Application Brief

Benefits of Using TPS548B23 Versus TPS548B28 in Data Center Applications

Introduction

Modern data center SoCs require more power and better thermals to maintain performance levels. Yet designers expect smaller BOM solution size as one of their key preferences. The 3 × 4mm package used by the previous generation TPS548B28 family is a widely-adopted industry standard, however the new generation TPS548B23 in 3 × 3mm offers an improvement in size and performance requiring less external components. This application brief describes the upgrades of the TPS548B23 in different aspects. Table 1 shows the key specification comparison. Table 2 shows the family devices of TPS548B28 and TPS548B23.

Table 1. TPS548B23 and TPS548B28 Specification Comparison

	TPS548B23	TPS548B28
V_{IN}	4 – 16V	4 – 16V
V_{OUT}	0.5 – 5.5V	0.6 – 5.5V
I_{OUT}	20A	20A
Control Mode	D-CAP4	D-CAP3
FB Accuracy (-40°C< TJ<125°C)	±1.0%	±1.0%
Package	3mm × 3mm 19-pin QFN	4mm × 3mm 21-pin QFN
Pin Pitch	0.4mm	0.4mm
Pin-Strap Configurability without External Components	Yes	No
Junction Temperature	–40°C to +125°C	–40°C to +125°C
Switching Frequency	600KHz, 800KHz, 1MHz, 1.2MHz	600KHz, 800KHz, 1MHz
$R_{DS(ON)}$	8.4mΩ/3.3mΩ	7.7mΩ/2.4mΩ
Efficiency (12Vin, 3.3Vout, 800KHz, 10A, int VCC)	95%	93%
External VCC Bias Support	3.1 – 5.3V	3.13 – 3.6V

Table 2. TPS548B28 and TPS548B23 Family Devices

Devices	Package	I_{OUT}	V_{REF}
TPS548B28	3mm × 4mm	20A	600mV
TPS54JB20		20A	900mV
TPS548A28		15A	600mV
TPS54JA20		12A	900mV
TPS548B23	3mm × 3mm	20A	500mV
TPS548A23		12A	500mV

Efficiency and Thermal Performance

For a power-intensive server application, maintaining high efficiency in a buck converter is crucial because efficiency directly leads to reduced heat dissipation and, consequently, improved overall performance and reliability. Figure 1 shows the efficiency comparison between TPS548B23 and TPS548B28 at the condition of 12V input, 3.3V output, and 800KHz. Figure 1 shows that TPS548B23 has an overall efficiency upgrade compared with TPS548B28. Even though the on-resistance of the TPS548B28's power MOSFETs is slightly lower, the TPS548B23 efficiency is higher due to reduced package parasitics, gate drive, and dead-time improvements.

