TPS6302x 4A スイッチ搭載の高効率シングル・インダクタ昇降圧コンバータ

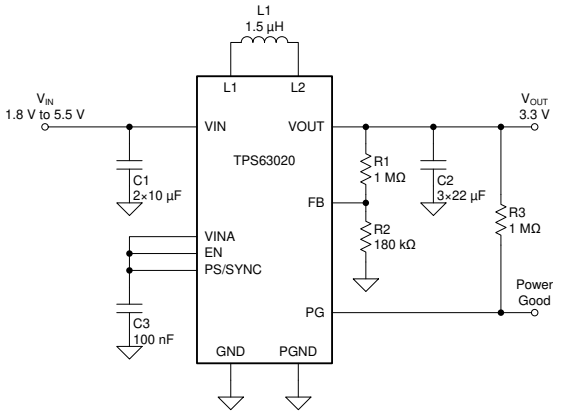
1 特長

- 1.8V ～ 5.5V の入力電圧範囲で動作
- 出力電圧を 1.2V ～ 5.5V の範囲で変更可能
- V_{IN} > 2.5V、V_{OUT} = 3.3V 時の出力電流 2A
- 全負荷範囲にわたって高効率を実現
  - 動作時静止電流：25µA
  - モード選択によるパワーセーブ・モード
- 平均電流モード昇降圧アーキテクチャ
  - モード間の自動遷移
  - 2.4MHz の固定周波数で動作
  - 同期が可能
- パワー・グッド出力
- 安全で堅牢な動作を実現する機能
  - 過熱、過電圧保護
  - シャットダウン中の負荷切断
- WEBENCH Power Designerでカスタム設計を作成
  - TPS63020 用 WEBENCH Power Designer
  - TPS63021 用 WEBENCH Power Designer

2 アプリケーション

- バッテリ駆動デバイスのプリレギュレーション：EPOS (ポータブル・データ端末、バーコード・スキャナ)、電子タバコ、シングル・ボード・コンピュータ、IP ネットワーク・カメラ、ビデオ付きドアベル、陸上モバイル無線
- 電圧スタビライザ：有線通信、ワイヤレス通信、PLC、光モジュール
- バックアップ用スーパーキャパシタ電源：電気メーター、ソリッド・ステート・ドライブ (SSD) - エンタープライズ

概略回路図



3 概要

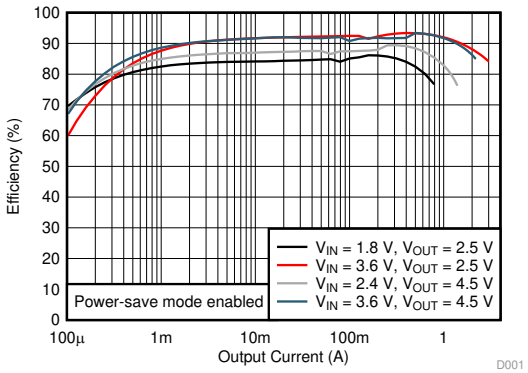
TPS6302x デバイスは、2 セル/3 セルのアルカリ、ニッケルカドミウム、ニッケル水素バッテリ、または 1 セルのリチウム・イオンやリチウム・ポリマー・バッテリ、スーパーキャパシタ、その他の電源レールから給電される製品向けの電源ソリューションを提供します。最大 3A の出力電流がサポートされます。バッテリを使用するとき、2V を下回るまでの放電が可能です。昇降圧コンバータは固定周波数、パルス幅変調 (PWM) コントローラを基礎とし、同期整流を使用して最大効率を実現します。負荷電流が低い時にはコンバータがパワー・セーブ・モードに移行し、広い負荷電流範囲にわたって高効率を維持します。パワー・セーブ・モードを無効にし、コンバータを常に固定スイッチング周波数で動作させることもできます。スイッチの最大平均電流は、標準値4Aに制限されています。出力電圧は外付けの分圧抵抗を使用してプログラムすることも、チップ内部で固定された電圧を使用することもできます。コンバータをディスエーブルにすれば、バッテリの消耗を最小限に抑えることができます。シャットダウン時には、バッテリーから負荷が切断されます。

製品情報(1)

型番	出力電圧	パッケージ
TPS63020	可変	VSON (14)
TPS63021	3.3V	

(1) 利用可能なすべてのパッケージについては、このデータシートの末尾にある注文情報を参照してください。

効率と出力電流との関係



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4 改訂履歴

Revision H (August 2019) から Revision I に変更 **Page**

- Changed ESD numbers to reflect latest test insights ... 6
- Changed Footnotes in order to reflect wording of latest JEP155 and JEP157 specifications ... 6
- Changed V_{FB} naming and description for better readability ... 7

Revision G (March 2019) から Revision H に変更 **Page**

- Changed R3 68 kΩ To: R4 68 kΩ in Figure 28 ... 22

Revision F (March 2019) から Revision G に変更 **Page**

- 概略回路図を変更し、VINA から VIN への接続を削除 ... 1
- Changed Figure 7, removed the connection from VINA to VIN ... 14
- Changed Figure 28, removed the connection from VINA to VIN ... 22

Revision E (May 2017) から Revision F に変更 **Page**

- 最初のページの「特長」と「アプリケーション」を更新 ... 1
- 「*製品情報*」表の「本体サイズ」列を「出力電圧」に変更 ... 1
- Changed the *Pin Configuration* image ... 5
- Changed Chapter order in Application Information 14
- Updated output capacitor selection section ... 16
- Added Table of *Typical Characteristics Curves*. ... 18
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- Added Figure 26 and Figure 27 ... 21
- Changed Figure 28 ... 22
- Added system examples *Supercapacitor Backup Power Supply With Active Cell Balancing* and *Low-Power TEC Driver* 23

Revision D (October 2015) から **Revision E** に変更 **Page**

- Added Voltage AC-spec to *Absolute Maximum Ratings* table for L1, L2. 6

Revision C (February 2013) から **Revision D** に変更 **Page**

- 「*取り扱い定格*」表、「*機能説明*」セクション、「*デバイスの機能モード*」セクション、「*アプリケーションと実装*」セクション、「*電源に関する推奨事項*」セクション、「*レイアウト*」セクション、「*デバイスおよびドキュメントのサポート*」セクション、「*メカニカル、パッケージ、および注文情報*」セクション 追加 1

Revision B (August 2012) から **Revision C** に変更 **Page**

- Changed Figure 7 schematic to show correct component values. 14
- Changed Figure 28 schematic to show correct component values. 22

Revision A (December 2011) から **Revision B** に変更 **Page**

- Changed the Duty cycle in step down conversion values, added MIN = 20%, deleted TYP = 30% and MAX = 40% 7

2010年4月発行のものから更新 **Page**

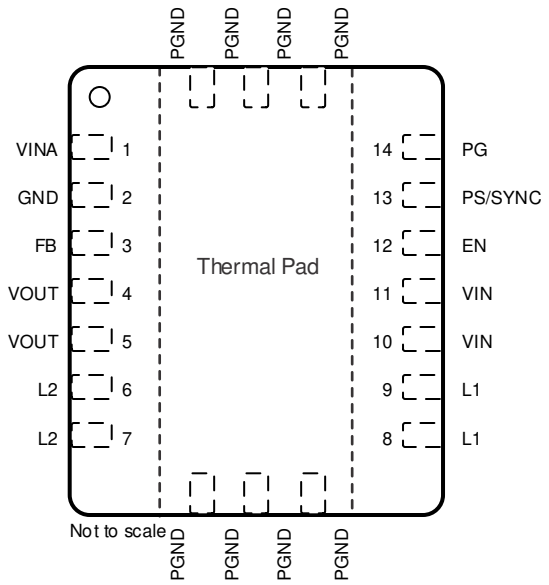
- Updated Figure 31 - PCB Layout Suggestion 24

5 概要 (続き)

TPS6302xデバイスは空気中において、-40℃～85℃の温度範囲で動作します。このデバイスは、3mm × 4mm (DSJ) の 14 ピン VSON パッケージで供給されます。

6 Pin Configuration and Functions

DSJ Package
14-Pin VSON with Exposed Thermal Pad
Top View



Pin Functions

PIN		I/O	DESCRIPTION
NAME	NO.		
EN	12	I	Enable input (1 enabled, 0 disabled), must not be left open
FB	3	I	Voltage feedback of adjustable versions, must be connected to VOUT on fixed output voltage versions
GND	2	–	Control / logic ground
L1	8, 9	I	Connection for inductor
L2	6, 7	I	Connection for inductor
PG	14	O	Output power good (1 good, 0 failure; open-drain), can be left open
PGND		–	Power ground
PS/SYNC	13	I	Enable / disable power save mode (1 disabled, 0 enabled, clock signal for synchronization), must not be left open
VIN	10, 11	I	Supply voltage for power stage
VINA	1	I	Supply voltage for control stage
VOUT	4, 5	O	Buck-boost converter output
Exposed Thermal Pad		–	The exposed thermal pad is connected to PGND.

7 Specifications

7.1 Absolute Maximum Ratings

over operating free-air temperature range (unless otherwise noted)(1)

		MIN	MAX	UNIT
Voltage(2)	VIN, VINA, VOUT, PS/SYNC, EN, FB, PG	–0.3	7	V
	L1, L2 (DC)	–0.3	7	V
	L1, L2 (AC, less than 10 ns)(3)	–3	10	V
Operating junction temperature, T_J		–40	150	°C
Storage temperature, T_{stg}		–65	150	°C

(1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions* is not implied. Exposure to absolute-maximum-rated conditions for extended periods my affect device reliability.
(2) All voltages are with respect to network ground terminal.
(3) Normal switching operation

7.2 ESD Ratings

			VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human body model (HBM), per ANSI/ESDA/JEDEC JS-001, pins VIN, VINA, L1(1)	±500	V
		Human body model (HBM), per ANSI/ESDA/JEDEC JS-001, all other pins(1)	±2000	
		Charged device model (CDM), per JEDEC specification JESD22-C101, all pins(2)	±1500	

(1) JEDEC document JEP155 states that, with basic ESD control methods applied, 500 V HBM allows a safe manufacturing with proven margin.
(2) JEDEC document JEP157 states that, with basic ESD control methods applied, 250 V CDM allows a safe manufacturing.

7.3 Recommended Operating Conditions

	MIN	NOM	MAX	UNIT
Supply voltage at VIN, VINA	1.8		5.5	V
Operating free air temperature, T_A	–40		85	°C
Operating junction temperature, T_J	–40		125	°C

7.4 Thermal Information

THERMAL METRIC(1)		TPS6302x DSJ (VSON) 14 PINS	UNIT
$R_{\theta JA}$	Junction-to-ambient thermal resistance	41.8	°C/W
$R_{\theta JC(top)}$	Junction-to-case (top) thermal resistance	47	°C/W
$R_{\theta JB}$	Junction-to-board thermal resistance	17	°C/W
ψ_{JT}	Junction-to-top characterization parameter	0.9	°C/W
ψ_{JB}	Junction-to-board characterization parameter	16.8	°C/W
$R_{\theta JC(bot)}$	Junction-to-case (bottom) thermal resistance	3.6	°C/W

(1) For more information about traditional and new thermal metrics, see the *Semiconductor and IC Package Thermal Metrics* application report.

