

UCC23313 4A/5A、3.75kV_{RMS} 光兼容单通道隔离式栅极驱动器

1 特性

- 具有光兼容输入的 3.75kV_{RMS} 单通道隔离式栅极驱动器
- 适用于光隔离式栅极驱动器的引脚对引脚普适版升级
- 可输出 4.5A 峰值拉电流、5.3A 峰值灌电流
- 14V 至 33V 输出驱动器电源电压
- 轨至轨输出
- 105ns（最大值）传播延迟
- 25ns（最大值）部件对部件延迟匹配
- 35ns（最大值）脉宽失真度
- 150kV/μs（最小值）共模瞬态抗扰度 (CMTI)
- 隔离栅寿命 > 50 年
- 输入级具有 13V 反极性电压处理能力
- 扩展型 SO-6 封装，爬电距离和间隙 > 8.5mm
- 工作结温 T_J 范围：-40°C 至 +150°C
- 安全相关认证（计划）：
 - 符合 DIN V VDE V0884-11:2017-01 标准的 6000V_{PK} 基础型隔离
 - 符合 UL 1577 标准且长达 1 分钟的 3.75kV_{RMS} 隔离
 - 获得 CQC 认证，符合 GB4943.1-2011 标准

2 应用

- 工业电机控制驱动
- 工业用电源，UPS
- 光伏逆变器
- 感应加热

3 说明

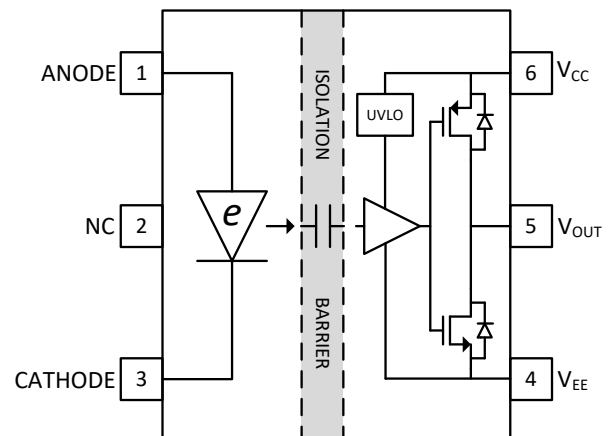
UCC23313 是一款适用于 IGBT、MOSFET 和 SiC MOSFET 的光兼容单通道隔离式栅极驱动器，具有 4.5A 峰值拉电流和 5.3A 峰值灌电流以及 3.75kV_{RMS} 基本隔离额定值。由于具有 33V 的高电源电压范围，因此允许使用双极电源来有效驱动 IGBT 和 SiC 功率 FET。UCC23313 可以驱动低侧和高侧电源 FET。这些关键的特性 此器件与传统基于光耦合的栅极驱动器相比，引脚完全兼容，同时性能得到了进一步升级。性能亮点包括高共模瞬态抗扰度 (CMTI)、低传播延迟和小脉冲宽度失真。严格的过程控制可实现较小的部件对部件偏移。输入级是仿真二极管，这意味着与传统的 LED 相比，具有长期可靠性和出色的老化特性。它采用扩展型 SO6 封装，爬电距离和间隙 > 8.5mm，来自材料组 I 的模压化合物的相对漏电起痕指数 (CTI) > 600V。UCC23313 具有高性能和高可靠性，非常适合所有类型的电机驱动器、光伏逆变器、工业电源和电器。较高的操作温度为之前光耦无法支持的应用提供了机会。

器件信息⁽¹⁾

器件型号	封装	封装尺寸（标称值）
UCC23313	扩展型 SO-6	7.5mm x 4.68mm

(1) 如需了解所有可用封装，请参阅数据表末尾的可订购产品附录。

UCC23313 (SO6) 的功能方框图



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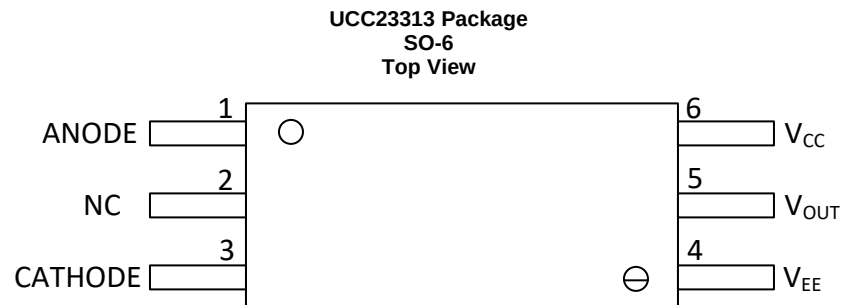
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4 修订历史记录

注：之前版本的页码可能与当前版本有所不同。

Changes from Original (September 2019) to Revision A	Page
• Changed Minimum internal gap unit from mm to μm	7

5 Pin Configuration and Function



Pin Functions

PIN		TYPE ⁽¹⁾	DESCRIPTION
NAME	NO.		
	UCC23313		
ANODE	1	I	Anode
CATHODE	3	I	Cathode
NC	2	-	No Connection
V _{CC}	6	P	Positive output supply rail
V _{EE}	4	P	Negative output supply rail
V _{OUT}	5	O	Gate-drive output

(1) P = Power, G = Ground, I = Input, O = Output

6 Specifications

6.1 Absolute Maximum Ratings

Over operating free air temperature range (unless otherwise noted)⁽¹⁾

		MIN	MAX	UNIT
Average Input Current	$I_{F(AVG)}$	-	25	mA
Peak Transient Input Current	$I_{F(TRAN)} < 1\mu s$ pulse, 300pps		1	A
Reverse Input Voltage	$V_{R(MAX)}$		14	V
Output supply voltage	$V_{CC} - V_{EE}$	-0.3	35	V
Output signal voltage	$V_{OUT} - V_{CC}$		0.3	V
Output signal voltage	$V_{OUT} - V_{EE}$	-0.3		V
Junction temperature	$T_J^{(2)}$	-40	150	°C
Storage temperature	T_{stg}	-65	150	°C

- (1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions*. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
- (2) To maintain the recommended operating conditions for T_J , see the .

