

## UCC27200-Q1 具有 8V UVLO 功能的汽车级 120V、3A/3A 半桥驱动器

### 1 特性

- 符合面向汽车应用的 AEC-Q100 标准：器件温度等级 1
- $-40^{\circ}\text{C}$  至  $+150^{\circ}\text{C}$  的结温范围
- 可驱动两个采用高侧和低侧配置的 N 沟道 MOSFET
- 最大引导电压：120V
- 最大  $V_{DD}$  电压：20V
- 片上  $0.65\text{V } V_F$ 、 $0.65\ \Omega R_D$  自举二极管
- 22ns 传播延迟时间
- 3A 灌电流，3A 拉电流输出
- 1000pF 负载时上升时间为 8ns，下降时间为 7ns
- 1ns 延迟匹配

### 2 应用

- 汽车直流/直流转换器和 OBC
- 两轮车/三轮车牵引驱动器和电池包
- 电动助力转向 (EPS)
- 无线充电
- 智能玻璃模块

### 3 说明

UCC27200-Q1 高频 N 沟道 MOSFET 驱动器由 120V 自举二极管和高侧/低侧驱动器组成，其中高侧/低侧驱动器配有独立输入，可最大限度提高控制灵活性。这可在半桥转换器、全桥转换器、双开关正激转换器和有源钳位正激转换器中实现 N 沟道 MOSFET 控制。低侧和高侧栅极驱动器是独立控制的，并在彼此的接通和关断之间实现了 1ns 的延迟匹配。

由于在芯片上集成了一个自举二极管，因此无需采用外部分立式二极管。高侧和低侧驱动器均配有欠压锁定功能，如果驱动电压低于规定的阈值，则强制将输出置为低电平。

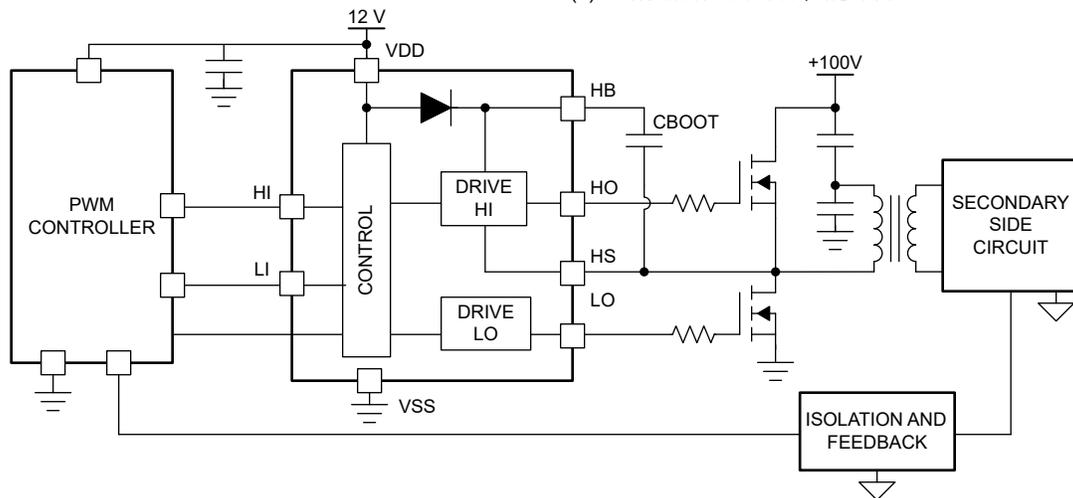
UCC27200-Q1 具有高抗噪 CMOS 输入阈值。

该器件采用 8 引脚 SO PowerPAD™ (DDA) 封装。

#### 器件信息

器件型号	封装 <sup>(1)</sup>	本体尺寸 (标称值)
UCC27200-Q1	DDA ( PowerPAD™ SOIC , 8 )	4.9mm × 3.9mm

(1) 有关所有可用封装，请参阅节 12。



简化版应用示意图



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## 4 Pin Configuration and Functions

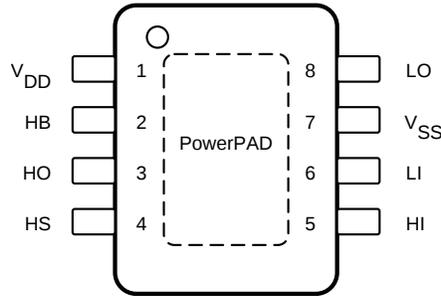


图 4-1. DDA Package 8-Pin SO With PowerPAD Top View

表 4-1. Pin Functions

PIN		TYPE <sup>(1)</sup>	DESCRIPTION
NO.	NAME		
1	V <sub>DD</sub>	P	Positive supply to the lower gate driver. Decouple this pin to V <sub>SS</sub> (GND). Typical decoupling capacitor range is 0.22 $\mu$ F to 1 $\mu$ F.
2	HB	I	High-side bootstrap supply. The bootstrap diode is on-chip, but the external bootstrap capacitor is required. Connect positive side of the bootstrap capacitor to this pin. Typical range of HB bypass capacitor is 0.022 $\mu$ F to 0.1 $\mu$ F, however, the value is dependant on the gate charge of the high-side MOSFET.
3	HO	O	High-side output. Connect to the gate of the high-side power MOSFET.
4	HS	I	High-side source connection. Connect to source of high-side power MOSFET. Connect negative side of bootstrap capacitor to this pin.
5	HI	I	High-side input
6	LI	I	Low-side input
7	V <sub>SS</sub>	O	Negative supply terminal for the device which is generally grounded
8	LO	—	Low-side output. Connect to the gate of the low-side power MOSFET.
PowerPAD™ (2)	PowerPAD™	—	Electrically referenced to V <sub>SS</sub> (GND). Connect to a large thermal mass trace or GND plane to dramatically improve thermal performance.

- (1) I = Input, O = Output, P = Power
- (2) The thermal pad is not directly connected to any leads of the package; however, it is electrically and thermally connected to the substrate which is the ground of the device.

## 5 Specifications

### 5.1 Absolute Maximum Ratings

Over operating free-air temperature range and all voltages are with respect to  $V_{SS}$  (unless otherwise noted).<sup>(1)</sup>

		MIN	MAX	UNIT
$V_{DD}$	Supply voltage	- 0.3	20	V
$V_{HI}, V_{LI}$	Input voltages on HI and LI	- 0.3	20	V
$V_{LO}$	Output voltage on LO	DC	$V_{DD} + 0.3$	V
		Repetitive pulse < 100 ns <sup>(2)</sup>	$V_{DD} + 0.3$	
$V_{HO}$	Output voltage on HO	DC	$V_{HS} - 0.3$	V
		Repetitive pulse < 100 ns <sup>(2)</sup>	$V_{HS} - 2$	
$V_{HS}$	Voltage on HS	DC	120	V
		Repetitive pulse < 100 ns <sup>(2)</sup>	- 5	
$V_{HB}$	Voltage on HB	- 0.3	120	V
	Voltage on HB-HS	- 0.3	20	V
$T_J$	Operating junction temperature	- 40	150	°C
$T_{stg}$	Storage temperature	- 65	150	°C

- (1) Operation outside the *Absolute Maximum Ratings* may cause permanent device damage. *Absolute Maximum Ratings* do not imply functional operation of the device at these or any other conditions beyond those listed under *Recommended Operating Conditions*. If used outside the *Recommended Operating Conditions* but within the *Absolute Maximum Ratings*, the device may not be fully functional, and this may affect device reliability, functionality, performance, and shorten the device lifetime.
- (2) Values are verified by characterization and are not production tested.

### 5.2 ESD Ratings

		VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human-body model (HBM), per AEC Q100-002 <sup>(1)</sup>	±2000
		Charged-device model (CDM), per AEC Q100-011	±1000

- (1) AEC Q100-002 indicates that HBM stressing shall be in accordance with the ANSI/ESDA/JEDEC JS-001 specification.

### 5.3 Recommended Operating Conditions

Over operating free-air temperature range and all voltages are with respect to  $V_{SS}$  (unless otherwise noted).

		MIN	NOM	MAX	UNIT
$V_{DD}$	Supply voltage	8	12	17	V
$V_{HS}$	Voltage on HS	- 1		105	V
	Voltage on HS (repetitive pulse < 100 ns) <sup>(1)</sup>	- 5		110	
$V_{HB}$	Voltage on HB	$V_{HS} + 8.0, V_{DD} - 1$		$V_{HS} + 17, 115$	
$SR_{HS}$	Voltage slew rate on HS			50	V/ns
$T_J$	Operating junction temperature	- 40		150	°C

- (1) Values are verified by characterization and are not production tested.

### 5.4 Thermal Information

THERMAL METRIC <sup>(1)</sup>		UCC27200-Q1	
		DDA (PowerPad™ SOIC)	
		8 Pins	
			UNIT
$R_{\theta JA}$	Junction-to-ambient thermal resistance	44.8	°C/W
$R_{\theta JC(top)}$	Junction-to-case (top) thermal resistance	68.5	°C/W
$R_{\theta JB}$	Junction-to-board thermal resistance	20	°C/W

## 5.4 Thermal Information (续)

THERMAL METRIC <sup>(1)</sup>		UCC27200-Q1	UNIT
		DDA (PowerPad™ SOIC)	
		8 Pins	
$\psi_{JT}$	Junction-to-top characterization parameter	6.9	°C/W
$\psi_{JB}$	Junction-to-board characterization parameter	20	°C/W
$R_{\theta JC(bot)}$	Junction-to-case (bottom) thermal resistance	8.4	°C/W

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

## 5.5 Electrical Characteristics

$V_{DD} = V_{HB} = 12\text{ V}$ ,  $V_{HS} = V_{SS} = 0\text{ V}$ , No load on LO or HO,  $T_A = T_J = -40^\circ\text{C}$  to  $+150^\circ\text{C}$  (unless otherwise noted).

