带有集成金属氧化物半导体场效应晶体管 (MOSFET)，输入电压范围为 4.5V 至 18V，输出电流为 2A/3A 的双路同步降压稳压器

查询样品: TPS65270

特性

- 宽输入电源电压范围 **(4.5V-18V)**
- **0.8V，±1%** 精度基准
- 高达 **2A**（降压 **1**）和 **3A**（降压 **2**）最大持续输出负载电流
- 低功耗脉冲跳跃模式可在轻负载时实现高效率
- 可调开关频率 由外部电阻器设定的 **300kHz-1.4MHz**
- 针对每个降压的专用启用和软启动
- 具有简单补偿电路的峰值电流模式控制
- 逐周期过流保护
- **180°** 相移运行可减少输入电容量和电源感应噪声
- 采用 **24** 引线耐热增强型超薄小外形尺寸封装 **(HSSTOP) (PWP)** 和 **4mm x 4mm** 四方扁平无引线 **(RGE)** 封装

应用范围

- 数字电视
- **DSL** 调制解调器
- 线缆调制解调器
- 机顶盒
- 车载 **DVD** 播放器
- 家庭网关和访问点网络
- 无线路由器

说明/订购信息

TPS65270 是一款单片双路同步降压稳压器，此稳压器具有可运行在 5，9，12，或者 15V 总线电压和多种化学类型电池上的宽输入电压。 这个转换器设计用于在为设计人员提供选项来按照目标应用来优化转换器用法的同时简化它的应用。

TPS65270 特有一个精准 0.8V 基准并且能够生成高达 15V 的输出电压。每个转换器特有使能引脚，此引脚可实现对每个通道的专用控制，从而提供电源排序的灵活性。 每个通道的软启动时间可通过选择不同的外部电阻器来调节。

恒定频率模式峰值电流简化了补偿并提供快速瞬态响应。 逐周期过流保护和断续模式操作在短路或者负载故障条件下限制 MOSFET 功率耗散。 低侧反向电流保护还能够防止过多吸收电流损坏转换器。

可使用一个外部电阻器将此转换器的开关频率设定在 300kHz 至 1.4MHz 之间。 为了大大降低对输入滤波器的要求，减轻电磁干扰 (EMI) 以及对输入电容器的需求，两个转换器具有相移为 180° 的时钟信号。

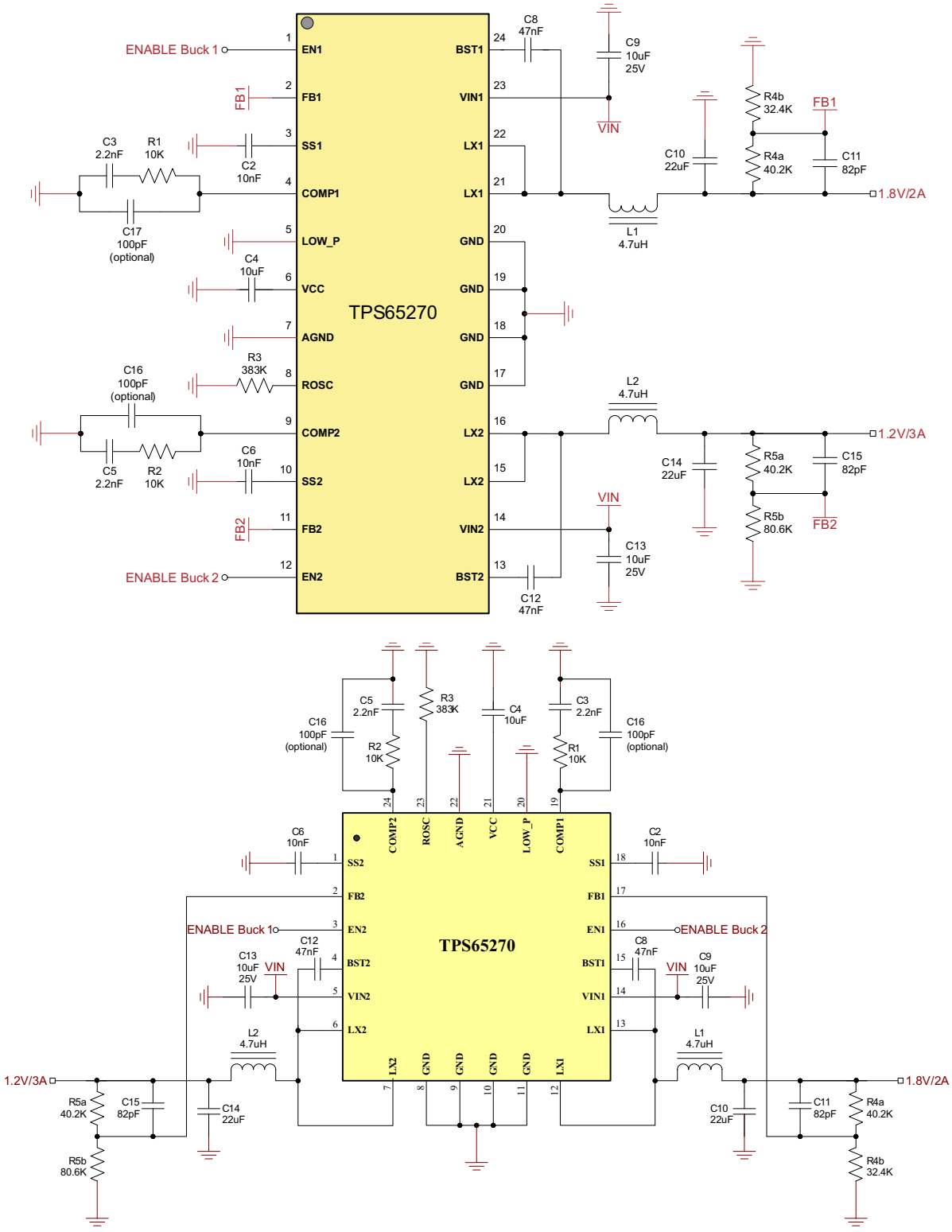
TPS65270 还特有一个轻负载脉冲跳跃模式 (PSM)。 为了实现轻负载下的高效率，PSM 模式可在轻负载时减少系统输入电源上的功率损失。

TPS65270 采用一个 24 引线耐热增强型 HTSSOP (PWP) 封装和 24 引脚 QFN 4mm x 4mm (RGE) 封装。

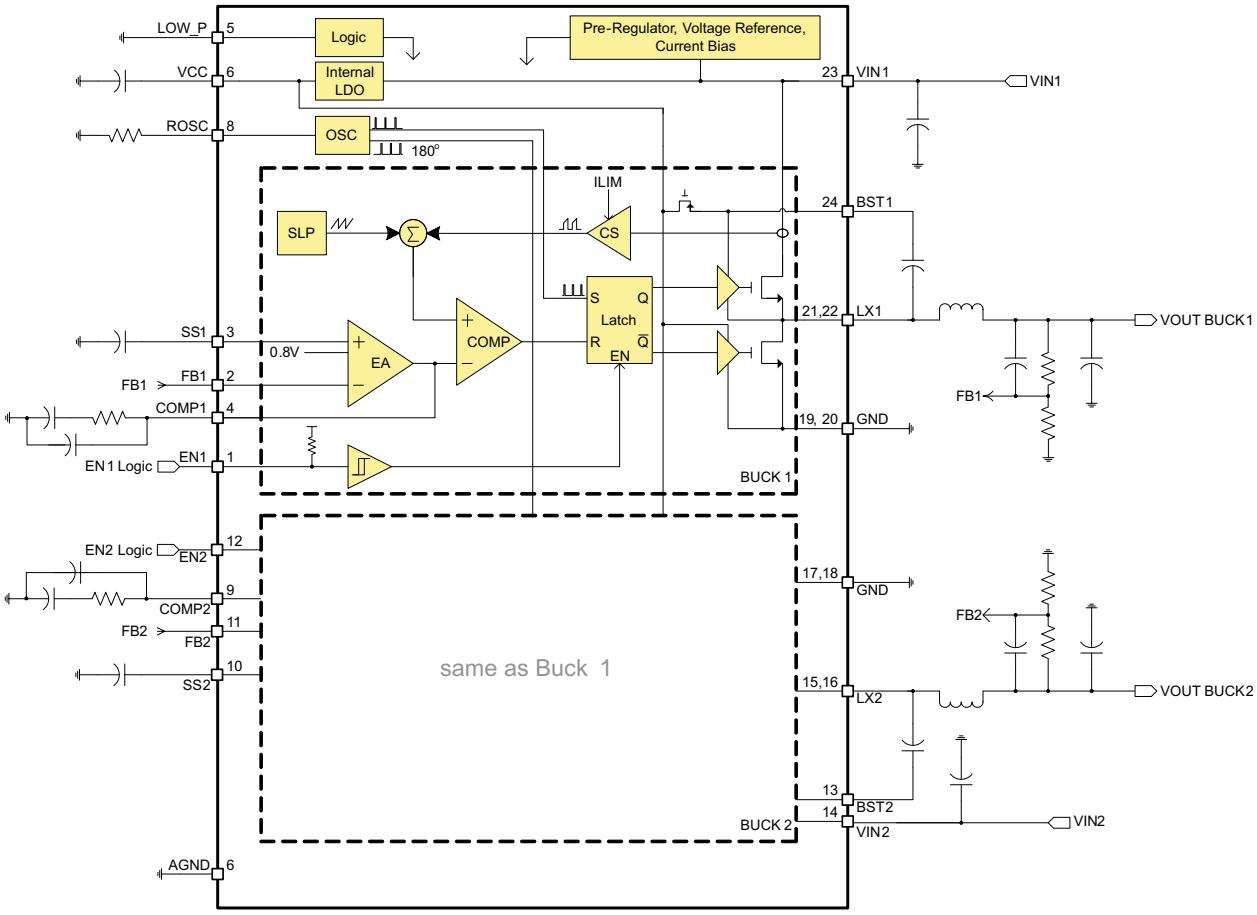
This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

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.

TYPICAL APPLICATION



FUNCTIONAL BLOCK DIAGRAM



Note: Pin numbers in block diagram are for HTSSOP (PWP) 24-pin package.

