

## Dual 4-A High Speed Low-Side MOSFET Drivers With Enable

 Check for Samples: [UCC27423](#), [UCC27424](#), [UCC27425](#)

### FEATURES

- Industry-Standard Pin-Out
- Enable Functions for Each Driver
- High Current Drive Capability of  $\pm 4A$
- Unique BiPolar and CMOS True Drive Output Stage Provides High Current at MOSFET Miller Thresholds
- TTL/CMOS Compatible Inputs Independent of Supply Voltage
- 20ns Typical Rise and 15ns Typical Fall Times with 1.8nF Load
- Typical Propagation Delay Times of 25ns with Input Falling and 35ns with Input Rising
- 4V to 15V Supply Voltage
- Dual Outputs Can Be Paralleled for Higher Drive Current
- Available in Thermally Enhanced MSOP PowerPAD™ Package with  $4.7^{\circ}C/W \theta_{JC}$
- Rated From  $-40^{\circ}C$  to  $125^{\circ}C$

### APPLICATIONS

- Switch Mode Power Supplies
- DC/DC Converters
- Motor Controllers
- Line Drivers
- Class D Switching Amplifiers

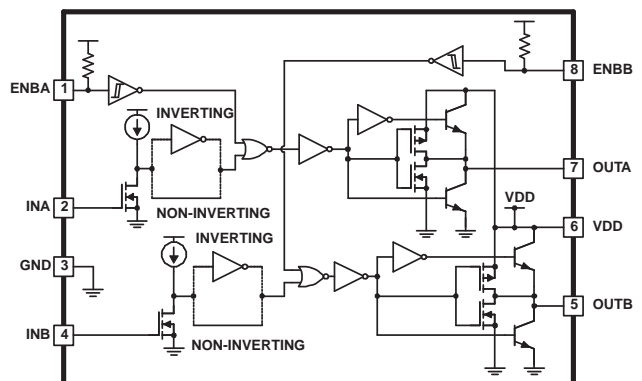
### DESCRIPTION

The UCC27423/4/5 family of high-speed dual MOSFET drivers can deliver large peak currents into capacitive loads. Three standard logic options are offered – dual-inverting, dual-noninverting and one-inverting and one-noninverting driver. The thermally enhanced 8-pin PowerPAD™ MSOP package (DGN) drastically lowers the thermal resistance to improve long-term reliability. It is also offered in the standard SOIC-8 (D) or PDIP-8 (P) packages.

Using a design that inherently minimizes shoot-through current, these drivers deliver 4A of current where it is needed most at the Miller plateau region during the MOSFET switching transition. A unique BiPolar and MOSFET hybrid output stage in parallel also allows efficient current sourcing and sinking at low supply voltages.

The UCC27423/4/5 provides enable (ENBL) functions to have better control of the operation of the driver applications. ENBA and ENBB are implemented on pins 1 and 8 which were previously left unused in the industry standard pin-out. They are internally pulled up to Vdd for active high logic and can be left open for standard operation.

### BLOCK DIAGRAM



UDG-01063



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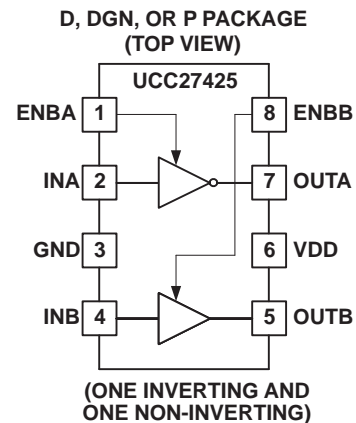
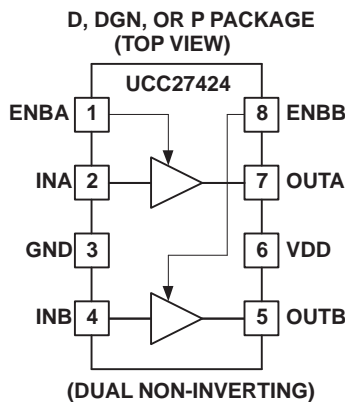
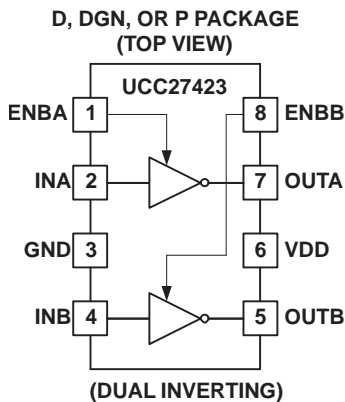
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**ORDERING INFORMATION**

OUTPUT CONFIGURATION	TEMPERATURE RANGE $T_A = T_J$	PACKAGED DEVICES		
		SOIC-8 (D) <sup>(1)</sup>	MSOP-8 PowerPAD (DGN) <sup>(2)</sup>	PDIP-8 (P)
Dual inverting	-40°C to 125°C	UCC27423D	UCC27423DGN	UCC27423P
Dual nonInverting	-40°C to 125°C	UCC27424D	UCC27424DGN	UCC27424P
One inverting, one noninverting	-40°C to 125°C	UCC27425D	UCC27425DGN	UCC27425P

- (1) D (SOIC-8) and DGN (PowerPAD-MSOP) packages are available taped and reeled. Add R suffix to device type (e.g. UCC27423DR, UCC27424DGNR) to order quantities of 2,500 devices per reel for D or 1,000 devices per reel for DGN package.
- (2) The PowerPAD™ 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.



**POWER DISSIPATION RATING TABLE**

PACKAGE	SUFFIX	$\theta_{JC}$ (°C/W)	$\theta_{JA}$ (°C/W)	POWER RATING (mW) $T_A = 70^\circ\text{C}^{(1)}$	DERATING FACTOR ABOVE $70^\circ\text{C}$ (mW/°C) <sup>(1)</sup>
SOIC-8	D	42	84 - 160‡	344–655 <sup>(2)</sup>	6.25–11.9 <sup>(2)</sup>
PDIP-8	P	49	110	500	9
MSOP PowerPAD-8 <sup>(3)</sup>	DGN	4.7	50 - 59‡	1370	17.1

- (1) 125°C operating junction temperature is used for power rating calculations
- (2) The range of values indicates the effect of pc-board. These values are intended to give the system designer an indication of the best and worst case conditions. In general, the system designer should attempt to use larger traces on the pc-board where possible in order to spread the heat away from the device more effectively. For information on the PowerPAD™ package, refer to Technical Brief, *PowerPad Thermally Enhanced Package*, Texas Instruments (SLMA002) and Application Brief, *PowerPad Made Easy*, Texas Instruments (SLMA004).
- (3) The PowerPAD™ 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.

**Table 1. Input/Output Table**

		INPUTS (VIN_L, VIN_H)		UCC27423		UCC27424		UCC27425	
ENBA	ENBB	INA	INB	OUTA	OUTB	OUTA	OUTB	OUTA	OUTB
H	H	L	L	H	H	L	L	H	L
H	H	L	H	H	L	L	H	H	H
H	H	H	L	L	H	H	L	L	L
H	H	H	H	L	L	H	H	L	H
L	L	X	X	L	L	L	L	L	L

## ABSOLUTE MAXIMUM RATINGS

 over operating free-air temperature range (unless otherwise noted) <sup>(1)</sup>

		VALUE	UNIT
V <sub>DD</sub>	Supply voltage	-0.3 to 16	V
I <sub>OUT_DC</sub>	Output current (OUTA, OUTB) DC	0.2	A
I <sub>OUT_PULSED</sub>	Pulsed, (0.5μs)	4.5	A
V <sub>IN</sub>	Input voltage (INA, INB)	-5 to 6 or V <sub>DD</sub> +0.3 (whichever is larger)	V
	Enable voltage (ENBA, ENBB)	-0.3 V to 6 V or V <sub>DD</sub> +0.3 (whichever is larger)	
Power dissipation at T <sub>A</sub> = 25°C	DGN package	3	W
	D package	650	mW
	P package	350	
T <sub>J</sub>	Junction operating temperature	-55 to 150	°C
T <sub>stg</sub>	Storage temperature	-65 to 150	
	Lead temperature (soldering, 10 sec)	300	

 (1) When V<sub>DD</sub> ≤ 6 V, EN rating max value is 6 V; when V<sub>DD</sub> > 6 V, EN rating max value is V<sub>DD</sub> + 0.3 V.

## ELECTRICAL CHARACTERISTICS

 V<sub>DD</sub> = 4.5V to 15V, T<sub>A</sub> = -40°C to 125°C, T<sub>A</sub> = T<sub>J</sub>, (unless otherwise noted)

PARAMETER		TEST CONDITION	MIN	TYP	MAX	UNIT
<b>INPUT (INA, INB)</b>						
V <sub>IN_H</sub>	Logic 1 input threshold		2			V
V <sub>IN_L</sub>	Logic 0 input threshold				1	
	Input current	0 V ≤ V <sub>IN</sub> ≤ V <sub>DD</sub>	-10	0	10	μA
<b>OUTPUT (OUTA, OUTB)</b>						
	Output current	V <sub>DD</sub> = 14 V <sup>(1)</sup>		4		A
V <sub>OH</sub>	High-level output voltage	V <sub>OH</sub> = V <sub>DD</sub> - V <sub>OUT</sub> , I <sub>OUT</sub> = -10 mA		330	450	mV
V <sub>OL</sub>	Low-level output level	I <sub>OUT</sub> = 10 mA		22	45	
Output resistance high		T <sub>A</sub> = 25°C, I <sub>OUT</sub> = -10 mA, V <sub>DD</sub> = 14 V <sup>(2)</sup>	25	30	35	Ω
		T <sub>A</sub> = full range, I <sub>OUT</sub> = -10 mA, V <sub>DD</sub> = 14 V <sup>(2)</sup>	18		45	
Output resistance low		T <sub>A</sub> = 25°C, I <sub>OUT</sub> = 10 mA, V <sub>DD</sub> = 14 V <sup>(2)</sup>	1.9	2.2	2.5	
		T <sub>A</sub> = full range, I <sub>OUT</sub> = 10 mA, V <sub>DD</sub> = 14 V <sup>(2)</sup>	1.2		4.0	
	Latch-up protection		500			mA
<b>SWITCHING TIME</b>						
t <sub>r</sub>	Rise time (OUTA, OUTB)	C <sub>LOAD</sub> = 1.8 nF		20	40	ns
t <sub>f</sub>	Fall time (OUTA, OUTB)	C <sub>LOAD</sub> = 1.8 nF		15	40	
t <sub>d1</sub>	Delay, IN rising (IN to OUT)	C <sub>LOAD</sub> = 1.8 nF		25	40	
t <sub>d2</sub>	Delay, IN falling (IN to OUT)	C <sub>LOAD</sub> = 1.8 nF		35	50	

(1) The pullup / pulldown circuits of the driver are bipolar and MOSFET transistors in parallel. The pulsed output current rating is the combined current from the bipolar and MOSFET transistors.