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
<b>SUPPLY CURRENTS</b>						
$I_{DD}$	VDD quiescent current	$V_{LI} = V_{HI} = 0\text{ V}$		0.11	0.8	mA
$I_{DDO}$	VDD operating current	$f = 500\text{ kHz}$ , $C_{LOAD} = 0$		1	3	mA
$I_{HB}$	Boot voltage quiescent current	$V_{LI} = V_{HI} = 0\text{ V}$		0.065	0.8	mA
$I_{HBO}$	Boot voltage operating current	$f = 500\text{ kHz}$ , $C_{LOAD} = 0$		0.9	3	mA
$I_{HBS}$	HB to VSS quiescent current	$V_{HS} = V_{HB} = 105\text{ V}$		0.0005	1	$\mu\text{A}$
$I_{HBSO}$	HB to VSS operating current	$f = 500\text{ kHz}$ , $C_{LOAD} = 0$		0.03		mA
<b>INPUT</b>						
$V_{HIT}$	Input voltage high threshold			6	8	V
$V_{LIT}$	Input voltage low threshold		3	5.6		V
$V_{IHYS}$	Input voltage hysteresis			0.4		V
$R_{IN}$	Input pull-down resistance	$V_{IN} = 3\text{ V}$	100	200	350	k $\Omega$
<b>UNDERVOLTAGE PROTECTION (UVLO)</b>						
$V_{DDR}$	VDD rising threshold		6.2	7.1	7.8	V
$V_{DDHYS}$	VDD threshold hysteresis			0.5		V
$V_{HBR}$	VHB rising threshold		5.8	6.7	7.2	V
$V_{HBHYS}$	VHB threshold hysteresis			0.4		V
<b>BOOTSTRAP DIODE</b>						
$V_F$	Low-current forward voltage	$I_{VDD-HB} = 100\ \mu\text{A}$		0.65	0.85	V
$V_{FI}$	High-current forward voltage	$I_{VDD-HB} = 100\text{ mA}$		0.85	1.1	V
$R_D$	Dynamic resistance, $\Delta V_F / \Delta I$	$I_{VDD-HB} = 120\text{ mA}$ and $100\text{ mA}$		0.65	1	$\Omega$
<b>LO GATE DRIVER</b>						
$V_{LOL}$	Low level output voltage	$I_{LO} = 100\text{ mA}$		0.1	0.4	V
$V_{LOH}$	High level output voltage	$I_{LO} = -100\text{ mA}$ , $V_{LOH} = V_{DD} - V_{LO}$		0.13	0.42	V
	Peak pullup current <sup>(1)</sup>	$V_{LO} = 0\text{ V}$		3		A
	Peak pulldown current <sup>(1)</sup>	$V_{LO} = 12\text{ V}$		3		A
<b>HO GATE DRIVER</b>						
$V_{HOL}$	Low level output voltage	$I_{HO} = 100\text{ mA}$		0.1	0.4	V
$V_{HOH}$	High level output voltage	$I_{HO} = -100\text{ mA}$ , $V_{HOH} = V_{HB} - V_{HO}$		0.13	0.42	V
	Peak pullup current <sup>(1)</sup>	$V_{HO} = 0\text{ V}$		3		A
	Peak pulldown current <sup>(1)</sup>	$V_{HO} = 12\text{ V}$		3		A

(1) Parameter not tested in production.

## 5.6 Switching Characteristics

$V_{DD} = V_{HB} = 12\text{ V}$ ,  $V_{HS} = V_{SS} = 0\text{ V}$ , No load on LO or HO,  $T_A = T_J = -40^\circ\text{C}$  to  $+150^\circ\text{C}$  (unless otherwise noted).

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
<b>PROPAGATION DELAYS</b>						
$t_{DLFF}$	VLI falling to VLO falling	$C_{LOAD} = 0\text{ pF}$ , from $V_{LIT}$ of LI to 90% of LO falling		22	50	ns
$t_{DHFF}$	VHI falling to VHO falling	$C_{LOAD} = 0\text{ pF}$ , from $V_{HIT}$ of HI to 90% of HO falling		22	50	ns
$t_{DLRR}$	VLI rising to VLO rising	$C_{LOAD} = 0\text{ pF}$ , from $V_{HIT}$ of LI to 10% of LO rising		22	50	ns
$t_{DHRR}$	VHI rising to VHO rising	$C_{LOAD} = 0\text{ pF}$ , from $V_{HIT}$ of HI to 10% of HO rising		22	50	ns
<b>DELAY MATCHING</b>						
$t_{MON}$	LI ON, HI OFF			1	7	ns
$t_{MOFF}$	LI OFF, HI ON			1	7	ns
<b>OUTPUT RISE AND FALL TIME</b>						
$t_{R\_LO}$	LO rise time	$C_{LOAD} = 1000\text{ pF}$ , from 10% to 90%		8		ns
$t_{R\_HO}$	HO rise time	$C_{LOAD} = 1000\text{ pF}$ , from 10% to 90%		8		ns
$t_{F\_LO}$	LO fall time	$C_{LOAD} = 1000\text{ pF}$ , from 10% to 90%		7		ns
$t_{F\_HO}$	HO fall time	$C_{LOAD} = 1000\text{ pF}$ , from 10% to 90%		7		ns
$t_{R\_LO\_p1}$	LO rise time (3 V to 9 V)	$C_{LOAD} = 0.1\ \mu\text{F}$ , (3V to 9V)		0.26	0.6	$\mu\text{s}$
$t_{R\_HO\_p1}$	HO rise time (3 V to 9 V)	$C_{LOAD} = 0.1\ \mu\text{F}$ , (3V to 9V)		0.26	0.6	$\mu\text{s}$
$t_{F\_LO\_p1}$	LO fall time (9 V to 3 V)	$C_{LOAD} = 0.1\ \mu\text{F}$ , (9V to 3V)		0.22	0.6	$\mu\text{s}$
$t_{F\_HO\_p1}$	HO fall time (9 V to 3 V)	$C_{LOAD} = 0.1\ \mu\text{F}$ , (9V to 3V)		0.22	0.6	$\mu\text{s}$
<b>MISCELLANEOUS</b>						
$t_{IN\_PW}$	Minimum input pulse width that changes the output LO				50	ns
$t_{IN\_PW}$	Minimum input pulse width that changes the output HO				50	ns
$t_{OFF\_BSD}$	Bootstrap diode turnoff time <sup>(1) (2)</sup>	$I_F = 20\text{ mA}$ , $I_{REV} = 0.5\text{ A}$ <sup>(3)</sup>		20		ns

(1) Parameter not tested in production.

(2) Typical values for  $T_A = 25^\circ\text{C}$ .

(3)  $I_F$ : Forward current applied to bootstrap diode,  $I_{REV}$ : Reverse current applied to bootstrap diode.

