Maximum Output Current of the TPS62050

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ABSTRACT

The TPS62050 is a highly integrated synchronous step-down dc/dc converter capable of delivering output currents up to 800 mA. However, the maximum output current is limited by parameters such as ambient temperature, input-output voltage ratio, and switching frequency. This application report provides the maximum allowable output current of the TPS62050.

The maximum allowable output current of the TPS6205x is obtained in terms of various conditions such as ambient temperature, input-output voltage ratio, and switching frequency. The converter power loss (comprised of conduction loss, switching loss, and gate drive loss) is dissipated as heat through the device package, resulting in an increased IC junction temperature. Since the operational junction temperature of the TPS62050 is 125°C, the maximum allowable output current is limited by the operational junction temperature. If the junction temperature exceeds 145°C, the device enters a thermal shutdown mode to turn off the step-down converter and to disable the controller. Thus, the maximum allowable output current is limited by the junction temperature of 125°C and the package dissipation ratings. In terms of the input-output voltage ratio, ambient temperature, and switching frequency, the total power converter loss is calculated and the maximum allowable output current is obtained.

The following values are used for determining the maximum allowable output current:

- Input voltage and output voltages, V_I and V_O (shown in the graphs)
- Ambient free-air temperatures (shown in the graphs)
- Switching frequency of 850 kHz (with 1.2 MHz, the maximum allowable output currents in the graphs are reduced by 20 mA)
- Inductor of 10 μH
- Thermal resistance junction-to-ambient of 180°C/W. The thermal resistance changes with board layout and copper plane area. Refer to the application report *PowerPAD Thermally Enhanced Package* (SLMA002) for PowerPAD package thermal performance.

Figure 1 shows the device power dissipation limit in terms of ambient temperature. The dotted line in the figure is shown as an example. At 50°C, the device dissipation limit is 417 mW.

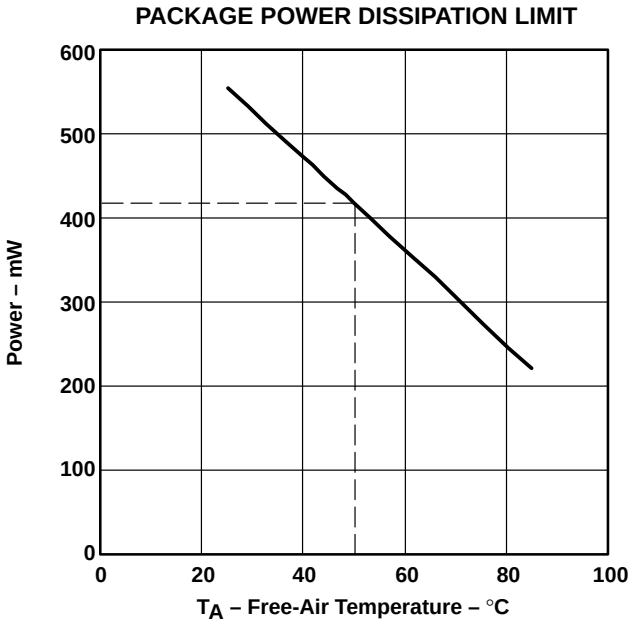

Figure 1. Package Power Dissipation Limit

Figure 2 shows the total converter loss including PMOS conduction loss and NMOS conduction loss when a load current of 800 mA at T_A = 50°C is applied. The total converter loss reaches 550 mW, which is out of the safe region for the device. Thus, the load current should be derated from 800 mA to ensure the device operates in a safe operating region. In this case, the maximum allowable current is 720~765 mA, depending on the input voltage.

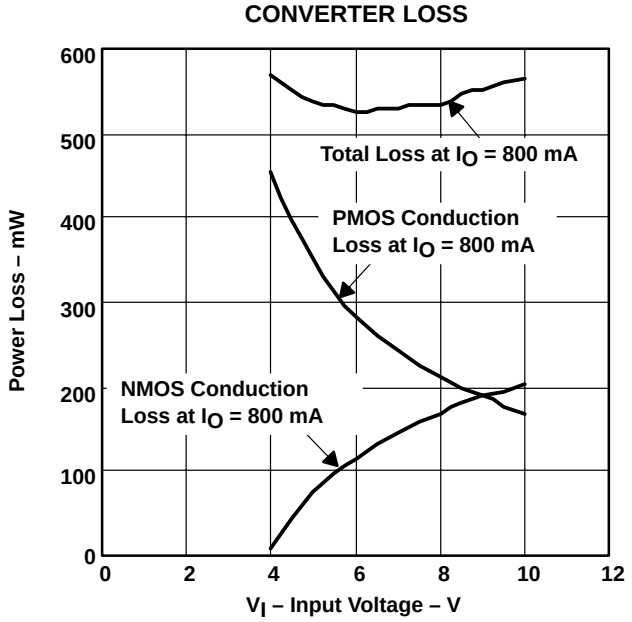

Figure 2. Converter Power Loss (T_A = 50 C, I_O = 800 mA, V_O = 3.3 V)

Based on the listed environmental parameters, the maximum output currents are obtained and shown in Figure 3 though Figure 5.

Figure 3 shows the maximum allowable output current for V_O = 3.3 V. At T_A = 25°C or below, the device is capable of delivering 800 mA as specified in the data sheet. At T_A = 40°C, the 800-mA output current capability is degraded at about 4 V_I since the power dissipation exceeds the maximum limit of the device. At T_A = 85°C, the maximum output current should be further decreased to 450~530 mA.