7.5 Electrical Characteristics

over recommended free-air temperature range and over recommended input voltage range (typical at an ambient temperature range of 25°C) (unless otherwise noted)

PARAMETER			TEST CONDITIONS	MIN	TYP	MAX	UNIT
DC/DC STAGE							
V_{IN}	Input voltage			1.8		5.5	V
	Minimum input voltage for start-up		$0°C \le T_A \le 85°C$	1.5	1.8	1.9	V
	Minimum input voltage for start-up			1.5	1.8	2.0	V
V_{OUT}	TPS63020 output voltage			1.2		5.5	V
	Duty cycle in step down conversion			20%			
V_{FB_PWM}	TPS63020 feedback voltage		PS/SYNC = V_{IN}	495	500	505	mV
	TPS63021 output voltage			3.267	3.3	3.333	V
V_{FB_PS}	TPS63020 feedback voltage / TPS63021 output voltage regulation in PS mode		PS/SYNC = GND; referenced to V_{FB_PWM}	0.6%		5%	
	Maximum line regulation				0.5%		
	Maximum load regulation				0.5%		
f	Oscillator frequency			2200	2400	2600	kHz
	Frequency range for synchronization			2200	2400	2600	kHz
I_{SW}	Average switch current limit		$V_{IN} = V_{INA} = 3.6$ V, $T_A = 25°C$	3500	4000	4500	mA
	High side switch on resistance		$V_{IN} = V_{INA} = 3.6$ V		50		mΩ
	Low side switch on resistance		$V_{IN} = V_{INA} = 3.6$ V		50		mΩ
I_q	Quiescent current	VIN and VINA	$I_{OUT} = 0$ mA, $V_{EN} = V_{IN} = V_{INA} = 3.6$ V, $V_{OUT} = 3.3$ V		25	50	µA
		VOUT			5	10	µA
	TPS63021 FB input impedance		V_{EN} = HIGH		1		MΩ
I_S	Shutdown current		$V_{EN} = 0$ V, $V_{IN} = V_{INA} = 3.6$ V		0.1	1	µA
CONTROL STAGE							
UVLO	Under voltage lockout threshold		V_{INA} voltage decreasing	1.4	1.5	1.6	V
	Under voltage lockout hysteresis				200		mV
V_{IL}	EN, PS/SYNC input low voltage					0.4	V
V_{IH}	EN, PS/SYNC input high voltage			1.2			V
	EN, PS/SYNC input current		Clamped to GND or VINA		0.01	0.1	µA
	PG output low voltage		$V_{OUT} = 3.3$ V, $I_{PGL} = 10$ µA		0.04	0.4	V
	PG output leakage current				0.01	0.1	µA
	Output overvoltage protection			5.5		7	V
	Overtemperature protection				140		°C
	Overtemperature hysteresis				20		°C

7.6 Typical Characteristics

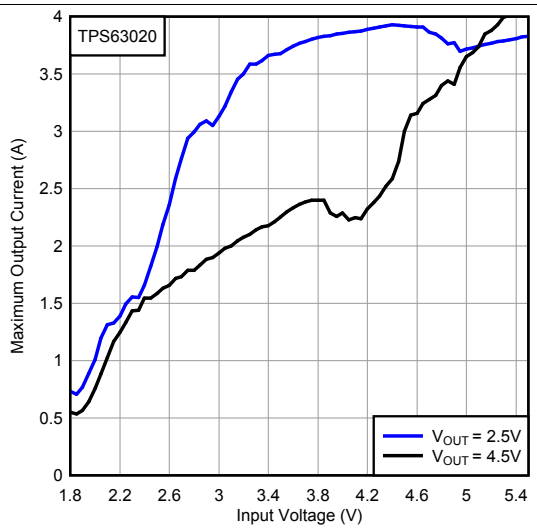


Figure 1. Maximum Output Current Versus Input Voltage, TPS63020, V_{OUT} = 2.5 V/4.5 V

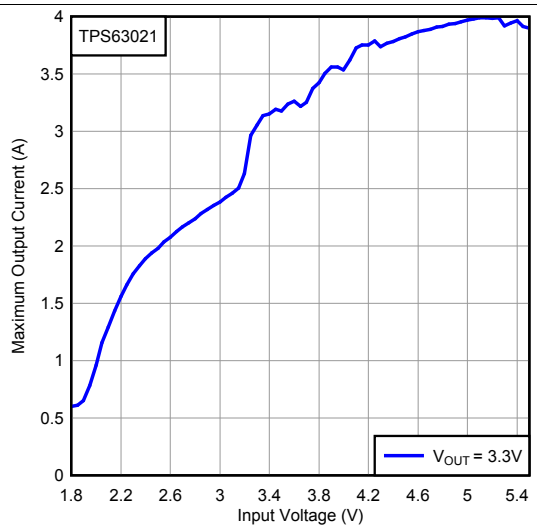


Figure 2. Maximum Output Current Versus Input Voltage, TPS63021, V_{OUT} = 3.3V

8 Detailed Description

8.1 Overview

The control circuit of the device is based on an average current mode topology. The controller also uses input and output voltage feed forward. Changes of input and output voltage are monitored and can immediately change the duty cycle in the modulator to achieve a fast response to those errors. The voltage error amplifier gets its feedback input from the FB pin. At adjustable output voltages, a resistive voltage divider must be connected to that pin. At fixed output voltages, FB must be connected to the output voltage to directly sense the voltage. Fixed output voltage versions use a trimmed internal resistive divider. The feedback voltage will be compared with the internal reference voltage to generate a stable and accurate output voltage.

The device uses four internal N-channel MOSFETs to maintain synchronous power conversion at all possible operating conditions. This enables the device to keep high efficiency over a wide input voltage and output power range.

To avoid ground shift problems due to the high currents in the switches, two separate ground pins GND and PGND are used. The reference for all control functions is the GND pin. The power switches are connected to PGND. Both grounds must be connected on the PCB at only one point, ideally close to the GND pin. Due to the 4-switch topology, the load is always disconnected from the input during shutdown of the converter. To protect the device from overheating an internal temperature sensor is implemented.

8.2 Functional Block Diagram

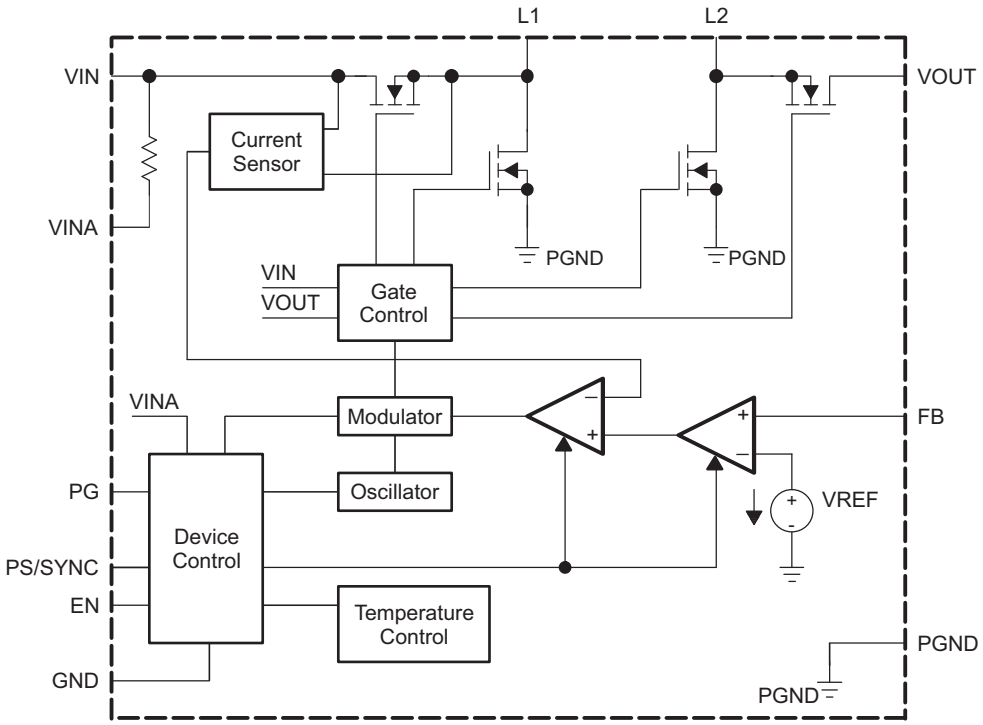


Figure 3. Functional Block Diagram (TPS63020)

Functional Block Diagram (continued)

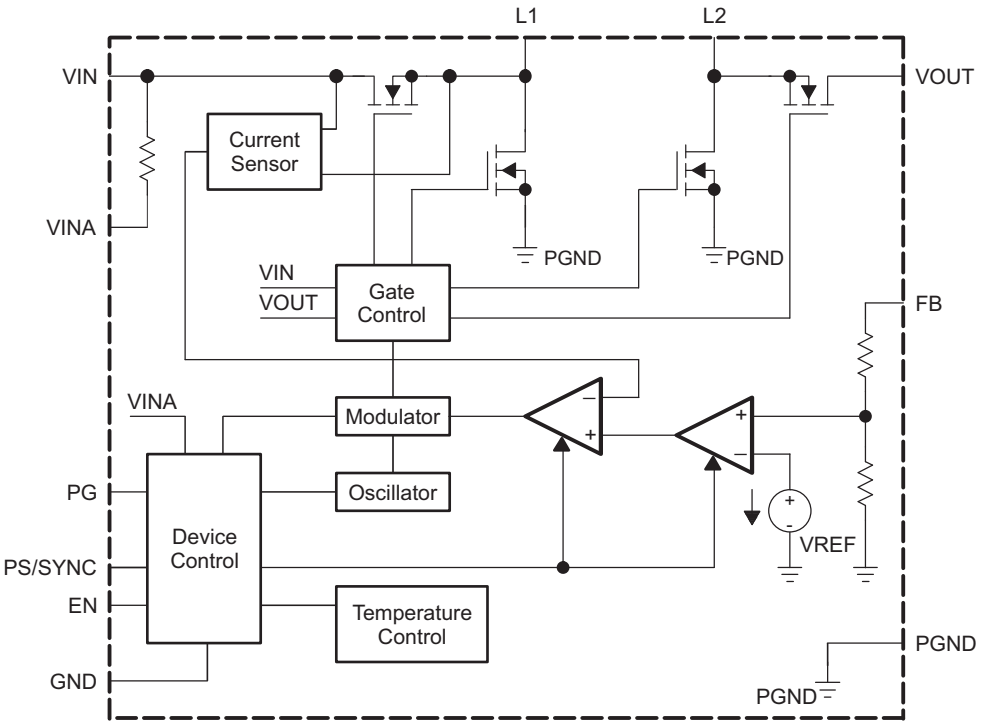


Figure 4. Functional Block Diagram (TPS63021)

8.3 Feature Description

8.3.1 Dynamic Voltage Positioning

As detailed in Figure 6, the output voltage is typically 3% above the nominal output voltage at light load currents, as the device is in power save mode. This gives additional headroom for the voltage drop during a load transient from light load to full load. This allows the converter to operate with a small output capacitor and still have a low absolute voltage drop during heavy load transient changes.

8.3.2 Dynamic Current Limit

To protect the device and the application, the average inductor current is limited internally on the IC. At nominal operating conditions, this current limit is constant. The current limit value can be found in the electrical characteristics table. If the supply voltage at VIN drops below 2.3 V, the current limit is reduced. This can happen when the input power source becomes weak. Increasing output impedance, when the batteries are almost discharged, or an additional heavy pulse load is connected to the battery, can cause the VIN voltage to drop. The dynamic current limit has its lowest value when reaching the minimum recommended supply voltage at VIN. At this voltage, the device is forced into burst mode operation, trying to stay active as long as possible even with a weak input power source.

If the die temperature increases above the recommended maximum temperature, the dynamic current limit becomes active. Similar to the behavior when the input voltage at VIN drops, the current limit is reduced with temperature increasing.

8.3.3 Device Enable

The device is put into operation when EN is set high. It is put into a shutdown mode when EN is set to GND. In shutdown mode, the regulator stops switching, all internal control circuitry is switched off, and the load is disconnected from the input. This means that the output voltage can drop below the input voltage during shutdown. During start-up of the converter, the duty cycle and the peak current are limited in order to avoid high peak currents flowing from the input.

Feature Description (continued)

8.3.4 Power Good

The device has a built-in power-good function to indicate whether the output voltage is regulated properly. As soon as the average inductor current limit is reached, the power-good output gets low impedance. The output is open-drain and can be left open if not needed. By connecting a pullup resistor to the supply voltage of the externally connected logic, it is possible to adjust the voltage level within the absolute maximum ratings.

Because it is monitoring the status of the current control loop, the power-good output provides the earliest indication possible for an output voltage break down and leaves the connected application a maximum time to safely react.