### 5.7 Timing Diagrams

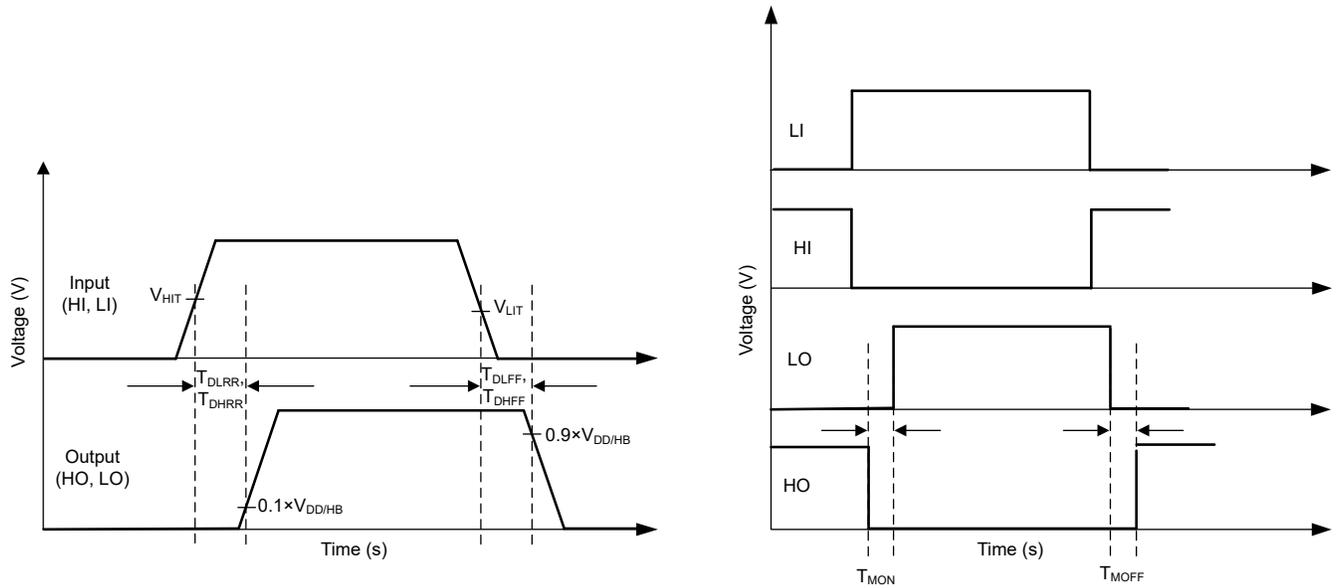


图 5-1. Timing Diagrams

### 5.8 Typical Characteristics

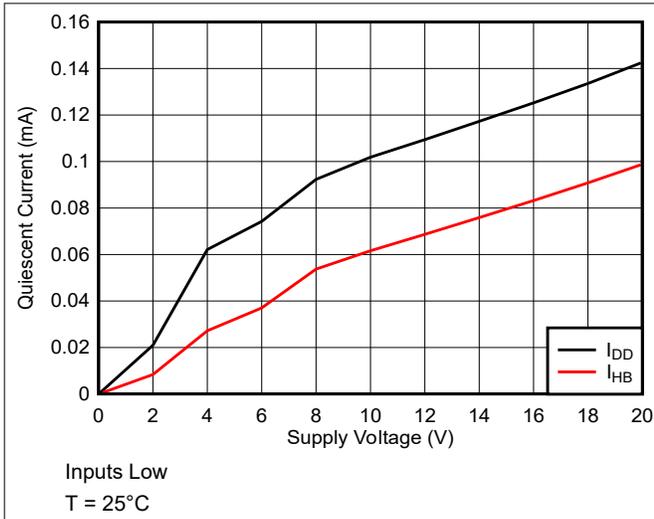


图 5-2. Quiescent Current vs Supply Voltage

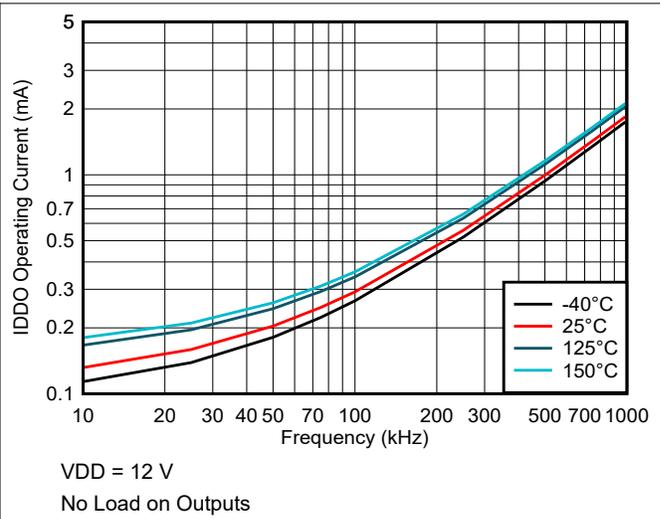


图 5-3. VDD Operating Current vs Frequency

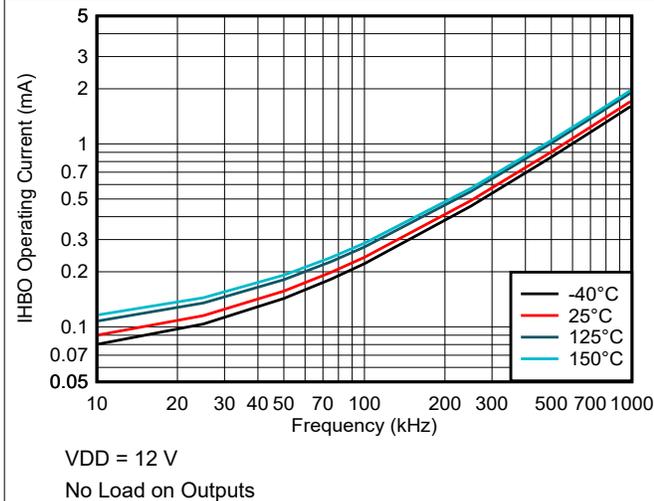


图 5-4. Boot Voltage Operating Current vs Frequency

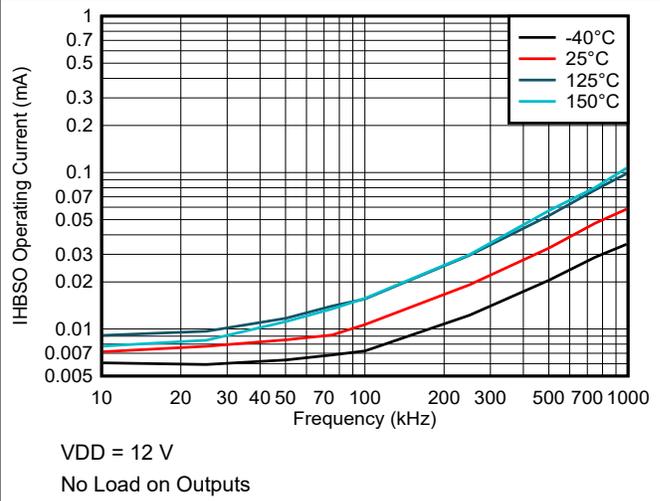


图 5-5. HB to VSS Operating Current vs Frequency

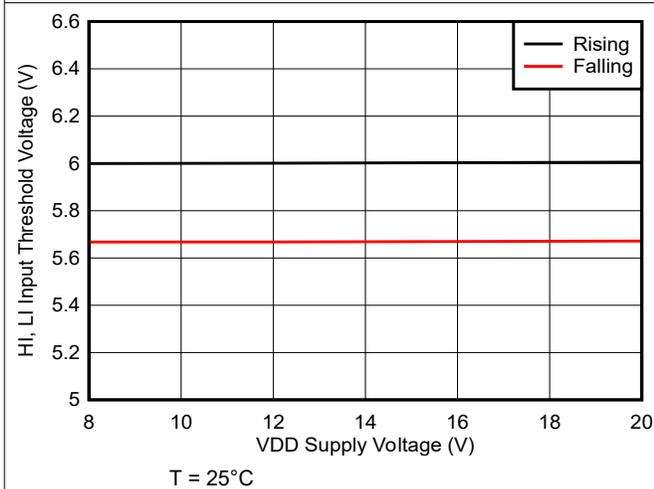


图 5-6. Input Threshold vs Supply Voltage

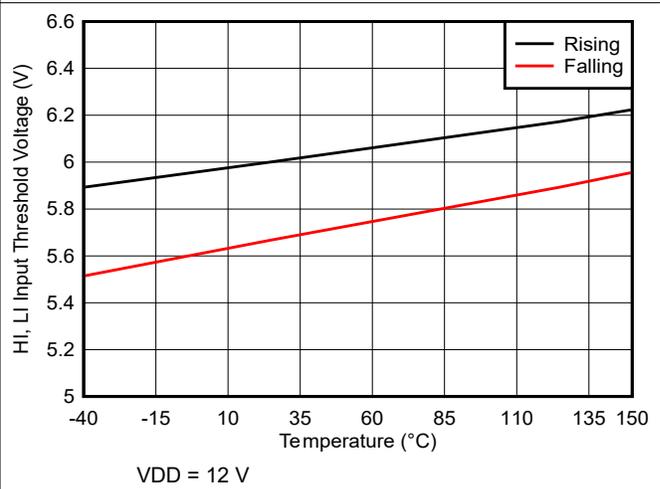


图 5-7. Input Threshold vs Temperature

### 5.8 Typical Characteristics (continued)

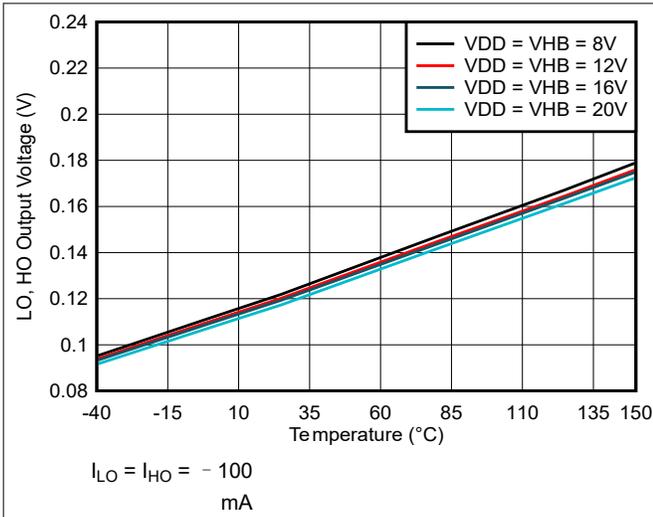


图 5-8. LO and HO High-Level Output Voltage vs Temperature

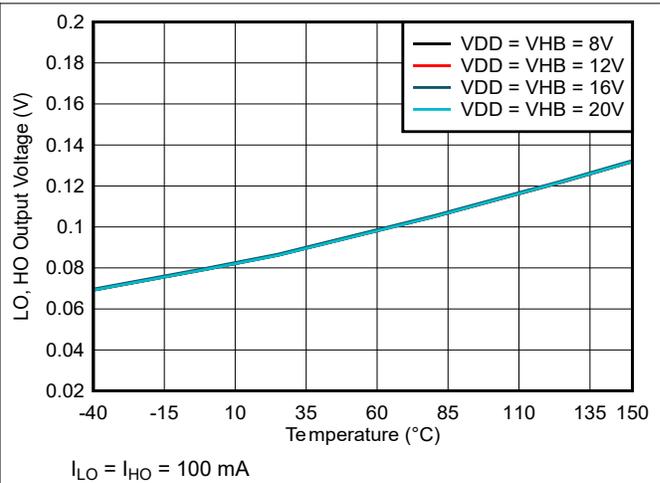


图 5-9. LO and HO Low-Level Output Voltage vs Temperature

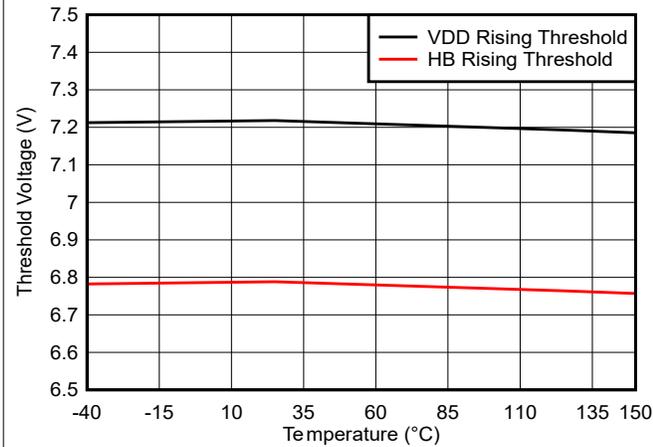


图 5-10. Undervoltage Lockout Threshold vs Temperature

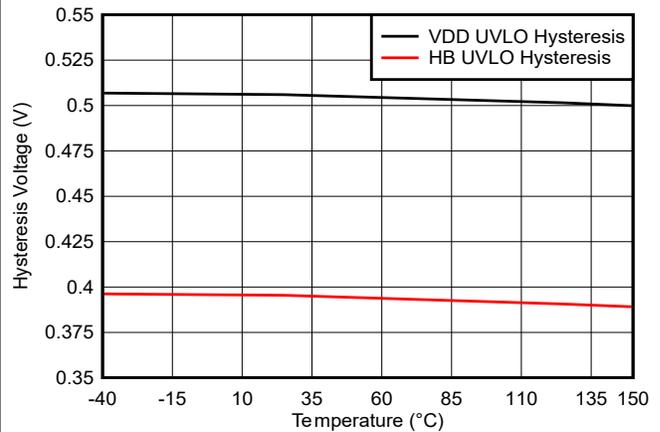


图 5-11. Undervoltage Lockout Threshold Hysteresis vs Temperature

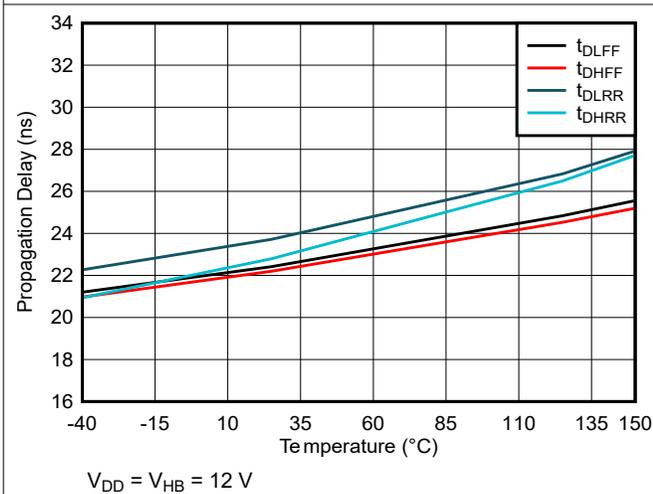


图 5-12. Propagation Delays vs Temperature

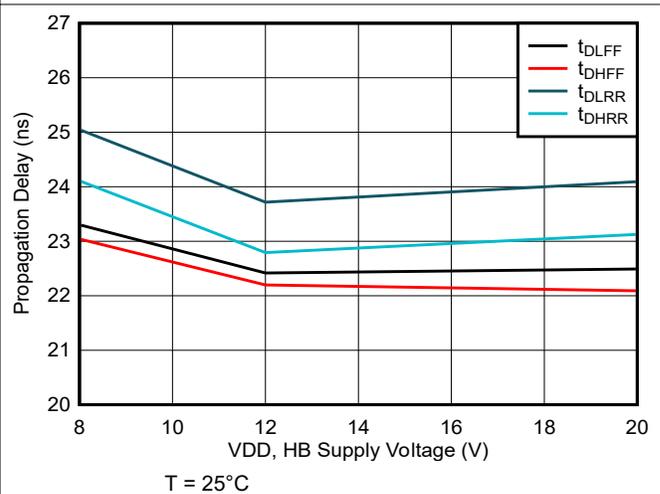
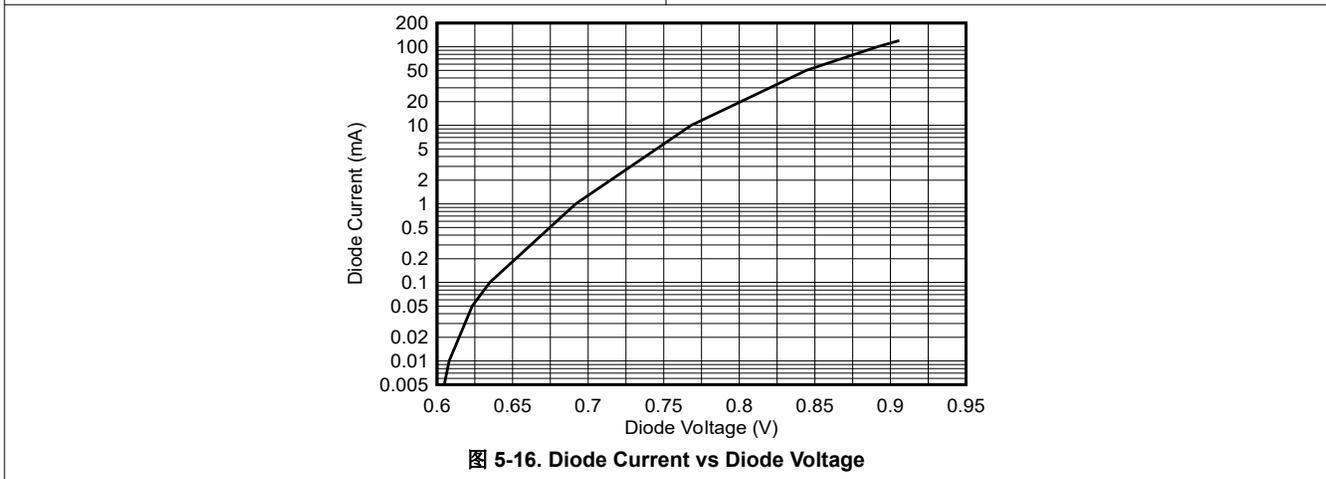
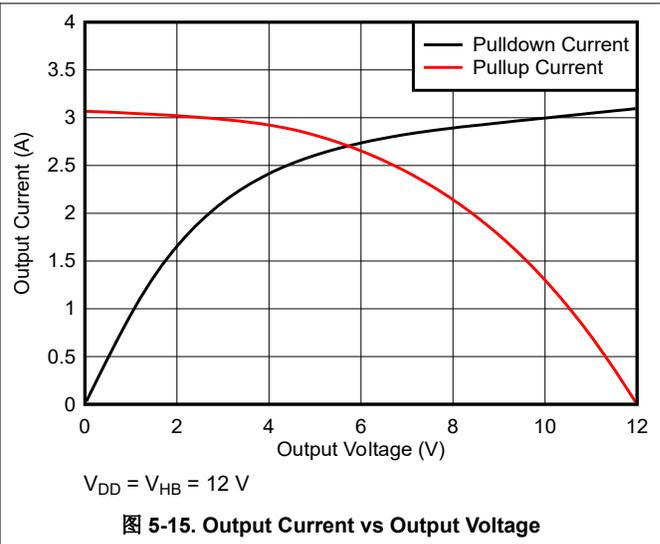
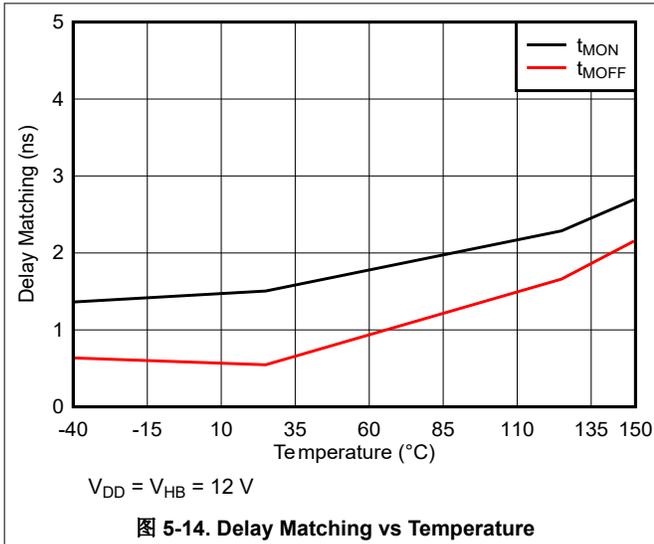


图 5-13. Propagation Delay vs Supply Voltage

### 5.8 Typical Characteristics (continued)

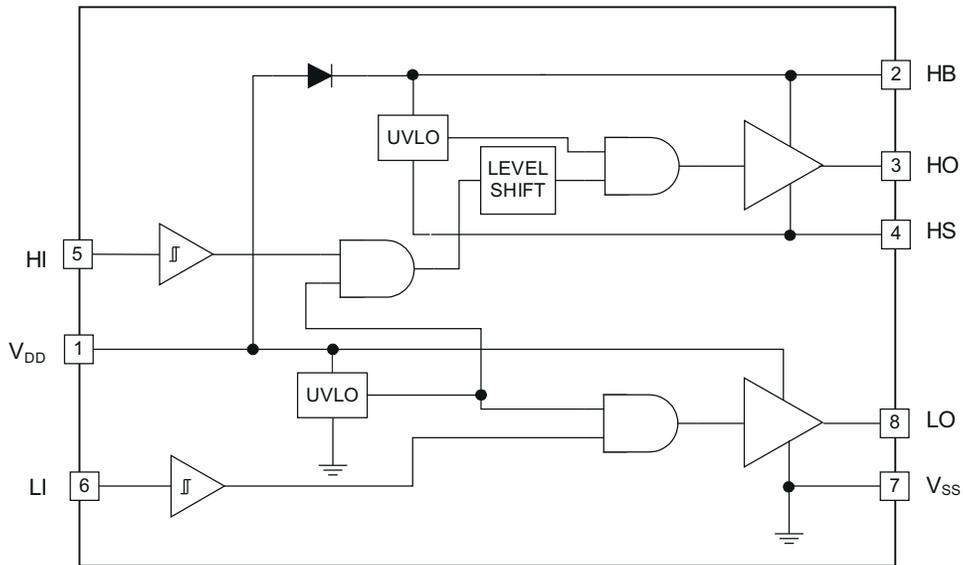


## 6 Detailed Description

### 6.1 Overview

The UCC27200-Q1 device is a high-side and low-side driver. The high-side and low-side each have independent inputs, which allow maximum flexibility of input control signals in the application. The boot diode for the high-side driver bias supply is internal to the UCC27200-Q1. This device has CMOS-compatible inputs. The high-side driver is referenced to the switch node (HS), which is typically the source pin of the high-side MOSFET and drain pin of the low-side MOSFET. The low-side driver is referenced to  $V_{SS}$ , which is typically ground. The functions contained are the input stages, UVLO protection, level shift, boot diode, and output driver stages.

### 6.2 Functional Block Diagram



### 6.3 Feature Description

#### 6.3.1 Input Stages

The input stages provide the interface to the PWM output signals. The input impedance of the UCC27200-Q1 is 200k $\Omega$  nominal and input capacitance is approximately 4pF. The 200k $\Omega$  is a pulldown resistance to  $V_{SS}$  (ground). The CMOS-compatible input of the UCC27200-Q1 provides a rising threshold of 6V and a falling threshold of 5.6V. The inputs of the UCC27200-Q1 are intended to be driven from 0 to  $V_{DD}$  levels.

