2.5A 和 5A，35V_{MAX} VDD 场效应晶体管 (FET) 和绝缘栅双极晶体管 (IGBT) 单栅极驱动器

特性

- 符合汽车应用要求
- 具有符合 **AEC-Q100** 的下列结果：
  - 器件温度 **1** 级
  - 器件人体模型 **(HBM)** 静电放电 **(ESD)** 分类等级 **H2**
  - 器件充电器件模型 **(CDM) ESD** 分类等级 **C4B**
- 低成本栅极驱动器（为驱动 **FET** 和 **IGBT** 提供最佳解决方案）
- 离散晶体管对驱动的出色替代产品（提供与控制器的简便对接）
- **TTL** 和 **CMOS** 兼容输入逻辑阀值，（与电源电压无关）
- 分离输出选项实现打开和关闭电流调节
- 反向和非反向输入配置
- 由固定 **TTL** 兼容阀值启用
- **18V VDD** 时的高 **2.5A** 源电流和 **2.5A** 或 **5A** 灌峰值驱动电流
- 从 **10V** 到高达 **35V** 的宽 **VDD** 范围
- 能够耐受比接地最多低 **5V** 的直流电压的输入和使能引脚
- 当输入悬空或 **VDD** 欠压闭锁 **(UVLO)** 期间，输出保持低电平
- 快速传播延迟（典型值 **17ns**）
- 快速上升和下降时间（**1800pF** 负载时的典型值分别为 **15ns** 和 **7ns**）
- 欠压闭锁 **(UVLO)**
- 被用作高侧或低侧驱动器（如果采用适当的偏置和信号隔离设计）
- 低成本、节省空间的 **6** 引脚 **DBV**（小外形尺寸晶体管 **(SOT)-23**）封装 选项
- **-40°C** 至 **140°C** 的运行温度范围

应用范围

- 车载
- 开关模式电源
- 直流到直流转换器
- 太阳能逆变器、电机控制、不间断电源 **(UPS)**
- 混合动力车 **(HEV)** 和电动车辆 **(EV)** 充电器
- 家用电器
- 可再生能源功率转换
- **SiC FET** 转换器

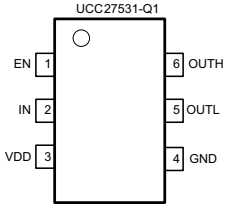
说明

UCC27531-Q1 是一款单通道、高速、栅极驱动器，此驱动器可借助于高达 2.5A 源电流和 5A 灌电流（非对称驱动）峰值电流来有效驱动金属氧化物半导体场效应晶体管 (MOSFET) 和 IGBT 电源开关。 强劲的非对称驱动中的吸收能力提升了抗寄生米勒 (Miller) 接通效应的能力。 UCC27531-Q1 器件还特有一个分离输出配置，在此配置中栅极驱动电流从 OUTH 引脚拉出并从 OUTL 引脚被灌入。 这个独特的引脚安排使得用户能够分别在 OUTH 和 OUTL 引脚上采用独立的接通和关闭电阻器并且能很轻易地控制开关的转换率。

此驱动器具有轨到轨驱动能力和典型值为 17ns 的极小传播延迟。

UCC27531-Q1 的输入阀值基于与 TTL 和 COMS 兼容的低压逻辑电路，此逻辑电路是固定的且与 VDD 电源电压无关。 1V 滞后典型值提供出色的抗扰度。

UCC27531-Q1
(顶视图)



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

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ESD 可能会损坏该集成电路。德州仪器 (TI) 建议通过适当的预防措施处理所有集成电路。如果不遵守正确的处理措施和安装程序，可能会损坏集成电路。

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

说明（继续）

此驱动器具有支持固定 TTL 兼容阀值的 EN 引脚。 EN 被内部上拉；将 EN 下拉为低电平禁用驱动器，而将其保持打开可提供正常运行。 EN 引脚可被用作一个额外输入，其性能与 IN 引脚一样。

将驱动器的输入引脚保持开状态将把输出保持为低电平。 驱动器的逻辑运行方式被显示在应用图、时序图和输入与输出逻辑真值表中。

VDD 引脚上的内部电路提供一个欠压闭锁功能，此功能在 VDD 电源电压处于运行范围内之前将输出保持为低电平。

UCC27531-Q1 驱动器采用 6 引脚标准 SOT-23 (DBV) 封装。 此器件在 -40°C 至 140°C 的宽运行温度范围运行。

ABSOLUTE MAXIMUM RATINGS(1)(2)(3)

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

		MIN	MAX	UNIT
Supply voltage range,	VDD	–0.3	35	V
Continuous	OUTH, OUTL, OUT	–0.3	VDD + 0.3	
Pulse	OUTH, OUTL, OUT (200 ns)	–2	VDD + 0.3	
Continuous IN, EN, IN+, IN-, IN1, IN2		–5	27	V
Pulse IN, EN, IN+, IN-, IN1, IN2 (1.5 µs)		–6.5	27	
Electrostatic discharge (ESD) ratings	Human body model, HBM classification level H2		±2000	
	Charged device model, CDM classification level C4B		750	
Operating virtual junction temperature range, T_J		–40	150	°C
Storage temperature range, T_{stg}		–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) These devices are sensitive to electrostatic discharge; follow proper device handling procedures.

THERMAL INFORMATION

THERMAL METRIC(1)		UCC27531-Q1 DBV (6 PINS)	UNIT
θ_{JA}	Junction-to-ambient thermal resistance	178.3	°C/W
θ_{JCtop}	Junction-to-case (top) thermal resistance	109.7	
θ_{JB}	Junction-to-board thermal resistance	28.3	
ψ_{JT}	Junction-to-top characterization parameter	14.7	
ψ_{JB}	Junction-to-board characterization parameter	27.8	

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

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RECOMMENDED OPERATING CONDITIONS

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

	MIN	TYP	MAX	UNIT
Supply voltage range, VDD	10	18	32	V
Ambient temperature range	–40		140	°C
Input voltage, IN, IN+, IN-, IN1, IN2	–5		25	V
Enable, EN	–5		25	

ELECTRICAL CHARACTERISTICS

Unless otherwise noted, VDD = 18 V, T_A = –40°C to 140°C, 1-µF capacitor from VDD to GND, f = 100 kHz. Currents are positive into, negative out of the specified terminal. OUTH and OUTL are tied together for UCC27531-Q1. Typical condition specifications are at 25°C.

PARAMETER		TEST CONDITION	MIN	TYP	MAX	UNITS
Bias Currents						
I_{DDoff}	Startup current	VDD = 7, IN, EN = VDD	100	200	300	µA
		IN, EN = GND	100	217	300	
Under Voltage Lockout (UVLO)						
V_{ON}	Supply start threshold		8	8.9	9.8	V
V_{OFF}	Minimum operating voltage after supply start		7.3	8.2	9.1	
V_{DD_H}	Supply voltage hysteresis			0.7		
Input (IN)						
V_{IN_H}	Input signal high threshold, output high	Output High, EN = HIGH	1.8	2	2.2	V
V_{IN_L}	Input signal low threshold, output low	Output Low, EN = HIGH	0.8	1	1.2	
V_{IN_HYS}	Input signal hysteresis			1		
Enable (EN)						
V_{EN_H}	Enable signal high threshold	Output High	1.7	1.9	2.1	V
V_{EN_L}	Enable signal low threshold	Output Low	0.8	1	1.2	
V_{EN_HYS}	Enable signal hysteresis			0.9		
Outputs (OUTH/OUTL)						
$I_{SRC/SNK}$	Source peak current (OUTH)/ sink peak current (OUTL)	CLOAD = 0.22 µF, f = 1 kHz		–2.5 / +5		A
V_{OH}	OUTH, high voltage	I_{OUTH} = –10 mA	VDD - 0.2	VDD - 0.12	VDD - 0.07	V
V_{OL}	OUTL, low voltage	I_{OUTL} = 100 mA		0.065	0.125	
R_{OH}	OUTH, pullup resistance	T_A = 25°C, I_{OUT} = –10 mA	11	12	12.5	Ω
		T_A = –40°C to 140°C, I_{OUT} = –10 mA	7	12	20	
R_{OL}	OUTL, pulldown resistance	T_A = 25°C, I_{OUT} = 100 mA	0.45	0.65	0.85	
		T_A = –40°C to 140°C, I_{OUT} = 100 mA	0.3	0.65	1.25	
Switching Time						
t_R	Rise time	C_{LOAD} = 1.8 nF		15		ns
t_F	Fall time	C_{LOAD} = 1.8 nF		7		
t_{D1}	Turn-on propagation delay	C_{LOAD} = 1.8 nF, IN = 0 V to 5 V		17	26	
t_{D2}	Turn-off propagation delay	C_{LOAD} = 1.8 nF, IN = 5 V to 0 V		17	26	

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TIMING DIAGRAM

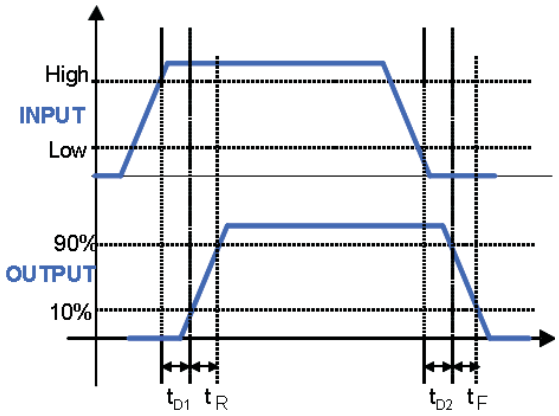


Figure 1. (OUTPUT = OUTH tied to OUTL) INPUT = IN, (EN = VDD), or INPUT = EN, (IN = VDD)

