限流配电开关

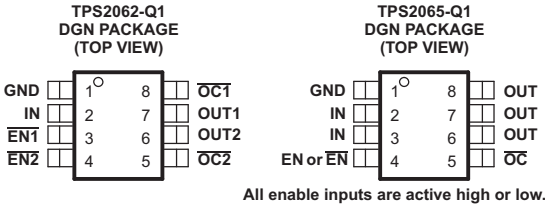
查询样品: TPS2062-Q1, TPS2065-Q1

特性

- 符合汽车应用要求
- **70mΩ** 高侧金属氧化物半导体场效应晶体 **(MOSFET)**
- **1A** 持续电流
- 散热和短路保护
- 精确电流限制 （最小值 **1.1A**，最大值**1.9**）
- 工作电压范围：**2.7V** 至 **5.5V**
- 上升时间典型值 **0.6ms**
- 欠压闭锁
- 毛刺脉冲消除故障报告 **($\overline{OC}$)**
- 加电期间无$\overline{OC}$毛刺脉冲
- 最大待机电源电流 **1μA**
- 双向开关
- 环境温度范围：**–40°C** 至 **125°C**
- 内置软启动
- **UL** 列表-文件号**E169910**

应用范围

- 大电容负载
- 短路保护



说明

TPS2062/5-Q1 配电开关主要用于很可能出现大电容负载和短路情况的应用。 这个器件组装有一个用于配电系统的 70mΩ N-通道 MOSFET 电源开关。此类系统要求在单一封装内具有多个电源开关。 每个开关由一个逻辑使能输入控制。 栅极驱动由一个内部电荷泵提供，此电荷泵设计用于控制电源开关上升时间和下降时间以大大减少切换期间的电流涌入。 电荷泵无需外部组件并可在低至 2.7V 的电源电压下工作。

当输出负载超过限流阀值或者短路出现时，此器件通过切换至恒定电流模式，并通过将过流 ($\overline{OCx}$) 下拉至逻辑输出低电平来将输出电流限制在安全水平上。 当持续重过载和短路增加了开关内的功率耗散时，将引起结温上升，这时一个过热保护电路将关闭此开关以避免器件损坏。 一旦器件充分冷却，此器件将自动从热关断中恢复。 内部电路确保此开关在有效输入电压出现前保持关闭状态。 这个配电开关设计用于将电流限值的典型值设定在 1.5A 上。

GENERAL SWITCH CATALOG

33 mΩ, Single		80 mΩ, Single		80 mΩ, Dual		80 mΩ, Dual		80 mΩ, Triple		80 mΩ, Quad		80 mΩ, Quad	
TPS201xA	0.2 A to 2 A	TPS2014	600 mA	TPS2042B	500 mA	TPS2080	500 mA	TPS2043B	500 mA	TPS2044B	500 mA	TPS2085	500 mA
TPS202x	0.2 A to 2 A	TPS2015	1 A	TPS2052B	500 mA	TPS2081	500 mA	TPS2053B	500 mA	TPS2054B	500 mA	TPS2086	500 mA
TPS203x	0.2 A to 2 A	TPS2041B	500 mA	TPS2046B	250 mA	TPS2082	500 mA	TPS2047B	250 mA	TPS2048A	250 mA	TPS2087	500 mA
		TPS2051B	500 mA	TPS2056	250 mA	TPS2090	250 mA	TPS2057A	250 mA	TPS2058	250 mA	TPS2095	250 mA
		TPS2045A	250 mA	TPS2062	1 A	TPS2091	250 mA	TPS2063	1 A			TPS2096	250 mA
		TPS2049	100 mA	TPS2066	1 A	TPS2092	250 mA	TPS2067	1 A			TPS2097	250 mA
		TPS2055A	250 mA	TPS2060	1.5 A								
		TPS2061	1 A	TPS2064	1.5 A								
		TPS2065	1 A										
		TPS2068	1.5 A										
		TPS2069	1.5 A										

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PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of the Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

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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.

ORDERING INFORMATION(1)

T_A	PACKAGE(2)		ORDERABLE PART NUMBER	TOP-SIDE MARKING
–40°C to 125°C	MSOP – DGN	Reel of 2500	TPS2062QDGNRQ1	PSOQ
	VSSOP - DGN	Reel of 2500	TPS2065QDGNRQ1	PTLQ

(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.

ABSOLUTE MAXIMUM RATINGS

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

Input voltage range, $V_{I(IN)}$ (2)		-0.3 V to 6 V
Output voltage range(2), $V_{O(OUTx)}$		-0.3 V to 6 V
Input voltage range, $V_{I(\overline{ENx})}$		-0.3 V to 6 V
Voltage range, $V_{I(\overline{OCx})}$		-0.3 V to 6 V
Continuous output current, $I_{O(OUTx)}$		Internally limited
Continuous total power dissipation		See Dissipation Rating Table
Operating virtual junction temperature range, T_J		-40°C to 150°C
Storage temperature range, T_{stg}		-65°C to 150°C
Electrostatic discharge (ESD) protection	Human body model (HBM)	2 kV
	Charge device model (CDM)	1000 V
	Machine model (MM)	100 V

(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.
(2) All voltages are with respect to GND.

DISSIPATING RATING TABLE

PACKAGE	$T_A \le 25°C$ POWER RATING	DERATING FACTOR ABOVE $T_A = 25°C$	$T_A = 125°C$ POWER RATING
DGN-8	2.14 W	17.123 mW/°C	428 mW

RECOMMENDED OPERATING CONDITIONS

	MIN	MAX	UNIT
Input voltage, $V_{I(IN)}$	2.7	5.5	V
Input voltage, $V_{I(\overline{ENx})}$	0	5.5	V
Continuous output current, $I_{O(OUTx)}$	0	1	A
Ambient temperature, T_A	-40	125	°C
Operating virtual junction temperature, T_J	-40	150	°C

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ELECTRICAL CHARACTERISTICS

over recommended operating junction temperature range, $V_{I(IN)}$ = 5.5 V, I_O = 1 A, $V_{I(\overline{ENx})}$ = 0 V (unless otherwise noted)

PARAMETER		TEST CONDITIONS[1]		MIN	TYP	MAX	UNIT
POWER SWITCH							
$r_{DS(on)}$	Static drain-source on-state resistance, 5-V operation and 3.3-V operation	$V_{I(IN)}$ = 5 V or 3.3 V, I_O = 1 A, -40°C ≤ T_A ≤ 125°C			70	135	mΩ
	Static drain-source on-state resistance, 2.7-V operation[2]	$V_{I(IN)}$ = 2.7 V, I_O = 1 A, -40°C ≤ T_A ≤ 125°C			75	150	mΩ
t_r	Rise time, output	$V_{I(IN)}$ = 5.5 V	C_L = 1 µF, R_L = 5 Ω, T_A = 25°C		0.6	1.5	ms
		$V_{I(IN)}$ = 2.7 V			0.4	1	
t_f	Fall time, output	$V_{I(IN)}$ = 5.5 V	C_L = 1 µF, R_L = 5 Ω, T_A = 25°C	0.05		0.5	ms
		$V_{I(IN)}$ = 2.7 V		0.05		0.5	
ENABLE INPUT $\overline{EN}$ OR EN							
V_{IH}	High-level input voltage	2.7 V ≤ $V_{I(IN)}$ ≤ 5.5 V		2			V
V_{IL}	Low-level input voltage	2.7 V ≤ $V_{I(IN)}$ ≤ 5.5 V				0.8	
I_I	Input current	$V_{I(\overline{ENx})}$ = 0 V or 5.5 V		-1		1	µA
t_{on}	Turnon time	C_L = 100 µF, R_L = 5 Ω				3	ms
t_{off}	Turnoff time	C_L = 100 µF, R_L = 5 Ω				10	
CURRENT LIMIT							
I_{OS}	Short-circuit output current[1]	$V_{I(IN)}$ = 5 V, OUT connected to GND, Device enabled into short-circuit	T_A = 25°C	1.1	1.5	1.9	A
			-40°C ≤ T_A ≤ 125°C	1.1	1.5	2.1	
I_{OC_TRIP}	Overcurrent trip threshold	$V_{I(IN)}$ = 5 V, current ramp (≤ 100 A/s) on OUT		1.6	2.3	2.9	A
SUPPLY CURRENT (TPS2062-Q1)							
Supply current, low-level output		No load on OUT, $V_{I(\overline{ENx})}$ = 5.5 V	T_A = 25°C		0.5	1	µA
			-40°C ≤ T_A ≤ 125°C		0.5	5	
Supply current, high-level output		No load on OUT, $V_{I(\overline{ENx})}$ = 0 V	T_A = 25°C		50	70	µA
			-40°C ≤ T_A ≤ 125°C		50	90	
Leakage current		OUT connected to ground, $V_{I(\overline{ENx})}$ = 5.5 V	-40°C ≤ T_A ≤ 125°C		1		µA
Reverse leakage current		$V_{I(OUTx)}$ = 5.5 V, IN = ground	T_A = 25°C		0.2		µA
SUPPLY CURRENT (TPS2065-Q1)							
Supply current, low-level output		No load on OUT, $V_{I(\overline{ENx})}$ = 5.5 V, or $V_{I(ENx)}$ = 0 V	T_A = 25°C		0.5	1	µA
			-40°C ≤ T_A ≤ 125°C		0.5	5	
Supply current, high-level output		No load on OUT, $V_{I(\overline{ENx})}$ = 0 V, or $V_{I(ENx)}$ = 5.5 V	T_A = 25°C		43	60	µA
			-40°C ≤ T_A ≤ 125°C		43	70	
Leakage current		OUT connected to ground, $V_{I(\overline{EN})}$ = 5.5 V, or $V_{I(EN)}$ = 0 V	-40°C ≤ T_A ≤ 125°C		1		µA
Reverse leakage current		$V_{I(OUTx)}$ = 5.5 V, IN = ground	T_A = 25°C		0		µA
UNDERVOLTAGE LOCKOUT							
Low-level input voltage, IN				2		2.5	V
Hysteresis, IN		T_A = 25°C			75		mV
OVERCURRENT $\overline{OC1}$ and $\overline{OC2}$							
Output low voltage, $V_{OL(OCx)}$		$I_{O(\overline{OCx})}$ = 5 mA				0.4	V
Off-state current		$V_{O(\overline{OCx})}$ = 5 V or 3.3 V				1	µA
$\overline{OC}$ deglitch[2]		$\overline{OCx}$ assertion or deassertion		4	8	15	ms
THERMAL SHUTDOWN[3]							
Thermal shutdown threshold				135			°C
Recovery from thermal shutdown				125			°C
Hysteresis					10		°C

(1) Pulse-testing techniques maintain junction temperature close to ambient temperature; thermal effects must be taken into account separately.
(2) Not tested in production, specified by design.
(3) The thermal shutdown only reacts under overcurrent conditions.

