TPS565201 4.5-V to 17-V Input, 5-A Synchronous Step-Down Voltage Regulator

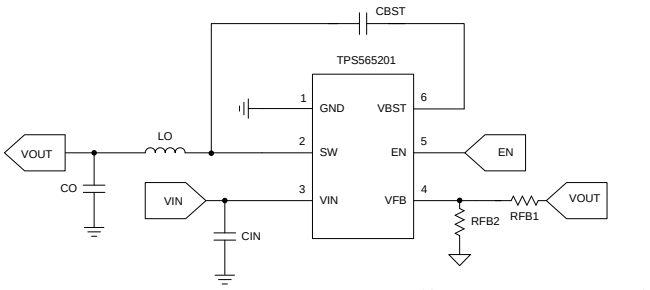
1 Features

- 5-A Maximum Output Current
- Integrated 31-mΩ and 16-mΩ FETs
- D-CAP2™ Mode Control with Fast Transient Response
- Input Voltage Range: 4.5 V to 17 V
- Output Voltage Range: 0.76 V to 7 V
- High Efficiency at Light Loads with Pulse-skipping Eco-mode™
- 500-kHz Switching Frequency
- ≤1 µA Shutdown Current
- 1% Feedback Voltage Accuracy
- Startup from Pre-Biased Output Voltage
- Cycle-by-Cycle Current Limit
- Hiccup-mode Overcurrent Protection
- Non-Latch UVP, UVLO and TSD Protections

2 Applications

- Digital TV Power Supply
- High Definition Blu-ray™ Disc Players
- Networking Home Terminal
- Digital Set Top Box (STB)
- Surveillance

Simplified Schematic



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3 Description

The TPS565201 is a simple, easy-to-use, 5-A synchronous step-down converter.

The device is optimized to operate with minimum external component counts and also optimized to achieve low standby current.

This switch mode power supply (SMPS) device employs D-CAP2™ control, which provides fast transient response and requires no external compensation components. D-CAP2 also allows the use of low-equivalent series resistance (ESR) specialty polymer capacitors and ceramic output capacitors.

The TPS565201 operates in pulse skip mode, maintaining high efficiency during light load operation.

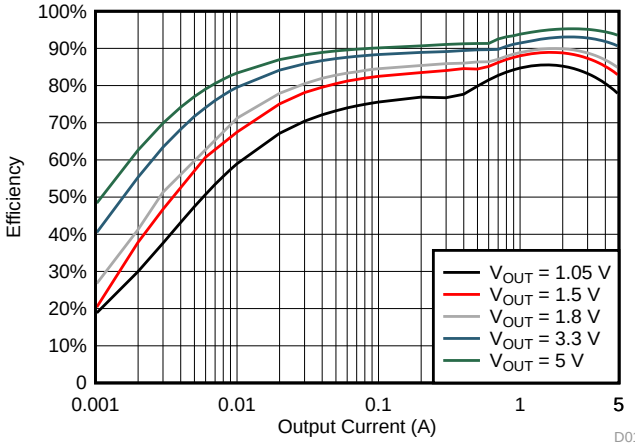
The TPS565201 device is available in a 6-pin 1.6-mm × 2.9-mm SOT (DDC) package, and operates over a –40°C to 125°C junction temperature range.

Device Information(1)

PART NUMBER	PACKAGE	BODY SIZE (NOM)
TPS565201	DDC (6)	1.60 mm × 2.90 mm

(1) For all available packages, see the orderable addendum at the end of the data sheet.

TPS565201 Efficiency



D017

An IMPORTANT NOTICE at the end of this data sheet addresses availability, warranty, changes, use in safety-critical applications, intellectual property matters and other important disclaimers. PRODUCTION DATA.

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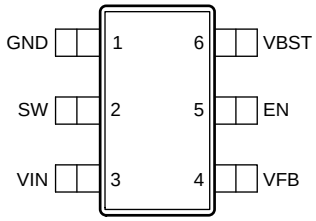
4 Revision History

DATE	REVISION	NOTES
September 2017	*	Initial release.

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5 Pin Configuration and Functions

DDC Package
6-Pin SOT
Top View



Pin Functions

PIN		I/O	DESCRIPTION
NAME	NO.		
GND	1	—	Ground pin. Source terminal of low-side power NFET as well as the ground terminal for controller circuit. Connect sensitive VFB to this GND at a single point.
SW	2	O	Switch node connection between high-side NFET and low-side NFET.
VIN	3	I	Input voltage supply pin. The drain terminal of high-side power NFET.
VFB	4	I	Converter feedback input. Connect to output voltage with feedback resistor divider.
EN	5	I	Enable input control. Active high and must be pulled up to enable the device.
VBST	6	O	Supply input for the high-side NFET gate drive circuit. Connect 0.1 µF capacitor between VBST and SW pins.

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6 Specifications

6.1 Absolute Maximum Ratings

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

		MIN	MAX	UNIT
Input voltage	VIN, EN	–0.3	19	V
	VBST	–0.3	25	V
	VBST (10 ns transient)	–0.3	27	V
	VBST (vs SW)	–0.3	6.5	V
	VFB	–0.3	6.5	V
	SW	–2	19	V
	SW (10 ns transient)	–3.5	21	V
Operating junction temperature, T_J		–40	150	°C
Storage temperature, T_{stg}		–55	150	°C

(1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions*. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

6.2 ESD Ratings

			VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001(1)	±4000	V
		Charged-device model (CDM), per JEDEC specification JESD22-C101(2)	±1500	

(1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.
(2) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process.

6.3 Recommended Operating Conditions

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

			MIN	NOM	MAX	UNIT
V_{IN}	Supply input voltage range		4.5		17	V
V_I	Input voltage range	VBST	–0.1		23	V
		VBST (10 ns transient)	–0.1		26	
		VBST (vs SW)	–0.1		6.0	
		EN	–0.1		17	
		VFB	–0.1		5.5	
		SW	–1.8		17	
		SW (10 ns transient)	–3.5		20	
T_J	Operating junction temperature		–40		125	°C

6.4 Thermal Information

THERMAL METRIC(1)		TPS565201 DDC (SOT) 6 PINS	UNIT
$R_{\theta JA}$	Junction-to-ambient thermal resistance	95.9	°C/W
$R_{\theta JC(top)}$	Junction-to-case (top) thermal resistance	35.6	°C/W
$R_{\theta JB}$	Junction-to-board thermal resistance	16.4	°C/W
ψ_{JT}	Junction-to-top characterization parameter	1.4	°C/W
ψ_{JB}	Junction-to-board characterization parameter	16.5	°C/W

(1) For more information about traditional and new thermal metrics, see the *Semiconductor and IC Package Thermal Metrics* application report, SPRA953.

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6.5 Electrical Characteristics

T_J = –40°C to 125°C, V_{IN} = 12 V (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
SUPPLY CURRENT						
I_{VIN}	Operating – non-switching supply current	V_{IN} current, EN = 5 V, V_{FB} = 1 V		320	510	µA
I_{VINSDN}	Shutdown supply current	V_{IN} current, EN = 0 V		0.8	5	µA
LOGIC THRESHOLD						
V_{ENH}	EN high-level input voltage		1.6			V
V_{ENL}	EN low-level input voltage				0.8	V
R_{EN}	EN pin resistance to GND	V_{EN} = 12 V	120	245	400	kΩ
V_{FB} VOLTAGE AND DISCHARGE RESISTANCE						
V_{FBTH}	V_{FB} threshold voltage		753	760	767	mV
I_{VFB}	V_{FB} input current	V_{FB} = 0.8 V. T_A = 25°C		0	±0.1	µA
MOSFET						
$R_{DS(on)h}$	High-side switch resistance	T_A = 25°C, V_{BST} – V_{SW} = 5.5 V		31		mΩ
$R_{DS(on)l}$	Low-side switch resistance	T_A = 25°C		16		mΩ
CURRENT LIMIT						
I_{OCL}	Current limit		5.3	6.7	8	A
THERMAL SHUTDOWN						
T_{SDN}	Thermal shutdown threshold(1)	Shutdown temperature		172		°C
		Hysteresis		38		
ON-TIME TIMER CONTROL						
$t_{OFF(MIN)}$	Minimum off time	V_{FB} = 0.61 V		236	280	ns
SOFT START						
t_{SS}	Soft-start time	Internal soft-start time		1.0		ms
FREQUENCY						
F_{sw}	Switching frequency	V_{IN} = 12 V, V_O = 5 V, CCM mode		500		kHz
OUTPUT UNDERVOLTAGE AND OVERVOLTAGE PROTECTION						
V_{UVP}	Output UVP threshold	Hiccup detect (H > L)		65		%
T_{HICCUP_WAIT}	Hiccup on time			1.8		ms
T_{HICCUP_RE}	Hiccup time before restart			14.9		ms
UVLO						
UVLO	UVLO threshold	Wake up VIN voltage		4.0	4.3	V
		Shutdown VIN voltage	3.3	3.6		
		Hysteresis VIN voltage(1)		0.4		

(1) Not production tested.

