

4.5V to 18V Input, 6.5-A Synchronous Step-Down SWIFT™ Converter with ECO-Mode™

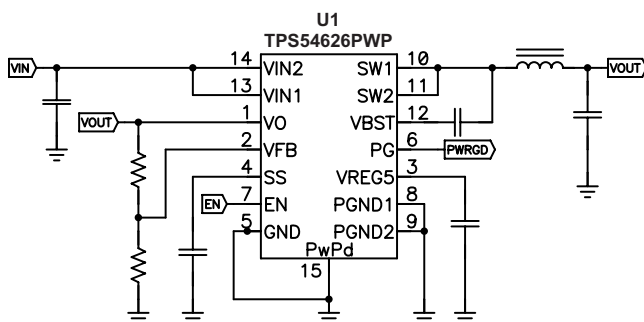
Check for Samples: [TPS54626](#)

FEATURES

- **D-CAP2™ Mode Enables Fast Transient Response**
- **Low Output Ripple and Allows Ceramic Output Capacitor**
- **Wide Vin Input Voltage Range: 4.5 V to 18 V**
- **Output Voltage Range: 0.76 V to 5.5 V**
- **Highly Efficient Integrated FET's Optimized for Lower Duty Cycle Applications –36 mΩ (High Side) and 28 mΩ (Low Side)**
- **High Efficiency, less than 10 µA at shutdown**
- **High Initial Bandgap Reference Accuracy**
- **Adjustable Soft Start**
- **Pre-Biased Soft Start**
- **650-kHz Switching Frequency (f_{sw})**
- **Cycle By Cycle Over Current Limit**
- **Power Good Output**
- **Auto-Skip Eco-mode™ for High Efficiency at Light Load**

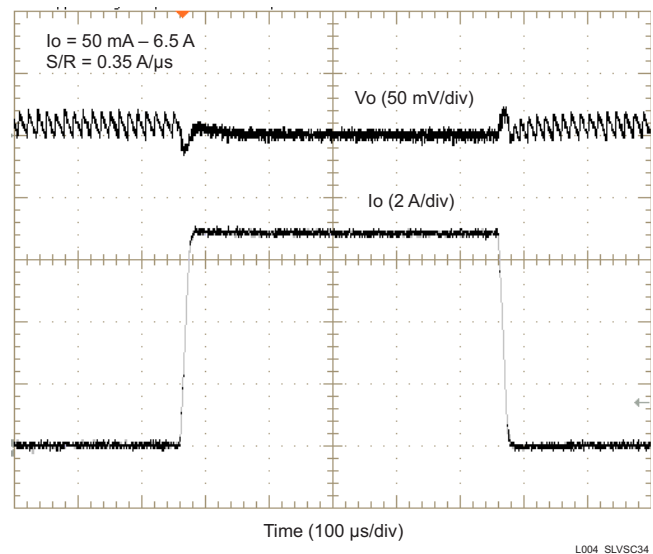
APPLICATIONS

- **Wide Range of Applications for Low Voltage System**
 - Digital TV Power Supply
 - High Definition Blu-ray Disc™ Players
 - Networking Home Terminal
 - Digital Set Top Box (STB)



DESCRIPTION

The TPS54626 is an adaptive on-time D-CAP2™ mode synchronous Buck converter. The TPS54626 enables system designers to complete the suite of various end equipment's power bus regulators with a cost effective, low component count, low standby current solution. The main control loop for the TPS54626 uses the D-CAP2™ mode control which provides a very fast transient response with no external components. The adoptive on-time control supports seamless operation between PWM mode at heavy load condition and reduced frequency operation at light load for high efficiency. The TPS54626 also has a proprietary circuit that enables the device to adopt to both low equivalent series resistance (ESR) output capacitors, such as SP-CAP and ultra-low ESR ceramic capacitors. The device operates from 4.5-V to 18-V VIN input power supply voltage. The output voltage can be programmed between 0.76 V and 5.5 V. The device also features an adjustable soft start time and a power good function. The TPS54626 is available in the 14 pin HTSSOP package, designed to operate from –40°C to 85°C.



L004_SLVSC34



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This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

ORDERING INFORMATION⁽¹⁾

| T _A | PACKAGE ⁽²⁾ (3) | ORDERABLE PART NUMBER | PIN | TRANSPORT MEDIA |
|----------------|----------------------------|-----------------------|-----|-----------------|
| –45°C to 85°C | PWP | TPS54626PWP | 14 | Tube |
| | | TPS54626PWPR | | Tape and Reel |

- (1) For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI web site at www.ti.com.
 (2) Package drawings, thermal data, and symbolization are available at www.ti.com/packaging.
 (3) All package options have Cu NIPDAU lead/ball finish.

ABSOLUTE MAXIMUM RATINGS

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

| | | | VALUE | | UNIT |
|-------------------|--------------------------------|----------------------------|-------|-----|------|
| | | | MIN | MAX | |
| V _I | Input voltage range | VIN1, VIN2, EN | –0.3 | 20 | V |
| | | VBST | –0.3 | 26 | V |
| | | VBST (10 ns transient) | –0.3 | 28 | V |
| | | VBST (vs Sw1, SW2) | –0.3 | 6.5 | V |
| | | VFB, VO, SS, PG | –0.3 | 6.5 | V |
| | | SW1, SW2 | –2 | 20 | V |
| | | SW1, SW2 (10 ns transient) | –3 | 22 | V |
| V _O | Output voltage range | VREG5 | –0.3 | 6.5 | V |
| | | PGND1, PGND2 | –0.3 | 0.3 | V |
| V _{diff} | Voltage from GND to POWERPAD | | –0.2 | 0.2 | V |
| ESD rating | Electrostatic discharge | Human Body Model (HBM) | | 2 | kV |
| | | Charged Device Model (CDM) | | 500 | V |
| T _J | Operating junction temperature | | –40 | 150 | °C |
| T _{stg} | Storage temperature | | –55 | 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 may affect device reliability.

THERMAL INFORMATION

| THERMAL METRIC ⁽¹⁾ | | TPS54626 | UNITS |
|-------------------------------|--|---------------|-------|
| | | PWP (14 PINS) | |
| θ _{JA} | Junction-to-ambient thermal resistance | 40.5 | °C/W |
| θ _{JCtop} | Junction-to-case (top) thermal resistance | 28.7 | |
| θ _{JB} | Junction-to-board thermal resistance | 24.2 | |
| ψ _{JT} | Junction-to-top characterization parameter | 0.8 | |
| ψ _{JB} | Junction-to-board characterization parameter | 23.9 | |
| θ _{JCbot} | Junction-to-case (bottom) thermal resistance | 2.4 | |

- (1) For more information about traditional and new thermal metrics, see the *IC Package Thermal Metrics* application report, [SPRA953](http://www.ti.com/lit/an/spra953).

RECOMMENDED OPERATING CONDITIONS

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

| | | MIN | MAX | UNIT |
|----------|--------------------------------|------|-----|------------|
| V_{IN} | Supply input voltage range | 4.5 | 18 | V |
| V_I | VBST | –0.1 | 24 | V |
| | VBST (10 ns transient) | –0.1 | 27 | |
| | VBST (vs SW) | –0.1 | 6.0 | |
| | SS, PG | –0.1 | 5.7 | |
| | EN | –0.1 | 18 | |
| | VO, VFB | –0.1 | 5.5 | |
| | SW1, SW2 | –1.8 | 18 | |
| | SW1, SW2 (10 ns transient) | –3 | 21 | |
| | PGND1, PGND2 | –0.1 | 0.1 | |
| V_O | Output voltage range | –0.1 | 5.7 | V |
| I_O | Output Current range | 0 | 5 | mA |
| R_{PG} | Power Good resistor | 25 | 150 | k Ω |
| T_A | Operating free-air temperature | –40 | 85 | °C |
| T_J | Operating junction temperature | –40 | 150 | °C |

ELECTRICAL CHARACTERISTICS

over operating free-air temperature range, $V_{IN} = 12V$ (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|--|--|-----|------------|-----|---------------|
| SUPPLY CURRENT | | | | | | |
| I_{VIN} | Operating - non-switching supply current | V_{IN} current, $T_A = 25^\circ\text{C}$, EN = 5 V, $V_{VFB} = 0.8\text{ V}$ | 950 | 1400 | | μA |
| I_{VINSN} | Shutdown supply current | V_{IN} current, $T_A = 25^\circ\text{C}$, EN = 0 V | 3.6 | 10 | | μA |
| LOGIC THRESHOLD | | | | | | |
| V_{ENH} | EN high-level input voltage | En | 1.6 | | | V |
| V_{ENL} | EN low-level input voltage | EN | | | 0.6 | V |
| R_{EN} | EN pin resistance to GND | $V_{EN} = 12\text{ V}$ | 200 | 400 | 800 | k Ω |
| VFB VOLTAGE AND DISCHARGE RESISTANCE | | | | | | |
| V_{FBTH} | VFB threshold voltage | VFB voltage light load mode, $T_A = 25^\circ\text{C}$, $V_O = 1.05\text{ V}$, $I_O = 10\text{mA}$ | | 772 | | mV |
| | | $T_A = 25^\circ\text{C}$, $V_O = 1.05\text{ V}$, continuous mode | 757 | 765 | 773 | |
| | | $T_A = 0^\circ\text{C}$ to 85°C , $V_O = 1.05\text{ V}$, continuous mode ⁽¹⁾ | 753 | | 777 | |
| | | $T_A = -40^\circ\text{C}$ to 85°C , $V_O = 1.05\text{ V}$, continuous mode ⁽¹⁾ | 751 | | 779 | |
| I_{VFB} | VFB input current | $V_{VFB} = 0.8\text{ V}$, $T_A = 25^\circ\text{C}$ | 0 | ± 0.15 | | μA |
| R_{Dischg} | V_O discharge resistance | $V_{EN} = 0\text{ V}$, $V_O = 0.5\text{ V}$, $T_A = 25^\circ\text{C}$ | 100 | 150 | | Ω |
| VREG5 OUTPUT | | | | | | |
| V_{VREG5} | VREG5 output voltage | $T_A = 25^\circ\text{C}$, $6\text{ V} < V_{IN} < 18\text{ V}$, $0 < I_{VREG5} < 5\text{ mA}$ | 5.2 | 5.5 | 5.7 | V |
| I_{VREG5} | Output current | $V_{IN} = 6\text{ V}$, $V_{VREG5} = 4\text{ V}$, $T_A = 25^\circ\text{C}$ | 20 | | | mA |
| MOSFET | | | | | | |
| R_{dsonh} | High side switch resistance | $T_A = 25^\circ\text{C}$, VBST-SW1,2 = 5.5V | | 36 | | m Ω |
| R_{dsonl} | Low side switch resistance | $T_A = 25^\circ\text{C}$ | | 28 | | m Ω |