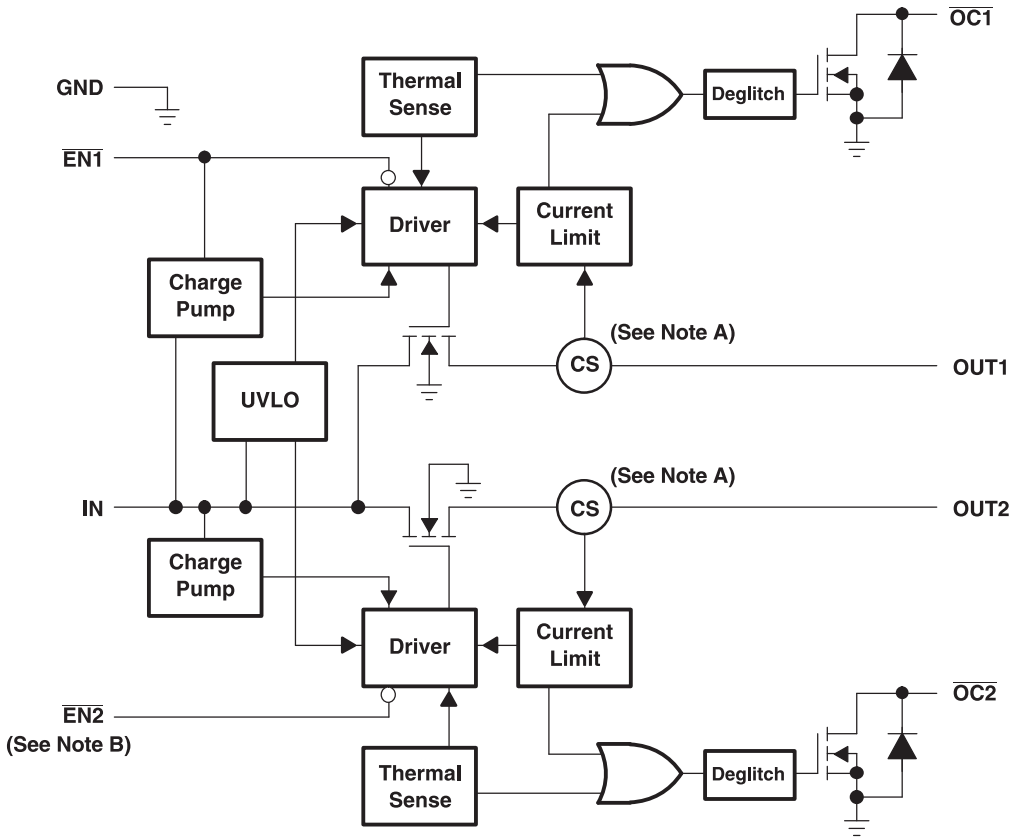
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DEVICE INFORMATION

Pin Functions - TPS2062-Q1

PINS		I/O	DESCRIPTION
TPS2062-Q1			
NAME	NO.		
$\overline{EN1}$	3	I	Enable input, logic low turns on power switch IN-OUT1
$\overline{EN2}$	4	I	Enable input, logic low turns on power switch IN-OUT2
EN1	-	I	Enable input, logic high turns on power switch IN-OUT1
EN2	-	I	Enable input, logic high turns on power switch IN-OUT2
GND	1		Ground
IN	2	I	Input voltage
$\overline{OC1}$	8	O	Overcurrent, open-drain output, active low, IN-OUT1
$\overline{OC2}$	5	O	Overcurrent, open-drain output, active low, IN-OUT2
OUT1	7	O	Power-switch output, IN-OUT1
OUT2	6	O	Power-switch output, IN-OUT2
PowerPAD™	-		Internally connected to GND; used to heat-sink the part to the circuit board traces. Should be connected to GND pin.

Functional Block Diagram - TPS2062-Q1



A. Current sense

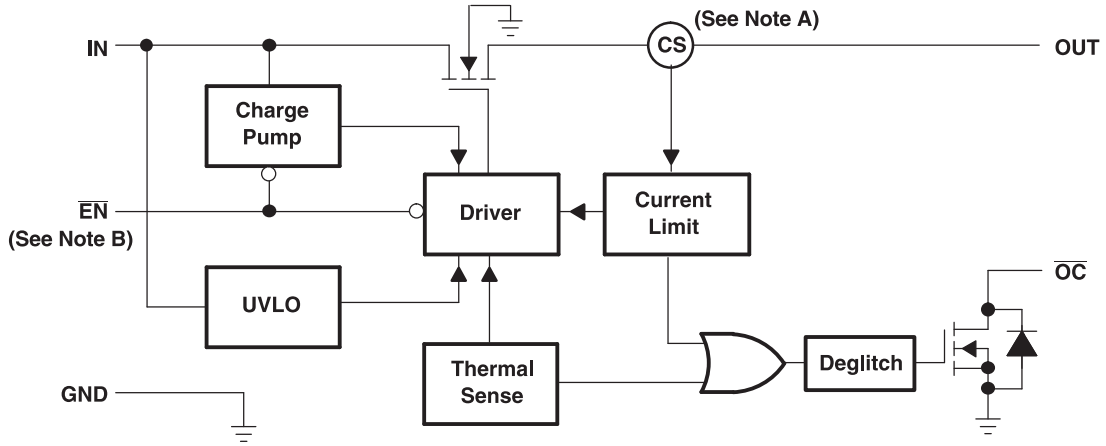
B. Active low ($\overline{EN}$) for TPS2062-Q1

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Pin Functions - TPS2065-Q1

PINS		I/O	DESCRIPTION
TPS2065-Q1			
NAME	NO.		
$\overline{EN}$	-	I	Enable input, logic low turns on power switch IN-OUT1
EN	4	I	Enable input, logic high turns on power switch IN-OUT1
GND	1		Ground
IN	2, 3	I	Input voltage
$\overline{OC}$	5	O	Overcurrent, open-drain output, active low, IN-OUT1
OUT	6, 7, 8	O	Power-switch output, IN-OUT1
PowerPAD™	-		Internally connected to GND; used to heat-sink the part to the circuit board traces. Should be connected to GND pin.

Functional Block Diagram - TPS2065-Q1



A. Current sense

B. Active high (EN) for TPS2065-Q1

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PARAMETER MEASUREMENT INFORMATION

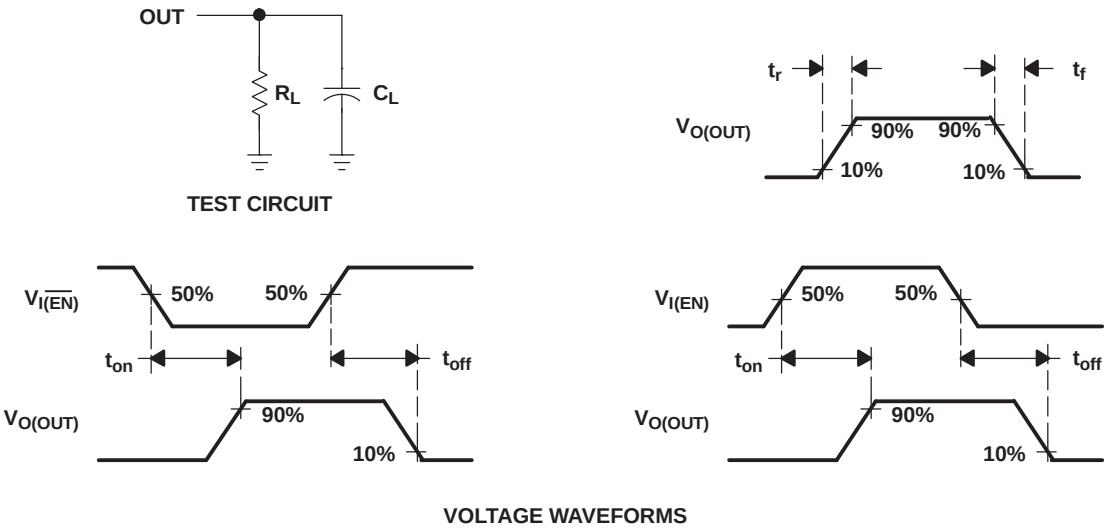


Figure 1. Test Circuit and Voltage Waveforms

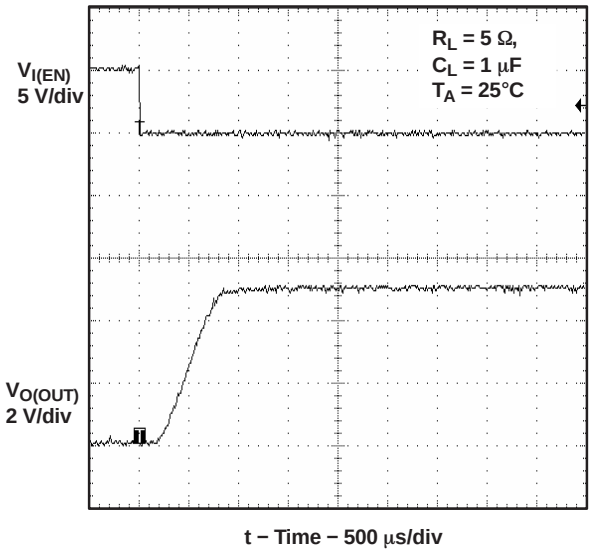


Figure 2. Turnon Delay and Rise Time With 1-μF Load

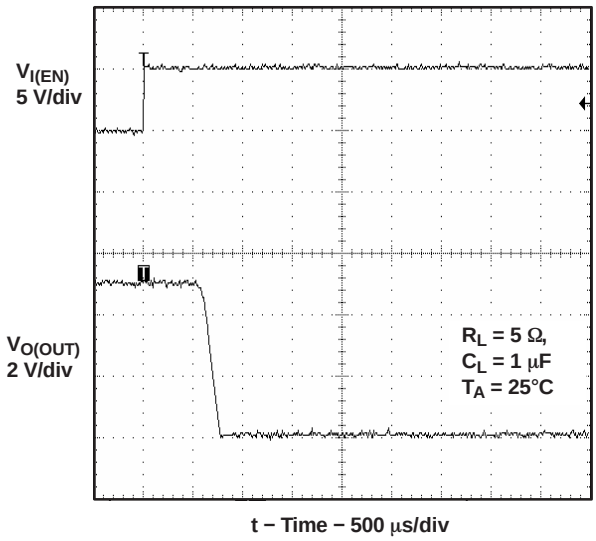


Figure 3. Turnoff Delay and Fall Time With 1-μF Load

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PARAMETER MEASUREMENT INFORMATION (continued)