BLOCK DIAGRAM

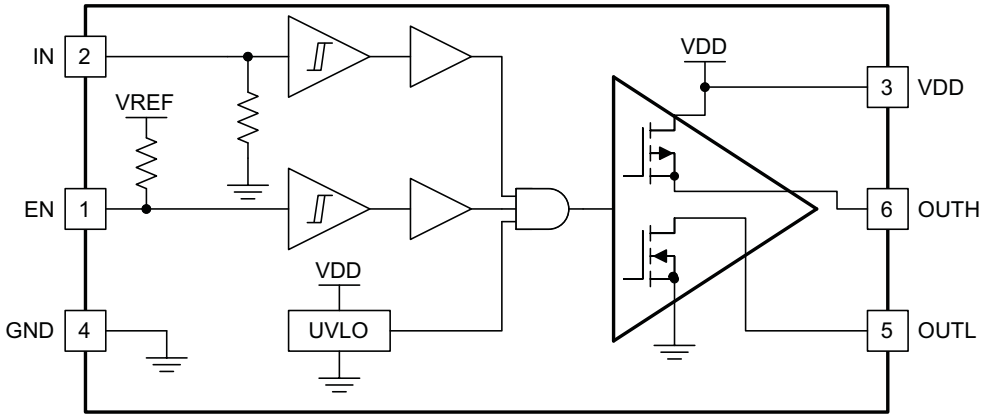


Figure 2. UCC27531-Q1 (EN Pullup Resistance to VREF = 500 kΩ, VREF = 5.8 V, in Pulldown Resistance to GND = 230 kΩ)

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TYPICAL APPLICATION DIAGRAMS

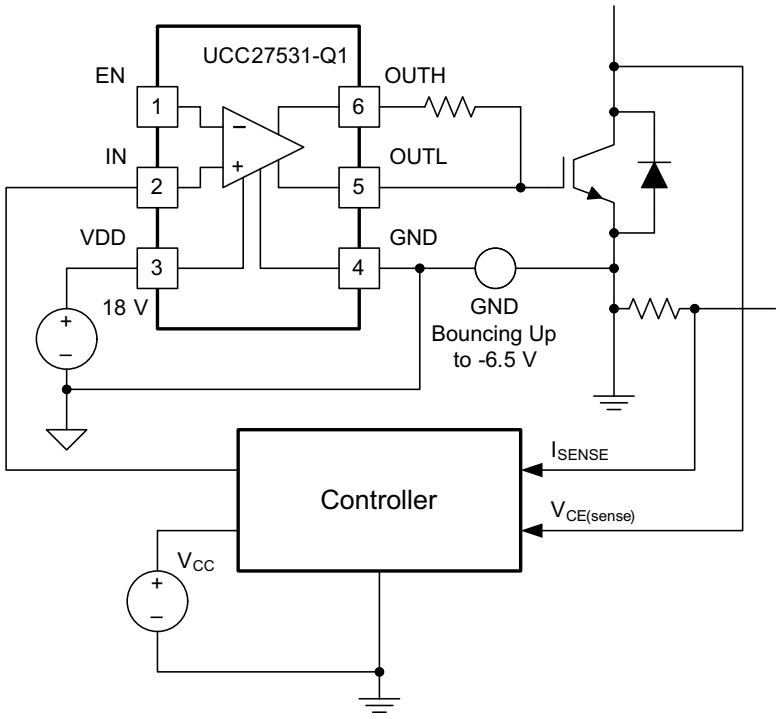


Figure 3. Driving IGBT Without Negative Bias

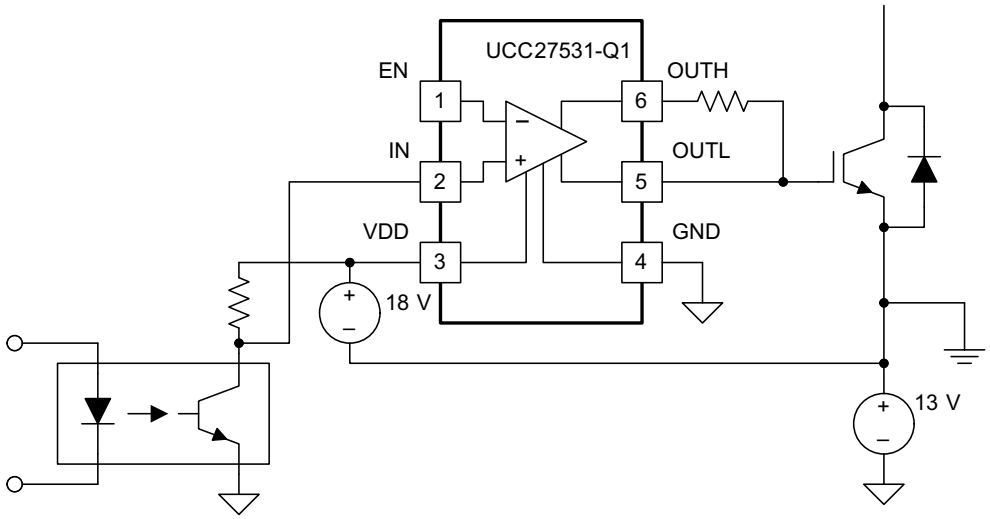


Figure 4. Driving IGBT With 13-V Negative Turn-Off Bias

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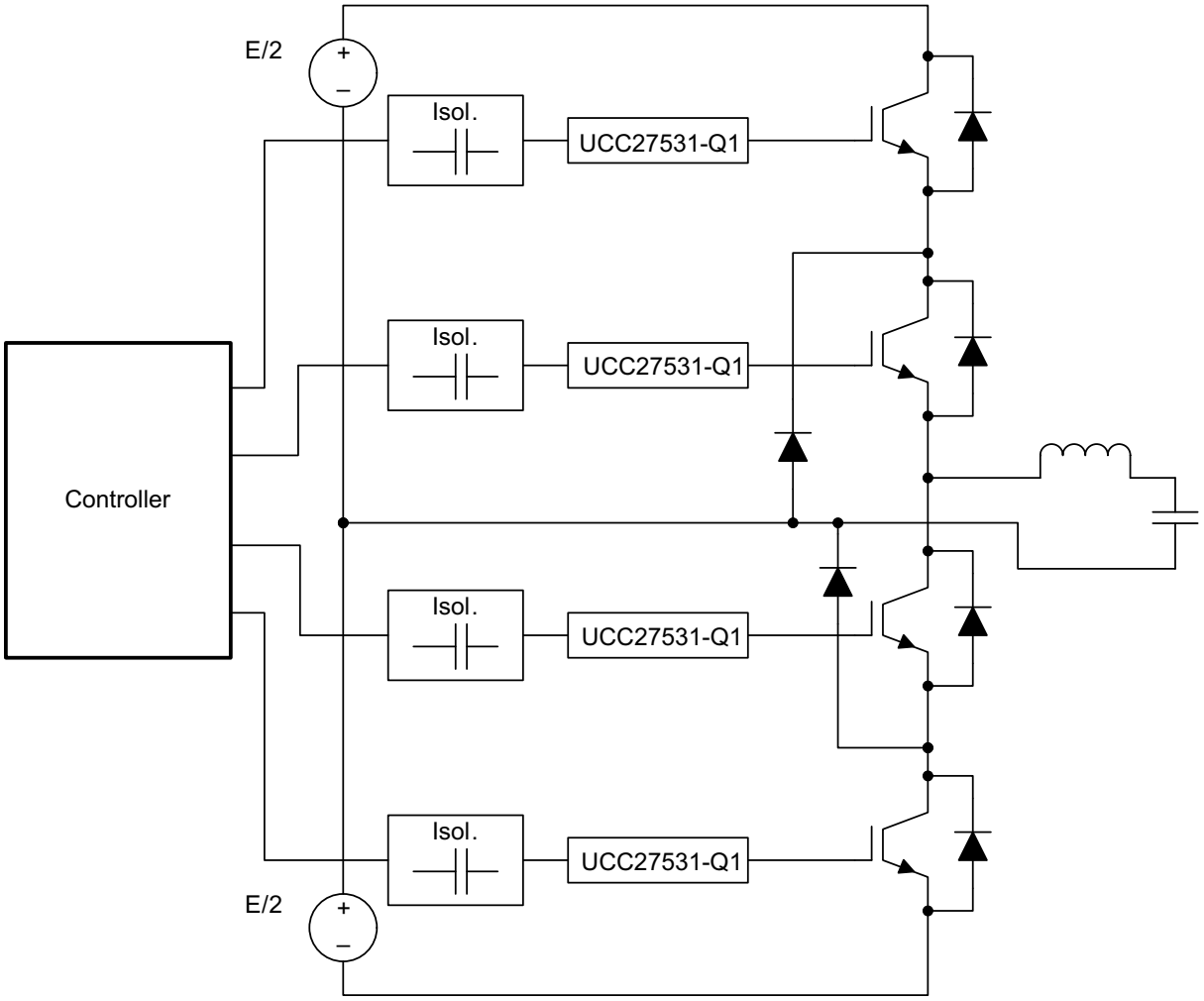
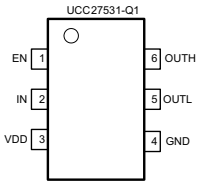