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6.6 Typical Characteristics

V_{IN} = 12 V (unless otherwise noted)

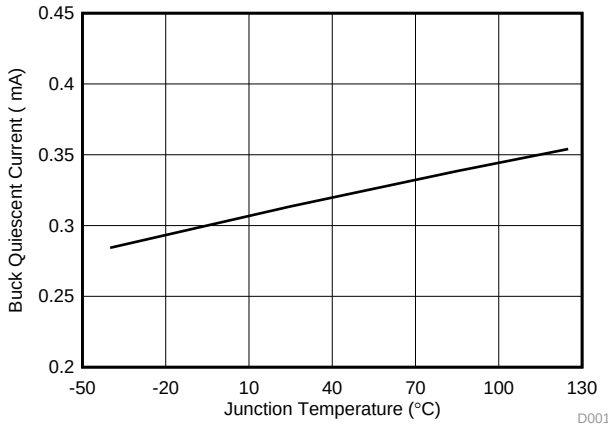


Figure 1. TPS565201 Supply Current vs Junction Temperature

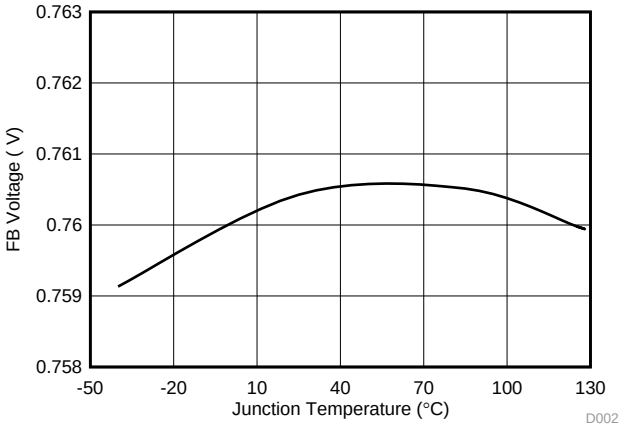


Figure 2. VFB Voltage vs Junction Temperature

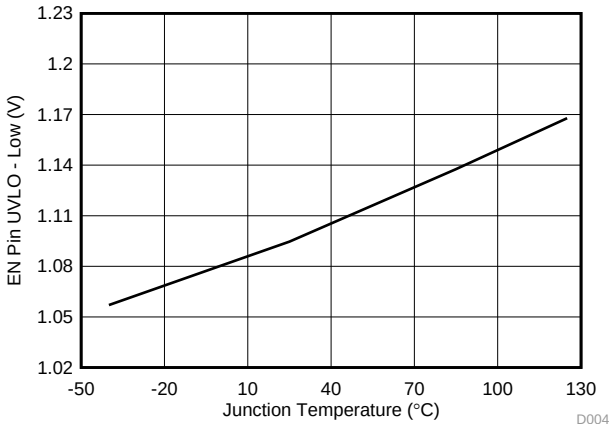


Figure 3. EN Pin UVLO Low Voltage vs Junction Temperature

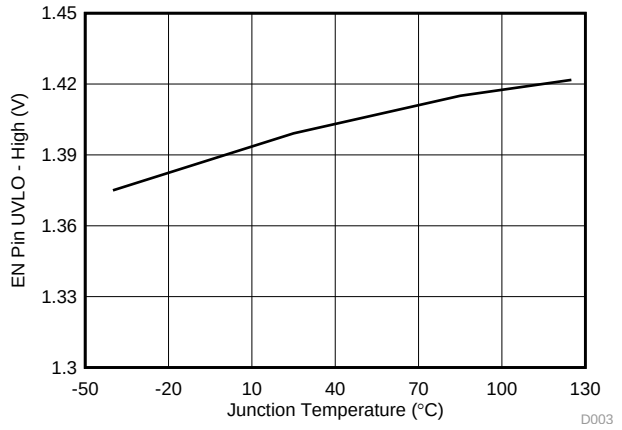


Figure 4. TPS565201 EN Pin UVLO High Voltage vs Junction Temperature

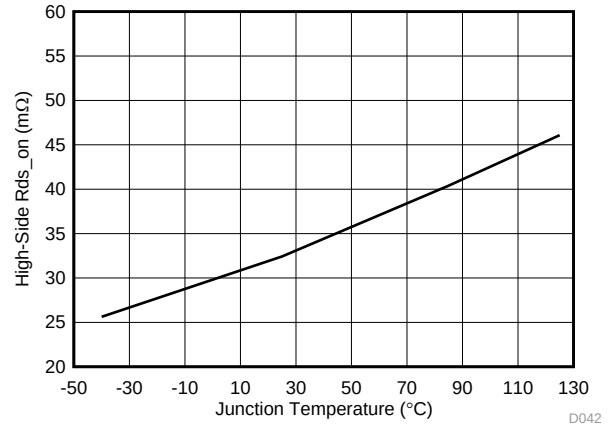


Figure 5. TPS565201 High-Side $R_{ds\text{-}On}$ vs Junction Temperature

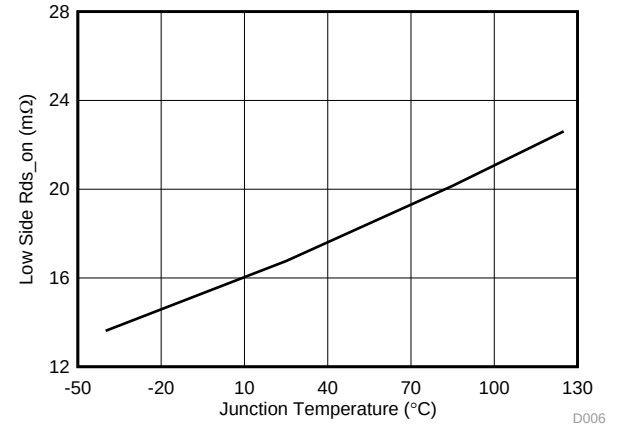


Figure 6. Low-Side $R_{ds\text{-}On}$ vs Junction Temperature

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Typical Characteristics (continued)

V_{IN} = 12 V (unless otherwise noted)

