

## Dual 5-A High-Speed Low-Side Gate Driver

 Check for Samples: [UCC27523](#), [UCC27524](#), [UCC27525](#), [UCC27526](#)

### FEATURES

- Industry-Standard Pin Out
- Two Independent Gate-Drive Channels
- 5-A Peak Source/Sink Drive Current
- Independent Enable Function for Each Output
- TTL/CMOS Compatible Logic Threshold Independent of Supply Voltage
- Hysteretic Logic Thresholds for High Noise Immunity
- Inputs and Enable Pin Voltage Levels Not Restricted by VDD Pin bias Supply Voltage
- 4.5-V to 18-V Single Supply Range
- Outputs Held Low During VDD UVLO, (ensures glitch-free operation at power-up and power-down)
- Fast Propagation Delays (13-ns typical)
- Fast Rise/Fall Times (7-ns / 6-ns typical)
- 1-ns Typical Delay Matching Between 2-Channels
- Two Outputs can be Paralleled for Higher Drive Current
- Outputs Held in LOW When Inputs Floating
- PDIP-8, SOIC-8, MSOP-8 PowerPAD™ and 3-mm x 3-mm WSON-8 Package Options
- Operating Temperature Range of -40°C to 140°C

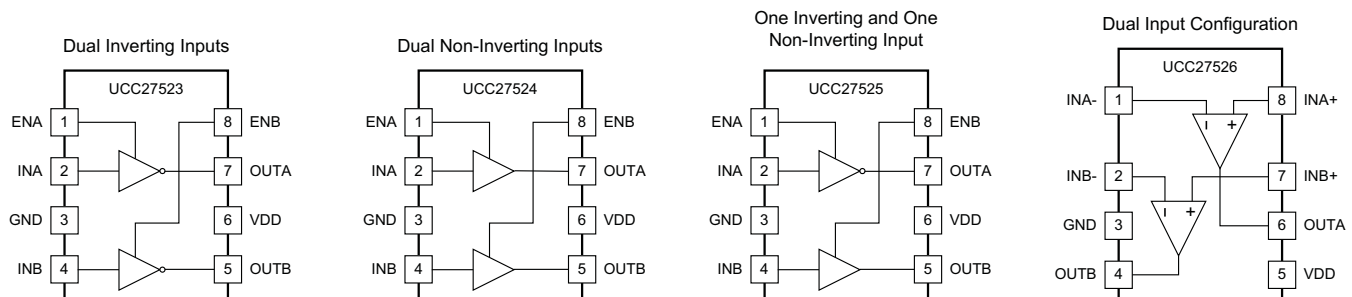
### APPLICATIONS

- Switch-Mode Power Supplies
- DC-to-DC Converters
- Motor Control, Solar Power
- Gate Drive for Emerging Wide Band Gap Power Devices such as GaN

### DESCRIPTION

The UCC2752x family of devices are dual-channel, high-speed, low-side gate driver devices capable of effectively driving MOSFET and IGBT power switches. Using a design that inherently minimizes shoot-through current, UCC2752x is capable of delivering high-peak current pulses of up to 5-A/5-A source/sink into capacitive loads along with rail-to-rail drive capability and extremely small propagation delay typically 13 ns. In addition, the drivers feature matched internal propagation delays between the two channels which are very well suited for applications requiring dual-gate drives with critical timing, such as synchronous rectifiers. This also enables connecting two channels in parallel to effectively increase current drive capability or driving two switches in parallel with a single input signal. The input pin thresholds are based on TTL/CMOS compatible low-voltage logic, which is fixed and independent of the VDD supply voltage. Wide hysteresis between the high and low thresholds offers excellent noise immunity.

### Product Matrix



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

PowerPAD is a trademark of Texas Instruments.



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

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

**DESCRIPTION (CONT.)**

The UCC27523/4/5 provide the combination of three standard logic options - dual-inverting, dual-non inverting, one inverting and one non-inverting driver. UCC27526 features a dual input design which offers flexibility of both inverting (IN- pin) and non-inverting (IN+ pin) configuration for each channel. Either IN+ or IN- pin can be used to control the state of the driver output. The unused input pin can be used for enable/disable function. For safety purpose, internal pull-up/down resistors on the input pins of all the devices in UCC2752x family in order to ensure that outputs are held LOW when input pins are in floating condition. UCC27323/4/5 feature an Enable pins (ENA/ENB) to have better control of the operation of the driver applications. The pins are internally pulled up to VDD for active high logic and can be left open for standard operation.

UCC27523/4/5 devices are available in SOIC-8 (D), MSOP-8 with exposed pad (DGN) and 3-mm x 3-mm WSON-8 with exposed pad (DSD) packages. UCC27524 is also offered in PDIP-8 (P) package. UCC27526 is only offered in 3-mm x 3-mm WSON (DSD) package.

**ORDERING INFORMATION<sup>(1)(2)</sup>**

PART NUMBER	PACKAGE	OPERATING TEMPERATURE RANGE, T <sub>A</sub>
UCC27523	SOIC 8-Pin (D), MSOP 8-pin (DGN), WSON 8-pin (DSD)	-40°C to 140°C
UCC27524	SOIC 8-Pin (D), MSOP 8-pin (DGN), WSON 8-pin (DSD), PDIP 8-pin (P)	
UCC27525	SOIC 8-Pin (D), MSOP 8-pin (DGN), WSON 8-pin (DSD)	
UCC27526	WSON 8-pin (DSD)	

- (1) For the most current package and ordering information, see Package Option Addendum at the end of this document.
- (2) All packages use Pb-Free lead finish of Pd-Ni-Au which is compatible with MSL level 1 at 255°C to 260°C peak reflow temperature to be compatible with either lead free or Sn/Pb soldering operations. DSD package is rated MSL level 2.

**ABSOLUTE MAXIMUM RATINGS<sup>(1)(2)</sup>**

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

		MIN	MAX	UNIT
Supply voltage range	VDD	-0.3 to	20.0	V
OUTA, OUTB voltage		-0.3 to	VDD + 0.3	
Output continuous source/sink current	I <sub>OUT_DC</sub>		0.3	A
Output pulsed source/sink current (0.5 μs)	I <sub>OUT_pulsed</sub>		5	
INA, INB, INA+, INA-, INB+, INB-, ENA, ENB voltage <sup>(3)</sup>		-0.3	20	V
ESD <sup>(4)</sup>	Human body model, HBM		4000	
	Charge device model, CDM		1000	
Operating virtual junction temperature, T <sub>J</sub> range		-40	150	°C
Storage temperature range, T <sub>stg</sub>		-65	150	
Lead temperature	Soldering, 10 sec.		300	
	Reflow		260	

- (1) Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
- (2) All voltages are with respect to GND unless otherwise noted. Currents are positive into, negative out of the specified terminal. See Packaging Section of the datasheet for thermal limitations and considerations of packages.
- (3) The maximum voltage on the Input and Enable pins is not restricted by the voltage on the VDD pin.
- (4) These devices are sensitive to electrostatic discharge; follow proper device handling procedures.

**RECOMMENDED OPERATING CONDITIONS**

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

	MIN	TYP	MAX	UNIT
Supply voltage range, VDD	4.5	12	18	V
Operating junction temperature range	-40		+140	°C
Input voltage, INA, INB, INA+, INA-, INB+, INB-	0		18	V
Enable voltage, ENA and ENB	0		18	

**THERMAL INFORMATION**

THERMAL METRIC		UCC27523, UCC27524, UCC27525	UCC27523, UCC27524, UCC27525	UNITS
		SOIC (D)	MSOP (DGN) <sup>(1)</sup>	
		8 PINS	8 PINS	
$\theta_{JA}$	Junction-to-ambient thermal resistance <sup>(2)</sup>	130.9	71.8	°C/W
$\theta_{JCTop}$	Junction-to-case (top) thermal resistance <sup>(3)</sup>	80.0	65.6	
$\theta_{JB}$	Junction-to-board thermal resistance <sup>(4)</sup>	71.4	7.4	
$\psi_{JT}$	Junction-to-top characterization parameter <sup>(5)</sup>	21.9	7.4	
$\psi_{JB}$	Junction-to-board characterization parameter <sup>(6)</sup>	70.9	31.5	
$\theta_{JCbott}$	Junction-to-case (bottom) thermal resistance <sup>(7)</sup>	n/a	19.6	

- (1) For more information about traditional and new thermal metrics, see the *IC Package Thermal Metrics* application report, [SPRA953](#).
- (2) The junction-to-ambient thermal resistance under natural convection is obtained in a simulation on a JEDEC-standard, high-K board, as specified in JESD51-7, in an environment described in JESD51-2a.
- (3) The junction-to-case (top) thermal resistance is obtained by simulating a cold plate test on the package top. No specific JEDEC-standard test exists, but a close description can be found in the ANSI SEMI standard G30-88.
- (4) The junction-to-board thermal resistance is obtained by simulating in an environment with a ring cold plate fixture to control the PCB temperature, as described in JESD51-8.
- (5) The junction-to-top characterization parameter,  $\psi_{JT}$ , estimates the junction temperature of a device in a real system and is extracted from the simulation data for obtaining  $\theta_{JA}$ , using a procedure described in JESD51-2a (sections 6 and 7).
- (6) The junction-to-board characterization parameter,  $\psi_{JB}$ , estimates the junction temperature of a device in a real system and is extracted from the simulation data for obtaining  $\theta_{JA}$ , using a procedure described in JESD51-2a (sections 6 and 7).
- (7) The junction-to-case (bottom) thermal resistance is obtained by simulating a cold plate test on the exposed (power) pad. No specific JEDEC standard test exists, but a close description can be found in the ANSI SEMI standard G30-88.

**THERMAL INFORMATION**

THERMAL METRIC		UCC27524	UCC27523, UCC27524, UCC27525, UCC27526	UNITS
		PDIP (P)	WSON (DSD) <sup>(1)</sup>	
		8 PINS	8 PINS	
$\theta_{JA}$	Junction-to-ambient thermal resistance <sup>(2)</sup>	62.1	46.7	°C/W
$\theta_{JCTop}$	Junction-to-case (top) thermal resistance <sup>(3)</sup>	52.7	46.7	
$\theta_{JB}$	Junction-to-board thermal resistance <sup>(4)</sup>	39.1	22.4	
$\psi_{JT}$	Junction-to-top characterization parameter <sup>(5)</sup>	31.0	0.7	
$\psi_{JB}$	Junction-to-board characterization parameter <sup>(6)</sup>	39.1	22.6	
$\theta_{JCbott}$	Junction-to-case (bottom) thermal resistance <sup>(7)</sup>	n/a	9.5	

- (1) For more information about traditional and new thermal metrics, see the *IC Package Thermal Metrics* application report, [SPRA953](#).
- (2) The junction-to-ambient thermal resistance under natural convection is obtained in a simulation on a JEDEC-standard, high-K board, as specified in JESD51-7, in an environment described in JESD51-2a.
- (3) The junction-to-case (top) thermal resistance is obtained by simulating a cold plate test on the package top. No specific JEDEC-standard test exists, but a close description can be found in the ANSI SEMI standard G30-88.
- (4) The junction-to-board thermal resistance is obtained by simulating in an environment with a ring cold plate fixture to control the PCB temperature, as described in JESD51-8.
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- (7) The junction-to-case (bottom) thermal resistance is obtained by simulating a cold plate test on the exposed (power) pad. No specific JEDEC standard test exists, but a close description can be found in the ANSI SEMI standard G30-88.