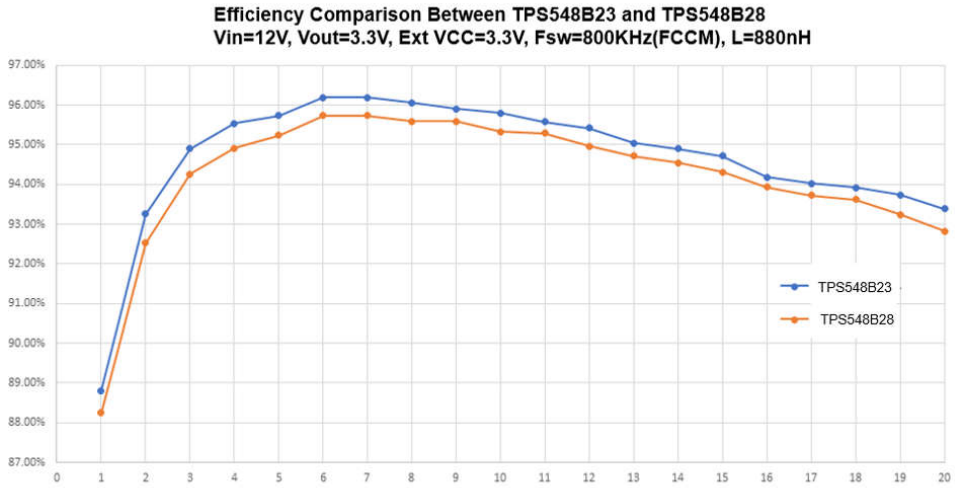

Figure 1. TPS548B23 and TPS548B28 Efficiency Comparison

Thermal performance is a key specification in designing power systems. Poor thermal performance can degrade load performance, leading to damage, particularly in high-power applications. With more advanced process technology and larger ground pad area, TPS548B23 achieves better thermal performance compared with TPS548B28. Figure 2 and Figure 3 shows thermal images at the condition of 12Vin, 1Vout, 800KHz, 20A, where a 10.7℃ drop can be seen.

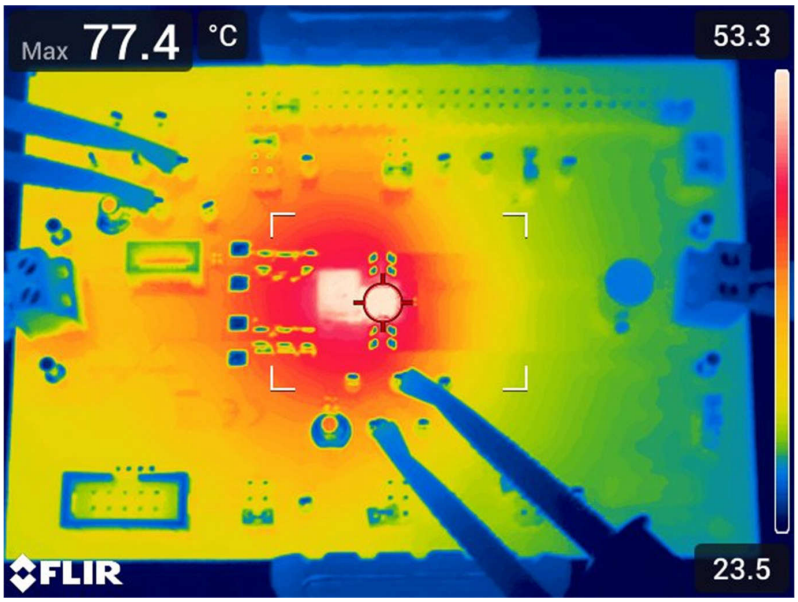

Figure 2. TPS548B23EVM Thermal Image at 12Vin, 1Vout, 800KHz, 20A

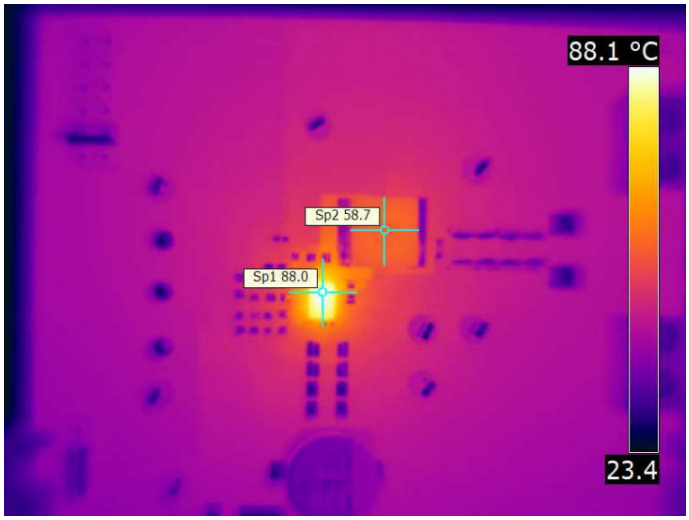

Figure 3. TPS548B28EVM Thermal Image at 12Vin, 1Vout, 800KHz, 20A

Package

The previous generation TPS548B28 is designed in a *4mm × 3mm 21-pin* QFN package as Figure 4 shows and previously was widely-adopted as the industry standard. However, as board area becomes increasingly limited, smaller size is required in power designs, especially for data center applications that are space-constrained. Figure 5 shows that TPS548B23 is designed in a smaller *3mm × 3mm 19-pin* QFN package with a *butterfly-style* pin-out. The *butterfly-style* pin-out is a symmetric pin-out that simplifies PCB layout with the highest power density and best thermal at the lowest cost, as Figure 6 shows.