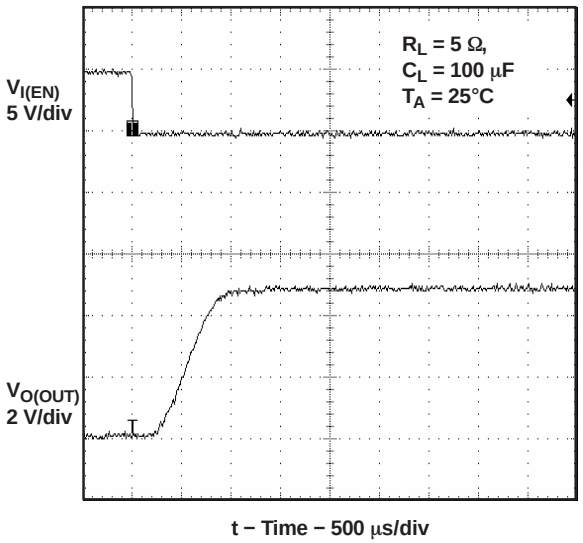


Figure 4. Turnon Delay and Rise Time With 100-μF Load

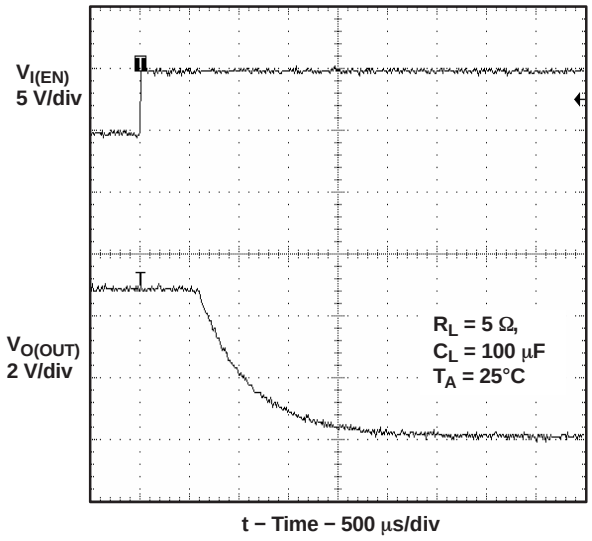


Figure 5. Turnoff Delay and Fall Time With 100-μF Load

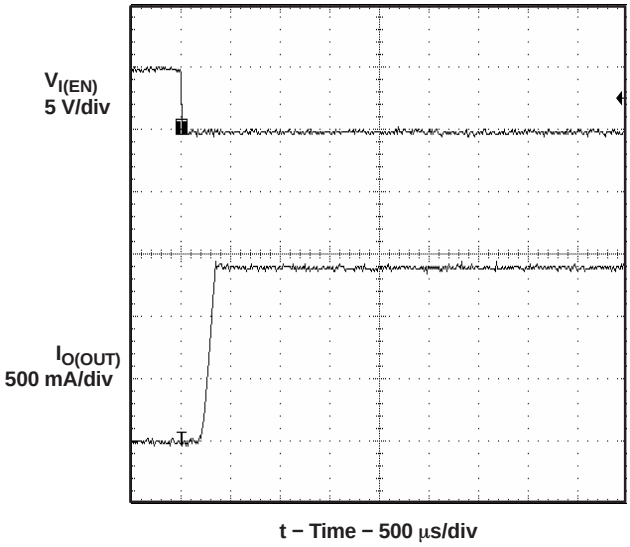


Figure 6. Short-Circuit Current, Device Enabled Into Short

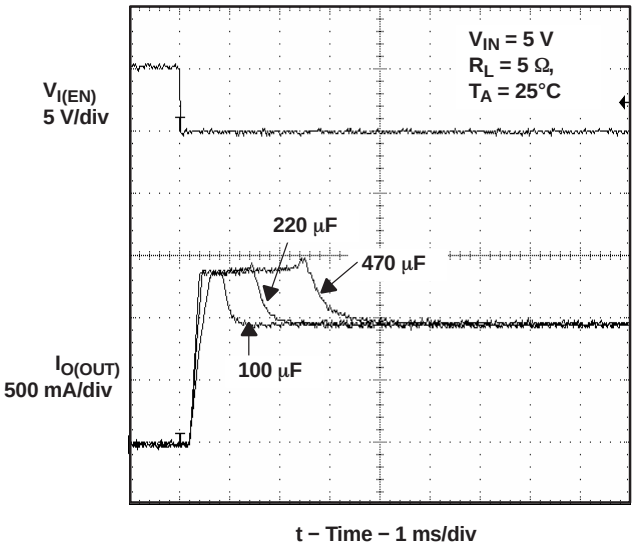


Figure 7. Inrush Current With Different Load Capacitance

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PARAMETER MEASUREMENT INFORMATION (continued)

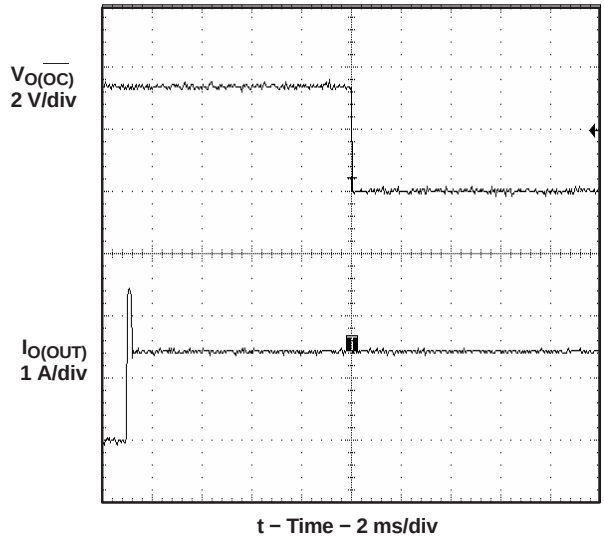


Figure 8. 2-Ω Load Connected to Enabled Device

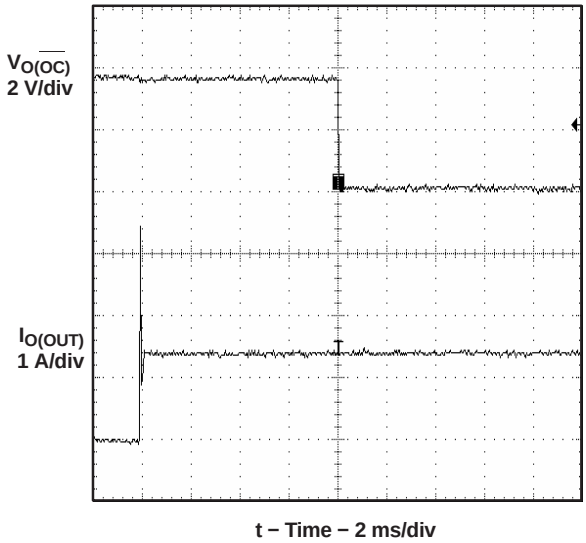


Figure 9. 1-Ω Load Connected to Enabled Device

TYPICAL CHARACTERISTICS

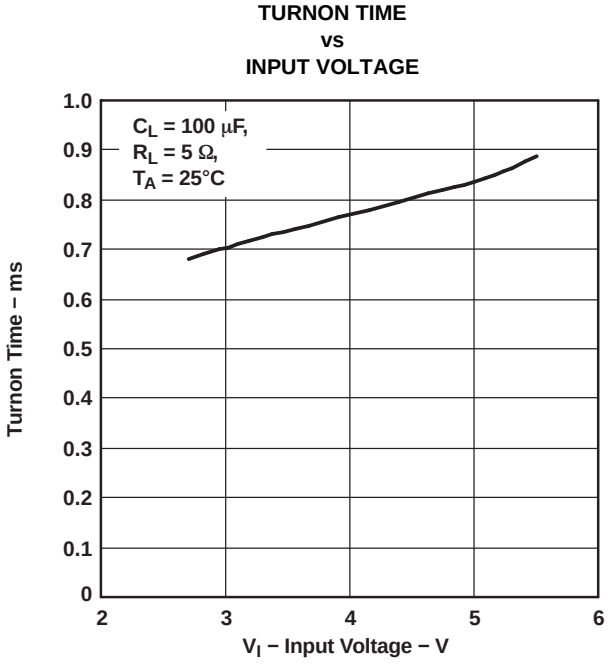


Figure 10.

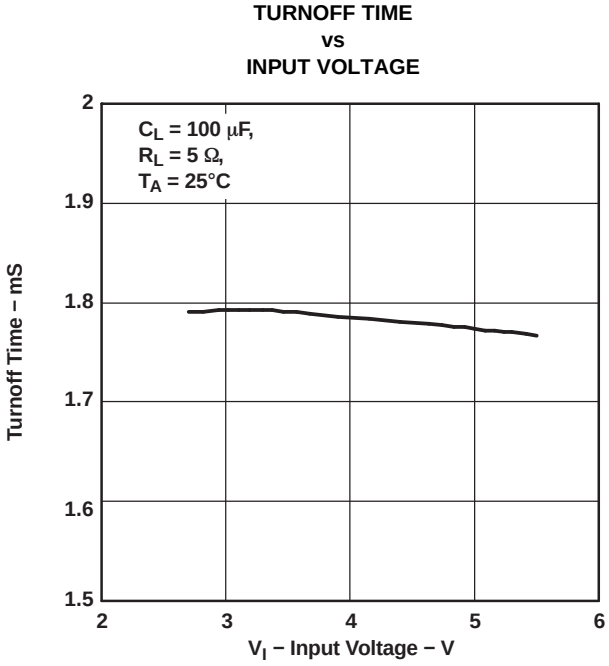


Figure 11.

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TYPICAL CHARACTERISTICS (continued)

RISE TIME vs INPUT VOLTAGE

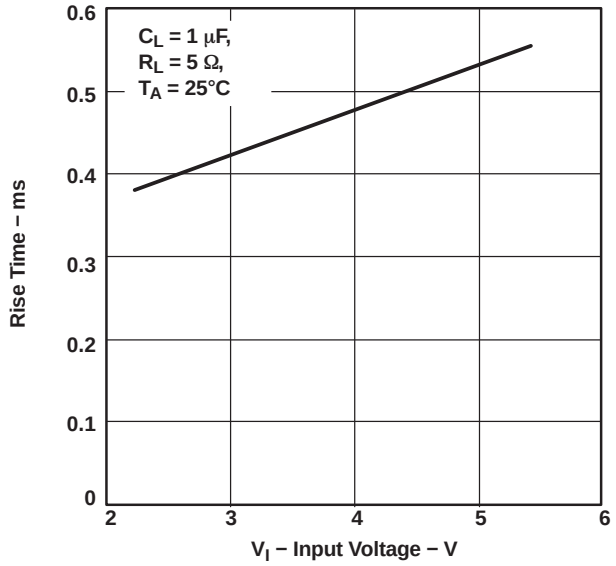


Figure 12.