6.2 ESD Ratings

			VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human body model (HBM), per ANSI/ESDA/JEDEC JS-001 ⁽¹⁾	±4000	V
		Charged device model (CDM), per JEDEC specification JESD22-C101 ⁽²⁾	±1000	

- (1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.
- (2) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process.

6.3 Recommended Operating Conditions

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

		MIN	NOM	MAX	UNIT
V_{CC}	Output Supply Voltage($V_{CC} - V_{EE}$)	14		33	V
I_F (ON)	Input Diode Forward Current (Diode "ON")	7		16	mA
V_F (OFF)	Anode voltage - Cathode voltage (Diode "OFF")	-13		0.9	V
T_J	Junction temperature	-40		150	°C
T_A	Ambient temperature	-40		125	°C

6.4 Thermal Information

THERMAL METRIC ⁽¹⁾		UCC23313	UNIT
		SO6	
		6 Pins	
R _{qJA}	Junction-to-ambient thermal resistance	126	°C/W
R _{qJC(top)}	Junction-to-case (top) thermal resistance	66.1	°C/W
R _{qJB}	Junction-to-board thermal resistance	62.8	°C/W
Y _{JT}	Junction-to-top characterization parameter	29.6	°C/W
Y _{JB}	Junction-to-board characterization parameter	60.8	°C/W

- (1) For more information about traditional and new thermal metrics, see the <http://www.ti.com/lit/SPRA953> application report.

6.5 Power Ratings

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
P_D	Maximum power dissipation on input and output	$V_{CC} = 20\text{ V}$, $I_F = 10\text{ mA}$ 10-kHz, 50% duty cycle, square wave, 180-nF load, $T_A = 25^\circ\text{C}$			750	mW
P_{D1}	Maximum input power dissipation				10	mW
P_{D2}	Maximum output power dissipation				740	mW

6.6 Insulation Specifications

PARAMETER		TEST CONDITIONS	SPECIFIC ATION	UNIT
CLR	External clearance ⁽¹⁾	Shortest terminal-to-terminal distance through air	>8.5	mm
CPG	External Creepage ⁽¹⁾	Shortest terminal-to-terminal distance across the package surface	>8.5	mm
DTI	Distance through the insulation	Minimum internal gap (internal clearance)	>17	μm
CTI	Comparative tracking index	DIN EN 60112 (VDE 0303-11); IEC 60112	>600	V
	Material Group	According to IEC 60664-1	I	
	Overvoltage category per IEC 60664-1	Rated mains voltage ≤ 600 V _{RMS}	I-IV	
		Rated mains voltage ≤ 1000 V _{RMS}	I-III	
DIN V VDE 0884-11 (VDE V 0884-11)				
V _{IORM}	Maximum repetitive peak isolation voltage	AC voltage (bipolar)	990	V _{PK}
V _{IOWM}	Maximum isolation working voltage	AC voltage (sine wave); time-dependent dielectric breakdown (TDDb) test; see Figure 1	700	V _{RMS}
		DC voltage	990	V _{DC}
V _{IOTM}	Maximum transient isolation voltage	V _{TEST} = V _{IOTM} , t = 60 sec (qualification) V _{TEST} = 1.2 × V _{IOTM} , t = 1 s (100% production)	5300	V _{PK}
V _{IOSM}	Maximum surge isolation voltage ⁽²⁾	Test method per IEC 62368, 1.2/50 ms waveform, V _{TEST} = 1.6 × V _{IOSM} = 9600 V _{PK} (qualification)	6000	V _{PK}
q _{pd}	Apparent charge ⁽³⁾	Method a: After I/O safety test subgroup 2/3, V _{ini} = V _{IOTM} , t _{ini} = 60 s; V _{pd(m)} = 1.2 × V _{IORM} = 1188 V _{PK} , t _m = 10 s	≤5	pC
		Method a: After environmental tests subgroup 1, V _{ini} = V _{IOTM} , t _{ini} = 60 s; V _{pd(m)} = 1.6 × V _{IORM} = 1584 V _{PK} , t _m = 10 s	≤5	
		Method b1: At routine test (100% production) and preconditioning (type test), V _{ini} = V _{IOTM} , t _{ini} = 1 s; V _{pd(m)} = 1.875 × V _{IORM} = 1856V _{PK} , t _m = 1 s	≤5	
C _{IO}	Barrier capacitance, input to output ⁽⁴⁾	V _{IO} = 0.4 × sin (2πft), f = 1 MHz	0.5	pF
R _{IO}	Insulation resistance, input to output ⁽⁴⁾	V _{IO} = 500 V, T _A = 25°C	>10 ¹²	Ω
		V _{IO} = 500 V, 100°C ≤ T _A ≤ 125°C	>10 ¹¹	
		V _{IO} = 500 V at T _S = 150°C	>10 ⁹	
	Pollution degree		2	
	Climatic category		40/125/21	
UL 1577				
V _{ISO}	Withstand isolation voltage	V _{TEST} = V _{ISO} = 5700 V _{RMS} , t = 60 s (qualification), V _{TEST} = 1.2 × V _{ISO} = 6840 V _{RMS} , t = 1 s (100% production)	3750	V _{RMS}

- (1) Creepage and clearance requirements should be applied according to the specific equipment isolation standards of an application. Care should be taken to maintain the creepage and clearance distance of a board design to ensure that the mounting pads of the isolator on the printed-circuit board do not reduce this distance. Creepage and clearance on a printed-circuit board become equal in certain cases. Techniques such as inserting grooves, ribs, or both on a printed-circuit board are used to help increase these specifications.
- (2) Testing is carried out in air or oil to determine the intrinsic surge immunity of the isolation barrier.
- (3) Apparent charge is electrical discharge caused by a partial discharge (pd).
- (4) All pins on each side of the barrier tied together creating a two-pin device.