### 6.3.2 Undervoltage Lockout (UVLO)

The bias supplies for the high-side and low-side drivers have UVLO protection.  $V_{DD}$  as well as  $V_{HB}$  to  $V_{HS}$  differential voltages are monitored. The  $V_{DD}$  UVLO disables both drivers when  $V_{DD}$  is below the specified threshold. The rising  $V_{DD}$  threshold is 7.1V with 0.5V hysteresis. The  $V_{HB}$  UVLO disables only the high-side driver when the  $V_{HB}$  to  $V_{HS}$  differential voltage is below the specified threshold. The  $V_{HB}$  UVLO rising threshold is 6.7V with 0.4V hysteresis.

### 6.3.3 Level Shift

The level-shift circuit is the interface from the high-side input to the high-side driver stage, which is referenced to the switch node (HS). The level shift allows control of the HO output referenced to the HS pin and provides excellent delay matching with the low-side driver.

### 6.3.4 Boot Diode

The boot diode necessary to generate the high-side bias is included in the UCC27200-Q1 family of drivers. The diode anode connects to  $V_{DD}$  and the cathode connects to VHB. With the VHB capacitor connected to HB and the HS pins, the  $V_{HB}$  capacitor charge refreshes every switching cycle when HS transitions to ground. The boot diode provides fast recovery times, low diode resistance, and a voltage rating margin that allow for efficient and reliable operation.

### 6.3.5 Output Stages

The output stages are the interface to the power MOSFETs in the power train. High-slew rate, low resistance, and high-peak current capability of both output drivers allow for efficient switching of the power MOSFETs. The low-side output stage reference is from  $V_{DD}$  to  $V_{SS}$  and the high-side output stage reference is from  $V_{HB}$  to  $V_{HS}$ .

## 6.4 Device Functional Modes

The device operates in normal mode and UVLO mode. See [Undervoltage Lockout \(UVLO\)](#) for information on UVLO operation mode. In the normal mode, the output state is dependent on states of the HI and LI pins. [表 6-1](#) lists the output states for different input pin combinations.

表 6-1. Device Logic Table

HI PIN	LI PIN	HO <sup>(1)</sup>	LO <sup>(2)</sup>
L	L	L	L
L	H	L	H
H	L	H	L
H	H	H	H

(1) HO is measured with respect to HS.

(2) LO is measured with respect to  $V_{SS}$ .