ORDERING INFORMATION(1)

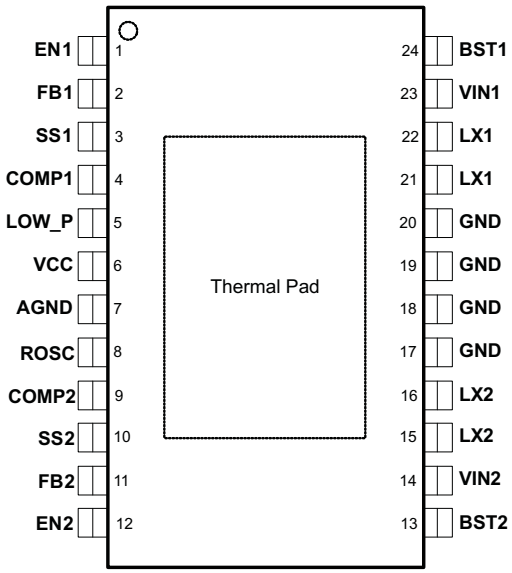
T_A	PACKAGE(2)	ORDERABLE PART NUMBER	TOP-SIDE MARKING
–40°C to 85°C	PWP (R-PDSO-G)	TPS65270PWPR	TPS65270
	RGE (S-PVQFN-N24)	TPS65270RGER or TPS65270RGET	TPS65270

(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.

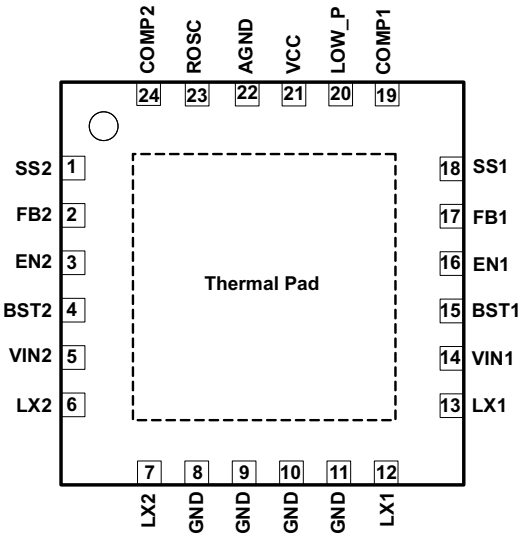
PIN OUT

PWP PACKAGE
(TOP VIEW)



Exposed pad must be soldered to PCB for optimal thermal performance.

RGE PACKAGE
(TOP VIEW)



Exposed pad must be soldered to PCB for optimal thermal performance.

TERMINAL FUNCTIONS

NAME	NO. (HTSSOP)	NO. (QFN)	DESCRIPTION
EN1	1	16	Enable for Buck 1. Logic high enables the Buck 1; Logic low disables Buck 1. If pin is left open a weak internal pull-up to V5V will allow for automatic enable; For a delayed start-up add a small ceramic capacitor from this pin to ground.
FB1	2	17	Feedback voltage for Buck 1. Connect a resistor divider to set 0.8 V from the output of the converter to ground.
SS1	3	18	Soft start input for Buck 1. An internal 5-µA charging current is sourcing to this pin. Connect a small ceramic capacitor to this pin to set the Buck 1 soft start time.
COMP1	4	19	Loop compensation pin for Buck 1. Connect a series RC circuit to this pin to compensate the control loop of this converter.
LOW_P	5	20	Low power operation mode. With active high, Buck 1 and Buck 2 operate at pulse skipping mode at light load; active low forces both Buck 1 and Buck 2 to PWM mode; this pin can't be left open.
VCC	6	21	Internal 6.5-V power supply bias. Connect a 10-µF ceramic capacitor from this pin to ground.
AGND	7	22	Analog ground. Connect all GND pins and power pad together.
ROSC	8	23	Oscillator frequency setup. Connect a resistor to ground to set the frequency of internal oscillator clock.
COMP2	9	24	Loop compensation pin for Buck 2. Connect a series RC circuit to this pin to compensate the control loop of this converter.
SS2	10	1	Soft start input for Buck 2. An internal 5-µA charging current is sourcing to this pin. Connect a small ceramic capacitor to this pin to set the Buck 1 soft start time.
FB2	11	2	Feedback voltage for Buck 2. Connect a resistor divider to set 0.8 V from the output of the converter to ground.
EN2	12	3	Enable for Buck 2. Logic high enables the Buck 2. Logic low disables Buck 2. If pin is left open a weak internal pull-up to V5V will allow for automatic enable; For a delayed start-up add a small ceramic capacitor from this pin to ground.
BST2	13	4	Bootstrapped power supply to high side floating gate driver in Buck 2. Connect a 47-nF ceramic capacitor from this pin to the switching node pin LX2.
VIN2	14	5	Input supply for Buck 2. Connect a 10-µF ceramic capacitor close to this pin.
LX2	15, 16	6, 7	Switching node connecting to inductor for Buck 2.
GND	17, 18, 19, 20	8, 9, 10, 11	Power ground for Buck 1 and Buck 2.
LX1	21, 22	12, 13	Switching node connecting to inductor for Buck 1.
VIN1	23	14	Input supply for Buck 1. Conne ct a 10-µF ceramic capacitor close to this pin.
BST1	24	15	Bootstrapped power supply to high side floating gate driver in Buck 1. Connect a 47-nF ceramic capacitor from this pin to the switching node pin LX1.
Thermal Pad			Must be soldered to PCB for optimal thermal performance. Have thermal vias on the PCB to enhance power dissipation.

ABSOLUTE MAXIMUM RATINGS (1)

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

	Voltage range at VIN1, VIN2, LX1, LX2	–0.3 to 18	V
	Voltage range at LX1, LX2 (maximum withstand voltage transient < 10 ns)	–1 to 18	V
	Voltage at BST1, BST2, referenced to LX1, LX2 pin	–0.3 to 7	V
	Voltage at VCC, EN1, EN2, COMP1, COMP2, LOW_P	–0.3 to 7	V
	Voltage at SS1, SS2, FB1, FB2, ROSC	–0.3 to 3.6	V
	Voltage at AGND, GND	–0.3 to 0.3	V
T_J	Operating virtual junction temperature range	–40 to 125	°C
T_{STG}	Storage temperature range	–55 to 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.

RECOMMENDED OPERATING CONDITIONS

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

		MIN	NOM	MAX	UNIT
VIN	Input operating voltage	4.5		18	V
T_A	Ambient temperature	–40		85	°C

ELECTROSTATIC DISCHARGE (ESD) PROTECTION

	MIN	MAX	UNIT
Human body model (HBM)	2000		V
Charge device model (CDM)	500		V

PACKAGE DISSIPATION RATINGS (1)(2)(3)

PACKAGE	θ_{JA} (°C/W)	θ_{JC} (°C/W)	T_A = 25°C POWER RATING (W)	T_A = 55°C POWER RATING (W)	T_A = 85°C POWER RATING (W)
PWP	32.6	10	3.07	2.15	1.23
RGE	32.6	10	3.07	2.15	1.23

(1) This assumes a JEDEC JESD 51-5 standard board with thermal vias with High K profile - See Texas Instruments application report (SLMA002) regarding thermal characteristics of the PowerPAD™ package.
(2) This assumes junction to exposed PAD.
(3) Based on JEDEC 51.5 HIGH K environment measured on a 76.2 x 114 x .6-mm board with the following layer arrangement:
(a) Top layer: 2 Oz Cu, 6.7% coverage
(b) Layer 2: 1 Oz Cu, 90% coverage
(c) Layer 3: 1 Oz Cu, 90% coverage
(d) Bottom layer: 2 Oz Cu, 20% coverage

ELECTRICAL CHARACTERISTICS

T_A = -40°C to 125°C, V_{IN} = 12 V, f_{SW} = 625 kHz (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
INPUT SUPPLY						
V_{IN}	Input Voltage range	VIN1 and VIN2	4.5		18	V
IDD_{SDN}	Shutdown	EN1 = EN2 = 0 V		10		µA
IDD_{Q_nsw}	Non switching quiescent power supply current	VFB1 = VFB2 = 900 mV, LOW_P = high		1		mA
UVLO	V_{IN} under voltage lockout	Rising V_{IN}	4	4.20	4.45	V
		Falling V_{IN}	3.65	3.85	4.10	
		Hysteresis		0.35		
V_{CC}	Internal biasing supply	V_{CC} load current = 0 A, V_{IN} = 12 V		6.25		V
V_{CC_drop}	V_{CC} LDO Drop-Out Voltage	V_{IN} = 5 V, V_{CC} load current = 20 mA		180		mV
I_{VCC}	V_{CC} current limit	4.5 V < V_{IN} < 18 V		200		mA
FEEDBACK AND ERROR AMPLIFIER						
V_{FB}	Regulated feedback voltage	V_{IN} = 12 V , V_{COM}P = 1.2 V, T_J = 25°C	-1%	0.8	1%	V
		V_{IN} = 12 V, V_{COMP} = 1.2 V, T_J = -40°C to 125°C	-2%	0.8	2%	
$V_{LINEREG}$	Line regulation - DC	V_{IN} = 4.5 V to 18 V, I_{OUT} = 1 A		0.5		%/V
$V_{LOADREG}$	Load regulation - DC	I_{OUT} = 10 % - 90% $I_{OUT,MAX}$		0.4		%/A
G_{m_EA}	Error amplifier trans-conductance	-2 µA < I_{COMP} < 2 µA		130		µs
G_{m_SRC}	COMP voltage to inductor current Gm	ILX = 0.5 A		10		A/V
ENABLE, PFM MODE AND SOFT-START						
V_{EN}	EN1 and EN2 pin threshold	Rising	1.55			V
		Falling		0.4		
V_{PSM}	PSM low power mode threshold	Rising	1.55			V
		Falling		0.4		
I_{SS}	SS1 and SS2 soft-start charging current			5		µA
OSCILLATOR						
F_{SW_BK}	Switching frequency range	Set by external resistor ROSC	0.3		1.4	MHz
F_{SW}	Programmable frequency	ROSC = 250 kΩ	0.85	1	1.15	MHz
		ROSC = 500 kΩ	425	500	575	kHz
PROTECTION						
I_{LIMIT1}	Buck 1 peak inductor current limit	4.5 V < V_{IN} < 18 V		3.2		A
I_{LIMIT1_LS1}	Buck 1 low side MOSFET current limit	4.5 V < V_{IN} < 18 V		2		A
I_{LIMIT2}	Buck 2 peak inductor current limit	4.5 V < V_{IN} < 18V		4.1		A
I_{LIMIT1_LS2}	Buck 2 low side MOSFET current limit	4.5 V < V_{IN} < 18 V		2		A
MOSFET ON-RESISTANCES						
R_{dson_HS1}	On resistance of high side FET on CH1	BST1 to LX1 = 6.25 V		120		mΩ
R_{dson_LS1}	On resistance of low side FET on CH1	V_{IN} = 12 V		80		mΩ
R_{dson_HS2}	On resistance of high side FET on CH2	BST2 to LX2 = 6.25 V		95		mΩ
R_{dson_LS2}	On resistance of low side FET on CH2	V_{IN} = 12 V		50		mΩ
T_{on_min}	Minimum in time			80	120	ns
THERMAL SHUTDOWN						
T_{TRIP}	Thermal protection trip point	Rising temperature		160		°C
T_{HYST}	Thermal protection hysteresis			20		°C