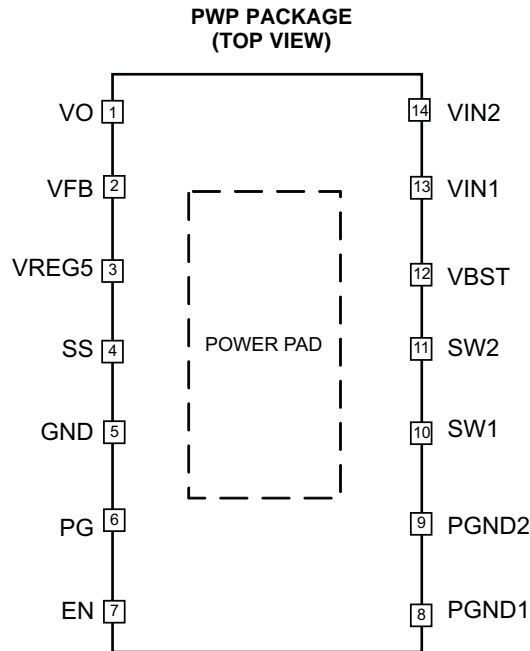
(1) Not production tested.

ELECTRICAL CHARACTERISTICS (continued)over operating free-air temperature range, $V_{IN} = 12V$ (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|--|----------------------------|---|---------|------|------|------|
| CURRENT LIMIT | | | | | | |
| I _{ocl} | Current limit | L = 1.5 μH ⁽²⁾ , | 7.2 | 8.2 | 9.5 | A |
| THERMAL SHUTDOWN | | | | | | |
| T _{SDN} | Thermal shutdown threshold | Shutdown temperature ⁽²⁾ | 165 | | | °C |
| | | Hysteresis ⁽²⁾ | 35 | | | |
| ON-TIME TIMER CONTROL | | | | | | |
| T _{ON} | On time | V _{IN} = 12 V, V _O = 1.05 V | 150 | | | ns |
| T _{OFF(MIN)} | Minimum off time | T _A = 25°C, V _{FB} = 0.7 V | 260 310 | | | ns |
| SOFT START | | | | | | |
| I _{SSC} | SS charge current | V _{SS} = 1.0 V | 4.2 | 6.0 | 7.8 | μA |
| I _{SSD} | SS discharge current | V _{SS} = 0.5 V | 1.5 | 3.3 | | mA |
| POWER GOOD | | | | | | |
| V _{THPG} | PG threshold | V _{VFB} rising (good) | 85% | 90% | 95% | |
| | | V _{VFB} falling (fault) | 85% | | | |
| I _{PG} | PG sink current | V _{PG} = 0.5 V | 2.5 | 5 | | mA |
| OUTPUT UNDERVOLTAGE AND OVERVOLTAGE PROTECTION | | | | | | |
| V _{OVP} | Output OVP trip threshold | OVP detect | 120% | 125% | 130% | |
| T _{OVPDEL} | Output OVP prop delay | | 10 | | | μs |
| V _{UVP} | Output UVP trip threshold | UVP detect | 60% | 65% | 70% | |
| | | Hysteresis | 10% | | | |
| T _{UVPDEL} | Output UVP delay | | 0.25 | | | ms |
| T _{UVPEN} | Output UVP enable delay | Relative to soft-start time | X 1.7 | | | |
| UVLO | | | | | | |
| V _{UVLO} | UVLO threshold | Wake up VREG5 voltage | 3.45 | 3.75 | 4.05 | V |
| | | Hysteresis VREG5 voltage | 0.13 | 0.32 | 0.48 | |

(2) Not production tested.

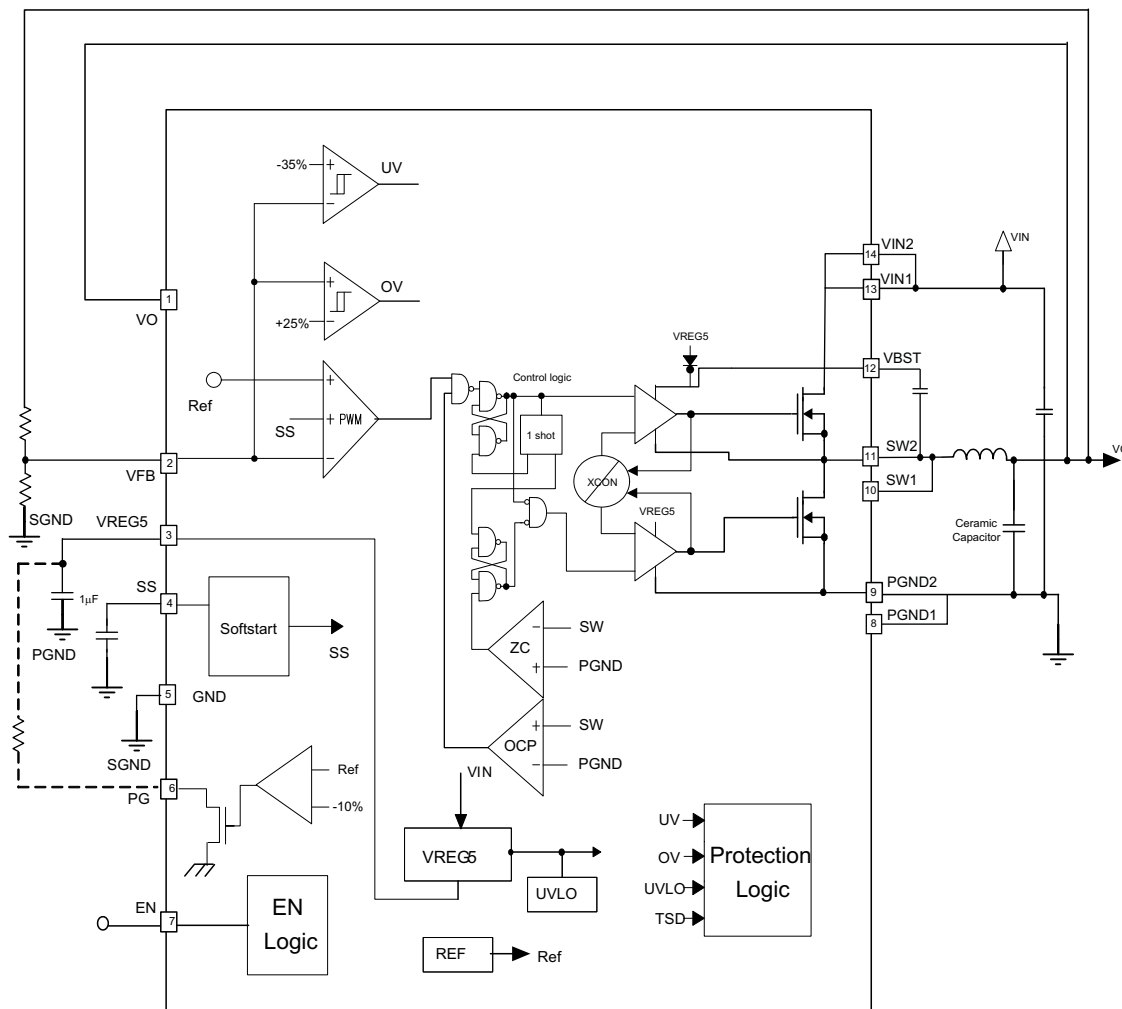
DEVICE INFORMATION



PIN FUNCTIONS

| PIN | | DESCRIPTION |
|--------------|-----------|--|
| NAME | NUMBER | |
| VO | 1 | Connect to output of converter. This pin is used for output discharge function. |
| VFB | 2 | Converter feedback input. Connect with feedback resistor divider. |
| VREG5 | 3 | 5.5V power supply output. A Capacitor (typical 1µF) should be connected to GND. VREG5 is not active when EN is low. |
| SS | 4 | Soft start control. An external capacitor should be connected to GND. |
| GND | 5 | Signal ground pin. |
| PG | 6 | Open drain power good output |
| EN | 7 | Enable control input. EN is active high and must be pulled up to enable the device. |
| PGND1, PGND2 | 8, 9 | Ground returns for low-side MOSFET. Also serve as inputs of current comparators. Connect PGND and GND strongly together near the IC. |
| SW1, SW2 | 10,11 | Switch node connection between high-side NFET and low-side NFET. Also serve as inputs to current comparator. |
| VBST | 12 | Supply input for high-side NFET gate driver (boost terminal). Connect capacitor from this pin to respective SW1,SW2 terminals. An internal PN diode is connected between VREG5 and VBST pin. |
| VIN1,VIN2 | 13,14 | Power Input and connected to high side NFET drain. |
| | | Supply Input for 5V internal linear regulator for the control circuitry |
| PowerPAD™ | Back side | Thermal pad of the package. Must be soldered to achieve appropriate dissipation. Should be connected to PGND |

FUNCTIONAL BLOCK DIAGRAM (HTSSOP)



OVERVIEW

The TPS54626 is a 6.5-A synchronous step-down (buck) converter with two integrated N-channel MOSFETs and auto-skip Eco-mode™ to improve light load efficiency. It operates using D-CAP2™ mode control. The fast transient response of D-CAP2™ control reduces the output capacitance required to meet a specific level of performance. Proprietary internal circuitry allows the use of low ESR output capacitors including ceramic and special polymer types.