6.7 Safety-Related Certifications

VDE	UL	CQC
Plan to certify according to DIN V VDE V 0884-11: 2017-01	Plan to certify according to UL 1577 Component Recognition Program	Plan to certify according to GB4943.1-2011
Basic insulation Maximum transient isolation voltage, 5300 V _{PK} ; Maximum repetitive peak isolation voltage, 990 V _{PK} ; Maximum surge isolation voltage, 6000 V _{PK}	Single protection, 3750 V _{RMS}	Reinforced insulation, Altitude ≤ 5000 m, Tropical Climate
Certificate planned	Certificate planned	Certificate planned

6.8 Safety Limiting Values

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
I _S	Safety input, output, or supply current	R _{qJA} = 126°C/W, V _I = 15 V, T _J = 150°C, T _A = 25°C			50	mA
		R _{qJA} = 126°C/W, V _I = 30 V, T _J = 150°C, T _A = 25°C			25	
P _S	Safety input, output, or total power	R _{qJA} = 126°C/W, T _J = 150°C, T _A = 25°C			750	mW
T _S	Maximum safety temperature ⁽¹⁾				150	°C

- (1) The maximum safety temperature, T_S, has the same value as the maximum junction temperature, T_J, specified for the device. The I_S and P_S parameters represent the safety current and safety power respectively. The maximum limits of I_S and P_S should not be exceeded. These limits vary with the ambient temperature, T_A. The junction-to-air thermal resistance, R_{qJA}, in the Thermal Information table is that of a device installed on a high-K test board for leaded surface-mount packages. Use these equations to calculate the value for each parameter: T_J = T_A + R_{qJA} · P, where P is the power dissipated in the device. T_{J(max)} = T_S = T_A + R_{qJA} · P_S, where T_{J(max)} is the maximum allowed junction temperature. P_S = I_S · V_I, where V_I is the maximum supply voltage.

6.9 Electrical Characteristics

Unless otherwise noted, all typical values are at $T_A = 25^\circ\text{C}$, $V_{CC}-V_{EE} = 15\text{V}$, $V_{EE} = \text{GND}$. All min and max specifications are at recommended operating conditions ($T_J = -40^\circ\text{C}$ to 150°C , $I_{F(\text{on})} = 7\text{ mA}$ to 16 mA , $V_{EE} = \text{GND}$, $V_{CC} = 15\text{ V}$ to 30 V , $V_{F(\text{off})} = -5\text{V}$ to 0.8V)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
INPUT						
I_{FLH}	Input forward threshold current low to High	$V_{OUT} > 5\text{ V}$, $C_g = 1\text{ nF}$	1.5	2.8	4	mA
V_F	Input Forward Voltage	$I_F = 10\text{ mA}$	1.8	2.1	2.4	V
V_{F_HL}	Threshold input voltage High to low	$V < 5\text{ V}$, $C_g = 1\text{ nF}$	0.9			V
$\Delta V_F/\Delta T$	Temp coefficient of Input forward voltage	$I_F = 10\text{ mA}$		1	1.35	mV/°C
V_R	Input Reverse Breakdown voltage	$I_R = 10\text{ uA}$	15			V
C_{IN}	Input Capacitance	$F = 0.5\text{ MHz}$		15		pF
OUTPUT						
I_{OH}	High Level Peak Output Current	$I_F = 10\text{ mA}$, $V_{CC} = 15\text{V}$, $C_{LOAD} = 0.18\text{uF}$, $C_{VDD} = 10\text{uF}$, pulse width $< 10\text{us}$	3	4.5		A
I_{OL}	Low Level Peak Output Current	$V_F = 0\text{ V}$, $V_{CC} = 15\text{V}$, $C_{LOAD} = 0.18\text{uF}$, $C_{VDD} = 10\text{uF}$, pulse width $< 10\text{us}$	3.5	5.3		A
V_{OH}	High Level Output Voltage	$I_F = 10\text{ mA}$, $I_O = -20\text{mA}$ (with respect to V_{CC})	0.07	0.18	0.36	V
		$I_F = 10\text{ mA}$, $I_O = 0\text{ mA}$		V_{CC}		V
V_{OL}	Low Level Output Voltage	$V_F = 0\text{ V}$, $I_O = 20\text{ mA}$			25	mV
I_{CC_H}	Output Supply Current (Diode On)	$I_F = 10\text{ mA}$, $I_O = 0\text{ mA}$			2.2	mA
I_{CC_L}	Output Supply Current (Diode Off)	$V_F = 0\text{ V}$, $I_O = 0\text{ mA}$			2	mA
UNDER VOLTAGE LOCKOUT						
$UVLO_R$	Under Voltage Lockout V_{CC} rising	V_{CC_Rising} , $I_F = 10\text{ mA}$	11	12.5	13.5	V
$UVLO_F$	Under Voltage Lockout V_{CC} falling	$V_{CC_Falling}$, $I_F = 10\text{ mA}$	10	11.5	12.5	V
$UVLO_{HYS}$	UVLO Hysteresis			1.0		V