FALL TIME vs INPUT VOLTAGE

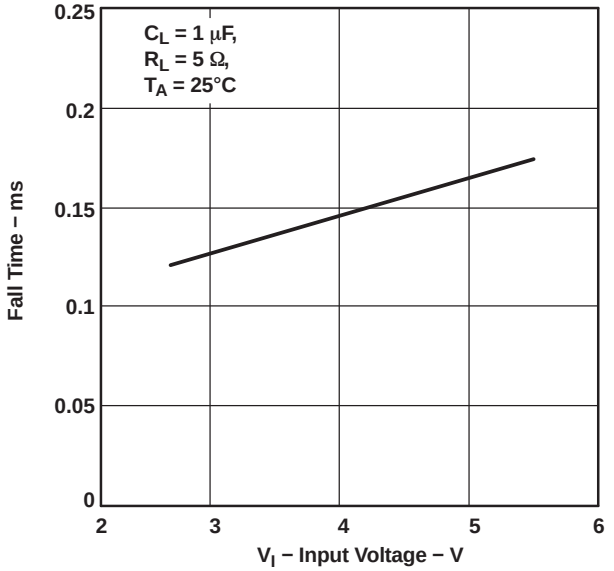


Figure 13.

TPS2062-Q1 SUPPLY CURRENT, OUTPUT ENABLED vs JUNCTION TEMPERATURE

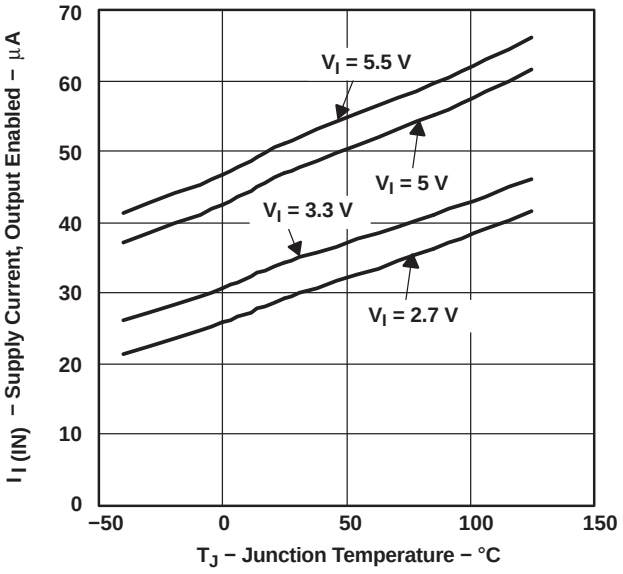


Figure 14.

TPS2065-Q1 SUPPLY CURRENT, OUTPUT ENABLED vs JUNCTION TEMPERATURE

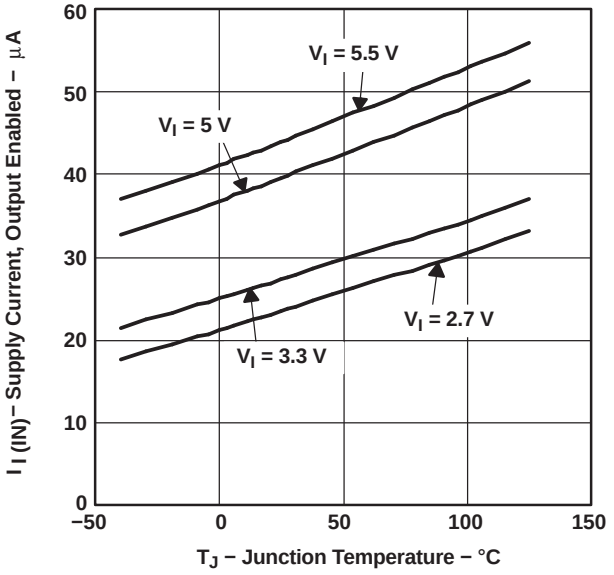


Figure 15.

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TYPICAL CHARACTERISTICS (continued)

TPS2062-Q1
SUPPLY CURRENT, OUTPUT DISABLED
vs
JUNCTION TEMPERATURE

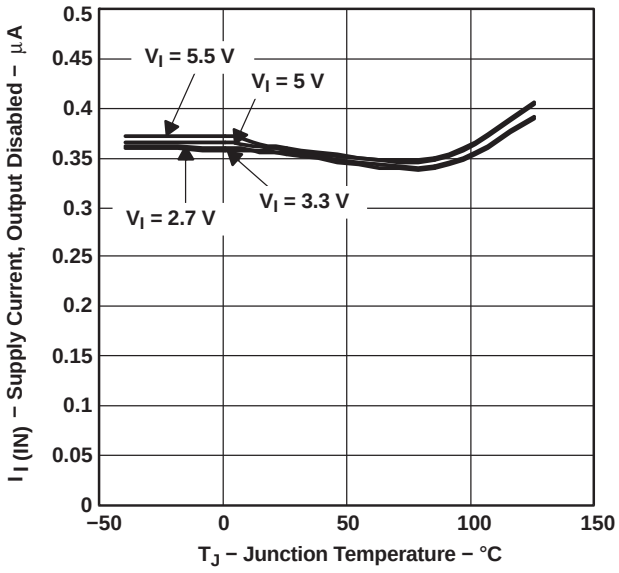


Figure 16.

TPS2065-Q1
SUPPLY CURRENT, OUTPUT DISABLED
vs
JUNCTION TEMPERATURE

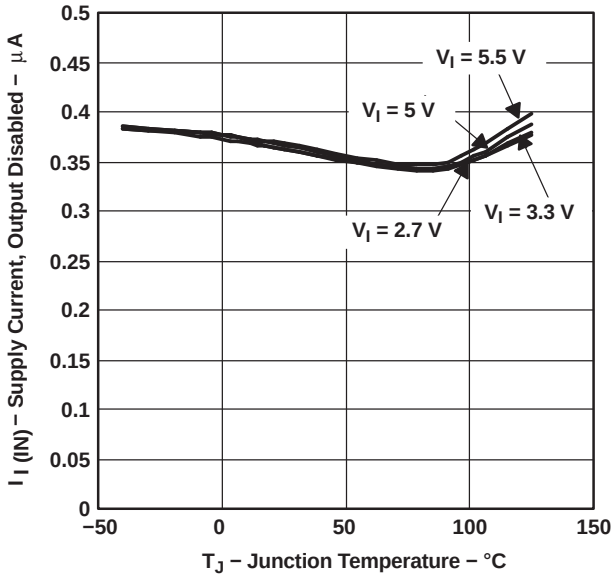


Figure 17.

STATIC DRAIN-SOURCE ON-STATE RESISTANCE
vs
JUNCTION TEMPERATURE

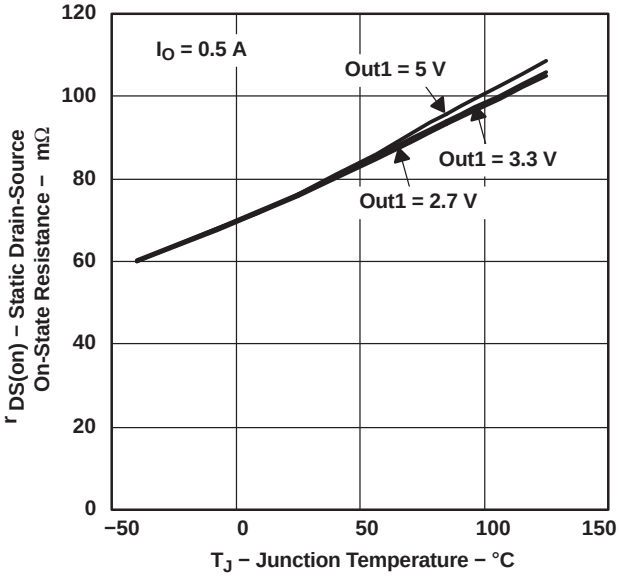


Figure 18.

SHORT-CIRCUIT OUTPUT CURRENT
vs
JUNCTION TEMPERATURE

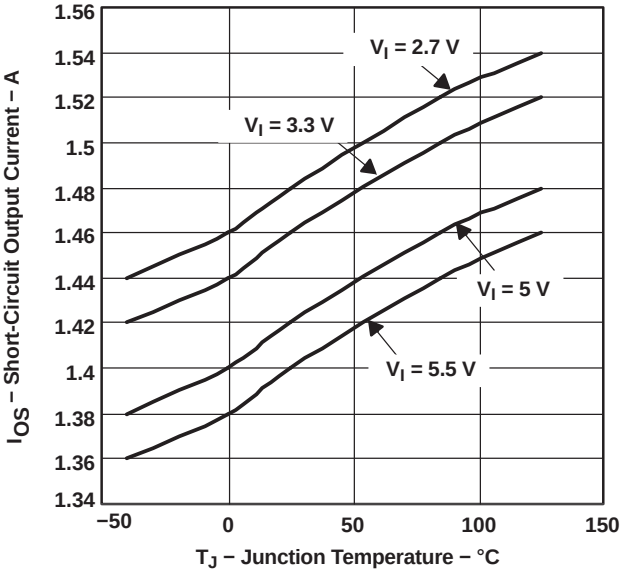


Figure 19.

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TYPICAL CHARACTERISTICS (continued)

THRESHOLD TRIP CURRENT vs INPUT VOLTAGE

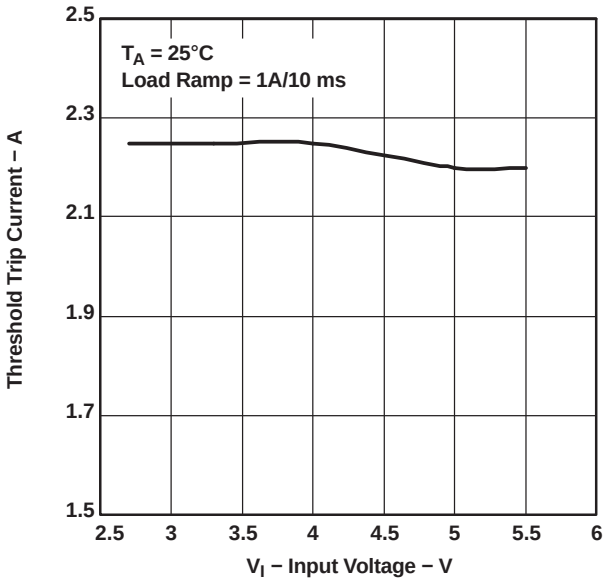


Figure 20.

