Application Report
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Doubling the Power With Ganged TPS2062/TPS2066

Heping Dai *PMP Systems Power*

ABSTRACT

The TPS2062 and TPS2066 devices are dual-channel, 1-A, power-distribution switches that are intended for applications where heavy capacitive loads and short circuits are likely to be encountered. These devices incorporate 70-mΩ, N-channel MOSFET power switches for power-distribution systems that require multiple power switches in a single package. When the output load exceeds the current-limit threshold or a short is present, the device limits the output current to a safe level by switching into a constant-current mode, pulling the overcurrent logic output low. The current limit for each power switch is set at 1.5 A, typically. When continuous heavy overloads and short circuits increase the power dissipation in the switch, causing the junction temperature to rise, a thermal protection circuit shuts off the switch to prevent damage. Recovery from a thermal shutdown is automatic once the device has cooled sufficiently. Internal circuitry ensures that the switch remains off until valid input voltage is present.

While the 1-A continuous current for one switch can provide up to 5 W of power to the switch output, it may still not be enough for some applications. A simple solution is to gang the two power switches in one package by connecting the two output pins together. Mathematically, this can double the power to a load. However, if voltage drops, switch impedances, and/or thermal distributions are different between the two channels, the currents in the two power switches will be imbalanced. A current imbalance could cause one power path to run away until breakdown or over-heating occurs. This application report shows that the TPS2062 and TPS2066 switches can share the current almost equally when the switches are ganged and effectively double the power outage compared to an individual single switch.

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1 Doubling Power to Load

Because the bias voltage for the two switches of the TPS2062 or the TPS2066 are the same as their inputs are tied together internally in the device, the major factors that affect current sharing are the turnon resistance (Rdson), thermal sensing circuits, and the layout of the two power switches of the device. Due to the symmetrical layout design of the devices, the Rdson of the two switches match well, as does the thermal sensing (based on simulation and product test results). In order to verify the ganging performance, a test circuit was developed, as shown in Figure 1.

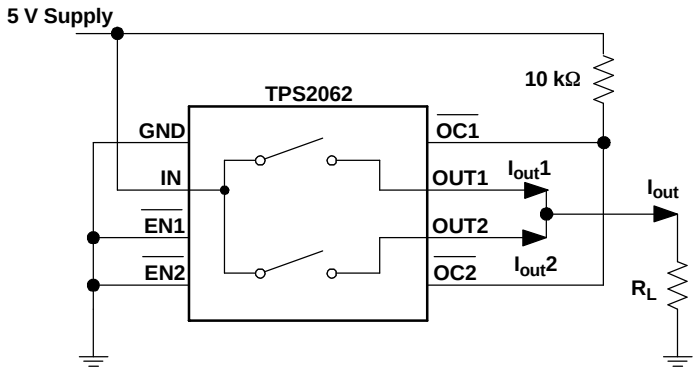

Figure 1. Paralleling Two Power Switches of TPS2062

During testing, the load resistance R_L was adjusted to find where the current limit takes place. A 2-Ω resistor on the load has an equivalent 2.5-A load current to the device. Figure 3 shows the testing result of the individual current for each of the two power switches (Iout1 and Iout2). It is clear that the two power switches share the load well as Iout1 = 1.2 A and Iout2 = 1.2 A.

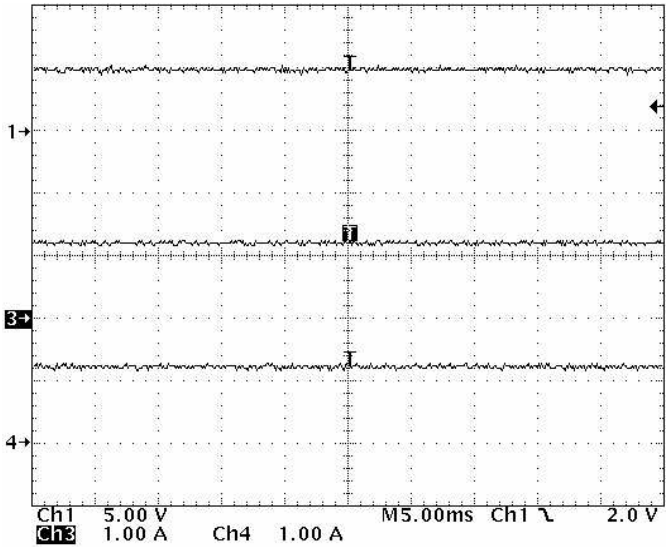

Figure 2. Power Switch Currents With R_L = 2 Ω (ch1:$\overline{OC}$; ch3:Iout1; ch4:Iout2)

The test results show that the TPS2062 can deliver at least 2-A of continuous current to the load when the power switch outputs are tied together.