TYPICAL CHARACTERISTICS

T_A = 25°C, V_{IN} = 12 V, f_{SW} = 625 kHz (unless otherwise noted)

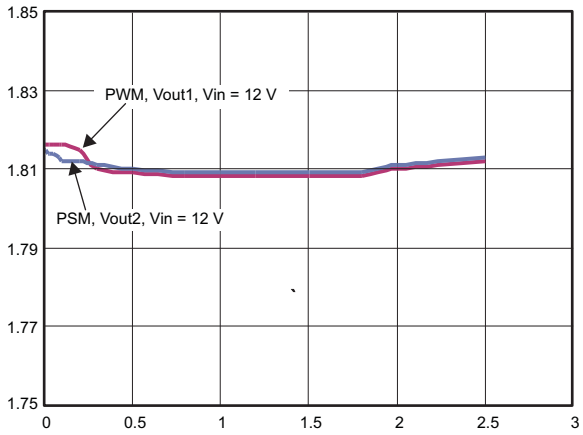


Figure 1. Load Regulation
Buck 1 at 1.8 V, 1% Resistors

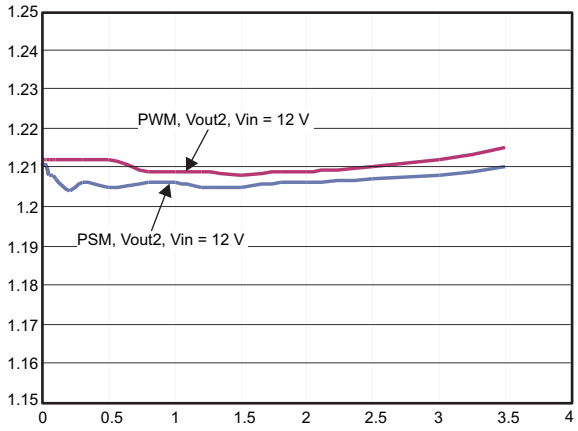


Figure 2. Load Regulation
Buck 1 at 1.2 V, 1% Resistor s

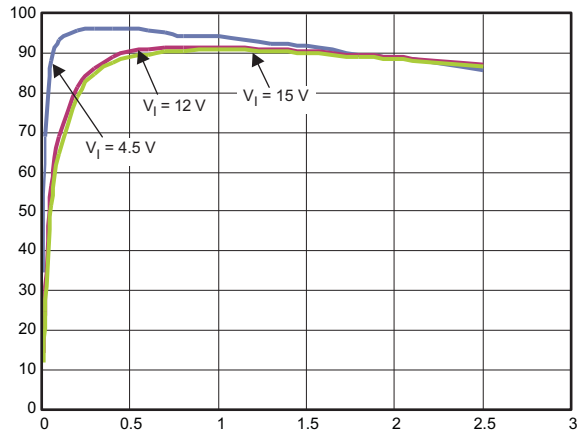


Figure 3. Efficiency
Buck 1 at 3.3 V

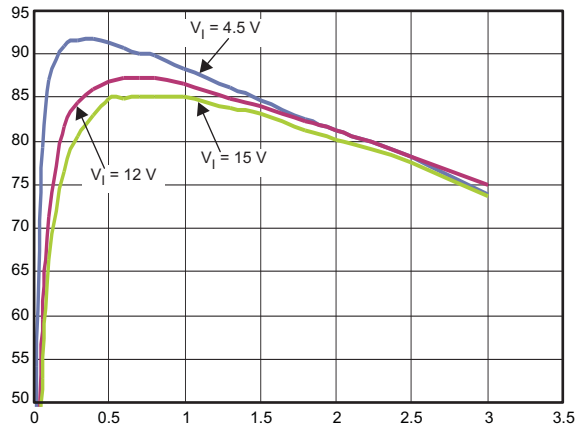


Figure 4. Efficiency
Buck 2 at 1 V

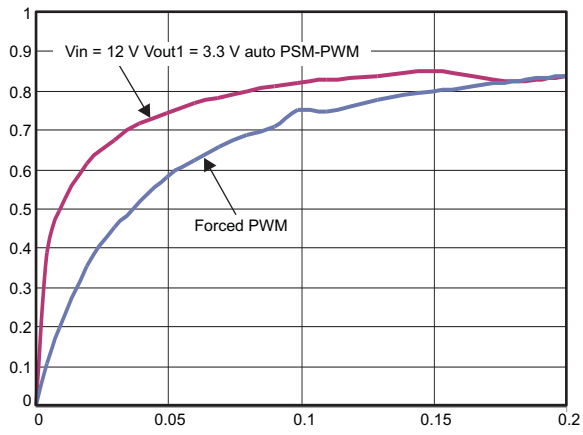


Figure 5. Efficiency
Buck 1 at 3.3 V

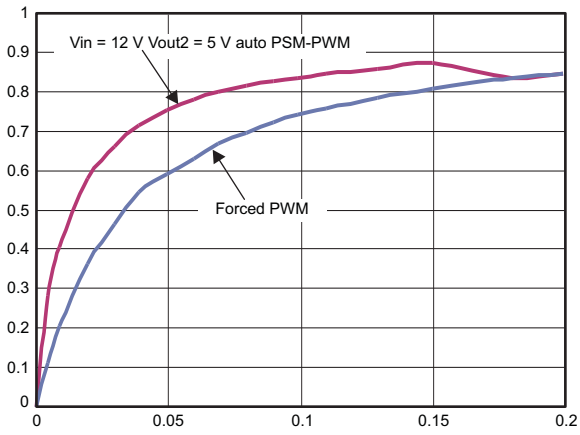


Figure 6. Efficiency
Buck 2 at 5 V

TYPICAL CHARACTERISTICS (continued)

T_A = 25°C, V_{IN} = 12 V, f_{SW} = 625 kHz (unless otherwise noted)