DETAILED DESCRIPTION

PWM Operation

The main control loop of the TPS54626 is an adaptive on-time pulse width modulation (PWM) controller that supports a proprietary D-CAP2™ mode control. D-CAP2™ mode control combines constant on-time control with an internal compensation circuit for pseudo-fixed frequency and low external component count configuration with both low ESR and ceramic output capacitors. It is stable with virtually no ripple at the output.

At the beginning of each cycle, the high-side MOSFET is turned on. The MOSFET is turned off after the internal one-shot timer expires. The one-shot timer is set by the converter input voltage, VIN, and the output voltage, VO, 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 internal ramp is added to reference voltage to simulate output ripple, eliminating the need for ESR induced output ripple from D-CAP2™ mode control.

PWM Frequency and Adaptive On-Time Control

TPS54626 uses an adaptive on-time control scheme and does not have a dedicated on board oscillator. The TPS54626 runs with a pseudo-constant frequency of 650 kHz by using the input voltage and output voltage to set the on-time one-shot timer. The on-time is inversely proportional to the input voltage and proportional to the output voltage. Therefore, when duty ratio is VOUT/VIN, the frequency is constant.

Auto-Skip Eco-Mode™ Control

The TPS54626 is designed with Auto-Skip mode to increase 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 its zero inductor current is detected. As the load current further decreases the converter run into discontinuous conduction mode. The on-time is kept almost the same as is 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. The transition point to the light load operation IOUT(LL) current can be calculated in [Equation 1](#).

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

Soft Start and Pre-Biased Soft Start

The soft start function is adjustable. When the EN pin becomes high, 6 μA current begins charging the capacitor which is connected from the SS pin to GND. Smooth control of the output voltage is maintained during start up. The equation for the slow start time is shown in [Equation 2](#). VFB voltage is 0.765 V and SS pin source current is 6 μA.

$$t_{SS(ms)} = \frac{C_{SS}(nF) \times V_{REF} \times 1.1}{I_{SS}(\mu A)} = \frac{C_{SS}(nF) \times 0.765 \times 1.1}{6} \quad (2)$$

TPS54626 contains a unique circuit to prevent current from being pulled from the output during startup if the output is pre-biased. When the soft-start commands a voltage higher than the pre-bias level (internal soft-start becomes greater than feedback voltage VFB), the controller slowly activates synchronous rectification by starting the first low side FET gate driver pulses with a narrow on-time. It then increments that on-time on a cycle-by-cycle basis until it coincides with the time dictated by (1-D), where D is the duty cycle of the converter. This scheme prevents the initial sinking of the pre-bias output, and ensure that the out voltage (VO) starts and ramps up smoothly into regulation and the control loop is given time to transition from pre-biased start-up to normal mode operation.

Power Good

The TPS54626 has power good open drain output. The power-good function is activated after soft start has finished. The power good function becomes active after 1.7 times soft-start time. When the output voltage becomes within –10% of the target value, internal comparators detect power good state and the power good signal becomes high. Rpg resistor value, which is connected between PG and VREG5, is required from 25kΩ to 150kΩ. If the feedback voltage goes under 15% of the target value, the power good signal becomes low.

Output Discharge Control

TPS54626 discharges the output when EN is low, or the controller is turned off by the protection functions (OVP, UVP, UVLO and thermal shutdown). The device discharges the output using an internal 100-Ω MOSFET which is connected from VO to PGND. The internal low-side MOSFET is not turned on during the output discharge operation to avoid the possibility of causing negative voltage at the output.

Current Protection

The output over-current protection (OCP) is implemented using a cycle-by-cycle valley detect control circuit. The switch current is monitored by measuring the low-side FET switch voltage between the SW pin and GND. This voltage 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} , the on-time 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 measured voltage is above the voltage proportional to the current limit, then the device constantly monitors the low side FET switch voltage, which is proportional to the switch current, during the low-side on-time.

The converter maintains the low-side switch on until the measured voltage is below the voltage corresponding to the current limit at which time the switching cycle is terminated and new switching cycle begins. IN subsequent switching cycles, the on-time is set to 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 one half of the peak-to-peak inductor current is higher than the over-current threshold. 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 under-voltage protection circuit to be activated. This protection itself is non-latching.

Over/Under Voltage Protection

TPS54626 detects over and under voltage conditions by monitoring the feedback voltage (VFB). This function is enabled after approximately 1.7 x times the softstart time.

When the feedback voltage becomes higher than 125% of the target voltage, the OVP comparator output goes high and the circuit latches and both the high-side MOSFET driver and the low-side MOSFET driver turn off.

When the feedback voltage becomes lower than 65% of the target voltage, the UVP comparator output goes high and an internal UVP delay counter begins. After 250us, the device latches off both internal top and bottom MOSFET.

UVLO Protection

Under voltage lock out protection (UVLO) monitors the voltage of the V_{REG5} pin. When the V_{REG5} voltage is lower than UVLO threshold voltage, the TPS54626 is shut off. This protection is non-latching.

Thermal Shutdown

Thermal protection is self-activating. If the junction temperature exceeds the threshold value (typically 165°C), the TPS54626 is shut off. This protection is non-latching.

TYPICAL CHARACTERISTICS

$V_{IN} = 12\text{ V}$, $T_A = 25\text{ }^{\circ}\text{C}$ (unless otherwise noted)

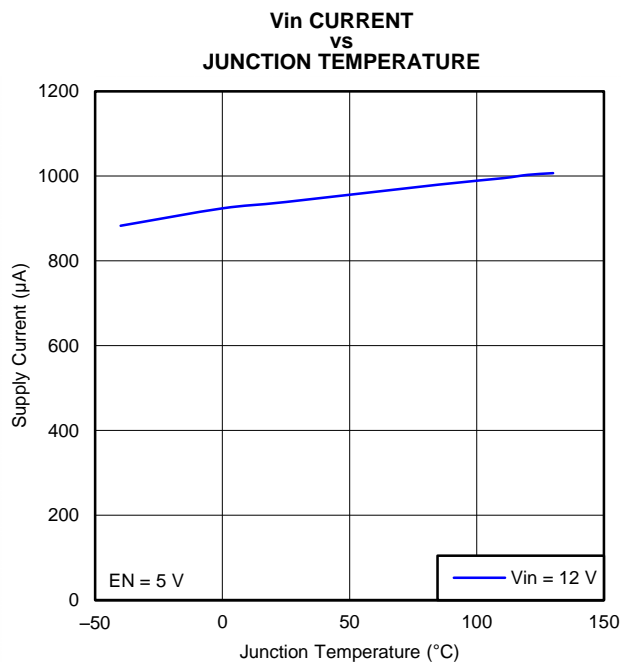


Figure 1.

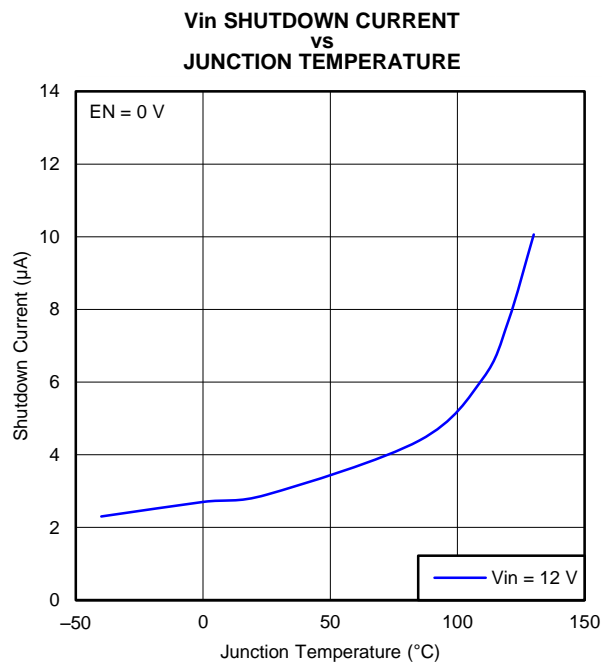


Figure 2.

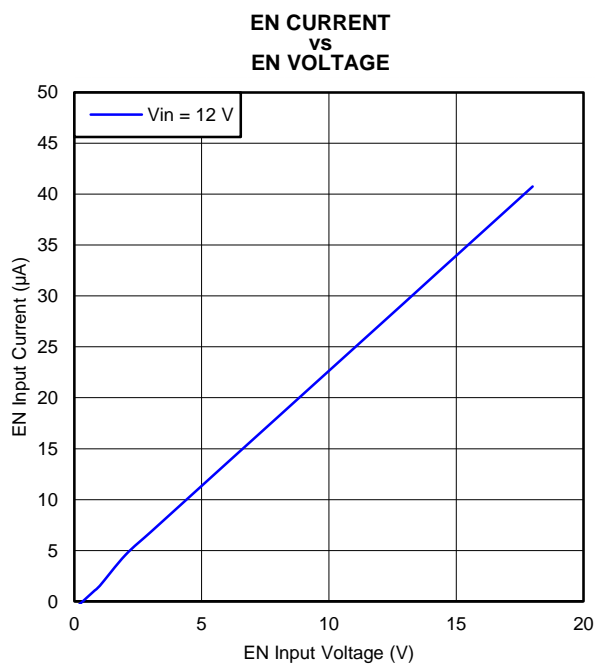


Figure 3.