Figure 5. Using UCC27531-Q1 Drivers in an Inverter

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UCC27531-Q1 PRODUCT MATRIX

UCC27531-Q1 Product Matrix

	UCC27531-Q1
I_{ON} PEAK	2.5 A
I_{OFF} PEAK	5 A
PACKAGE	SOT-23-6
IN	Single
IN LOGIC	TTL/CMOS
EN	Yes
OUTPUT	Split
INVERTING	No
MAX VDD	35 V
PIN OUT	

PIN FUNCTIONS

PIN		I/O	FUNCTION
NAME	NO.		
EN	1	I	Enable (Pull EN to GND in order to disable output, pull it high or leave open to enable output)
GND	4	-	Ground (all signals are referenced to this node)
IN	2	I	Driver non-inverting input
OUTH	6	O	2.5-A Source Current Output of driver
OUTL	5	O	5-A sink current output of driver
VDD	3	I	Bias supply input

INPUT/OUTPUT LOGIC TRUTH TABLE (For Single Output Driver)

UCC27531QDBVRQ1				
IN PIN	**EN PIN**	**OUTH PIN**	**OUTL PIN**	**OUT (OUTH and OUTL pins tied together)**
L	L	High-impedance	L	L
L	H	High-impedance	L	L
H	L	High-impedance	L	L
H	H	H	High-impedance	H
H	FLOAT	H	High-impedance	H
FLOAT	H	High-impedance	L	L

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TYPICAL CHARACTERISTICS

If not specified, INPUT refers to non-inverting input

RISE TIME vs SUPPLY VOLTAGE

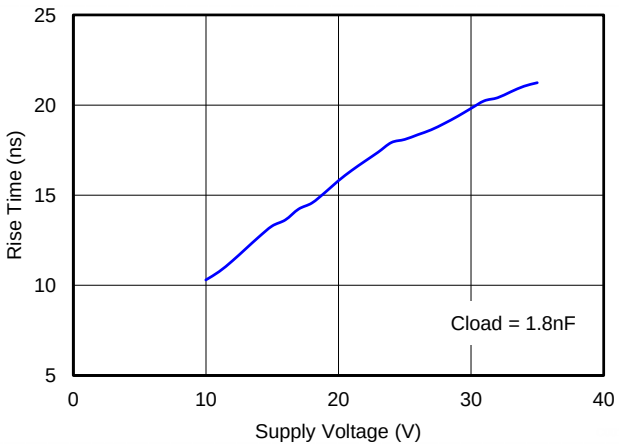


Figure 6.

FALL TIME vs SUPPLY VOLTAGE

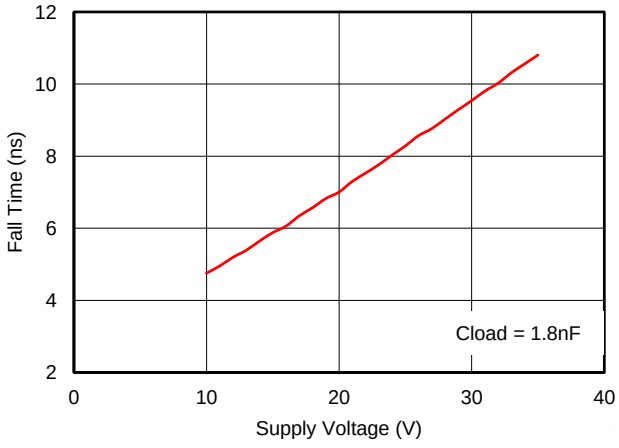


Figure 7.

PROPAGATION DELAY vs SUPPLY VOLTAGE

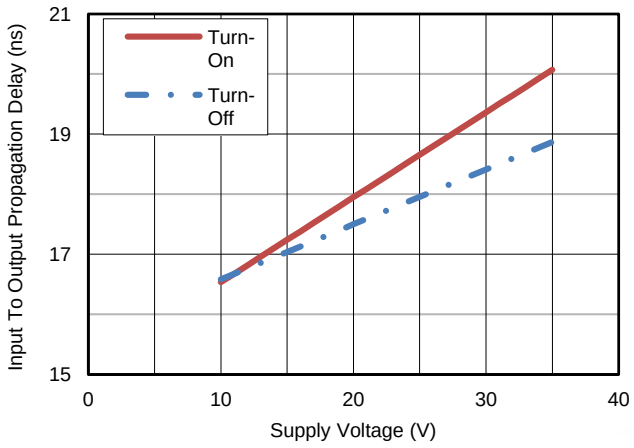


Figure 8.

IN - PROPAGATION DELAY vs SUPPLY

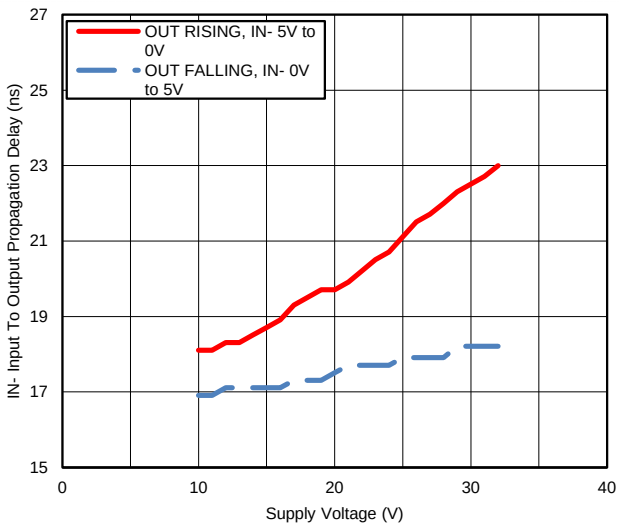


Figure 9.

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TYPICAL CHARACTERISTICS (continued)

If not specified, INPUT refers to non-inverting input

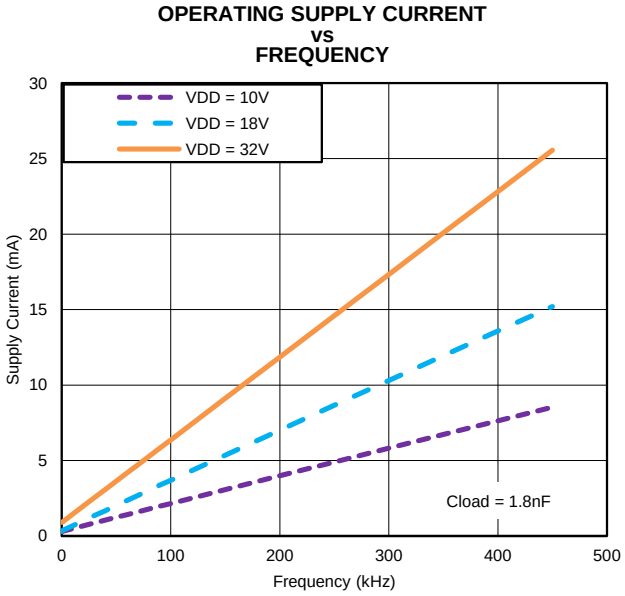


Figure 10.

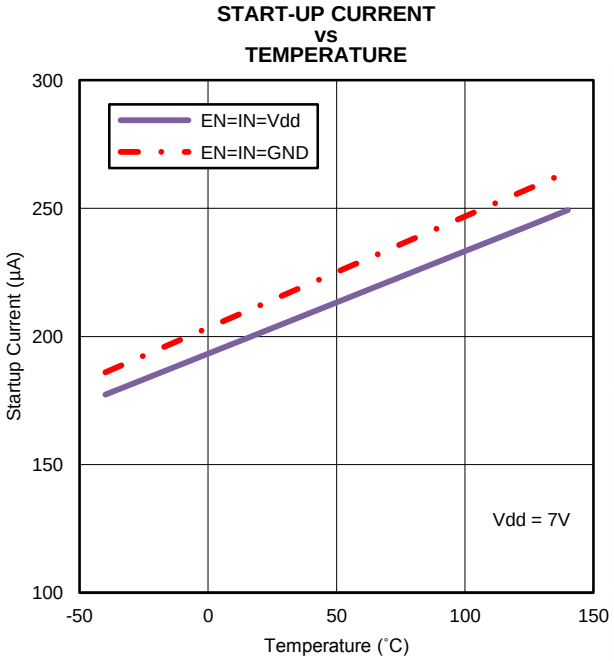


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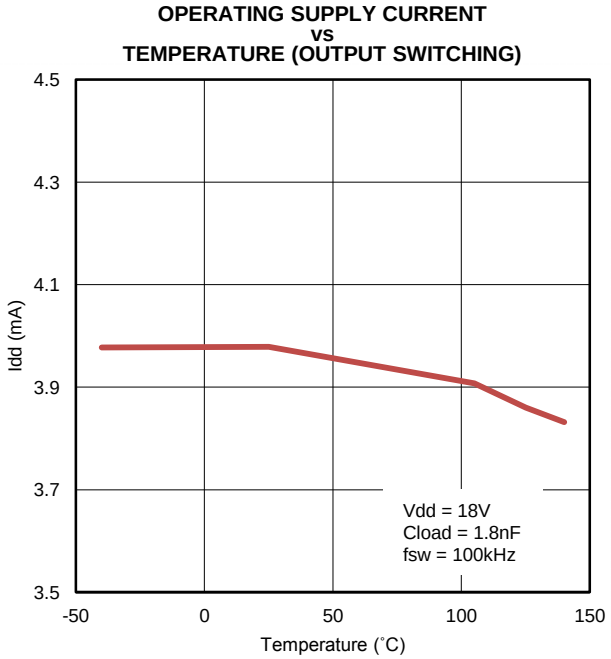


Figure 12.