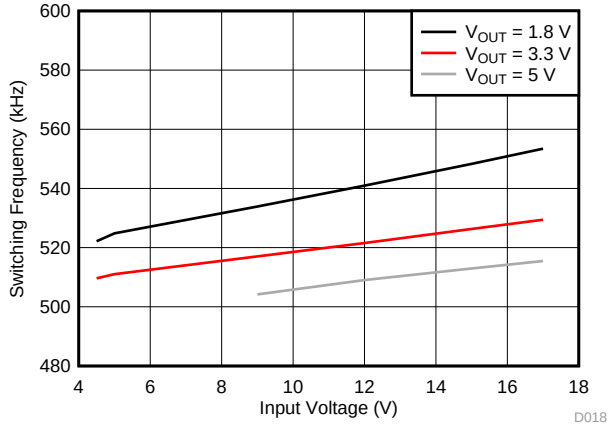


Figure 7. TPS565201 Switching Frequency vs Input Voltage

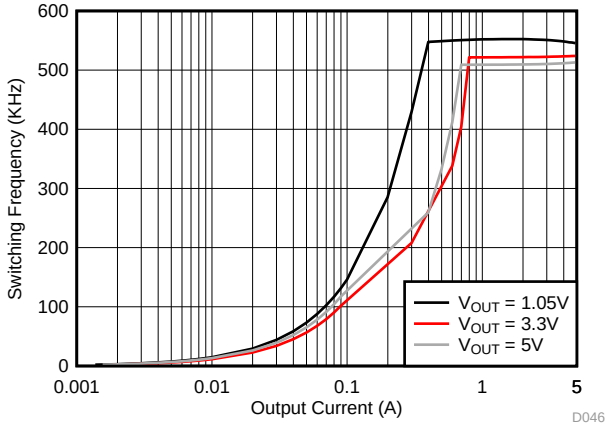
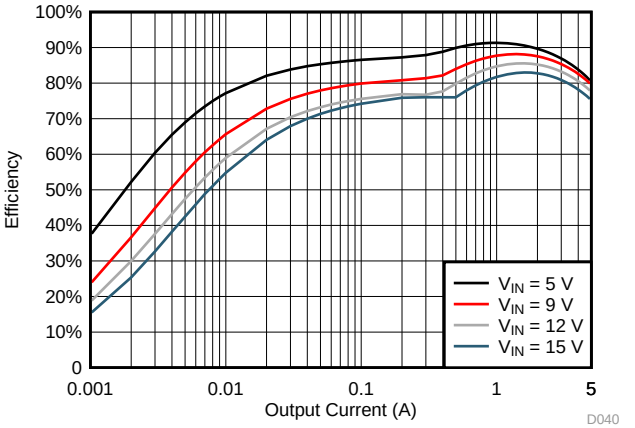
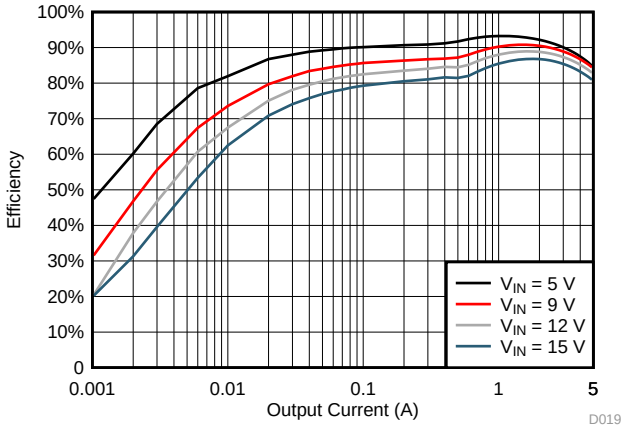


Figure 8. TPS565201 Switching Frequency vs Output Current



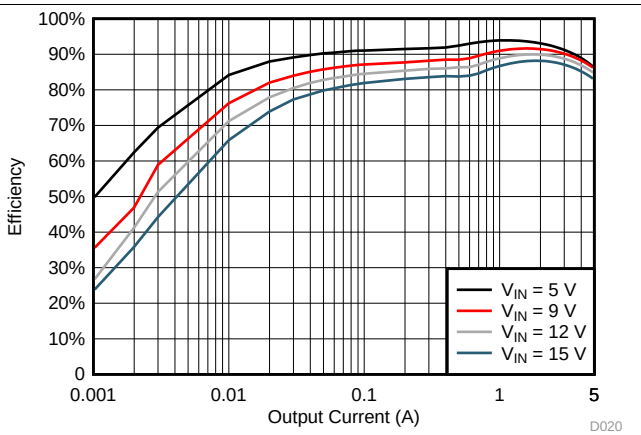
V_{OUT} = 1.05 V L = 2.2 µH

Figure 9. TPS565201 Efficiency vs Output Current



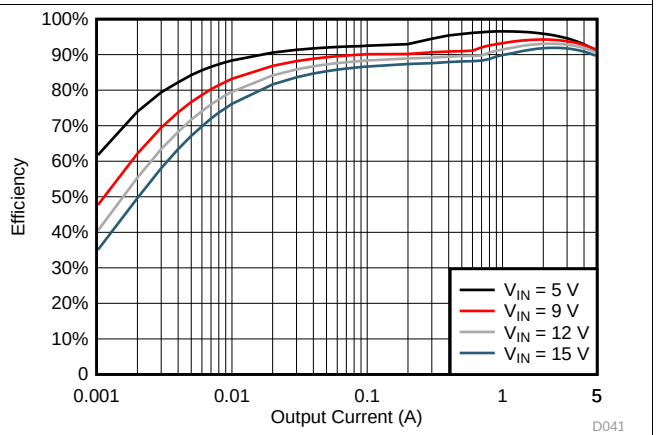
V_{OUT} = 1.5 V L = 2.2 µH

Figure 10. TPS565201 Efficiency vs Output Current



V_{OUT} = 1.8 V L = 2.2 µH

Figure 11. TPS565201 Efficiency vs Output Current



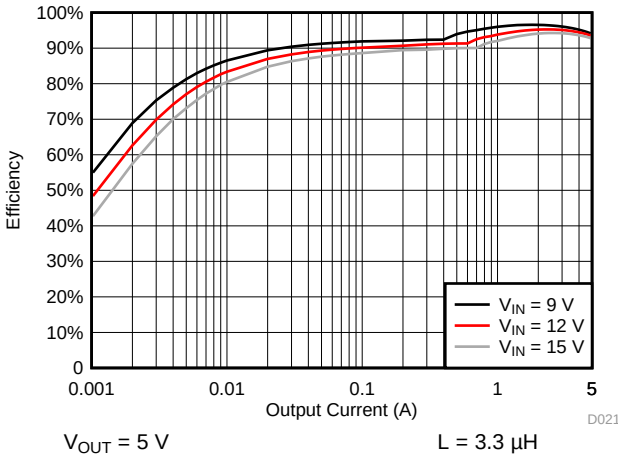
V_{OUT} = 3.3 V L = 2.2 µH

Figure 12. TPS565201 Efficiency vs Output Current

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Typical Characteristics (continued)

V_{IN} = 12 V (unless otherwise noted)



V_{OUT} = 5 V L = 3.3 µH

Figure 13. TPS565201 Efficiency vs Output Current

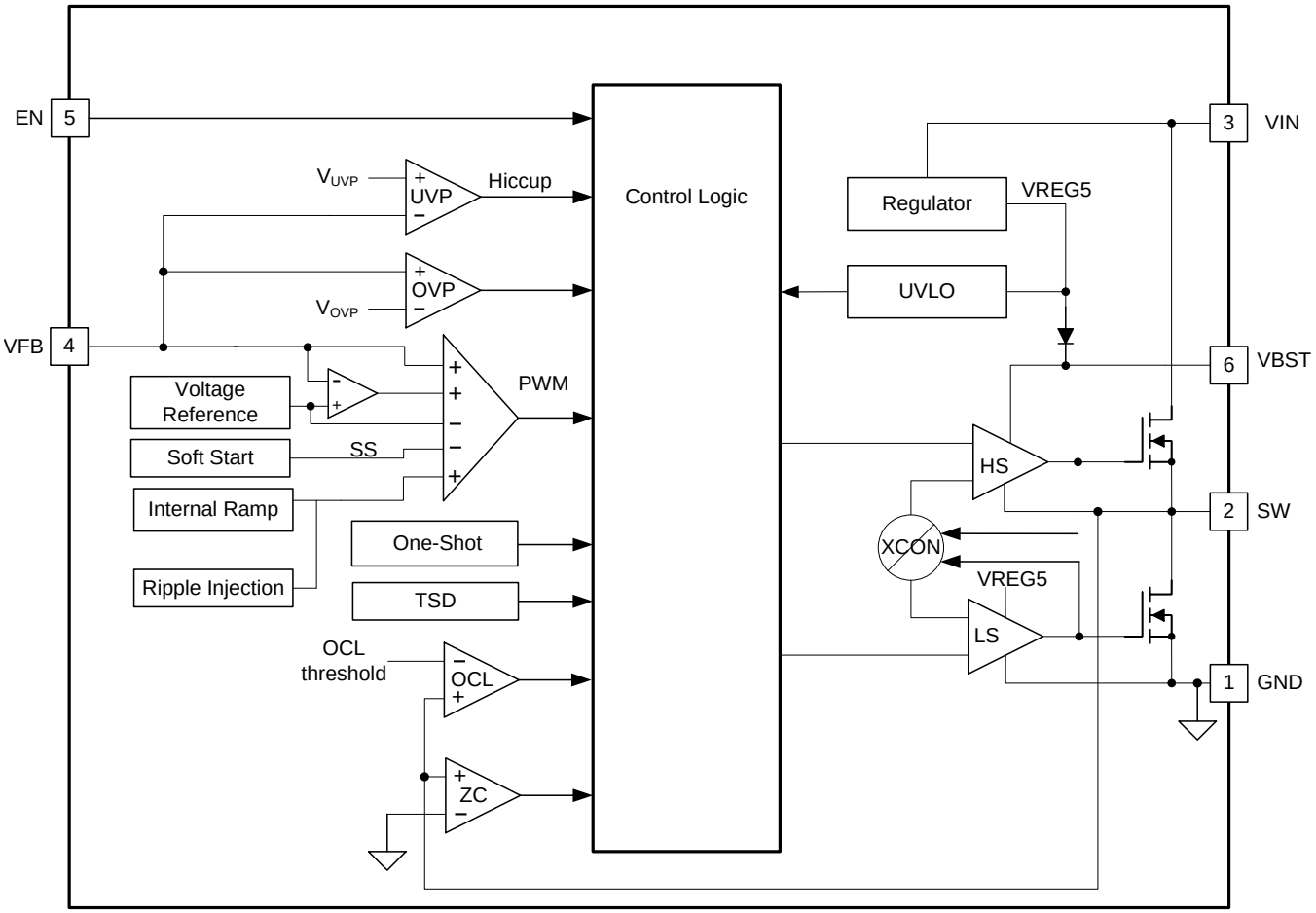
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7 Detailed Description