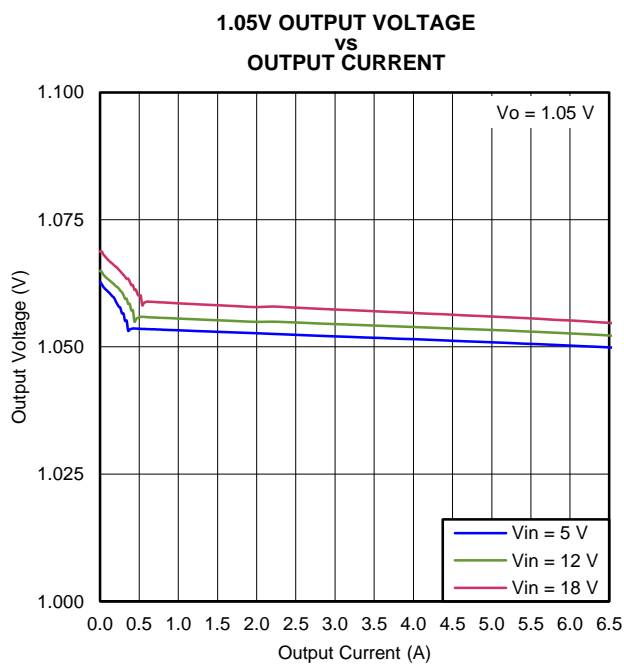


Figure 4.

TYPICAL CHARACTERISTICS (continued)

$V_{IN} = 12\text{ V}$, $T_A = 25\text{ }^{\circ}\text{C}$ (unless otherwise noted)

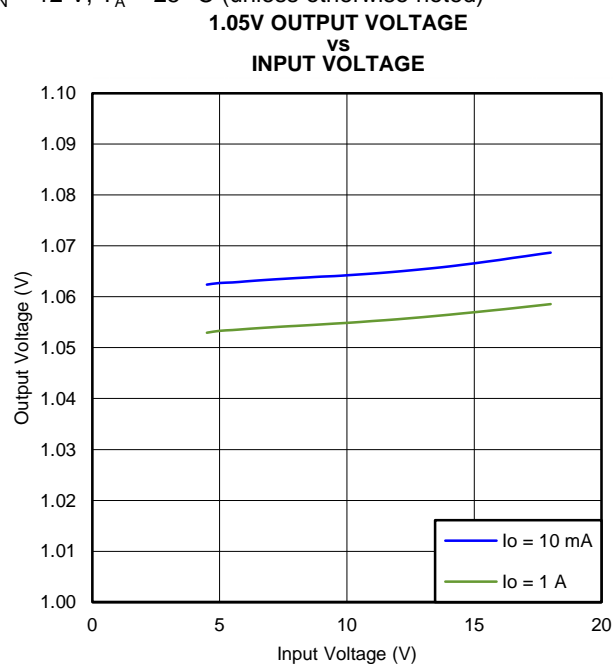
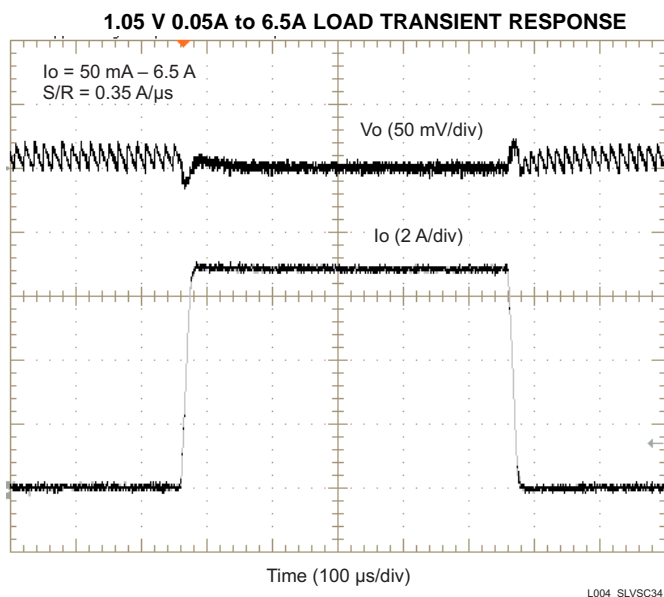
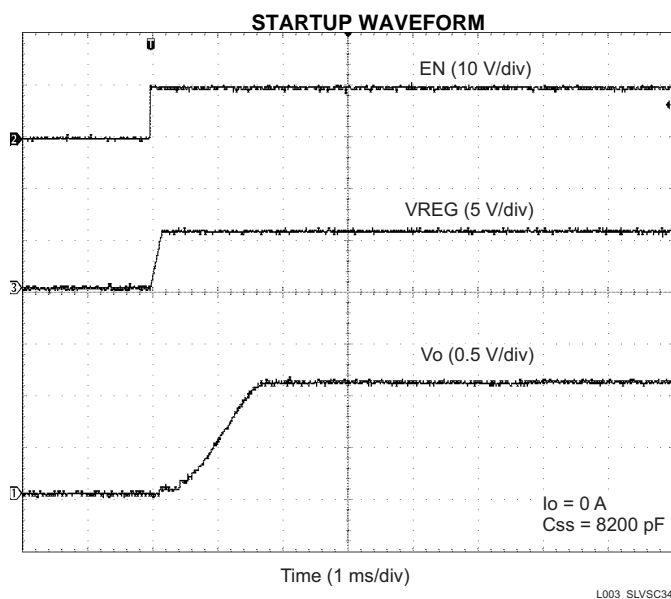


Figure 5.



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Figure 6.



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Figure 7.

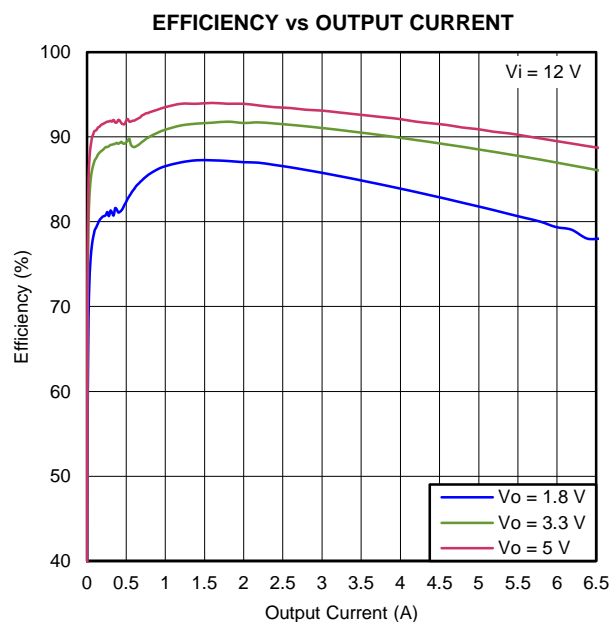


Figure 8.

TYPICAL CHARACTERISTICS (continued)

$V_{IN} = 12\text{ V}$, $T_A = 25\text{ }^{\circ}\text{C}$ (unless otherwise noted)

LIGHT LOAD EFFICIENCY vs OUTPUT CURRENT

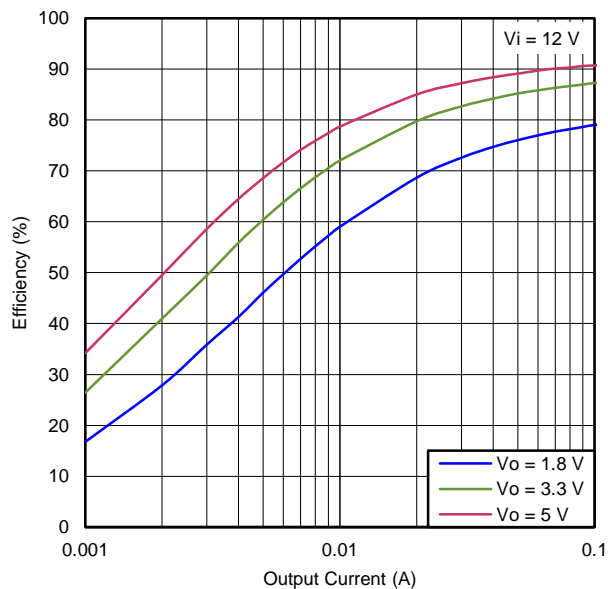


Figure 9.