## ELECTRICAL CHARACTERISTICS

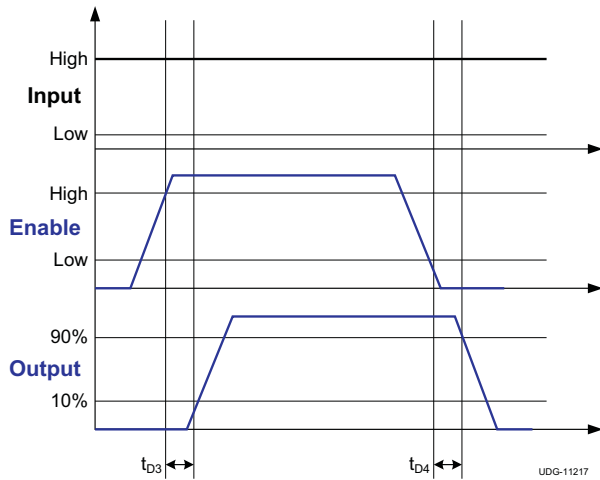
$V_{DD} = 12\text{ V}$ ,  $T_A = T_J = -40^\circ\text{C}$  to  $140^\circ\text{C}$ ,  $1\text{-}\mu\text{F}$  capacitor from  $V_{DD}$  to GND. Currents are positive into, negative out of the specified terminal (unless otherwise noted.)

PARAMETER		TEST CONDITION	MIN	TYP	MAX	UNITS
<b>Bias Currents</b>						
$I_{DD(\text{off})}$	Startup current, (based on UCC27524 Input configuration)	$V_{DD} = 3.4\text{ V}$ , $INA = V_{DD}$ , $INB = V_{DD}$	55	110	175	$\mu\text{A}$
		$V_{DD} = 3.4\text{ V}$ , $INA = \text{GND}$ , $INB = \text{GND}$	25	75	145	
<b>Under Voltage LockOut (UVLO)</b>						
$V_{ON}$	Supply start threshold	$T_J = 25^\circ\text{C}$	3.91	4.20	4.50	V
		$T_J = -40^\circ\text{C}$ to $140^\circ\text{C}$	3.70	4.20	4.65	
$V_{OFF}$	Minimum operating voltage after supply start		3.40	3.90	4.40	
$V_{DD\_H}$	Supply voltage hysteresis		0.20	0.30	0.50	
<b>Inputs (INA, INB, INA+, INA-, INB+, INB-)</b>						
$V_{IN\_H}$	Input signal high threshold	Output High for Non-inverting input pins Output Low for Inverting input pins	1.9	2.1	2.3	V
$V_{IN\_L}$	Input signal low threshold	Output Low for Non-inverting input pins Output High for Inverting input pins	1.0	1.2	1.4	
$V_{IN\_HYS}$	Input hysteresis		0.70	0.90	1.10	
<b>Enable (ENA, ENB) (UCC27523, UCC27524, UCC27525)</b>						
$V_{EN\_H}$	Enable signal high threshold	Output enabled	1.9	2.1	2.3	V
$V_{EN\_L}$	Enable signal low threshold	Output disabled	0.95	1.15	1.35	
$V_{EN\_HYS}$	Enable hysteresis		0.70	0.95	1.10	
<b>Outputs (OUTA, OUTB)</b>						
$I_{SNK/SRC}$	Sink/source peak current <sup>(1)</sup>	$C_{LOAD} = 0.22\ \mu\text{F}$ , $F_{SW} = 1\ \text{kHz}$		$\pm 5$		A
$V_{DD} - V_{OH}$	High output voltage	$I_{OUT} = -10\ \text{mA}$			0.075	V
$V_{OL}$	Low output voltage	$I_{OUT} = 10\ \text{mA}$			0.01	
$R_{OH}$	Output pull-up resistance	$I_{OUT} = -10\ \text{mA}$	2.5	5	7.5	$\Omega$
$R_{OL}$	Output pull-down resistance	$I_{OUT} = 10\ \text{mA}$	0.15	0.5	1	$\Omega$
<b>Switching Time</b>						
$t_R$	Rise time <sup>(2)</sup>	$C_{LOAD} = 1.8\ \text{nF}$		7	18	ns
$t_F$	Fall time <sup>(2)</sup>	$C_{LOAD} = 1.8\ \text{nF}$		6	10	
$t_M$	Delay matching between 2 channels	$INA = INB$ , OUTA and OUTB at 50% transition point		1	4	
$t_{PW}$	Minimum input pulse width that changes the output state			10	20	
$t_{D1}$ , $t_{D2}$	Input to output propagation delay <sup>(2)</sup>	$C_{LOAD} = 1.8\ \text{nF}$ , 5-V input pulse	6	13	23	
$t_{D3}$ , $t_{D4}$	EN to output propagation delay <sup>(2)</sup>	$C_{LOAD} = 1.8\ \text{nF}$ , 5-V enable pulse	6	13	23	

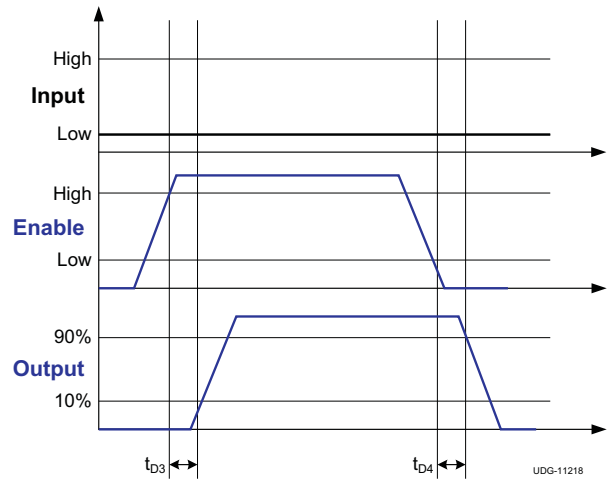
(1) Ensured by design.

(2) See timing diagrams in [Figure 1](#), [Figure 2](#), [Figure 3](#) and [Figure 4](#)

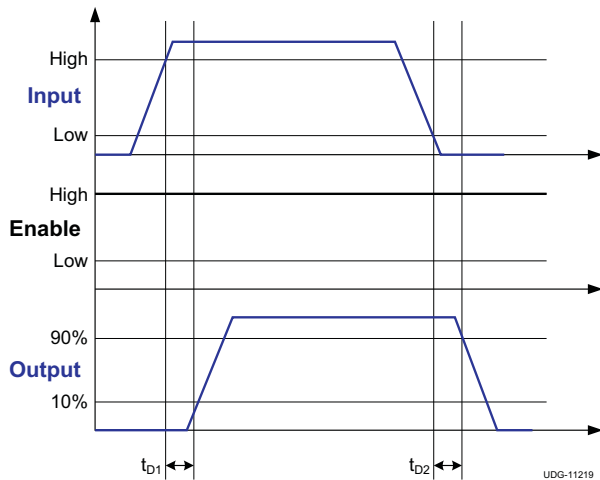
**Timing Diagrams**



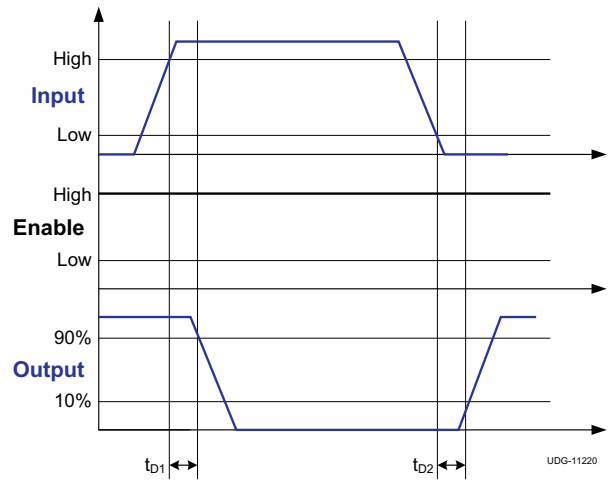
**Figure 1. Enable Function (for non-inverting input driver operation)**



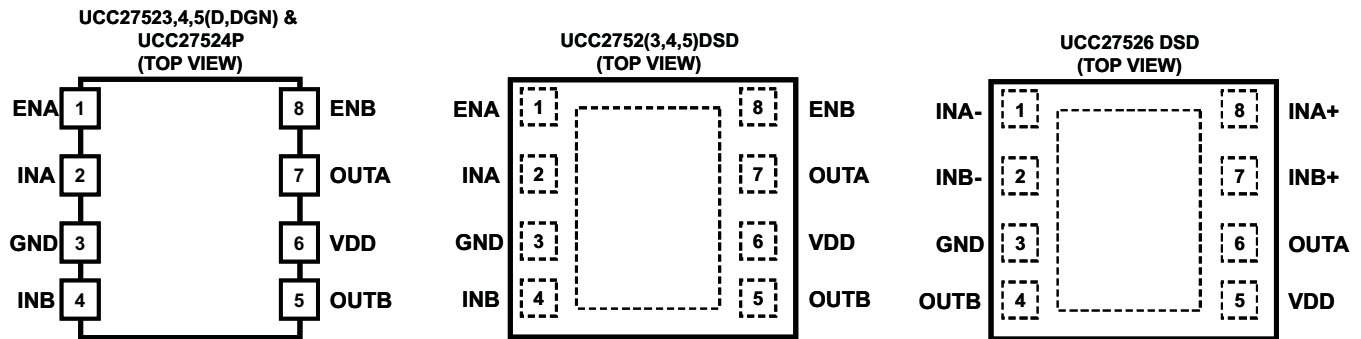
**Figure 2. Enable Function (for inverting input driver operation)**



**Figure 3. Non-Inverting Input Driver Operation**



**Figure 4. Inverting Input Driver Operation**

**DEVICE INFORMATION**

**Figure 5.**
**TERMINAL FUNCTIONS (UCC27523/UCC27524/UCC27525)**

TERMINAL		I/O	FUNCTION
NUMBER	NAME		
1	ENA	I	<b>Enable input for Channel A:</b> ENA biased LOW Disables Channel A output regardless of INA state, ENA biased HIGH or floating Enables Channel A output, ENA allowed to float hence it is pin-to-pin compatible with UCC2732X N/C pin.
2	INA	I	<b>Input to Channel A:</b> Inverting Input in UCC27523, Non-Inverting Input in UCC27524, Inverting Input in UCC27525, OUTA held LOW if INA is unbiased or floating.
3	GND	-	<b>Ground:</b> All signals referenced to this pin.
4	INB	I	<b>Input to Channel B:</b> Inverting Input in UCC27523, Non-Inverting Input in UCC27524, Non-Inverting Input in UCC27525, OUTB held LOW if INB is unbiased or floating.
5	OUTB	O	<b>Output of Channel B</b>
6	VDD	I	<b>Bias supply input</b>
7	OUTA	O	<b>Output of Channel A</b>
8	ENB	I	<b>Enable input for Channel B:</b> ENB biased LOW Disables Channel B output regardless of INB state, ENB biased HIGH or floating Enables Channel B output, ENB allowed to float hence it is pin-to-pin compatible with UCC2732X N/C pin.