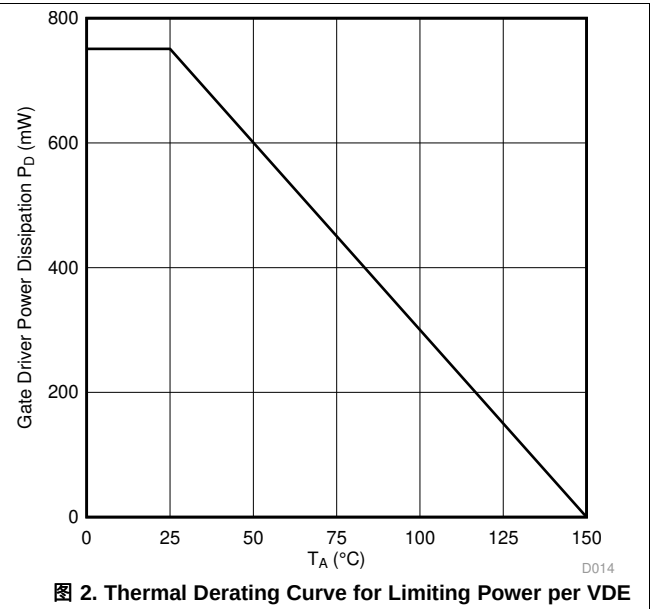
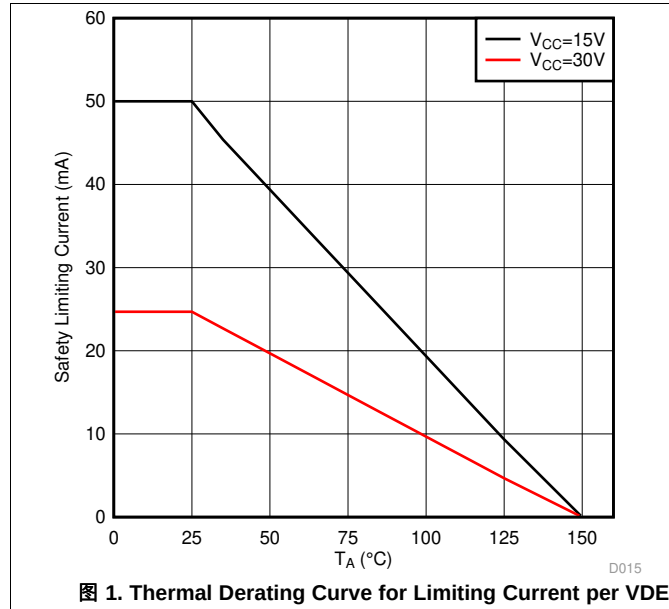
6.10 Switching Characteristics

Unless otherwise noted, all typical values are at $T_A = 25^\circ\text{C}$, $V_{CC}-V_{EE} = 30\text{ V}$, $V_{EE} = \text{GND}$. All min and max specifications are at recommended operating conditions ($T_J = -40$ to 150°C , $I_{F(\text{ON})} = 7\text{ mA}$ to 16 mA , $V_{EE} = \text{GND}$, $V_{CC} = 15\text{ V}$ to 30 V , $V_{F(\text{OFF})} = -5\text{V}$ to 0.8V)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
t_r	Output-signal rise time	$C_g = 1\text{ nF}$ $F_{SW} = 20\text{ kHz}$, (50% Duty Cycle) $V_{CC} = 15\text{V}$			28	ns
t_f	Output-signal fall time				25	ns
t_{PLH}	Propagation delay, high			70	105	ns
t_{PHL}	Propagation delay, low			70	105	ns
t_{PWD}	Pulse width distortion $ t_{PHL} - t_{PLH} $				35	ns
$t_{sk(pp)}$	Part-to-part skew in propagation delay between any two parts ⁽¹⁾	$C_g = 1\text{ nF}$ $F_{SW} = 20\text{ kHz}$, (50% Duty Cycle) $V_{CC} = 15\text{V}$, $I_F = 10\text{mA}$			25	ns
t_{UVLO_rec}	UVLO recovery delay of V_{CC} (Rising from 0V to 15V)			20	30	μs
$CMTI_H$	Common-mode transient immunity (output high)	$I_F = 10\text{ mA}$, $V_{CM} = 1500\text{ V}$, $V_{CC} = 30\text{ V}$, $T_A = 25^\circ\text{C}$	150			kV/ μs
$CMTI_L$	Common-mode transient immunity (output low)	$V_F = 0\text{ V}$, $V_{CM} = 1500\text{ V}$, $V_{CC} = 30\text{ V}$, $T_A = 25^\circ\text{C}$	150			kV/ μs

(1) $t_{sk(pp)}$ is the magnitude of the difference in propagation delay times between the output of different devices switching in the same direction while operating at identical supply voltages, temperature, input signals and loads ensured by characterization.

6.11 Insulation Characteristics Curves



6.12 Typical Characteristics

$V_{CC} = 15\text{ V}$, $1\text{-}\mu\text{F}$ capacitor from V_{CC} to V_{EE} , $C_{LOAD} = 1\text{ nF}$ for timing tests and 180 nF for I_{OH} and I_{OL} tests, $T_J = -40^\circ\text{C}$ to $+150^\circ\text{C}$, (unless otherwise noted)