8.3.5 Overvoltage Protection

If, for any reason, the output voltage is not fed back properly to the input of the voltage amplifier, control of the output voltage will not work anymore. Therefore, overvoltage protection is implemented to avoid the output voltage exceeding critical values for the device and possibly for the system it is supplying. The implemented overvoltage protection circuit monitors the output voltage internally as well. In case it reaches the overvoltage threshold, the voltage amplifier regulates the output voltage to this value.

8.3.6 Undervoltage Lockout

An undervoltage lockout function prevents device start-up if the supply voltage on VINA is lower than approximately its threshold (see *Electrical Characteristics*). When in operation, the device automatically enters the shutdown mode if the voltage at VINA drops below the undervoltage lockout threshold. The device automatically restarts if the input voltage recovers to the minimum operating input voltage.

8.3.7 Overtemperature Protection

The device has a built-in temperature sensor which monitors the internal IC temperature. If the temperature exceeds the programmed threshold (see *Electrical Characteristics*), the device stops operating. As soon as the IC temperature has decreased below the programmed threshold, it starts operating again. There is a built-in hysteresis to avoid unstable operation at IC temperatures at the overtemperature threshold.

8.4 Device Functional Modes

8.4.1 Soft-start and Short Circuit Protection

After being enabled, the device starts operating. The average current limit ramps up from an initial 400 mA following the output voltage increasing. At an output voltage of about 1.2 V, the current limit is at its nominal value. If the output voltage does not increase, the current limit does not increase. There is no timer implemented. Thus, the output voltage overshoot at start-up, as well as the inrush current, is kept at a minimum. The device ramps up the output voltage in a controlled manner even if a large capacitor is connected at the output. When the output voltage does not increase above 1.2 V, the device assumes a short circuit at the output, and keeps the current limit low to protect itself and the application. At a short on the output during operation, the current limit also is decreased accordingly.

8.4.2 Buck-Boost Operation

To regulate the output voltage at all possible input voltage conditions, the device automatically switches from step-down operation to boost operation and back as required by the configuration. It always uses one active switch, one rectifying switch, one switch permanently on, and one switch permanently off. Therefore, it operates as a step-down converter (buck) when the input voltage is higher than the output voltage, and as a boost converter when the input voltage is lower than the output voltage. There is no mode of operation in which all four switches are permanently switching. Controlling the switches this way allows the converter to maintain high efficiency at the most important point of operation when input voltage is close to the output voltage. The RMS current through the switches and the inductor is kept at a minimum to minimize switching and conduction losses. For the remaining two switches, one is kept permanently on and the other is kept permanently off, thus causing no switching losses.

Device Functional Modes (continued)

8.4.3 Control Loop

The controller circuit of the device is based on an average current mode topology. The average inductor current is regulated by a fast current regulator loop which is controlled by a voltage control loop. Figure 5 shows the control loop.

The non-inverting input of the transconductance amplifier, gmv, is assumed to be constant. The output of gmv defines the average inductor current. The inductor current is reconstructed by measuring the current through the high-side buck MOSFET. This current corresponds exactly to the inductor current in boost mode. In buck mode, the current is measured during the on-time of the same MOSFET. During the off-time, the current is reconstructed internally starting from the peak value at the end of the on-time cycle. The average current and the feedback from the error amplifier gmv forms the correction signal gmc. This correction signal is compared to the buck and the boost sawtooth ramp giving the PWM signal. Depending on which of the two ramps, the gmc output crosses either the buck or the boost stage is initiated. When the input voltage is close to the output voltage, one buck cycle is always followed by a boost cycle. In this condition, no more than three cycles in a row of the same mode are allowed. This control method in the buck-boost region ensures a robust control and the highest efficiency.

The buck-boost overlap control makes sure that the classical buck-boost function, which would cause two switches to be on every half a cycle, is avoided. Thanks to this block, whenever all switches becomes active during one clock cycle, the two ramps are shifted away from each other. On the other hand, when there is no switching activities because there is a gap between the ramps, the ramps are moved closer together. As a result, the number of classical buck-boost cycles or no switching is reduced to a minimum and high efficiency values has been achieved.

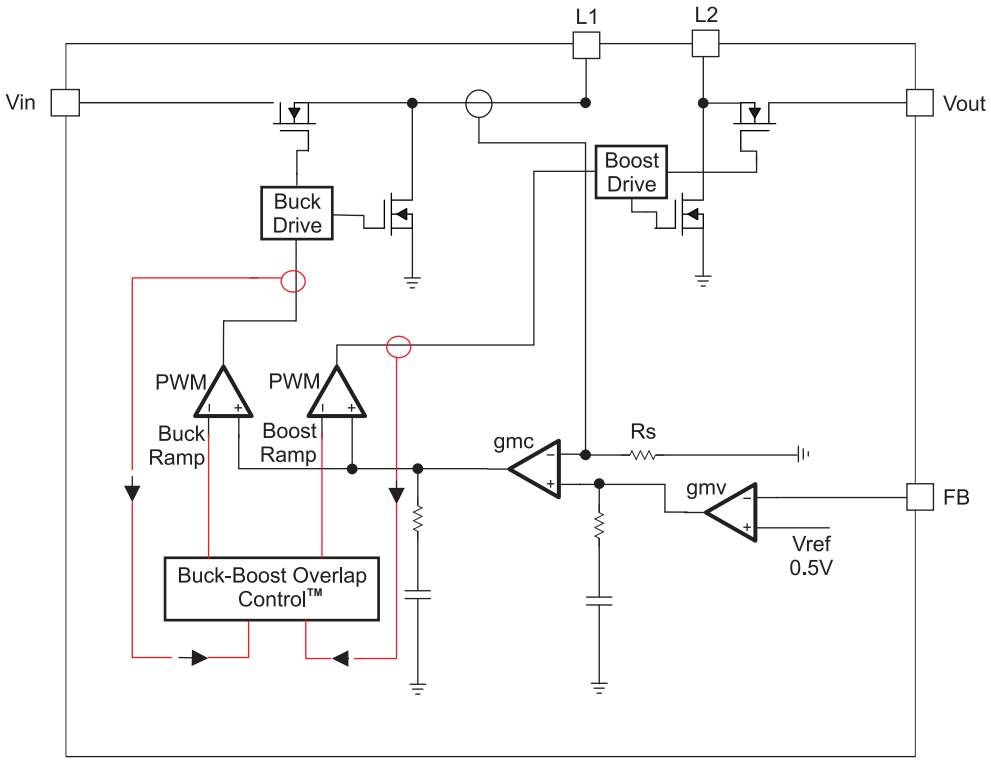


Figure 5. Average Current Mode Control

Device Functional Modes (continued)

8.4.4 Power Save Mode and Synchronization

The PS/SYNC pin can be used to select different operation modes. Power save mode is used to improve efficiency at light load. To enable power save mode, PS/SYNC must be set low. If PS/SYNC is set low, then power save mode is entered when the average inductor current gets lower than about 100 mA. At this point, the converter operates with reduced switching frequency and with a minimum quiescent current to maintain high efficiency. See Figure 6 for detailed operation of the power save mode.

During the power save mode, the output voltage is monitored with a comparator by the threshold comp low and comp high. When the device enters power save mode, the converter stops operating and the output voltage drops. The slope of the output voltage depends on the load and the value of output capacitance. As the output voltage falls below the comp low threshold set to 2.5% typical above V_{OUT}, the device ramps up the output voltage again, by starting operation using a programmed average inductor current higher than required by the current load condition. Operation can last one or several pulses. The converter continues these pulses until the comp high threshold, set to typically 3.5% above V_{OUT} nominal, is reached and the average inductance current gets lower than about 100 mA. When the load increases above the minimum forced inductor current of about 100 mA, the device automatically switches to pulse width modulation (PWM) mode.

The power save mode can be disabled by programming high at the PS/SYNC. Connecting a clock signal at PS/SYNC forces the device to synchronize to the connected clock frequency.

Synchronization is done by a phase-locked loop (PLL), so synchronizing to lower and higher frequencies compared to the internal clock works without any issues. The PLL can also tolerate missing clock pulses without the converter malfunctioning. The PS/SYNC input supports standard logic thresholds.

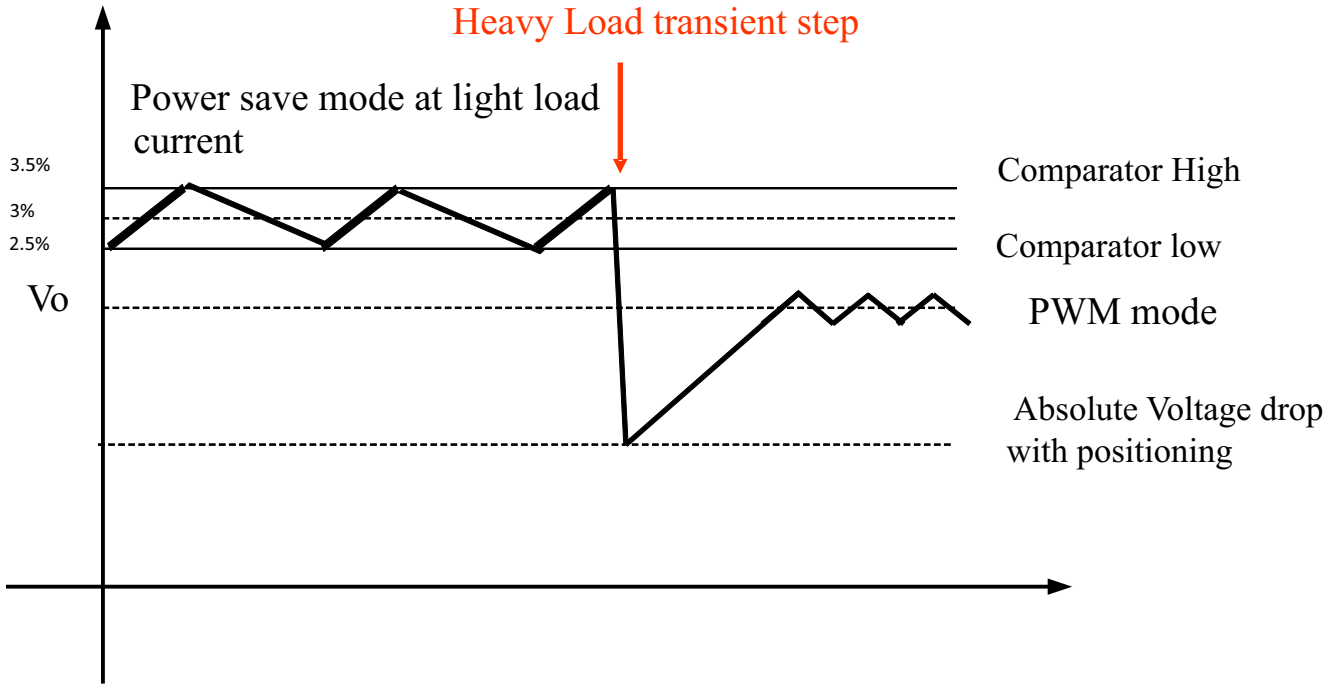


Figure 6. Power Save Mode Thresholds and Dynamic Voltage Positioning

9 Application and Implementation

NOTE

Information in the following applications sections is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI's customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation to confirm system functionality.

9.1 Application Information

The TPS6302x are high efficiency, low quiescent current, non-inverting buck-boost converters suitable for applications that need a regulated output voltage from an input supply that can be higher, lower, or equal to the output voltage. Output currents can go as high as 2 A in boost mode and as high as 4 A in buck mode. The average current in the switches is limited to a typical value of 4 A.