The TPS2062 has current limiting and thermal protection. To trip the current limit and thermal protection in the device, reduce the load resistance to 1 Ω . Figure 3 shows the individual current on each switch and the total load current. As shown, the current limits on both switches are always triggered at the same time and go to thermal shutdown (the period with 0-A current) at the same time as well.

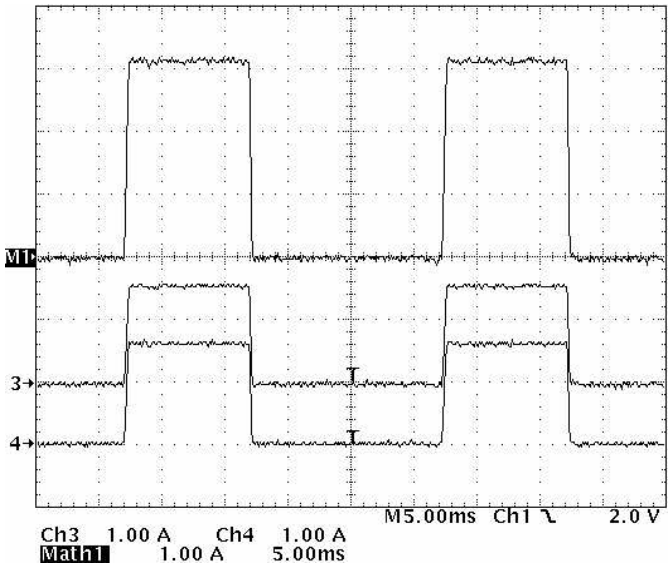

Figure 3. Power Switch in Current Limiting and Thermal Shutdown With R_L = 1 Ω (M1:Iout; ch3:Iout1; ch4:Iout2)

Figure 4 shows the combined overcurrent flag output ($\overline{OC}$) of the two power switches and the switch currents. It shows the $\overline{OC}$ is asserted about 8 ms after the overcurrent trip due to the internal $\overline{OC}$ deglitch.

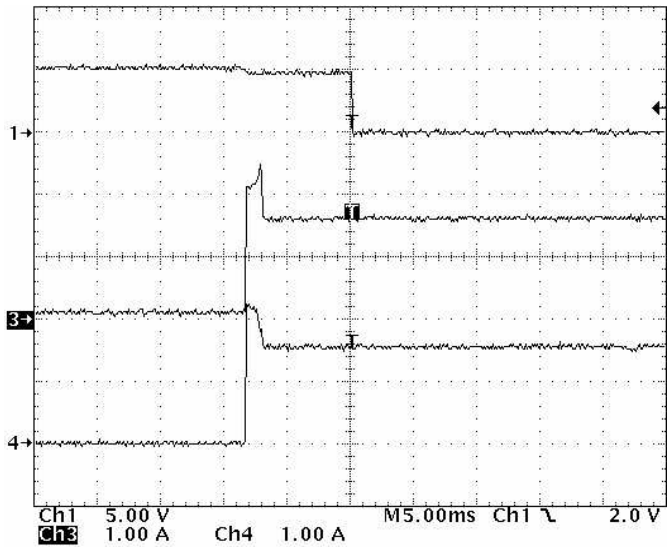

Figure 4. A Overcurrent Load (1 Ω) Connected to Powered Output (ch1:$\overline{OC}$; ch3:Iout1; ch4:Iout2)

2 Statistic Product Data

A more thorough investigation of ganging the TPS2062 power switch outputs was performed by testing a large quantity of TPS2062 devices. Statistical current-limit data was generated. For the individual power switches in the TPS2062/TPS2066, their statistics current limits are shown in Figure 5 and Figure 6 with minimum (–6 sigma), mean, and maximum (+6 sigma) data.