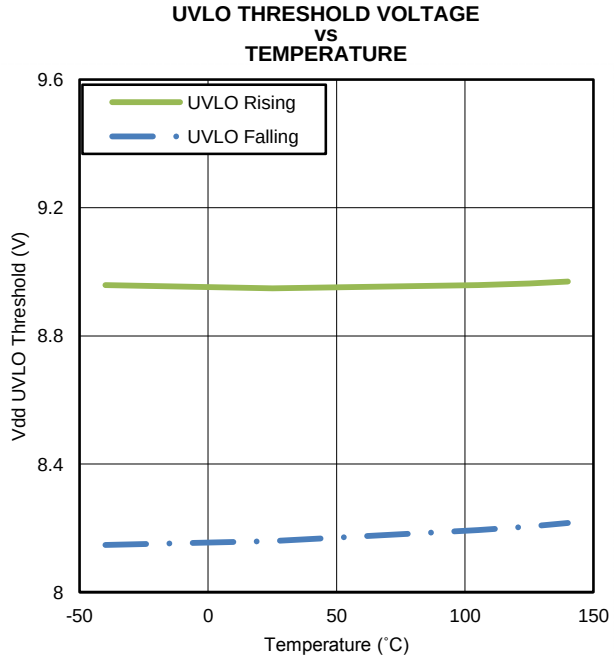


Figure 13.

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TYPICAL CHARACTERISTICS (continued)

If not specified, INPUT refers to non-inverting input

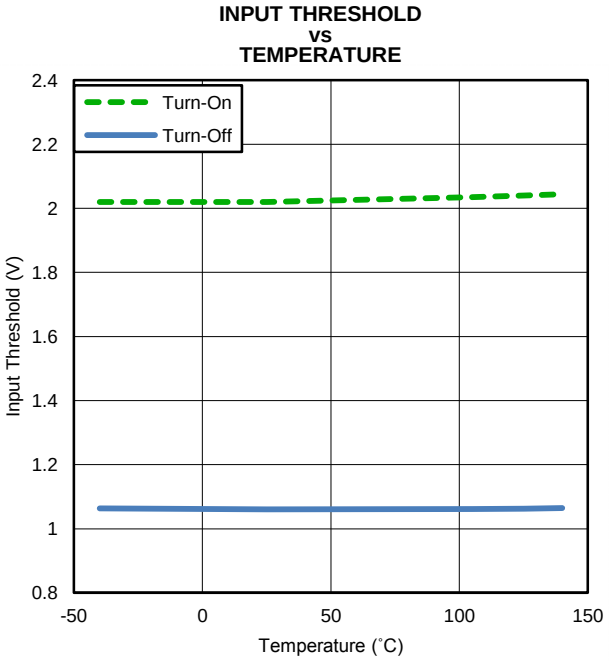


Figure 14.

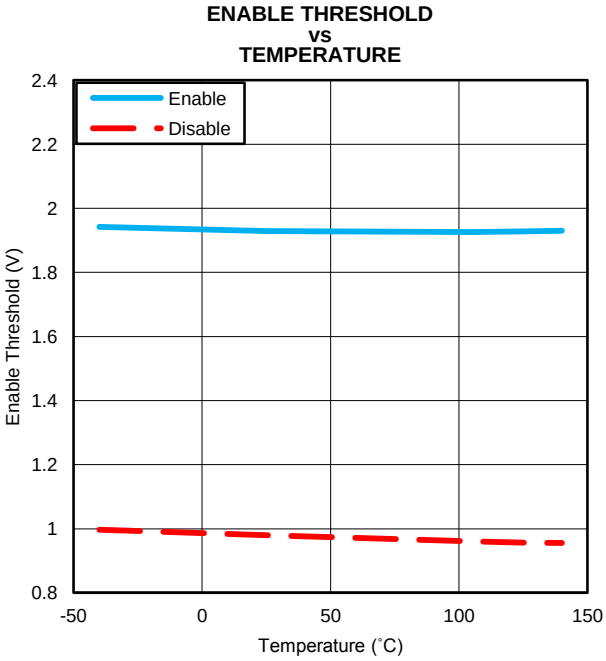


Figure 15.

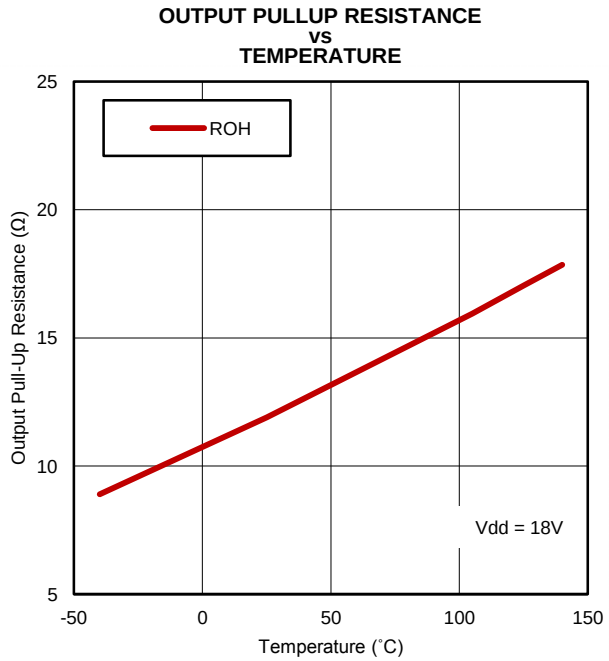


Figure 16.

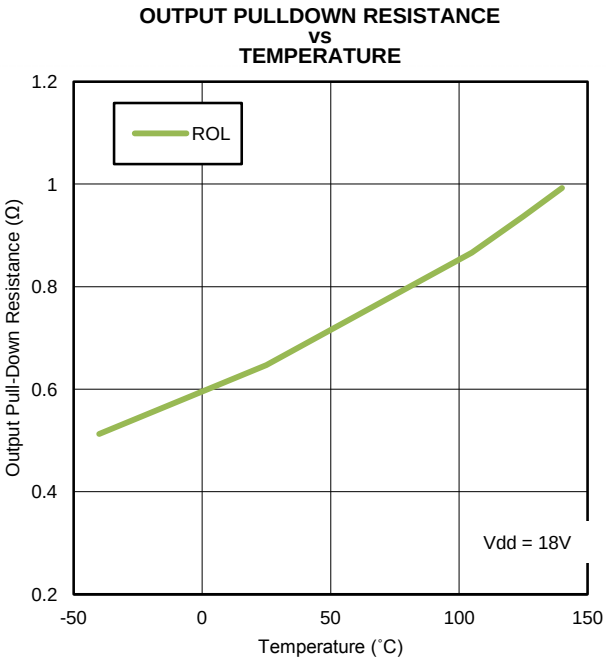


Figure 17.

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TYPICAL CHARACTERISTICS (continued)

If not specified, INPUT refers to non-inverting input

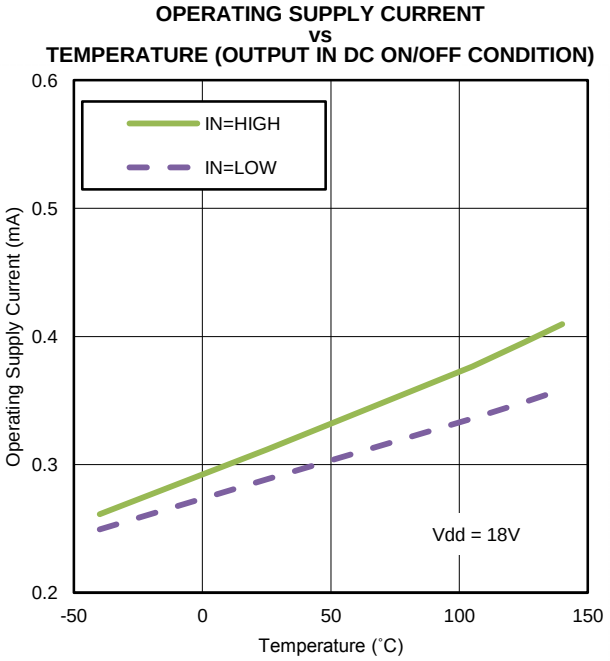


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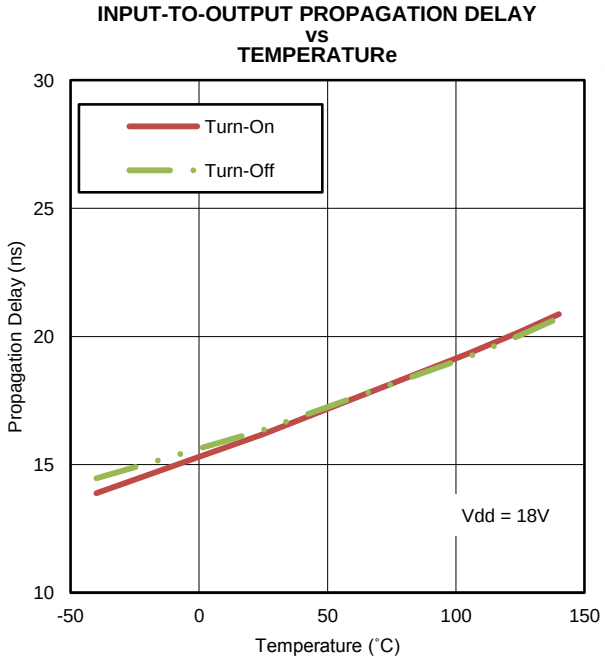