**TERMINAL FUNCTIONS (UCC27526)**

TERMINAL		I/O	FUNCTION
NUMBER	NAME		
1	INA-	I	<b>Inverting Input to Channel A:</b> when Channel A is used in Non-Inverting configuration connect INA- to GND in order to Enable Channel A output, OUTA held LOW if INA- is unbiased or floating.
2	INB-	I	<b>Inverting Input to Channel B:</b> when Channel B is used in Non-Inverting configuration connect INB- to GND in order to Enable Channel B output, OUTB held LOW if INB- is unbiased or floating.
3	GND	-	<b>Ground:</b> All signals referenced to this pin.
4	OUTB	I	<b>Output of Channel B</b>
5	VDD	O	<b>Bias Supply Input</b>
6	OUTA	I	<b>Output of Channel A</b>
7	INB+	O	<b>Non-Inverting Input to Channel B:</b> When Channel B is used in Inverting configuration connect INB+ to VDD in order to Enable Channel B output, OUTB held LOW if INB+ is unbiased or floating.
8	INA+	I	<b>Non-Inverting Input to Channel A:</b> When Channel A is used in Inverting configuration connect INA+ to VDD in order to Enable Channel A output, OUTA held LOW if INA+ is unbiased or floating.

**Table 1. Device Logic Table (UCC27523/UCC27524/UCC27525)**

ENA	ENB	INA	INB	UCC27523		UCC27524		UCC27525	
				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	Any	Any	L	L	L	L	L	L
Any	Any	x <sup>(1)</sup>	x <sup>(1)</sup>	L	L	L	L	L	L
x <sup>(1)</sup>	x <sup>(1)</sup>	L	L	H	H	L	L	H	L
x <sup>(1)</sup>	x <sup>(1)</sup>	L	H	H	L	L	H	H	H
x <sup>(1)</sup>	x <sup>(1)</sup>	H	L	L	H	H	L	L	L
x <sup>(1)</sup>	x <sup>(1)</sup>	H	H	L	L	H	H	L	H

(1) Floating condition.

**Table 2. Device Logic Table (UCC27526)**

INx+ (x = A or B)	INx- (x = A or B)	OUTx (x = A or B)
L	L	L
L	H	L
H	L	H
H	H	L
x <sup>(1)</sup>	Any	L
Any	x <sup>(1)</sup>	L

(1) x = Floating condition.

Functional Block Diagrams

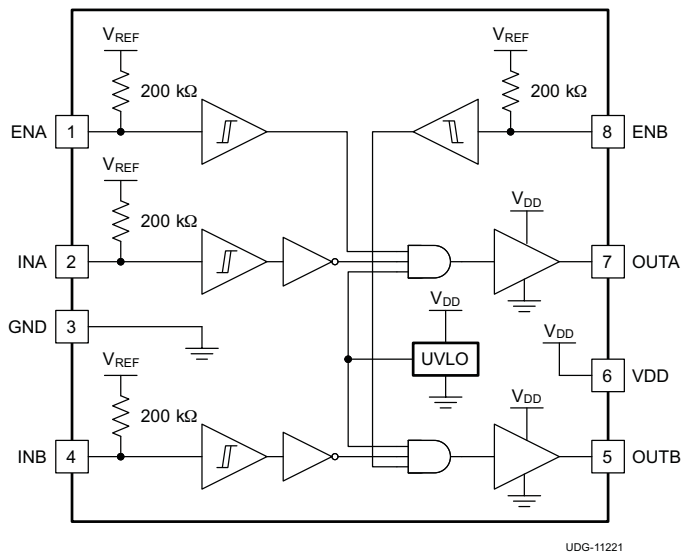


Figure 6. UCC27523 Block Diagram

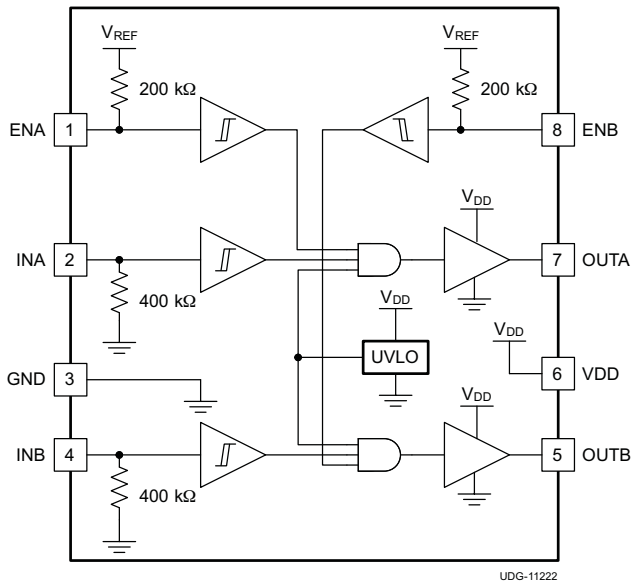


Figure 7. UCC27524 Block Diagram

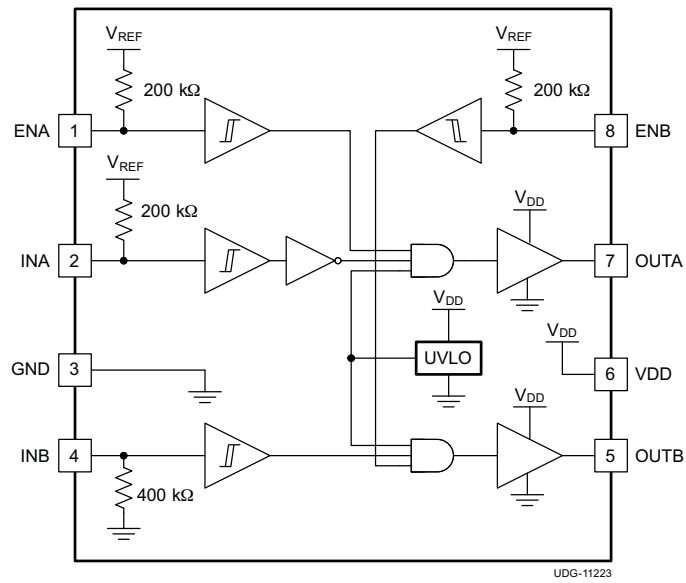


Figure 8. UCC27525 Block Diagram

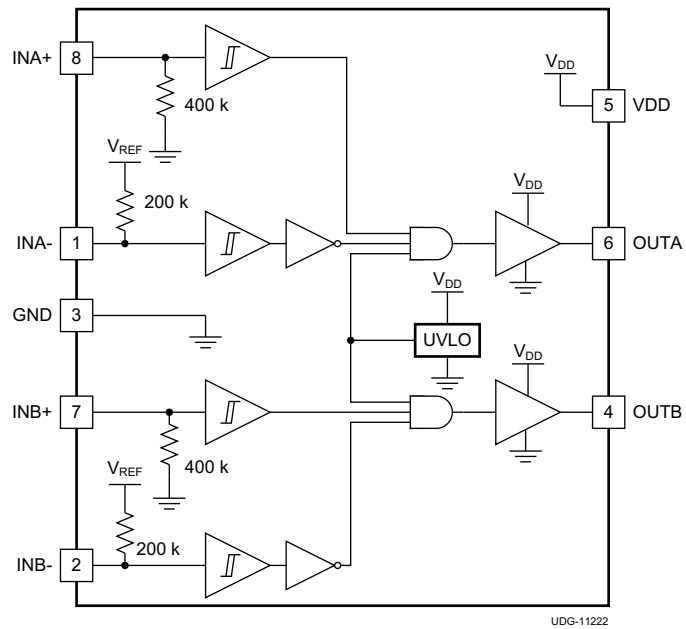


Figure 9. UCC27526 Block Diagram

TYPICAL CHARACTERISTICS

START-UP CURRENT  
vs  
TEMPERATURE

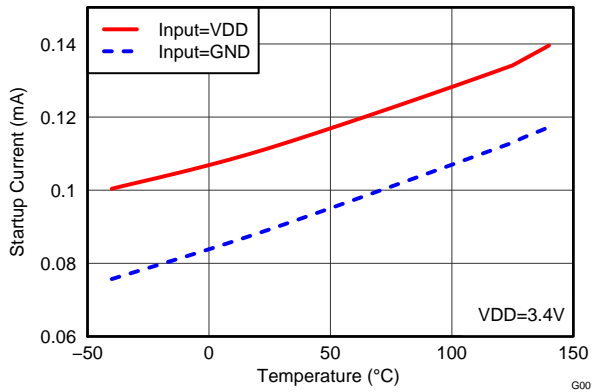


Figure 10.

OPERATING SUPPLY CURRENT  
vs  
TEMPERATURE (Outputs switching)

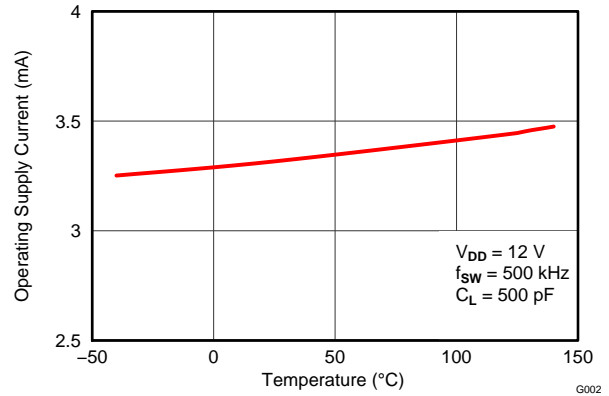


Figure 11.

SUPPLY CURRENT  
vs  
TEMPERATURE (Outputs in DC on/off condition)

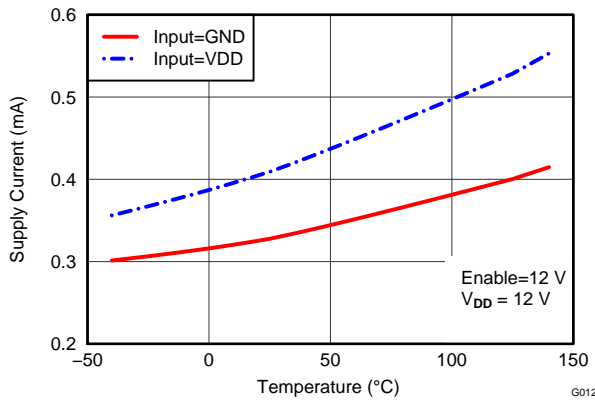


Figure 12.

UVLO THRESHOLD  
vs  
TEMPERATURE

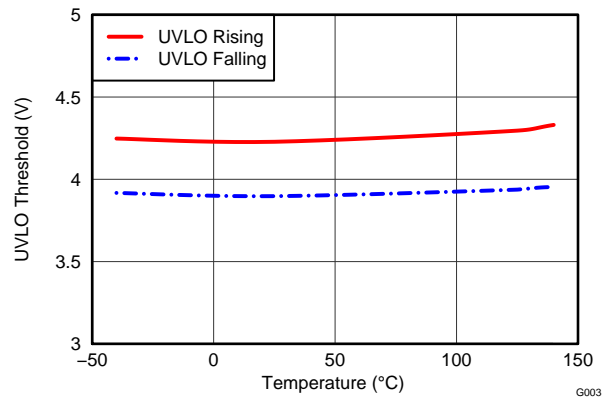


Figure 13.

INPUT THRESHOLD  
vs  
TEMPERATURE

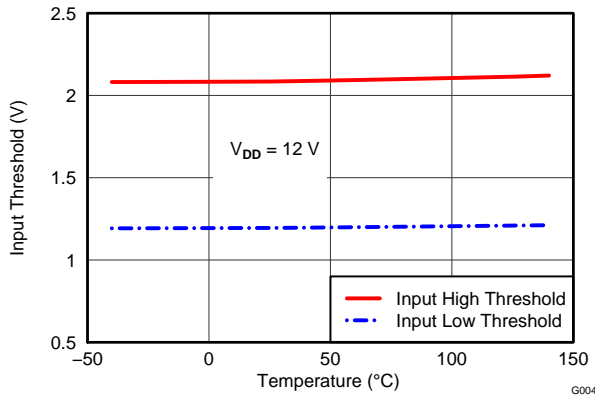


Figure 14.