SWITCHING FREQUENCY vs INPUT VOLTAGE ($I_O = 1\text{ A}$)

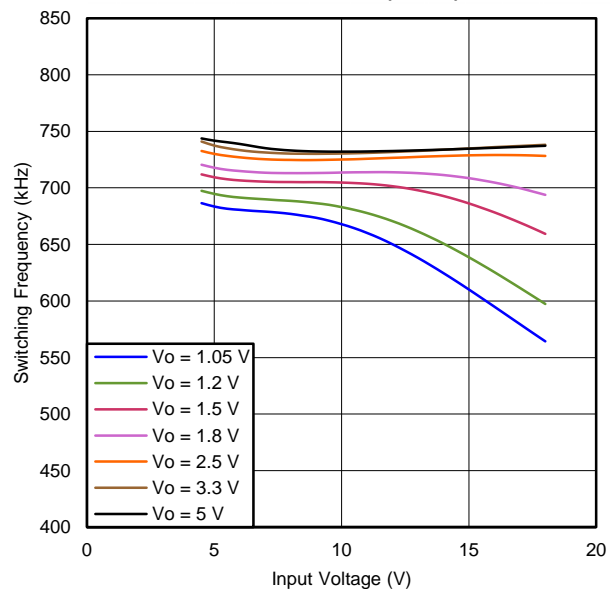


Figure 10.

SWITCHING FREQUENCY vs OUTPUT CURRENT

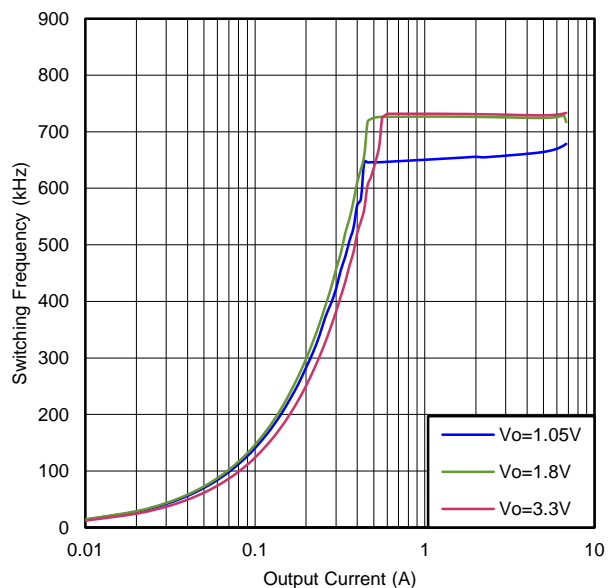


Figure 11.

VFB VOLTAGE vs JUNCTION TEMPERATURE

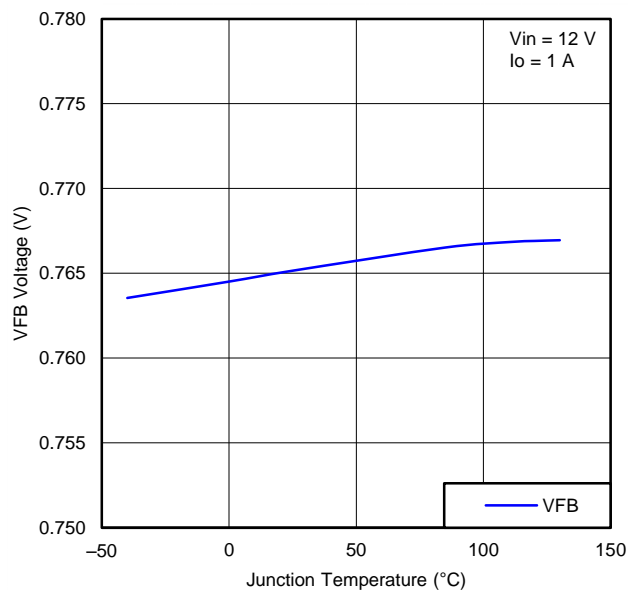


Figure 12.

TYPICAL CHARACTERISTICS (continued)

$V_{IN} = 12\text{ V}$, $T_A = 25\text{ }^{\circ}\text{C}$ (unless otherwise noted)

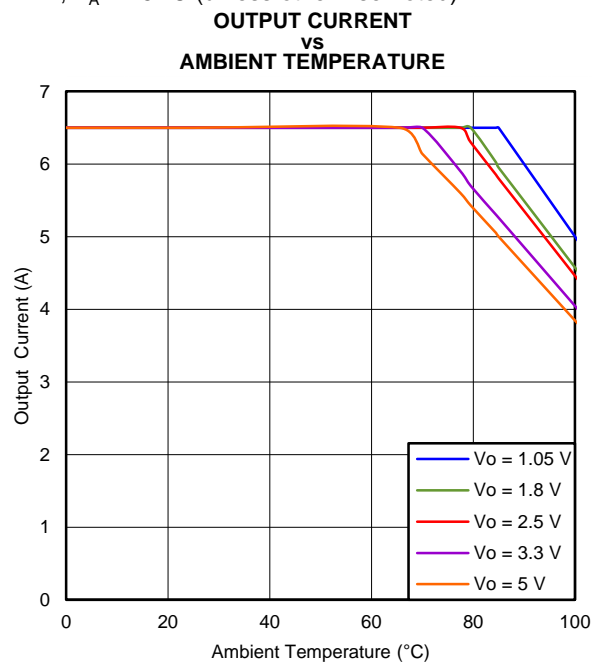


Figure 13.

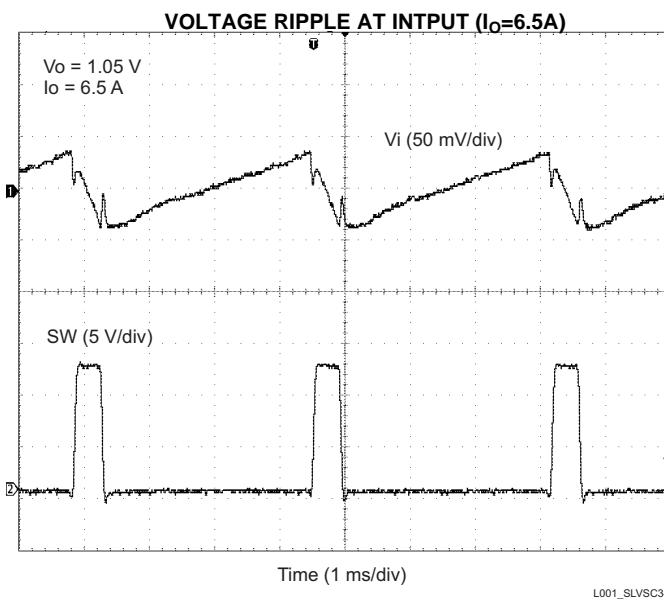


Figure 14.

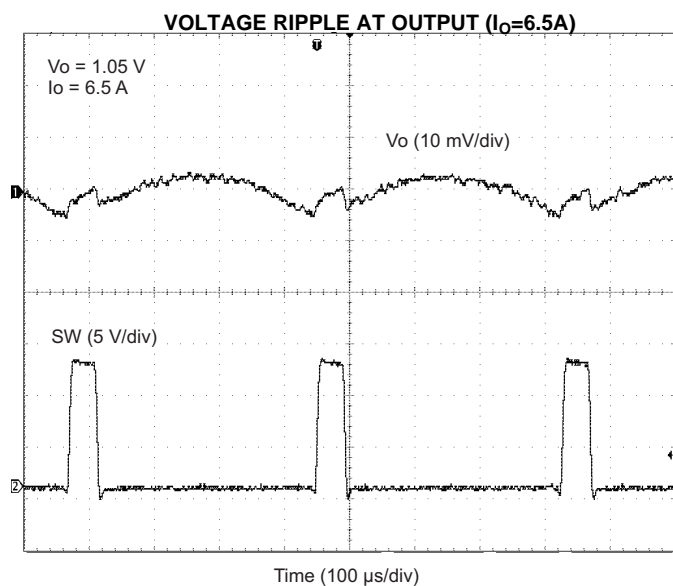


Figure 15.

DESIGN GUIDE

Step By Step Design Procedure

To begin the design process, you must know a few application parameters:

- Input voltage range
- Output voltage
- Output current
- Output voltage ripple
- Input voltage ripple

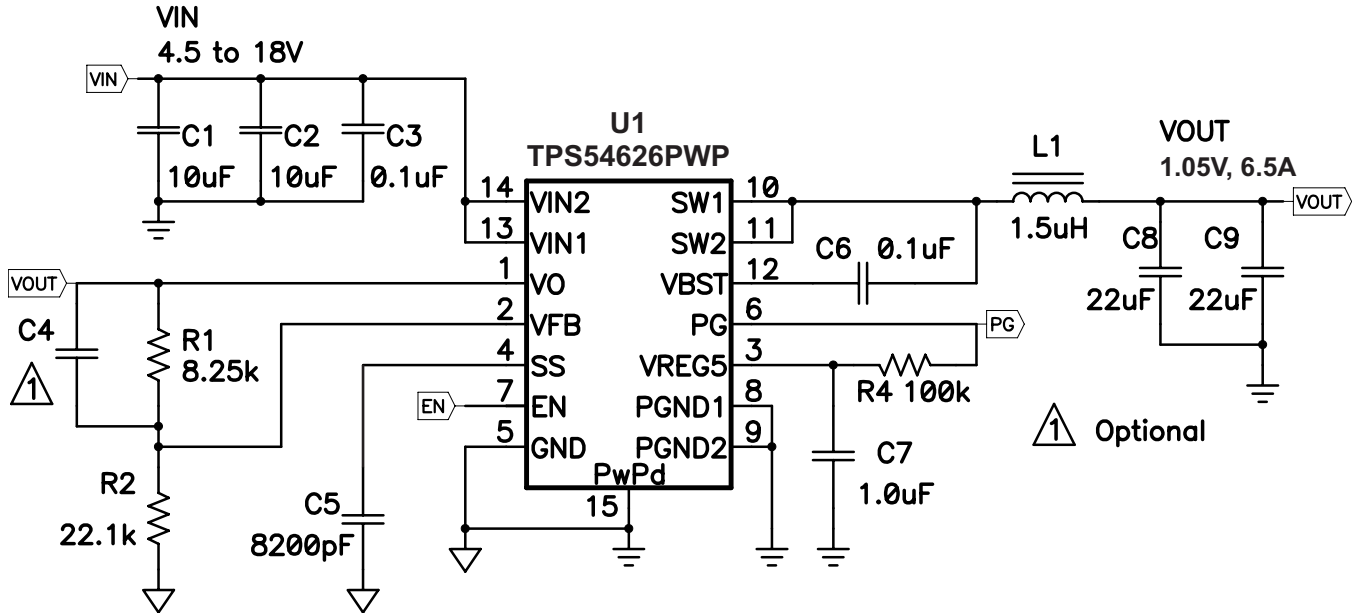


Figure 16. Schematic

Output Voltage Resistors Selection

The output voltage is set with a resistor divider from the output node to the VFB pin. It is recommended to use 1% tolerance or better divider resistors. Start by using Equation 3 to calculate V_{OUT}

