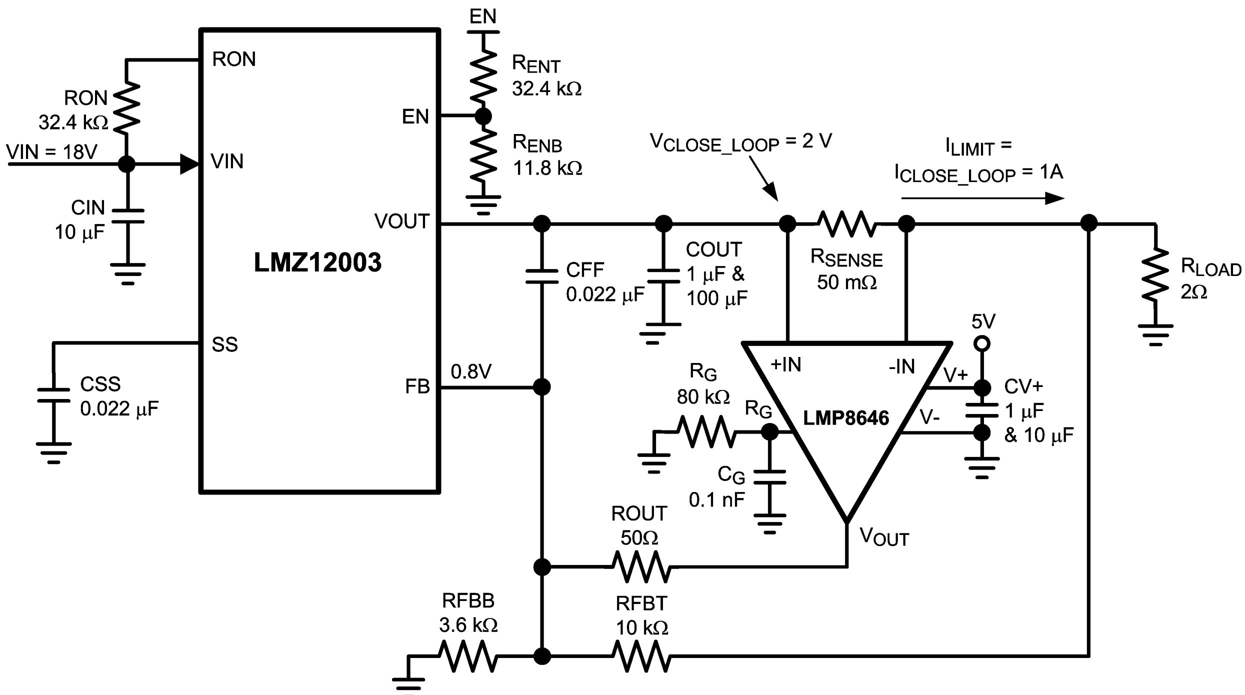

Figure 1. Resistive Load Application with LMZ12003 Regulator and LMP8646 Precision Current Limiter

2 Example

To see the current limiting capability of the LMP8646, the open-loop current must be greater than the close-loop current. An open-loop occurs when the LMP8646 output is not connected the LMZ12003's feedback pin. For this example, the open-loop current is 1.5A and the close-loop current, I_{LIMIT}, is 1A.

Step 1: Choose the components for the Regulator.

To select the appropriate components for the LMZ12003 voltage regulator, see *AN-2031 LMZ12003 3A Demo Board SIMPLE SWITCHER Power Module Quick Start Guide* (SNVA427). The LMZ12003 components chosen for this example can be seen in Figure 1.

Step 2: Step 2: Choose the sense resistor, R_{SENSE}

R_{SENSE} sets the voltage V_{SENSE} between +IN and -IN and has the following equation:

$$R_{SENSE} = V_{OUT} / [(I_{LIMIT}) \times (R_G / 5kOhm)] \quad (1)$$

In general, R_{SENSE} depends on the output voltage, limit current, and gain. To choose the appropriate R_{SENSE} value, see the Selection of the Sense Resistor, R_{SENSE} section in *LMP8646 Precision Current Limiter* (SNOSC63). Typically, R_{SENSE} is a power resistor in the mOhm range. In this example, use 50 mOhm.

Step 3: Choose the gain resistor, R_G, for LMP8646

R_G is chosen from I_{LIMIT}. As stated in Equation 1, since $V_{OUT} = V_{FB} = 0.8V$, $I_{LIMIT} = 1A$, and R_{SENSE} = 50 mOhm, R_G can be calculated as:

$$R_G = (V_{OUT} \times 5\ kOhm) / (R_{SENSE} \times I_{LIMIT}) \quad (2)$$

$$R_G = (0.8 \times 5\ kOhm) / (50\ mOhm \times 1A) = 80\ kOhm\ (approximate)$$

Step 4: Choose the Bandwidth Capacitance, C_G.

The product of C_G and R_G determines the bandwidth for the LMP8646. To see the range for the LMP8646 bandwidth and gain, see the Typical Performance Characteristics plots in *LMP8646 Precision Current Limiter* (SNOSC63). Since each application is very unique, the LMP8646 bandwidth capacitance, C_G, needs to be adjusted to fit the appropriate application.

Bench data has been collected for the supercap application with the LMZ12003 regulator; it was discovered that this application works best for a bandwidth of 2 kHz to 30 kHz. Operating anything less than this recommended bandwidth might prevent the LMP8646 from quickly limiting the current. Choosing a bandwidth that is in the middle of this range is recommended and using the equation:

$$C_G = 1/(2 \times pi \times R_G \times Bandwidth) \quad (3)$$

to find C_G (this example uses a C_G value of 0.1nF).

After selecting an initial C_G value, capture the plot for I_{LIMIT} and adjust C_G until a desired load current plot is obtained.

Step 5: Choose the Output Resistor, ROUT

ROUT plays a very small role in the overall system performance for the resistive load application. ROUT is more important for a supercap load because the initial current error is typically large with a capacitive load. Because current is directly proportional to voltage for a resistive load, the output current is not large at startup. The bigger the ROUT, the longer it takes for the output voltage to reach its final value. It is recommended that the value for ROUT is at least 50 Ω, which is the value used for this example.

Step 6: Adjusting the Components

Capture the output current and output voltage plots and adjust the components as necessary. The most common components to adjust is C_G for the bandwidth. An example output current and voltage plot can be seen in Figure 2

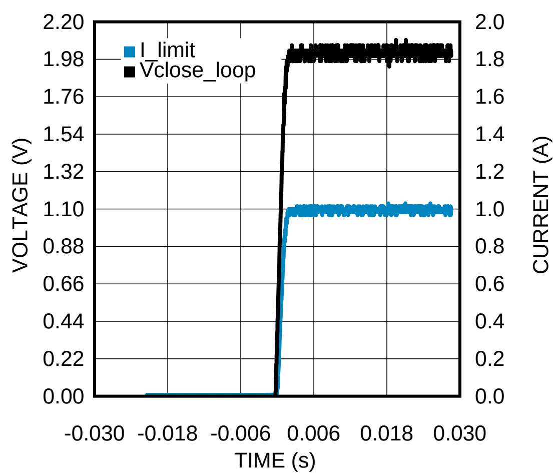

Figure 2. SuperCap Application with LMZ12003 Regulator Plot