ENABLE THRESHOLD  
vs  
TEMPERATURE

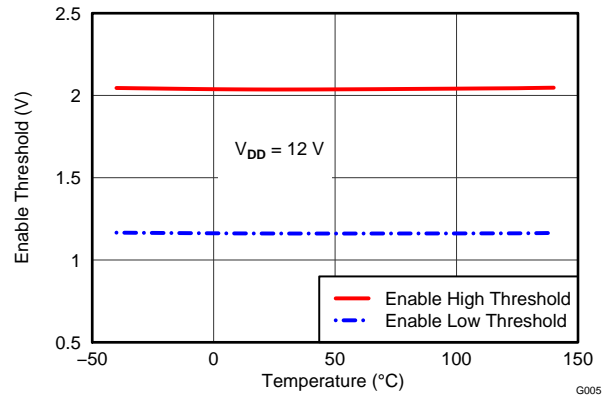


Figure 15.

**TYPICAL CHARACTERISTICS (continued)**

**OUTPUT PULL-UP RESISTANCE  
vs  
TEMPERATURE**

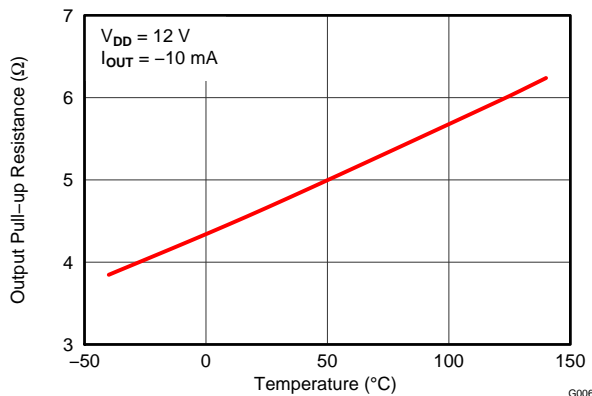


Figure 16.

**OUTPUT PULL-DOWN RESISTANCE  
vs  
TEMPERATURE**

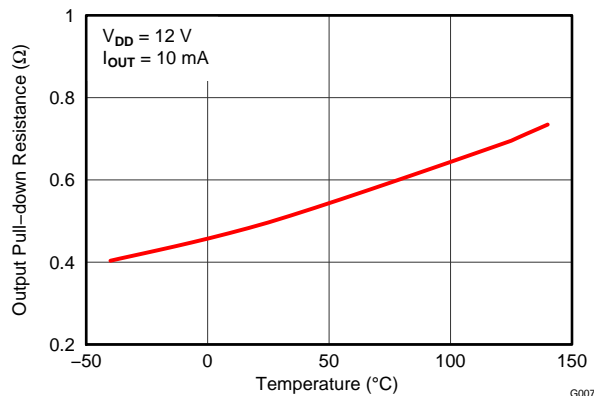


Figure 17.

**RISE TIME  
vs  
TEMPERATURE**

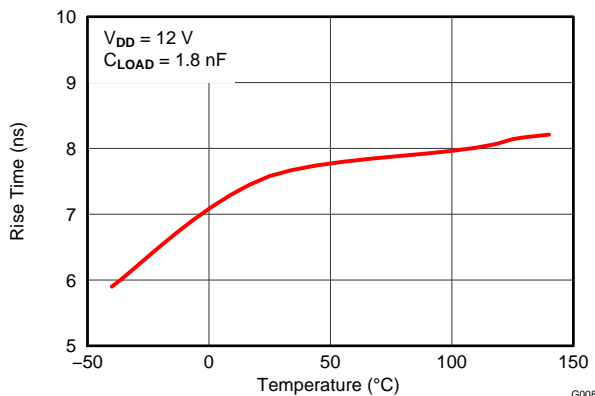


Figure 18.

**FALL TIME  
vs  
TEMPERATURE**

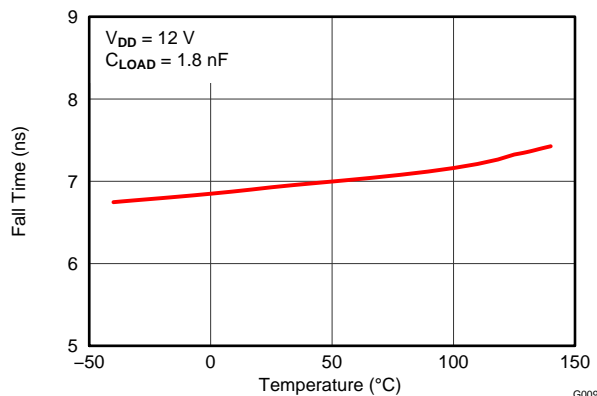


Figure 19.

**INPUT TO OUTPUT PROPAGATION DELAY  
vs  
TEMPERATURE**

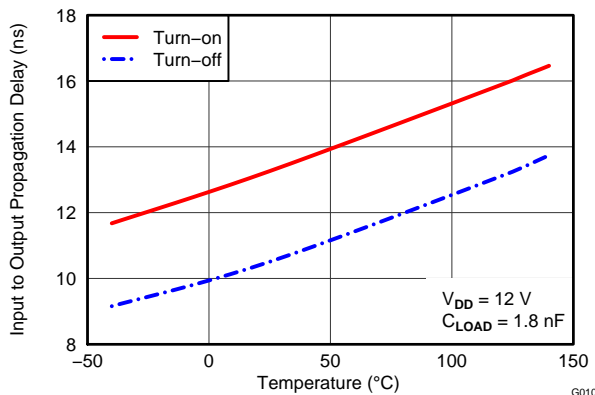


Figure 20.

**EN TO OUTPUT PROPAGATION DELAY  
vs  
TEMPERATURE**

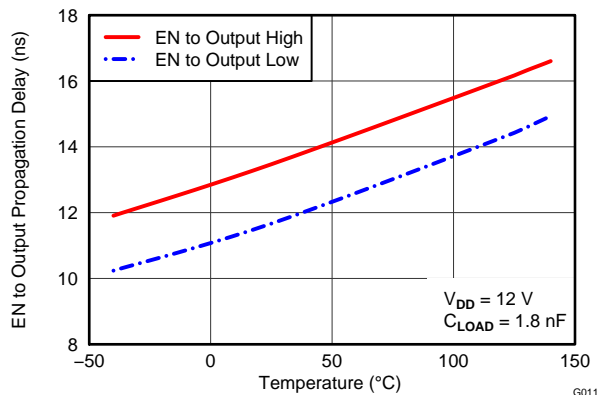


Figure 21.

TYPICAL CHARACTERISTICS (continued)

OPERATING SUPPLY CURRENT  
vs  
FREQUENCY

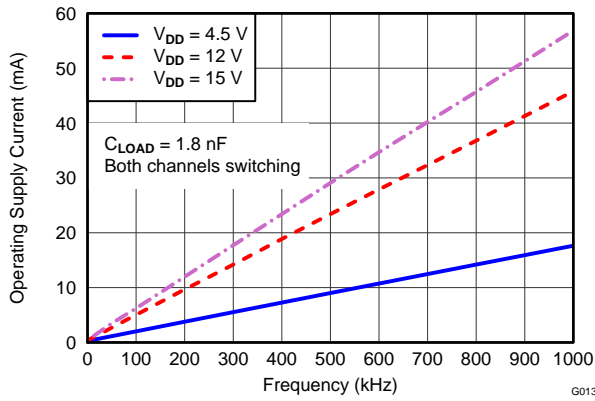


Figure 22.

PROPAGATION DELAYS  
vs  
SUPPLY VOLTAGE

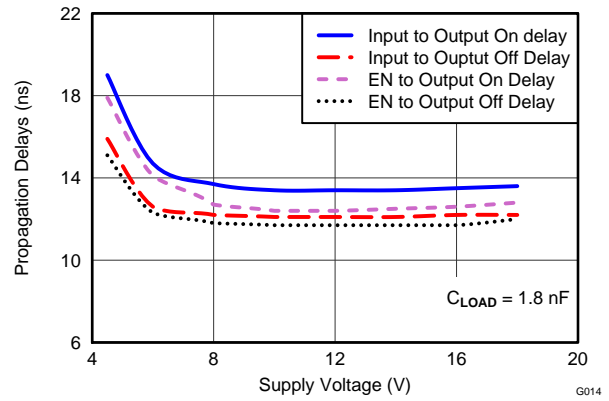


Figure 23.

RISE TIME  
vs  
SUPPLY VOLTAGE

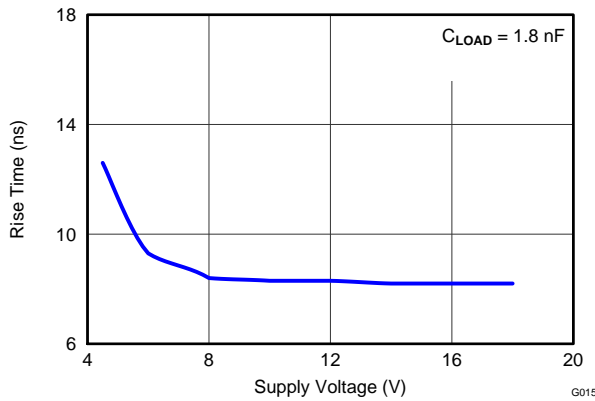


Figure 24.

FALL TIME  
vs  
SUPPLY VOLTAGE

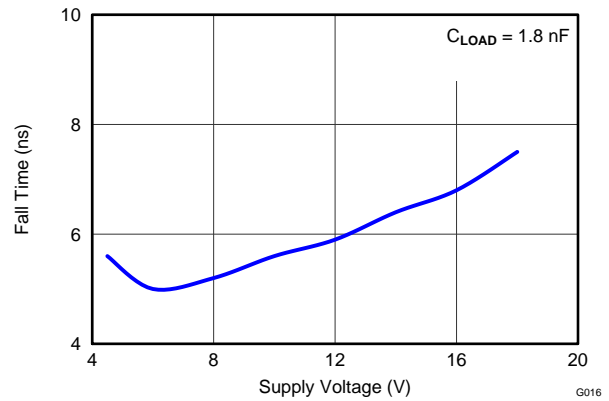


Figure 25.