7.1 Overview

The TPS565201 is a 5-A synchronous step-down converter. The proprietary D-CAP2™ mode control supports low ESR output capacitors such as specialty polymer capacitors and multi-layer ceramic capacitors without complex external compensation circuits. The fast transient response of D-CAP2™ mode control can reduce the output capacitance required to meet a specific level of performance.

7.2 Functional Block Diagram



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7.3 Feature Description

7.3.1 Adaptive On-Time Control and PWM Operation

The main control loop of the TPS565201 is adaptive on-time pulse width modulation (PWM) controller that supports a proprietary D-CAP2™ mode control. The D-CAP2™ mode control combines adaptive on-time control with an internal compensation circuit for pseudo-fixed frequency and low external component count configuration with low-ESR ceramic output capacitors. It is stable even with virtually no ripple at the output.

At the beginning of each cycle, the high-side MOSFET is turned on. This MOSFET is turned off after internal one-shot timer expires. This one shot duration is set inversely proportional to the converter input voltage, V_{IN}, and proportional to the output voltage V_O, to maintain a pseudo-fixed frequency over the input voltage range, hence it is called adaptive on-time control. The one-shot timer is reset and the high-side MOSFET is turned on again when the feedback voltage falls below the reference voltage. An ripple is added to reference voltage to simulate output ripple, eliminating the need for ESR induced output ripple from D-CAP2™ mode control.

7.3.2 Pulse Skip Mode

The TPS565201 is designed with Eco-mode™ to maintain high light load efficiency. As the output current decreases from heavy load condition, the inductor current is also reduced and eventually comes to point that its rippled valley touches zero level, which is the boundary between continuous conduction and discontinuous conduction modes. The rectifying MOSFET is turned off when the zero inductor current is detected. As the load current further decreases the converter runs into discontinuous conduction mode. The on-time is kept almost the same as it was in the continuous conduction mode so that it takes longer time to discharge the output capacitor with smaller load current to the level of the reference voltage. This makes the switching frequency lower, proportional to the load current, and keeps the light load efficiency high. The transition point to the light load operation IOUT(LL) current can be calculated in Equation 1.

$$I_{OUT(LL)} = \frac{1}{2 \times L \times f_{SW}} \times \frac{(V_{IN} - V_{OUT}) \times V_{OUT}}{V_{IN}} \quad (1)$$

7.3.3 Soft Start and Pre-Biased Soft Start

The TPS565201 has an internal 1.0-ms soft-start. When the EN pin becomes high, the internal soft-start function begins ramping up the reference voltage to the PWM comparator.

If the output capacitor is pre-biased at startup, the device initiates switching and starts ramping up only after the internal reference voltage becomes greater than the feedback voltage V_{FB}. This scheme ensures that the converter ramps up smoothly into regulation point.

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Feature Description (continued)

7.3.4 Current Protection

The output over-current limit (OCL) is implemented using a cycle-by-cycle valley detect control circuit. The inductor current is monitored during the OFF state by measuring the low-side FET drain to source voltage, which is proportional to the switch current. To improve accuracy, the voltage sensing is temperature compensated.

During the on time of the high-side FET switch, the switch current increases at a linear rate determined by V_{IN}, V_{OUT}, and the output inductor value. During the on time of the low-side FET switch, this current decreases linearly. The average value of the switch current is the load current I_{OUT}. If the monitored current is above the OCL level, the converter maintains low-side FET on and delays the creation of a new set pulse, even the voltage feedback loop requires one, until the current level becomes OCL level or lower. In subsequent switching cycles, the on-time is set to a fixed value and the current is monitored in the same manner.

There are some important considerations for this type of over-current protection. The load current is higher than the over-current threshold by one half of the peak-to-peak inductor ripple current. Also, when the current is being limited, the output voltage tends to fall as the demanded load current may be higher than the current available from the converter. This may cause the output voltage to fall. When the VFB voltage falls below the UVP threshold voltage, the UVP comparator detects it. And then, the device shuts down after the UVP delay time (typically 24 µs) and re-starts after the hiccup time (typically 14.9 ms).

When the over current condition is removed, the output voltage returns to the regulated value.

7.3.5 Undervoltage Lockout (UVLO) Protection

UVLO protection monitors input voltage. When the voltage is lower than UVLO threshold voltage, the device is shut off. This protection is non-latching.

7.3.6 Thermal Shutdown

The device monitors the temperature of itself. If the temperature exceeds the threshold value (typically 172°C), the device is shut off. This is a non-latch protection.

7.4 Device Functional Modes

7.4.1 Normal Operation

When the input voltage is above the UVLO threshold and the EN voltage is above the enable threshold, the TPS565201 operates in the normal switching mode. Normal continuous conduction mode (CCM) occurs when the minimum switch current is above 0 A. In CCM, the TPS565201 operates at a quasi-fixed frequency of 500 kHz.

7.4.2 Eco-mode™ Operation

When the TPS565201 is in the normal CCM operating mode and the switch current falls to 0 A, the TPS565201 begins operating in pulse skipping eco-mode. Each switching cycle is followed by a period of energy saving sleep time. The sleep time ends when the VFB voltage falls below the eco-mode threshold voltage. As the output current decreases, the perceived time between switching pulses increases.

7.4.3 Standby Operation

When the TPS565201 is operating in either normal CCM or Eco-mode™, it may be placed in standby by asserting the EN pin low.

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8 Application and Implementation

NOTE

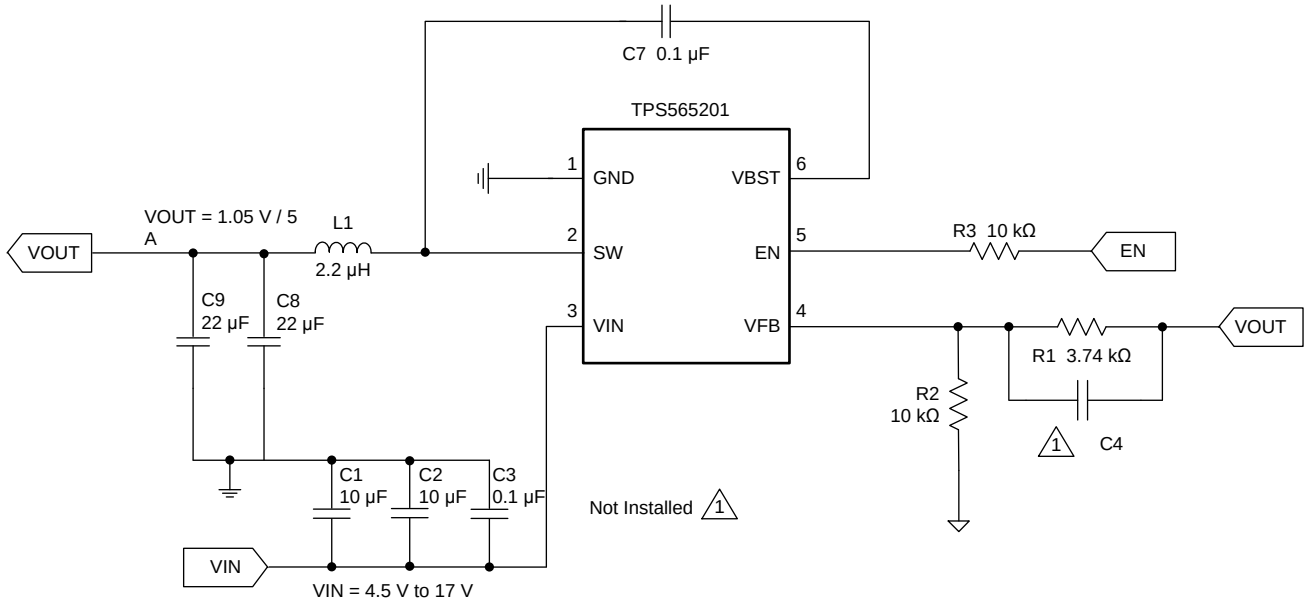
Information in the following applications sections is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI's customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation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

8.1 Application Information

The device is a typical step-down DC-DC converter for converting a higher dc voltage to a lower dc voltage with a maximum available output current of 5 A. The following design procedure can be used to select component values for the TPS565201. Alternately, the WEBENCH® software may be used to generate a complete design. The WEBENCH software uses an iterative design procedure and accesses a comprehensive database of components when generating a design. This section presents a simplified discussion of the design process.