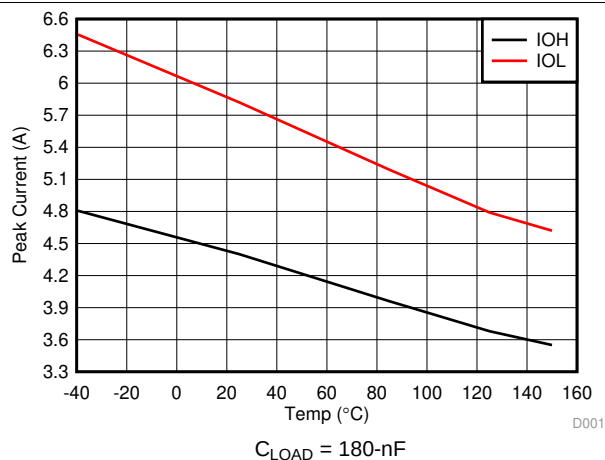


图 3. Output Drive currents versus Temperature

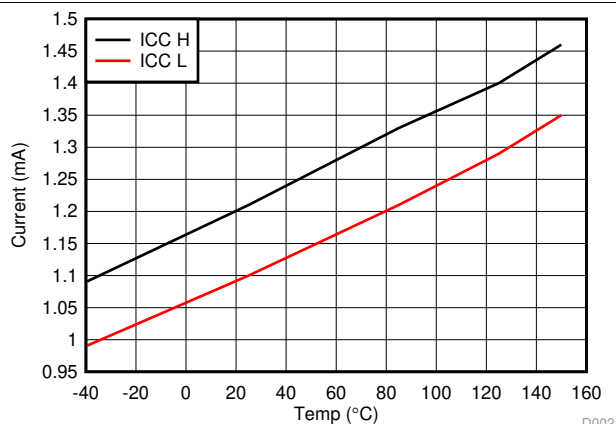


图 4. Supply currents versus Temperature

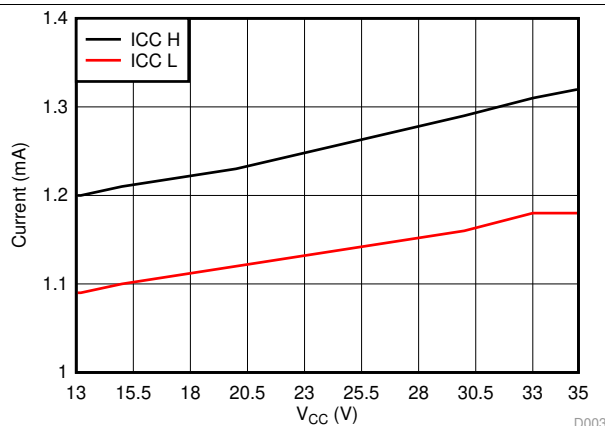


图 5. Supply current versus Supply Voltage

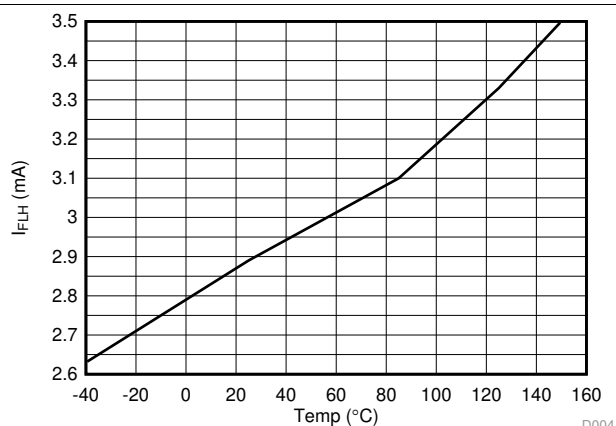


图 6. Forward threshold current versus Temperature

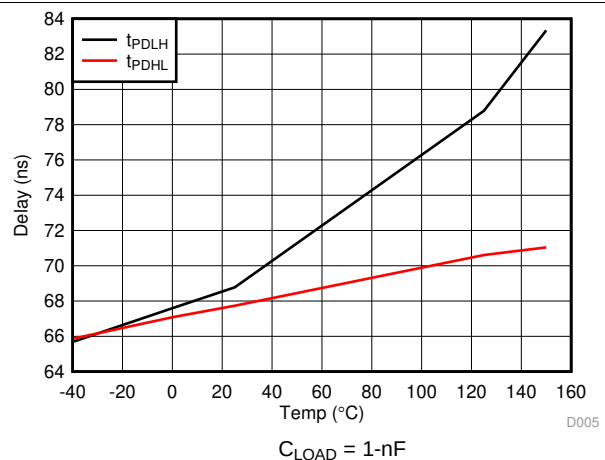


图 7. Propagation delay versus Temperature

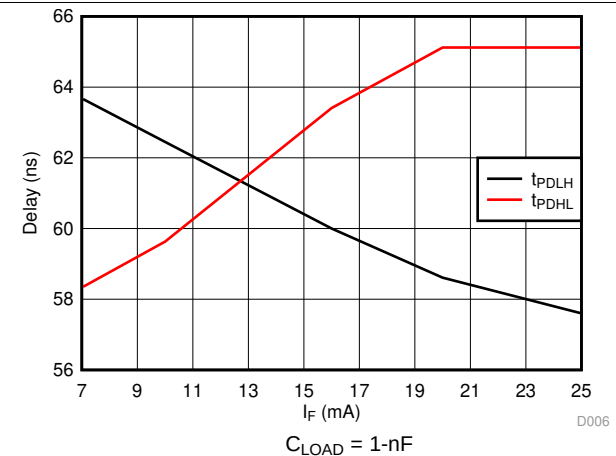


图 8. Propagation delay versus Forward current

Typical Characteristics (接下页)

$V_{CC} = 15\text{ V}$, $1\text{-}\mu\text{F}$ capacitor from V_{CC} to V_{EE} , $C_{LOAD} = 1\text{ nF}$ for timing tests and 180 nF for I_{OH} and I_{OL} tests, $T_J = -40^\circ\text{C}$ to $+150^\circ\text{C}$, (unless otherwise noted)