ENABLE THRESHOLD  
vs  
TEMPERATURE

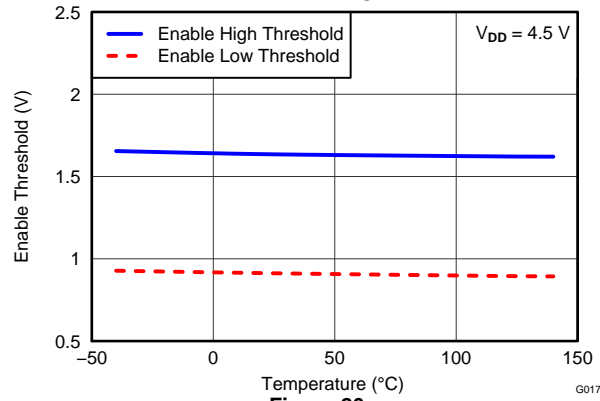
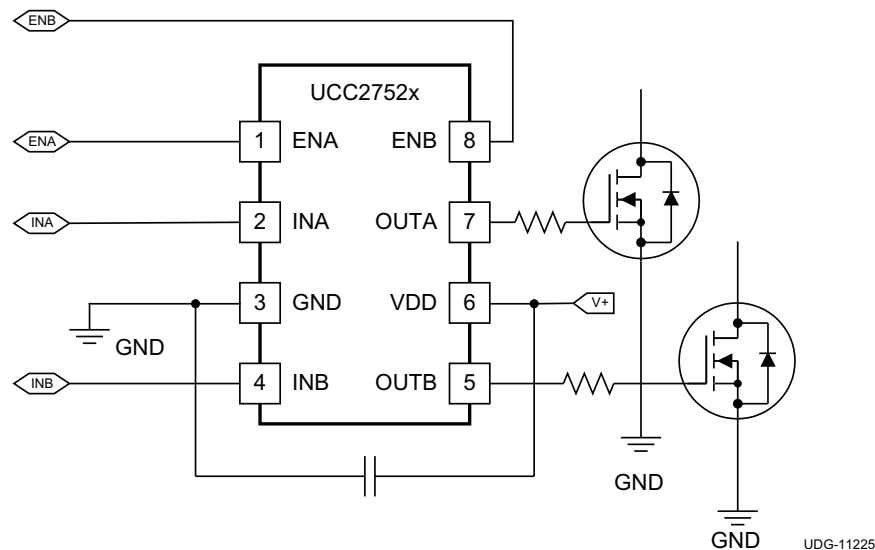


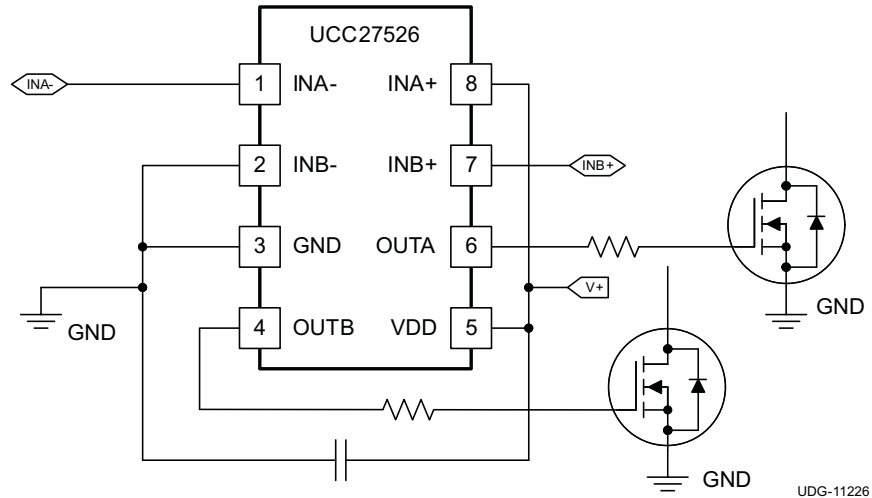
Figure 26.

**APPLICATION INFORMATION**

High-current gate-driver devices are required in switching power applications for a variety of reasons. In order to effect fast switching of power devices and reduce associated switching power losses, a powerful gate driver device can be employed between the PWM output of control devices and the gates of the power semiconductor devices. Further, gate driver devices are indispensable when sometimes it is just not feasible to have the PWM controller device directly drive the gates of the switching devices. With advent of digital power, this situation will be often encountered since the PWM signal from the digital controller is often a 3.3-V logic signal which is not capable of effectively turning on a power switch. A level shifting circuitry is needed to boost the 3.3-V signal to the gate-drive voltage (such as 12 V) in order 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 since they lack level-shifting capability. Gate driver devices effectively combine both the level-shifting and buffer drive functions. Gate driver devices 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 controller devices by moving gate charge power losses into itself etc. Finally, emerging wide band-gap power device technologies such as GaN based switches, which are capable of supporting very high switching frequency operation, are driving special requirements in terms of gate drive capability. These requirements include operation at low VDD voltages (5 V or lower), low propagation delays, tight delay matching and availability in compact, low-inductance packages with good thermal capability. In summary Gate-driver devices are an extremely important component in switching power combining benefits of high performance, low cost, component count, board-space reduction and simplified system design.

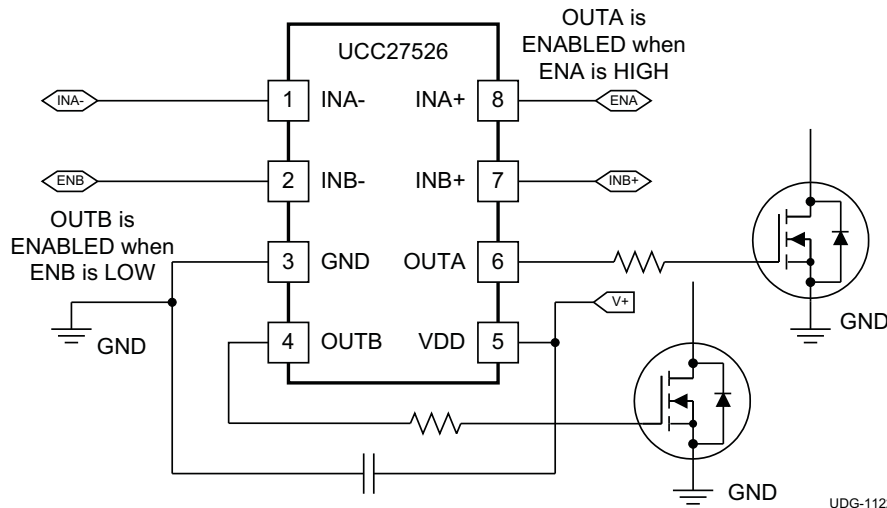


**Figure 27. UCC2752x Typical Application Diagram (x = 3, 4 or 5)**



UDG-11226

Figure 28. UCC27526 Channel A in Inverting and Channel B in Non-Inverting Configuration, (enable function not used)



UDG-11227

Figure 29. UCC27526 Channel A in Inverting and Channel B in Non-Inverting Configuration, (enable function implemented)

**Introduction**

The UCC2752x family of products represent Texas Instruments’ latest generation of dual-channel, low-side high-speed gate driver devices featuring 5-A source/sink current capability, industry best-in-class switching characteristics and a host of other features listed in table below all of which combine to guarantee efficient, robust and reliable operation in high-frequency switching power circuits.

**Table 3. UCC2752x Family of Features and Benefits**

FEATURE	BENEFIT
Best-in-class 13-ns (typ) propagation delay	Extremely low pulse transmission distortion
1-ns (typ) delay matching between channels	Ease of paralleling outputs for higher (2x) current capability, ease of driving parallel power switches
Expanded VDD Operating range of 4.5 V to 18 V	Flexibility in system design
Expanded operating temperature range of -40°C to 140°C (See <a href="#">ELECTRICAL CHARACTERISTICS</a> table)	
VDD UVLO Protection	Outputs are held Low in UVLO condition, which ensures predictable, glitch-free operation at power-up and power-down
Outputs held Low when input pins (INx) in floating condition	Safety feature, especially useful in passing abnormal condition tests during safety certification
Outputs enabled when enable pins (ENx) in floating condition	Pin-to-pin compatibility with UCC2732X family of products from TI, in designs where pin #1, 8 are in floating condition
CMOS/TTL compatible input and enable threshold with wide hysteresis	Enhanced noise immunity, while retaining compatibility with microcontroller logic level input signals (3.3V, 5V) optimized for digital power
Ability of input and enable pins to handle voltage levels not restricted by VDD pin bias voltage	System simplification, especially related to auxiliary bias supply architecture

## VDD and Under Voltage Lockout

The UCC2752x devices have internal under voltage lockout (UVLO) protection feature on the VDD pin supply circuit blocks. When VDD is rising and the level is still below UVLO threshold, this circuit holds the output LOW, regardless of the status of the inputs. The UVLO is typically 4.25 V with 350-mV typical hysteresis. This hysteresis helps prevent chatter when low VDD supply voltages have noise from the power supply and also when there are droops in the VDD bias voltage when the system commences switching and there is a sudden increase in  $I_{DD}$ . The capability to operate at low voltage levels such as below 5 V, along with best in class switching characteristics, is especially suited for driving emerging GaN power semiconductor devices.

For example, at power-up, the UCC2752x driver-device output remains LOW until the  $V_{DD}$  voltage reaches the UVLO threshold if Enable pin is active or floating. The magnitude of the OUT signal rises with  $V_{DD}$  until steady-state  $V_{DD}$  is reached. The non-inverting operation in Figure 30 shows that the output remains LOW until the UVLO threshold is reached, and then the output is in-phase with the input. The inverting operation in Figure 31 shows that the output remains LOW until the UVLO threshold is reached, and then the output is out-phase with the input. With UCC27526 the output turns to high state only if INX+ is high and INX- is low after the UVLO threshold is reached.

Since the device draws current from the VDD pin to bias all internal circuits, for the best high-speed circuit performance, two VDD bypass capacitors are recommended to prevent noise problems. The use of surface mount components is highly recommended. A 0.1- $\mu$ F ceramic capacitor should be located as close as possible to the VDD to GND pins of the gate-driver device. In addition, a larger capacitor (such as 1- $\mu$ F) with relatively low ESR should be connected in parallel and close proximity, in order to help deliver the high-current peaks required by the load. The parallel combination of capacitors should present a low impedance characteristic for the expected current levels and switching frequencies in the application.

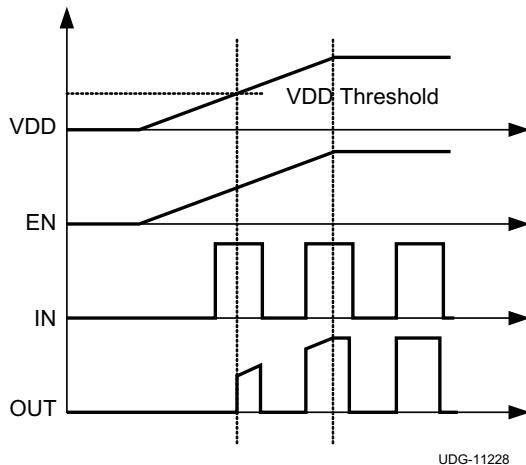


Figure 30. Power-Up Non-Inverting Driver

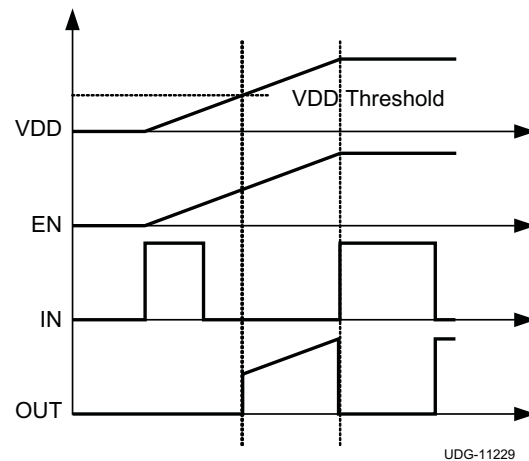


Figure 31. Power-Up Inverting Driver

## Operating Supply Current

The UCC2752x products feature very low quiescent  $I_{DD}$  currents. The typical operating supply current in Under Voltage Lock-Out (UVLO) state and fully-on state (under static and switching conditions) are summarized in Figure 10, Figure 11 and Figure 12. The  $I_{DD}$  current when the device is fully on and outputs are in a static state (DC high or DC low, refer Figure 11) represents lowest quiescent  $I_{DD}$  current when all the internal logic circuits of the device are fully operational. The total supply current is the sum of the quiescent  $I_{DD}$  current, the average  $I_{OUT}$  current due to switching and finally any current related to pull-up resistors on the enable pins and inverting input pins. For example when the inverting Input pins are pulled low additional current is drawn from VDD supply through the pull-up resistors (refer to Figure 6 though Figure 9). Knowing the operating frequency ( $f_{SW}$ ) and the MOSFET gate ( $Q_G$ ) charge at the drive voltage being used, the average  $I_{OUT}$  current can be calculated as product of  $Q_G$  and  $f_{SW}$ .