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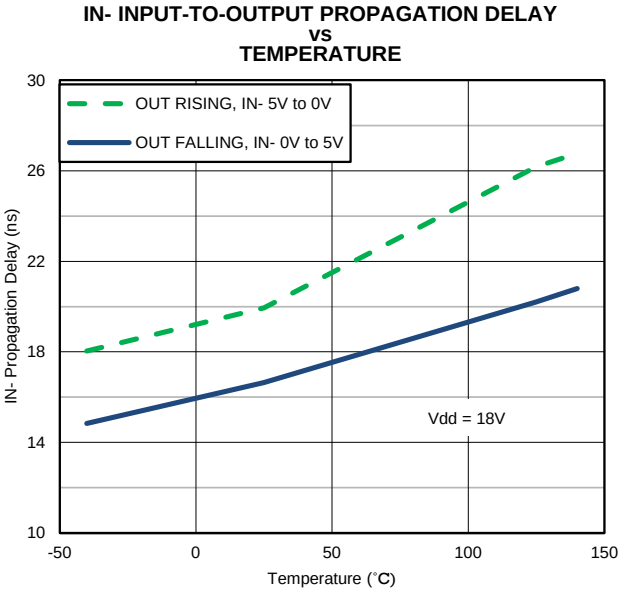


Figure 20.

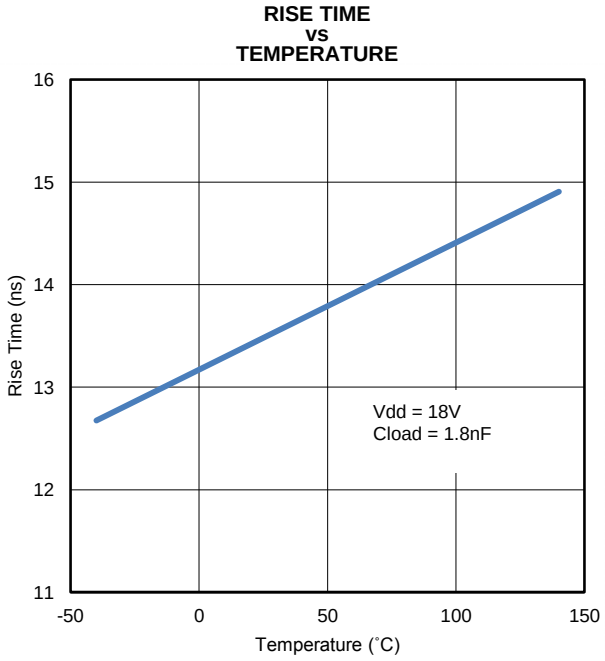


Figure 21.

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TYPICAL CHARACTERISTICS (continued)

If not specified, INPUT refers to non-inverting input

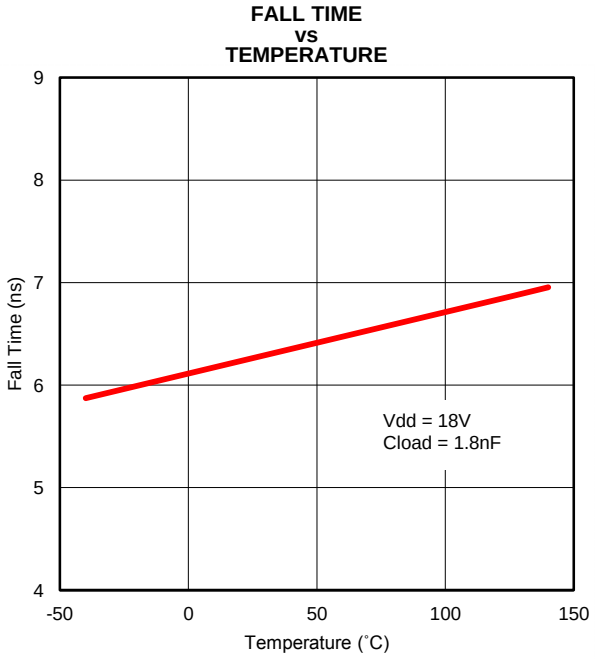


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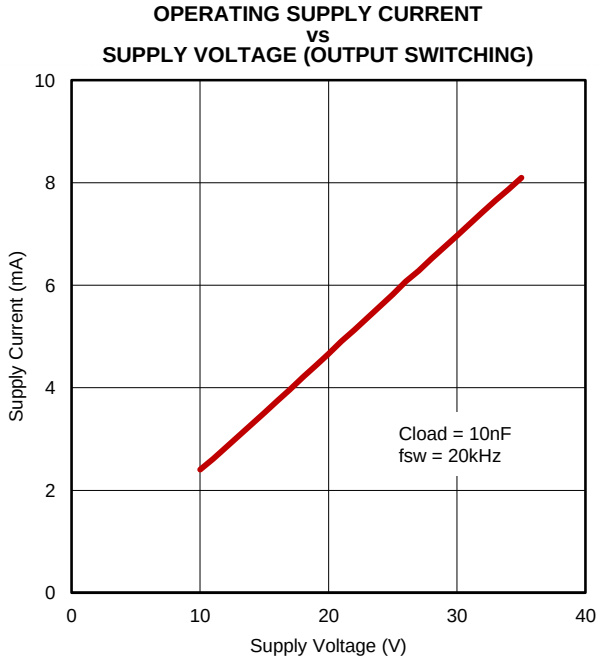


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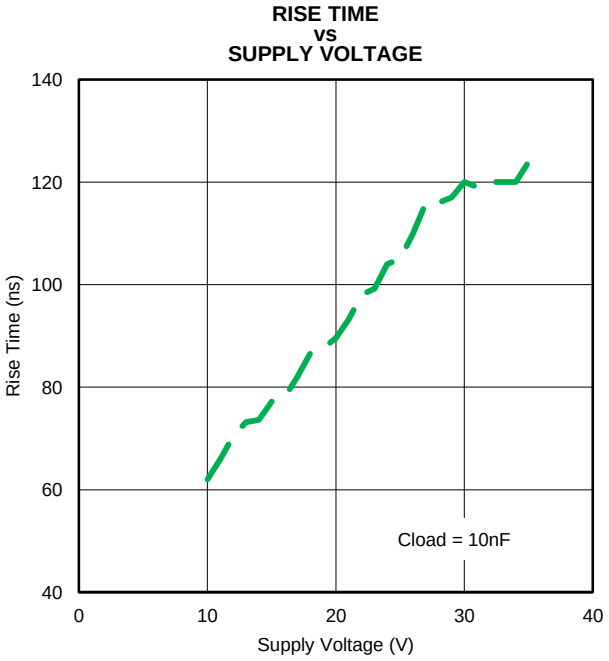


Figure 24.

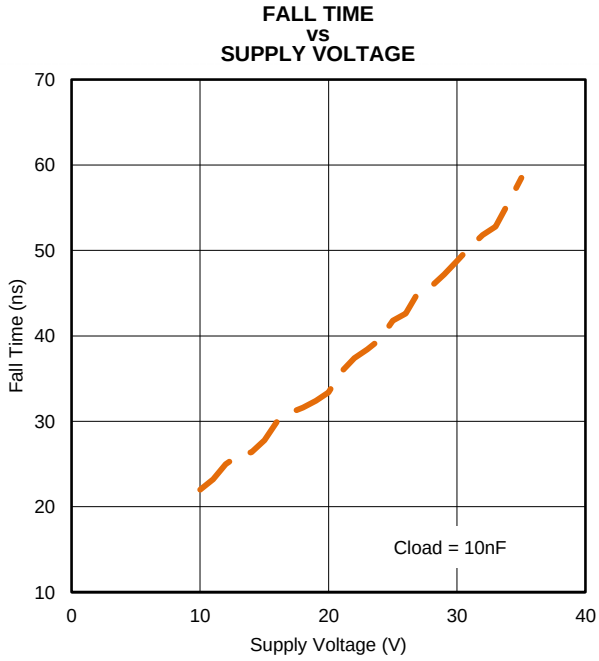


Figure 25.

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APPLICATION INFORMATION

High-current gate driver devices are required in switching power applications for a variety of reasons. In order to enable fast switching of power devices and reduce associated switching power losses, a powerful gate driver can be employed between the PWM output of controllers or signal isolation devices and the gates of the power semiconductor devices. Further, gate drivers are indispensable when sometimes it is just not feasible to have the PWM controller directly drive the gates of the switching devices. The situation is encountered often because the PWM signal from a digital controller or signal isolation device is often a 3.3-V or 5-V logic signal which is not capable of effectively turning on a power switch. A level shifting circuitry is needed to boost the logic-level signal to the gate-drive voltage in order to fully turn on the power device and minimize conduction losses. Traditional buffer drive circuits based on NPN/PNP bipolar, (or p- n-channel MOSFET), transistors in totem-pole arrangement, being emitter follower configurations, prove inadequate for this because they lack level-shifting capability and low-drive voltage protection. Gate drivers effectively combine both the level-shifting, buffer drive and UVLO functions. Gate drivers also find other needs such as minimizing the effect of switching noise by locating the high-current driver physically close to the power switch, driving gate-drive transformers and controlling floating power device gates, reducing power dissipation and thermal stress in controllers by moving gate charge power losses into itself.