9.2 Typical Application

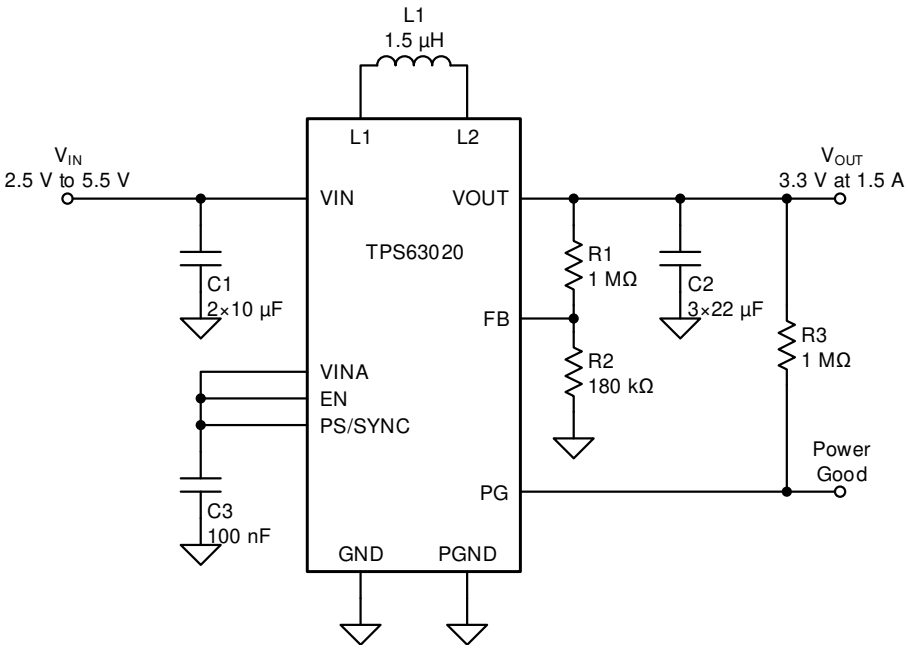


Figure 7. Application Circuit

9.2.1 Design Requirements

The design guideline provides a component selection to operate the device within the recommended operating conditions. See Table 1 for possible inductor and capacitor combinations.

For the fixed output voltage option, the feedback pin needs to be connected to the VOUT pin.

Table 1. Matrix of Output Capacitor and Inductor Combinations

NOMINAL INDUCTOR VALUE [µH](1)	NOMINAL OUTPUT CAPACITOR VALUE [µF](2)			
	2×22	3×22	4×22	≥ 100
1.0		+	+	+
1.5	+	+(3)	+	+
2.2			+	+

(1) Inductor tolerance and current derating is anticipated. The effective inductance can vary by 20% and –30%.
(2) Capacitance tolerance and DC bias voltage derating is anticipated. The effective capacitance can vary by 20% and –50%.
(3) Typical application. Other check marks indicate possible filter combinations.

9.2.2 Detailed Design Procedure

The TPS6302x series of buck-boost converter has internal loop compensation. Therefore, the external inductor and output capacitors have to be selected to work with the internal compensation. When selecting the external components, a low limit for the inductor value exists to avoid subharmonic oscillation which can be caused by a far too fast ramp up of the inductor current. For the TPS6302x series, the inductor value must be kept at or above 1 µH.

In particular, either 1 µH or 1.5 µH is recommended working at an output current between 1.5 A and 2 A. If operating with a lower load current, it is also possible to use 2.2 µH.

Selecting a larger output capacitor value is less critical because the corner frequency moves to lower frequencies.

9.2.2.1 Custom Design with WEBENCH Tools

Click here to create a custom design using the TPS63020 device with the WEBENCH® Power Designer.

1. Start by entering your V_{IN}, V_{OUT} and I_{OUT} requirements.
2. Optimize your design for key parameters like efficiency, footprint or cost using the optimizer dial and compare this design with other possible solutions from Texas Instruments.
3. WEBENCH Power Designer provides you with a customized schematic along with a list of materials with real time pricing and component availability.
4. In most cases, you will also be able to:
   - Run electrical simulations to see important waveforms and circuit performance,
   - Run thermal simulations to understand the thermal performance of your board,
   - Export your customized schematic and layout into popular CAD formats,
   - Print PDF reports for the design, and share your design with colleagues.
5. Get more information about WEBENCH tools at www.ti.com/webench.

9.2.2.2 Inductor Selection

The inductor selection is affected by several parameters such as the following:

- Inductor ripple current
- Output voltage ripple
- Transition point into Power Save Mode
- Efficiency

See Table 2 for a list of typical inductors.

For high efficiencies, the inductor must have a low DC resistance to minimize conduction losses. Especially at high-switching frequencies, the core material has a high impact on efficiency. When using small chip inductors, the efficiency is reduced mainly due to higher inductor core losses. This needs to be considered when selecting the appropriate inductor. The inductor value determines the inductor ripple current. The larger the inductor value, the smaller the inductor ripple current and the lower the conduction losses of the converter. Conversely, larger inductor values cause a slower load transient response. Use Equation 2 to avoid saturation of the inductor when calculating the peak current for the inductor in steady state operation. Only the equation which defines the switch current in boost mode is shown because this provides the highest value of current and represents the critical current value for selecting the right inductor.

$$\text{Duty Cycle Boost} \qquad D = \frac{V_{OUT} - V_{IN}}{V_{OUT}} \tag{1}$$

$$I_{PEAK} = \frac{Iout}{\eta \times (1 - D)} + \frac{Vin \times D}{2 \times f \times L} \tag{2}$$

where

- D = duty cycle in boost mode
- f = converter switching frequency (typical 2.5 MHz)
- L = inductor value
- η = estimated converter efficiency (use the number from the efficiency curves or 0.9 as an assumption)

NOTE

The calculation must be done for the minimum input voltage in boost mode.

Calculating the maximum inductor current using the actual operating conditions gives the minimum saturation current of the inductor needed. It is recommended to choose an inductor with a saturation current 20% higher than the value calculated using Equation 2. Table 2 lists the possible inductors.

Table 2. List of Recommended Inductors (1)

INDUCTOR VALUE [µH]	SATURATION CURRENT [A]	DCR [mΩ]	PART NUMBER	MANUFACTURER	SIZE (LxWxH mm)
1.5	5.1	15	XFL4020-152ME	Coilcraft	4 x 4 x 2.1
1.5	5.4	24	FDV0530S-H-1R5M	muRata	5 x 5 x 3

(1) See *Third-party Products Disclaimer.*

9.2.2.3 Output Capacitor Selection

For the output capacitor, it is recommended to use of small ceramic capacitors placed as close as possible to the VOUT and PGND pins of the IC. The recommended nominal output capacitors are three times 22 µF. If, for any reason, the application requires the use of large capacitors that cannot be placed close to the IC, use a smaller ceramic capacitor in parallel to the large capacitor. Place the small capacitor as close as possible to the VOUT and PGND pins of the IC.

There are no additional requirements regarding minimum ESR. There is also no upper limit for the output capacitance value. Larger capacitors cause lower output voltage ripple as well as lower output voltage drop during load transients.

9.2.2.4 Input Capacitor Selection

A 10 µF input capacitor is recommended to improve line transient behavior of the regulator and EMI behavior of the total power supply circuit. An X5R or X7R ceramic capacitor placed as close as possible to the VIN and PGND pins of the IC is recommended. This capacitance can be increased without limit. If the input supply is located more than a few inches from the TPS6302x converter, additional bulk capacitance can be required in addition to the ceramic bypass capacitors. An electrolytic or tantalum capacitor with a value of 47 µF is a typical choice.

9.2.2.5 Bypass Capacitor

To make sure that the internal control circuits are supplied with a stable low noise supply voltage, a capacitor can be connected between VINA and GND. Using a ceramic capacitor with a value of 0.1 µF is recommended. The value of this capacitor must not be higher than 0.22 µF.

9.2.3 Setting The Output Voltage

When the adjustable output voltage version TPS63020 is used, the output voltage is set by an external resistor divider. The resistor divider must be connected between VOUT, FB, and GND. The feedback voltage is 500 mV nominal. The low-side resistor R2 (between FB and GND) must be kept in the range of 200 kΩ. Use Equation 3 to calculate the high-side resistor R1 (between VOUT and FB).

$$R1 = R2 \times \left(\frac{V_{OUT}}{V_{FB}} - 1 \right) \quad (3)$$

where

- V_{FB}= 500 mV

Table 3. Resistor Selection For Typical Output Voltages

V_{OUT}	R1	R2
2.5 V	750 kΩ	180 kΩ
3.3 V	1 MΩ	180 kΩ
3.6 V	1.1 MΩ	180 kΩ

Table 3. Resistor Selection For Typical Output Voltages (continued)

V_{OUT}	R1	R2
4.5 V	1.43 MΩ	180 kΩ
5 V	1.6 MΩ	180 kΩ

9.2.4 Application Curves

Table 4. Components for Application Characteristic Curves for V_{OUT} = 3.3 V(1)(2)

REFERENCE	DESCRIPTION	PART NUMBER	MANUFACTURER
U1	High Efficiency Single Inductor Buck-Boost Converter With 4-A Switches	TPS63020 or TPS63021	Texas Instruments
L1	1.5 µH, 4 mm x 4 mm x 2 mm	XFL4020-152ML	Coilcraft
C1	2 × 10 µF 6.3 V, 0603, X5R ceramic	GRM188R60J106ME84D	muRata
C2	3 × 22 µF 6.3 V, 0603, X5R ceramic	GRM188R60J226MEAOL	muRata
C3	0.1 µF, X5R or X7R ceramic	Standard	Standard
R1	1 MΩ at TPS63020, 0 Ω at TPS63021	Standard	Standard
R2	180 kΩ at TPS63020, not used at TPS63021	Standard	Standard
R3	1 MΩ	Standard	Standard

(1) See *Third-Party Products Disclaimer*.
(2) For other output voltages, refer to Table 3 for resistor values.

Table 5. Typical Characteristics Curves

PARAMETER	CONDITIONS	FIGURE
EFFICIENCY		
Efficiency vs Output Current, TPS63020 (Power save mode enabled)	V_{IN} = 1.8 V, 2.4 V, 3.6 V, V_{OUT} = 2.5 V, 4.5 V, PS/SYNC = Low	Figure 8
Efficiency vs Output Current, TPS63020 (PWM only)	V_{IN} = 1.8 V, 2.4 V, 3.6 V, V_{OUT} = 2.5 V, 4.5 V, PS/SYNC = High	Figure 9
Efficiency vs Output Current, TPS63021 (Power save mode enabled)	V_{IN} = 2.4 V, 3.6 V, V_{OUT} = 3.3 V, PS/SYNC = Low	Figure 10
Efficiency vs Output Current, TPS63021 (PWM only)	V_{IN} = 2.4 V, 3.6 V, V_{OUT} = 3.3 V, PS/SYNC = High	Figure 11
Efficiency vs Input Voltage, TPS63020 (Power save mode enabled)	V_{OUT} = 2.5 V, Load = 10 mA, 500 mA, 1 A, 2 A, PS/SYNC = Low	Figure 12
Efficiency vs Input Voltage, TPS63020 (Power save mode enabled)	V_{OUT} = 4.5 V, Load = 10 mA, 500 mA, 1 A, 2 A, PS/SYNC = Low	Figure 13
Efficiency vs Input Voltage, TPS63020 (PWM only)	V_{OUT} = 2.5 V, Load = 10 mA, 500 mA, 1 A, 2 A, PS/SYNC = Low	Figure 14
Efficiency vs Input Voltage, TPS63020 (PWM only)	V_{OUT} = 2.5 V, Load = 10 mA, 500 mA, 1 A, 2 A, PS/SYNC = Low	Figure 15
Efficiency vs Input Voltage, TPS63021 (Power save mode enabled)	V_{OUT} = 3.3 V, Load = 10 mA, 500 mA, 1 A, 2 A, PS/SYNC = Low	Figure 16
Efficiency vs Input Voltage, TPS63021 (PWM only)	V_{OUT} = 3.3 V, Load = 10 mA, 500 mA, 1 A, 2 A, PS/SYNC = Low	Figure 17
REGULATION ACCURACY		
Load Regulation, PWM Boost Operation, TPS63020	V_{IN} = 3.6 V , V_{OUT} = 4.5 V, PS/SYNC = High	Figure 18
Load Regulation, PWM Buck Operation, TPS63020	V_{IN} = 3.6 V, V_{OUT} = 2.5 V, PS/SYNC = High	Figure 19
Load Regulation, PWM Operation, TPS63021	V_{IN} = 3.6 V, V_{OUT} = 3.3 V, PS/SYNC = High	Figure 20
Load Transient, TPS63021	V_{IN} = 2.4 V, V_{OUT} = 3.3 V, Load = 500 mA to 1.5 A	Figure 21
Load Transient, TPS63021	V_{IN} = 4.2 V, V_{OUT} = 3.3 V, Load = 500 mA to 1.5 A	Figure 22
Line Transient, TPS63021	V_{IN} = 3.0 V to 3.7 V, V_{OUT} = 3.3 V, Load = 1.5 A	Figure 23
START-UP		
Start-up Behavior from Rising Enable, TPS63021	V_{IN} = 2.4 V, V_{OUT} = 3.3 V, Load = 2.2 Ω	Figure 24
Start-up Behavior from Rising Enable, TPS63021	V_{IN} = 4.2 V, V_{OUT} = 3.3 V, Load = 2.2 Ω	Figure 25
Start-up Behavior from Rising Enable, TPS63021	V_{IN} = 2.4 V, V_{OUT} = 3.3 V, Load = 2.2 Ω	Figure 26
Start-up Behavior from Rising Enable, TPS63021	V_{IN} = 4.2 V, V_{OUT} = 3.3 V, Load = 2.2 Ω	Figure 27