UNDERVOLTAGE LOCKOUT vs JUNCTION TEMPERATURE

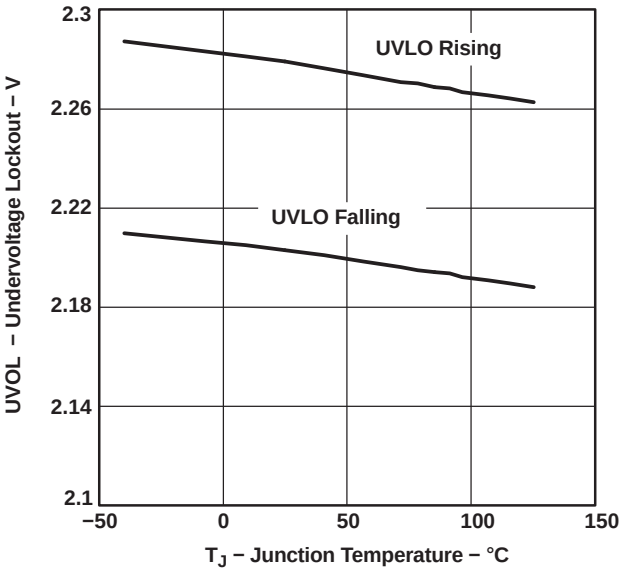


Figure 21.

CURRENT-LIMIT RESPONSE vs PEAK CURRENT

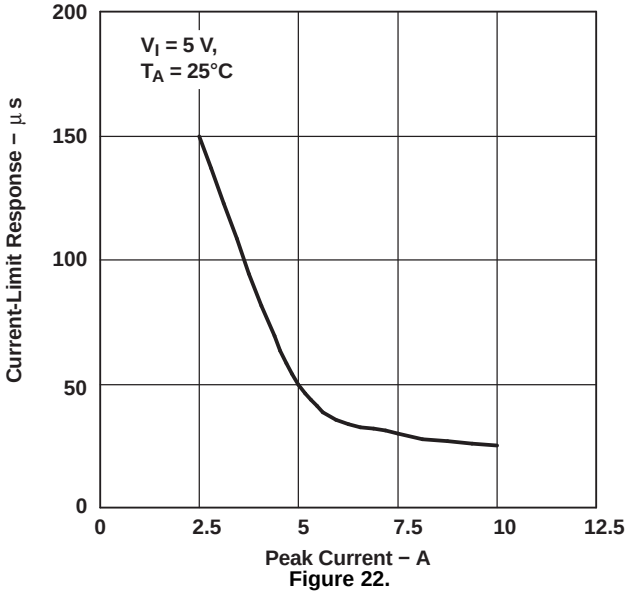


Figure 22.

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APPLICATION INFORMATION

POWER-SUPPLY CONSIDERATIONS

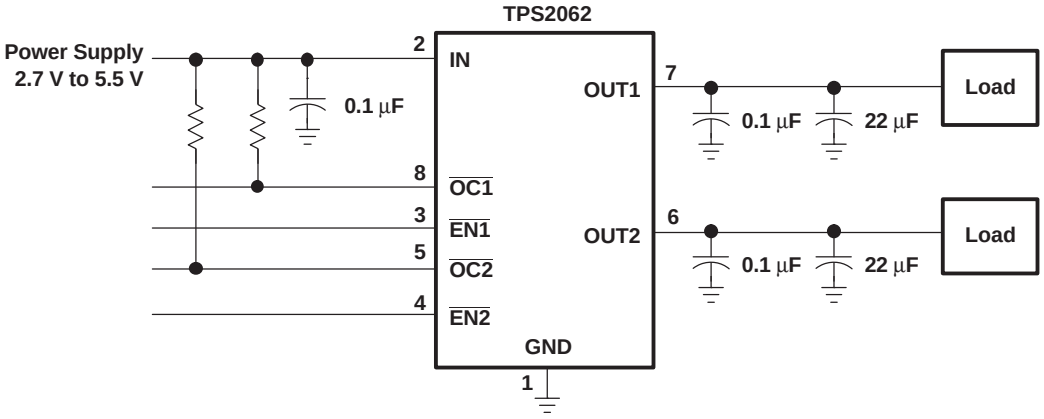


Figure 23. Typical Application

A 0.01-µF to 0.1-µF ceramic bypass capacitor between IN and GND, close to the device, is recommended. Placing a high-value electrolytic capacitor on the output pin(s) is recommended when the output load is heavy. This precaution reduces power-supply transients that may cause ringing on the input. Additionally, bypassing the output with a 0.01-µF to 0.1-µF ceramic capacitor improves the immunity of the device to short-circuit transients.

OVERCURRENT

A sense FET is employed to check for overcurrent conditions. Unlike current-sense resistors, sense FETs do not increase the series resistance of the current path. When an overcurrent condition is detected, the device maintains a constant output current and reduces the output voltage accordingly. Complete shutdown occurs only if the fault is present long enough to activate thermal limiting.

Three possible overload conditions can occur. In the first condition, the output has been shorted before the device is enabled or before $V_{I(IN)}$ has been applied (see Figure 14). The TPS206x-Q1 senses the short and immediately switches into a constant-current output.

In the second condition, a short or an overload occurs while the device is enabled. At the instant the overload occurs, high currents may flow for a short period of time before the current-limit circuit can react. After the current-limit circuit has tripped (reached the overcurrent trip threshold), the device switches into constant-current mode.

In the third condition, the load has been gradually increased beyond the recommended operating current. The current is permitted to rise until the current-limit threshold is reached or until the thermal limit of the device is exceeded (see Figure 16). The TPS2065-Q1 and TPS2062-Q1 are capable of delivering current up to the current-limit threshold without damaging the device. Once the threshold has been reached, the device switches into its constant-current mode.

$\overline{\text{OC}}$ RESPONSE

The $\overline{\text{OC}}$x open-drain output is asserted (active low) when an overcurrent or overtemperature shutdown condition is encountered after a 10-ms deglitch timeout. The output remains asserted until the overcurrent or overtemperature condition is removed. Connecting a heavy capacitive load to an enabled device can cause a momentary overcurrent condition; however, no false reporting on $\overline{\text{OC}}$x occurs due to the 10-ms deglitch circuit. The TPS2065-Q1 and TPS2062-Q1 are designed to eliminate false overcurrent reporting. The internal overcurrent deglitch eliminates the need for external components to remove unwanted pulses. $\overline{\text{OC}}$x is not deglitched when the switch is turned off due to an overtemperature shutdown.

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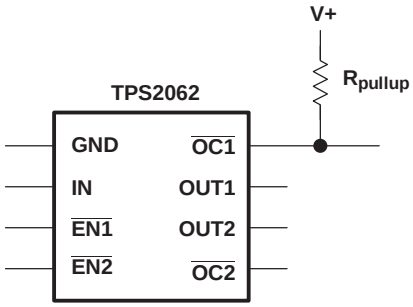


Figure 24. Typical Circuit for the $\overline{OC}$ Pin

POWER DISSIPATION AND JUNCTION TEMPERATURE

The low on-resistance on the N-channel MOSFET allows the small surface-mount packages to pass large currents. The thermal resistances of these packages are high compared to those of power packages; it is good design practice to check power dissipation and junction temperature. Begin by determining the $r_{DS(on)}$ of the N-channel MOSFET relative to the input voltage and operating temperature. As an initial estimate, use the highest operating ambient temperature of interest and read $r_{DS(on)}$ from Figure 18. Using this value, the power dissipation per switch can be calculated by:

- $P_D = r_{DS(on)} \times I^2$

Multiply this number by the number of switches being used. This step renders the total power dissipation from the N-channel MOSFETs.

The thermal resistance, $R\theta_{JA}$ = 1 / (DERATING FACTOR), where DERATING FACTOR is obtained from the Dissipation Ratings Table. Thermal resistance is a strong function of the printed circuit board construction , and the copper trace area connecting the integrated circuit.

Finally, calculate the junction temperature:

- $T_J = P_D \times R_{\theta JA} + T_A$

Where:

- T_A= Ambient temperature °C
- $R_{\theta JA}$ = Thermal resistance
- P_D = Total power dissipation based on number of switches being used.

Compare the calculated junction temperature with the initial estimate. If they do not agree within a few degrees, repeat the calculation, using the calculated value as the new estimate. Two or three iterations are generally sufficient to get a reasonable answer.

THERMAL PROTECTION

Thermal protection prevents damage to the IC when heavy-overload or short-circuit faults are present for extended periods of time. The TPS2065-Q1 and TPS2062-Q1 implement a thermal sensing to monitor the operating junction temperature of the power distribution switch. In an overcurrent or short-circuit condition, the junction temperature rises due to excessive power dissipation. Once the die temperature rises above a minimum of 135°C due to overcurrent conditions, the internal thermal sense circuitry turns the power switch off, thus preventing the power switch from damage. Hysteresis is built into the thermal sense circuit, and after the device has cooled approximately 10°C, the switch turns back on. The switch continues to cycle in this manner until the load fault or input power is removed. The $\overline{OCx}$ open-drain output is asserted (active low) when an overtemperature shutdown or overcurrent occurs.

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UNDERVOLTAGE LOCKOUT (UVLO)

An undervoltage lockout ensures that the power switch is in the off state at power up. Whenever the input voltage falls below approximately 2 V, the power switch is quickly turned off. This facilitates the design of hot-insertion systems where it is not possible to turn off the power switch before input power is removed. The UVLO also keeps the switch from being turned on until the power supply has reached at least 2 V, even if the switch is enabled. On reinsertion, the power switch is turned on, with a controlled rise time to reduce EMI and voltage overshoots.

UNIVERSAL SERIAL BUS (USB) APPLICATIONS

The universal serial bus (USB) interface is a 12-Mb/s, or 1.5-Mb/s, multiplexed serial bus designed for low-to-medium bandwidth PC peripherals (e.g., keyboards, printers, scanners, and mice). The four-wire USB interface is conceived for dynamic attach-detach (hot plug-unplug) of peripherals. Two lines are provided for differential data, and two lines are provided for 5-V power distribution.

USB data is a 3.3-V level signal, but power is distributed at 5 V to allow for voltage drops in cases where power is distributed through more than one hub across long cables. Each function must provide its own regulated 3.3 V from the 5-V input or its own internal power supply.

The USB specification defines the following five classes of devices, each differentiated by power-consumption requirements:

- Hosts/self-powered hubs (SPH)
- Bus-powered hubs (BPH)
- Low-power, bus-powered functions
- High-power, bus-powered functions
- Self-powered functions

SPHs and BPHs distribute data and power to downstream functions. The TPS2065-Q1 and TPS2062-Q1 have higher current capability than required by one USB port; so, it can be used on the host side and supplies power to multiple downstream ports or functions.

HOST/SELF-POWERED AND BUS-POWERED HUBS

Hosts and SPHs have a local power supply that powers the embedded functions and the downstream ports (see Figure 25). This power supply must provide from 5.25 V to 4.75 V to the board side of the downstream connection under full-load and no-load conditions. Hosts and SPHs are required to have current-limit protection and must report overcurrent conditions to the USB controller. Typical SPHs are desktop PCs, monitors, printers, and stand-alone hubs.