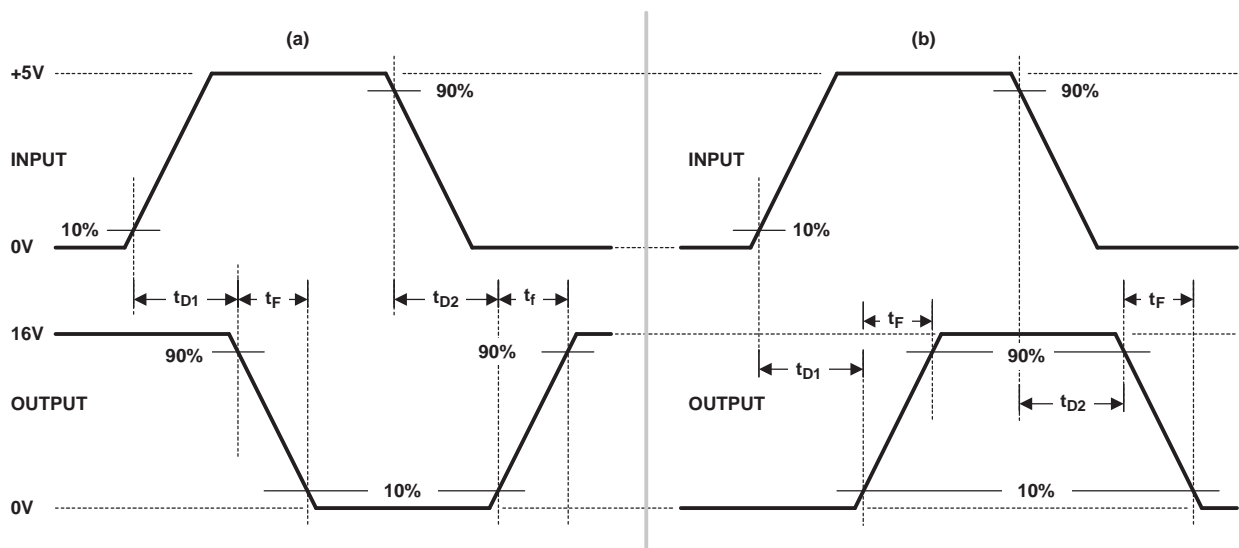
 (2) The pullup / pulldown circuits of the driver are bipolar and MOSFET transistors in parallel. The output resistance is the R<sub>ds(on)</sub> of the MOSFET transistor when the voltage on the driver output is less than the saturation voltage of the bipolar transistor.

**ELECTRICAL CHARACTERISTICS (Continued)**

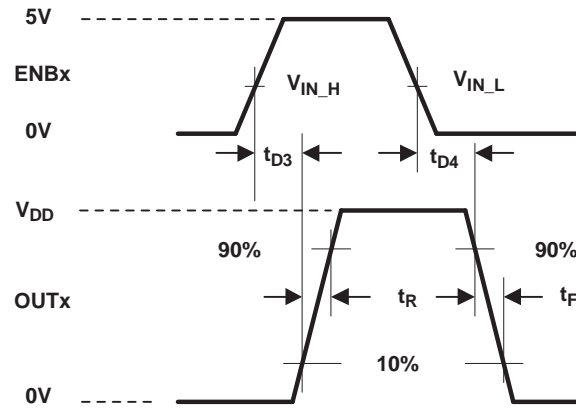
$V_{DD} = 4.5V$  to  $15V$ ,  $T_A = -40^\circ C$  to  $125^\circ C$ ,  $T_A = T_J$  (unless otherwise noted) <sup>(1)</sup> <sup>(2)</sup>

PARAMETER		TEST CONDITION	MIN	TYP	MAX	UNITS
<b>ENABLE (ENBA, ENBB)</b>						
$V_{IN\_H}$	High-level input voltage	LO to HI transition	1.7	2.4	2.9	V
$V_{IN\_L}$	Low-level input voltage	HI to LO transition	1.1	1.8	2.2	
Hysteresis			0.15	0.55	0.90	
$R_{ENBL}$	Enable impedance	$V_{DD} = 14V$ , ENBL = GND	75	100	140	k $\Omega$
$t_{D3}$	Propagation delay time (see Figure 2)	$C_{LOAD} = 1.8nF$		30	60	ns
$t_{D4}$	Propagation delay time (see Figure 2)	$C_{LOAD} = 1.8nF$		100	150	
<b>OVERALL</b>						
$I_{DD}$	Static operating current, $V_{DD} = 15V$ , ENBA = ENBB = $15V$	UCC27423	INA = 0V, INB = 0V	900	1350	$\mu A$
			INA = 0V, INB = HIGH	750	1100	
			INA = HIGH, INB = 0V	750	1100	
			INA = HIGH, INB = HIGH	600	900	
		UCC27424	INA = 0V, INB = 0V	300	450	$\mu A$
			INA = 0V, INB = HIGH	750	1100	
			INA = HIGH, INB = 0V	750	1100	
			INA = HIGH, INB = HIGH	1200	1800	
		UCC27425	INA = 0V, INB = 0V	600	900	$\mu A$
			INA = 0V, INB = HIGH	1050	1600	
			INA = HIGH, INB = 0V	450	700	
			INA = HIGH, INB = HIGH	900	1350	
$I_{DD}$	Disabled, $V_{DD} = 15V$ , ENBA = ENBB = 0V	All	INA = 0V, INB = 0V	300	450	$\mu A$
			INA = 0V, INB = HIGH	450	700	
			INA = HIGH, INB = 0V	450	700	
			INA = HIGH, INB = HIGH	600	900	

- (1) The pullup / pulldown circuits of the driver are bipolar and MOSFET transistors in parallel. The peak output current rating is the combined current from the bipolar and MOSFET transistors.
- (2) The pullup / pulldown circuits of the driver are bipolar and MOSFET transistors in parallel. The output resistance is the  $R_{ds(on)}$  of the MOSFET transistor when the voltage on the driver output is less than the saturation voltage of the bipolar transistor.



**Figure 1. Switching Waveforms for (a) Inverting Driver and (b) Noninverting Driver**



NOTE: The 10% and 90% thresholds depict the dynamics of the BiPolar output devices that dominate the power MOSFET transition through the Miller regions of operation.

**Figure 2. Switching Waveform for Enable to Output**

### Terminal Functions

TERMINAL		I/O	FUNCTION
NO.	NAME		
1	ENBA	I	Enable input for the driver A with logic compatible threshold and hysteresis. The driver output can be enabled and disabled with this pin. It is internally pulled up to $V_{DD}$ with 100k $\Omega$ resistor for active high operation. The output state when the device is disabled will be low regardless of the input state.
2	INA	I	Input A. Input signal of the A driver which has logic compatible threshold and hysteresis. If not used, this input should be tied to either VDD or GND. It should not be left floating. <sup>(1)</sup>
3	GND		Common ground. This ground should be connected very closely to the source of the power MOSFET which the driver is driving.
4	INB	I	Input B. Input signal of the A driver which has logic compatible threshold and hysteresis. If not used, this input should be tied to either VDD or GND. It should not be left floating.
5	OUTB	O	Driver output B. The output stage is capable of providing 4A drive current to the gate of a power MOSFET.
6	VDD	I	Supply. Supply voltage and the power input connection for this device.
7	OUTA	O	Driver output A. The output stage is capable of providing 4A drive current to the gate of a power MOSFET.
8	ENBB	I	Enable input for the driver B with logic compatible threshold and hysteresis. The driver output can be enabled and disabled with this pin. It is internally pulled up to $V_{DD}$ with 100k $\Omega$ resistor for active high operation. The output state when the device is disabled will be low regardless of the input state. <sup>(1)</sup>

(1) Refer to [APPLICATION INFORMATION](#) Section for more details.

## APPLICATION INFORMATION

### General Information

High frequency power supplies often require high-speed, high-current drivers such as the UCC27423/4/5 family. A leading application is the need to provide a high power buffer stage between the PWM output of the control IC and the gates of the primary power MOSFET or IGBT switching devices. In other cases, the driver IC is utilized to drive the power device gates through a drive transformer. Synchronous rectification supplies also have the need to simultaneously drive multiple devices which can present an extremely large load to the control circuitry.

Driver ICs are utilized when it is not feasible to have the primary PWM regulator IC directly drive the switching devices for one or more reasons. The PWM IC may not have the brute drive capability required for the intended switching MOSFET, limiting the switching performance in the application. In other cases there may be a desire to minimize the effect of high frequency switching noise by placing the high current driver physically close to the load. Also, newer ICs that target the highest operating frequencies may not incorporate onboard gate drivers at all. Their PWM outputs are only intended to drive the high impedance input to a driver such as the UCC27423/4/5. Finally, the control IC may be under thermal stress due to power dissipation, and an external driver can help by moving the heat from the controller to an external package.

### Input Stage

The input thresholds have a 3.3V logic sensitivity over the full range of  $V_{DD}$  voltages; yet it is equally compatible with 0 to  $V_{DD}$  signals. The inputs of UCC27423/4/5 family of drivers are designed to withstand 500-mA reverse current without either damage to the IC for logic upset. The input stage of each driver should be driven by a signal with a short rise or fall time. This condition is satisfied in typical power supply applications, where the input signals are provided by a PWM controller or logic gates with fast transition times (<200 ns). The input stages to the drivers function as a digital gate, and they are not intended for applications where a slow changing input voltage is used to generate a switching output when the logic threshold of the input section is reached. While this may not be harmful to the driver, the output of the driver may switch repeatedly at a high frequency.

Users should not attempt to shape the input signals to the driver in an attempt to slow down (or delay) the signal at the output. If limiting the rise or fall times to the power device is desired, limit the rise or fall times to the power device, then an external resistance can be added between the output of the driver and the load device, which is generally a power MOSFET gate. The external resistor may also help remove power dissipation from the device package, as discussed in the section on Thermal Considerations.

### Output Stage

Inverting outputs of the UCC27423 and OUTA of the UCC27425 are intended to drive external P-channel MOSFETs. Noninverting outputs of the UCC27424 and OUTB of the UCC27425 are intended to drive external N-channel MOSFETs.

Each output stage is capable of supplying  $\pm 4A$  peak current pulses and swings to both  $V_{DD}$  and GND. The pullup/pulldown circuits of the driver are constructed of bipolar and MOSFET transistors in parallel. The peak output current rating is the combined current from the bipolar and MOSFET transistors. The output resistance is the  $R_{DS(on)}$  of the MOSFET transistor when the voltage on the driver output is less than the saturation voltage of the bipolar transistor. Each output stage also provides a very low impedance to overshoot and undershoot due to the body diode of the external MOSFET. This means that in many cases, external-schottky-clamp diodes are not required.

The UCC27423 family delivers 4A of gate drive where it is most needed during the MOSFET switching transition – at the Miller plateau region – providing improved efficiency gains. A unique BiPolar and MOSFET hybrid output stage in parallel also allows efficient current sourcing at low supply voltages.