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

$$V_{OUT} = 0.765 \cdot \left(1 + \frac{R1}{R2}\right) \quad (3)$$

Output Filter Selection

The output filter used with the TPS54626 is an LC circuit. This LC filter has double pole at:

$$F_p = \frac{1}{2\pi \sqrt{L_{OUT} \times C_{OUT}}} \quad (4)$$

At low frequencies, the overall loop gain is set by the output set-point resistor divider network and the internal gain of the TPS54626. The low frequency phase is 180 degrees. 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 degrees one decade above the zero frequency. The inductor and capacitor selected for the output filter must be selected so that the double pole of Equation 4 is located below the high frequency zero but close enough that the phase boost provided by the high frequency zero provides adequate phase margin for a stable circuit. To meet this requirement use the values recommended in Table 1

Table 1. Recommended Component Values

| Output Voltage (V) | R1 (kΩ) | R2 (kΩ) | C4 (pF) ⁽¹⁾ | L1 (μH) | C8 + C9 (μF) |
|--------------------|---------|---------|------------------------|-----------------|--------------|
| 1 | 6.81 | 22.1 | 5 - 220 | 1.0 - 1.5 - 4.7 | 22 - 68 |
| 1.05 | 8.25 | 22.1 | 5 - 220 | 1.0 - 1.5 - 4.7 | 22 - 68 |
| 1.2 | 12.7 | 22.1 | 5 - 100 | 1.0 - 1.5 - 4.7 | 22 - 68 |
| 1.5 | 21.5 | 22.1 | 5 - 68 | 1.0 - 1.5 - 4.7 | 22 - 68 |
| 1.8 | 30.1 | 22.1 | 5 - 22 | 1.2 - 1.5 - 4.7 | 22 - 68 |
| 2.5 | 49.9 | 22.1 | 5 - 22 | 1.5 - 2.2 - 4.7 | 22 - 68 |
| 3.3 | 73.2 | 22.1 | 5 - 22 | 1.8 - 2.2 - 4.7 | 22 - 68 |
| 5 | 124 | 22.1 | 5 - 22 | 2.5 - 3.3 - 4.7 | 22 - 68 |

(1) Optional

For higher output voltages at or above 1.8 V, additional phase boost can be achieved by adding a feed forward capacitor (C4) in parallel with R1.

The inductor peak-to-peak ripple current, peak current and RMS current are calculated using [Equation 5](#), [Equation 6](#) and [Equation 7](#). 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 650 kHz for f_{SW} .

Use 650 kHz for f_{SW} , and also use 1.5μH for LO. Make sure the chosen inductor is rated for the peak current of [Equation 6](#) and the RMS current of [Equation 7](#).

$$I_{lp} - p = \frac{V_{OUT}}{V_{IN(max)}} \cdot \frac{V_{IN(max)} - V_{OUT}}{L_O \cdot f_{SW}} \quad (5)$$

$$I_{lpeak} = I_O + \frac{I_{lp} - p}{2} \quad (6)$$

$$I_{Lo(RMS)} = \sqrt{I_O^2 + \frac{1}{12} I_{lp} - p^2} \quad (7)$$

For this design example, the calculated peak current is 7.01 A and the calculated RMS current is 6.51 A. The inductor used is a TDK SPM6530-1R5M100 with a peak current rating of 11.5 A and an RMS current rating of 11 A.

The capacitor value and ESR determines the amount of output voltage ripple. The TPS54626 is intended for use with ceramic or other low ESR capacitors. Recommended values range from 22μF to 68μF. Use [Equation 8](#) to determine the required RMS current rating for the output capacitor

$$I_{CO(RMS)} = \frac{V_{OUT} \cdot (V_{IN} - V_{OUT})}{\sqrt{12} \cdot V_{IN} \cdot L_O \cdot f_{SW}} \quad (8)$$

For this design two TDK C3216X5R0J226M 22μF output capacitors are used. The typical ESR is 2 mΩ each. The calculated RMS current is 0.284 A and each output capacitor is rated for 4 A.

Input Capacitor Selection

The TPS54626 requires an input decoupling capacitor and a bulk capacitor is needed depending on the application. A ceramic capacitor over 10 μF is recommended for the decoupling capacitor. An additional 0.1 μF capacitor from pin 14 to ground is recommended to improve the stability of the over-current limit function. The capacitor voltage rating needs to be greater than the maximum input voltage.

Bootstrap Capacitor Selection

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

VREG5 Capacitor Selection

A 1-μF ceramic capacitor must be connected between the VREG5 to GND pin for proper operation. It is recommended to use a ceramic capacitor.

THERMAL INFORMATION

This PowerPad™ package incorporates an exposed thermal pad that is designed to be directly to an external heatsink. The thermal pad must be soldered directly to the printed 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 additional information on the PowerPAD™ package and how to use the advantage of its heat dissipating abilities, refer to Technical Brief, *PowerPAD™ Thermally Enhanced Package*, Texas Instruments Literature No. [SLMA002](#) and Application Brief, *PowerPAD™ Made Easy*, Texas Instruments Literature No. [SLMA004](#).

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

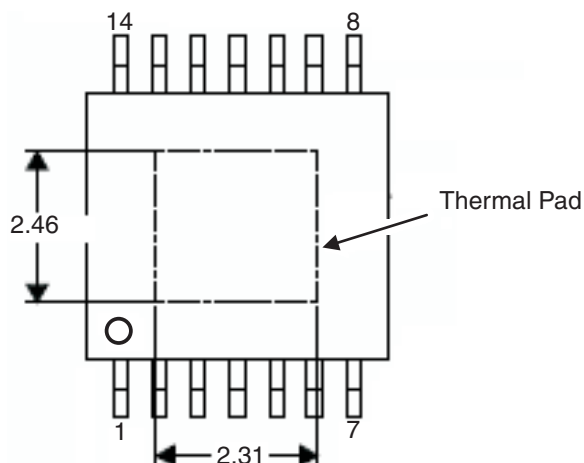


Figure 17. Thermal Pad Dimensions

LAYOUT CONSIDERATIONS

1. A top side area should be filled with ground as much as possible due to relatively higher current output device.
2. The ground area under the device thermal pad should be large as possible and directly connect to the thermal pad. Also 2nd, 3rd and 4th PCB layer should be connected to ground directly from the thermal pad.
3. Keep the input switching current loop as small as possible.
4. Keep the SW node as physically small and short as possible to minimize parasitic capacitance and inductance and to minimize radiated emissions. Kelvin connections should be brought from the output to the feedback pin of the device.
5. Keep analog and non-switching components away from switching components.
6. Make a single point connection from the signal ground to power ground.
7. Do not allow switching current to flow under the device.
8. Keep the pattern lines for VIN and PGND broad.
9. Exposed pad of device must be connected to PGND with solder.
10. VREG5 capacitor should be placed near the device, and connected PGND.
11. Output capacitor should be connected to a broad pattern of the PGND.
12. Voltage feedback loop should be as short as possible, and preferably with ground shield.
13. Lower resistor of the voltage divider which is connected to the VFB pin should be tied to SGND.
14. Providing sufficient via is preferable for VIN, SW and PGND connection.
15. PCB pattern for VIN, SW, and PGND should be as broad as possible.
16. VIN Capacitor should be placed as near as possible to the device.