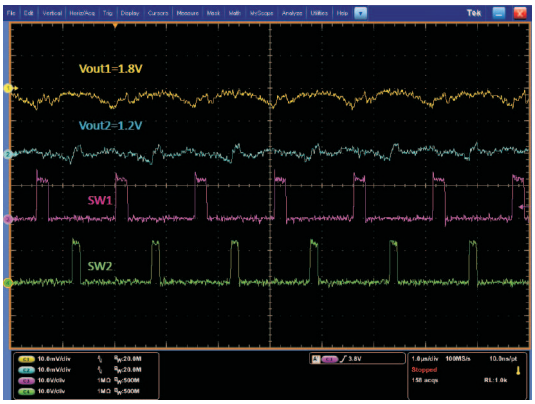


Figure 7. Buck 1 and Buck 2 in Steady State
I_{O1} = 0 A, I_{O2} = 0 A

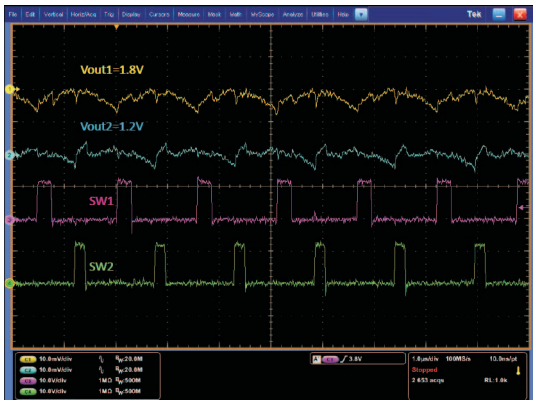


Figure 8. Buck 1 and Buck 2 in Steady State
I_{O1} = 2 A, I_{O2} = 3 A

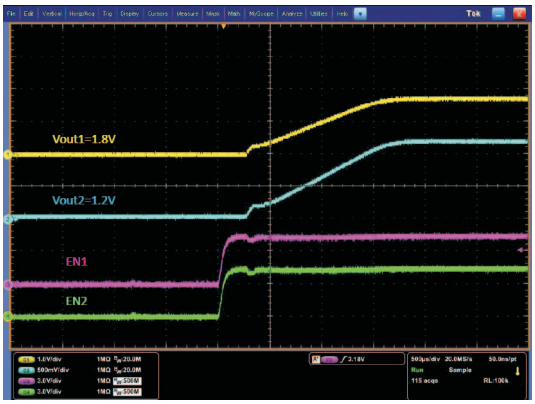


Figure 9. Startup With EN
V_{O1} = 1.8 V, V_{O2} = 1.2 V

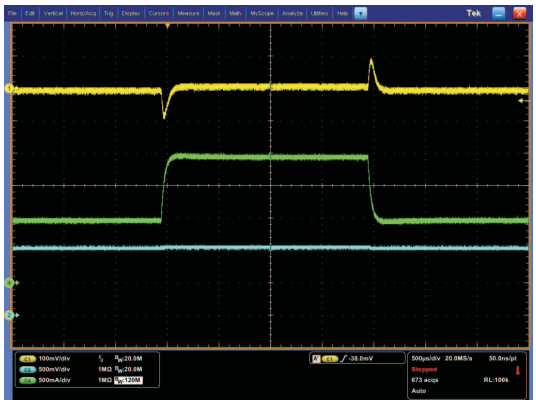


Figure 10. Buck 1 Load Transient
V_{O1} = 3.3 V, I_{O1} = 1 A - 2 A

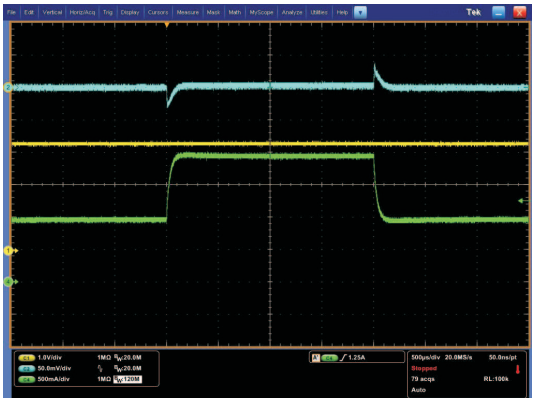


Figure 11. Buck 2 Load Transient
V_{O2} = 1 V, I_{O1} = 1 A - 2 A

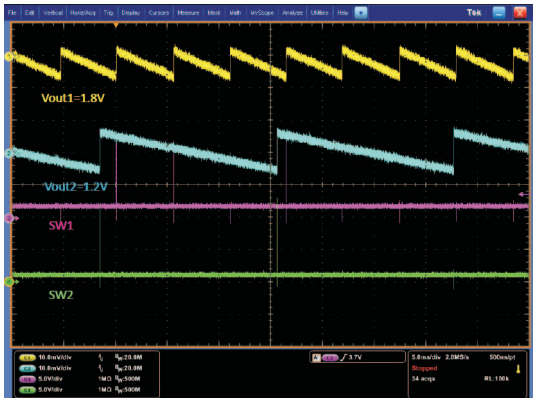


Figure 12. Buck 1 and Buck 2 in PSM Mode

TYPICAL CHARACTERISTICS (continued)

T_A = 25°C, V_{IN} = 12 V, f_{SW} = 625 kHz (unless otherwise noted)

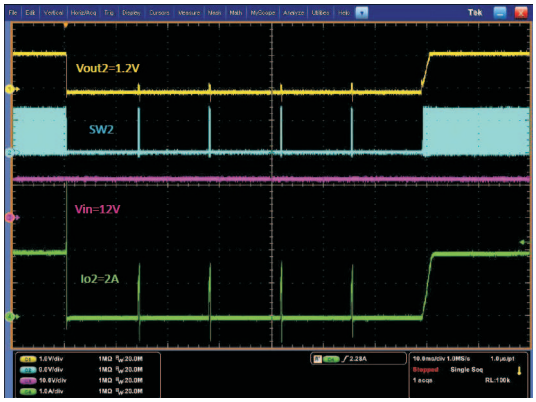


Figure 13. Buck 2 Hard Short and Recover

OVERVIEW

TPS65270 is a power management IC with two step-down buck converters. Both high-side and low-side MOSFETs are integrated to provide fully synchronous conversion with higher efficiency. TPS65270 can support 4.5-V to 18-V input supply, 2-A continuous current for Buck 1 and 3 A for Buck 2. The buck converters have an automatic PSM mode, which can improve power dissipation during light loads. Alternatively, the device implements a constant frequency mode by connecting the LOW_P pin to ground. The wide switching frequency of 300 kHz to 1.4 MHz allows for efficiency and size optimization. The switching frequency is adjustable by selecting a resistor to ground on the ROSC pin. Input ripple is reduced by 180° out-of-phase operation between Buck 1 and Buck 2.

Both buck converters have peak current mode control which simplifies the loop compensation. A traditional type II compensation network can stabilize the system and achieve fast transient response. Moreover, an optional capacitor in parallel with the upper resistor of the feedback divider provides one more zero and makes the crossover frequency over 100 kHz. Each buck converter has an individual cycle-by-cycle current limit and low side reverse current limit.

The device has a built-in LDO regulator. During a standby mode, the 6.5-V LDO can be used to drive MCU and other active loads. with this LDO, system is able to turn off the two buck converters so as to reduce the power consumption and improve the standby efficiency. Each converter has its own programmable soft start that can reduce the input inrush current. The individual Enable pins for each independent control of each output voltage and power sequence.

DETAILED DESCRIPTION

Adjustable Switching Frequency

To select the internal switching frequency connect a resistor from ROSC to ground. Figure 14 shows the required resistance for a given switching frequency.

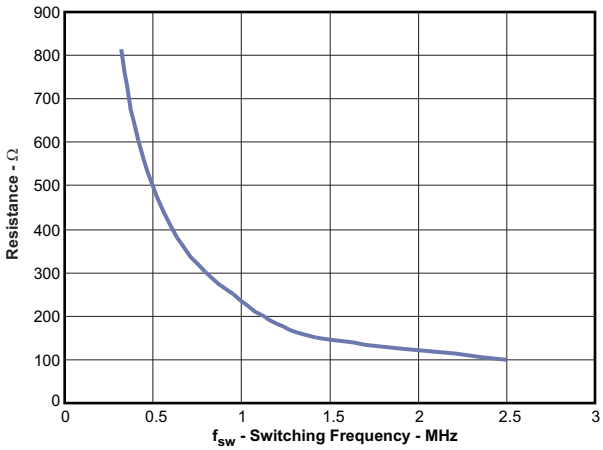


Figure 14. ROSC vs Switching Frequency

$$R_{OSC}(k\Omega) = 239.13 \bullet f_{SW}^{-1.149} \quad (1)$$

For operation at 800 kHz, a 300-kΩ resistor is required.

Out-of-Phase Operation

In order to reduce input ripple current, Buck 1 and Buck 2 operate 180° out-of-phase. This enables the system having less input ripple, then to lower component cost, save board space and reduce EMI.

Delayed Start-Up

If a delayed start-up is required on any of the buck converters fit a ceramic capacitor to the ENx pins. The delay added is ~0.75 ms per nF connected to the pin. Note that the EN pins have a weak 1-MΩ pull-up to the 5-V rail.

Soft Start Time

The device has an internal pull-up current source of 5 µA that charges an external slow start capacitor to implement a slow start time. Equation 2 shows how to select a slow start capacitor based on an expected slow start time. The voltage reference (V_{REF}) is 0.8 V and the slow start charge current (I_{SS}) is 5 µA. The soft start circuit requires 1 nF per 160 µs to be connected at the SS pin. An 800-µs soft-start time is implemented for all converters fitting 4.7 nF to the relevant pins.

$$T_{ss}(ms) = V_{REF}(V) \bullet \left(\frac{C_{ss}(nF)}{I_{ss}(\mu A)} \right) \quad (2)$$

Adjusting the Output Voltage

The output voltage is set with a resistor divider from the output node to the FB pin. It is recommended to use 1% tolerance or better divider resistors. In order to improve efficiency at light load, start with 40.2 kΩ for the R1 resistor and use the Equation 3 to calculate R2.

$$R2 = R1 \cdot \left(\frac{0.8V}{V_O - 0.8V} \right) \quad (3)$$

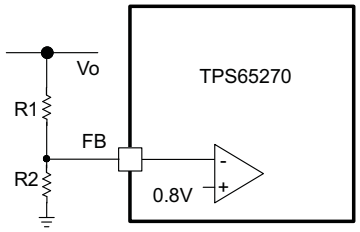


Figure 15. Voltage Divider Circuit

Input Capacitor

Use 10-µF X7R/X5R ceramic capacitors at the input of the converter inputs. These capacitors should be connected as close as physically possible to the input pins of the converters.

Bootstrap Capacitor

The device has two integrated boot regulators and requires a small ceramic capacitor between the BST and LX pin to provide the gate drive voltage for the high side MOSFET. The value of the ceramic capacitor is recommended to be 0.047 µF. A ceramic capacitor with an X7R or X5R grade dielectric is desired because of the stable characteristics over temperature and voltage.

Error Amplifier

The device has a transconductance error amplifier. The transconductance of the error amplifier is 130 µA/V during normal operation. The frequency compensation network is connected between the COMP pin and ground.

Loop Compensation

TPS65270 is a current mode control dc/dc converter. The error amplifier has 130-µA/V transconductance.

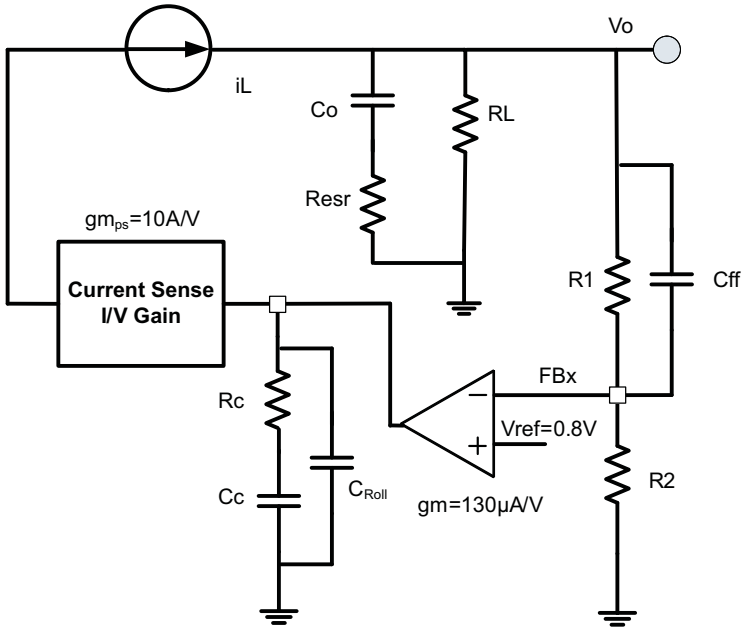


Figure 16. Loop Compensation

A typical compensation circuit could be type II (Rc and Cc) to have a phase margin between 60 and 90 degrees, or type III (Rc, Cc and Cff) to improve the converter transient response. C_{Roll} adds a high frequency pole to attenuate high-frequency noise when needed. It may also prevent noise coupling from other rails if there is possibility of cross coupling in between rails when layout is very compact.