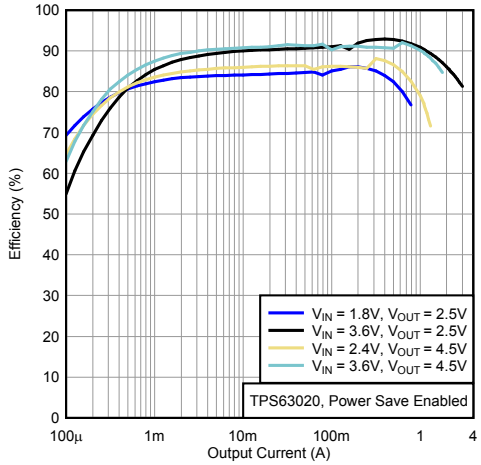


Figure 8. Efficiency Versus Output Current, TPS63020, Power Save Enabled

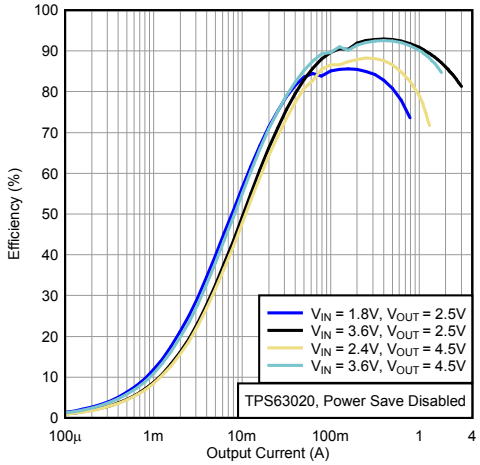


Figure 9. Efficiency Versus Output Current, TPS63020, Power Save Disabled

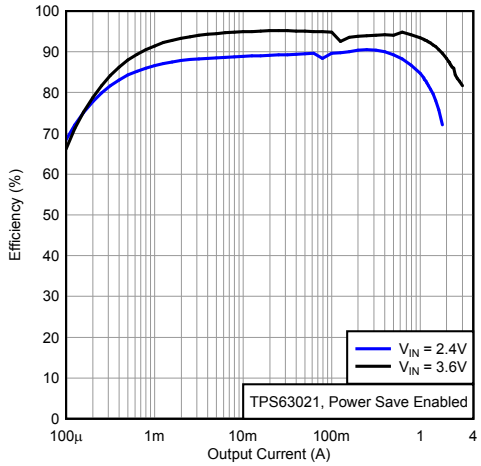


Figure 10. Efficiency Versus Output Current, TPS63021, Power Save Enabled

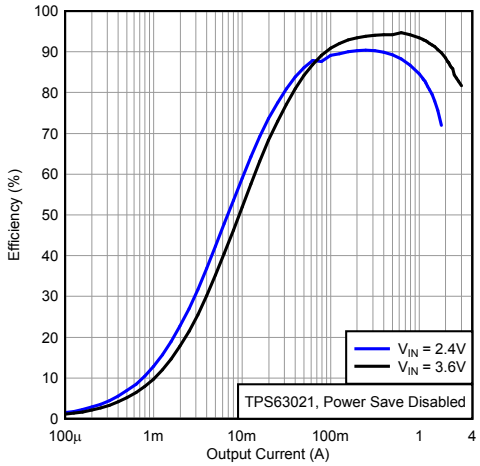


Figure 11. Efficiency Versus Output Current, TPS63021, Power Save Disabled

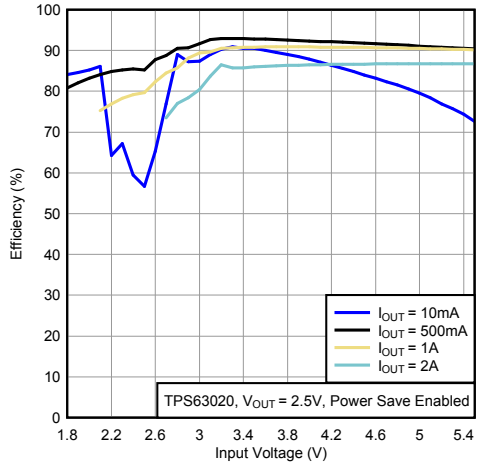


Figure 12. Efficiency Versus Input Voltage, TPS63020, V_{OUT} = 2.5 V, Power Save Enabled

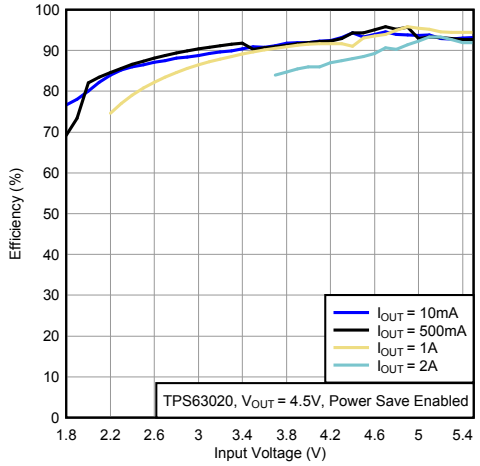


Figure 13. Efficiency Versus Input Voltage, TPS63020, V_{OUT} = 4.5 V, Power Save Enabled

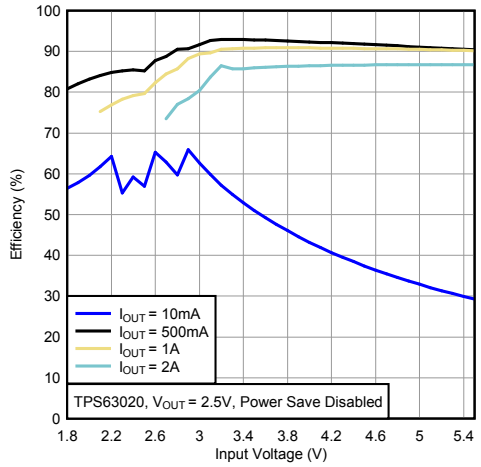


Figure 14. Efficiency Versus Input Voltage, TPS63020, V_{OUT} = 2.5 V, Power Save Disabled

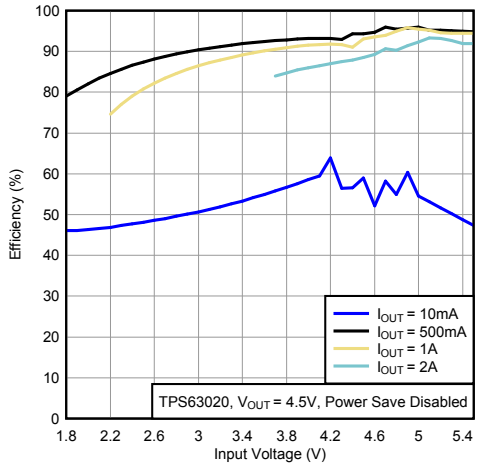


Figure 15. Efficiency Versus Input Voltage, TPS63020, V_{OUT} = 4.5 V, Power Save Disabled

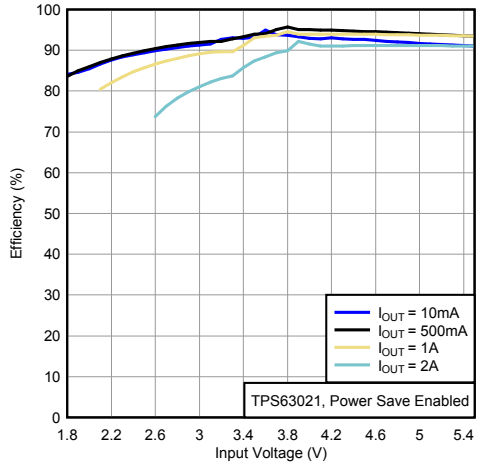


Figure 16. Efficiency Versus Input Voltage, TPS63021, Power Save Enabled

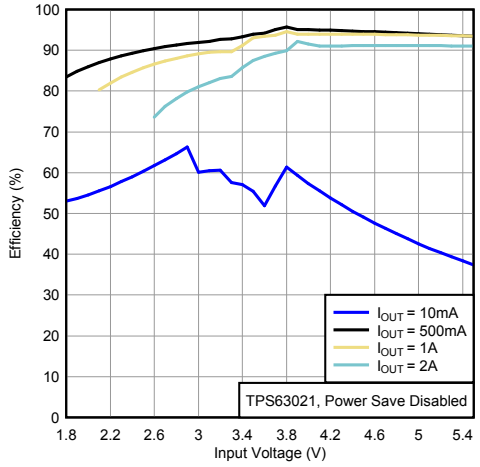


Figure 17. Efficiency Versus Input Voltage, TPS63021, Power Save Disabled

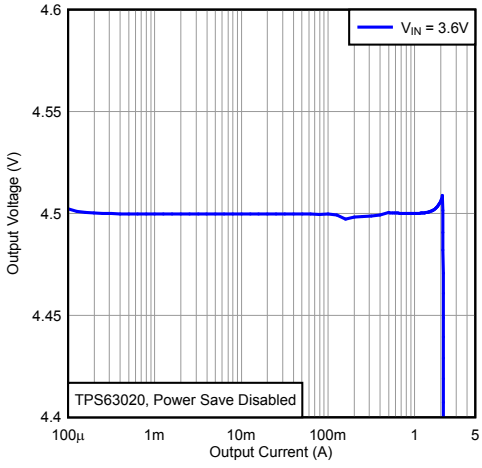


Figure 18. Output Voltage Versus Output Current, TPS63020, Power Save Disabled

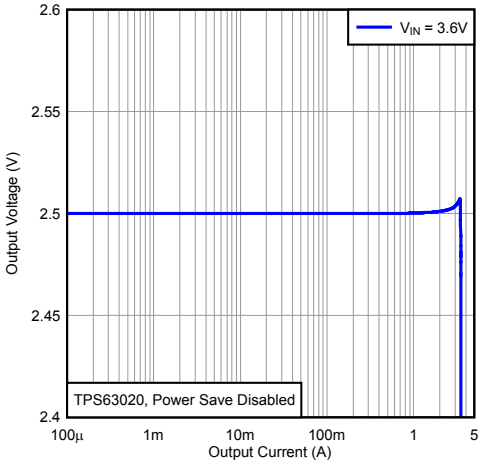


Figure 19. Output Voltage Versus Output Current, TPS63020, Power Save Enabled

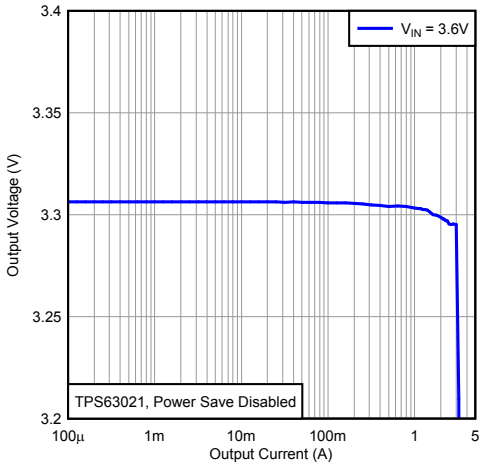
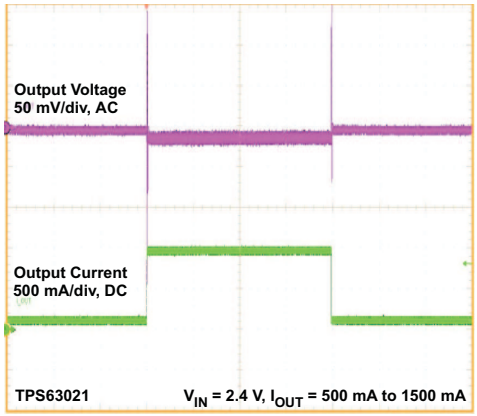
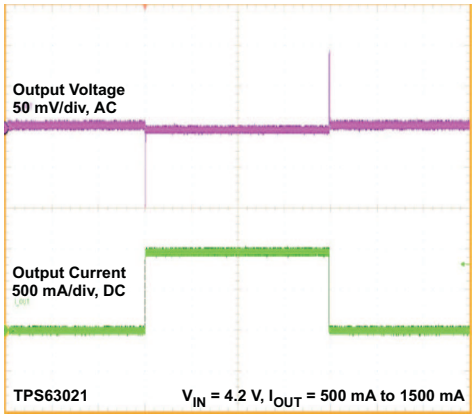