The UCC27531-Q1 is very flexible in this role with a strong current drive capability and wide supply voltage range up to 32 V. This allows the driver to be used in 12-V Si MOSFET applications, 20-V and –5-V (relative to Source) SiC FET applications, 15-V and –15-V(relative to Emitter) IGBT applications and many others. As a single-channel driver, the UCC27531-Q1 can be used as a low-side or high-side driver. To use as a low-side driver, the switch ground is usually the system ground so it can be connected directly to the gate driver. To use as a high-side driver with a floating return node however, signal isolation is needed from the controller as well as an isolated bias to the UCC27531-Q1. Alternatively, in a high-side drive configuration the UCC27531-Q1 can be tied directly to the controller signal and biased with a non-isolated supply. However, in this configuration the outputs of the UCC27531-Q1 need to drive a pulse transformer which then drives the power-switch to work properly with the floating source and emitter of the power switch. Further, having the ability to control turn-on and turn-off speeds independently with both the OUTH and OUTL pins ensures optimum efficiency while maintaining system reliability. These requirements coupled with the need for low propagation delays and availability in compact, low-inductance packages with good thermal capability makes gate driver devices such as the UCC27531-Q1 extremely important components in switching power combining benefits of high-performance, low cost, component count and board space reduction and simplified system design.

Table 1. UCC27531-Q1 Features and Benefits

FEATURE	BENEFIT
High source and sink current capability, 2.5 A and 5 A (asymmetrical).	High current capability offers flexibility in employing UCC27531-Q1 device to drive a variety of power switching devices at varying speeds.
Low 17 ns (typ) propagation delay.	Extremely low pulse transmission distortion.
Wide VDD operating range of 10 V to 32 V.	Flexibility in system design.
	Can be used in split-rail systems such as driving IGBTs with both positive and negative (relative to Emitter) supplies.
	Optimal for many SiC FETs.
VDD UVLO protection.	Outputs are held Low in UVLO condition, which ensures predictable, glitch-free operation at power-up and power-down.
	High UVLO of 8.9-V typical ensures that power switch is not on in high-impedance state which could result in high power dissipation or even failures.
Outputs held low when input pin (INx) in floating condition.	Safety feature, especially useful in passing abnormal condition tests during safety certification
Split output structure option (OUTH, OUTL).	Allows independent optimization of turn-on and turn-off speeds using series gate resistors.
Strong sink current (5 A) and low pulldown impedance (0.65 Ω).	High immunity to high dV/dt Miller turn-on events.
CMOS and TTL compatible input threshold logic with wide hysteresis.	Enhanced noise immunity, while retaining compatibility with microcontroller logic level input signals (3.3 V, 5 V) optimized for digital power.
Input capable of withstanding –6.5 V.	Enhanced signal reliability in noisy environments that experience ground bounce on the gate driver.

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VDD Under Voltage Lockout

The UCC27531-Q1 device has internal under voltage lockout (UVLO) protection feature on the VDD pin supply circuit blocks. To ensure acceptable power dissipation in the power switch, this UVLO prevents the operation of the gate driver at low supply voltages. Whenever the driver is in UVLO condition (when VDD voltage less than V_{ON} during power-up and when VDD voltage is less than V_{OFF} during power down), this circuit holds all outputs LOW, regardless of the status of the inputs. The UVLO is typically 8.9 V with 700-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 voltage levels such as 10 V to 32 V provides flexibility to drive Si MOSFETs, IGBTs, and emerging SiC FETs.

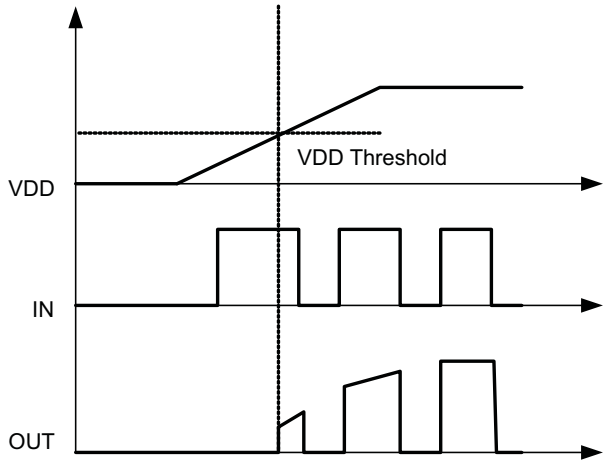


Figure 26. Power Up

Input Stage

The input pins of UCC27531-Q1 device are based on a TTL and CMOS compatible input threshold logic that is independent of the VDD supply voltage. With typical high threshold = 2 V and typical low threshold = 1 V, the logic level thresholds can be conveniently driven with PWM control signals derived from 3.3-V or 5-V logic. Wider hysteresis (typically 1 V) offers enhanced noise immunity compared to traditional TTL logic implementations, where the hysteresis is typically less than 0.5 V. This device also features tight control of the input pin threshold voltage levels which eases system design considerations and guarantees stable operation across temperature. The very low input capacitance , typically 20 pF, on these pins reduces loading and increases switching speed.

The device features an important safety function wherein, whenever the input pin is in a floating condition, the output is held in the low state. This is achieved using pullup or pulldown resistors on the input pins as shown in the block diagrams.

The input stage of the driver should preferably be driven by a signal with a short rise or fall time. Caution must be exercised whenever the driver is used with slowly varying input signals, especially in situations where the device is located in a separate daughter board or PCB layout has long input connection traces:

- High dI/dt current from the driver output coupled with board layout parasitics can cause ground bounce. Since the device features just one GND pin which may be referenced to the power ground, this may interfere with the differential voltage between Input pins and GND and trigger an unintended change of output state. Because of fast 17 ns propagation delay, this can ultimately result in high-frequency oscillations, which increases power dissipation and poses risk of damage
- 1-V Input threshold hysteresis boosts noise immunity compared to most other industry standard drivers.

If limiting the rise or fall times to the power device to reduce EMI is necessary, then an external resistance is highly recommended between the output of the driver and the power device instead of adding delays on the input signal. 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.

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Finally, because of the unique input structure that allows negative voltage capability on the Input and Enable pins, caution must be used in the following applications:

- Input or Enable pins are switching to amplitude > 15 V
- Input or Enable pins are switched at dV/dt > 2 V/ns

If both of these conditions occur, it is advised to add a series 150-Ω resistor for the pin(s) being switched to limit the current through the input structure.

Enable Function

The Enable (EN) pin of the UCC27531-Q1 has an internal pullup resistor to an internal reference voltage so leaving Enable floating turns on the driver and allows it to send output signals properly. If desired, the Enable can also be driven by low-voltage logic to enable and disable the driver.

Output Stage

The output stage of the UCC27531-Q1 device is illustrated in Figure 27. The UCC27531-Q1 device 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 power switch turn-on transition (when the power switch drain/collector voltage experiences dV/dt). The device output stage features a hybrid pullup structure using a parallel arrangement of N-Channel and P-Channel MOSFET devices. By turning on the N-Channel MOSFET during a narrow instant when the output changes state from low to high, the gate driver device is able to deliver a brief boost in the peak sourcing current enabling fast turn on.

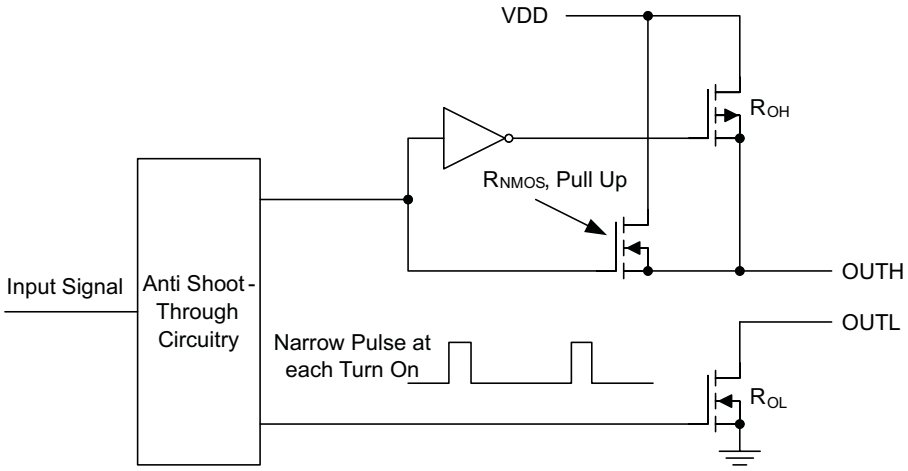


Figure 27. UCC27531-Q1 Gate Driver Output Stage

Split output depicted in Figure 27. For devices with single OUT pin, OUTH and OUTL are connected internally and then connected to OUT.