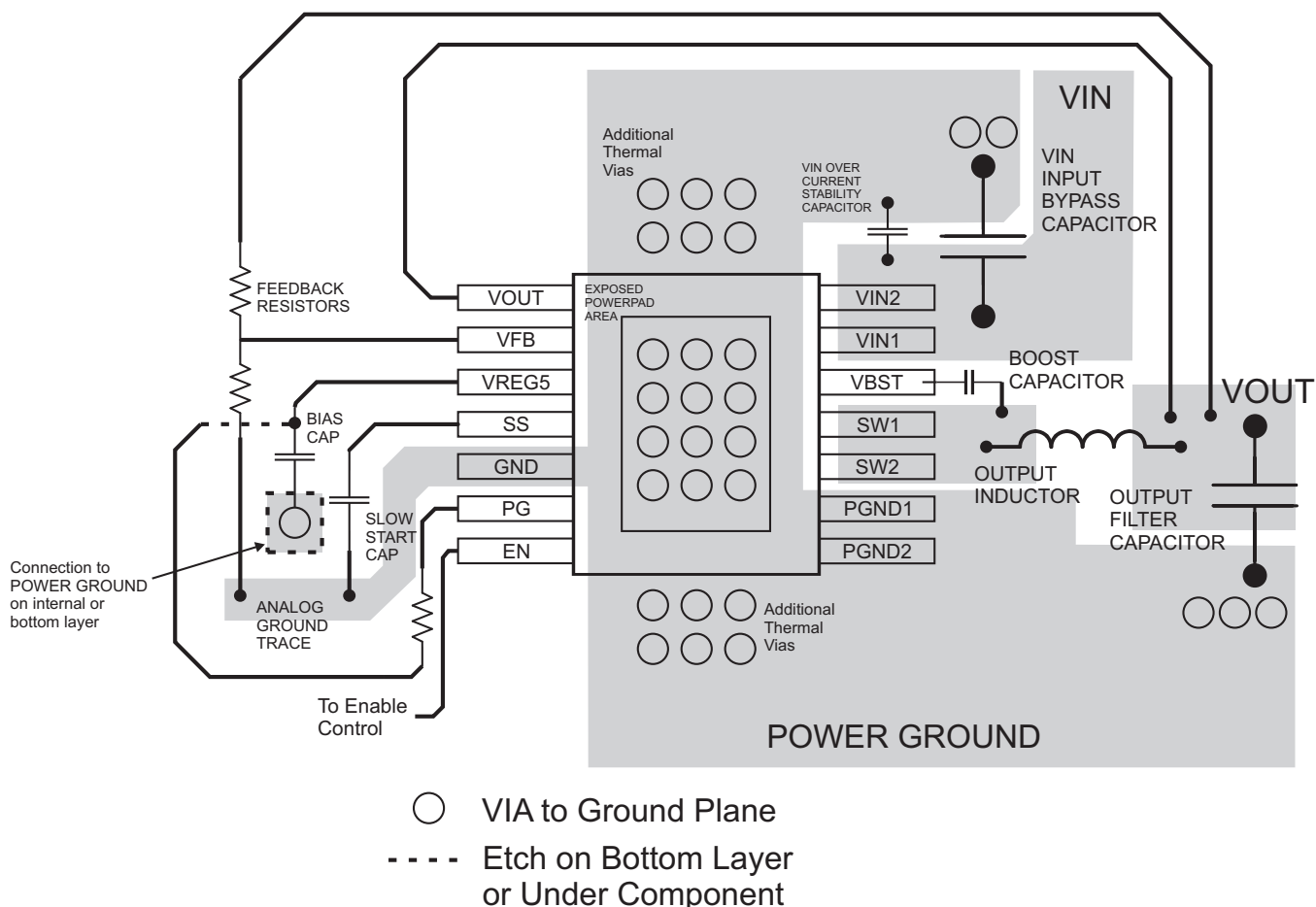


Figure 18. PCB Layout for PWP Package

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) |
|------------------------------|---------------|----------------------|-------------------|-----------------------|-------------|--------------------------------------|-----------------------------------|--------------|---------------------|
| TPS54626PWP | Active | Production | HTSSOP (PWP) 14 | 90 TUBE | Yes | NIPDAU | Level-2-260C-1 YEAR | -40 to 85 | PS54626 |
| TPS54626PWP.A | Active | Production | HTSSOP (PWP) 14 | 90 TUBE | Yes | NIPDAU | Level-2-260C-1 YEAR | -40 to 85 | PS54626 |
| TPS54626PWPR | Active | Production | HTSSOP (PWP) 14 | 2000 LARGE T&R | Yes | NIPDAU | Level-2-260C-1 YEAR | -40 to 85 | PS54626 |
| TPS54626PWPR.A | Active | Production | HTSSOP (PWP) 14 | 2000 LARGE T&R | Yes | NIPDAU | Level-2-260C-1 YEAR | -40 to 85 | PS54626 |
| TPS54626PWPRG4 | Active | Production | HTSSOP (PWP) 14 | 2000 LARGE T&R | Yes | NIPDAU | Level-2-260C-1 YEAR | -40 to 85 | PS54626 |
| TPS54626PWPRG4.A | Active | Production | HTSSOP (PWP) 14 | 2000 LARGE T&R | Yes | NIPDAU | Level-2-260C-1 YEAR | -40 to 85 | PS54626 |

(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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In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

TAPE AND REEL INFORMATION



*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 |
|----------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| TPS54626PWPR | HTSSOP | PWP | 14 | 2000 | 330.0 | 12.4 | 6.9 | 5.6 | 1.6 | 8.0 | 12.0 | Q1 |
| TPS54626PWPRG4 | HTSSOP | PWP | 14 | 2000 | 330.0 | 12.4 | 6.9 | 5.6 | 1.6 | 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) |
|----------------|--------------|-----------------|------|------|-------------|------------|-------------|
| TPS54626PWPR | HTSSOP | PWP | 14 | 2000 | 350.0 | 350.0 | 43.0 |
| TPS54626PWPRG4 | HTSSOP | PWP | 14 | 2000 | 350.0 | 350.0 | 43.0 |

TUBE



*All dimensions are nominal

| Device | Package Name | Package Type | Pins | SPQ | L (mm) | W (mm) | T (μm) | B (mm) |
|---------------|--------------|--------------|------|-----|--------|--------|--------|--------|
| TPS54626PWP | PWP | HTSSOP | 14 | 90 | 530 | 10.2 | 3600 | 3.5 |
| TPS54626PWP.A | PWP | HTSSOP | 14 | 90 | 530 | 10.2 | 3600 | 3.5 |

GENERIC PACKAGE VIEW

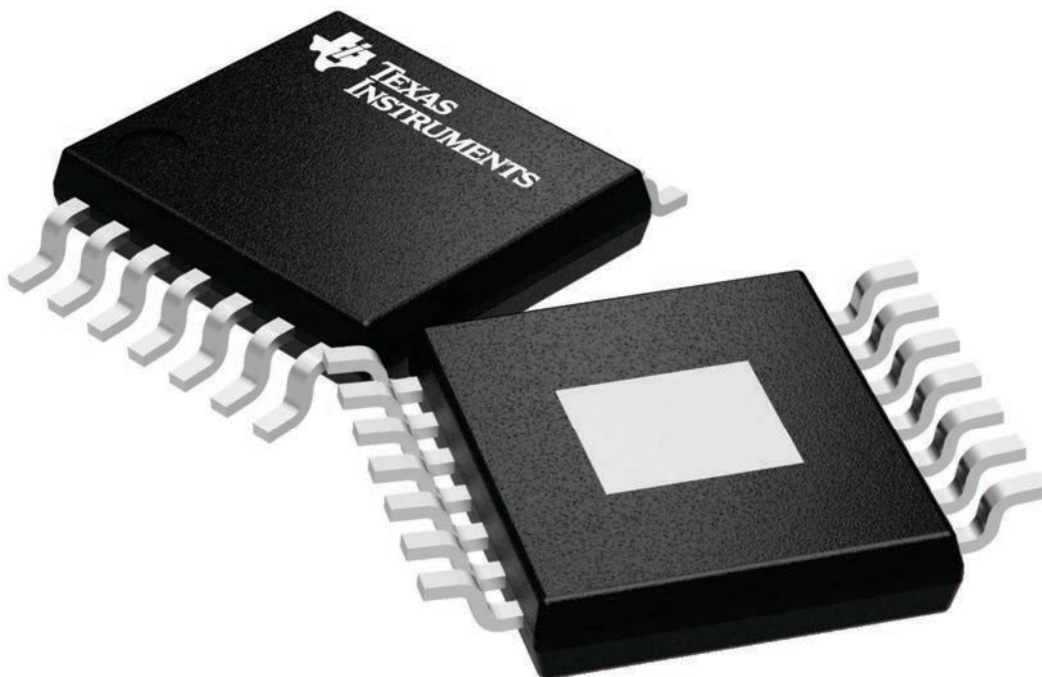
PWP 14

PowerPAD TSSOP - 1.2 mm max height

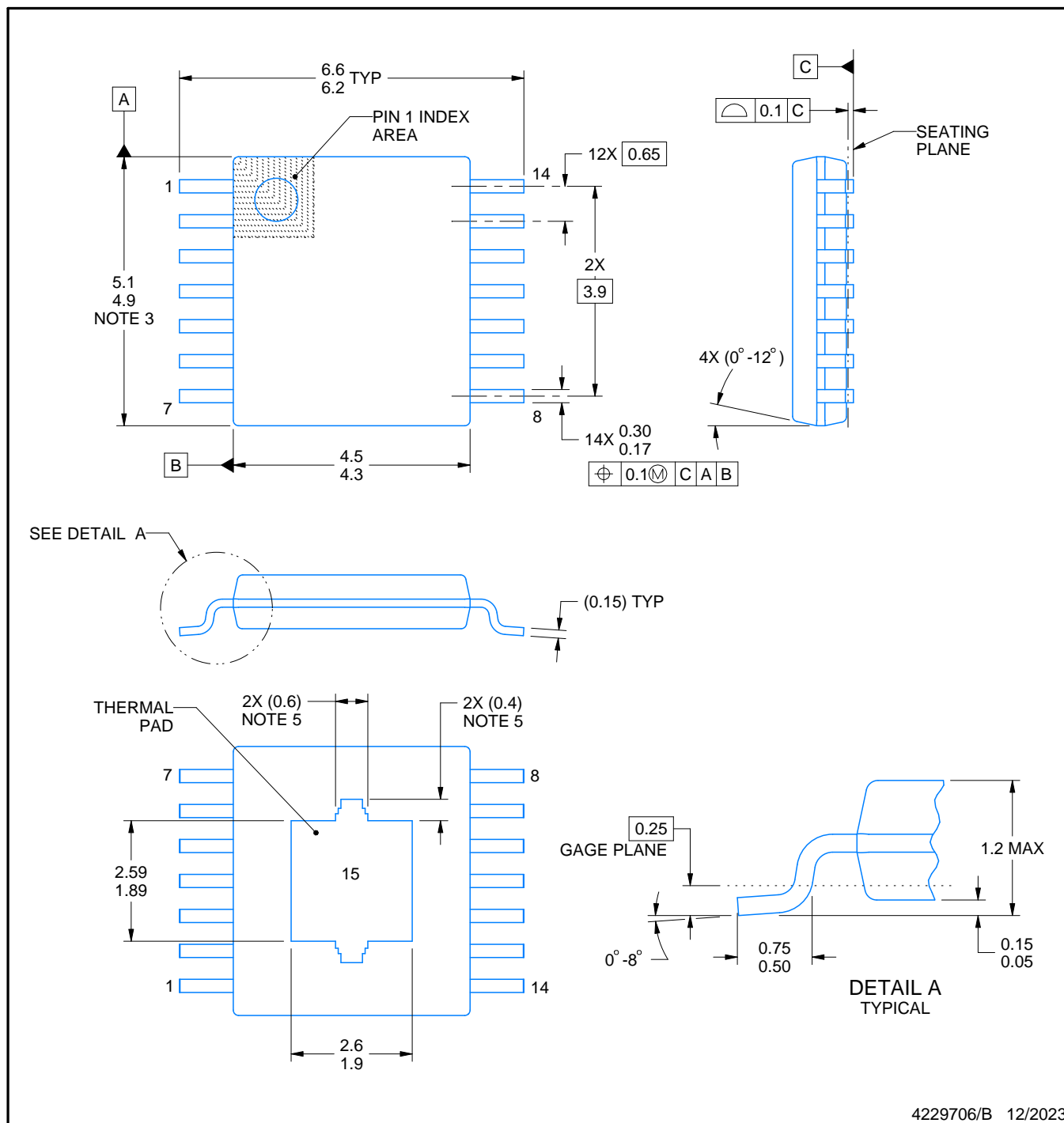
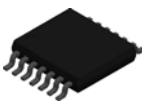
4.4 x 5.0, 0.65 mm pitch