Figure 20. Output Voltage Versus Output Current, TPS63021, Power Save Disabled



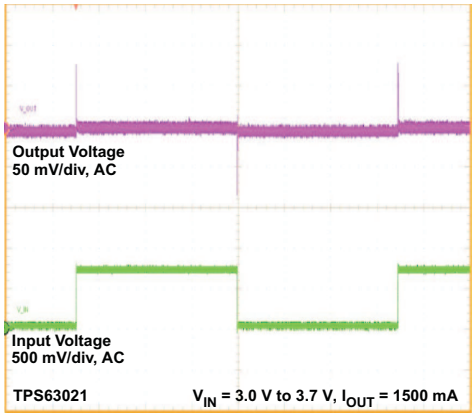
Time 2 ms/div

Figure 21. Load Transient Response, TPS63021



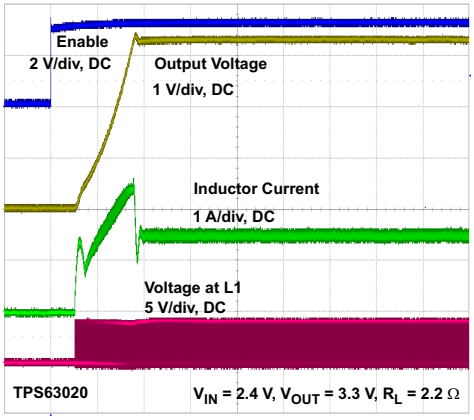
Time 2 ms/div

Figure 22. Load Transient Response, TPS63021



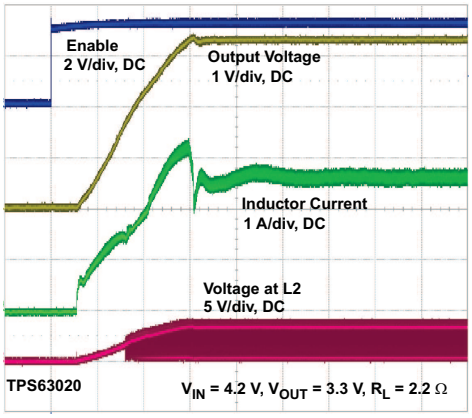
Time 2 ms/div

Figure 23. Line Transient Response, TPS63021



Time 100 µs/div

Figure 24. Start-up Behavior from Rising Enable, TPS63020



Time 100 µs/div

Figure 25. Start-up Behavior from Rising Enable, TPS63020

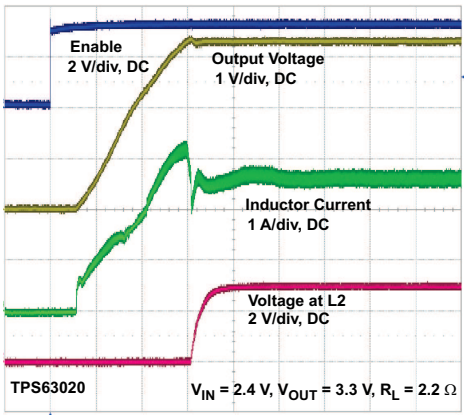


Figure 26. Start-up Behavior from Rising Enable, TPS63020

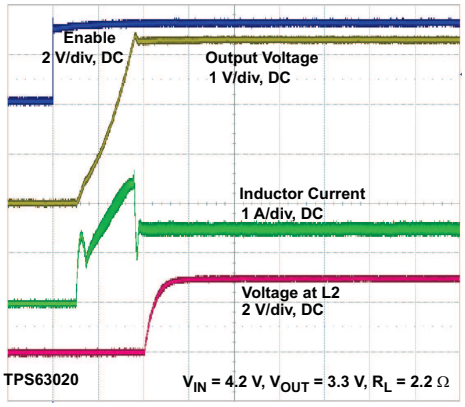


Figure 27. Start-up Behavior from Rising Enable, TPS63020

9.3 System Examples

9.3.1 Improved Transient Response for 2 A Load Current

Capacitor C4 and resistor R4 are added for improved load transient performance.

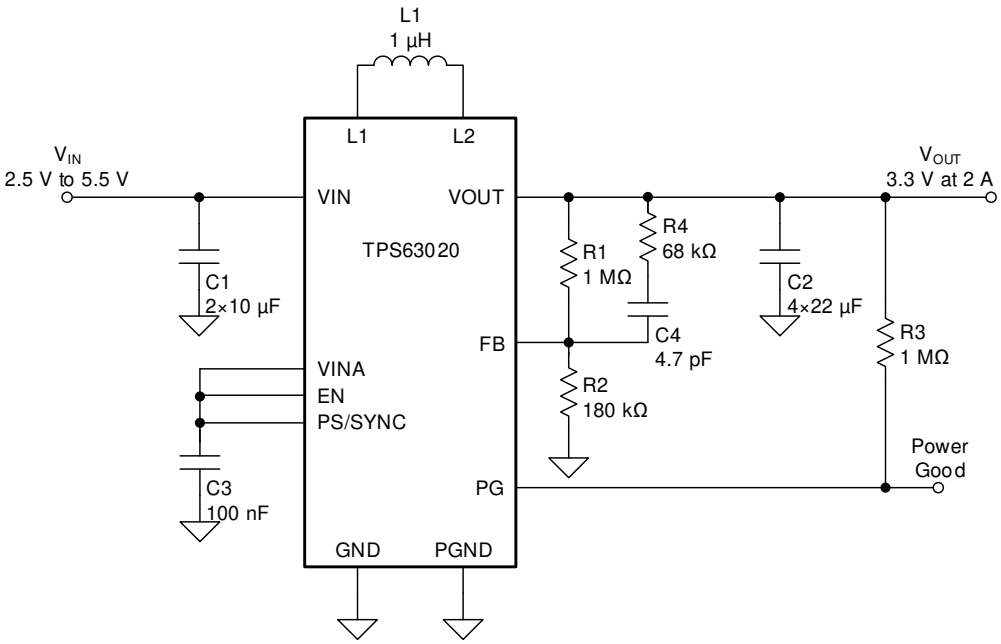


Figure 28. Application Circuit for 2 A Load Current

System Examples (continued)

9.3.2 Supercapacitor Backup Power Supply With Active Cell Balancing

The TPS63020 can be used to charge backup capacitors to a user-defined voltage level while the main power supply is supplying a system, and discharges these capacitors into the system when the main power supply is interrupted. With this design, the system voltage during backup operation keeps constant independent of the voltage reduction on the backup capacitors. Refer to the *PMP9766 Test Results Application Report* for more details.

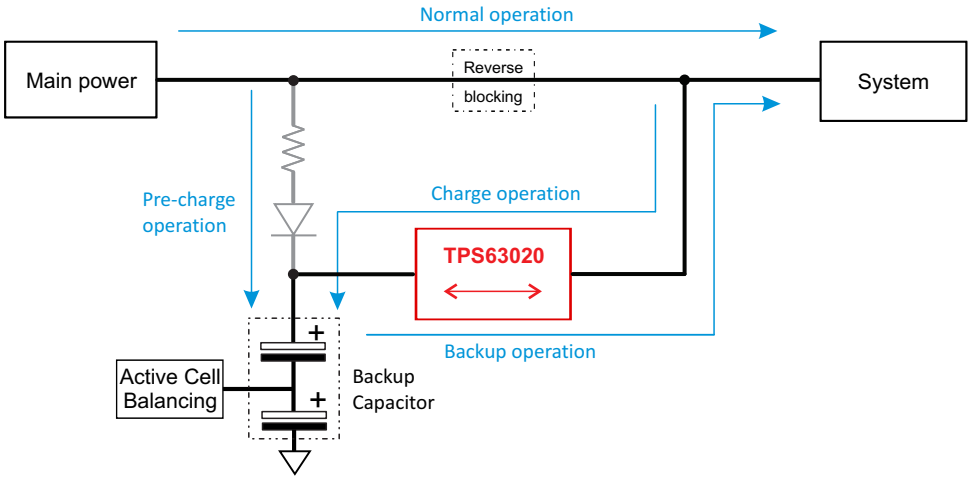


Figure 29. Simplified Block Diagram of a Backup Power System

9.3.3 Low-Power TEC Driver

Controlling the operating temperature of electronic circuits helps attain the best system performance. For passive control, that is, when heat sinks is not giving the right performance, active cooling using a thermoelectric cooler (TEC) might be able to solve the thermal issue. Figure 30 shows an example driving such a TEC element with the TPS63020. Refer to the *Low-power TEC Driver Application Report*.

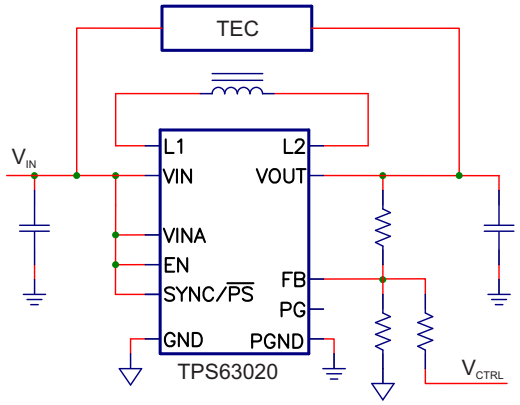


Figure 30. Low-Power TEC Driver Schematic

10 Power Supply Recommendations

The TPS6302x devices have no special requirements for its input power supply. The output current of the input power supply needs to be rated according to the supply voltage, output voltage, and output current of the TPS6302x.

11 Layout

11.1 Layout Guidelines

For all switching power supplies, the layout is an important step in the design, especially at high peak currents and high switching frequencies. If the layout is not carefully done, the regulator can show stability problems as well as EMI problems. Therefore, use wide and short traces for the main current path and for the power ground tracks. Place the input capacitor, output capacitor, and the inductor as close as possible to the IC. Use a common ground node for power ground and a different one for control ground to minimize the effects of ground noise. Connect these ground nodes at any place close to one of the ground pins of the IC.

The feedback divider must be placed as close as possible to the control ground pin of the IC. To lay out the control ground, short traces are recommended as well, separation from the power ground traces. This avoids ground shift problems, which can occur due to superimposition of power ground current and control ground current.