## 7 Application and Implementation

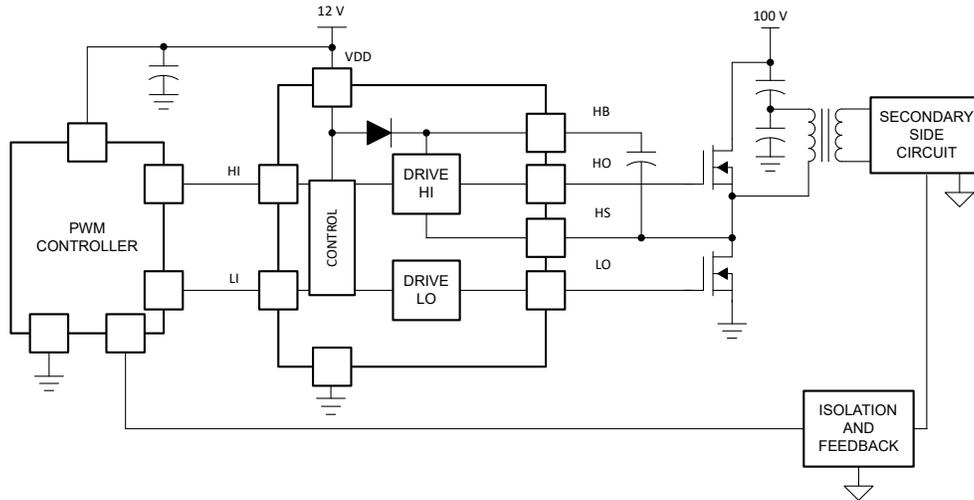
### 备注

以下应用部分中的信息不属于 TI 器件规格的范围，TI 不担保其准确性和完整性。TI 的客户应负责确定器件是否适用于其应用。客户应验证并测试其设计，以确保系统功能。

### 7.1 Application Information

To enable fast switching of power devices and reduce associated switching power losses, a powerful gate driver is employed between the PWM output of controllers and the gates of the power semiconductor devices. Also, gate drivers are indispensable when it is impossible for the PWM controller to directly drive the gates of the switching devices. With the advent of digital power, this situation will be often encountered because the PWM signal from the digital controller is often a 3.3V logic signal which cannot effectively turn on a power switch. Level shifting circuitry is needed to boost the 3.3V signal to the gate-drive voltage (such as 12V) to fully turn on the power device and minimize conduction losses. Traditional buffer drive circuits based on NPN/PNP bipolar transistors in totem-pole arrangement, being emitter follower configurations, prove inadequate with digital power because they lack level-shifting capability. Gate drivers effectively combine both the level-shifting and buffer-drive functions. Gate drivers also find other needs such as minimizing the effect of high-frequency switching noise by locating the high-current driver physically close to the power switch, driving gate-drive transformers, and controlling floating power-device gates, reducing power dissipation and thermal stress in controllers by moving gate charge power losses from the controller into the driver.

### 7.2 Typical Application



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图 7-1. UCC27200-Q1 Typical Application Diagram

#### 7.2.1 Design Requirements

For this design example, use the parameters listed in 表 7-1.

表 7-1. Design Specifications

DESIGN PARAMETER	EXAMPLE VALUE
Supply voltage, VDD	12V
Voltage on HS, VHS	0V to 100V
Voltage on HB, VHB	12V to 112V
Output current rating, IO	- 3A to 3A

表 7-1. Design Specifications (续)

DESIGN PARAMETER	EXAMPLE VALUE
Operating frequency	200kHz

## 7.2.2 Detailed Design Procedure

### 7.2.2.1 Input Threshold Type

The UCC27200-Q1 device features CMOS compatible input threshold logic with wide hysteresis. The threshold voltage levels are low voltage and independent of the VDD supply voltage, which allows compatibility with both logic-level input signals from microcontrollers as well as higher-voltage input signals from analog controllers. See the [Electrical Characteristics](#) table for the actual input threshold voltage levels and hysteresis specifications for the UCC27200-Q1 device.

### 7.2.2.2 V<sub>DD</sub> Bias Supply Voltage

The bias supply voltage to be applied to the VDD pin of the device should never exceed the values listed in the [Absolute Maximum Ratings](#) table. Different power switches demand different voltage levels to be applied at the gate terminals for effective turnon and turnoff. With certain power switches, a positive gate voltage may be required for turnon and a negative gate voltage may be required for turnoff, in which case the VDD bias supply equals the voltage differential. With a wide operating range from 8V to 17V, the UCC27200-Q1 device can be used to drive a variety of power switches, such as Si MOSFETs, IGBTs, and wide-bandgap power semiconductors.

### 7.2.2.3 Peak Source and Sink Currents

Generally, the switching speed of the power switch during turnon and turnoff should be as fast as possible in order to minimize switching power losses. The gate driver device must be able to provide the required peak current for achieving the targeted switching speeds with the targeted power MOSFET. The system requirement for the switching speed is typically described in terms of the slew rate of the drain-to-source voltage of the power MOSFET (such as  $dV_{DS}/dt$ ). For example, the system requirement might state that a SPP20N60C3 power MOSFET must be turned-on with a  $dV_{DS}/dt$  of 20V/ns or higher with a DC bus voltage of 400V in a continuous-conduction-mode (CCM) boost PFC-converter application. This type of application is an inductive hard-switching application and reducing switching power losses is critical. This requirement means that the entire drain-to-source voltage swing during power MOSFET turnon event (from 400V in the OFF state to  $V_{DS(on)}$  in on state) must be completed in approximately 20ns or less. When the drain-to-source voltage swing occurs, the Miller charge of the power MOSFET ( $Q_{GD}$  parameter in the SPP20N60C3 data sheet is 33nC typical) is supplied by the peak current of gate driver. According to power MOSFET inductive switching mechanism, the gate-to-source voltage of the power MOSFET at this time is the Miller plateau voltage, which is typically a few volts higher than the threshold voltage of the power MOSFET,  $V_{GS(TH)}$ .

To achieve the targeted  $dV_{DS}/dt$ , the gate driver must be capable of providing the  $Q_{GD}$  charge in 20ns or less. In other words a peak current of 1.65A (= 33nC / 20ns) or higher must be provided by the gate driver. The UCC27200-Q1 gate driver is capable of providing 3A peak sourcing current which clearly exceeds the design requirement and has the capability to meet the switching speed needed. The overdrive capability provides an extra margin against part-to-part variations in the  $Q_{GD}$  parameter of the power MOSFET along with additional flexibility to insert external gate resistors and fine tune the switching speed for efficiency versus EMI optimizations. However, in practical designs the parasitic trace inductance in the gate drive circuit of the PCB will have a definitive role to play on the power MOSFET switching speed. The effect of this trace inductance is to limit the  $dI/dt$  of the output current pulse of the gate driver. In order to illustrate this, consider output current pulse waveform from the gate driver to be approximated to a triangular profile, where the area under the triangle ( $\frac{1}{2} \times I_{PEAK} \times \text{time}$ ) would equal the total gate charge of the power MOSFET ( $Q_G$  parameter in SPP20N60C3 power MOSFET datasheet = 87nC typical). If the parasitic trace inductance limits the  $dI/dt$  then a situation may occur in which the full peak current capability of the gate driver is not fully achieved in the time required to deliver the  $Q_G$  required for the power MOSFET switching. In other words the time parameter in the equation would dominate and the  $I_{PEAK}$  value of the current pulse would be much less than the true peak current capability of the device, while the required  $Q_G$  is still delivered. Because of this, the desired switching speed may not be realized,

even when theoretical calculations indicate the gate driver is capable of achieving the targeted switching speed. Thus, placing the gate driver device very close to the power MOSFET and designing a tight gate drive-loop with minimal PCB trace inductance is important to realize the full peak-current capability of the gate driver.

#### 7.2.2.4 Propagation Delay

The acceptable propagation delay from the gate driver is dependent on the switching frequency at which it is used and the acceptable level of pulse distortion to the system. The UCC27200-Q1 device features 22ns (typical) propagation delays, which ensures very little pulse distortion and allows operation at very high-frequencies. See the [Electrical Characteristics](#) table for the propagation and switching characteristics of the UCC27200-Q1 device.

#### 7.2.2.5 Power Dissipation

Power dissipation of the gate driver has two portions as shown in [方程式 1](#).

$$P_{DISS} = P_{DC} + P_{SW} \quad (1)$$

Use [方程式 2](#) to calculate the DC portion of the power dissipation (PDC).

$$PDC = I_Q \times V_{DD} \quad (2)$$

where

- $I_Q$  is the quiescent current for the driver.

The quiescent current is the current consumed by the device to bias all internal circuits such as input stage, reference voltage, logic circuits, protections, and also any current associated with switching of internal devices when the driver output changes state (such as charging and discharging of parasitic capacitances, parasitic shoot-through, and so forth). The UCC27200-Q1 features very low quiescent currents (refer to the [Electrical Characteristics](#) table) and contain internal logic to eliminate any shoot-through in the output driver stage. Thus the effect of the PDC on the total power dissipation within the gate driver can be safely assumed to be negligible. The power dissipated in the gate-driver package during switching (PSW) depends on the following factors:

- Gate charge required of the power device (usually a function of the drive voltage  $V_G$ , which is very close to input bias supply voltage  $V_{DD}$ )
- Switching frequency
- Use of external gate resistors. When a driver device is tested with a discrete, capacitive load calculating the power that is required from the bias supply is fairly simple. The energy that must be transferred from the bias supply to charge the capacitor is given by [方程式 3](#).

$$EG = \frac{1}{2} C_{LOAD} \times V_{DD}^2 \quad (3)$$

- where
- $C_{LOAD}$  is load capacitor
- $V_{DD}$  is bias voltage feeding the driver

There is an equal amount of energy dissipated when the capacitor is charged and when it is discharged. This leads to a total power loss given by [方程式 4](#).