To calculate the external compensation components follow the following steps:

	TYPE II CIRCUIT	TYPE III CIRCUIT
Select switching frequency that is appropriate for application depending on L, C sizes, output ripple, EMI concerns and etc. Switching frequencies between 500 kHz and 1 MHz give best trade off between performance and cost. When using smaller L and Cs, switching frequency can be increased. To optimize efficiency, switching frequency can be lowered.		Use type III circuit for switching frequencies higher than 500 kHz.
Select cross over frequency (fc) to be less than 1/5 to 1/10 of switching frequency.	Suggested fc = fs/10	Suggested fc = fs/10
Set and calculate R_c.	$R_C = \frac{2\pi \cdot fc \cdot Vo \cdot Co}{g_M \cdot Vref \cdot gm_{ps}}$	$R_C = \frac{2\pi \cdot fc \cdot Co}{g_M \cdot gm_{ps}}$
Calculate C_c by placing a compensation zero at or before the converter dominant pole $fp = \frac{1}{C_O \cdot R_L \cdot 2\pi}$	$C_c = \frac{R_L \cdot Co}{R_c}$	$C_c = \frac{R_L \cdot Co}{R_c}$
Add C_{Roll} if needed to remove large signal coupling to high impedance COMP node. Make sure that $fp_{Roll} = \frac{1}{2 \cdot \pi \cdot R_C \cdot C_{Roll}}$ is at least twice the cross over frequency.	$C_{Roll} = \frac{\mathrm{Re}\,sr \cdot Co}{R_C}$	$C_{Roll} = \frac{\mathrm{Re}\,sr \cdot Co}{R_C}$
Calculate C_{ff} compensation zero at low frequency to boost the phase margin at the crossover frequency. Make sure that the zero frequency (fz_{ff} is smaller than soft start equivalent frequency ($1/T_{ss}$).	NA	$C_{ff} = \frac{1}{2 \cdot \pi \cdot fz_{ff} \cdot R_1}$

Slope Compensation

The device has a built-in slope compensation ramp. The slope compensation can prevent sub harmonic oscillations in peak current mode control when duty cycle becomes too large.

Over Current Protection

The current through the internal high side MOSFET is sampled and scaled through an internal pilot device during the hig time. The sampled current is compared to over current limit. If the peak inductor current exceeds the over current limit reference level, an internal over current fault counter is set to 1 and an internal flag is set. The internal power MOSFET is immediately turned off and will not be turned on again until the next switching cycle. The protection circuitry continues to monitor the current and turns off the internal MOSFET as described. If the overcurrent condition persists for four sequential clock cycles, the over-current fault counter overflows indicating an overcurrent fault condition exists. The regulator is shut down and power good goes low. If the overcurrent condition clears prior to the counter reaching four consecutive cycles, the internal flag and counter are reset. The protection circuitry attempts to recover from the overcurrent condition after waiting four soft-start cycles. The internal overcurrent flag and counter are reset. A normal soft-start cycle is attempted and normal operation continues if the fault condition has cleared. If the overcurrent fault counter overflows during soft-start, the converter shuts down and this hiccup mode operation repeats.

Thermal Shutdown

The device implements an internal thermal shutdown to protect itself if the junction temperature exceeds 160°C. The thermal shutdown forces the device to stop switching when the junction temperature exceeds thermal trip threshold. Once the die temperature decreases below 140°C, the device reinitiates the power up sequence. The thermal shutdown hysteresis is 20°C.

Power Dissipation

The total power dissipation inside TPS65270 should not to exceed the maximum allowable junction temperature of 125°C to maintain reliable operation. The maximum allowable power dissipation is a function of the thermal resistance of the package (R_{JA}) and ambient temperature.

To calculate the temperature inside the device under continuous loading use the following procedure.

1. Define the set voltage for each converter.
2. Define the continuous loading on each converter. Make sure do not exceed the converter maximum loading.
3. Determine from the graphs below the expected losses in watts per converter inside the device. The losses depend on the input supply, the selected switching frequency, the output voltage and the converter chosen.
4. To calculate the maximum temperature inside the IC use the following formula:

$$T_{HOT\_SPOT} = T_A + P_{DIS} \bullet \theta_{JA} \quad (4)$$

Where:

T_A is the ambient temperature

P_{DIS} is the sum of losses in all converters

θ_{JA} is the junction to ambient thermal impedance of the device and it is heavily dependant on board layout

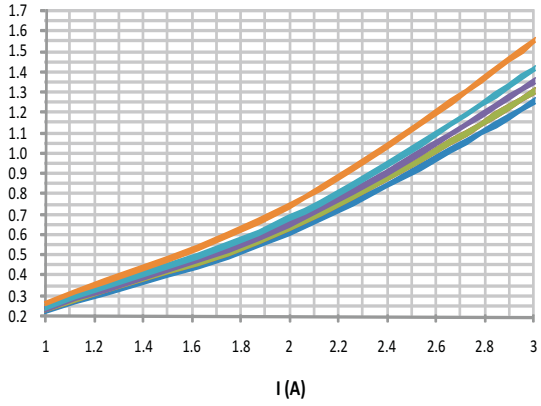


Figure 17. Buck 1
V_{IN} = 12 V, f_{SW} = 500 kHz
V_O (from top to bottom) = 5 V, 3.3 V, 2.5 V, 1.8 V, 1.2 V

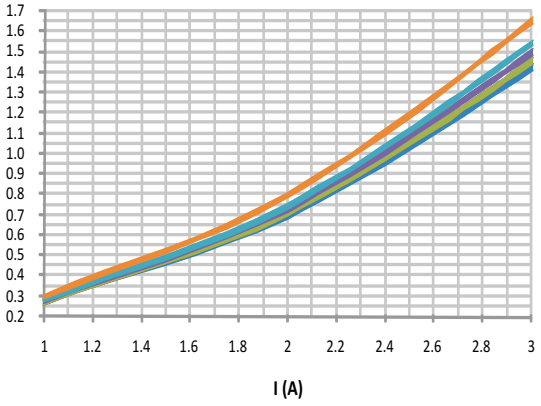


Figure 18. Buck 1
V_{IN} = 12 V, f_{SW} = 1.1 MHz
V_O (from top to bottom) = 5 V, 3.3 V, 2.5 V, 1.8 V, 1.2 V

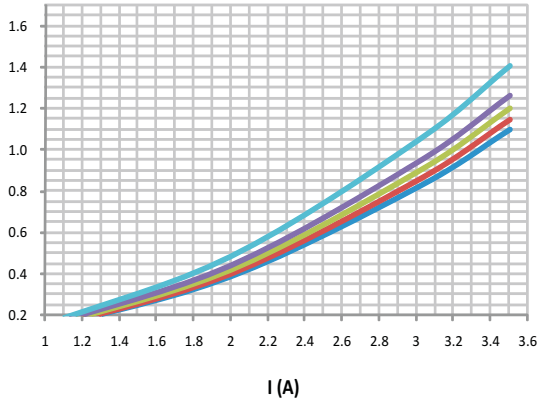


Figure 19. Buck 2
V_{IN} = 12 V, f_{SW} = 500 kHz
V_O (from top to bottom) = 5 V, 3.3 V, 2.5 V, 1.8 V, 1.2 V

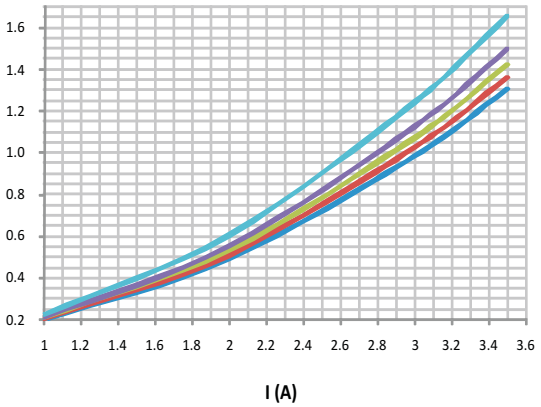


Figure 20. Buck 2
V_{IN} = 12 V, f_{SW} = 1.1 MHz
V_O (from top to bottom) = 5 V, 3.3 V, 2.5 V, 1.8 V, 1.2 V

Low Power Mode Operation

By pulling the Low_P pin high all converters will operate in pulse-skipping mode, greatly reducing the overall power consumption at light and no load conditions. When LOW_P is tied to low, all converters run in forced PWM mode.

Thermal Shutdown

The device implements an internal thermal shutdown to protect itself if the junction temperature exceeds 160°C. The thermal shutdown forces the device to stop switching when the junction temperature exceeds thermal trip threshold. Once the die temperature decreases below 140°C, the device reinitiates the power up sequence. The thermal shutdown hysteresis is 20°C.

Layout Recommendations

Layout is a critical portion of PMIC designs.

- Place VOUT, and LX on the top layer and an inner power plane for VIN.
- Fit also on the top layer connections for the remaining pins of the PMIC and a large top side area filled with ground.
- The top layer ground area sould be connected to the bottom ground layer(s) using vias at the input bypass capacitor, the output filter cpacitor and directly under the TPS65270 device to provide a thermal path from the Powerpad land to ground.
- The AGND pin should be tied directly to the power pad under the IC and the power pad.
- For operation at full rated load, the top side ground area together with the bottom ground plane, must provide adequate heat dissipating area.
- There are several signals paths that conduct fast changing currents or voltages that can interact with stray inductance or parasitic capacitance to generate noise or degrade the power supplies performance. To help eliminate these problems, the VIN pin should be bypassed to ground with a low ESR ceramic bypass capacitor with X5R or X7R dielectric. Care should be taken to minimize the loop area formed by the bypass capacitor connections, the VIN pins, and the ground connections. Since the LX connection is the switching node, the output inductor should be located close to the LX pins, and the area of the PCB conductor minimized to prevent excessive capacitive coupling.
- The output filter capacitor ground should use the same power ground trace as the VIN input bypass capacitor. Try to minimize this conductor length while maintaining adequate width.
- The compensation should be as close as possible to the COMP pins. The COMP and OSC pins are sensitive to noise so the components associated to these pins should be located as close as possible to the IC and routed with minimal lengths of trace.