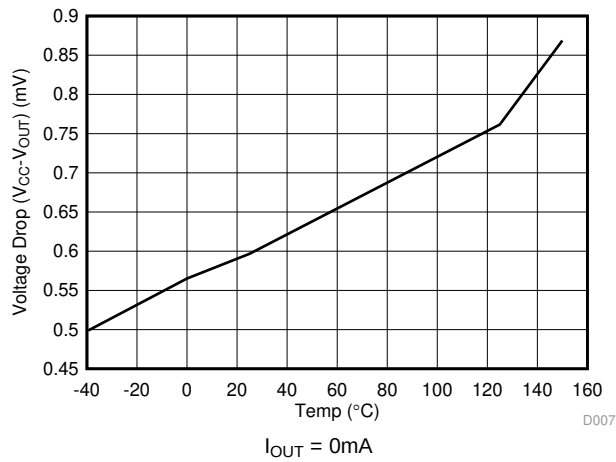


图 9. V_{OH} (No Load) versus Temperature

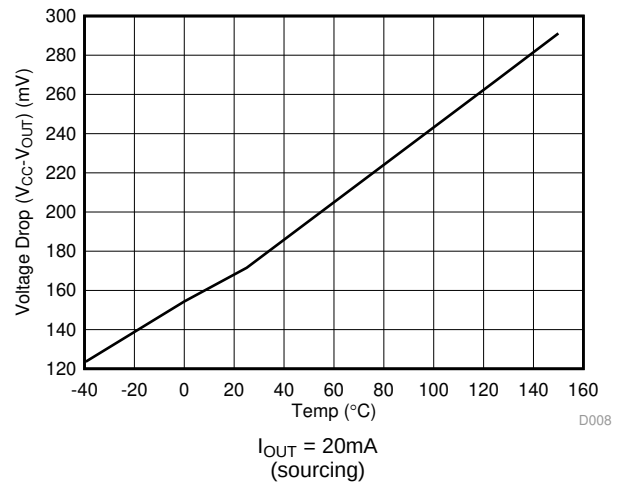


图 10. V_{OH} (20mA Load) versus Temperature

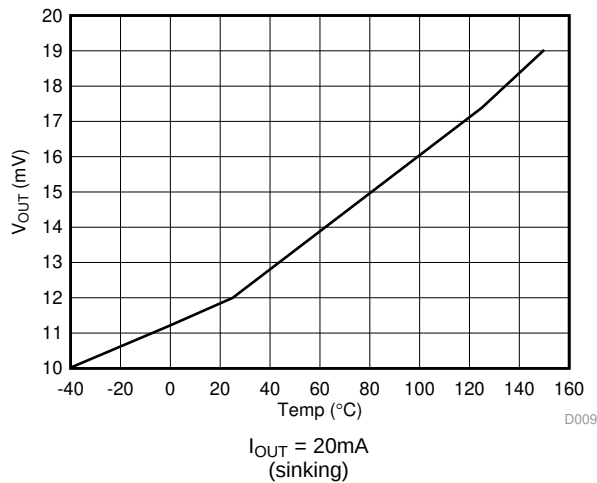


图 11. V_{OL} versus Temperature

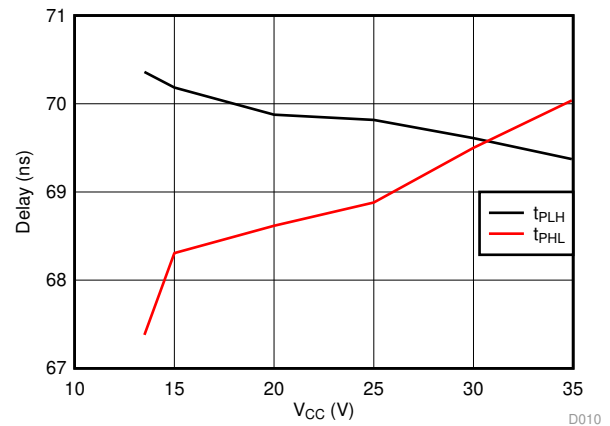


图 12. Propagation delay versus Supply voltage

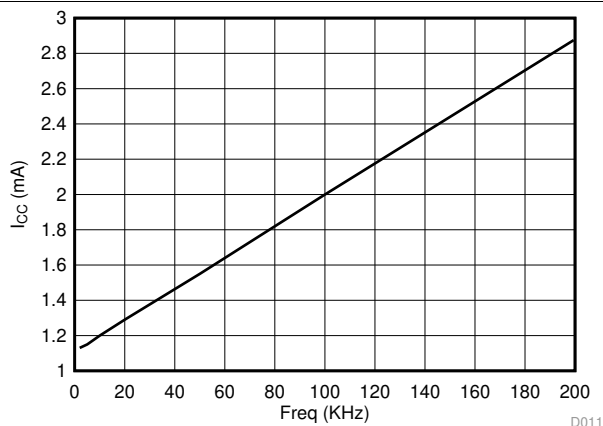


图 13. Supply current versus Frequency

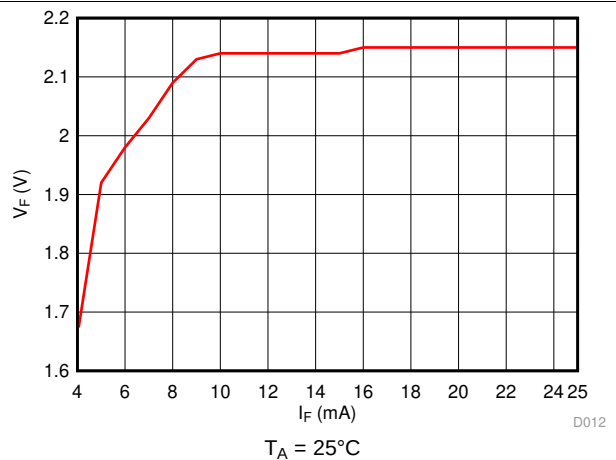


图 14. Forward current versus Forward voltage drop

Typical Characteristics (接下页)

$V_{CC} = 15\text{ V}$, $1\text{-}\mu\text{F}$ capacitor from V_{CC} to V_{EE} , $C_{LOAD} = 1\text{ nF}$ for timing tests and 180 nF for I_{OH} and I_{OL} tests, $T_J = -40^\circ\text{C}$ to $+150^\circ\text{C}$, (unless otherwise noted)

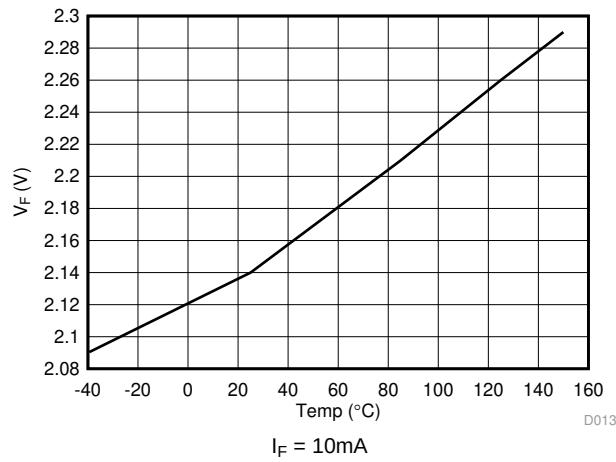


图 15. Forward voltage drop versus Temperature

7 Parameter Measurement Information

7.1 Propagation Delay, rise time and fall time

图 16 shows the propagation delay from the input forward current I_F to V_{OUT} . This figure also shows the circuit used to measure the rise (t_r) and fall (t_f) times and the propagation delays $t_{PD\,LH}$ and $t_{PD\,HL}$.