8.2 Typical Application

The application schematic in Figure 14 shows the TPS565201 4.5-V to 17-V input, 1.05-V output converter design meeting the requirements for 5-A output. This circuit is available as the evaluation module (EVM). The sections provide the design procedure.



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Figure 14. TPS565201 1.05-V, 5-A Reference Design

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Typical Application (continued)

8.2.1 Design Requirements

Table 1 shows the design parameters for this application.

Table 1. Design Parameters

PARAMETER	EXAMPLE VALUE
Input voltage range	4.5 to 17 V
Output voltage	1.05 V
Transient response, 1-A/us slew rate	ΔVout = ±5%
Input ripple voltage	400 mV
Output ripple voltage	20 mV
Output current rating	5 A
Operating frequency	550 kHz

8.2.2 Detailed Design Procedure

8.2.2.1 Output Voltage Resistors Selection

The output voltage is set with a resistor divider from the output node to the VFB pin. TI recommends to use 1% tolerance or better divider resistors. Start by using Equation 2 to calculate V_{OUT}.

To improve efficiency at very light loads consider using larger value resistors. However, using too high of resistance causes the circuit to be more susceptible to noise; and, voltage errors from the VFB input current will be more noticeable.

$$V_{OUT} = 0.760 \times \left(1 + \frac{R1}{R2}\right) \quad (2)$$

8.2.2.2 Output Filter Selection

The LC filter used as the output filter has double pole at:

$$f_P = \frac{1}{2\pi\sqrt{L_{OUT} \times C_{OUT}}} \quad (3)$$

At low frequencies, the overall loop gain is set by the output set-point resistor divider network and the internal gain of the device. The low frequency phase is 180°. At the output filter pole frequency, the gain rolls off at a –40 dB per decade rate and the phase drops rapidly. D-CAP2 introduces a high frequency zero that reduces the gain roll off to –20 dB per decade and increases the phase to 90° one decade above the zero frequency. The inductor and capacitor for the output filter must be selected so that the double pole of Equation 3 is located below the high frequency zero but close enough that the phase boost provided be the high frequency zero provides adequate phase margin for a stable circuit. To meet this requirement use the values recommended in Table 2.

Table 2. Recommended Component Values

OUTPUT VOLTAGE (V)	R1 (kΩ)	R2 (kΩ)	L1 (µH)			C8 + C9 (µF)
			MIN	TYP	MAX	
1	3.09	10.0	1.0	2.2	4.7	20 to 68
1.05	3.74	10.0	1.0	2.2	4.7	20 to 68
1.2	5.76	10.0	1.0	2.2	4.7	20 to 68
1.5	9.53	10.0	1.5	2.2	4.7	20 to 68
1.8	13.7	10.0	1.5	2.2	4.7	20 to 68
2.5	22.6	10.0	2.2	2.2	4.7	20 to 68
3.3	33.2	10.0	2.2	2.2	4.7	20 to 68
5	54.9	10.0	3.3	3.3	4.7	20 to 68
6.5	75	10.0	3.3	3.3	4.7	20 to 68

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The inductor peak-to-peak ripple current, peak current and RMS current are calculated using Equation 4, Equation 5, and Equation 6. The inductor saturation current rating must be greater than the calculated peak current and the RMS or heating current rating must be greater than the calculated RMS current.

Use 550 kHz for f_{SW}. Make sure the chosen inductor is rated for the peak current of Equation 5 and the RMS current of Equation 7.

$$I_{P-P} = \frac{V_{OUT}}{V_{IN(MAX)}} \times \frac{V_{IN(MAX)} - V_{OUT}}{L_O \times f_{SW}} \quad (4)$$

$$I_{PEAK} = I_O + \frac{I_{P-P}}{2} \quad (5)$$

$$I_{LO(RMS)} = \sqrt{I_O^2 + \frac{1}{12} I_{P-P}^2} \quad (6)$$

For this design example, the calculated peak current is 5.4 A and the calculated RMS current is 5 A. The inductor used is a WE 744311220 with a peak current rating of 13 A and an RMS current rating of 9 A.

The capacitor value and ESR determines the amount of output voltage ripple. The TPS565201 is intended for use with ceramic or other low ESR capacitors. Recommended values range from 20 µF to 68 µF. Use Equation 7 to determine the required RMS current rating for the output capacitor.

$$I_{CO(RMS)} = \frac{V_{OUT} \times (V_{IN} - V_{OUT})}{\sqrt{12} \times V_{IN} \times L_O \times f_{SW}} \quad (7)$$

For this design two TDK C3216X5R0J226M 22-µF output capacitors are used. The typical ESR is 2 mΩ each. The calculated RMS current is 0.229 A.

8.2.2.3 Input Capacitor Selection

The TPS565201 requires an input decoupling capacitor and a bulk capacitor is needed depending on the application. TI recommends a ceramic capacitor over 10 µF for the decoupling capacitor. An additional 0.1-µF capacitor (C3) from pin 3 to ground is optional to provide additional high frequency filtering. The capacitor voltage rating needs to be greater than the maximum input voltage.

8.2.2.4 Bootstrap Capacitor Selection

A 0.1-µF ceramic capacitor must be connected between the VBST to SW pin for proper operation. TI recommends to use a ceramic capacitor.