The R_{OH} parameter (see ELECTRICAL CHARACTERISTICS) is a DC measurement and it is representative of the on-resistance of the P-Channel device only, because the N-Channel device is turned-on only during output change of state from low to high. Thus the effective resistance of the hybrid pullup stage is much lower than what is represented by ROH parameter. The pulldown structure is composed of a N-Channel MOSFET only. The ROL parameter (see ELECTRICAL CHARACTERISTICS), which is also a DC measurement, is representative of true impedance of the pulldown stage in the device. In UCC27531-Q1, the effective resistance of the hybrid pullup structure is approximately 3 x R_{OL}.

The UCC27531-Q1 is capable of delivering 2.5-A source, and up to 5-A sink at VDD = 18 V. Strong sink capability results in a very low pulldown impedance in the driver output stage which boosts immunity against the parasitic Miller turn-on (high slew rate dV/dt turn on) effect that is seen in both IGBT and FET power switches .

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An example of a situation where Miller turn on is a concern is synchronous rectification (SR). In SR application, the dV/dt occurs on MOSFET drain when the MOSFET is already held in Off state by the gate driver. The current charging the C_{GD} Miller capacitance during this high dV/dt is shunted by the pulldown stage of the driver. If the pulldown impedance is not low enough then a voltage spike can result in the V_{GS} of the MOSFET, which can result in spurious turn on. This phenomenon is illustrated in Figure 28.

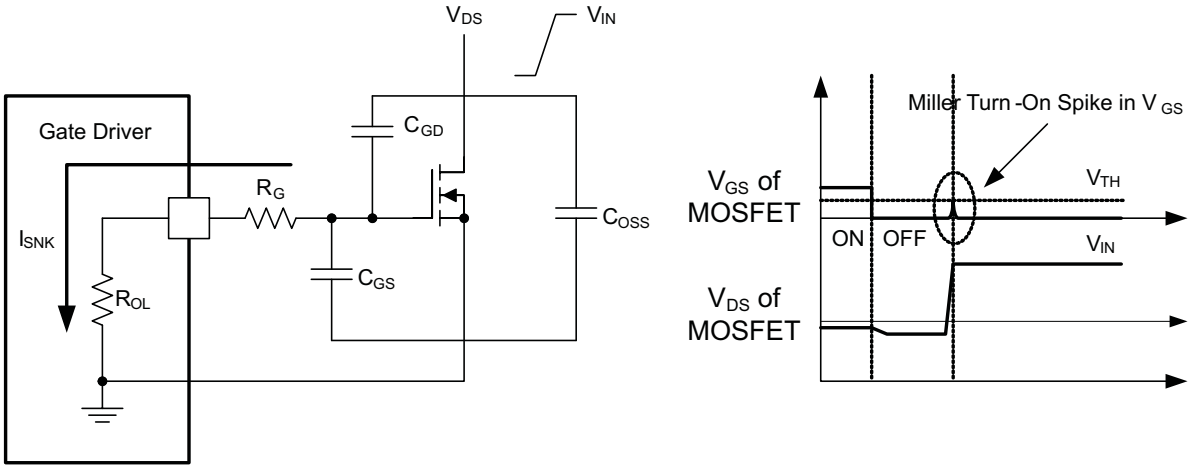


Figure 28. Low Pulldown Impedance in UCC27531-Q1 (Output Stage Mitigates Miller Turn-on Effect)

The driver output voltage swings between VDD and GND providing rail-to-rail operation, thanks to the MOS output stage which delivers very low dropout. The presence of the MOSFET body diodes also offers low impedance to switching overshoots and undershoots. This means that in many cases, external Schottky diode clamps may be eliminated.

Power Dissipation

Power dissipation of the gate driver has two portions as shown in Equation 1.

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

The DC portion of the power dissipation is $P_{DC} = I_Q \times VDD$ where I_Q is the quiescent current for the driver. The quiescent current is the current consumed by the device to bias all internal circuits such as input stage, reference voltage, logic circuits, protections etc and also any current associated with switching of internal devices when the driver output changes state (such as charging and discharging of parasitic capacitances, parasitic shoot-through). The UCC27531-Q1 features very low quiescent currents (less than 1 mA) and contains internal logic to eliminate any shoot-through in the output driver stage. Thus the effect of the P_{DC} on the total power dissipation within the gate driver can be safely assumed to be negligible. In practice this is the power consumed by driver when its output is disconnected from the gate of power switch.

The power dissipated in the gate driver package during switching (P_{SW}) depends on the following factors:

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

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 in Equation 2.

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

where

- C_{LOAD} is load capacitor and V_{DD} is bias voltage feeding the driver.

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There is an equal amount of energy dissipated when the capacitor is discharged. During turn off the energy stored in capacitor is fully dissipated in drive circuit. This leads to a total power loss during switching cycle given by Equation 3.

$$P_G = C_{LOAD} V_{DD}^2 f_{sw}$$

where

- f_{SW} is the switching frequency (3)

The switching load presented by a power FET and IGBT 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 of 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 Equation 4 for power

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

This power P_G is dissipated in the resistive elements of the circuit when the MOSFET and IGBT is being turned on or off. 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. When no external gate resistor is employed between the driver and MOSFET and IGBT, this power is completely dissipated inside the driver package. With the use of external gate drive resistors, the power dissipation is shared between the internal resistance of driver and external gate resistor in accordance to the ratio of the resistances (more power dissipated in the higher resistance component). Based on this simplified analysis, the driver power dissipation during switching is calculated in Equation 5.

$$P_{SW} = 0.5 \times Q_g \times V_{DD} \times f_{sw} \left(\frac{R_{OFF}}{(R_{OFF} + R_{GATE})} + \frac{R_{ON}}{(R_{ON} + R_{GATE})} \right)$$

where

- $R_{OFF} = R_{OL}$ and R_{ON} (effective resistance of pullup structure) = 3 x R_{OL} (5)

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 package. In order for a gate 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 thermal metrics for the driver package are summarized in the THERMAL INFORMATION section of the datasheet. For detailed information regarding the thermal information table, please refer to the TI Application Note, *IC Package Thermal Metrics* (SPRA953A).

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PCB Layout

Proper PCB layout is extremely important in a high current, fast switching circuit to provide appropriate device operation and design robustness. The UCC27531-Q1 gate driver 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 switch to facilitate voltage transitions very quickly. At higher VDD voltages, the peak current capability is even higher (2.5-A and 5-A peak current is at VDD = 18 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 driver Output pins and the gate of the power switch 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 switch. 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 switch 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 two instances – during turn-on and turn-off transients, which induces significant voltage transients on the output pins of the driver device and gate of the power switch.
- Wherever possible, parallel the source and return traces of a current loop, 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 switch, 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.

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REVISION HISTORY

Changes from Original (August 2013) to Revision A **Page**

- Changed 文档状态，从 *产品预览* 改为 *生成数据* 1

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PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
UCC27531QDBVRQ1	ACTIVE	SOT-23	DBV	6	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 125	EAHQ	Samples

(1) The marketing status values are defined as follows:
ACTIVE: Product device recommended for new designs.
LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.
PREVIEW: Device has been announced but is not in production. Samples may or may not be available.
OBSOLETE: TI has discontinued the production of the device.

(2) 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)

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

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

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

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OTHER QUALIFIED VERSIONS OF UCC27531-Q1 :

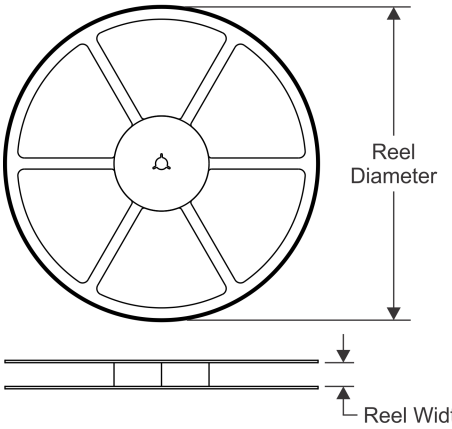
- Catalog: UCC27531

NOTE: Qualified Version Definitions:

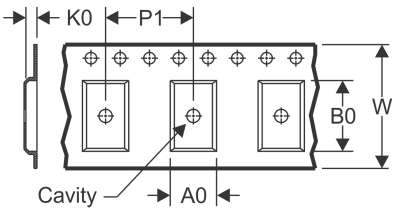
- Catalog - TI's standard catalog product