A complete characterization of the  $I_{DD}$  current as a function of switching frequency at different  $V_{DD}$  bias voltages under 1.8-nF switching load in both channels is provided in Figure 22. The strikingly linear variation and close correlation with theoretical value of average  $I_{OUT}$  indicates negligible shoot-through inside the gate-driver device attesting to its high-speed characteristics.

## Input Stage

The input pins of UCC2752x gate-driver devices are based on a TTL/CMOS compatible input threshold logic that is independent of the VDD supply voltage. With typically high threshold = 2.1 V and typically low threshold = 1.2 V, the logic level thresholds can be conveniently driven with PWM control signals derived from 3.3-V and 5-V digital power controller devices. Wider hysteresis (typ 0.9 V) offers enhanced noise immunity compared to traditional TTL logic implementations, where the hysteresis is typically less than 0.5 V. UCC2752x devices also feature tight control of the input pin threshold voltage levels which eases system design considerations and ensures stable operation across temperature (refer to [Figure 14](#)). The very low input capacitance on these pins reduces loading and increases switching speed.

The UCC2752x devices feature an important safety feature wherein, whenever any of the input pins is in a floating condition, the output of the respective channel is held in the low state. This is achieved using V<sub>DD</sub> pull-up resistors on all the Inverting inputs (INA, INB in UCC27523, INA in UCC27525 and INA-, INB- in UCC27526) or GND pull-down resistors on all the non-inverting input pins (INA, INB in UCC27524, INB in UCC27525 and INA+, INB+ in UCC27526), as shown in the device block diagrams.

While UCC27523/4/5 devices feature one input pin per channel, the UCC27526 features a dual input configuration with two input pins available to control the output state of each channel. With the UCC27526 device the user has the flexibility to drive each channel using either a non-inverting input pin (INx+) or an inverting input pin (INx-). The state of the output pin is dependent on the bias on both the INx+ and INx- pins (where x = A, B). Once an Input pin has been chosen to drive a channel, the other input pin of that channel (the unused input pin) must be properly biased in order to enable the output of the channel. The unused input pin cannot remain in a floating condition because, as mentioned earlier, whenever any input pin is left in a floating condition, the output of that channel is disabled using the internal pull-up/down resistors for safety purposes. Alternatively, the unused input pin can effectively be used to implement an enable/disable function, as explained below.

- In order to drive the channel x (x = A or B) in a non-inverting configuration, apply the PWM control input signal to INx+ pin. In this case, the unused input pin, INx-, must be biased low (eg. tied to GND) in order to enable the output of this channel.
  - Alternately, the INx- pin can be used to implement the enable/disable function using an external logic signal. OUTx is disabled when INx- is biased High and OUTx is enabled when INx- is biased low.
- In order to drive the channel x (x = A or B) in an Inverting configuration, apply the PWM control input signal to INx- pin. In this case, the unused input pin, INx+, must be biased high (eg. tied to VDD) in order to enable the output of the channel.
  - Alternately, the INx+ pin can be used to implement the enable/disable function using an external logic signal. OUTx is disabled when INx+ is biased low and OUTx is enabled when INx+ is biased high.
- Finally, it is worth noting that the UCC27526 output pin can be driven into high state only when INx+ pin is biased high and INx- input is biased low.

Refer to the input/output logic truth table and typical application diagram, ([Figure 28](#) and [Figure 29](#)), for additional clarification.

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) with a slow changing input voltage, the output of the driver may switch repeatedly at a high frequency. While the wide hysteresis offered in UCC2752x definitely alleviates this concern over most other TTL input threshold devices, extra care is necessary in these implementations. If limiting the rise or fall times to the power device is the primary goal, then an external resistance is highly recommended between the output of the driver and the power device. This external resistor has the additional benefit of reducing part of the gate charge related power dissipation in the gate driver device package and transferring it into the external resistor itself.

## Enable Function

The enable function is an extremely beneficial feature in gate driver devices especially for certain applications such as synchronous rectification where the driver outputs can be disabled in light-load conditions to prevent negative current circulation and to improve light-load efficiency.

UCC27523/4/5 devices are provided with independent enable pins ENx for exclusive control of each driver channel operation. The enable pins are based on a non-inverting configuration (active high operation). Thus when ENx pins are driven high the drivers are enabled and when ENx pins are driven low the drivers are disabled. Like the input pins, the enable pins are also based on a TTL/CMOS compatible input threshold logic that is independent of the supply voltage and can be effectively controlled using logic signals from 3.3-V and 5-V microcontrollers. The UCC2752X devices also feature tight control of the Enable function threshold voltage levels which eases system design considerations and ensures stable operation across temperature (refer to [Figure 15](#)). The ENx pins are internally pulled up to VDD using pull-up resistors as a result of which the outputs of the device are enabled in the default state. Hence the ENx pins can be left floating or Not Connected (N/C) for standard operation, where the enable feature is not needed. Essentially, this allows the UCC27523/4/5 devices to be pin-to-pin compatible with TI's previous generation drivers UCC27323/4/5 respectively, where pins #1, 8 are N/C pins. If the channel A and Channel B inputs and outputs are connected in parallel to increase the driver current capacity, ENA and ENB should be connected and driven together.

The UCC27526 device does not feature dedicated enable pins. However, as mentioned earlier, an enable/disable function can be easily implemented in UCC27526 using the unused input pin. When INx+ is pulled-down to GND or INx- is pulled-down to VDD, the output is disabled. Thus INx+ pin can be used like an enable pin that is based on active high logic, while INx- can be used like an enable pin that is based on active low logic. It is important to note that while the ENA, ENB pins in UCC27523/4/5 are allowed to be in floating condition during standard operation and the outputs will be enabled, the INx+, INx- pins in UCC27526 are not allowed to be floating since this will disable the outputs.

## Output Stage

Each output stage is capable of supplying 5-A peak current pulses and swings to both VDD and GND providing rail-to-rail operation, thanks to the MOS output stage of the gate driver. The UCC27523/4/5/6 devices features a unique architecture on the output stage which delivers the highest peak source current when it is most needed during the Miller Plateau region of the MOSFET turn-on transition when the MOSFET drain voltage experiences  $dV/dt$ . Each output stage also provides a very low impedance to overshoot and undershoot due to the body diode of the MOSFET. This means that in many cases, external Schottky diode clamps are not required. The outputs of these drivers are designed to withstand 500-mA reverse current without either damage to the device for logic malfunction.

The UCC2752x devices are particularly suited for dual-polarity, symmetrical drive gate transformer applications where the primary winding of transformer driven by OUTA and OUTB, with inputs INA and INB being driven complementary to each other. This is due to the extremely low drop-out offered by the MOS output stage of these devices, both during high (VOH) and low (VOL) states along with the low impedance of the driver output stage, all of which allow alleviate concerns regarding transformer demagnetization and flux imbalance. The low propagation delays also ensure accurate reset for high-frequency applications.

For applications that have zero voltage switching during power MOSFET turn-on or turn-off interval, the driver supplies high-peak current for fast switching even though the miller plateau is not present. This situation often occurs in synchronous rectifier applications because the body diode is generally conducting before power MOSFET is switched on.

### Low Propagation Delays and Tightly Matched Outputs

The UCC2752x driver devices feature a best in class, 13-ns (typical) propagation delay between input and output which goes to offer the lowest level of pulse transmission distortion available in the industry for high frequency switching applications. For example in synchronous rectifier applications, the SR MOSFETs can be driven with very low distortion when a single driver device is used to drive both the SR MOSFETs. Further, the driver devices also feature an extremely accurate, 1-ns (typ) matched internal propagation delays between the two channels which is beneficial for applications requiring dual gate drives with critical timing. For example in a PFC application, a pair of paralleled MOSFETs may be driven independently using each output channel, which the inputs of both channels are driven by a common control signal from the PFC controller device. In this case the 1ns delay matching ensures that the paralleled MOSFETs are driven in a simultaneous fashion with the minimum of turn-on delay difference. Yet another benefit of the tight matching between the two channels is that the two channels can be connected together to effectively increase current drive capability i.e. A and B channels may be combined into a single driver by connecting the INA and INB inputs together and the OUTA and OUTB outputs together. Then, a single signal can control the paralleled combination.

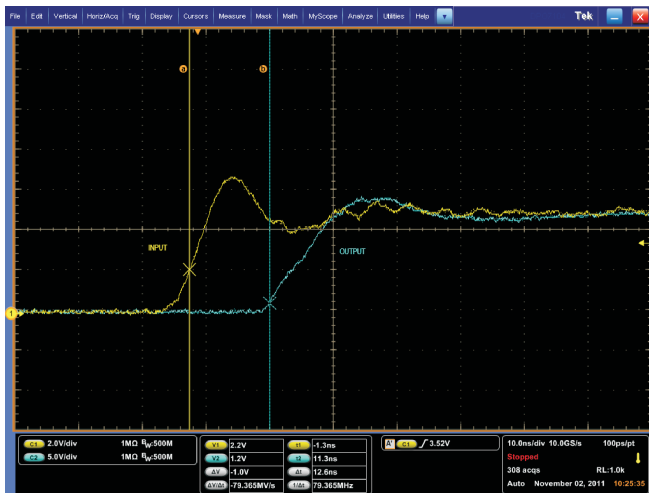


Figure 32. Turn-On Propagation Delay ( $C_L = 1.8 \text{ nF}$ ,  $V_{DD} = 12 \text{ V}$ )

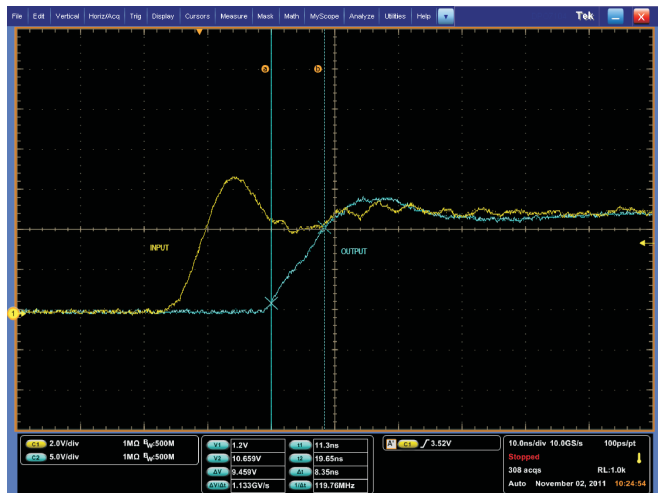


Figure 33. Turn-On Rise Time ( $C_L = 1.8 \text{ nF}$ ,  $V_{DD} = 12 \text{ V}$ )

