Using LMZ31710 for Higher Output Voltages

SVA - Simple Switcher

ABSTRACT

The LMZ31710 power module has been designed and characterized for operation at output voltages from 0.6 V to 5.5 V. However, several applications require higher voltages than the standard point-of-load voltages that the LMZ31710 is designed for. Following the guidance in this application note, the LMZ31710 can be used for output voltages up to 9.5 V. All data included in this application note has been taken at V_{IN} = PV_{IN} = 12 V.

Typical Application

Figure 1 shows a typical schematic for operating LMZ31710 at higher output voltages. The schematic is similar to the standard applications shown in the datasheet; with the exception of the feedback resistor divider requires two external resistors (R_{UPPER} & R_{SET}) and SENSE+ is now left open. Refer to Table 1 for resistor values and switching frequency ranges for several output voltages. Table 2 shows several switching frequencies and the corresponding R_{RT} resistor.

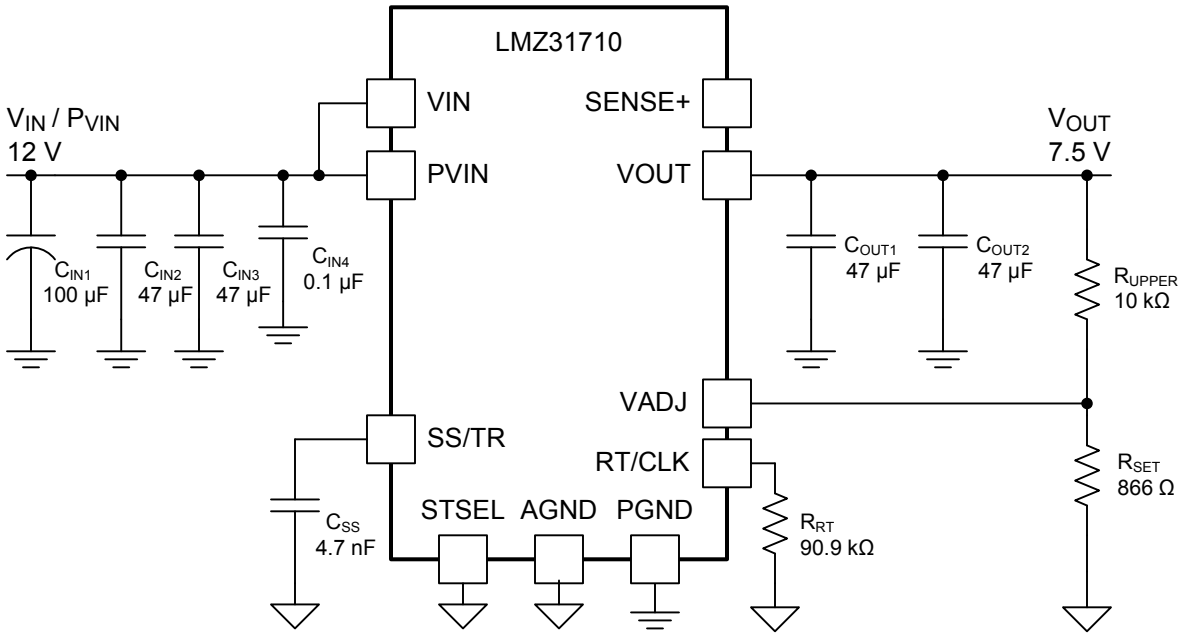

Figure 1. Typical High V_{OUT} Schematic

Operating Input Voltage

All data and recommended operating conditions in this application note apply to a 12-V input voltage. Both the VIN and PVIN were connected togther for all tests. Operation at higher input voltage is possible; however it will affect power dissipation, efficiency, ripple voltage and thermal performance. Additional testing may be required to ensure a safe design.