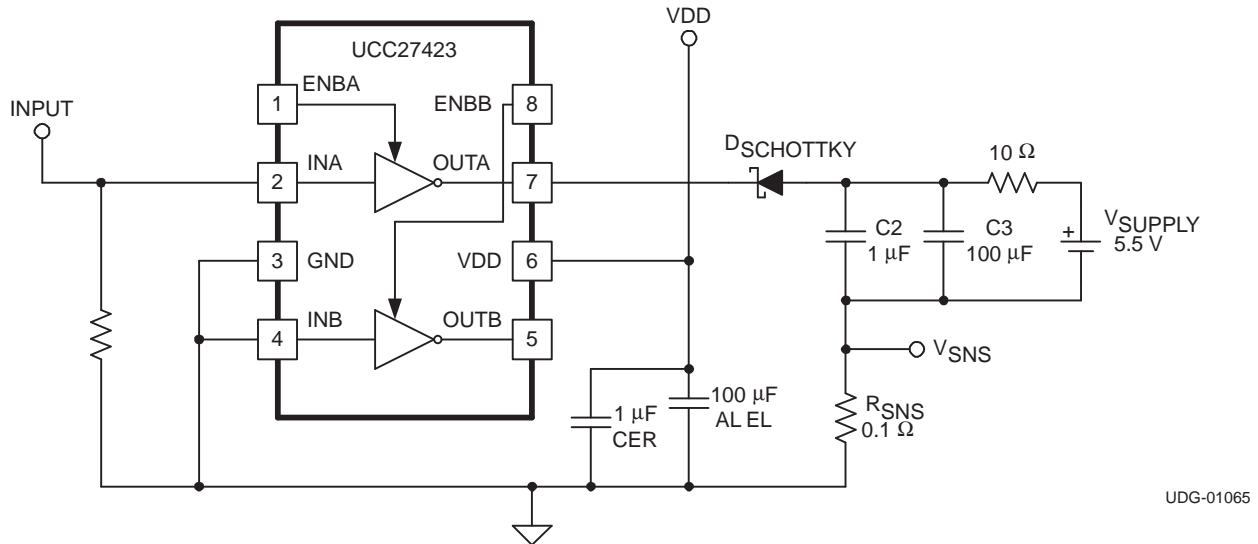
### Source/Sink Capabilities During Miller Plateau

Large power MOSFETs present a large load to the control circuitry. Proper drive is required for efficient, reliable operation. The UCC27423/4/5 drivers have been optimized to provide maximum drive to a power MOSFET during the Miller plateau region of the switching transition. This interval occurs while the drain voltage is swinging between the voltage levels dictated by the power topology, requiring the charging/discharging of the drain-gate capacitance with current supplied or removed by the driver device. <sup>[1]</sup>

Two circuits are used to test the current capabilities of the UCC27423 driver. In each case external circuitry is added to clamp the output near 5 V while the IC is sinking or sourcing current. An input pulse of 250 ns is applied at a frequency of 1 kHz in the proper polarity for the respective test. In each test there is a transient period where the current peaked up and then settled down to a steady-state value. The noted current measurements are made at a time of 200 ns after the input pulse is applied, after the initial transient.

The first circuit in [Figure 2](#) is used to verify the current sink capability when the output of the driver is clamped around 5V, a typical value of gate-source voltage during the Miller plateau region. The UCC27423 is found to sink 4.5A at  $V_{DD} = 15V$  and 4.28A at  $V_{DD} = 12V$ .

The circuit shown in [Figure 3](#) is used to test the current source capability with the output clamped to around 5 V with a string of Zener diodes. The UCC27423 is found to source 4.8 A at  $V_{DD} = 15 V$  and 3.7 A at  $V_{DD} = 12 V$ .



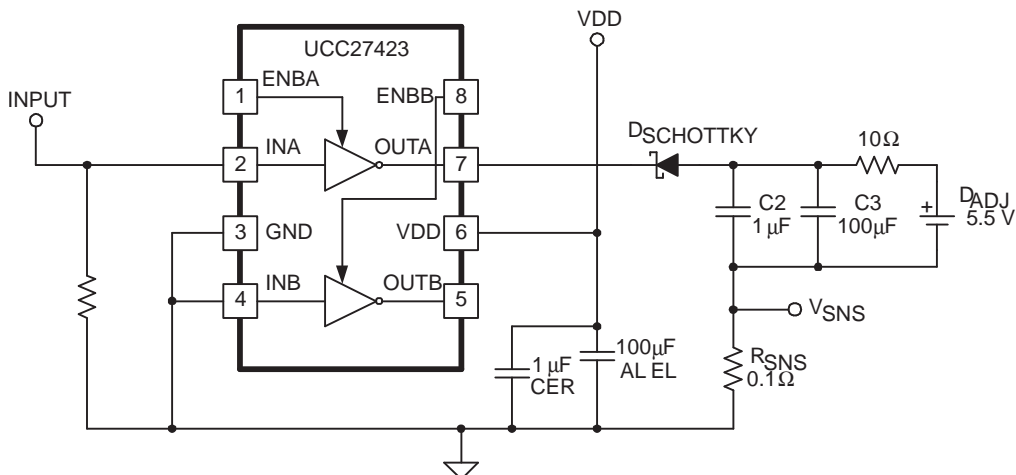
**Figure 3.**

It should be noted that the current sink capability is slightly stronger than the current source capability at lower VDD. This is due to the differences in the structure of the bipolar-MOSFET power output section, where the current source is a P-channel MOSFET and the current sink has an N-channel MOSFET.

In a large majority of applications it is advantageous that the turn-off capability of a driver is stronger than the turn-on capability. This helps to ensure that the MOSFET is held OFF during common power supply transients which may turn the device back ON.

### Parallel Outputs

The A and B drivers may be combined into a single driver by connecting the INA/INB inputs together and the OUTA/OUTB outputs together. Then, a single signal can control the paralleled combination as shown in [Figure 4](#).

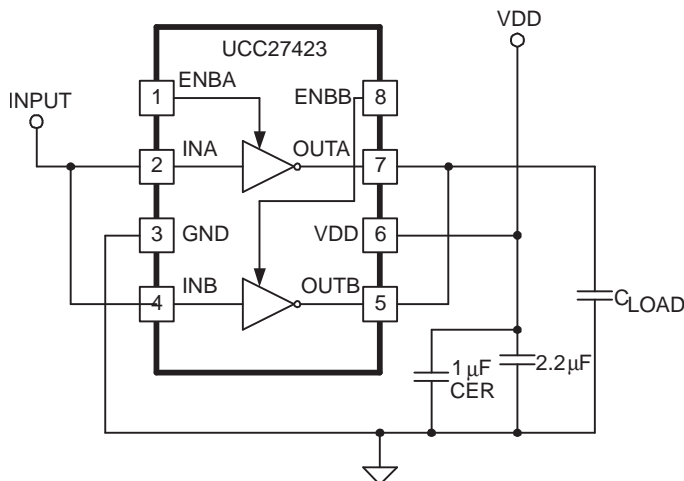


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Figure 4.

### Operational Waveforms and Circuit Layout

Figure 5 shows the circuit performance achievable with a single driver (1/2 of the 8-pin IC) driving a 10-nF load. The input pulsewidth (not shown) is set to 300ns to show both transitions in the output waveform. Note the linear rise and fall edges of the switching waveforms. This is due to the constant output current characteristic of the driver as opposed to the resistive output impedance of traditional MOSFET-based gate drivers.



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Figure 5.



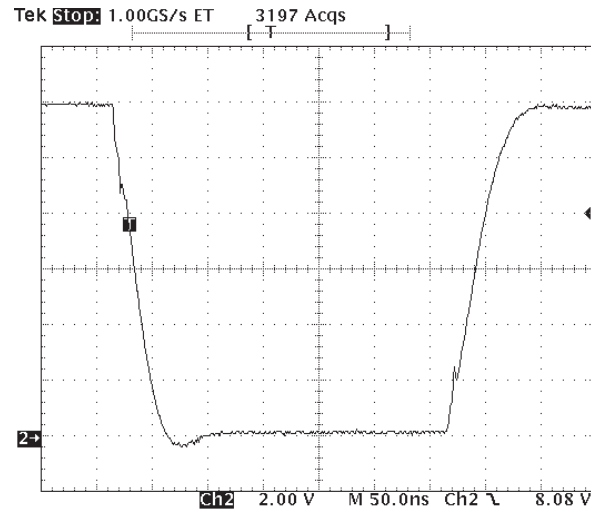


Figure 6.

In a power driver operating at high frequency, it is a significant challenge to get clean waveforms without much overshoot/undershoot and ringing. The low output impedance of these drivers produces waveforms with high di/dt. This tends to induce ringing in the parasitic inductances. Utmost care must be used in the circuit layout. It is advantageous to connect the driver IC as close as possible to the leads. The driver IC layout has ground on the opposite side of the output, so the ground should be connected to the bypass capacitors and the load with copper trace as wide as possible. These connections should also be made with a small enclosed loop area to minimize the inductance.

## VDD

Although quiescent VDD current is very low, total supply current will be higher, depending on OUTA and OUTB current and the programmed oscillator frequency. Total VDD current is the sum of quiescent VDD current and the average OUT current. Knowing the operating frequency and the MOSFET gate charge (Qg), average OUT current can be calculated from:

$$I_{OUT} = Qg \times f, \text{ where } f \text{ is frequency}$$

For the best high-speed circuit performance, two V<sub>DD</sub> bypass capacitors are recommended to prevent noise problems. The use of surface mount components is highly recommended. A 0.1µF ceramic capacitor should be located closest to the VDD to ground connection. In addition, a larger capacitor (such as 1µF) with relatively low ESR should be connected in parallel, to help deliver the high current peaks to the load. The parallel combination of capacitors should present a low impedance characteristic for the expected current levels in the driver application.

## Drive Current and Power Requirements

The UCC27423/4/5 family of drivers are capable of delivering 4A of current to a MOSFET gate for a period of several hundred nanoseconds. High peak current is required to turn the device ON quickly. Then, to turn the device OFF, the driver is required to sink a similar amount of current to ground. This repeats at the operating frequency of the power device. A MOSFET is used in this discussion because it is the most common type of switching device used in high frequency power conversion equipment.

References 1 and 2 discuss the current required to drive a power MOSFET and other capacitive-input switching devices. Reference 2 includes information on the previous generation of bipolar IC gate drivers.

When a driver IC is tested with a discrete, capacitive load it is a fairly simple matter to calculate the power that is required from the bias supply. The energy that must be transferred from the bias supply to charge the capacitor is given by:

$$E = \frac{1}{2} CV^2, \text{ where } C \text{ is the load capacitor and } V \text{ is the bias voltage feeding the driver.}$$

There is an equal amount of energy transferred to ground when the capacitor is discharged. This leads to a power loss given by the following:

$$P = 2 \times \frac{1}{2} CV^2 f, \text{ where } f \text{ is the switching frequency.}$$

This power is dissipated in the resistive elements of the circuit. Thus, with no external resistor between the driver and gate, this power is dissipated inside the driver. Half of the total power is dissipated when the capacitor is charged, and the other half is dissipated when the capacitor is discharged. An actual example using the conditions of the previous gate drive waveform should help clarify this.

With  $V_{DD} = 12V$ ,  $C_{LOAD} = 10nF$ , and  $f = 300kHz$ , the power loss can be calculated as:

$$P = 10nF \times (12)^2 \times (300kHz) = 0.432W$$

With a 12V supply, this would equate to a current of:

$$I = \frac{P}{V} = \frac{0.432 \text{ W}}{12 \text{ V}} = 0.036 \text{ A} \quad (1)$$

The actual current measured from the supply was 0.037A, and is very close to the predicted value. But, the  $I_{DD}$  current that is due to the IC internal consumption should be considered. With no load the IC current draw is 0.0027A. Under this condition the output rise and fall times are faster than with a load. This could lead to an almost insignificant, yet measurable current due to cross-conduction in the output stages of the driver. However, these small current differences are buried in the high frequency switching spikes, and are beyond the measurement capabilities of a basic lab setup. The measured current with 10nF load is reasonably close to that expected.

The switching load presented by a power MOSFET can be 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 of the device between the ON and OFF states. Most manufacturers provide specifications that provide the typical and maximum gate charge, in nC, to switch the device under specified conditions. Using the gate charge  $Q_g$ , one can determine the power that must be dissipated when charging a capacitor. This is done by using the equivalence  $Q_g = C_{eff}V$  to provide the following equation for power:

$$P = C \times V^2 \times f = Q_g \times f \quad (2)$$

This equation allows a power designer to calculate the bias power required to drive a specific MOSFET gate at a specific bias voltage.