$$PG = C_{LOAD} \times V_{DD}^2 \times f_{SW} \quad (4)$$

where

- $f_{SW}$  is the switching frequency

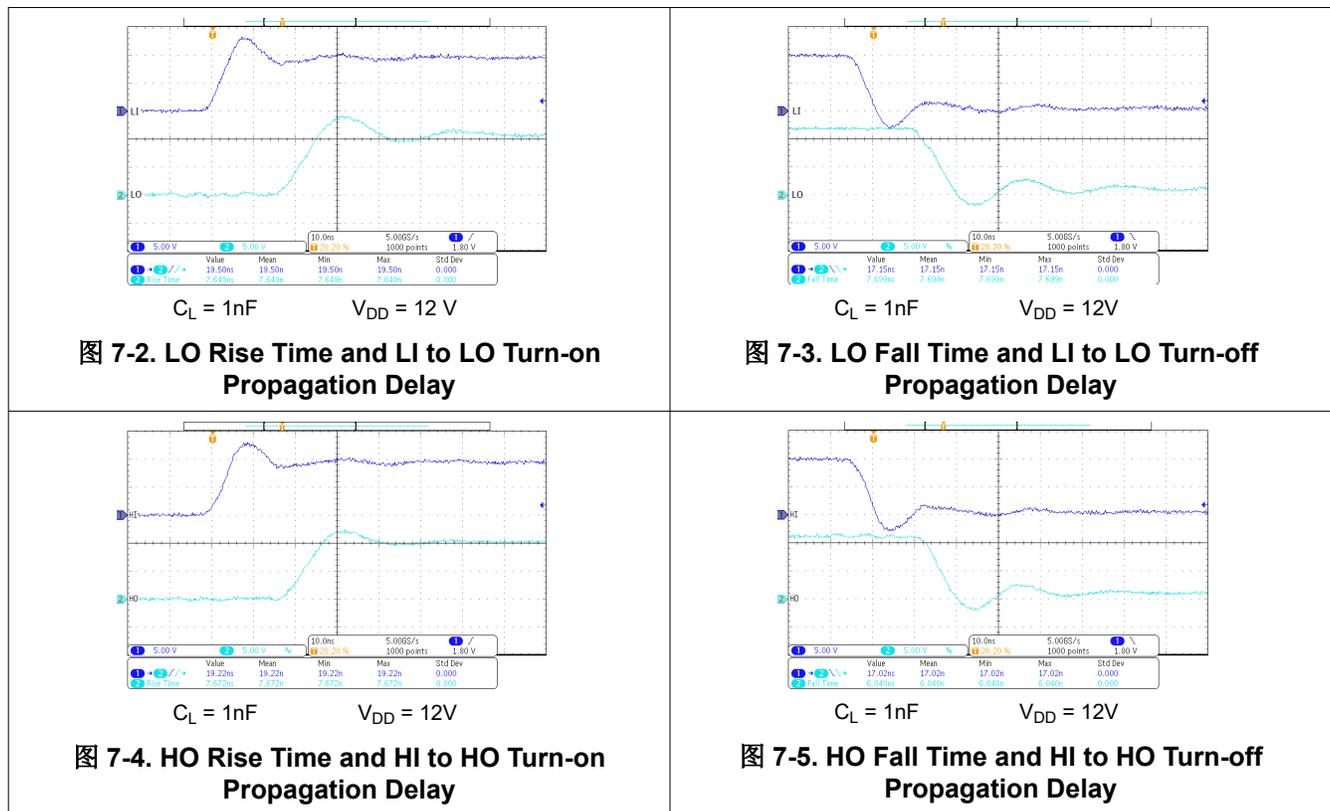
The switching load presented by a power MOSFET/IGBT is converted to an equivalent capacitance by examining the gate charge required to switch the device. This gate charge includes the effects of the input capacitance plus the added charge needed to swing the drain voltage of the power device as it switches

between the ON and OFF states. Most manufacturers provide specifications of typical and maximum gate charge, in nC, to switch the device under specified conditions. Using the gate charge  $Q_G$ , determine the power that must be dissipated when switching a capacitor which is calculated using the equation  $Q_G = C_{LOAD} \times V_{DD}$  to provide 方程式 5 for power.

$$P_G = C_{LOAD} \times V_{DD}^2 \times f_{SW} = Q_G \times V_{DD} \times f_{SW} \tag{5}$$

This power  $P_G$  is dissipated in the resistive elements of the circuit when the MOSFET/IGBT is being turned on and off. Half of the total power is dissipated when the load capacitor is charged during turnon, and the other half is dissipated when the load capacitor is discharged during turnoff. When no external gate resistor is employed between the driver and MOSFET/IGBT, this power is completely dissipated inside the driver package. With the use of external gate-drive resistors, the power dissipation is shared between the internal resistance of driver and external gate resistor.

### 7.2.3 Application Curves



## 8 Power Supply Recommendations

The bias supply voltage range for which the device is recommended to operate is from 8V to 17V. The lower end of this range is governed by the internal undervoltage-lockout (UVLO) protection feature on the  $V_{DD}$  pin supply circuit blocks. Whenever the driver is in UVLO condition when the  $V_{DD}$  pin voltage is below the  $V_{(ON)}$  supply start threshold, this feature holds the output low, regardless of the status of the inputs. The upper end of this range is driven by the 20V absolute maximum voltage rating of the  $V_{DD}$  pin of the device (which is a stress rating). Keeping a 3V margin to allow for transient voltage spikes, the maximum recommended voltage for the  $V_{DD}$  pin is 17V. The UVLO protection feature also involves a hysteresis function, which means that when the  $V_{DD}$  pin bias voltage has exceeded the threshold voltage and device begins to operate, and if the voltage drops, then the device continues to deliver normal functionality unless the voltage drop exceeds the hysteresis specification  $V_{DD(hys)}$ . Therefore, ensuring that, while operating at or near the 8V range, the voltage ripple on the auxiliary power supply output is smaller than the hysteresis specification of the device is important to avoid triggering device shutdown. During system shutdown, the device operation continues until the  $V_{DD}$  pin voltage has dropped below the  $V_{(OFF)}$  threshold, which must be accounted for while evaluating system shutdown timing design requirements. Likewise, at system start-up the device does not begin operation until the  $V_{DD}$  pin voltage has exceeded the  $V_{(ON)}$  threshold.

The quiescent current consumed by the internal circuit blocks of the device is supplied through the  $V_{DD}$  pin. Although this fact is well known, it is important to recognize that the charge for source current pulses delivered by the LO pin is also supplied through the same  $V_{DD}$  pin. As a result, every time a current is sourced out of the LO pin, a corresponding current pulse is delivered into the device through the  $V_{DD}$  pin. Thus, ensure that a local bypass capacitor is provided between the  $V_{DD}$  and GND pins and located as close to the device as possible for the purpose of decoupling is important. A low ESR, ceramic surface-mount capacitor is required. TI recommends using a capacitor in the range from 0.22  $\mu$ F to 4.7  $\mu$ F between  $V_{DD}$  and GND. In a similar manner, the current pulses delivered by the HO pin are sourced from the HB pin. Therefore, TI recommends placing a 0.022  $\mu$ F to 0.1  $\mu$ F local decoupling capacitor between the HB and HS pins.

## 9 Layout

### 9.1 Layout Guidelines

To improve the switching characteristics and efficiency of a design, the following layout rules must be followed.

- Locate the driver as close as possible to the MOSFETs.
- Locate the  $V_{DD}$  and  $V_{HB}$  (bootstrap) capacitors as close as possible to the driver.
- Pay close attention to the GND trace. Use the thermal pad of the DDA package as GND by connecting it to the  $V_{SS}$  pin (GND).

---

#### 备注

The GND trace from the driver goes directly to the source of the MOSFET, but must not be in the high-current path of the MOSFET(S) drain or source current.

- Use similar rules for the HS node as for GND for the high-side driver.
- Use wide traces for LO and HO closely following the associated GND or HS traces. Where possible, widths of 60mil to 100mil are preferred.
- Use two or more vias if the driver outputs or SW node must be routed from one layer to another. For GND, consider the number of vias of the thermal pad requirements of the thermal pad requirements as well as parasitic inductance.
- Avoid  $L_1$  and  $H_1$  (driver input) going close to the HS node or any other high dV/dT traces that can induce significant noise into the relatively high-impedance leads.
- Keep in mind that a poor layout can cause a significant drop in efficiency versus a good PCB layout and can even lead to decreased reliability of the whole system.

## 9.2 Layout Example

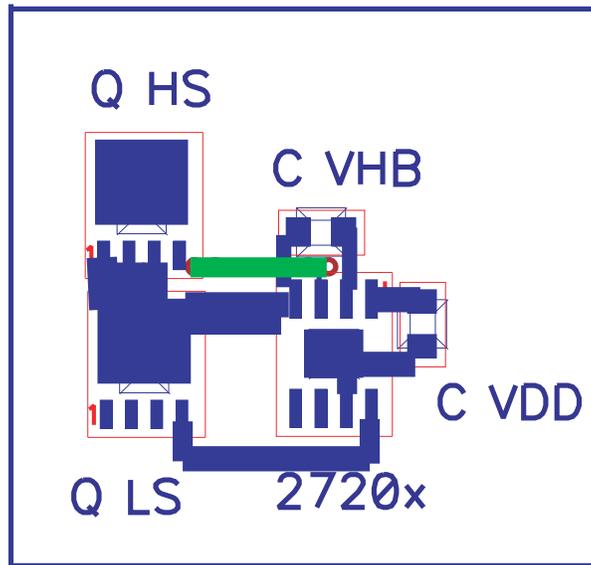


图 9-1. Example Component Placement

## 10 Device and Documentation Support

### 10.1 Documentation Support

#### 10.1.1 Related Documentation

For more related documentation, see the following:

- [PowerPAD™ Thermally Enhanced Package](#) (SLMA002)
- [PowerPAD™ Made Easy](#) (SLMA004)

### 10.2 接收文档更新通知

要接收文档更新通知，请导航至 [ti.com](https://www.ti.com) 上的器件产品文件夹。点击 [通知](#) 进行注册，即可每周接收产品信息更改摘要。有关更改的详细信息，请查看任何已修订文档中包含的修订历史记录。

### 10.3 支持资源

[TI E2E™ 中文支持论坛](#) 是工程师的重要参考资料，可直接从专家处获得快速、经过验证的解答和设计帮助。搜索现有解答或提出自己的问题，获得所需的快速设计帮助。

链接的内容由各个贡献者“按原样”提供。这些内容并不构成 TI 技术规范，并且不一定反映 TI 的观点；请参阅 TI 的 [使用条款](#)。

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ESD 的损坏小至导致微小的性能降级，大至整个器件故障。精密的集成电路可能更容易受到损坏，这是因为非常细微的参数更改都可能会导致器件与其发布的规格不相符。