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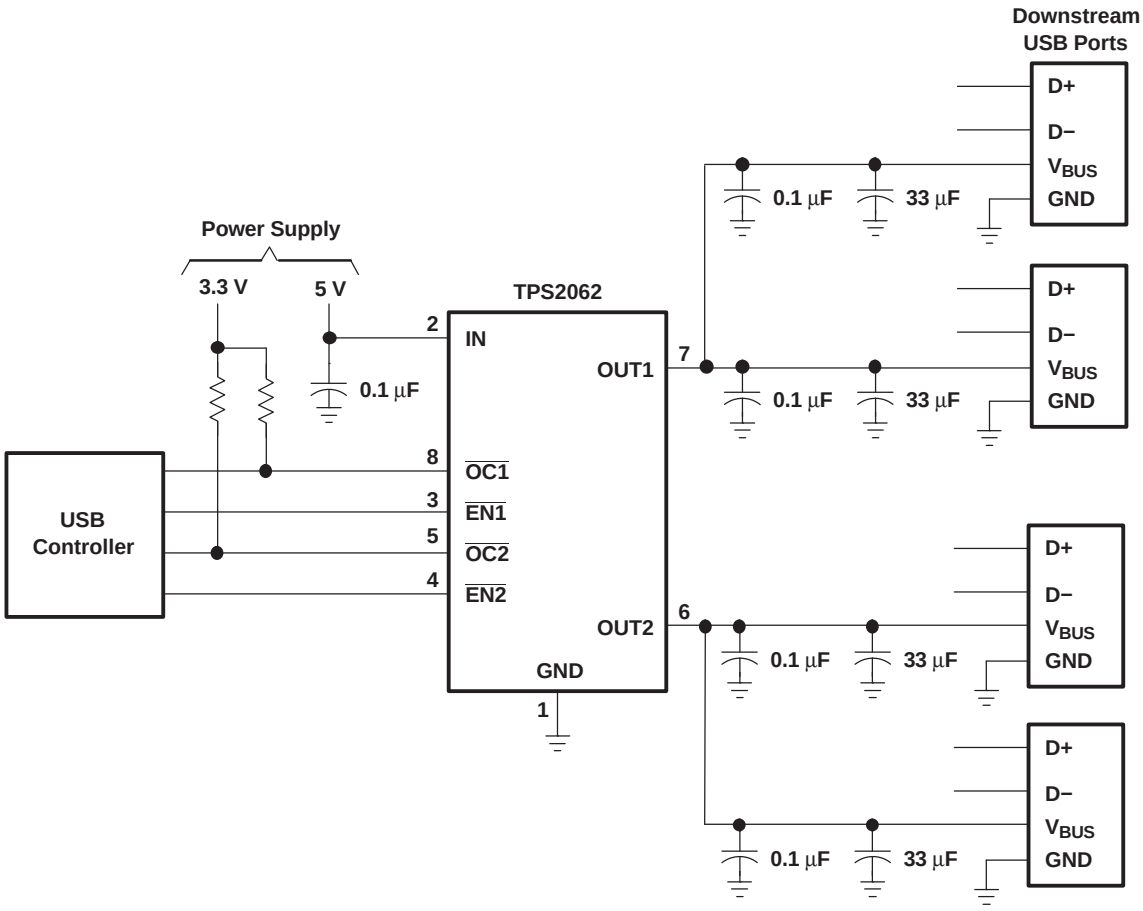


Figure 25. Typical Four-Port USB Host / Self-Powered Hub

BPHs obtain all power from upstream ports and often contain an embedded function. The hubs are required to power up with less than one unit load. The BPH usually has one embedded function, and power is always available to the controller of the hub. If the embedded function and hub require more than 100 mA on power up, the power to the embedded function may need to be kept off until enumeration is completed. This can be accomplished by removing power or by shutting off the clock to the embedded function. Power switching the embedded function is not necessary if the aggregate power draw for the function and controller is less than one unit load. The total current drawn by the bus-powered device is the sum of the current to the controller, the embedded function, and the downstream ports, and it is limited to 500 mA from an upstream port.

LOW-POWER BUS-POWERED AND HIGH-POWER BUS-POWERED FUNCTIONS

Both low-power and high-power bus-powered functions obtain all power from upstream ports; low-power functions always draw less than 100 mA; high-power functions must draw less than 100 mA at power up and can draw up to 500 mA after enumeration. If the load of the function is more than the parallel combination of 44 Ω and 10 µF at power up, the device must implement inrush current limiting (see Figure 26). With TPS2065-Q1 and TPS2062-Q1, the internal functions could draw more than 500 mA, which fits the needs of some applications such as motor driving circuits.

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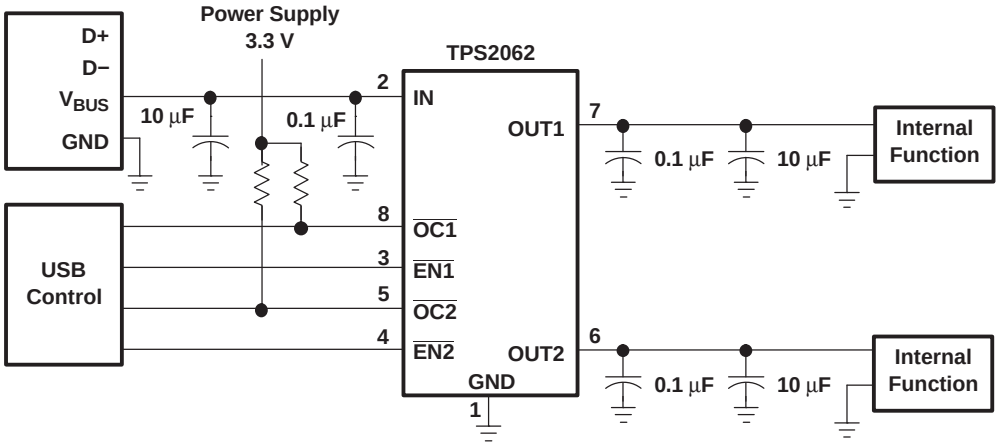


Figure 26. High-Power Bus-Powered Function

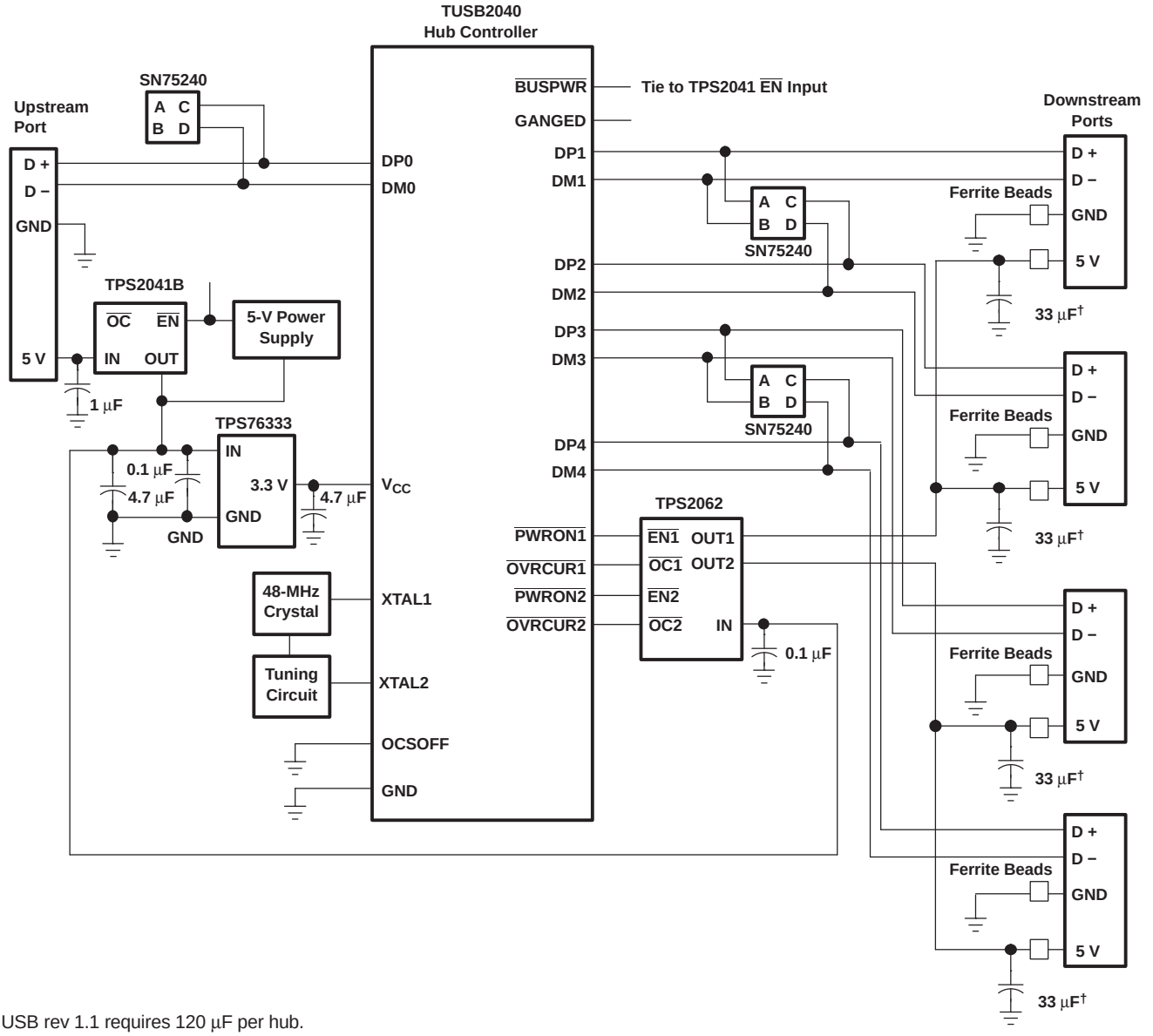
USB POWER-DISTRIBUTION REQUIREMENTS

USB can be implemented in several ways, and, regardless of the type of USB device being developed, several power-distribution features must be implemented.

- Hosts/SPHs must:
  - Current-limit downstream ports
  - Report overcurrent conditions on USB V_{BUS}
- BPHs must:
  - Enable/disable power to downstream ports
  - Power up at <100 mA
  - Limit inrush current (<44 Ω and 10 µF)
- Functions must:
  - Limit inrush currents
  - Power up at <100 mA

The feature set of the TPS2065-Q1 and TPS2062-Q1 allows them to meet each of these requirements. The integrated current-limiting and overcurrent reporting is required by hosts and self-powered hubs. The logic-level enable and controlled rise times meet the need of both input and output ports on bus-powered hubs, as well as the input ports for bus-powered functions (see Figure 27).

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† USB rev 1.1 requires 120 μF per hub.

Figure 27. Hybrid Self / Bus-Powered Hub Implementation

GENERIC HOT-PLUG APPLICATIONS

In many applications it may be necessary to remove modules or pc boards while the main unit is still operating. These are considered hot-plug applications. Such implementations require the control of current surges seen by the main power supply and the card being inserted. The most effective way to control these surges is to limit and slowly ramp the current and voltage being applied to the card, similar to the way in which a power supply normally turns on. Due to the controlled rise times and fall times of the TPS2065-Q1 and TPS2062-Q1, these devices can be used to provide a softer start-up to devices being hot-plugged into a powered system. The UVLO feature of the TPS2065-Q1 and TPS2062-Q1 ensures that the switch is off after the card has been removed, and that the switch is off during the next insertion. The UVLO feature insures a soft start with a controlled rise time for every insertion of the card or module.