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8.2.3 Application Curves

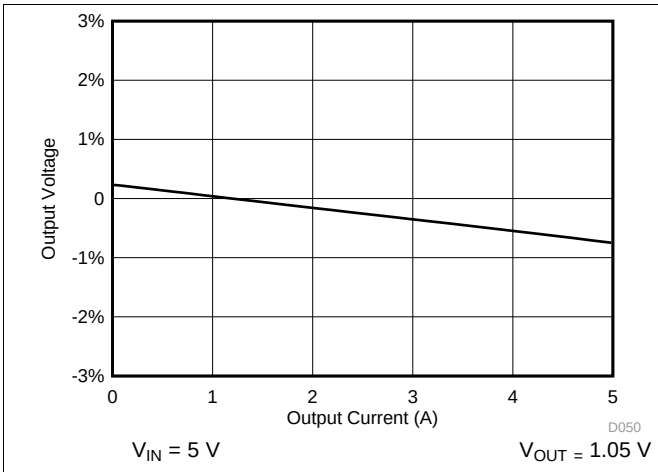


Figure 15. Load Regulation, V_{IN} = 5 V

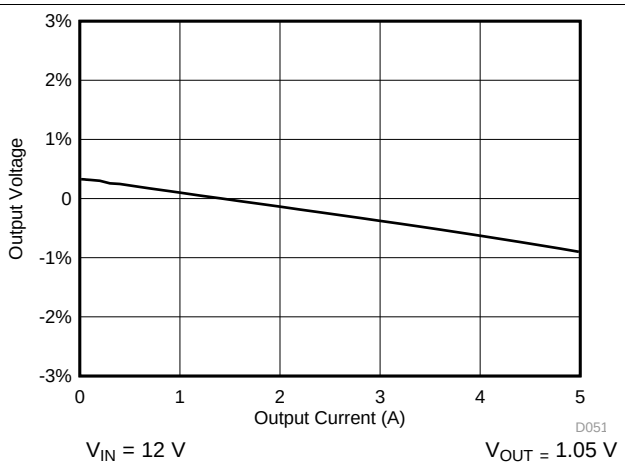


Figure 16. Load Regulation, V_{IN} = 12 V

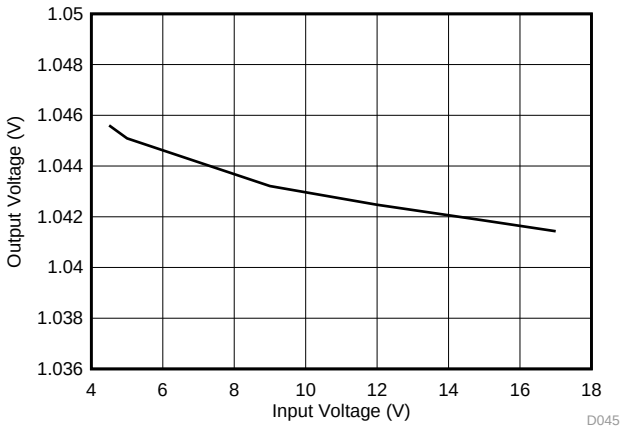


Figure 17. Line Regulation

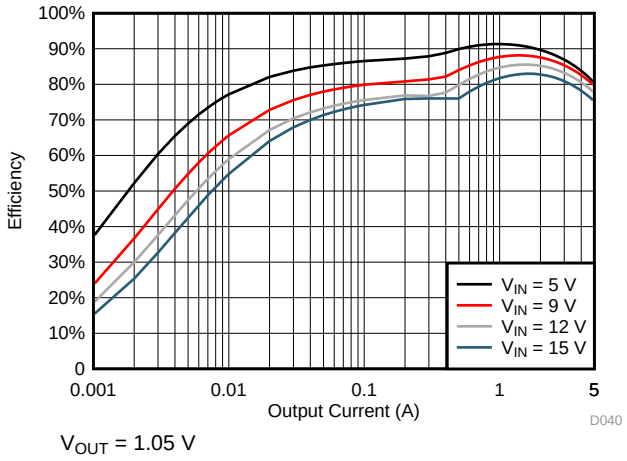
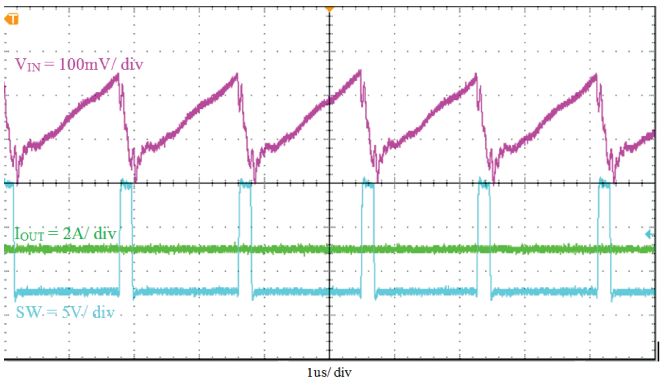
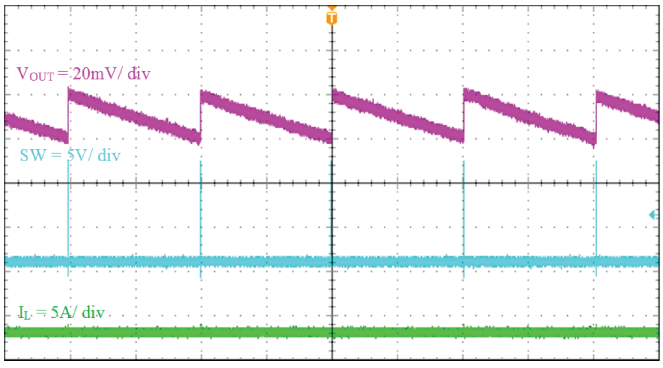