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)
TPS65270PWPR	Active	Production	HTSSOP (PWP) | 24	2000 | LARGE T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 85	TPS65270
TPS65270PWPR.B	Active	Production	HTSSOP (PWP) | 24	2000 | LARGE T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 85	TPS65270
TPS65270RGER	Active	Production	VQFN (RGE) | 24	3000 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	TPS 65270
TPS65270RGER.B	Active	Production	VQFN (RGE) | 24	3000 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	TPS 65270
TPS65270RGET	Active	Production	VQFN (RGE) | 24	250 | SMALL T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	TPS 65270
TPS65270RGET.B	Active	Production	VQFN (RGE) | 24	250 | SMALL T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	TPS 65270

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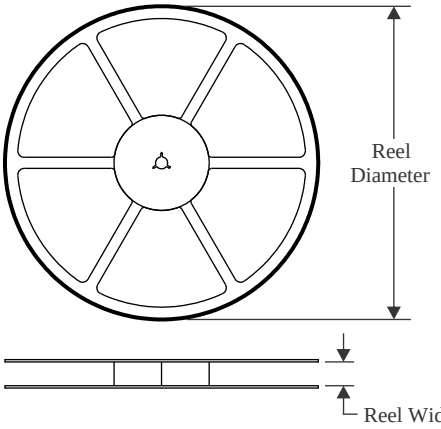
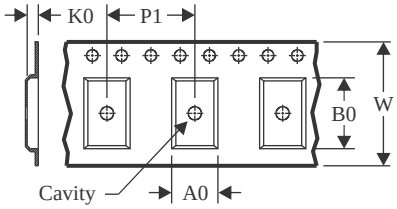
In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

TAPE AND REEL INFORMATION

REEL DIMENSIONS

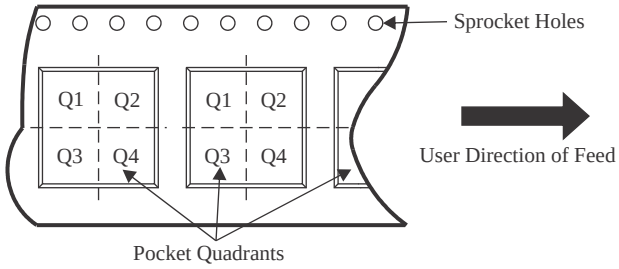


TAPE DIMENSIONS



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

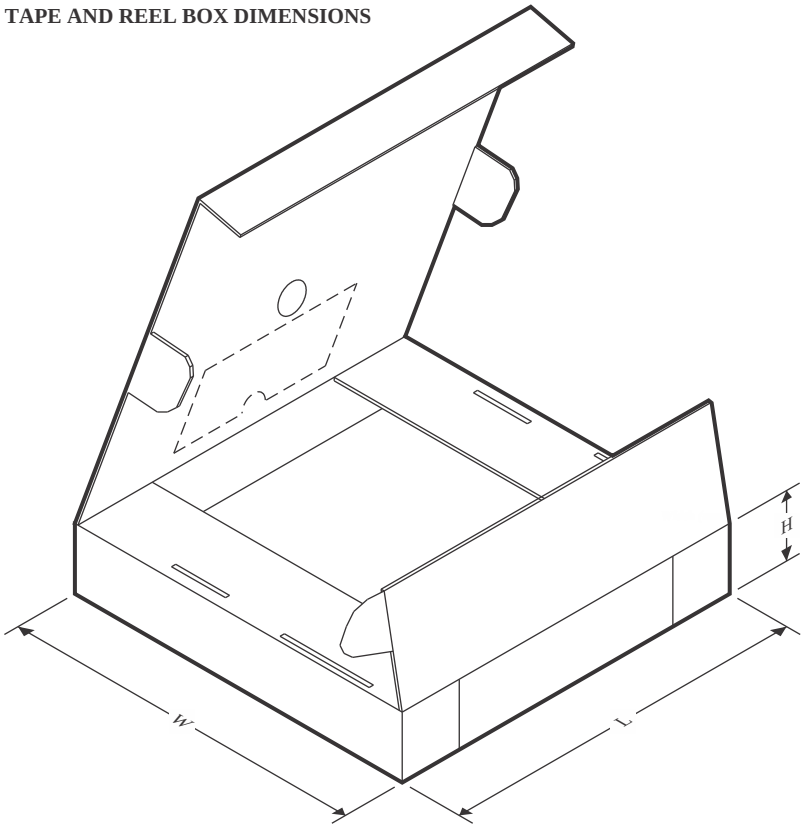
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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
TPS65270PWPR	HTSSOP	PWP	24	2000	330.0	16.4	6.95	8.3	1.6	8.0	16.0	Q1
TPS65270RGER	VQFN	RGE	24	3000	330.0	12.4	4.25	4.25	1.15	8.0	12.0	Q2
TPS65270RGET	VQFN	RGE	24	250	180.0	12.4	4.25	4.25	1.15	8.0	12.0	Q2

TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TPS65270PWPR	HTSSOP	PWP	24	2000	353.0	353.0	32.0
TPS65270RGER	VQFN	RGE	24	3000	346.0	346.0	33.0
TPS65270RGET	VQFN	RGE	24	250	182.0	182.0	20.0

GENERIC PACKAGE VIEW

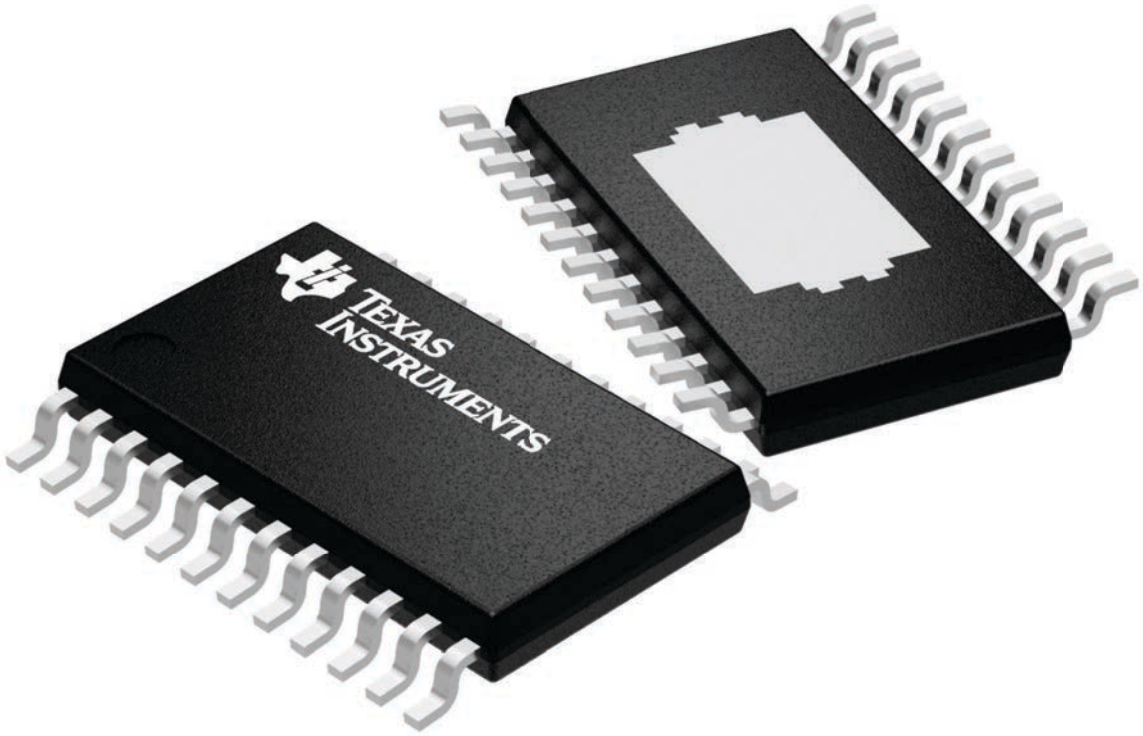
PWP 24

PowerPAD™ TSSOP - 1.2 mm max height

4.4 x 7.6, 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.