TAPE AND REEL INFORMATION

REEL DIMENSIONS

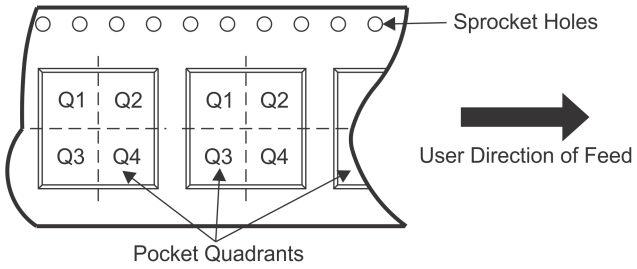


TAPE DIMENSIONS



A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

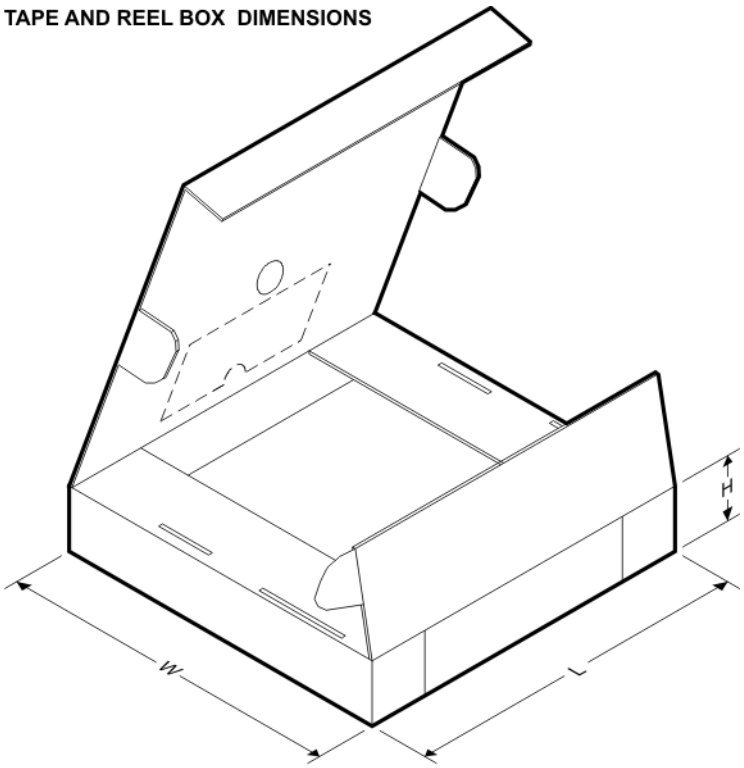
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
UCC27531QDBVRQ1	SOT-23	DBV	6	3000	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3

TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

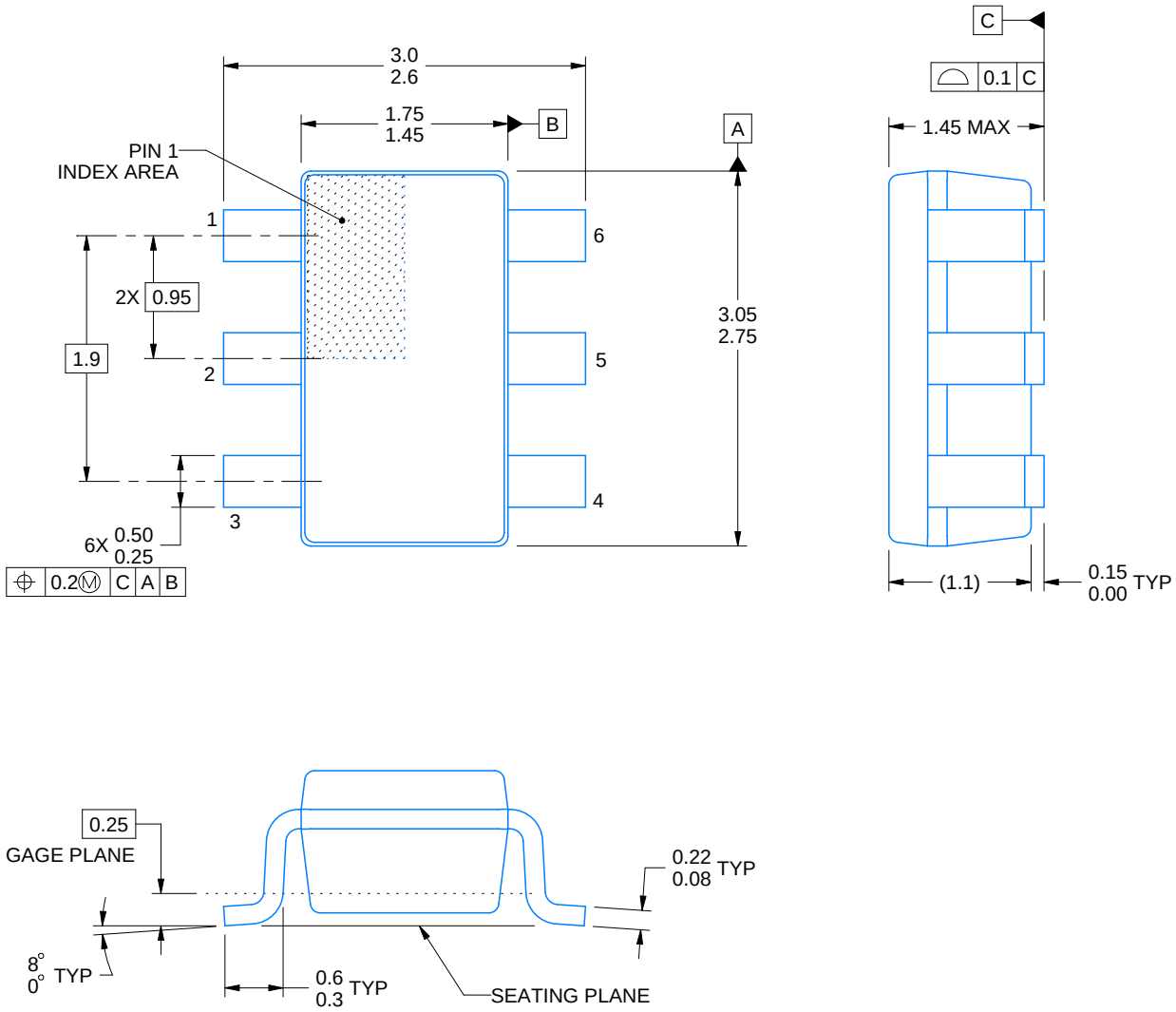
Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
UCC27531QDBVRQ1	SOT-23	DBV	6	3000	180.0	180.0	18.0

PACKAGE OUTLINE

DBV0006A

SOT-23 - 1.45 mm max height

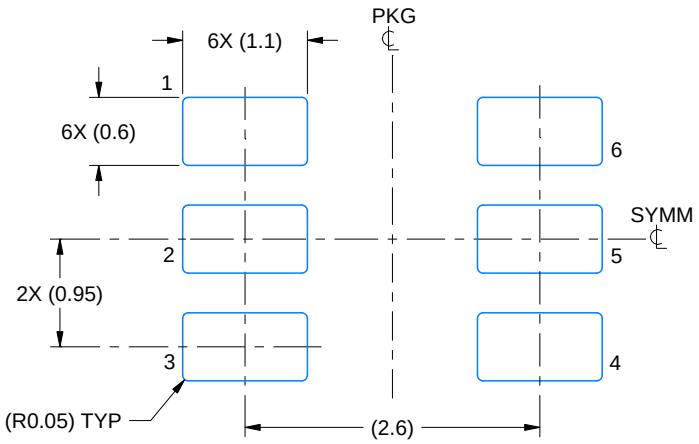
SMALL OUTLINE TRANSISTOR



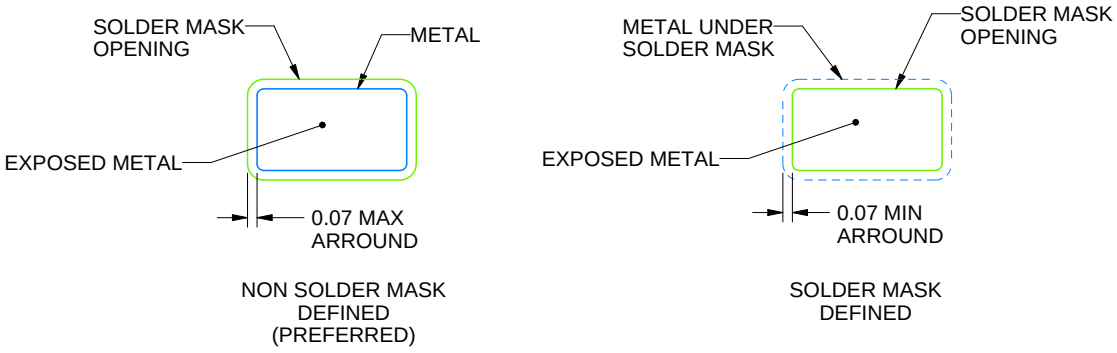
4214840/B 03/2018

NOTES:

1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. Body dimensions do not include mold flash or protrusion. Mold flash and protrusion shall not exceed 0.15 per side.
4. Leads 1,2,3 may be wider than leads 4,5,6 for package orientation.
5. Refernce JEDEC MO-178.



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE:15X

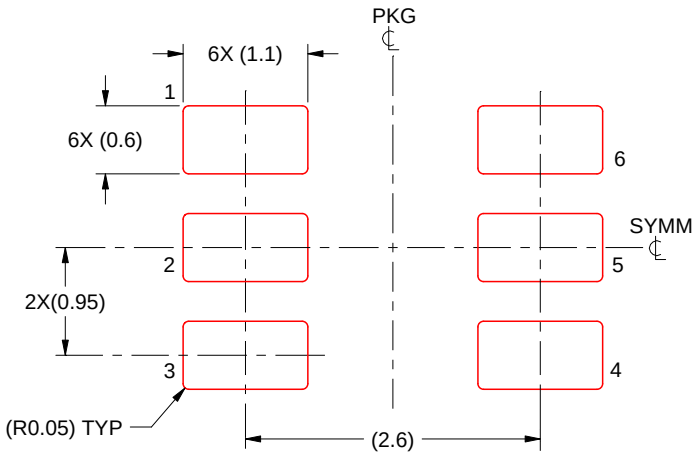


SOLDER MASK DETAILS

4214840/B 03/2018

NOTES: (continued)

6. Publication IPC-7351 may have alternate designs.
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.



SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL
SCALE:15X

4214840/B 03/2018

NOTES: (continued)

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

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