## ENABLE

UCC27423/4/5 provides dual Enable inputs for improved control of each driver channel operation. The inputs incorporate logic compatible thresholds with hysteresis. They are internally pulled up to  $V_{DD}$  with 100k $\Omega$  resistor for active high operation. When ENBA and ENBB are driven high, the drivers are enabled and when ENBA and ENBB are low, the drivers are disabled. The default state of the Enable pin is to enable the driver and therefore can be left open for standard operation. However, if the enable pin is left open, it is recommended to terminate any PCB traces to be as short as possible to limit noise. If large noise is present due to non-optimal PCB layout, it is recommended to tie the Enable pin to Vcc or to add a filter capacitor (0.1  $\mu F$ ) to the Enable pin. The output states when the drivers are disabled is low regardless of the input state. See the truth table of [Table 1](#) for the operation using enable logic.

Enable input are compatible with both logic signals and slow changing analog signals. They can be directly driven or a power-up delay can be programmed with a capacitor between ENBA, ENBB and AGND. ENBA and ENBB control input A and input B respectively.

## Thermal Information

The useful range of a driver is greatly affected by the drive power requirements of the load and the thermal characteristics of the IC package. In order for a power driver to be useful over a particular temperature range the package must allow for the efficient removal of the heat produced while keeping the junction temperature within rated limits. The UCC27423/4/5 family of drivers is available in three different packages to cover a range of application requirements.

As shown in the power dissipation rating table, the SOIC-8 (D) and PDIP-8 (P) packages each have a power rating of around 0.5W with  $T_A = 70^\circ\text{C}$ . This limit is imposed in conjunction with the power derating factor also given in the table. Note that the power dissipation in our earlier example is 0.432W with a 10nF load, 12VDD, switched at 300kHz. Thus, only one load of this size could be driven using the D or P package, even if the two onboard drivers are paralleled. The difficulties with heat removal limit the drive available in the older packages.

The MSOP PowerPAD-8 (DGN) package significantly relieves this concern by offering an effective means of removing the heat from the semiconductor junction. As illustrated in Reference 3, the PowerPAD packages offer a leadframe die pad that is exposed at the base of the package. This pad is soldered to the copper on the PC board directly underneath the IC package, reducing the  $\theta_{jc}$  down to  $4.7^\circ\text{C/W}$ . Data is presented in Reference 3 to show that the power dissipation can be quadrupled in the PowerPAD configuration when compared to the standard packages. The PC board must be designed with thermal lands and thermal vias to complete the heat removal subsystem, as summarized in Reference 4. This allows a significant improvement in heatsinking over that available in the D or P packages, and is shown to more than double the power capability of the D and P packages. Note that the PowerPAD™ 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.

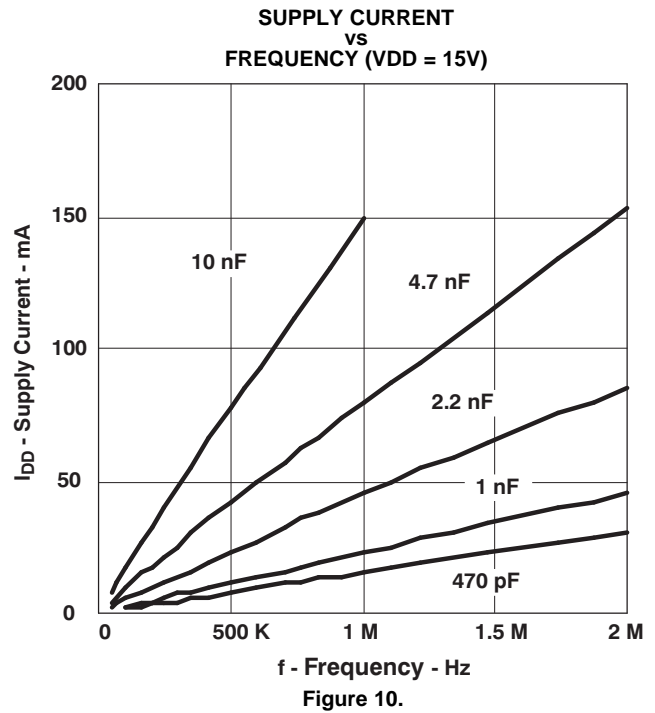
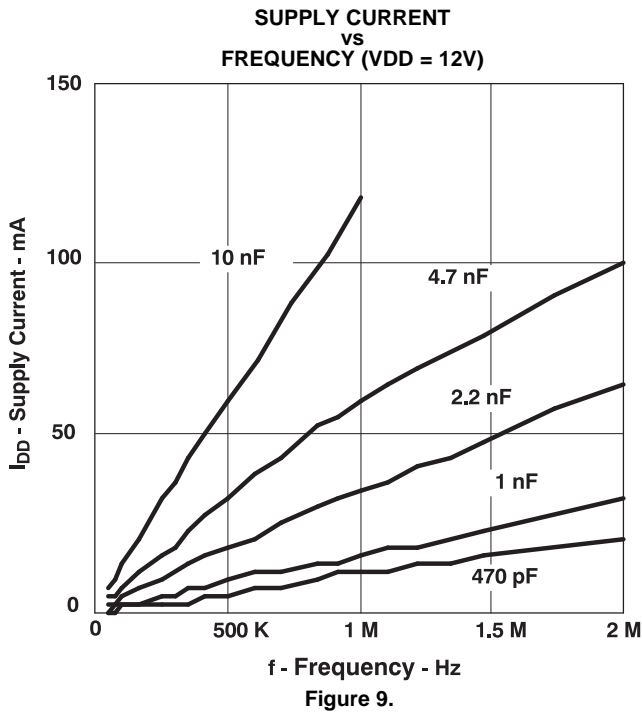
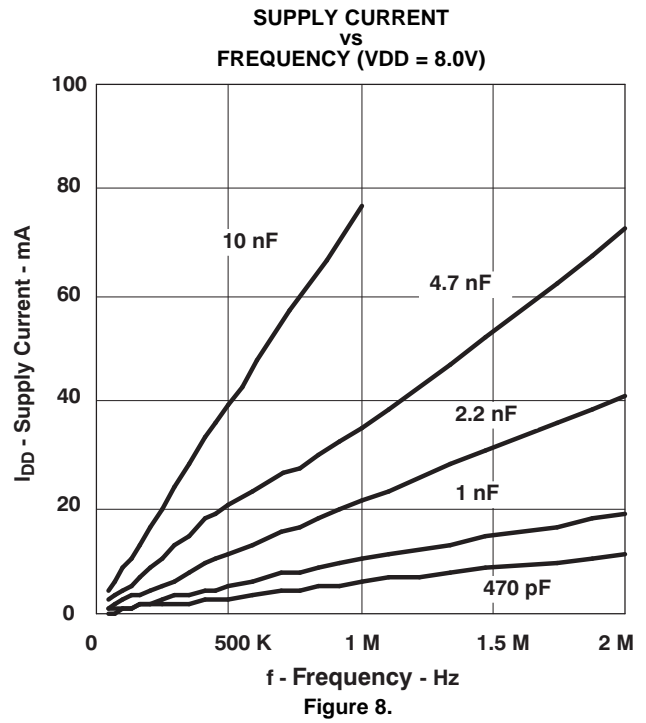
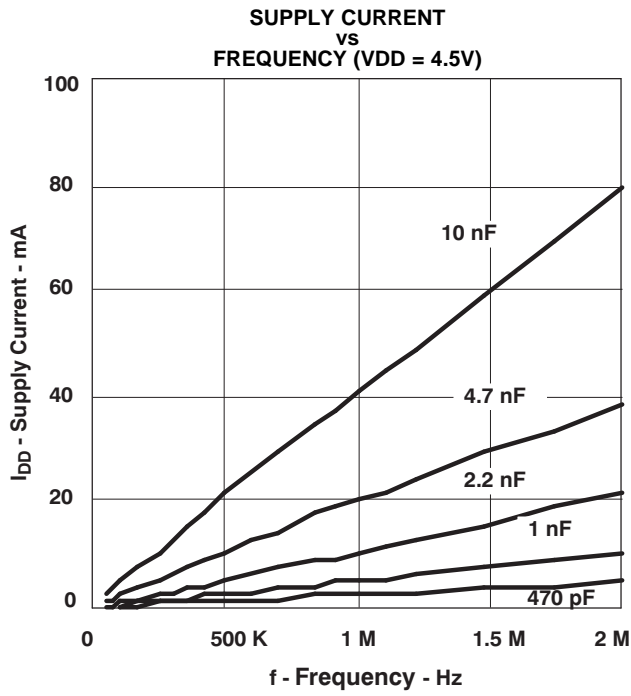
## References

1. Power Supply Seminar SEM-1400 Topic 2: *Design And Application Guide For High Speed MOSFET Gate Drive Circuits*, by Laszlo Balogh, Texas Instruments ([SLUP133](#)).
2. Application Note, *Practical Considerations in High Performance MOSFET, IGBT and MCT Gate Drive Circuits*, by Bill Andreyckak, Texas Instruments ([SLUA105](#))
3. Technical Brief, *PowerPad Thermally Enhanced Package*, Texas Instruments ([SLMA002](#))
4. Application Brief, *PowerPAD Made Easy*, Texas Instruments ([SLMA004](#))

## Related Products

PRODUCT	DESCRIPTION	PACKAGES
UCC37323/4/5	Dual 4-A Low-Side Drivers	MSOP-8 PowerPAD, SOIC-8, PDIP-8
UCC37321/2	Single 9-A Low-Side Driver with Enable	MSOP-8 PowerPAD, SOIC-8, PDIP-8
TPS2811/12/13	Dual 2-A Low-Side Drivers with Internal Regulator	TSSOP-8, SOIC-8, PDIP-8
TPS2814/15	Dual 2-A Low-Side Drivers with Two Inputs per Channel	TSSOP-8, SOIC-8, PDIP-8
TPS2816/17/18/19	Single 2-A Low-Side Driver with Internal Regulator	5-Pin SOT-23
TPS2828/29	Single 2-A Low-Side Driver	5-Pin SOT-23

TYPICAL CHARACTERISTICS



TYPICAL CHARACTERISTICS (continued)

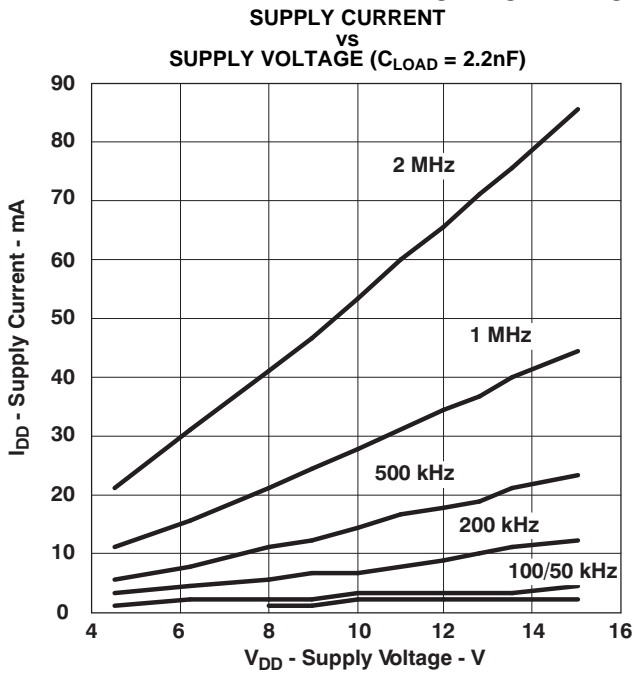


Figure 11.