11.2 Layout Example

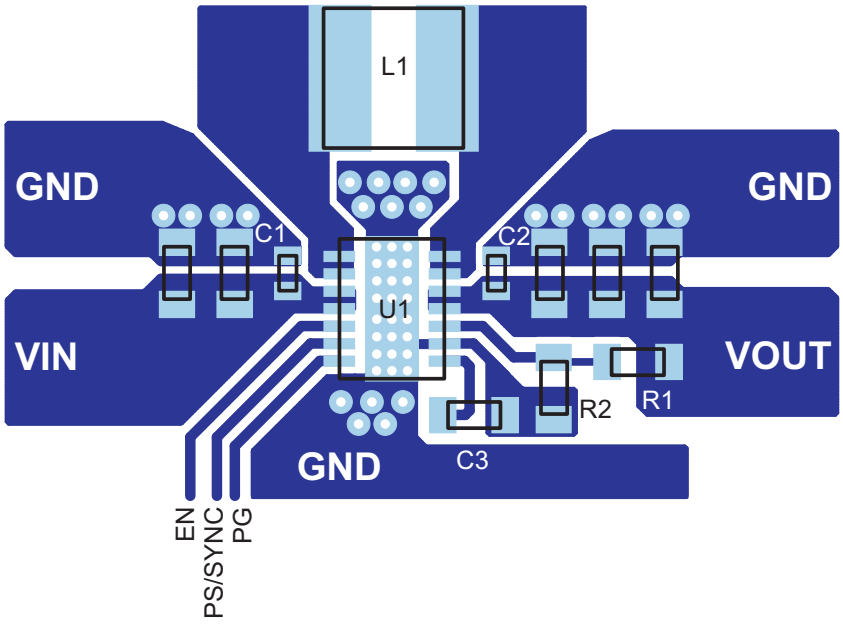


Figure 31. PCB Layout Suggestion

11.3 Thermal Considerations

Implementation of integrated circuits in low-profile and fine-pitch surface-mount packages typically requires special attention to power dissipation. Many system-dependent issues such as thermal coupling, airflow, added heat sinks and convection surfaces, and the presence of other heat-generating components affect the power-dissipation limits of a given component.

Three basic approaches for enhancing thermal performance are listed below:

- Improving the power dissipation capability of the PCB design
- Improving the thermal coupling of the component to the PCB by soldering the exposed thermal pad
- Introducing airflow in the system

Refer to the *Thermal Characteristics Application Note* and the *Semiconductor and IC Package Thermal Metrics Application Note* for more details on how to use the thermal parameters.

12 デバイスおよびドキュメントのサポート

12.1 ドキュメントの更新通知を受け取る方法

ドキュメントの更新についての通知を受け取るには、ti.comのデバイス製品フォルダを開いてください。右上の「アラートを受け取る」をクリックして登録すると、変更されたすべての製品情報に関するダイジェストを毎週受け取れます。変更の詳細については、修正されたドキュメントに含まれている改訂履歴をご覧ください。

12.2 デバイス・サポート

12.2.1 WEBENCHツールによるカスタム設計

ここをクリックすると、 WEBENCH® Power Designer により、TPS63021 デバイスを使用するカスタム設計を作成できます。

1. 最初に、V_{IN}、V_{OUT}、I_{OUT}の要件を入力します。
2. オプティマイザのダイヤルを使用して、効率、占有面積、コストなどの主要なパラメータについて設計を最適化し、この設計と、テキサス・インスツルメンツによる他の可能なソリューションとを比較します。
3. WEBENCH Power Designerでは、カスタマイズされた回路図と部品リストを、リアルタイムの価格や部品の在庫情報と併せて参照できます。
4. ほとんどの場合、次の操作も実行できます。
   - 電気的なシミュレーションを実行し、重要な波形と回路の性能を確認する。
   - 熱シミュレーションを実行し、基板の熱特性を把握する。
   - カスタマイズされた回路図やレイアウトを、一般的なCADフォーマットでエクスポートする。
   - 設計のレポートをPDFで印刷し、同僚と設計を共有する。
5. WEBENCHツールの詳細は、www.ti.com/webenchでご覧になれます。

12.2.2 デベロッパー・ネットワークの製品に関する免責事項

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12.3 ドキュメントのサポート

12.3.1 関連資料

関連資料については、以下を参照してください。

- テキサス・インスツルメンツ、*『Thermal Characteristics Application Note』* (英語)
- テキサス・インスツルメンツ、*『IC Package Thermal Metrics Application Note』* (英語)

12.4 関連リンク

次の表に、クイック・アクセス・リンクを示します。カテゴリには、技術資料、サポートおよびコミュニティ・リソース、ツールとソフトウェア、およびサンプル注文またはご購入へのクイック・アクセスが含まれます。

表 6. 関連リンク

製品	プロダクト・フォルダ	サンプルとご購入	技術資料	ツールとソフトウェア	サポートとコミュニティ
TPS63020	ここをクリック	ここをクリック	ここをクリック	ここをクリック	ここをクリック
TPS63021	ここをクリック	ここをクリック	ここをクリック	ここをクリック	ここをクリック

12.5 サポート・リソース

TI E2E™ support forums are an engineer's go-to source for fast, verified answers and design help — straight from the experts. Search existing answers or ask your own question to get the quick design help you need.

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12.6 商標

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12.7 静電気放電に関する注意事項

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12.8 Glossary

SLYZ022 — *TI Glossary*.

This glossary lists and explains terms, acronyms, and definitions.

13 メカニカル、パッケージ、および注文情報

以降のページには、メカニカル、パッケージ、および注文に関する情報が記載されています。この情報は、そのデバイスについて利用可能な最新のデータです。このデータは予告なく変更されることがあり、ドキュメントが改訂される場合もあります。本データシートのブラウザ版を使用されている場合は、画面左側の説明をご覧ください。

PACKAGING INFORMATION

Orderable part number	Status (1)	Material type (2)	Package | Pins	Package qty | Carrier	RoHS (3)	Lead finish/ Ball material (4)	MSL rating/ Peak reflow (5)	Op temp (°C)	Part marking (6)
TPS63020DSJR	Active	Production	VSON (DSJ) | 14	3000 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	PS63020
TPS63020DSJR.A	Active	Production	VSON (DSJ) | 14	3000 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	PS63020
TPS63020DSJR.B	Active	Production	VSON (DSJ) | 14	3000 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	PS63020
TPS63020DSJRG4	Active	Production	VSON (DSJ) | 14	3000 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	PS63020
TPS63020DSJRG4.A	Active	Production	VSON (DSJ) | 14	3000 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	PS63020
TPS63020DSJRG4.B	Active	Production	VSON (DSJ) | 14	3000 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	PS63020
TPS63020DSJT	Active	Production	VSON (DSJ) | 14	250 | SMALL T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	PS63020
TPS63020DSJT.A	Active	Production	VSON (DSJ) | 14	250 | SMALL T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	PS63020
TPS63020DSJT.B	Active	Production	VSON (DSJ) | 14	250 | SMALL T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	PS63020
TPS63021DSJR	Active	Production	VSON (DSJ) | 14	3000 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	PS63021
TPS63021DSJR.A	Active	Production	VSON (DSJ) | 14	3000 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	PS63021
TPS63021DSJR.B	Active	Production	VSON (DSJ) | 14	3000 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	PS63021
TPS63021DSJRG4	Active	Production	VSON (DSJ) | 14	3000 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	PS63021
TPS63021DSJRG4.A	Active	Production	VSON (DSJ) | 14	3000 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	PS63021
TPS63021DSJRG4.B	Active	Production	VSON (DSJ) | 14	3000 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	PS63021
TPS63021DSJT	Active	Production	VSON (DSJ) | 14	250 | SMALL T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	PS63021
TPS63021DSJT.A	Active	Production	VSON (DSJ) | 14	250 | SMALL T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	PS63021
TPS63021DSJT.B	Active	Production	VSON (DSJ) | 14	250 | SMALL T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	PS63021

(1) **Status:** For more details on status, see our product life cycle.

(2) **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

(3) **RoHS values:** Yes, No, RoHS Exempt. See the TI RoHS Statement for additional information and value definition.

(4) **Lead finish/Ball material:** Parts may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

(5) **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

(6) **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

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OTHER QUALIFIED VERSIONS OF TPS63020 :

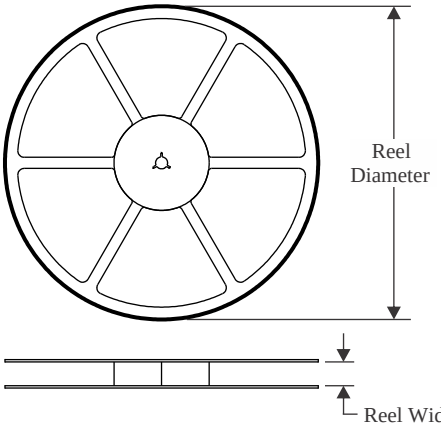
- Automotive : TPS63020-Q1

NOTE: Qualified Version Definitions:

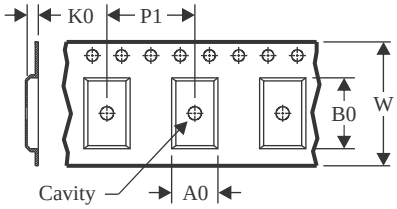
- Automotive - Q100 devices qualified for high-reliability automotive applications targeting zero defects

TAPE AND REEL INFORMATION

REEL DIMENSIONS

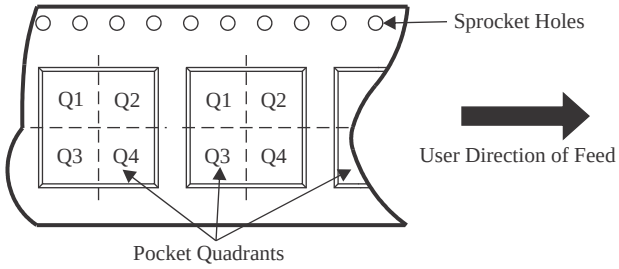


TAPE DIMENSIONS



A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

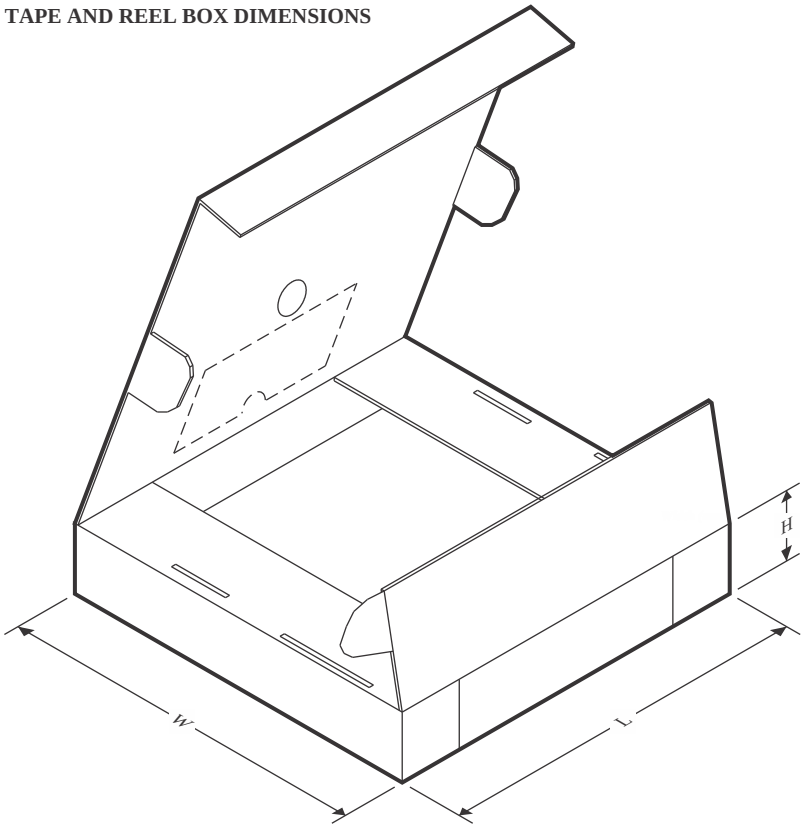
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
TPS63020DSJR	VSON	DSJ	14	3000	330.0	12.4	3.3	4.3	1.1	8.0	12.0	Q1
TPS63020DSJR	VSON	DSJ	14	3000	330.0	12.4	3.3	4.3	1.1	8.0	12.0	Q1
TPS63020DSJRG4	VSON	DSJ	14	3000	330.0	12.4	3.3	4.3	1.1	8.0	12.0	Q1
TPS63020DSJT	VSON	DSJ	14	250	180.0	12.4	3.3	4.3	1.1	8.0	12.0	Q1
TPS63020DSJT	VSON	DSJ	14	250	180.0	12.5	3.3	4.3	1.1	8.0	12.0	Q1
TPS63021DSJR	VSON	DSJ	14	3000	330.0	12.4	3.3	4.3	1.1	8.0	12.0	Q1
TPS63021DSJR	VSON	DSJ	14	3000	330.0	12.4	3.3	4.3	1.1	8.0	12.0	Q1
TPS63021DSJRG4	VSON	DSJ	14	3000	330.0	12.4	3.3	4.3	1.1	8.0	12.0	Q1
TPS63021DSJT	VSON	DSJ	14	250	180.0	12.4	3.3	4.3	1.1	8.0	12.0	Q1