Figure 18. Efficiency vs Output Current



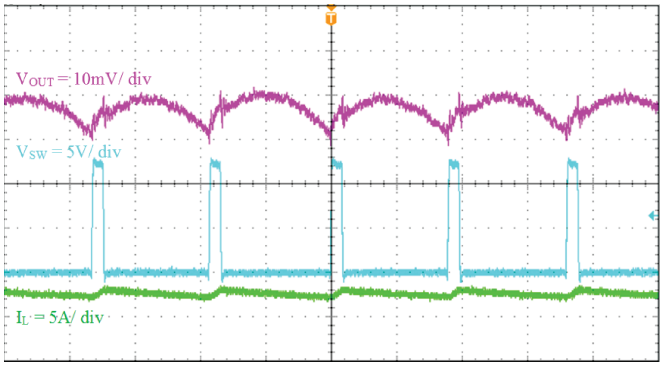
1 µs/div

Figure 19. TPS565201 Input Voltage Ripple



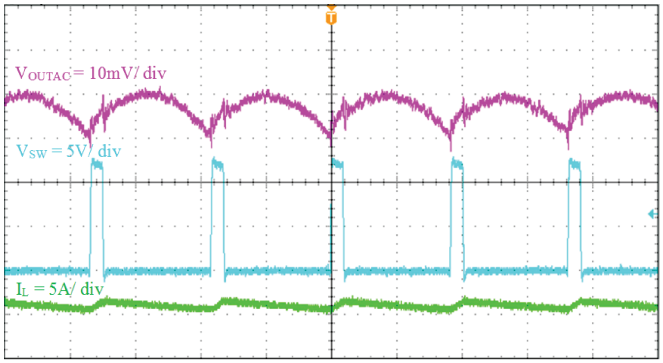
1 µs/div

Figure 20. TPS565201 Output Voltage Ripple, No Load



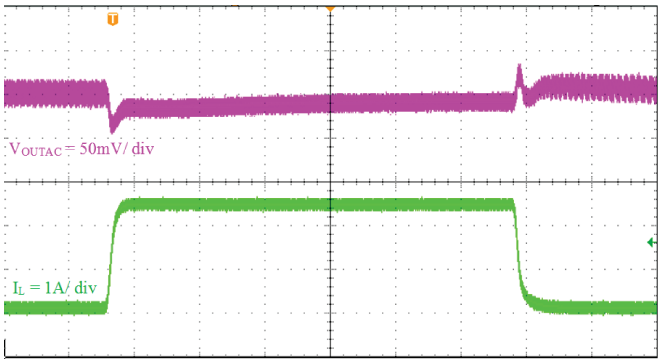
1 µs/div

Figure 21. TPS565201 Output Voltage Ripple, I_{OUT} 2.5 A



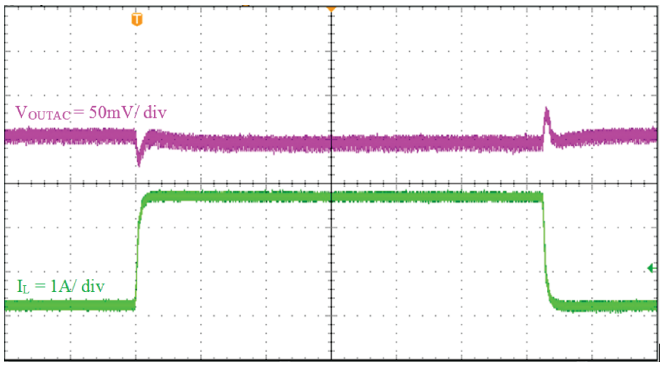
1 µs/div

Figure 22. TPS565201 Output Voltage Ripple, I_{OUT} 5 A



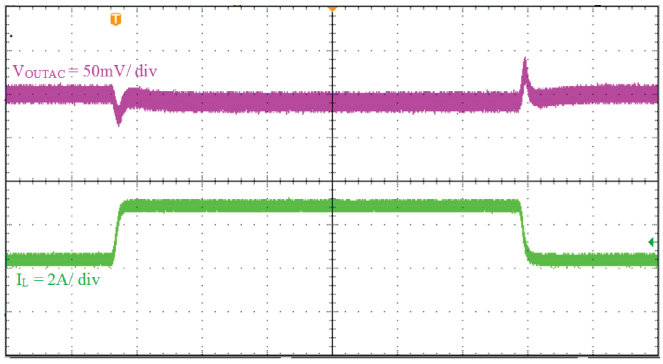
100 µs/div

Figure 23. TPS565201 Transient Response 0.1 to 2.5 A



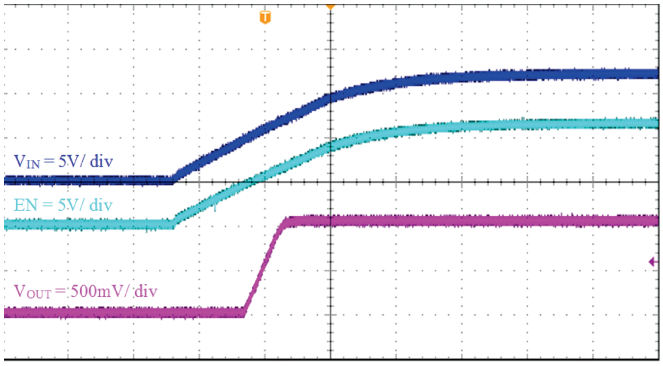
100 µs/div

Figure 24. TPS565201 Transient Response, 1.25 to 3.75 A



100 µs/div

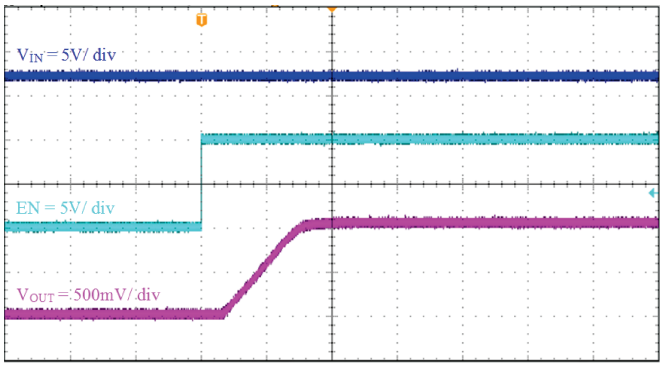
Figure 25. TPS565201 Transient Response, 2.5 to 5 A



2 ms/div

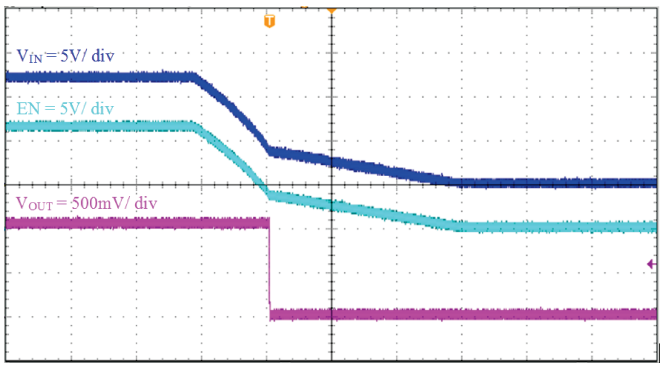
Figure 26. TPS565201 Startup Relative to V_{IN}

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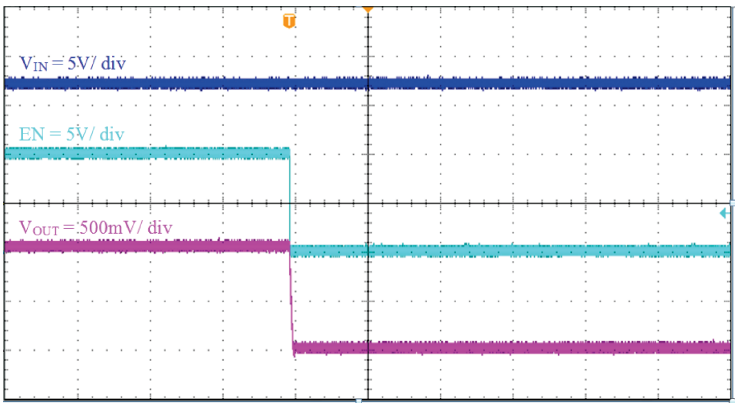
400 µs/div

Figure 27. TPS565201 Startup Relative to EN



20 ms/div

Figure 28. TPS565201 Shutdown Relative to V_{IN}



400 µs/div

Figure 29. TPS565201 Shutdown Relative to EN

9 Power Supply Recommendations

The TPS565201 is designed to operate from input supply voltage in the range of 4.5 V to 17 V. Buck converters require the input voltage to be higher than the output voltage for proper operation. The maximum recommended operating duty cycle is 83%. Using that criteria, the minimum recommended input voltage is V_O / 0.83.

10 Layout

10.1 Layout Guidelines

1. VIN and GND traces should be as wide as possible to reduce trace impedance. The wide areas are also of advantage from the view point of heat dissipation.
2. The input capacitor and output capacitor should be placed as close to the device as possible to minimize trace impedance.
3. Provide sufficient vias for the input capacitor and output capacitor.
4. Keep the SW trace as physically short and wide as practical to minimize radiated emissions.
5. Do not allow switching current to flow under the device.
6. A separate VOUT path should be connected to the upper feedback resistor.
7. Make a Kelvin connection to the GND pin for the feedback path.
8. Voltage feedback loop should be placed away from the high-voltage switching trace, and preferably has ground shield.
9. The trace of the VFB node should be as small as possible to avoid noise coupling.
10. The GND trace between the output capacitor and the GND pin should be as wide as possible to minimize its trace impedance.

10.2 Layout Example

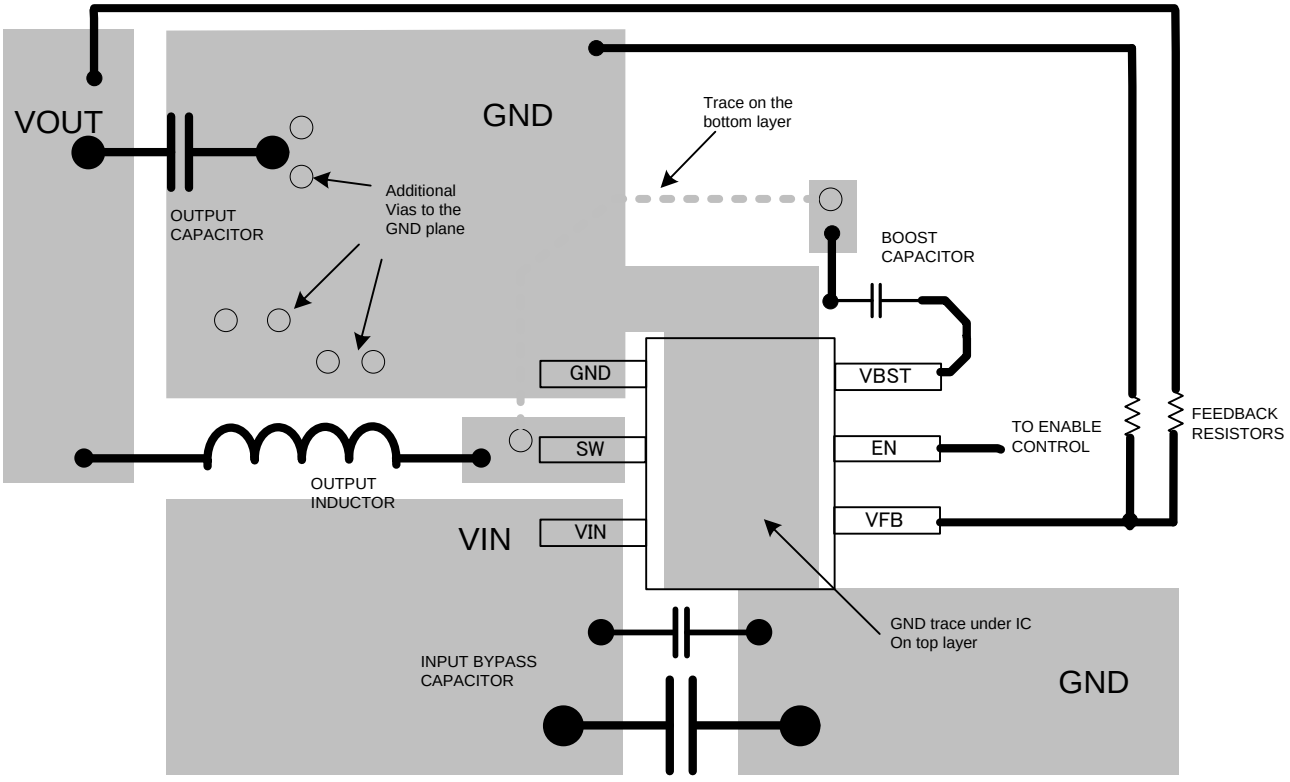


Figure 30. TPS565201 Layout Example

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11 Device and Documentation Support

11.1 Receiving Notification of Documentation Updates

To receive notification of documentation updates, navigate to the device product folder on ti.com. In the upper right corner, click on *Alert me* to register and receive a weekly digest of any product information that has changed. For change details, review the revision history included in any revised document.