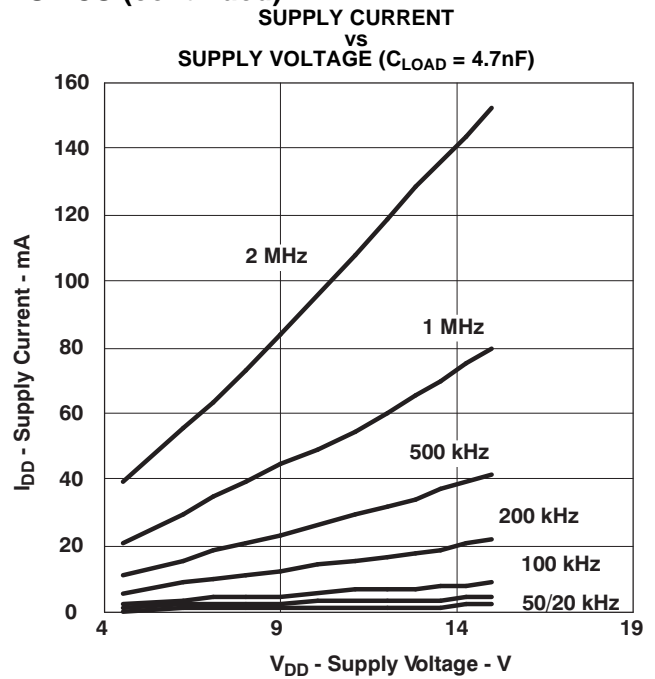


Figure 12.

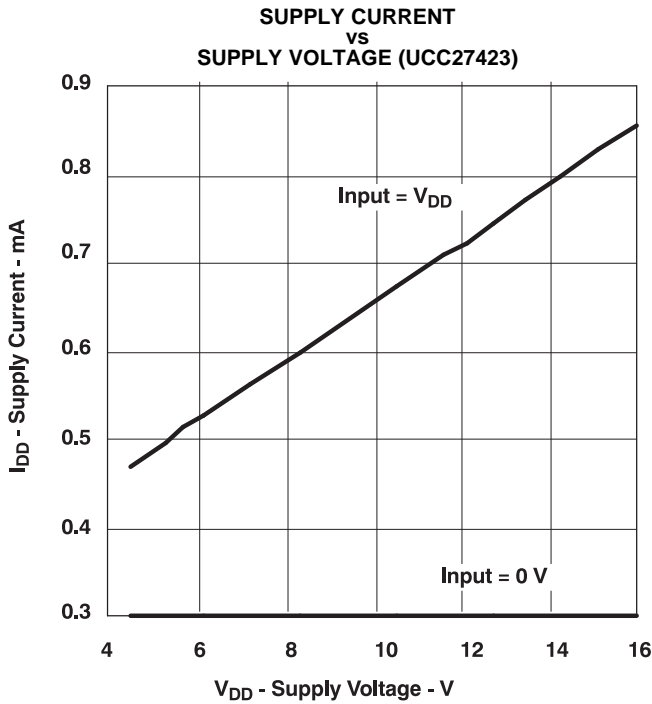


Figure 13.

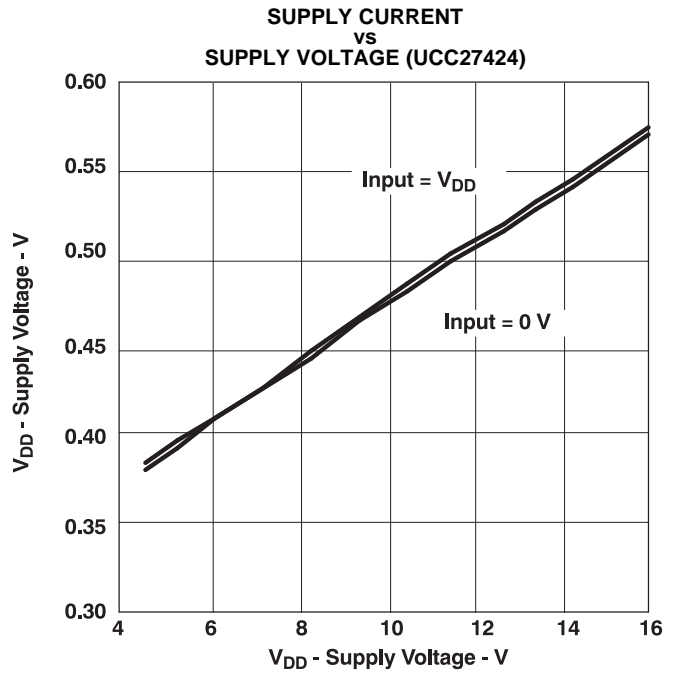


Figure 14.

**TYPICAL CHARACTERISTICS (continued)**

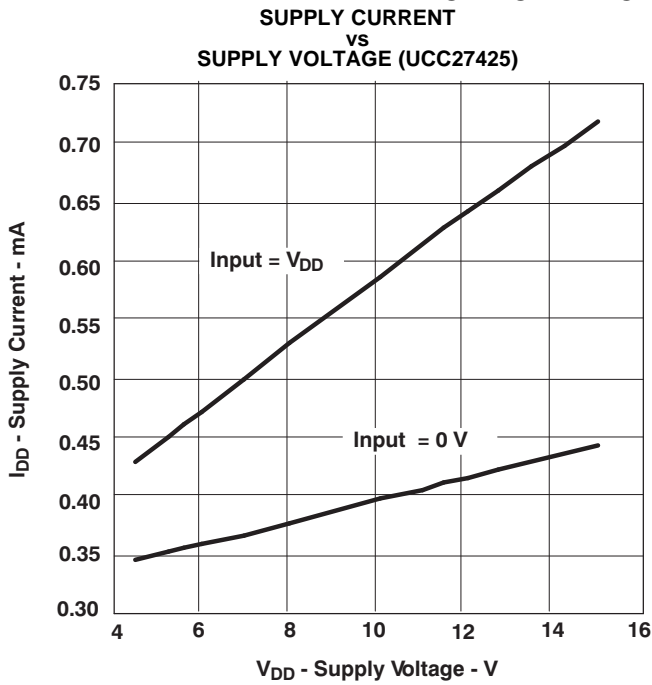


Figure 15.

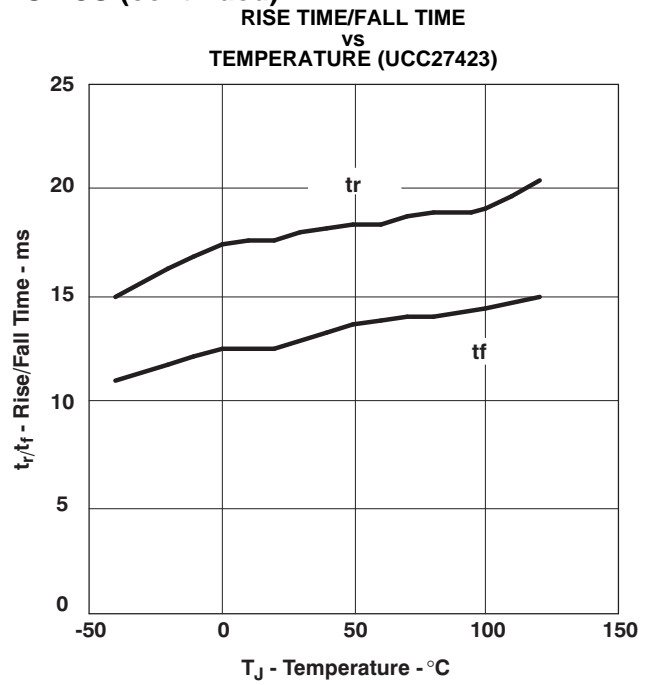


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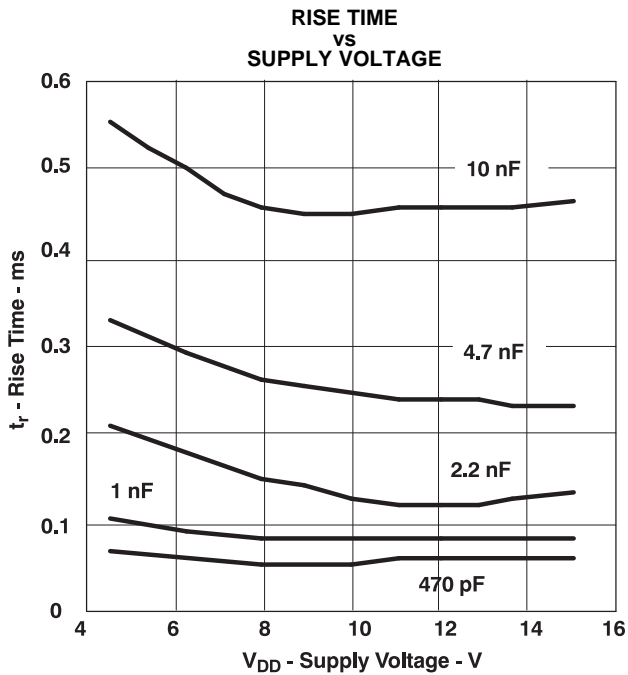


Figure 17.

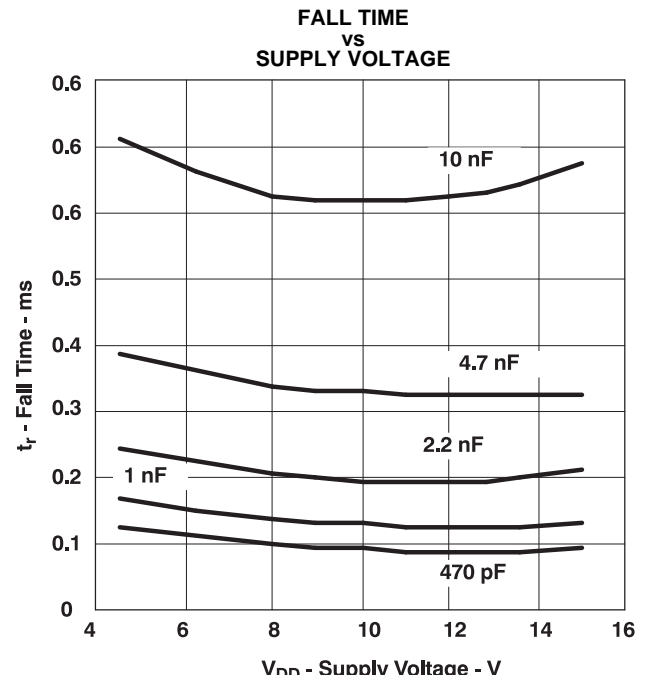


Figure 18.