### 10.6 术语表

[TI 术语表](#) 本术语表列出并解释了术语、首字母缩略词和定义。

## 11 Revision History

注：以前版本的页码可能与当前版本的页码不同

<b>Changes from Revision C (August 2016) to Revision D (July 2024)</b>	<b>Page</b>
• 更改了文档标题以反映器件的主要特性和器件型号，因为该数据表仅对应 1 个器件型号 ( 从 “UCC2720x-Q1” 更改为 “UCC27200-Q1” )。更新了若干规格以反映器件特性。从该数据表中删除了对 UCC27201-Q1 器件的所有引用。.....	1
• 更新了整个文档中的表格、图和交叉参考的编号格式.....	1
• 更改了“特性”部分：1) 删除了 HBM 和 CDM ESD 分类等级，以遵循最新的 TI 数据表标准。2) 将结温范围规格从 “-40°C 至 140°C” 更改为 “-40°C 至 150°C”。4) 更改了典型传播延迟 ( 从 “20ns” 更改为 “22ns” )。5) 删除了 “工作频率大于 1MHz”，因为开关频率不是指定的参数。6) 更改了典型自举二极管电阻 ( 从 “0.6Ω” 更改为 “0.65Ω” )。.....	1
• 更新了“应用”部分，添加了 5 大典型应用列表。.....	1
• 更改了“说明”部分，以将 UCC2720x-Q1 替换为 UCC27200-Q1，并删除了对 UCC27201-Q1 的所有引用。.....	1
• Changed Pin Functions table with a change to the power pad description. ....	3
• Updated Absolute Maximum Ratings section to remove "Power dissipation at TA = 25°C" and "Lead temperature (soldering, 10s)". Power dissipation can be calculated with thermal metrics in "Thermal Information" table.....	4
• Updated Recommended Operating Conditions: Operating Junction Temperature maximum changed from 140°C to 150°C, and removed Operating Ambient Temperature. ....	4
• Updated Thermal Information section to reflect device characteristics. ....	4
• Updated Supply Currents specifications in the Electrical Characteristics table: 1) I <sub>DD</sub> typical changed (From: 0.4mA. To: 0.11mA). 2) UC27200-Q1 I <sub>D<sub>DO</sub></sub> typical changed (From: 2.5mA. To: 1mA). 3) UCC27200-Q1 I <sub>D<sub>DO</sub></sub> maximum changed (From: 4mA. To: 3mA). 4) I <sub>HB</sub> typical changed (From: 0.4mA. To: 0.065mA). 5) I <sub>HBO</sub> typical changed (From: 2.5mA. To: 0.9mA). 6) I <sub>HBO</sub> maximum changed (From: 4mA. To: 3mA). 7) I <sub>HBS</sub> test condition changed to match V <sub>H<sub>S</sub></sub> maximum recommended operating conditions (From: 110V. To: 105V). 8) I <sub>HBSO</sub> typical changed (From: 0.1mA. To: 0.03mA).....	4
• Updated Input specifications in the Electrical Characteristics table: 1) UCC27200-Q1 V <sub>HIT</sub> typical changed (From: 5.8V. To: 6V). 2) UCC27200-Q1 V <sub>LIT</sub> typical changed (From: 5.4V. To: 5.6V). ....	4
• Updated Bootstrap diode specifications in the Electrical Characteristics table: 1) R <sub>D</sub> test conditions changed (From: 100mA and 80mA. To: 120mA and 100mA). 2) R <sub>D</sub> typical changed (From: 0.6Ω. To: 0.65Ω). ....	4
• Updated LO/HO Gate Driver specifications in the Electrical Characteristics table: 1) V <sub>LOL</sub> typical changed (From 0.18V. To 0.1V). 2) V <sub>LOH</sub> typical changed (From: 0.25V. To: 0.13V). ....	4
• Removed specifications with test conditions "-40°C to 125°C T <sub>J</sub> ", since all parameters are specified from -40°C to 150°C T <sub>J</sub> (unless otherwise noted). Changed Propagation Delays typical specification (From: 20ns. To: 22ns).....	4
• Updated Output Rise and Fall Time specifications: 1) t <sub>R</sub> typical changed (From: 0.35us. To: 0.26us). 2) t <sub>F</sub> typical changed (From: 0.3us. To: 0.22us). ....	4
• Updated all plots in Typical Characteristics section to reflect the device's typical specification. ....	8
• Updated Typical Application section to display a different application diagram and detailed design procedure since information in legacy data sheet had an outdated circuit with obsolete part numbers. ....	13
• Changed application curves to display propagation delay and rise/fall time plots. ....	16
• Updated Power Supply Recommendations section to fix 3 typos.....	17

<b>Changes from Revision B (March 2016) to Revision C (August 2016)</b>	<b>Page</b>
• 将特性部分中的器件温度等级从 0 级 ( - 40°C 至 150°C ) 更改为 1 级 ( - 40°C 至 125°C ) .....	1

- Added the *Receiving Notification of Documentation Updates* section..... 19
- 

<b>Changes from Revision A (November 2008) to Revision B (March 2016)</b>	<b>Page</b>
• 添加了 <i>ESD</i> 等级表、特性说明部分、器件功能模式、应用和实施部分、电源相关建议部分、布局部分、器件和文档支持部分以及机械、封装和可订购信息部分.....	1
• 添加了“通过 AEC-Q100 认证”要点.....	1
• 将器件编号 UCC2720x 和 UCC27200 更改为 UCC2720x-Q1 和 UCC27200-Q1.....	1
• Moved references from <i>Additional References</i> section to <i>Related Documentation</i> section.....	19

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## 12 Mechanical, Packaging, and Orderable Information

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

**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
UCC27200QDDARQ1	ACTIVE	SO PowerPAD	DDA	8	2500	RoHS & Green	NIPDAU   NIPDAUAG	Level-2-260C-1 YEAR	-40 to 150	27200Q	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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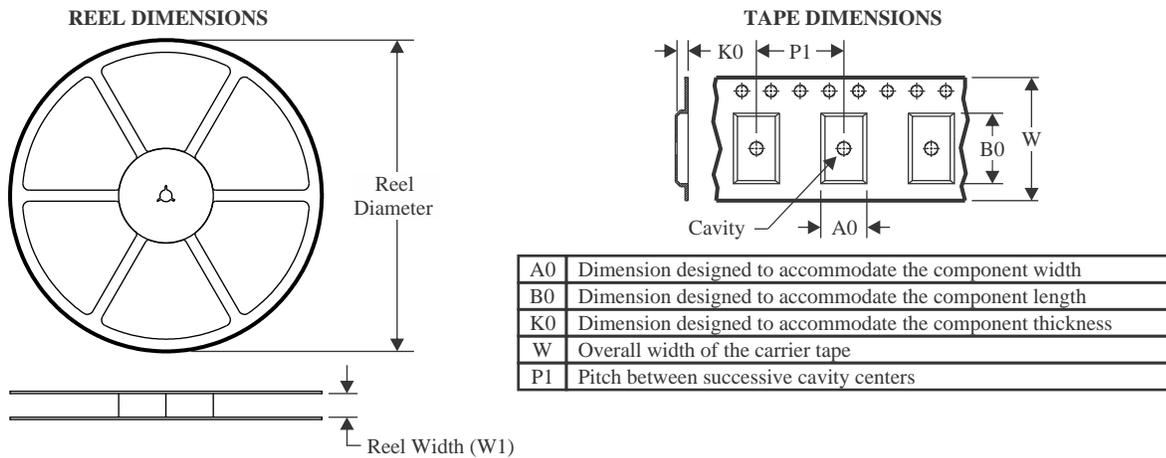
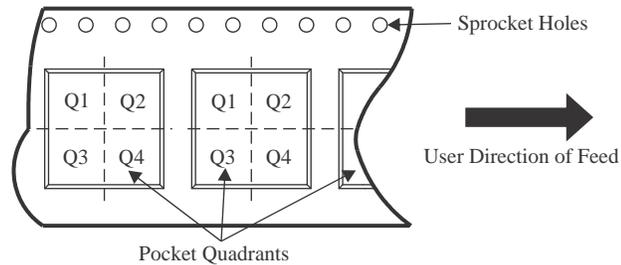
In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

**OTHER QUALIFIED VERSIONS OF UCC27200-Q1 :**

- Catalog : [UCC27200](#)

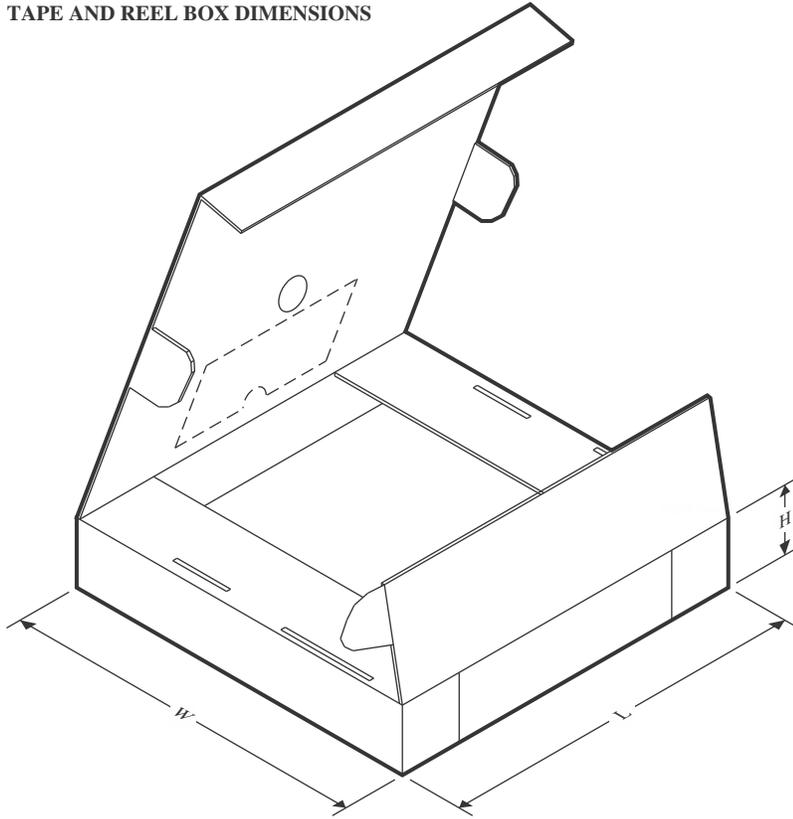
NOTE: Qualified Version Definitions:

- Catalog - TI's standard catalog product

**TAPE AND REEL INFORMATION**

**QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE**


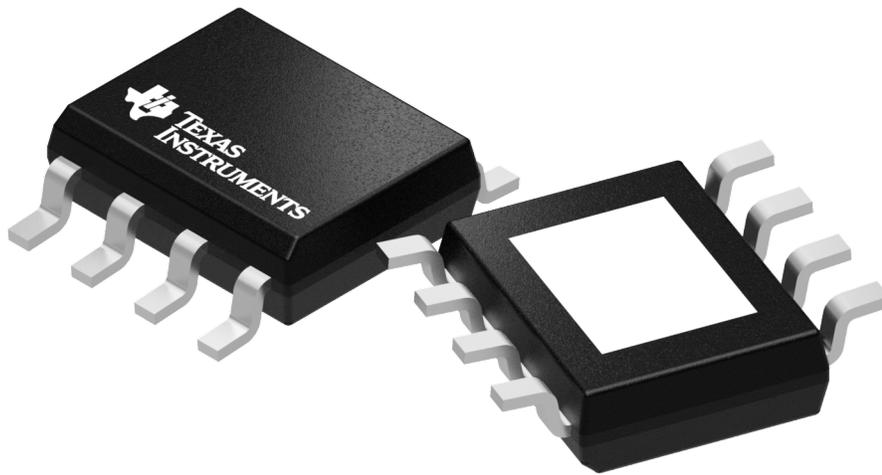
\*All dimensions are nominal

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
UCC27200QDDARQ1	SO PowerPAD	DDA	8	2500	330.0	12.8	6.4	5.2	2.1	8.0	12.0	Q1