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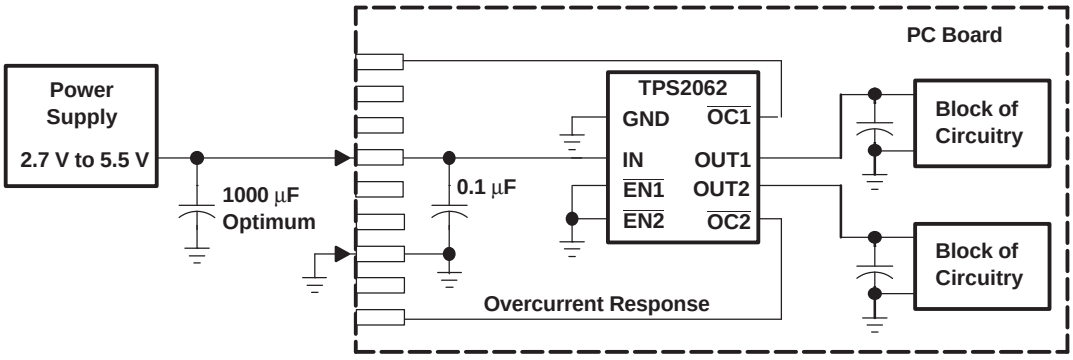


Figure 28. Typical Hot-Plug Implementation

By placing the TPS2065-Q1 and TPS2062-Q1 are between the V_{CC} input and the rest of the circuitry, the input power reaches these devices first after insertion. The typical rise time of the switch is approximately 1 ms, providing a slow voltage ramp at the output of the device. This implementation controls system surge currents and provides a hot-plugging mechanism for any device.

DETAILED DESCRIPTION

Power Switch

The power switch is an N-channel MOSFET with a low on-state resistance. Configured as a high-side switch, the power switch prevents current flow from OUT to IN and IN to OUT when disabled. The power switch supplies a minimum current of 1 A.

Charge Pump

An internal charge pump supplies power to the driver circuit and provides the necessary voltage to pull the gate of the MOSFET above the source. The charge pump operates from input voltages as low as 2.7 V and requires little supply current.

Driver

The driver controls the gate voltage of the power switch. To limit large current surges and reduce the associated electromagnetic interference (EMI) produced, the driver incorporates circuitry that controls the rise times and fall times of the output voltage.

Enable ($\overline{ENx}$)

The logic enable disables the power switch and the bias for the charge pump, driver, and other circuitry to reduce the supply current. The supply current is reduced to less than 1 µA when a logic high is present on $\overline{ENx}$. A logic zero input on $\overline{ENx}$ restores bias to the drive and control circuits and turns the switch on. The enable input is compatible with both TTL and CMOS logic levels.

Overcurrent ($\overline{OCx}$)

The $\overline{OCx}$ open-drain output is asserted (active low) when an overcurrent or overtemperature condition is encountered. The output remains asserted until the overcurrent or overtemperature condition is removed. A 10-ms deglitch circuit prevents the $\overline{OCx}$ signal from oscillation or false triggering. If an overtemperature shutdown occurs, the $\overline{OCx}$ is asserted instantaneously.

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Current Sense

A sense FET monitors the current supplied to the load. The sense FET measures current more efficiently than conventional resistance methods. When an overload or short circuit is encountered, the current-sense circuitry sends a control signal to the driver. The driver in turn reduces the gate voltage and drives the power FET into its saturation region, which switches the output into a constant-current mode and holds the current constant while varying the voltage on the load.

Thermal Sense

The TPS2065-Q1 and TPS2062-Q1 implement a thermal sensing to monitor the operating temperature of the power distribution switch. In an overcurrent or short-circuit condition the junction temperature rises. When the die temperature rises to approximately 140°C due to overcurrent conditions, the internal thermal sense circuitry turns off the switch, thus preventing the device from damage. Hysteresis is built into the thermal sense, and after the device has cooled approximately 10 degrees, the switch turns back on. The switch continues to cycle off and on until the fault is removed. The open-drain false reporting output ($\overline{OCx}$) is asserted (active low) when an overtemperature shutdown or overcurrent occurs.

Undervoltage Lockout

A voltage sense circuit monitors the input voltage. When the input voltage is below approximately 2 V, a control signal turns off the power switch.

REVISION HISTORY

Changes from Revision A (November 2011) to Revision B **Page**

- 经更改的包括使能 (EN) 引脚的引脚分配图。 1
- Added or EN to Electrical Characteristics table. 3

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PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead finish/ Ball material (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
TPS2062QDGNRQ1	ACTIVE	HVSSOP	DGN	8	2500	RoHS & Green	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	PSOQ	Samples
TPS2065QDGNRQ1	ACTIVE	HVSSOP	DGN	8	2500	RoHS & Green	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	PTLQ	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.

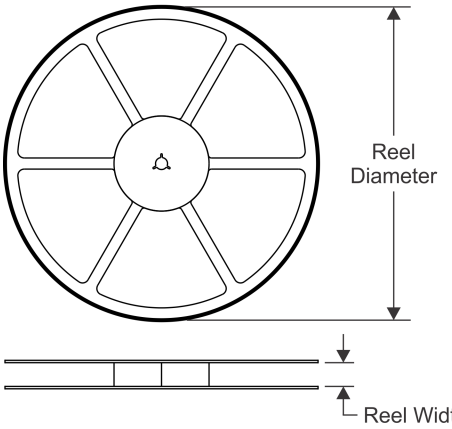
(6) Lead finish/Ball material - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

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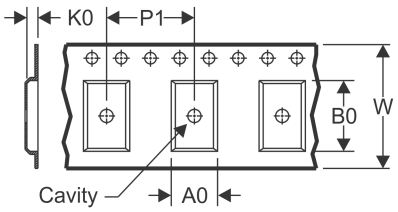
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TAPE AND REEL INFORMATION

REEL DIMENSIONS

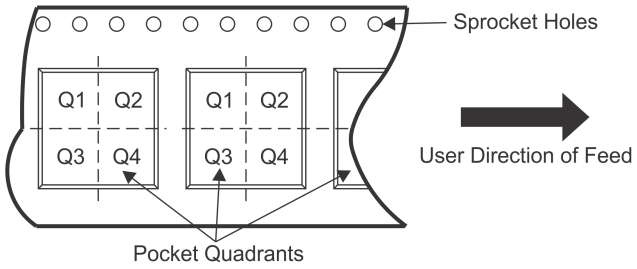


TAPE DIMENSIONS



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

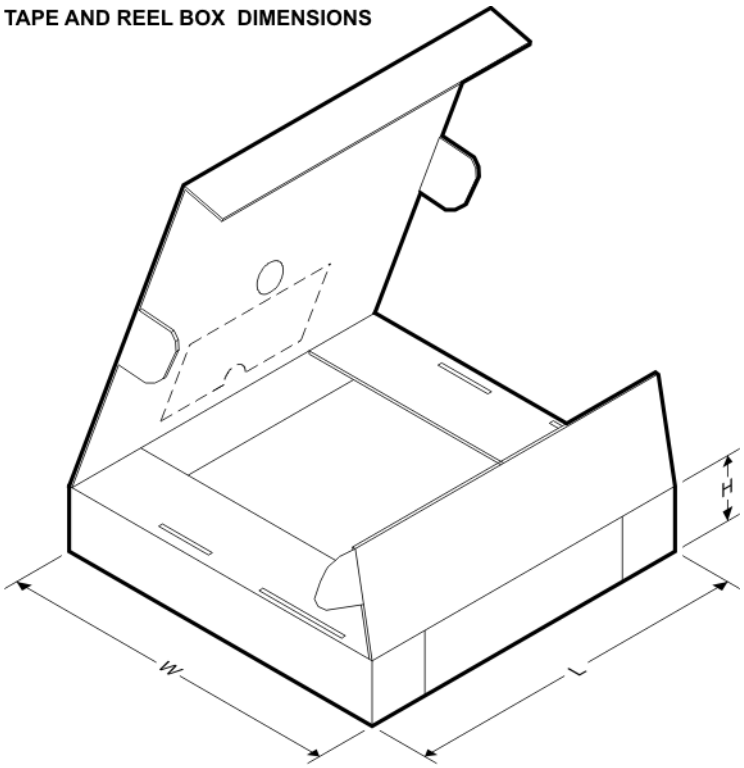
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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
TPS2062QDGNRQ1	HVSSOP	DGN	8	2500	330.0	12.4	5.3	3.3	1.3	8.0	12.0	Q1
TPS2065QDGNRQ1	HVSSOP	DGN	8	2500	330.0	12.4	5.3	3.3	1.3	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)
TPS2062QDGNRQ1	HVSSOP	DGN	8	2500	367.0	367.0	38.0
TPS2065QDGNRQ1	HVSSOP	DGN	8	2500	367.0	367.0	38.0

GENERIC PACKAGE VIEW

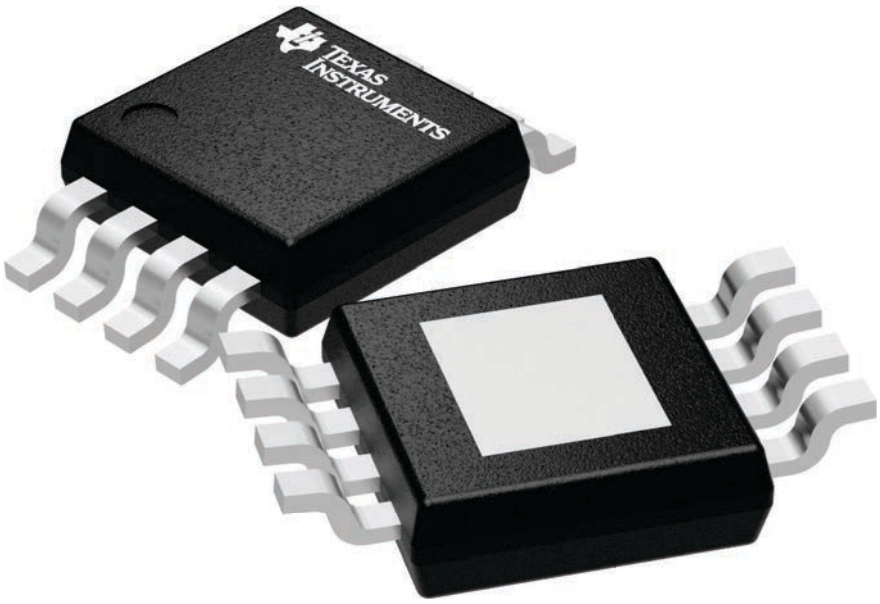
DGN 8

PowerPAD VSSOP - 1.1 mm max height

3 x 3, 0.65 mm pitch

SMALL OUTLINE PACKAGE

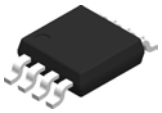
This image is a representation of the package family, actual package may vary.
Refer to the product data sheet for package details.