TYPICAL CHARACTERISTICS (continued)

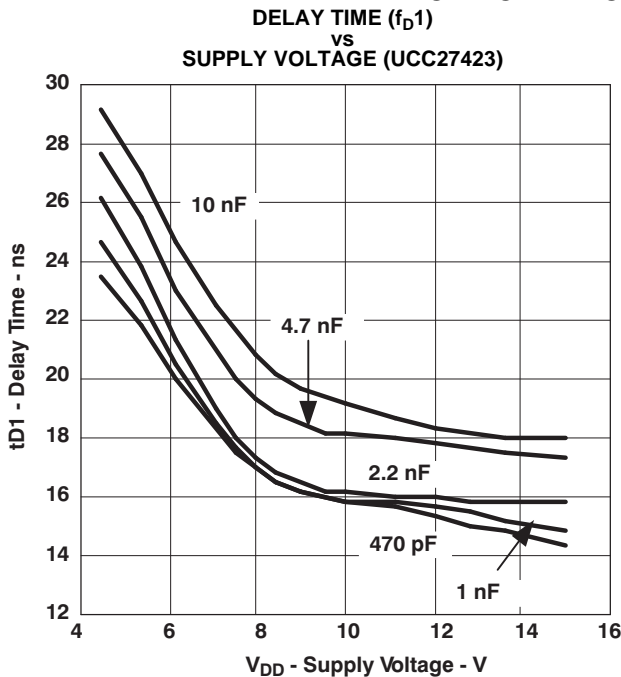


Figure 19.

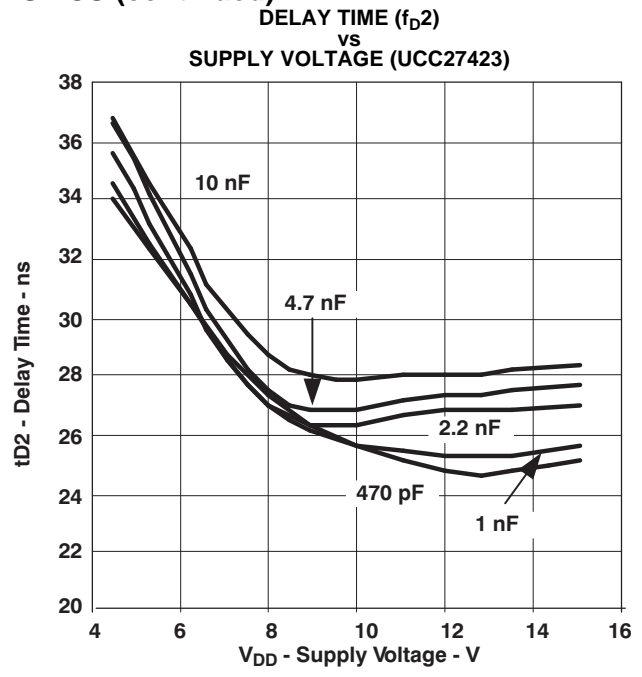


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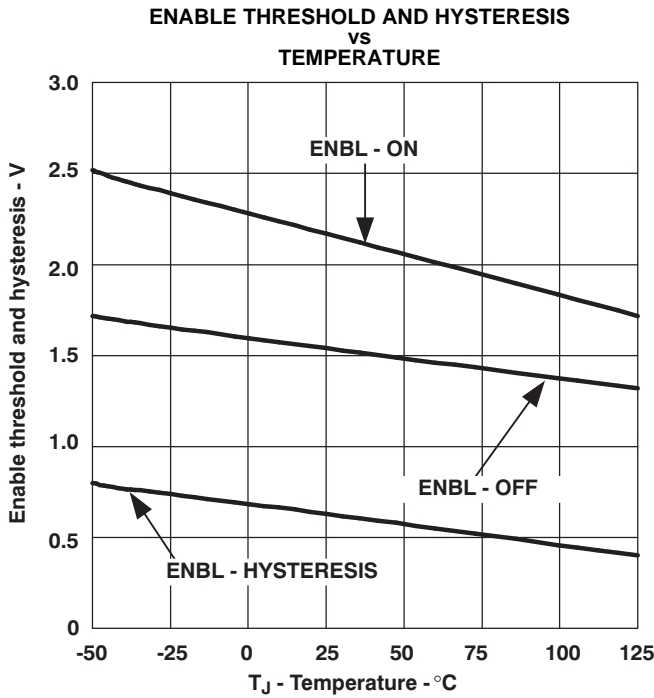


Figure 21.

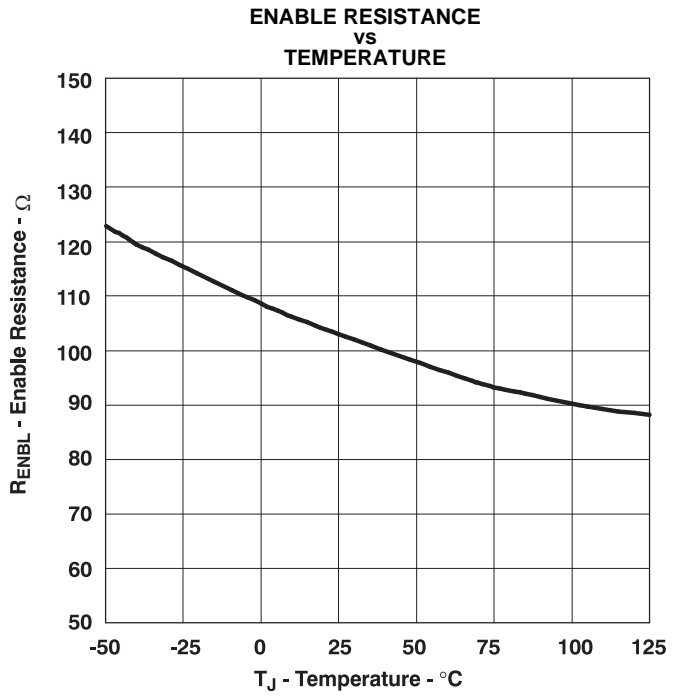


Figure 22.

**TYPICAL CHARACTERISTICS (continued)**

**OUTPUT BEHAVIOR  
vs  
SUPPLY VOLTAGE (INVERTING)**

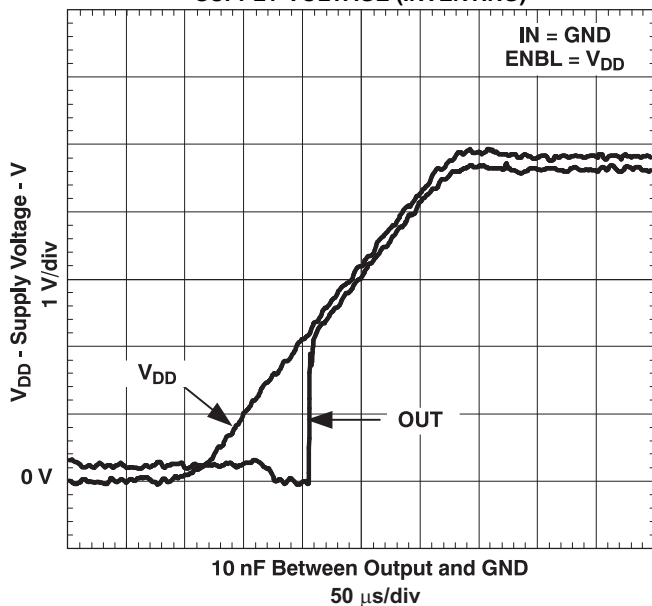


Figure 23.

**OUTPUT BEHAVIOR  
vs  
SUPPLY VOLTAGE (INVERTING)**

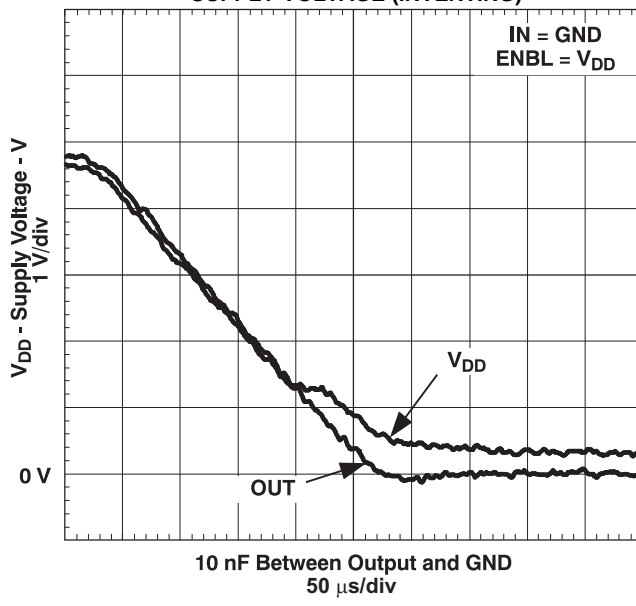


Figure 24.

**OUTPUT BEHAVIOR  
vs  
VDD (INVERTING)**

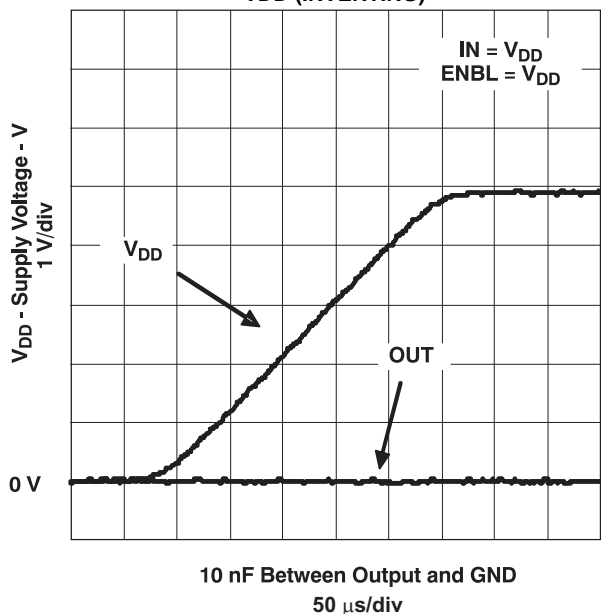


Figure 25.

**OUTPUT BEHAVIOR  
vs  
VDD (INVERTING)**

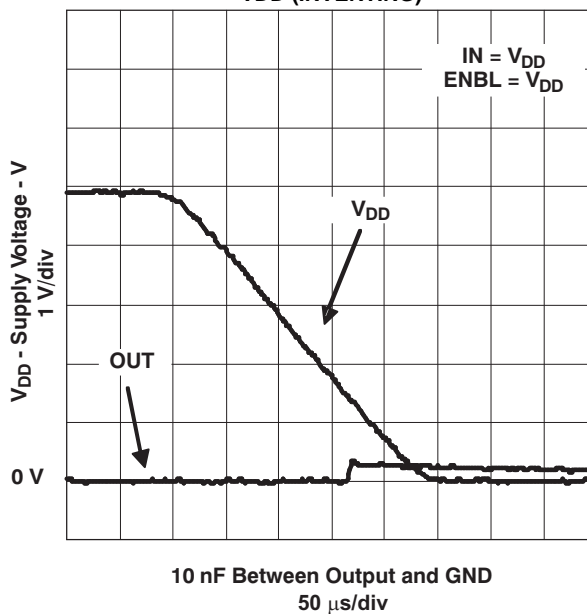


Figure 26.