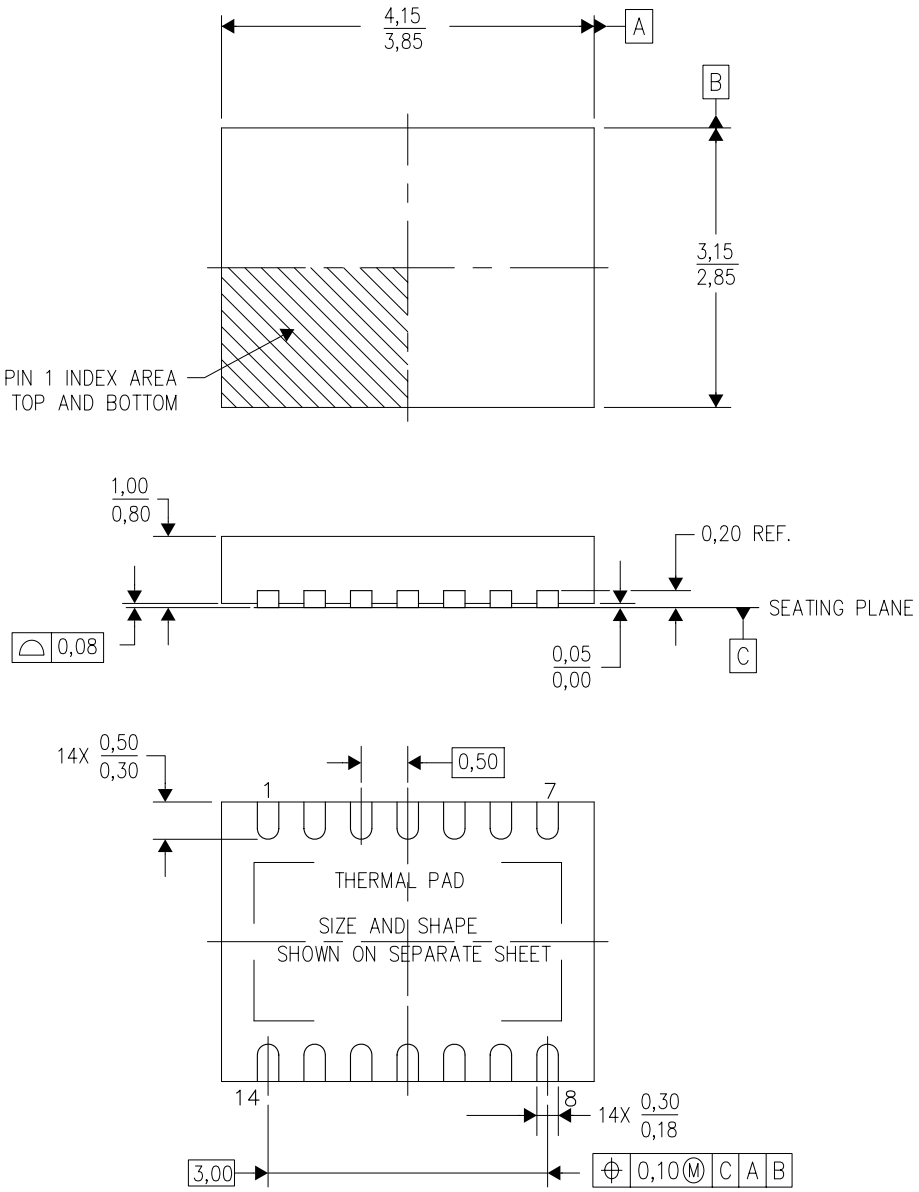
TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TPS63020DSJR	VSON	DSJ	14	3000	353.0	353.0	32.0
TPS63020DSJR	VSON	DSJ	14	3000	338.0	355.0	50.0
TPS63020DSJRG4	VSON	DSJ	14	3000	353.0	353.0	32.0
TPS63020DSJT	VSON	DSJ	14	250	213.0	191.0	35.0
TPS63020DSJT	VSON	DSJ	14	250	205.0	200.0	33.0
TPS63021DSJR	VSON	DSJ	14	3000	338.0	355.0	50.0
TPS63021DSJR	VSON	DSJ	14	3000	353.0	353.0	32.0
TPS63021DSJRG4	VSON	DSJ	14	3000	353.0	353.0	32.0
TPS63021DSJT	VSON	DSJ	14	250	213.0	191.0	35.0

DSJ (R–PVSON–N14) PLASTIC SMALL OUTLINE NO–LEAD



NOTES:
A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M–1994.
B. This drawing is subject to change without notice.
C. Quad Flatpack, No–Leads (QFN) package configuration.
D. The package thermal pad must be soldered to the board for thermal and mechanical performance.
E. See the additional figure in the Product Data Sheet for details regarding the exposed thermal pad features and dimensions.

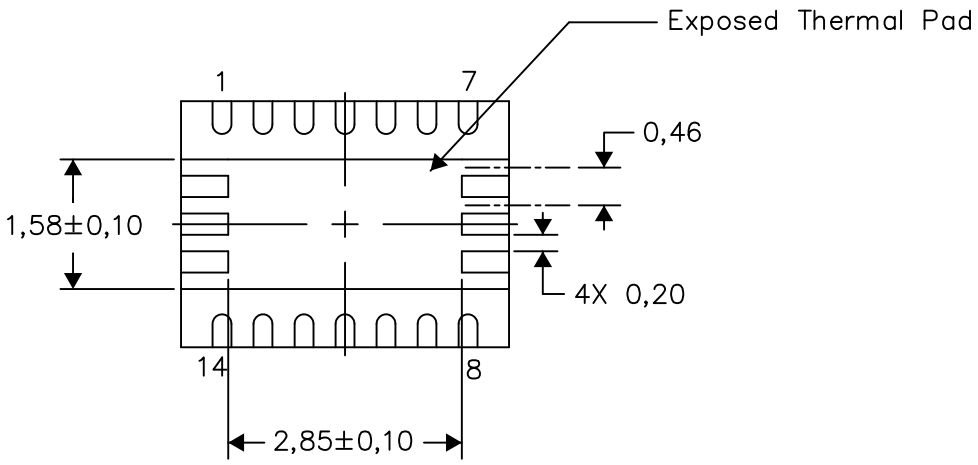
DSJ (R–PVSON–N14) PLASTIC SMALL OUTLINE NO–LEAD

THERMAL INFORMATION

This package incorporates an exposed thermal pad that is designed to be attached directly to an external heatsink. The thermal pad must be soldered directly to the printed circuit board (PCB). After soldering, the PCB can be used as a heatsink. In addition, through the use of thermal vias, the thermal pad can be attached directly to the appropriate copper plane shown in the electrical schematic for the device, or alternatively, can be attached to a special heatsink structure designed into the PCB. This design optimizes the heat transfer from the integrated circuit (IC).

For information on the Quad Flatpack No–Lead (QFN) package and its advantages, refer to Application Report, QFN/SON PCB Attachment, Texas Instruments Literature No. SLUA271. This document is available at www.ti.com.

The exposed thermal pad dimensions for this package are shown in the following illustration.



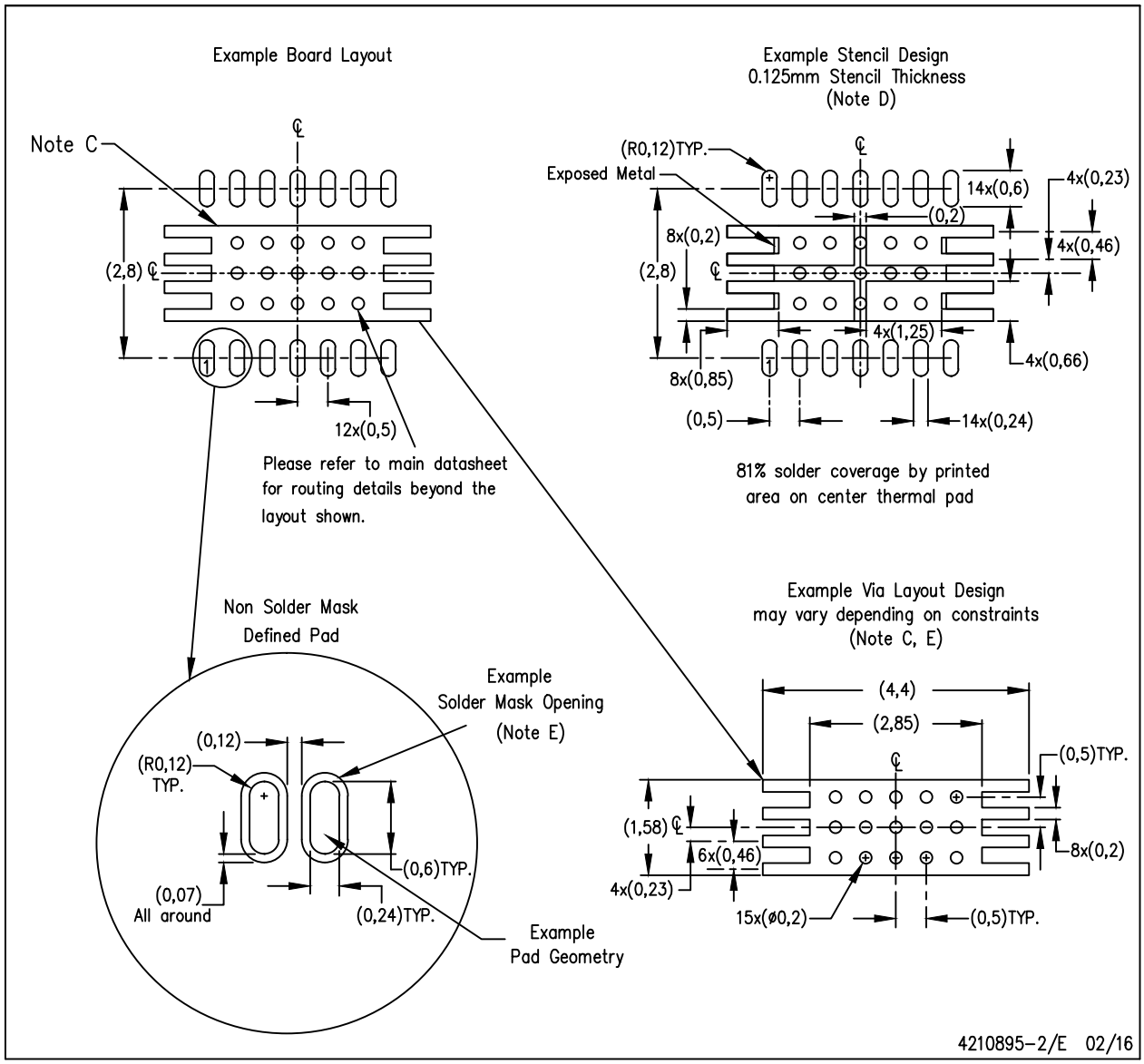
Bottom View

Exposed Thermal Pad Dimensions

4208549–3/G 04/15

NOTE: All linear dimensions are in millimeters

DSJ (R–PVSON–N14) PLASTIC SMALL OUTLINE NO–LEAD



NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. This package is designed to be soldered to a thermal pad on the board. Refer to Application Note, Quad Flat–Pack Packages, Texas Instruments Literature No. SCBA017, SLUA271, and also the Product Data Sheets for specific thermal information, via requirements, and recommended board layout. These documents are available at www.ti.com <http://www.ti.com>.
D. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC 7525 for stencil design considerations.
E. Customers should contact their board fabrication site for minimum solder mask web tolerances between signal pads.

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