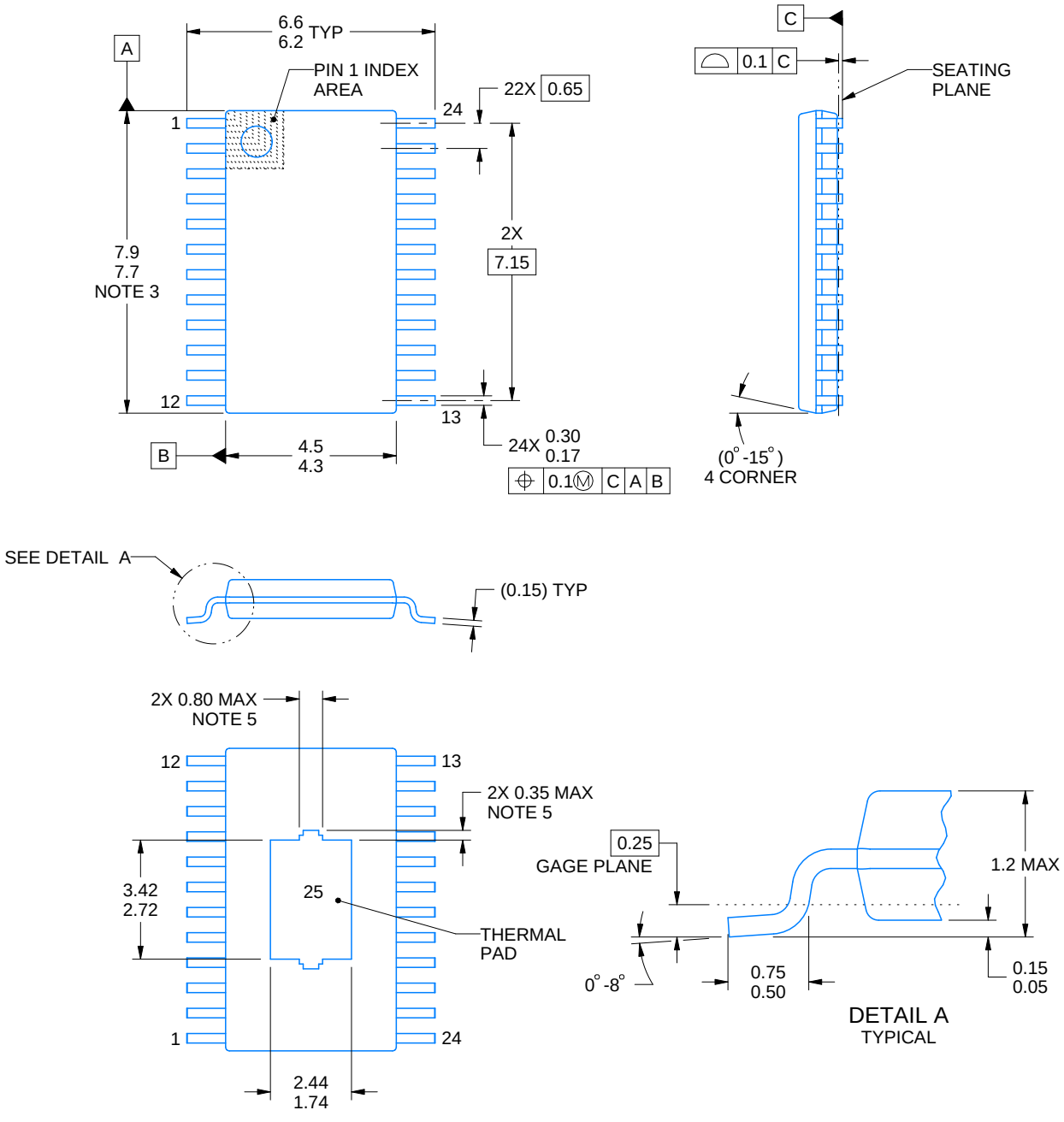
4224742/B

PACKAGE OUTLINE

PWP0024U

PowerPAD™ TSSOP - 1.2 mm max height

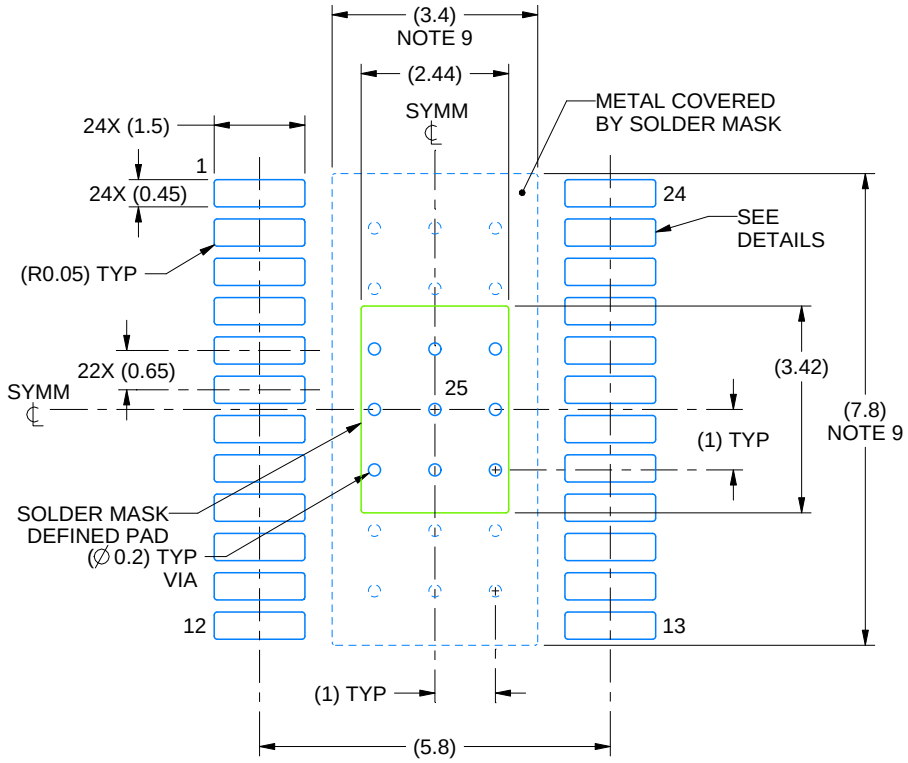
SMALL OUTLINE PACKAGE



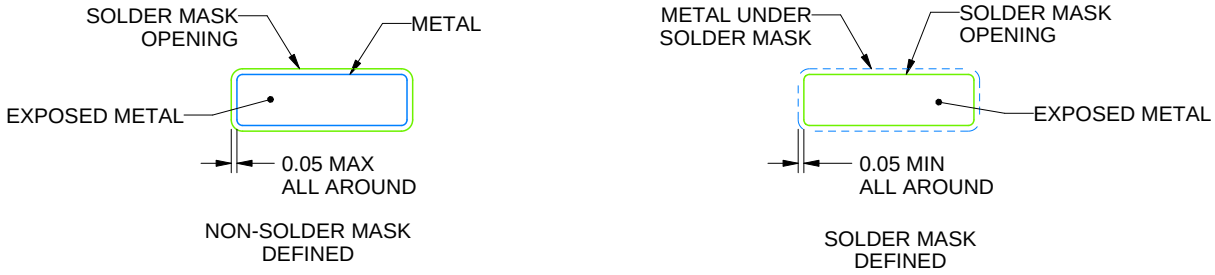
PowerPAD is a trademark of Texas Instruments.

NOTES:

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.



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE: 8X

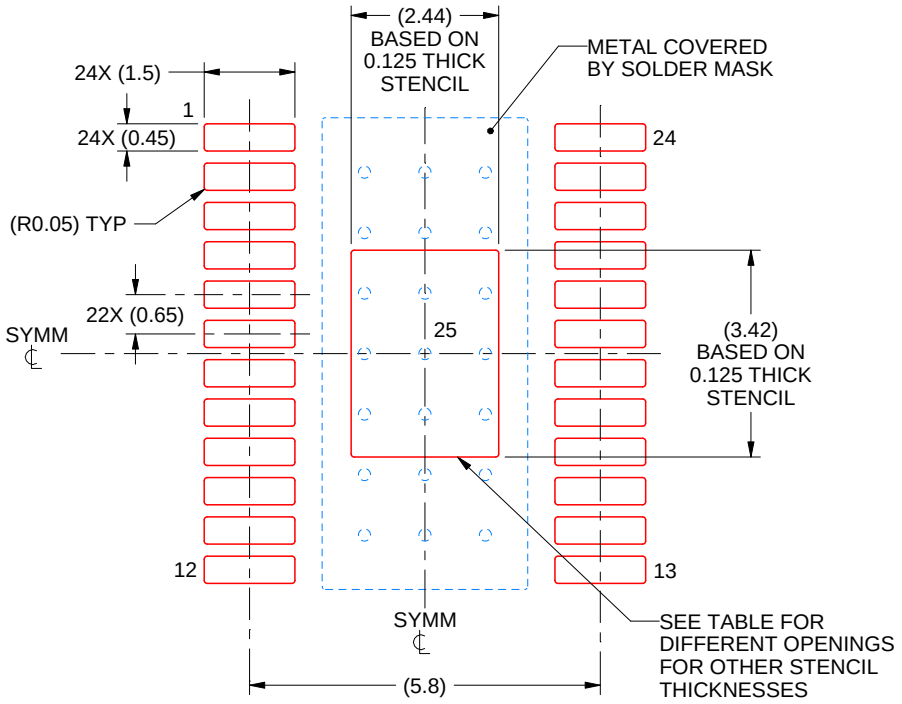


SOLDER MASK DETAILS

4230154/A 10/2023

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.



SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL
SCALE: 8X

STENCIL THICKNESS	SOLDER STENCIL OPENING
0.1	2.73 X 3.82
0.125	2.44 X 3.42 (SHOWN)
0.15	2.23 X 3.12
0.175	2.06 X 2.89

4230154/A 10/2023

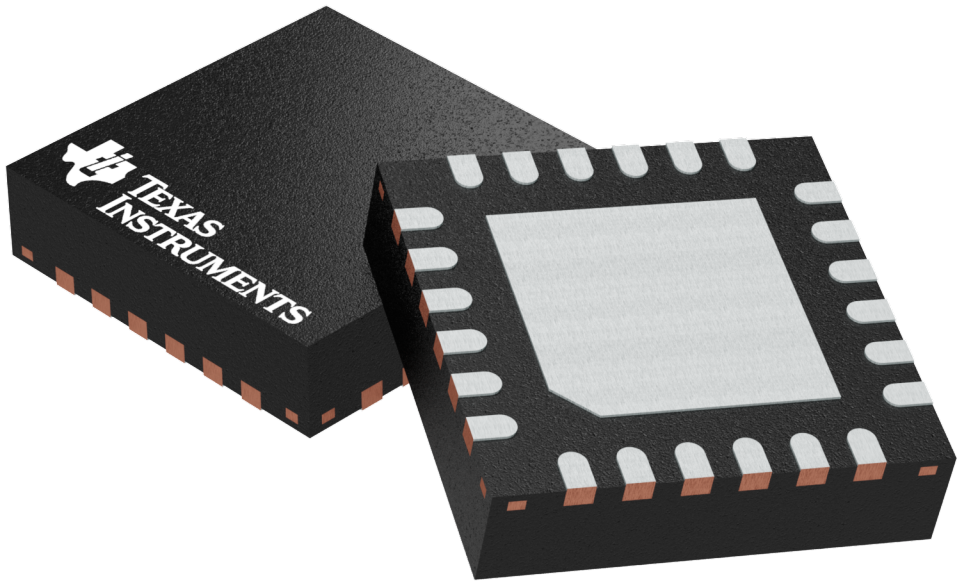
NOTES: (continued)

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.

GENERIC PACKAGE VIEW

RGE 24 VQFN - 1 mm max height

PLASTIC QUAD FLATPACK - NO LEAD



Images above are just a representation of the package family, actual package may vary.
Refer to the product data sheet for package details.