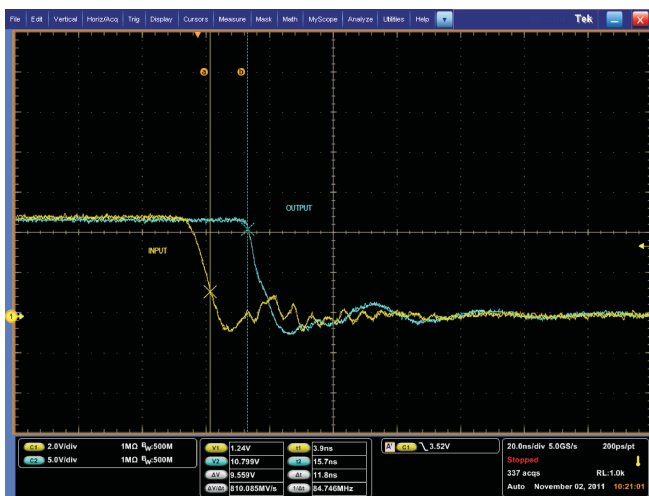


Figure 34. Turn-Off Propagation Delay ( $C_L = 1.8 \text{ nF}$ ,  $V_{DD} = 12 \text{ V}$ )

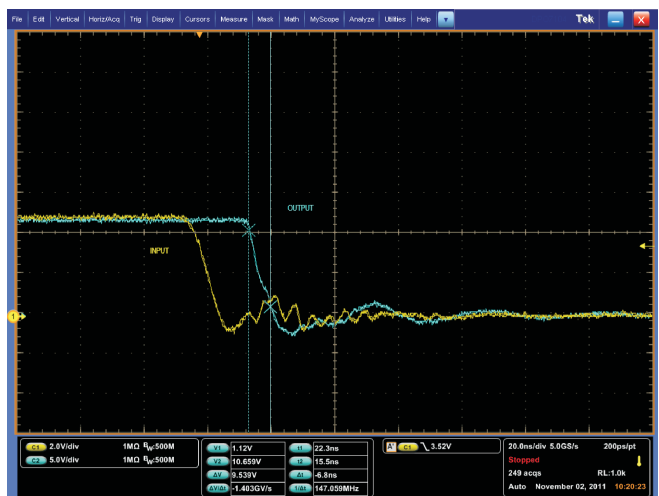


Figure 35. Turn-Off Fall Time ( $C_L = 1.8 \text{ nF}$ ,  $V_{DD} = 12 \text{ V}$ )

## Drive Current and Power Dissipation

The UCC27523/4/5/6 family of drivers are capable of delivering 5-A of current to a MOSFET gate for a period of several hundred nanoseconds at  $V_{DD} = 12\text{ V}$ . 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. The power dissipated in the gate driver device package depends on the following factors:

- Gate charge required of the power MOSFET (usually a function of the drive voltage  $V_{GS}$ , which is very close to input bias supply voltage  $V_{DD}$  due to low  $V_{OH}$  drop-out)
- Switching frequency
- Use of external gate resistors

Since UCC2752x features very low quiescent currents and internal logic to eliminate any shoot-through in the output driver stage, their effect on the power dissipation within the gate driver can be safely assumed to be negligible.

When a driver device 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:

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

where  $C_{LOAD}$  is load capacitor and  $V_{DD}$  is 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:

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

where  $f_{SW}$  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 completely dissipated inside the driver. With the use of external gate drive resistors, the power dissipation is shared between the internal impedance in the output stage of the driver device and the external gate resistor in accordance to the ratio of the impedances (more power dissipated in the higher impedance component). Half of the total power is dissipated when the load capacitor is charged during turn-on, and the other half is dissipated when the load capacitor is discharged during turn-off.

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

$$P_G = 10\text{ nF} \times 12\text{ V}^2 \times 300\text{ kHz} = 0.432\text{ W} \quad (3)$$

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 voltage of the power device as it switches 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  $Q_g = C_{LOAD}V_{DD}$  to provide the following equation for power:

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

Assuming that UCC2752x is driving power MOSFET with 60 nC of gate charge ( $Q_g = 60$  nC at  $V_{DD} = 12$  V) on each output, the gate charge related power loss can be calculated as:

$$P_G = 2 \times 60 \text{ nC} \times 12 \text{ V} \times 300 \text{ kHz} = 0.432 \text{ W} \quad (5)$$

In addition to the above gate charge related power dissipation, additional dissipation in the driver is related to the power associated with the quiescent bias current consumed by the device to bias all internal circuits such as input stage (with pull-up and pull-down resistors), enable, and UVLO sections. Referring to the [Figure 11](#) it can be seen that the quiescent current is less than 0.6 mA even in the highest case. The quiescent power dissipation can be simply calculated as:

$$P_Q = I_{DD}V_{DD} \quad (6)$$

Assuming ,  $I_{DD} = 6$  mA, the power loss is:

$$P_Q = 0.6 \text{ mA} \times 12 \text{ V} = 7.2 \text{ mW} \quad (7)$$

Clearly, this is insignificant compared to gate charge related power dissipation calculated earlier.

With a 12-V supply, the bias current can be estimated as follows, with an additional 0.6-mA overhead for the quiescent consumption:

$$I_{DD} \sim \frac{P_G}{V_{DD}} = \frac{0.432 \text{ W}}{12 \text{ V}} = 0.036 \text{ A} \quad (8)$$

## 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 device package. In order for a gate driver device 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 UCC27523/4/5/6 family of drivers is available in four different packages to cover a range of application requirements. The thermal metrics for each of these packages are summarized in the Thermal Information section of the datasheet. For detailed information regarding the thermal information table, please refer to Application Note from Texas Instruments entitled, "[IC Package Thermal Metrics](#)" ([Texas Instrument's Literature Number SPRA953A](#)).

Among the different package options available in the UCC2752x family, of particular mention are the DSD & DGN packages when it comes to power dissipation capability. The MSOP PowerPAD-8 (DGN) package and 3-mm x 3-mm WSON (DSD) package offer a means of removing the heat from the semiconductor junction through the bottom of the package. Both these packages offer an exposed thermal pad at the base of the package. This pad is soldered to the copper on the printed circuit board directly underneath the device package, reducing the thermal resistance to a very low value. This allows a significant improvement in heat-sinking over that available in the D or P packages. The printed circuit board must be designed with thermal lands and thermal vias to complete the heat removal subsystem. Note that the exposed pads in the MSOP-8 (PowerPAD™) and WSON-8 packages are not directly connected to any leads of the package. However, it is electrically and thermally connected to the substrate of the device which is the ground of the device. It is recommended to externally connect the exposed pads to GND in PCB layout for better EMI immunity.

## PCB Layout

Proper PCB layout is extremely important in a high current, fast switching circuit to provide appropriate device operation and design robustness. The UCC27523/4/5/6 family of gate drivers incorporates short propagation delays and powerful output stages capable of delivering large current peaks with very fast rise and fall times at the gate of power MOSFET to facilitate voltage transitions very quickly. At higher VDD voltages, the peak current capability is even higher (5-A peak current is at VDD = 12 V). Very high di/dt can cause unacceptable ringing if the trace lengths and impedances are not well controlled. The following circuit layout guidelines are strongly recommended when designing with these high-speed drivers.

- Locate the driver device as close as possible to power device in order to minimize the length of high-current traces between the Output pins and the Gate of the power device.
- Locate the VDD bypass capacitors between VDD and GND as close as possible to the driver with minimal trace length to improve the noise filtering. These capacitors support high peak current being drawn from VDD during turn-on of power MOSFET. The use of low inductance SMD components such as chip resistors and chip capacitors is highly recommended.
- The turn-on and turn-off current loop paths (driver device, power MOSFET and VDD bypass capacitor) should be minimized as much as possible in order to keep the stray inductance to a minimum. High di/dt is established in these loops at 2 instances – during turn-on and turn-off transients, which will induce significant voltage transients on the output pin of the driver device and Gate of the power MOSFET.
- Wherever possible parallel the source and return traces, taking advantage of flux cancellation
- Separate power traces and signal traces, such as output and input signals.
- Star-point grounding is a good way to minimize noise coupling from one current loop to another. The GND of the driver should be connected to the other circuit nodes such as source of power MOSFET, ground of PWM controller etc at one, single point. The connected paths should be as short as possible to reduce inductance and be as wide as possible to reduce resistance.
- Use a ground plane to provide noise shielding. Fast rise and fall times at OUT may corrupt the input signals during transition. The ground plane must not be a conduction path for any current loop. Instead the ground plane must be connected to the star-point with one single trace to establish the ground potential. In addition to noise shielding, the ground plane can help in power dissipation as well
- In noisy environments, it may be necessary to tie inputs of an unused channel of UCC27526 to VDD (in case of INx+) or GND (in case of INx-) using short traces in order to ensure that the output is enabled and to prevent noise from causing malfunction in the output.
- Exercise caution when replacing the UCC2732x/UCC2742x devices with the UCC2752x:
  - UCC2752x is a much stronger gate driver (5-A peak current versus 4-A peak current).
  - UCC2752x is a much faster gate driver (13-ns/13-ns rise/fall propagation delay versus 25-ns/35-ns rise/fall propagation delay).

## Revision History

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

- Changed datasheet status to Production Data. .... 1

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

- Added note to packaging section, "DSD package is rated MSL level 2". .... 2
- Changed Supply start threshold row to include two temperature ranges. .... 5
- Changed Minimum operating voltage after supply start min and max values from 3.6 V to 4.2 V to 3.40 V and 4.40 V. .... 5
- Changed Supply voltage hysteresis typ value from 0.35 to 0.30. .... 5
- Changed UCC27526 Block Diagram drawing. .... 10
- Changed UCC27526 Channel A in Inverting and Channel B in Non-Inverting Configuration drawing. .... 15

**PACKAGING INFORMATION**

Orderable Device	Status <sup>(1)</sup>	Package Type	Package Drawing	Pins	Package Qty	Eco Plan <sup>(2)</sup>	Lead/ Ball Finish	MSL Peak Temp <sup>(3)</sup>	Samples (Requires Login)
UCC27524D	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
UCC27524DGNR	PREVIEW	MSOP- PowerPAD	DGN	8	2500	TBD	Call TI	Call TI	
UCC27524DGNT	PREVIEW	MSOP- PowerPAD	DGN	8		TBD	Call TI	Call TI	
UCC27524DR	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
UCC27524DSDR	PREVIEW	SON	DSD	8	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	
UCC27524DSDT	PREVIEW	SON	DSD	8	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	
UCC27524P	PREVIEW	PDIP	P	8	50	Green (RoHS & no Sb/Br)	CU NIPDAU	N / A for Pkg Type	

<sup>(1)</sup> 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.

**OBSELETE:** TI has discontinued the production of the device.

<sup>(2)</sup> 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.