For output voltages of 1.8 V and 1.5 V, the maximum output currents are obtained and are shown in Figure 4 and Figure 5, respectively. The maximum output currents shown in the figures are continuous dc values.

When a pulsed load current is applied, the peak current can exceed the obtained maximum output current (I_{max}) as long as the load rms current (I_{rms}) is less than or equal to I_{max}. For example, if you have a pulsed load (1000 mA for 1 ms and 0 mA for 9 ms) under the conditions of 10 V_I, 1.5 V_O, and T_A = 50°C, it is acceptable under T_A = 50°C or below since the load rms current (I_{rms} = 316 mA) is less than the calculated maximum output current (I_{max} = 745 mA). The peak current should be less than 1400 mA.

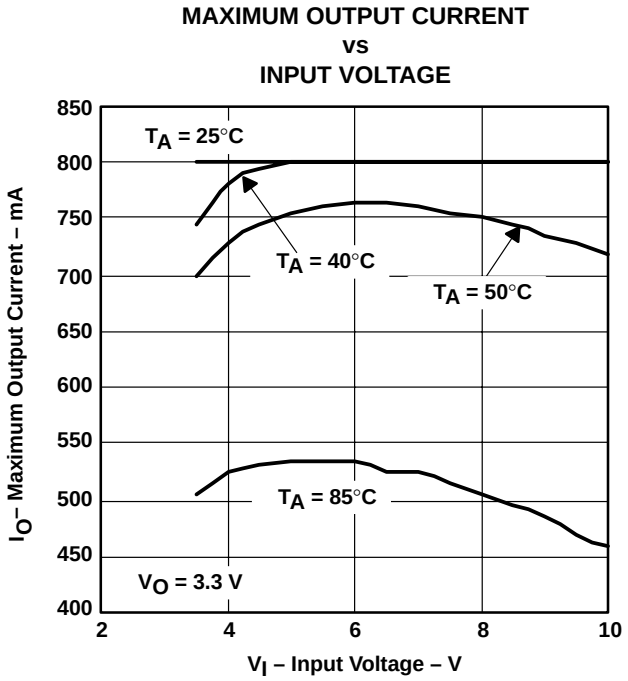

Figure 3. Maximum Output Currents for V_O = 3.3 V

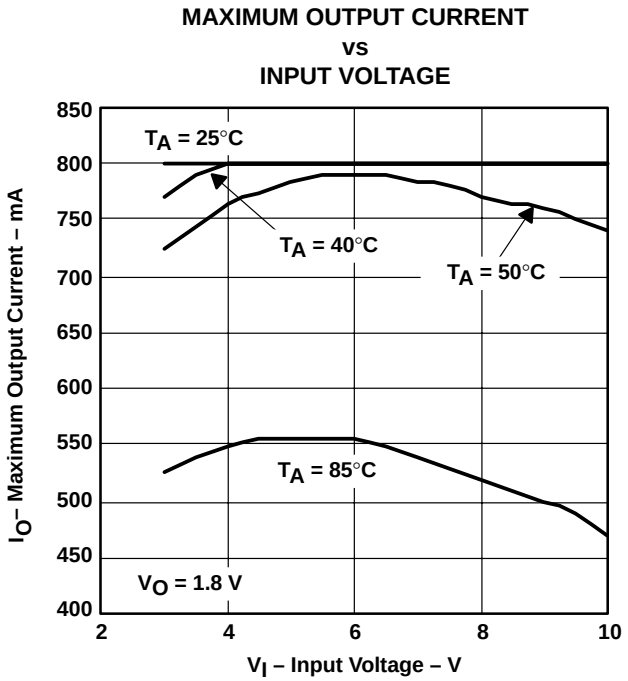

Figure 4. Maximum Output Currents for V_O = 1.8 V

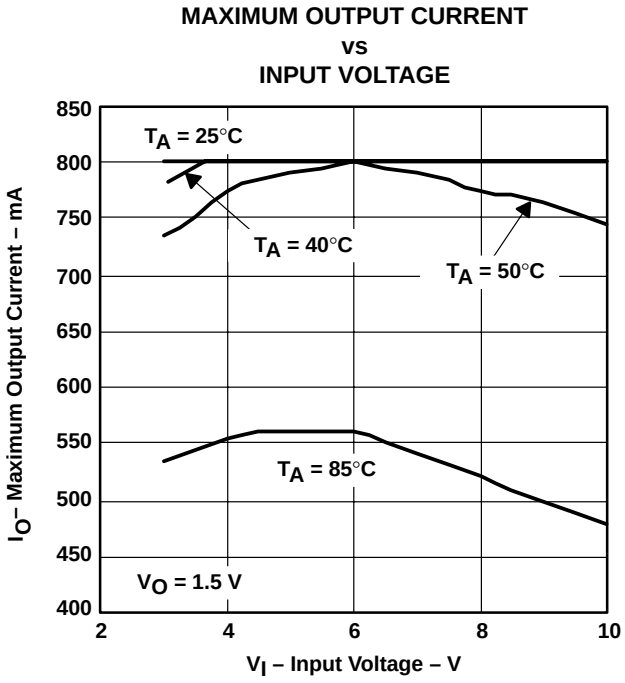

Figure 5. Maximum Output Currents for V_O = 1.5 V

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