Setting the Output Voltage

To set the output voltage for a high V_{OUT} application, two external feedback resistors (R_{UPPER} & R_{SET}) are required and the SENSE+ pin should be left open. Table 1 lists several output voltages, the required R_{UPPER} & R_{SET} resistors, and the allowable switching frequency range for that voltage. For output voltages not listed in the table, the R_{SET} value can be calculated using Equation 1, while R_{UPPER} remains 10 kΩ.

The output voltage range tested for this application note is 5.5 V to 9.5 V; from an input voltage of 12 V. Operation at output voltages greater than 9.5 V must be tested. In any case, the maximum output voltage should not exceed 80% of the input voltage and the power dissipation must be less than 4.5 W.

Table 1. Voltage Setting Resistors and Frequency Range

V_{OUT}	R_{UPPER}	R_{SET}	Switching Frequency Range
6.0 V	10 kΩ	1.1 kΩ	600 kHz - 1.2 MHz
6.5 V	10 kΩ	1.02 kΩ	600 kHz - 1.2 MHz
7.0 V	10 kΩ	931 Ω	600 kHz - 1.2 MHz
7.5 V	10 kΩ	866 Ω	600 kHz - 1.2 MHz
8.0 V	10 kΩ	806 Ω	600 kHz - 1.2 MHz
8.5 V	10 kΩ	759 Ω	600 kHz - 1.1 MHz
9.0 V	10 kΩ	715 Ω	600 kHz - 1.0 MHz
9.5 V	10 kΩ	673 Ω	600 kHz - 750 kHz

$$R_{SET} = \frac{10}{\left(\left(\frac{V_{OUT}}{0.6}\right) - 1\right)} \text{ (k}\Omega\text{)} \quad (1)$$

Switching Frequency

When operating the LMZ31710 at increased output voltages, the minimum allowable switching frequency is 600 kHz. The switching frequency can either be set using a frequency setting resistor (R_{RT}), or by applying an external clock. The switching frequency range for several output voltages is listed in Table 1. Operating near the lower end of the frequency range will improve efficiency, while increasing the frequency will reduce output voltage ripple. The switching frequency range applies to V_{IN} = PV_{IN} = 12 V.

Table 2. Switching Frequency Setting Resistor

Switching Frequency	600 kHz	750 kHz	900 kHz	1.0 MHz	1.2 MHz
R_{RT}	124 kΩ	90.9 kΩ	69.8 kΩ	63.4 kΩ	48.7 kΩ

Input and Output Capacitance

When operating the LMZ31710 at higher output voltages, the amount of required input and output capacitance is different from what is required in the datasheet.

The higher output voltage also means the input current will increase. To ensure a solid input voltage, additional input capacitors may be required. The minimum input capacitance is two 47 µF ceramic capacitors, plus an additional 100 µF, non-ceramic bulk capacitor is recommended.

To ensure stability over the higher output voltage range, the allowable output capacitance range is 94 µF to 300 µF. The minimum required capacitance must include at least two 47 µF, 16 V ceramic capacitors. Additional output capacitance can be either ceramic, low-ESR polymer type, or a combination of the two.

Power Dissipation

A key concern when adjusting the output voltage higher than the range of the LMZ31710 is power dissipation. Keeping the power dissipation of the device within the range of the device's datasheet will ensure safe thermal performance. The maximum power dissipation shown in the datasheet is 4.5 W. When increasing the output voltage, the power dissipation must be ≤ 4.5 W to ensure a thermally efficient design. Figure 2 shows the power dissipation for several output voltages at multiple switching frequencies. Power dissipation can also be calculated based on efficiency. Figure 3 shows the efficiency for the same output voltages and switching frequencies.