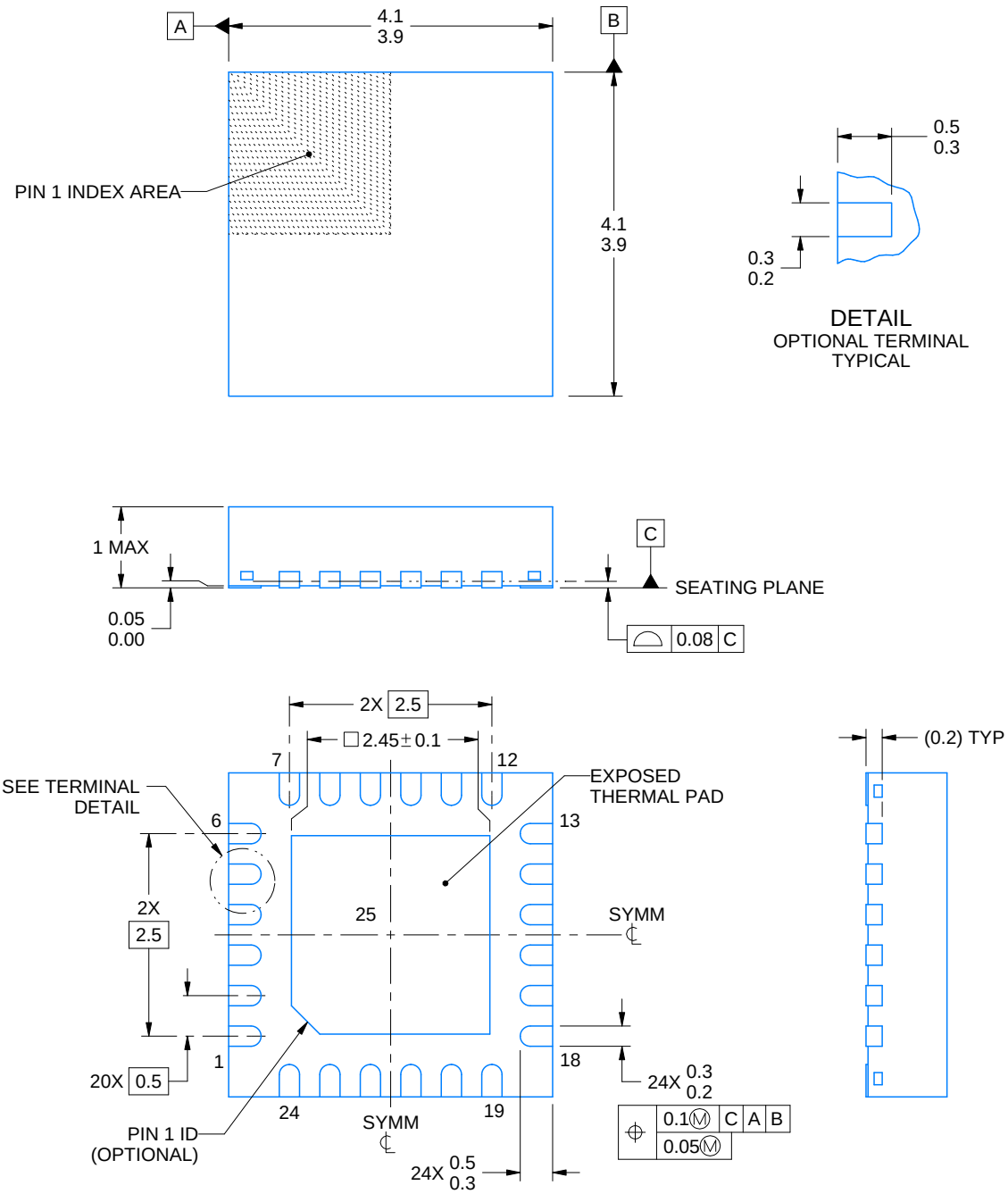
4204104/H

PACKAGE OUTLINE

RGE0024B

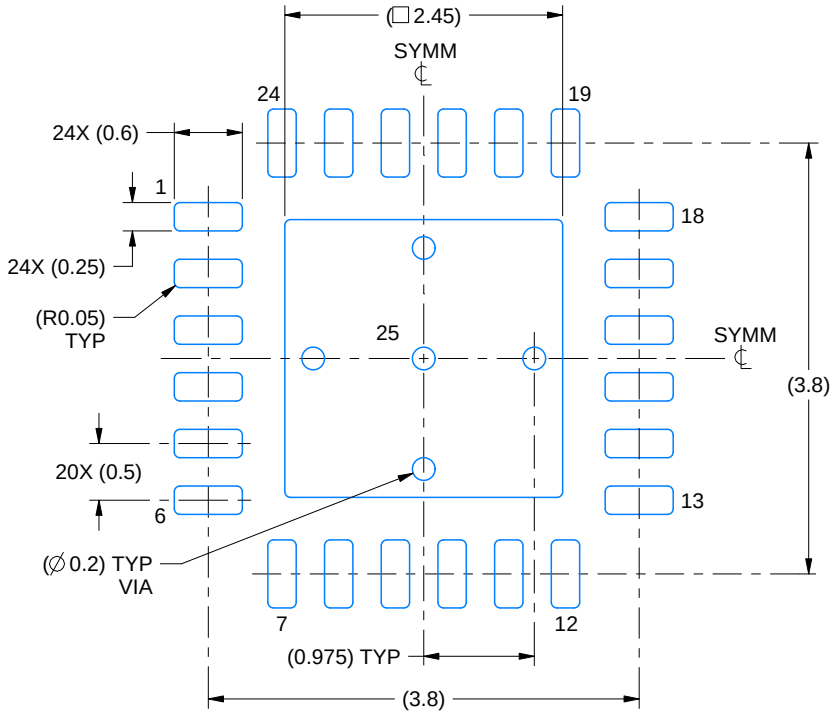
VQFN - 1 mm max height

PLASTIC QUAD FLATPACK - NO LEAD

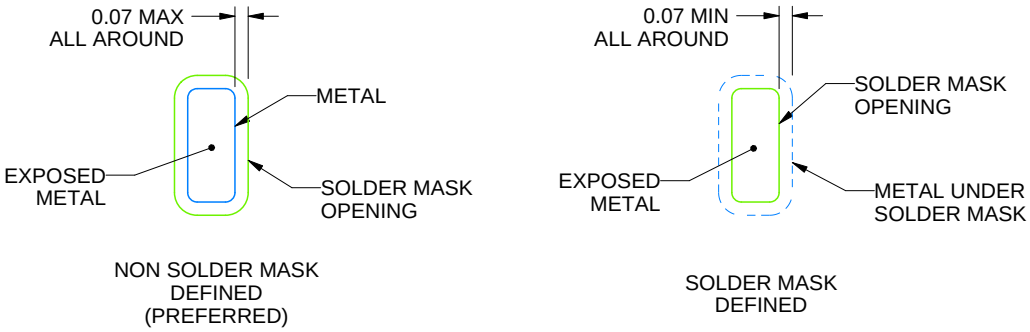


NOTES:

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. The package thermal pad must be soldered to the printed circuit board for thermal and mechanical performance.



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE:15X

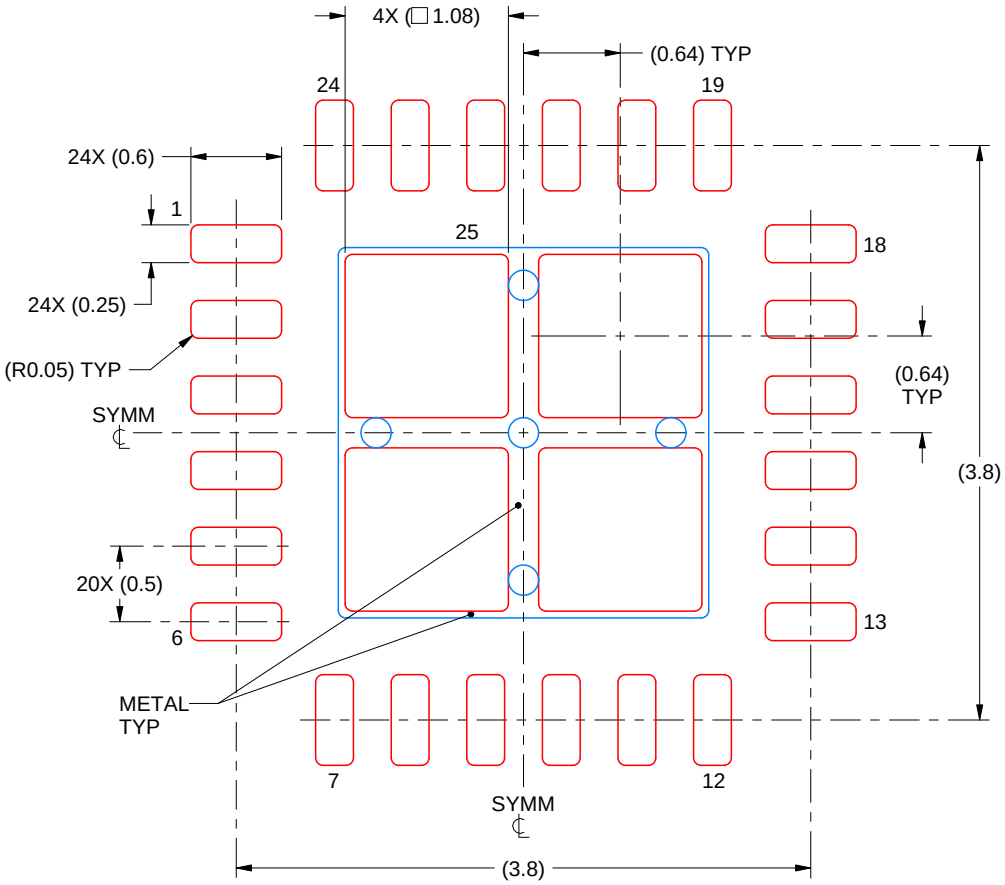


SOLDER MASK DETAILS

4219013/A 05/2017

NOTES: (continued)

4. This package is designed to be soldered to a thermal pad on the board. For more information, see Texas Instruments literature number SLUA271 (www.ti.com/lit/slua271).
5. Vias are optional depending on application, refer to device data sheet. If any vias are implemented, refer to their locations shown on this view. It is recommended that vias under paste be filled, plugged or tented.



SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL

EXPOSED PAD 25
78% PRINTED SOLDER COVERAGE BY AREA UNDER PACKAGE
SCALE:20X

4219013/A 05/2017

NOTES: (continued)

6. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.

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