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P (R-PDIP-T8)

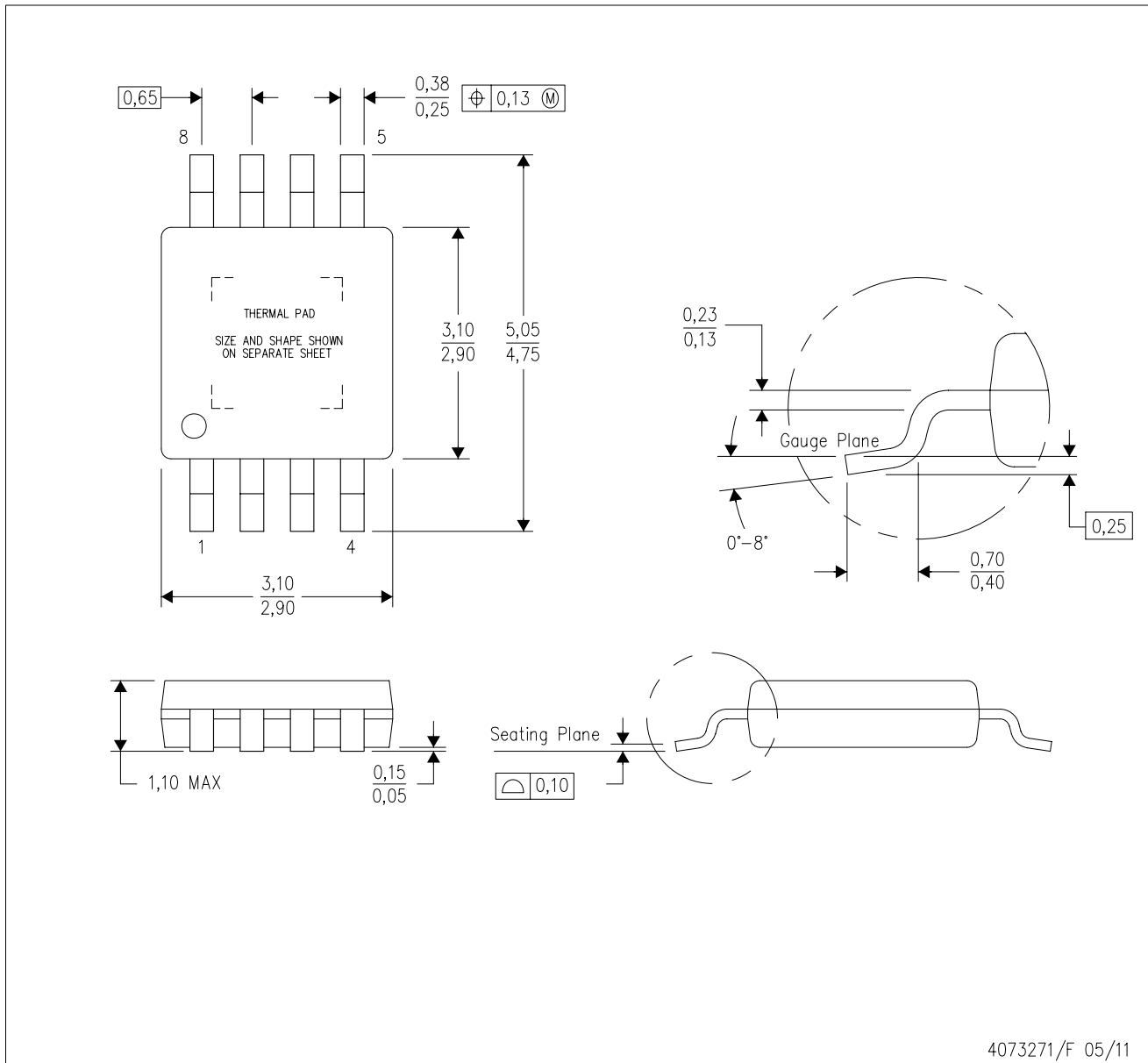
PLASTIC DUAL-IN-LINE PACKAGE



- 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

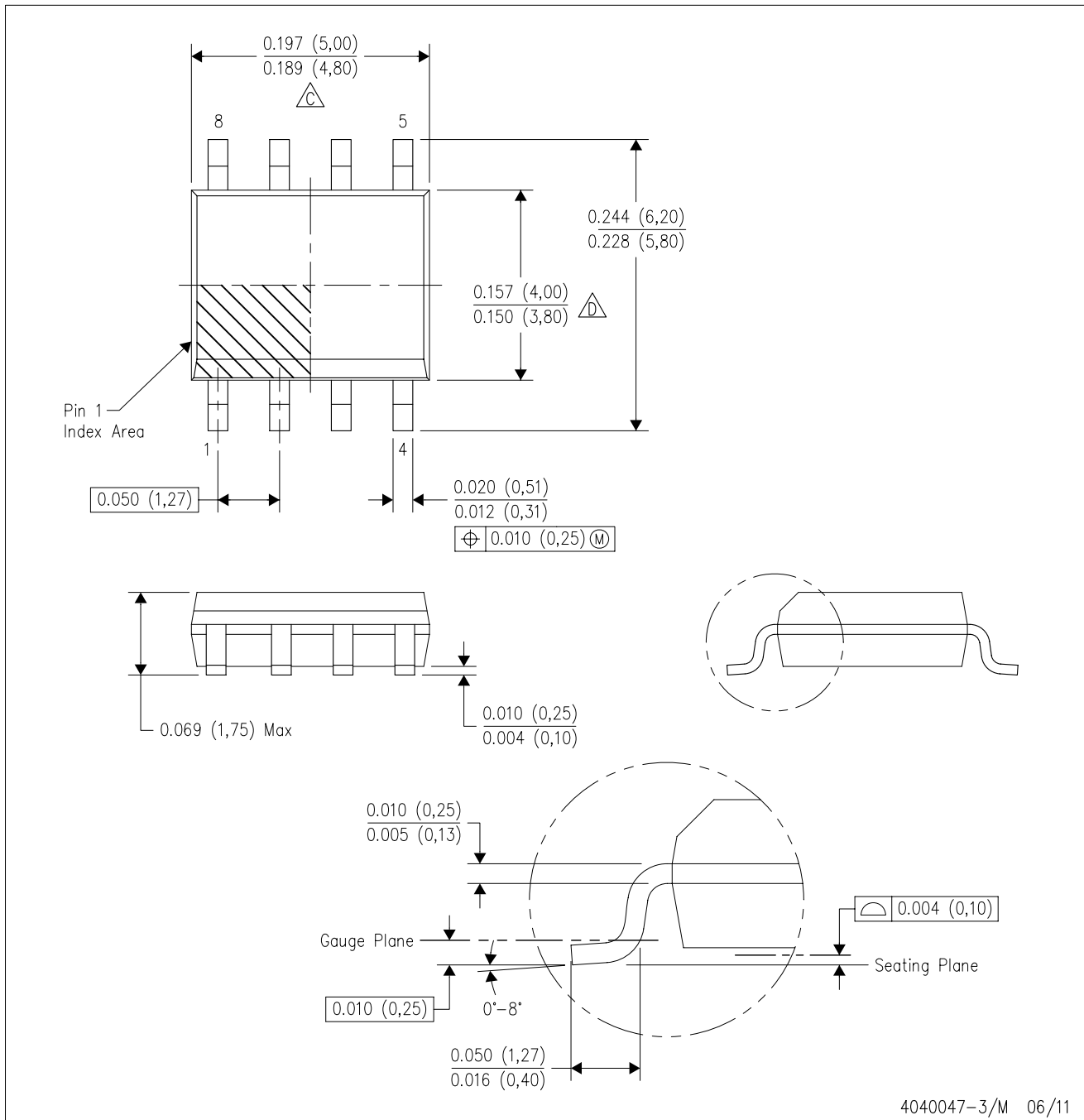


- NOTES:
- All linear dimensions are in millimeters.
  - This drawing is subject to change without notice.
  - Body dimensions do not include mold flash or protrusion.
  - This package is designed to be soldered to a thermal pad on the board. Refer to Technical Brief, PowerPad Thermally Enhanced Package, 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.

D (R-PDSO-G8)

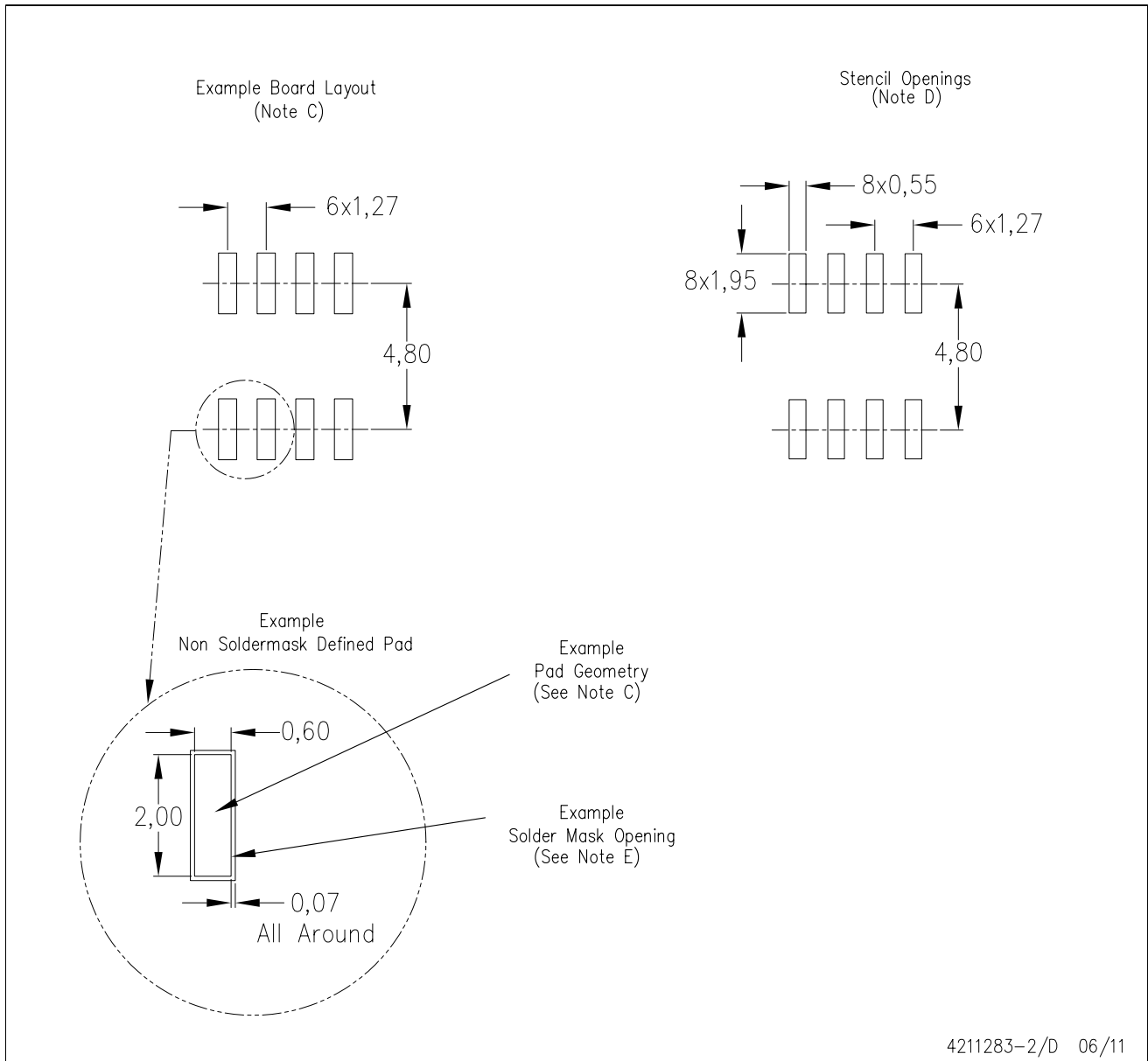
PLASTIC SMALL OUTLINE



- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  - 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.
  - 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



4211283-2/D 06/11

- NOTES:
- All linear dimensions are in millimeters.
  - This drawing is subject to change without notice.
  - Publication IPC-7351 is recommended for alternate designs.
  - 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.
  - Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.

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Industrial	<a href="http://www.ti.com/industrial">www.ti.com/industrial</a>
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