**TAPE AND REEL BOX DIMENSIONS**


\*All dimensions are nominal

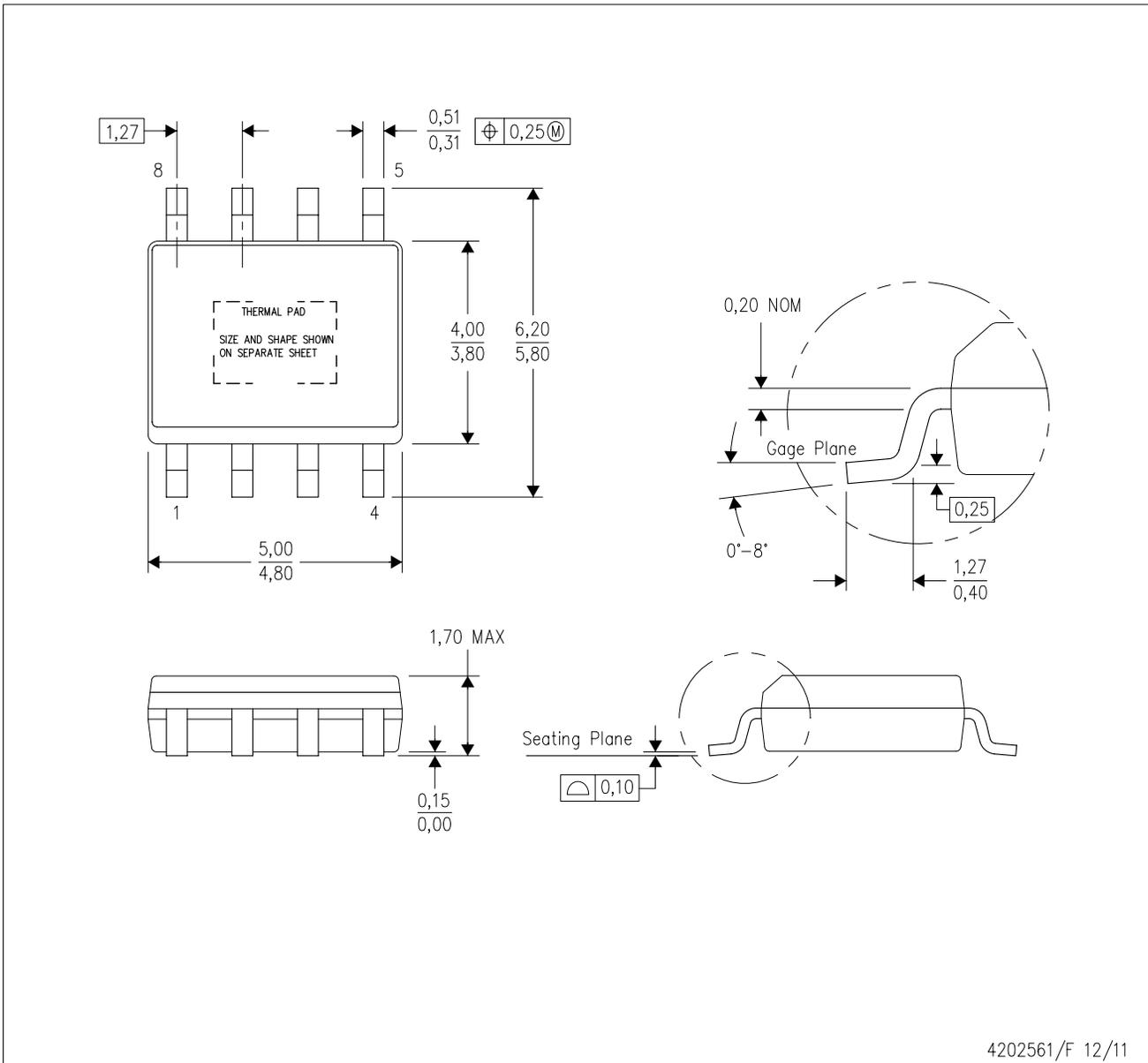
Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
UCC27200QDDARQ1	SO PowerPAD	DDA	8	2500	366.0	364.0	50.0



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

DDA (R-PDSO-G8)

PowerPAD™ PLASTIC SMALL-OUTLINE



4202561/F 12/11

- NOTES:
- A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5-1994.
  - B. This drawing is subject to change without notice.
  - C. Body dimensions do not include mold flash or protrusion not to exceed 0,15.
  - D. This package is designed to be soldered to a thermal pad on the board. Refer to Technical Brief, PowerPad Thermally Enhanced Package, Texas Instruments Literature No. SLMA002 for information regarding recommended board layout. This document is available at [www.ti.com](http://www.ti.com) <<http://www.ti.com>>.
  - E. See the additional figure in the Product Data Sheet for details regarding the exposed thermal pad features and dimensions.
  - F. This package complies to JEDEC MS-012 variation BA

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DDA (R-PDSO-G8)

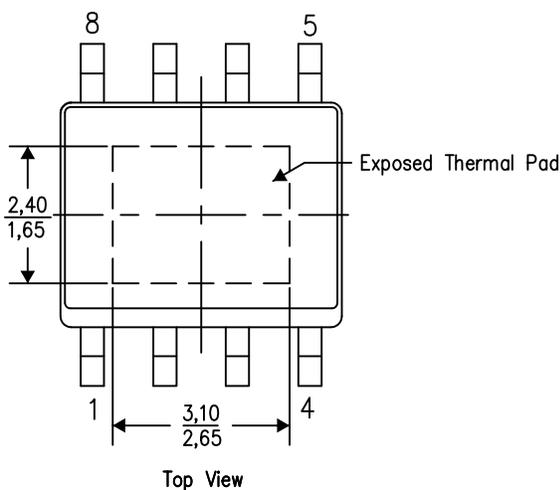
PowerPAD™ PLASTIC SMALL OUTLINE

## THERMAL INFORMATION

This PowerPAD™ package incorporates an exposed thermal pad that is designed to be attached to a printed circuit board (PCB). The thermal pad must be soldered directly to the 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 take 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. Both documents are available at [www.ti.com](http://www.ti.com).

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

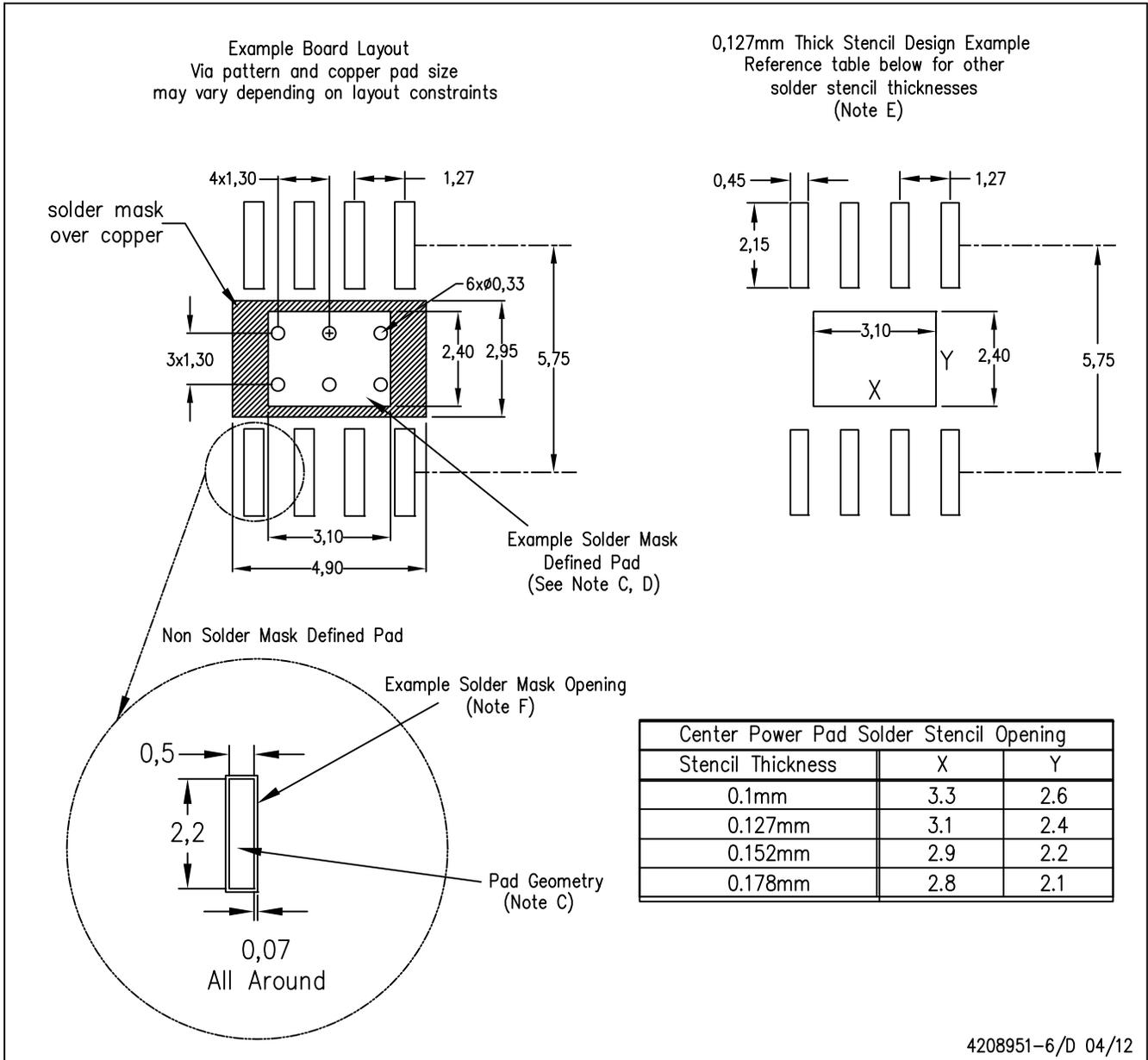


Exposed Thermal Pad Dimensions

4206322-6/L 05/12

NOTE: A. All linear dimensions are in millimeters

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- NOTES:
- A. All linear dimensions are in millimeters.
  - B. This drawing is subject to change without notice.
  - C. Publication IPC-7351 is recommended for alternate designs.
  - D. This package is designed to be soldered to a thermal pad on the board. Refer to Technical Brief, PowerPad Thermally Enhanced Package, Texas Instruments Literature No. SLMA002, SLMA004, and also the Product Data Sheets for specific thermal information, via requirements, and recommended board layout. These documents are available at [www.ti.com](http://www.ti.com) <<http://www.ti.com>>. Publication IPC-7351 is recommended for alternate designs.
  - E. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Example stencil design based on a 50% volumetric metal load solder paste. Refer to IPC-7525 for other stencil recommendations.
  - F. Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.

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