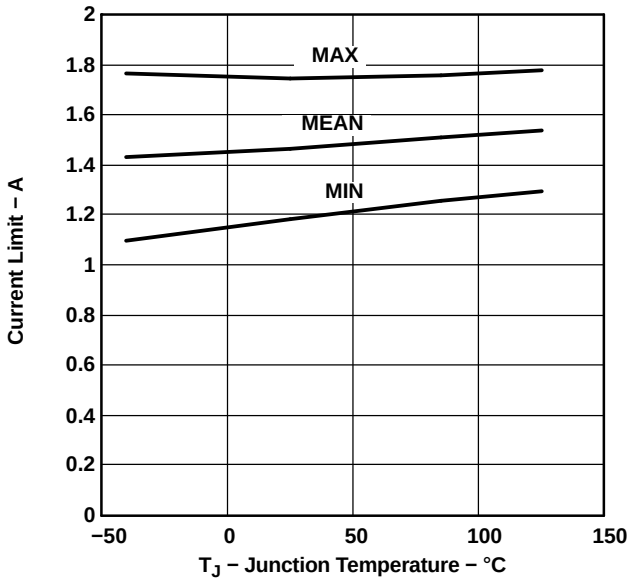

Figure 5. Statistical Current-Limit Test Results of Power Switch 1

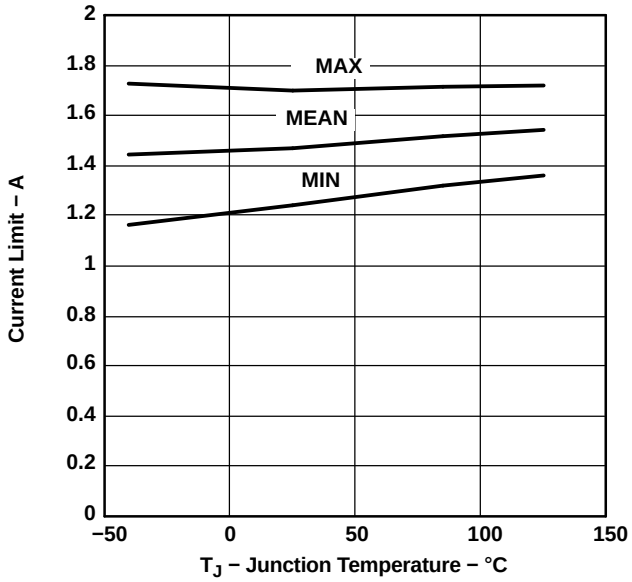

Figure 6. Statistical Current-Limit Test Results of Power Switch 2

The data show that the two power switches have almost equal current-limit distribution (minimum, mean, and maximum) due to the symmetrical power switch layout of the TPS2062.

When the two power switches are ganged, by connecting the two output pins together, the ganged current limit is also tested and its statistical results are shown in Figure 7.

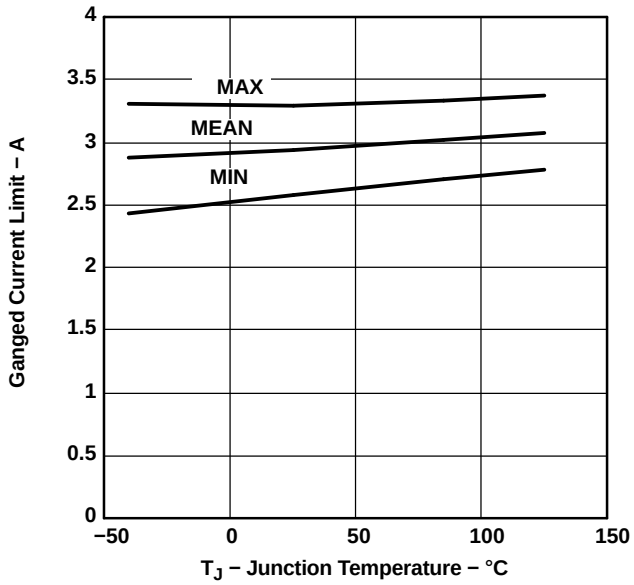

Figure 7. Statistical Current-Limit Test Results of Ganged TPS2062

The data in Figure 7 show that the ganged current limit is equal to the addition of the two individual current limits of the power switches from the minimum to the average and to the maximum. The results show that the ganged power switch can at least conduct 2 A of continuous current, and the typical current limit is about 3 A.

3 Layout Considerations

In order to have the best possible current sharing between the two internal power switches, not only do the power switches have to be laid out exactly the same, but all the external connections must be also symmetrical between the two channels. The best approach is to short the two outputs at the pins with enough copper plane underneath the output pins. The traces from the input power supply or connector to the TPS2062/TPS2066 input pin and from the ganged output pins to load or an output connector should be wide and short so that the trace impedance is small. A large bulk capacitor and a small ceramic capacitor (at least 0.1 µF) placed close to the input pin are recommended.

4 Conclusions

Due to its internal symmetrical layout, the TPS2062/TPS2066 becomes a power switch that has twice the current rating of its individual power switches when its two outputs are connected together. The current limit and thermal protection work the same way as in an individual TPS2062/TPS2066 power switch but with doubled, current-trip threshold and current limit. Therefore, the TPS2062/TPS2066 with two power switches ganged can provide twice the power to a load than that of an individual power switch.

5 Reference

1. *TPS2062, TPS2066, Dual, Current-Limited, Power-Distribution Switches* data sheet (SLVS490), Texas Instruments.

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