TYPICAL CHARACTERISTICS (continued)

OUTPUT BEHAVIOR  
vs  
VDD (NON-INVERTING)

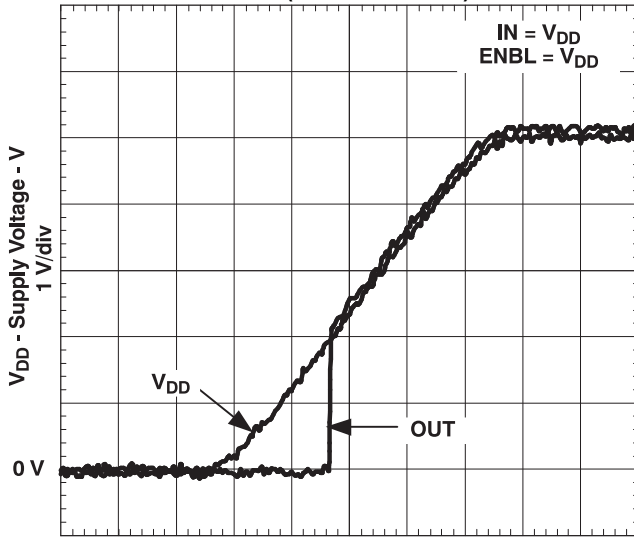


Figure 27.

OUTPUT BEHAVIOR  
vs  
VDD (NON-INVERTING)

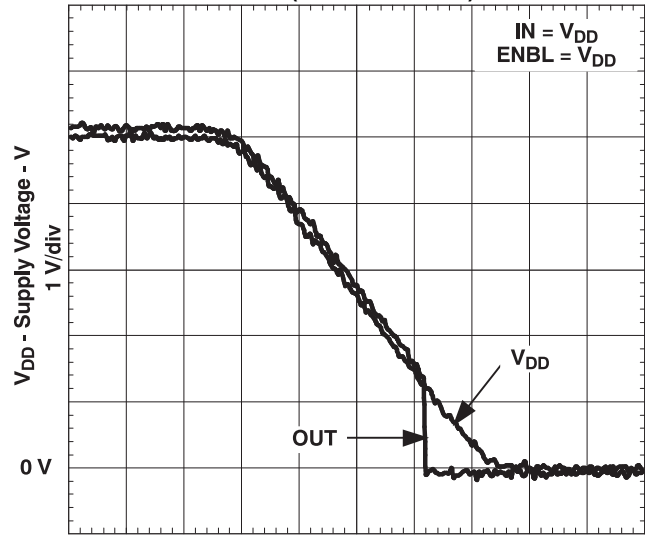


Figure 28.

OUTPUT BEHAVIOR  
vs  
VDD (NON-INVERTING)

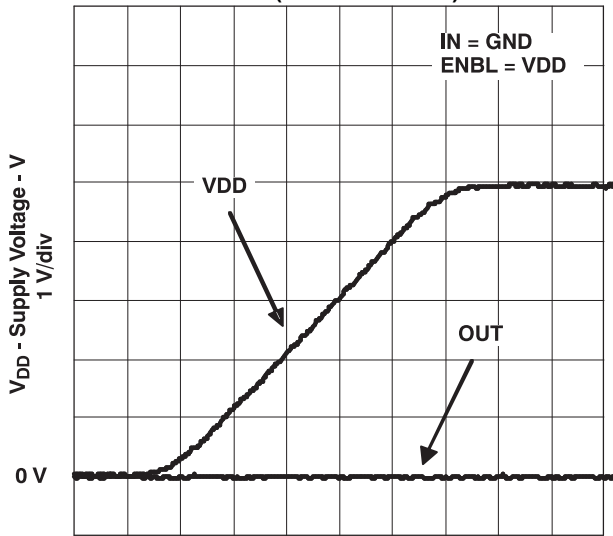


Figure 29.

OUTPUT BEHAVIOR  
vs  
VDD (NON-INVERTING)

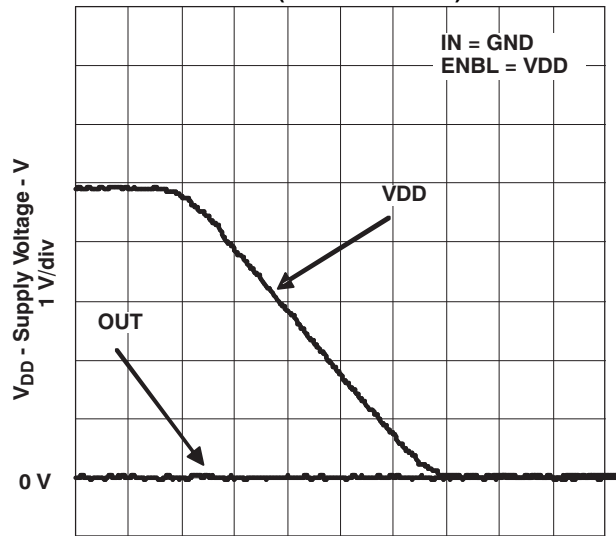


Figure 30.

**TYPICAL CHARACTERISTICS (continued)**  
**INPUT THRESHOLD**  
**VS**  
**TEMPERATURE**

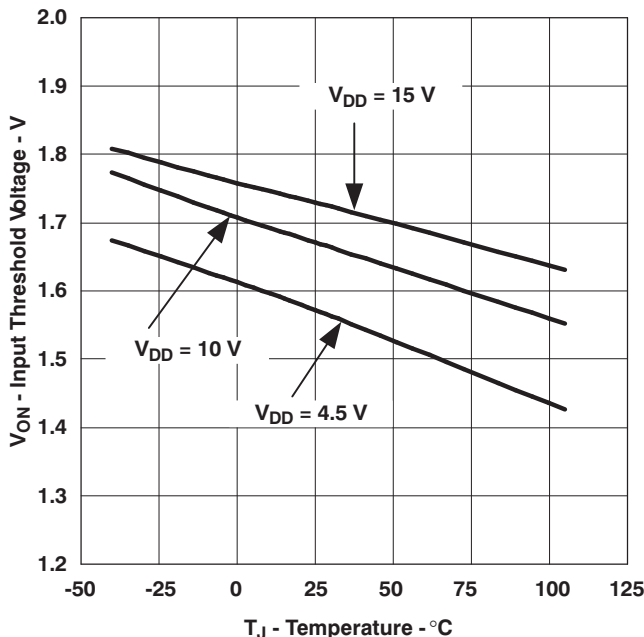


Figure 31.

**REVISION HISTORY**

**Changes from Revision B (November 2004) to Revision C** **Page**

- Changed temperature rating. .... 1
- Changed ORDERING INFORMATION temperature range, three instances. .... 2
- Changed Output current (OUTA, OUTB) DC from 0.3 A to 0.2 A. .... 3
- Changed ELECTRICAL CHARACTERISTICS temperature rating. .... 3
- Changed Low-level output level from 40 mV max to 45 mV max. .... 3

**Changes from Revision C (July, 2011) to Revision D** **Page**

- Added ABSOLUTE MAXIMUM RATINGS note. .... 3
- Added Terminal Functions note. .... 5
- Added additional ENABLE pin description. .... 10

**PACKAGING INFORMATION**

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)	Op Temp (°C)	Top-Side Markings (4)	Samples
UCC27423D	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 105	27423	<a href="#">Samples</a>
UCC27423DG4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 105	27423	<a href="#">Samples</a>
UCC27423DGN	ACTIVE	MSOP-PowerPAD	DGN	8	80	Green (RoHS & no Sb/Br)	CU NIPDAUAG	Level-1-260C-UNLIM	-40 to 105	27423	<a href="#">Samples</a>
UCC27423DGNG4	ACTIVE	MSOP-PowerPAD	DGN	8	80	Green (RoHS & no Sb/Br)	CU NIPDAUAG	Level-1-260C-UNLIM	-40 to 105	27423	<a href="#">Samples</a>
UCC27423DGNR	ACTIVE	MSOP-PowerPAD	DGN	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAUAG	Level-1-260C-UNLIM	-40 to 105	27423	<a href="#">Samples</a>
UCC27423DGNRG4	ACTIVE	MSOP-PowerPAD	DGN	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAUAG	Level-1-260C-UNLIM	-40 to 105	27423	<a href="#">Samples</a>
UCC27423DR	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 105	27423	<a href="#">Samples</a>
UCC27423DRG4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 105	27423	<a href="#">Samples</a>
UCC27423P	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type	-40 to 105	27423	<a href="#">Samples</a>
UCC27423PE4	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type	-40 to 105	27423	<a href="#">Samples</a>
UCC27424D	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 105	27424	<a href="#">Samples</a>
UCC27424DG4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 105	27424	<a href="#">Samples</a>
UCC27424DGN	ACTIVE	MSOP-PowerPAD	DGN	8	80	Green (RoHS & no Sb/Br)	CU NIPDAUAG	Level-1-260C-UNLIM	-40 to 105	27424	<a href="#">Samples</a>
UCC27424DGNG4	ACTIVE	MSOP-PowerPAD	DGN	8	80	Green (RoHS & no Sb/Br)	CU NIPDAUAG	Level-1-260C-UNLIM	-40 to 105	27424	<a href="#">Samples</a>
UCC27424DGNR	ACTIVE	MSOP-PowerPAD	DGN	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAUAG	Level-1-260C-UNLIM	-40 to 105	27424	<a href="#">Samples</a>
UCC27424DGNRG4	ACTIVE	MSOP-PowerPAD	DGN	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAUAG	Level-1-260C-UNLIM	-40 to 105	27424	<a href="#">Samples</a>
UCC27424DR	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 105	27424	<a href="#">Samples</a>

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)	Op Temp (°C)	Top-Side Markings (4)	Samples
UCC27424DRG4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 105	27424	<a href="#">Samples</a>
UCC27424P	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type	-40 to 105	27424	<a href="#">Samples</a>
UCC27424PE4	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type	-40 to 105	27424	<a href="#">Samples</a>
UCC27425D	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 105	27425	<a href="#">Samples</a>
UCC27425DG4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 105	27425	<a href="#">Samples</a>
UCC27425DGN	ACTIVE	MSOP-PowerPAD	DGN	8	80	Green (RoHS & no Sb/Br)	CU NIPDAUAG	Level-1-260C-UNLIM	-40 to 105	27425	<a href="#">Samples</a>
UCC27425DGNG4	ACTIVE	MSOP-PowerPAD	DGN	8	80	Green (RoHS & no Sb/Br)	CU NIPDAUAG	Level-1-260C-UNLIM	-40 to 105	27425	<a href="#">Samples</a>
UCC27425DGNR	ACTIVE	MSOP-PowerPAD	DGN	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAUAG	Level-1-260C-UNLIM	-40 to 105	27425	<a href="#">Samples</a>
UCC27425DGNRG4	ACTIVE	MSOP-PowerPAD	DGN	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAUAG	Level-1-260C-UNLIM	-40 to 105	27425	<a href="#">Samples</a>
UCC27425DR	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 105	27425	<a href="#">Samples</a>
UCC27425DRG4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 105	27425	<a href="#">Samples</a>
UCC27425P	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type	-40 to 105	27425	<a href="#">Samples</a>
UCC27425PE4	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type	-40 to 105	27425	<a href="#">Samples</a>

(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) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

**TBD:** The Pb-Free/Green conversion plan has not been defined.

**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

**Pb-Free (RoHS Exempt):** This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

**Green (RoHS & no Sb/Br):** TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

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

<sup>(4)</sup> Multiple Top-Side Markings will be inside parentheses. Only one Top-Side 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 Top-Side 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.