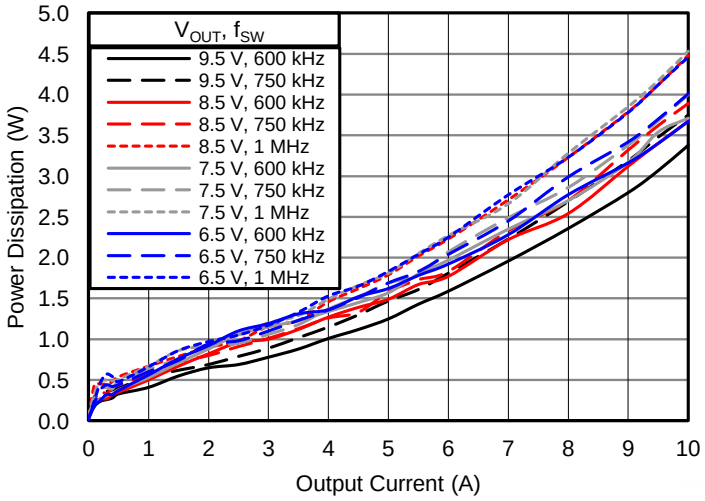

Figure 2. Power Dissipation

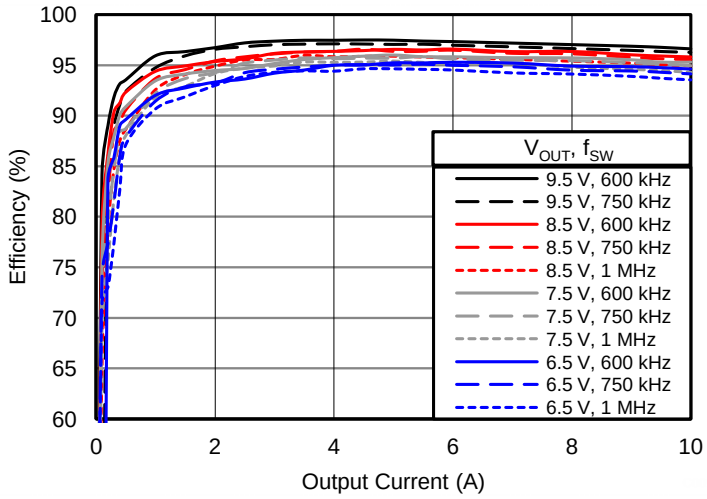

Figure 3. Efficiency

Thermal Performance

The thermal performance of the device is shown in the Safe Operating Area graph, Figure 2. The Safe Operating Area graph shows the operating conditions at which the LMZ31710 internal components are at or below their thermal limits. This graph applies to 12 V input voltage, increasing the input voltage will result in even more de-rating. The graphs are taken at natural convection, or 0 LFM. Increasing the airflow with improve the thermal de-rating.

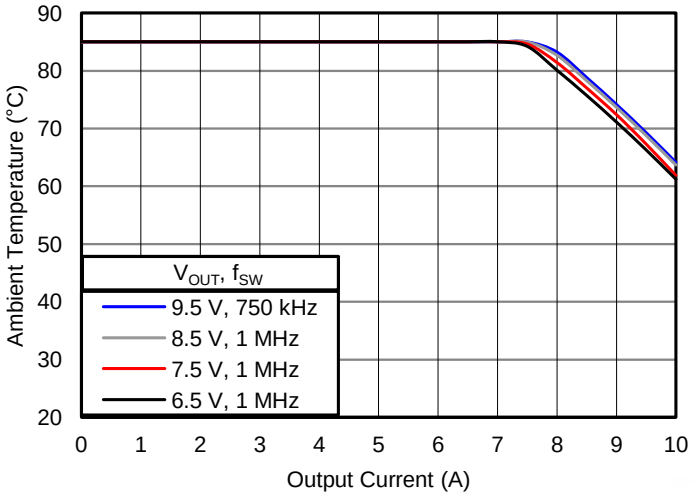

Figure 4. Safe Operating Area

Conclusion

Operating the LMZ31710 at output voltages beyond what is characterized in the datasheet is possible by following the guidance of this application note. Restrictions and operating conditions outline in this document must be followed to ensure a safe design. Final application testing must be performed on any design to ensure proper operation and behavior. Refer to the LMZ31710 datasheet for electrical characteristics and other device specifications. The high voltage operation described in the document also applies to LMZ31707 (7-A device) and LMZ31704 (4-A device).

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