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Design Support ***TI's Design Support*** Quickly find helpful E2E forums along with design support tools and contact information for technical support.

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11.4 Electrostatic Discharge Caution



These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

11.5 Glossary

SLYZ022 — *TI Glossary*.

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

12 Mechanical, Packaging, and Orderable Information

The following pages include mechanical, packaging, and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the left-hand navigation.

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PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
TPS565201DDCR	ACTIVE	SOT-23-THIN	DDC	6	3000	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 125	5201	Samples
TPS565201DDCT	ACTIVE	SOT-23-THIN	DDC	6	250	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 125	5201	Samples

(1) The marketing status values are defined as follows:
ACTIVE: Product device recommended for new designs.
LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.
PREVIEW: Device has been announced but is not in production. Samples may or may not be available.
OBSOLETE: TI has discontinued the production of the device.

(2) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".
RoHS Exempt: TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.
Green: TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

(3) MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

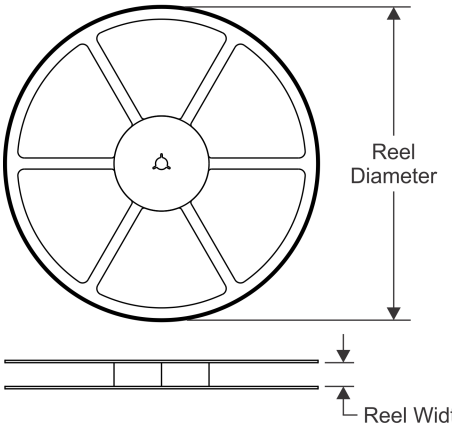
(6) Lead/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

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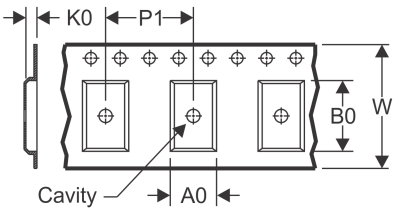
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TAPE AND REEL INFORMATION

REEL DIMENSIONS

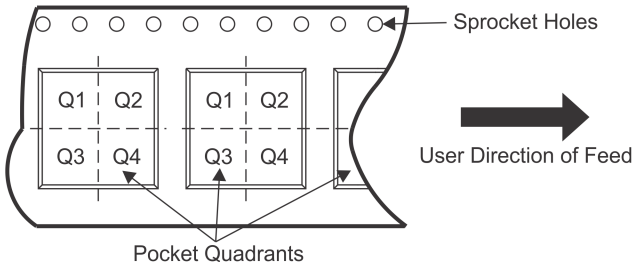


TAPE DIMENSIONS



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

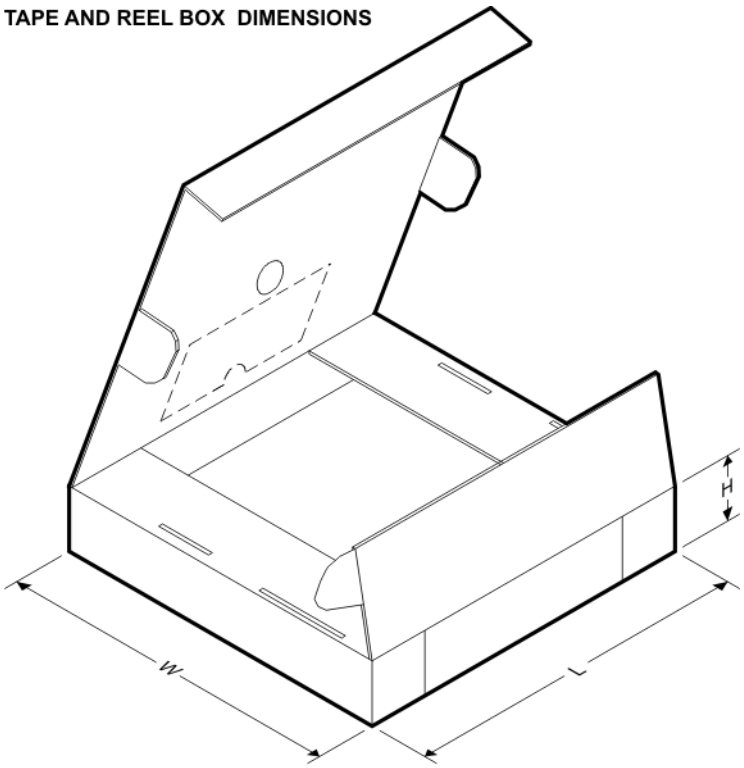
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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
TPS565201DDCR	SOT-23-THIN	DDC	6	3000	180.0	9.5	3.17	3.1	1.1	4.0	8.0	Q3
TPS565201DDCT	SOT-23-THIN	DDC	6	250	180.0	9.5	3.17	3.1	1.1	4.0	8.0	Q3

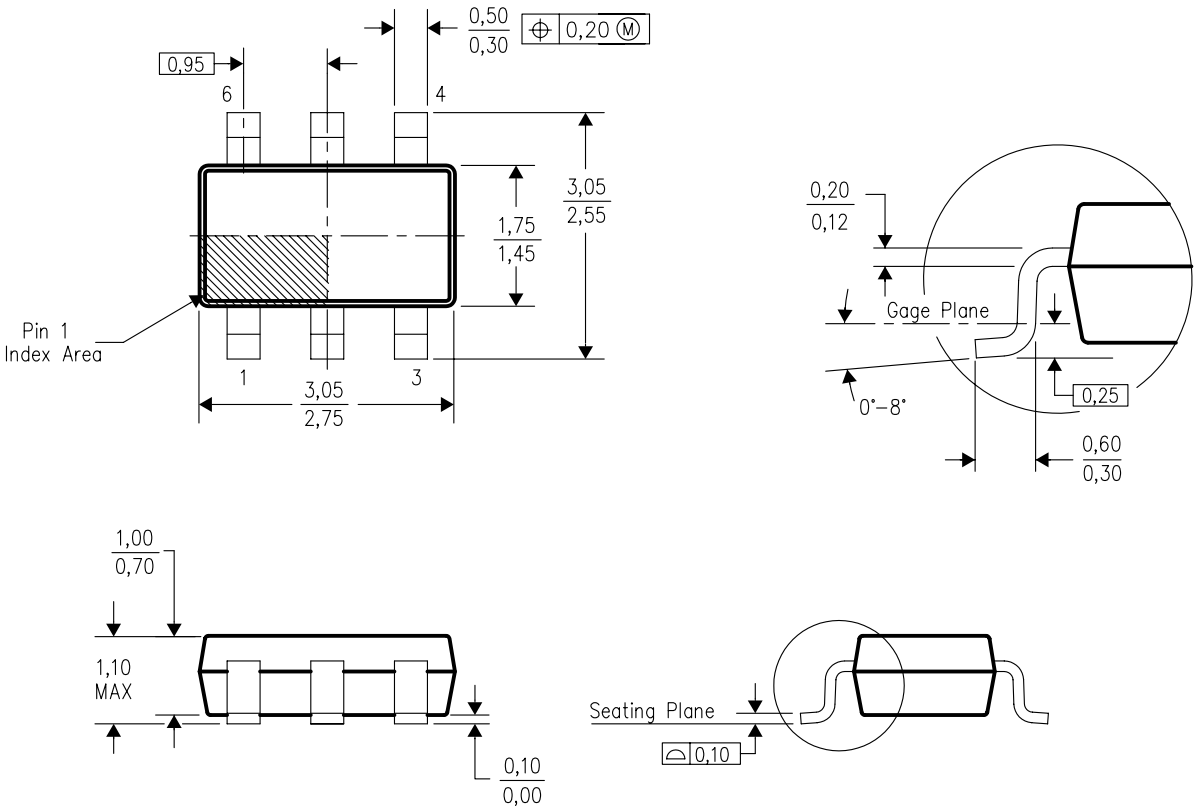
TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TPS565201DDCR	SOT-23-THIN	DDC	6	3000	184.0	184.0	19.0
TPS565201DDCT	SOT-23-THIN	DDC	6	250	184.0	184.0	19.0

DDC (R–PDSO–G6) PLASTIC SMALL–OUTLINE



4204403–3/E 06/05

NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion.
D. Falls within JEDEC MO–193 variation AA (6 pin).

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