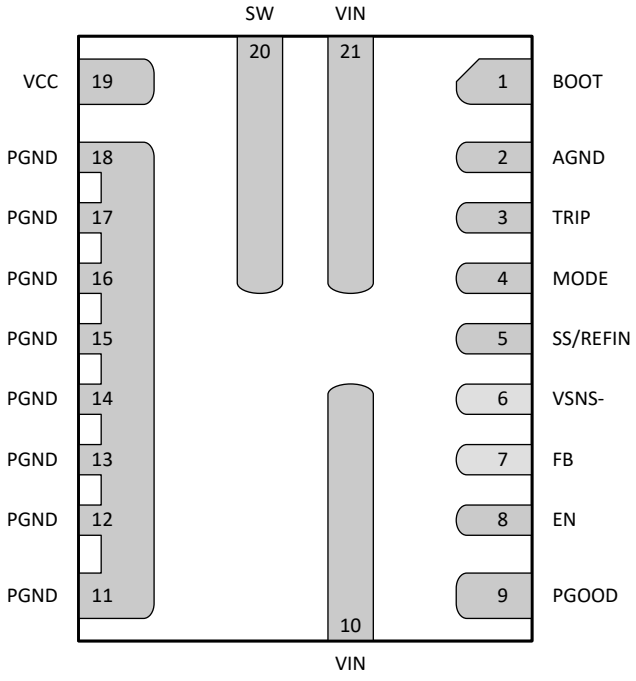

Figure 4. Bottom View of TPS548B28 Package - Asymmetric Pin-out

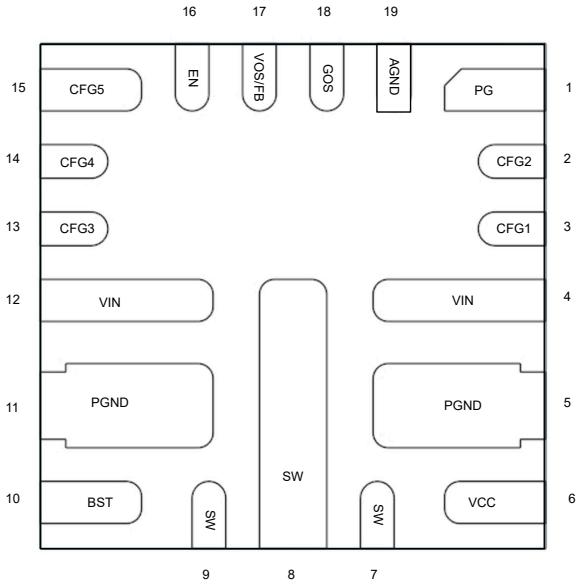

Figure 5. Bottom View of TPS548B23 Package - Symmetric Pin-out

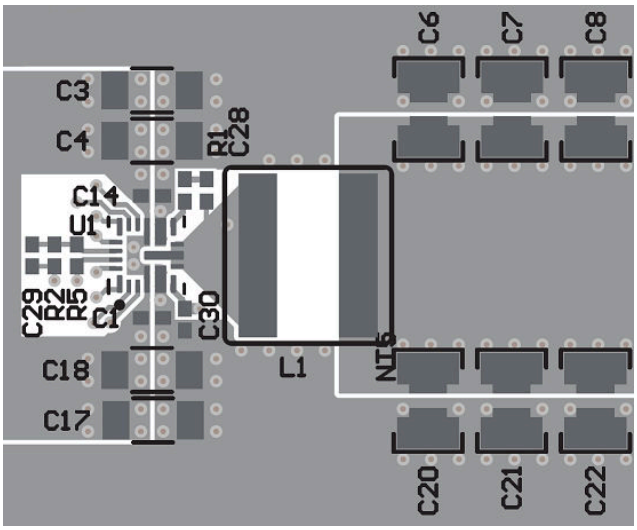

Figure 6. *Butterfly-style* Layout of TPS548B23

D-CAP4 Control Mode

The D-CAP series of control modes is a TI proprietary method of constant-on-time control, designed to maximize device transient performance. TPS548B23 offers the latest generation D-CAP4 to achieve an ultra-fast transient response. Compared with the previous generation D-CAP3, D-CAP4 has faster transient response especially at high output voltage condition, as Figure 7 shows. D-CAP4 requires less output capacitance in high current power rail applications that demand premium load transient performance compared to D-CAP3.

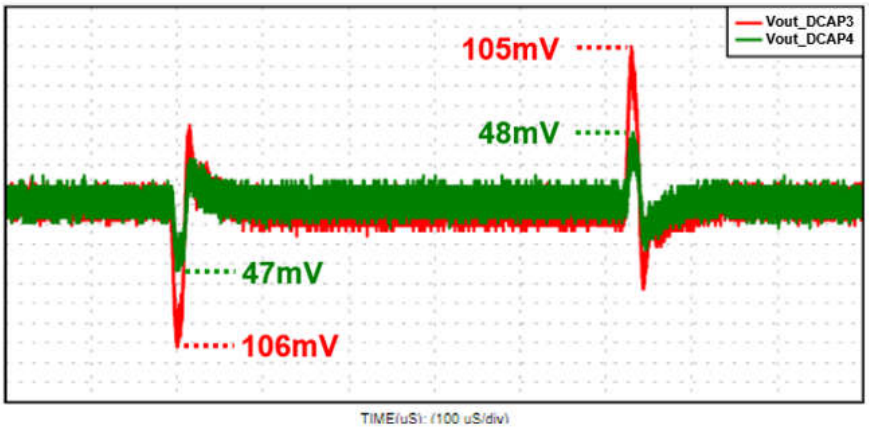

Figure 7. D-CAP4 Versus D-CAP3 Transient Performance at the Condition of 12Vin, 5Vout, 800KHz, 5A to 15A to 5A, 1A/us Slew Rate

Pinstrap Configurability

Unlike the TPS548B28, TPS548B23 configuration pins (CFG1-5) allow for less BOM components when adjusting:

- Overcurrent limit
- Faiult response
- Internal feedback
- External feedback
- Output voltage selection
- Switching frequency
- Soft-start time