4225482/A

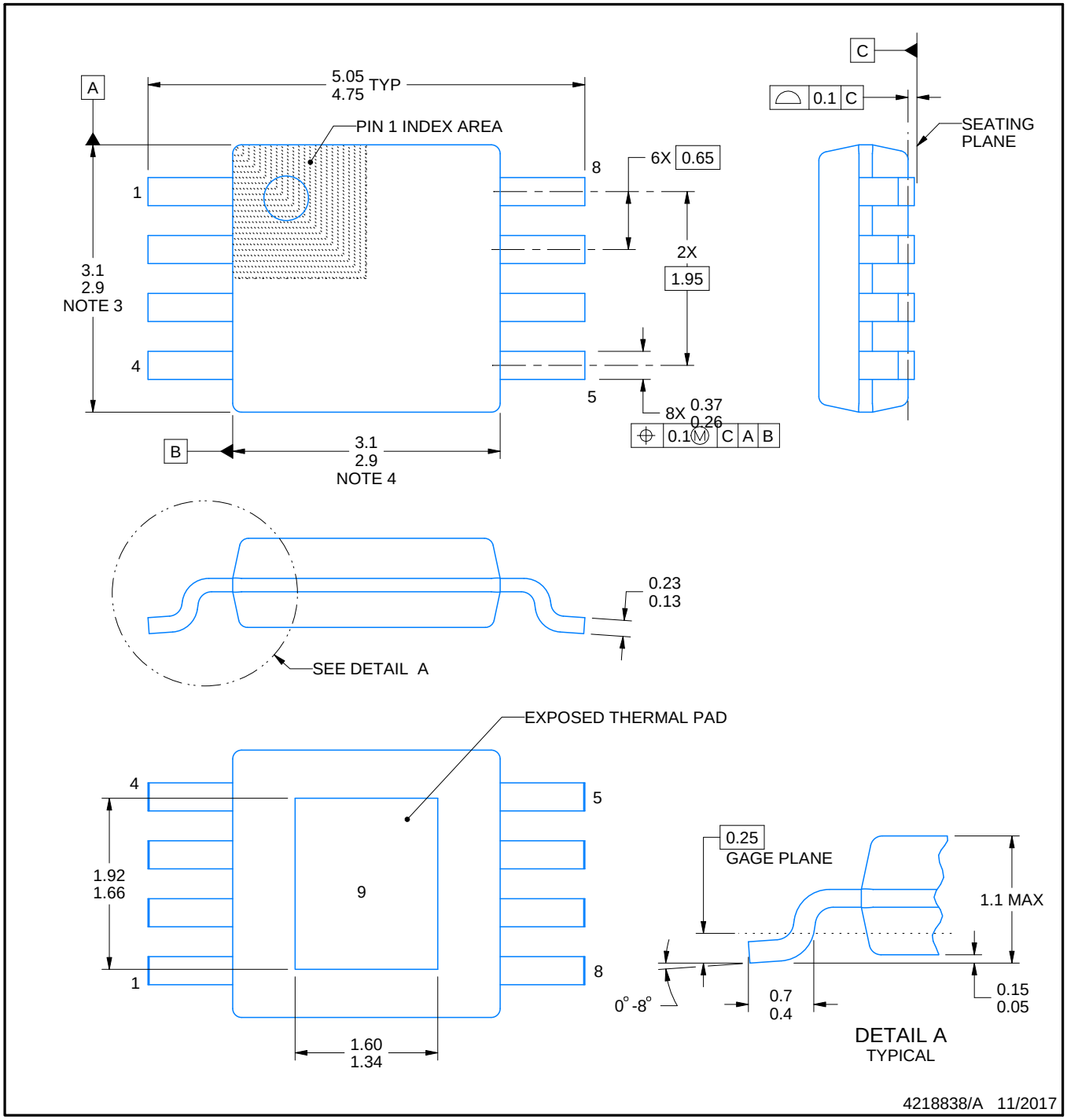
PACKAGE OUTLINE

DGN0008C



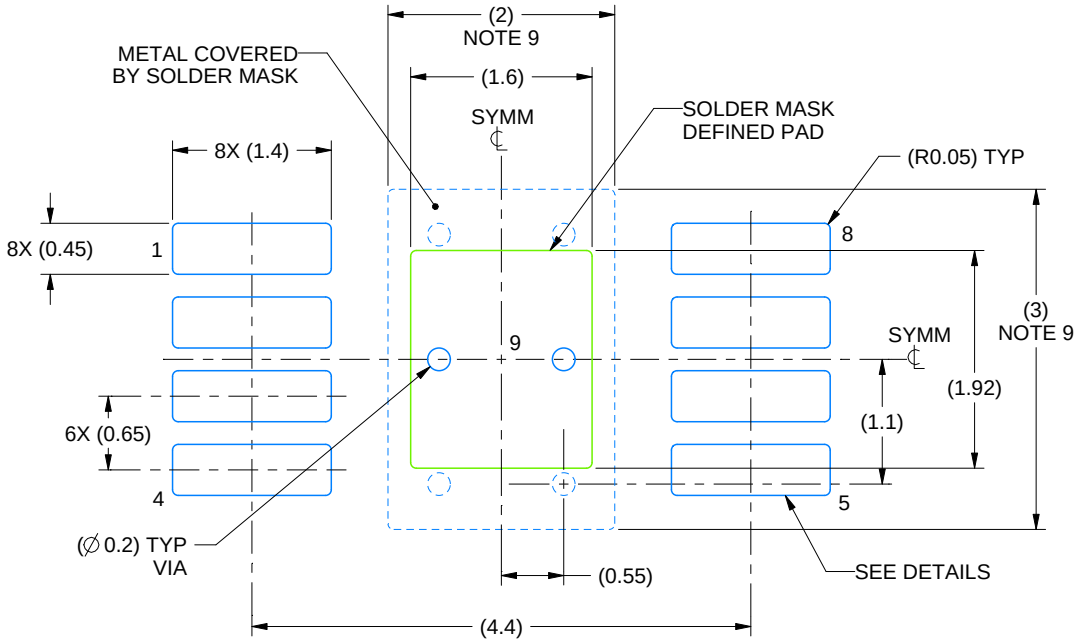
HVSSOP - 1.1 mm max height

SMALL OUTLINE PACKAGE

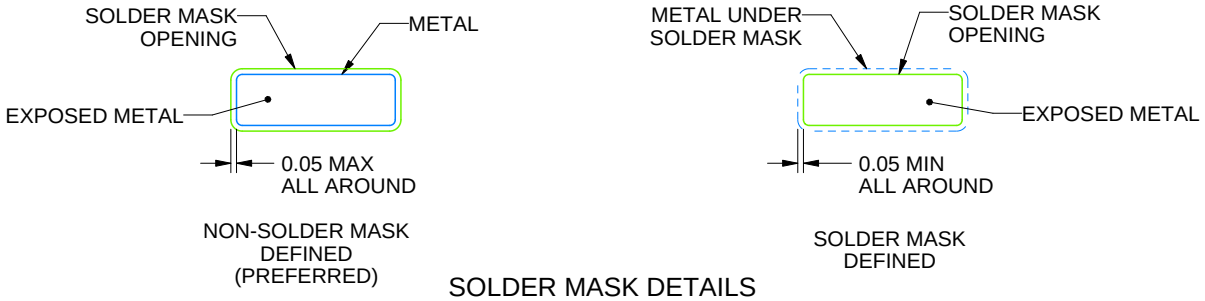


NOTES:

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. This dimension does not include interlead flash. Interlead flash shall not exceed 0.25 mm per side.
5. Reference JEDEC registration MO-187.



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE: 15X

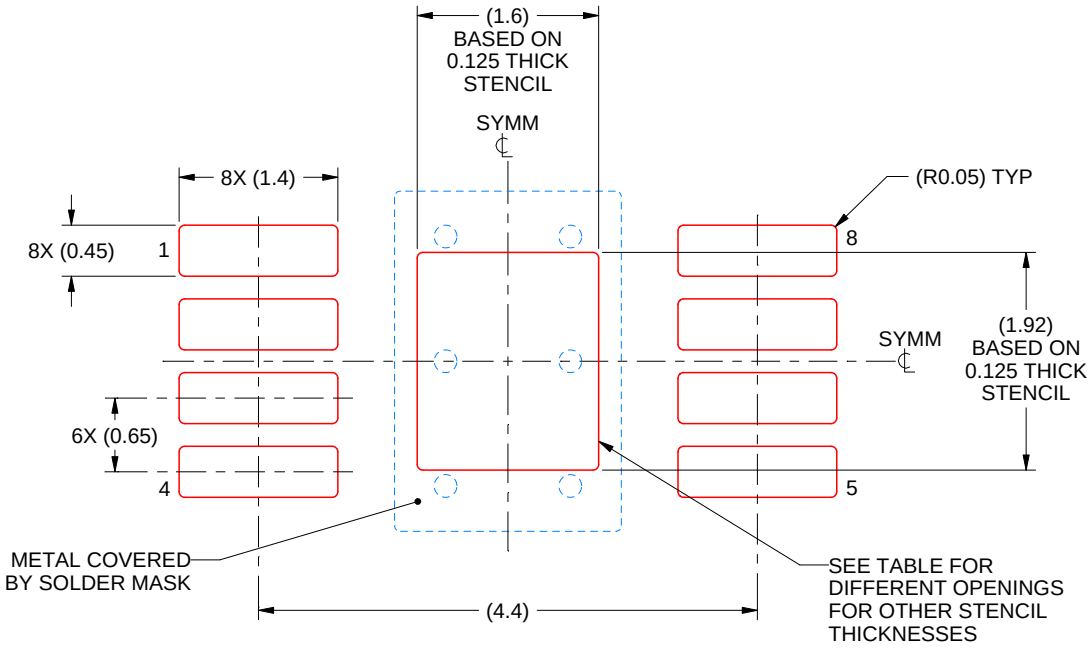


SOLDER MASK DETAILS

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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. 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.
9. Size of metal pad may vary due to creepage requirement.



SOLDER PASTE EXAMPLE
EXPOSED PAD 9:
100% PRINTED SOLDER COVERAGE BY AREA
SCALE: 15X

STENCIL THICKNESS	SOLDER STENCIL OPENING
0.1	1.79 X 2.15
0.125	1.60 X 1.92 (SHOWN)
0.15	1.46 X 1.75
0.175	1.35 X 1.62

4218838/A 11/2017

NOTES: (continued)

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

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