**OTHER QUALIFIED VERSIONS OF UCC27423, UCC27424, UCC27425 :**

- Automotive: [UCC27423-Q1](#), [UCC27424-Q1](#), [UCC27425-Q1](#)
- Enhanced Product: [UCC27423-EP](#), [UCC27424-EP](#)

NOTE: Qualified Version Definitions:

- Automotive - Q100 devices qualified for high-reliability automotive applications targeting zero defects
- Enhanced Product - Supports Defense, Aerospace and Medical Applications

**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
UCC27423DGNR	MSOP-Power PAD	DGN	8	2500	330.0	12.4	5.3	3.4	1.4	8.0	12.0	Q1
UCC27423DR	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1
UCC27424DGNR	MSOP-Power PAD	DGN	8	2500	330.0	12.4	5.3	3.4	1.4	8.0	12.0	Q1
UCC27424DR	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1
UCC27425DGNR	MSOP-Power PAD	DGN	8	2500	330.0	12.4	5.3	3.4	1.4	8.0	12.0	Q1
UCC27425DR	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1

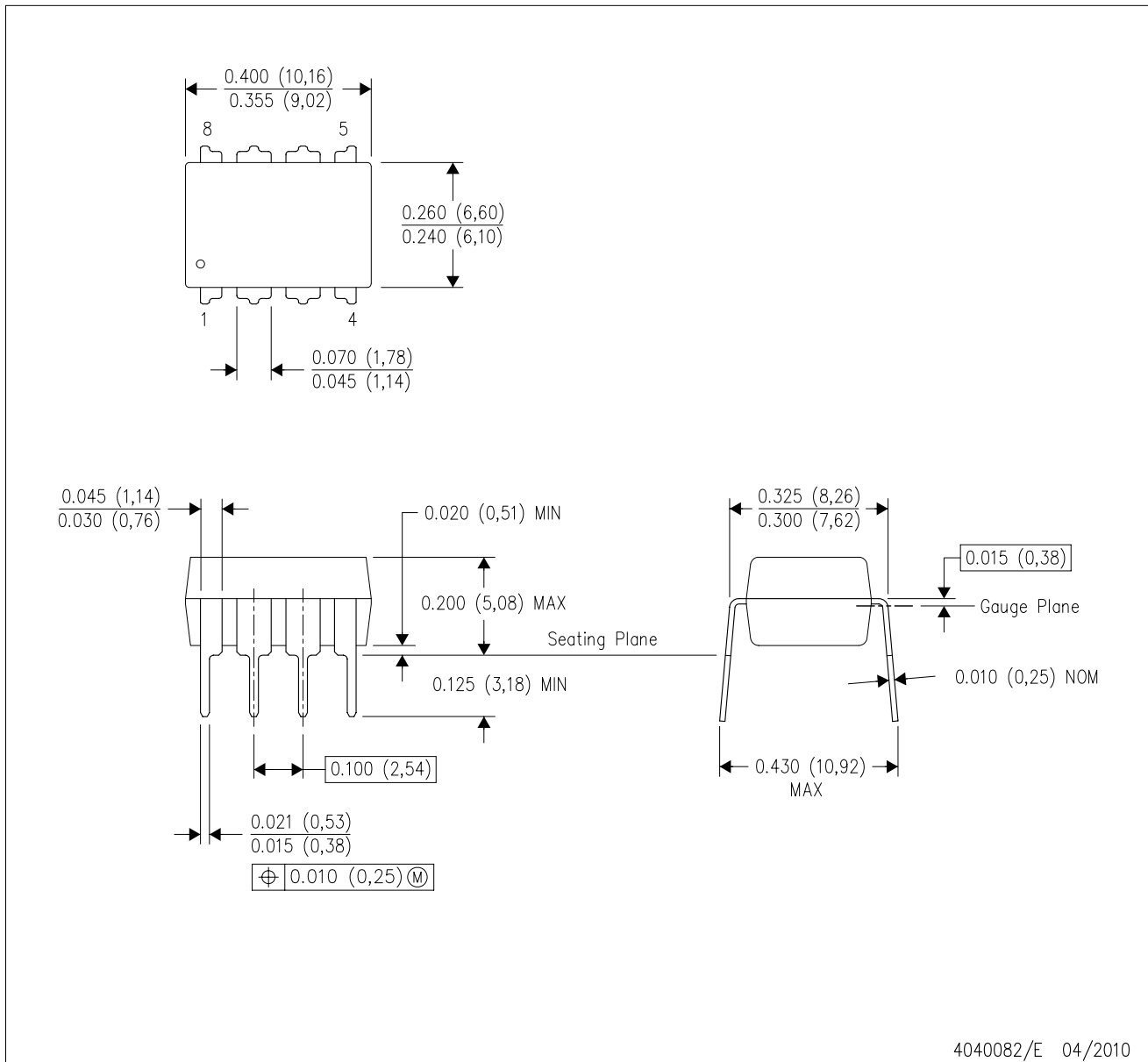
**TAPE AND REEL BOX DIMENSIONS**


\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
UCC27423DGNR	MSOP-PowerPAD	DGN	8	2500	364.0	364.0	27.0
UCC27423DR	SOIC	D	8	2500	340.5	338.1	20.6
UCC27424DGNR	MSOP-PowerPAD	DGN	8	2500	364.0	364.0	27.0
UCC27424DR	SOIC	D	8	2500	340.5	338.1	20.6
UCC27425DGNR	MSOP-PowerPAD	DGN	8	2500	364.0	364.0	27.0
UCC27425DR	SOIC	D	8	2500	340.5	338.1	20.6

P (R-PDIP-T8)

PLASTIC DUAL-IN-LINE PACKAGE

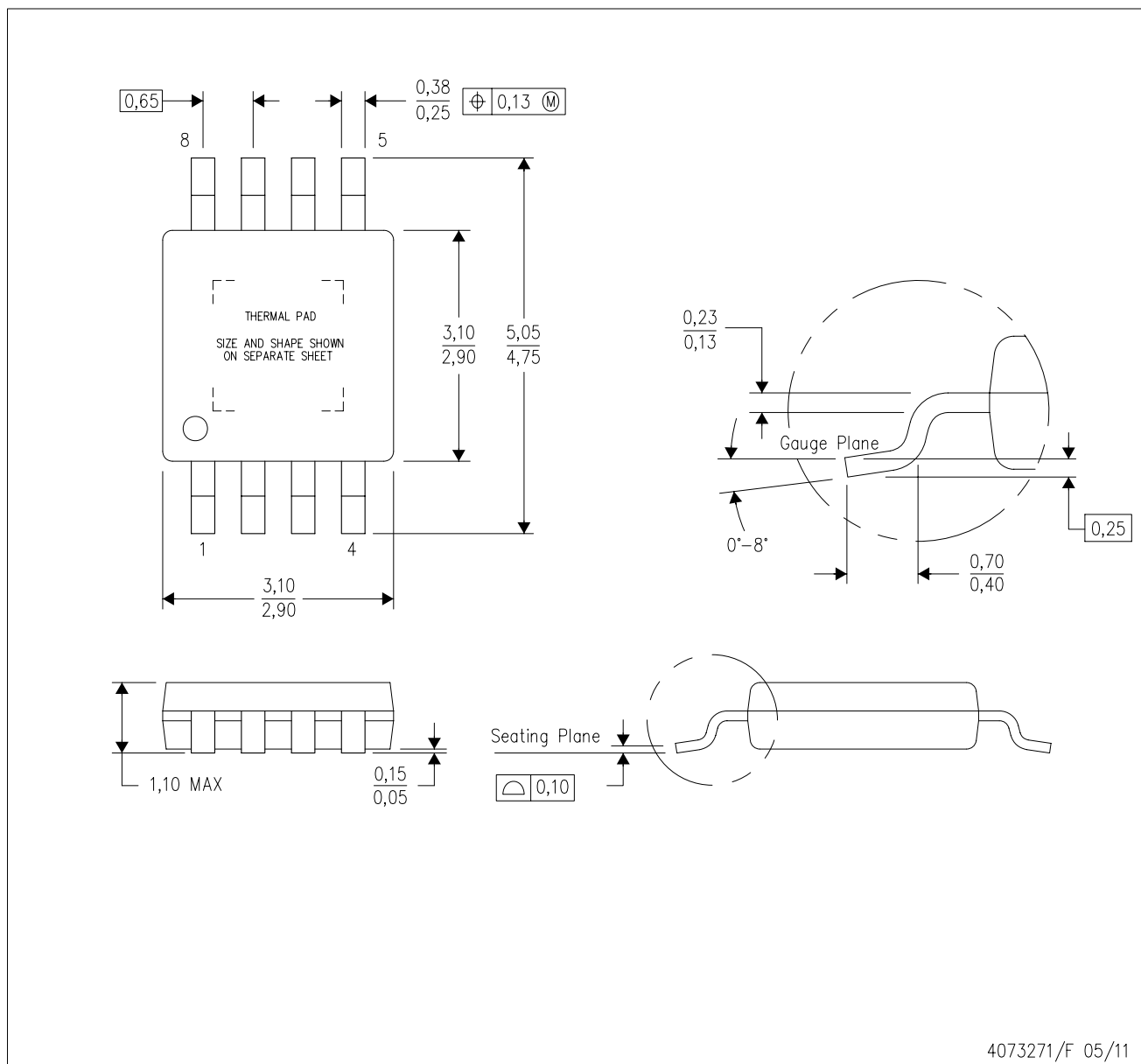


- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  - C. Falls within JEDEC MS-001 variation BA.



DGN (S-PDSO-G8)

PowerPAD™ PLASTIC SMALL OUTLINE



- NOTES:
- All linear dimensions are in millimeters.
  - This drawing is subject to change without notice.
  - Body dimensions do not include mold flash or protrusion.
  - 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>>.
  - See the additional figure in the Product Data Sheet for details regarding the exposed thermal pad features and dimensions.
  - Falls within JEDEC MO-187 variation AA-T

PowerPAD is a trademark of Texas Instruments.

DGN (S-PDSO-G8)

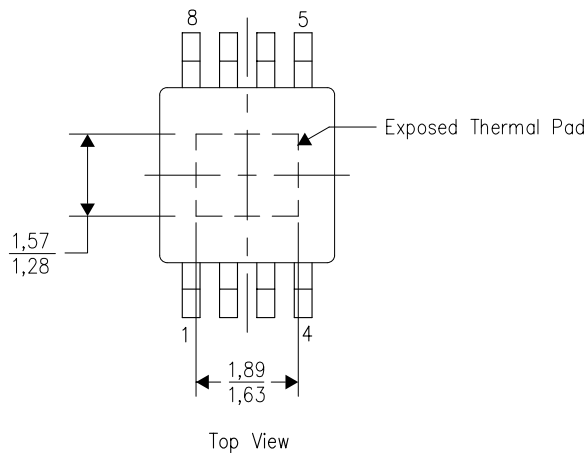
PowerPAD™ PLASTIC SMALL OUTLINE

## 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

4206323-2/1 12/11

NOTE: All linear dimensions are in millimeters

PowerPAD is a trademark of Texas Instruments



- NOTES:
- A. All linear dimensions are in millimeters.
  - B. This drawing is subject to change without notice.
  - C. Customers should place a note on the circuit board fabrication drawing not to alter the center solder mask defined pad.
  - 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>>.
  - 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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D (R-PDSO-G8)

PLASTIC SMALL OUTLINE



- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  - C. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.006 (0,15) each side.
  - D. Body width does not include interlead flash. Interlead flash shall not exceed 0.017 (0,43) each side.
  - E. Reference JEDEC MS-012 variation AA.

D (R-PDSO-G8)

PLASTIC SMALL OUTLINE



- 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. 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. Refer to IPC-7525 for other stencil recommendations.
  - E. Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.

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