Table 3 shows how to configure some of the key specifications for both TPS548B23 and TPS548B28. For more detailed configuration, see the TPS548B23 4V to 16V Input, 20A, Remote Sense, D-CAP4, Synchronous Buck Converter data sheet.

Table 3. Difference Between Key Specifications Configuration between TPS548B23 and TPS548B28

	TPS548B23	TPS548B28
V_{OUT}	By CFG3-5 when int Vfb, resistor divider when ext V_{FB}	By resistor divider
Light Load Mode	By CFG3-5	By connecting VCC, a resistor or AGND to MODE pin
Switching Frequency	By CFG1-2 both int and ext V_{FB}	By connecting VCC, a resistor or AGND to MODE pin
Soft-Start	By CFG1-2 when ext V_{FB}, fixed when int V_{FB}	By connecting a capacitor between SS/REFIN pin and VSNS- pin
Fault Recovery Mode (Hiccup or Latch-off)	By CFG1-2 when ext V_{FB}, hiccup when int V_{FB}.	Fixed, hiccup for OC and UV faults, latch-off for OV Fault
Valley OCP	By CFG1-2 both int and ext V_{FB}	By connecting a resistor to TRIP pin

Conclusion

TPS548B23 is TI's latest generation 16V, 20A DC/DC buck converter. Because of the efficiency and transient response upgrades, the TPS548B23 achieves better performance. Advanced pin-out leads to a more optimized layout, and configuration pins lead to less BOM components and easier design.

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