PLASTIC SMALL OUTLINE

This image is a representation of the package family, actual package may vary.
Refer to the product data sheet for package details.



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NOTES:

PowerPAD is a trademark of Texas Instruments.

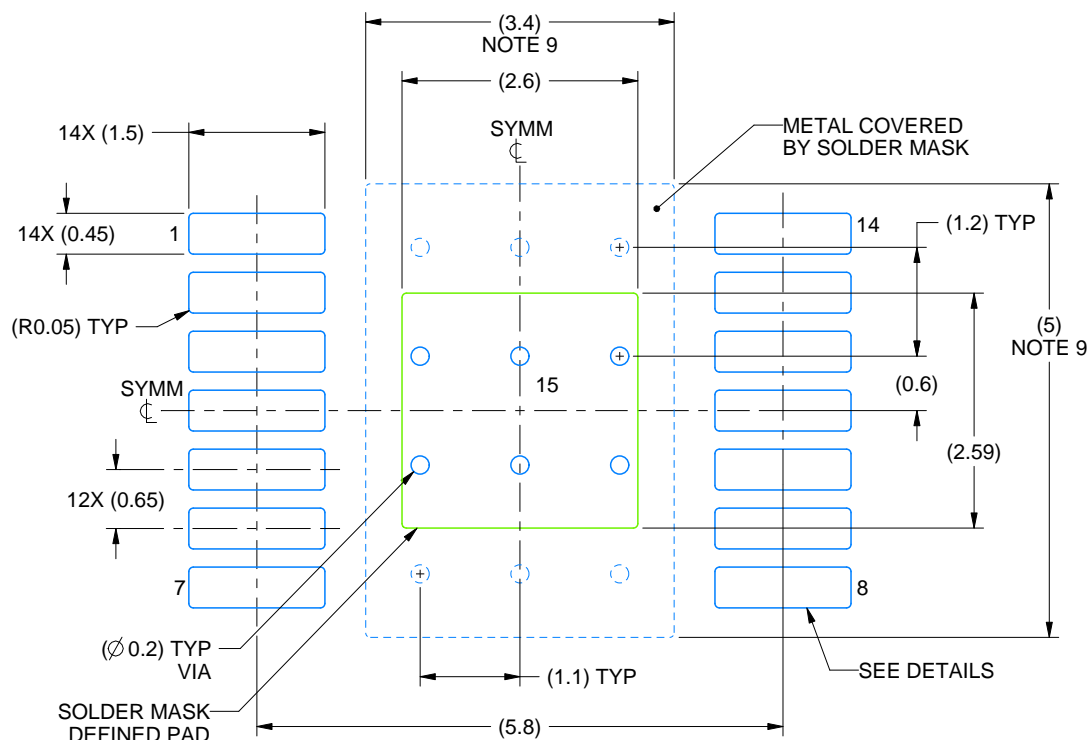
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm per side.
4. Reference JEDEC registration MO-153.
5. Features may differ or may not be present.

EXAMPLE BOARD LAYOUT

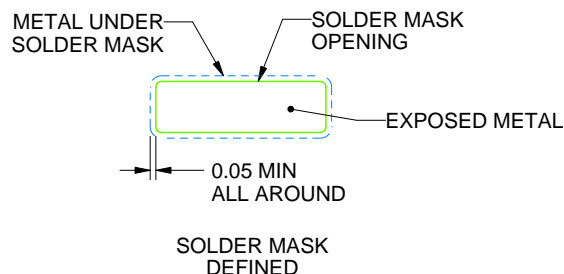
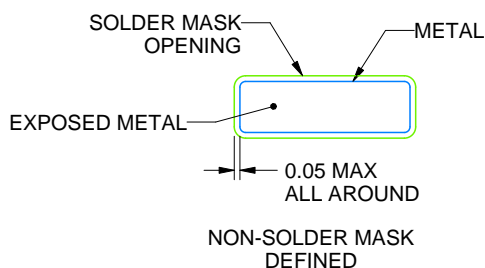
PWP0014K

PowerPAD™ TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE: 12X



SOLDER MASK DETAILS

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NOTES: (continued)

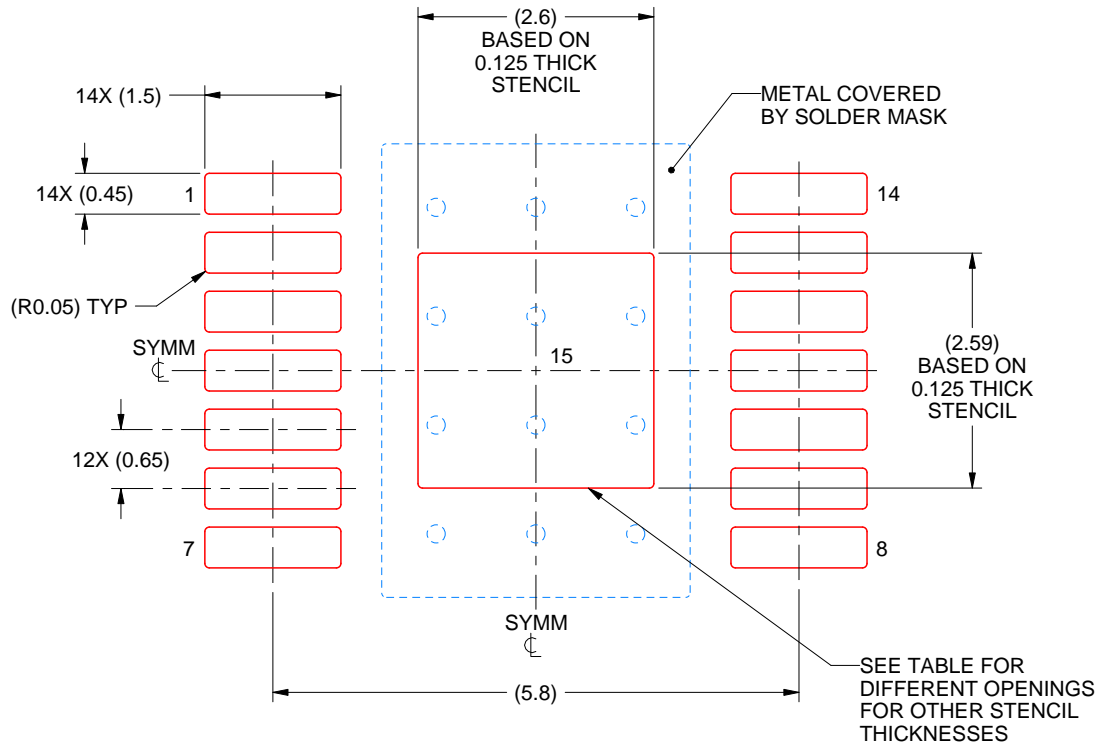
6. Publication IPC-7351 may have alternate designs.
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.
8. This package is designed to be soldered to a thermal pad on the board. For more information, see Texas Instruments literature numbers SLMA002 (www.ti.com/lit/slma002) and SLMA004 (www.ti.com/lit/slma004).
9. Size of metal pad may vary due to creepage requirement.
10. Vias are optional depending on application, refer to device data sheet. It is recommended that vias under paste be filled, plugged or tented.

EXAMPLE STENCIL DESIGN

PWP0014K

PowerPAD™ TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL
SCALE: 12X

| STENCIL THICKNESS | SOLDER STENCIL OPENING |
|-------------------|------------------------|
| 0.1 | 2.91 X 2.90 |
| 0.125 | 2.60 X 2.59 (SHOWN) |
| 0.15 | 2.37 X 2.36 |
| 0.175 | 2.20 X 2.19 |

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NOTES: (continued)

11. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
12. Board assembly site may have different recommendations for stencil design.

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