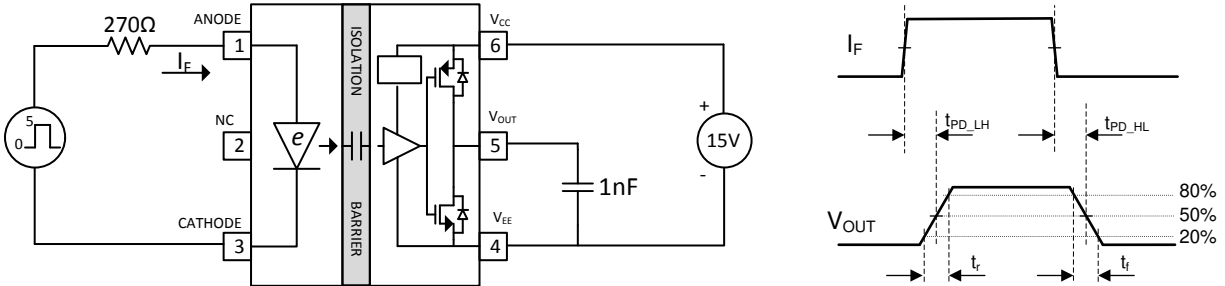


图 16. I_F to V_{OUT} Propagation Delay, Rise Time and Fall Time

7.2 I_{OH} and I_{OL} testing

图 17 shows the circuit used to measure the output drive currents I_{OH} and I_{OL} . A load capacitance of 180nF is used at the output. The peak dv/dt of the capacitor voltage is measured in order to determine the peak source and sink currents of the gate driver.

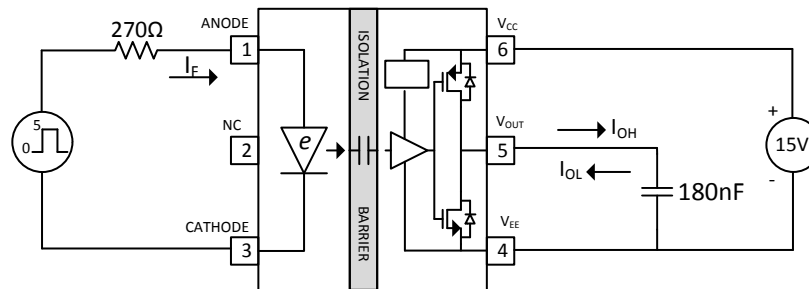


图 17. I_{OH} and I_{OL}

7.3 CMTI Testing

图 18 is the simplified diagram of the CMTI testing. Common mode voltage is set to 1500V. The test is performed with $I_F = 6mA$ ($V_{OUT} = \text{High}$) and $I_F = 0mA$ ($V_{OUT} = \text{LOW}$). The diagram also shows the fail criteria for both cases. During the application of the CMTI pulse with $I_F = 6mA$, if V_{OUT} drops from V_{CC} to $\frac{1}{2}V_{CC}$ it is considered as a failure. With $I_F = 0mA$, if V_{OUT} rises above 1V, it is considered as a failure.

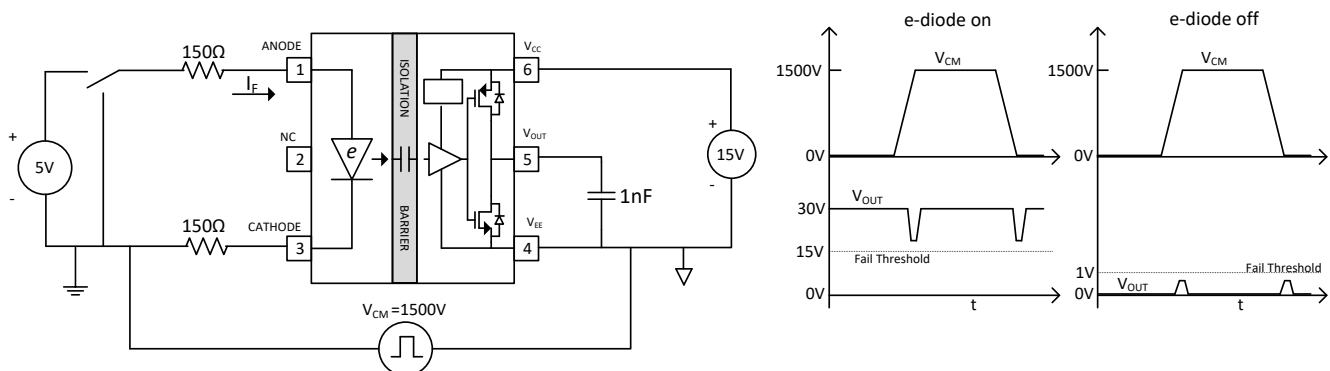


图 18. CMTI Test Circuit for UCC23313

8 Detailed Description

8.1 Overview

UCC23313 is a single channel isolated gate driver, with an opto-compatible input stage, that can drive IGBTs, MOSFETs and SiC FETs. It has 4A peak output current capability with max output driver supply voltage of 33V. The inputs and the outputs are galvanically isolated. UCC23313 is offered in an industry standard 6 pin (SO6) package with >8.5mm creepage and clearance. It has a working voltage of 1060- V_{RMS} , reinforced isolation rating of 3.75 kV_{RMS} for 60s and a surge rating of 6 kV_{PK} . It is pin-to-pin compatible with standard opto isolated gate drivers. While standard opto isolated gate drivers use an LED as the input stage, UCC23313 uses an emulated diode (or "e-diode") as the input stage which does not use light emission to transmit signals across the isolation barrier. The input stage is isolated from the driver stage by dual, series HV SiO_2 capacitors in full differential configuration that not only provides reinforced isolation but also offers best-in-class common mode transient immunity of >150kV/us. The e-diode input stage along with capacitive isolation technology gives UCC23313 several performance advantages over standard opto isolated gate drivers. They are as follows:

1. Since the e-diode does not use light emission for its operation, the reliability and aging characteristics of UCC23313 are naturally superior to those of standard opto isolated gate drivers.
2. Higher ambient operating temperature range of 125°C, compared to only 105°C for most opto isolated gate drivers
3. The e-diode forward voltage drop has less part-to-part variation and smaller variation across temperature. Hence, the operating point of the input stage is more stable and predictable across different parts and operating temperature.
4. Higher common mode transient immunity than opto isolated gate drivers
5. Smaller propagation delay than opto isolated gate drivers
6. Due to superior process controls achievable in capacitive isolation compared to opto isolation, there is less part-to-part skew in the prop delay, making the system design simpler and more robust
7. Smaller pulse width distortion than opto isolated gate drivers

The signal across the isolation has an on-off keying (OOK) modulation scheme to transmit the digital data across a silicon dioxide based isolation barrier (see 图 19). The transmitter sends a high-frequency carrier across the barrier to represent one digital state and sends no signal to represent the other digital state. The receiver demodulates the signal after advanced signal conditioning and produces the output through a buffer stage. The UCC23313 also incorporates advanced circuit techniques to maximize the CMTI performance and minimize the radiated emissions from the high frequency carrier and IO buffer switching. 图 20 shows conceptual detail of how the OOK scheme works.

8.2 Functional Block Diagram

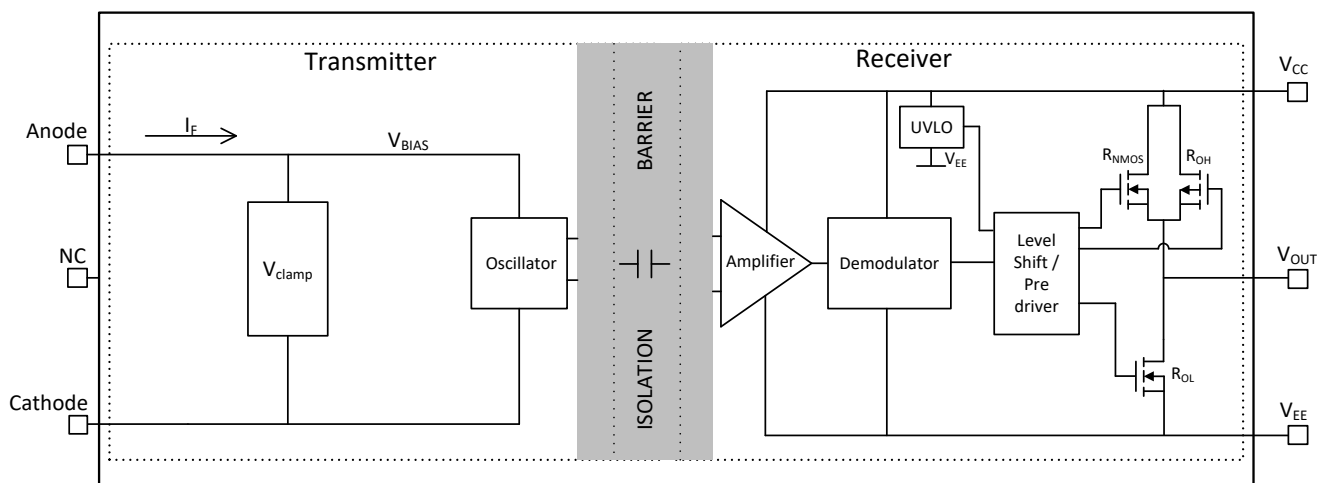


图 19. Conceptual Block Diagram of a Isolated Gate Driver with an Opto Emulated Input Stage (SO6 pkg)

Functional Block Diagram (接下页)

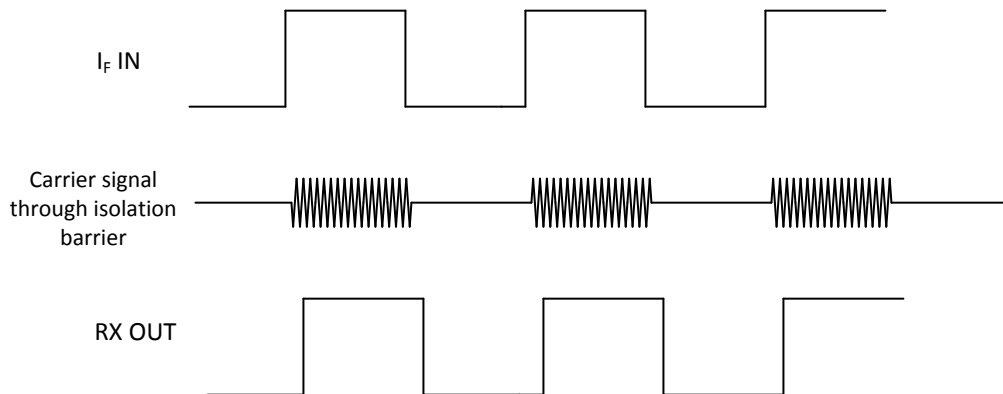


图 20. On-Off Keying (OOK) Based Modulation Scheme

8.3 Feature Description

8.3.1 Power Supply

Since the input stage is an emulated diode, no power supply is needed at the input.

The output supply, V_{CC} , supports a voltage range from 14V to 33V. For operation with bipolar supplies, the power device is turned off with a negative voltage on the gate with respect to the emitter or source. This configuration prevents the power device from unintentionally turning on because of current induced from the Miller effect. The typical values of the V_{CC} and V_{EE} output supplies for bipolar operation are 15V and -8V with respect to GND for IGBTs, and 20V and -5V for SiC MOSFETs.

For operation with unipolar supply, the V_{CC} supply is connected to 15V with respect to GND for IGBTs, and 20V for SiC MOSFETs. The V_{EE} supply is connected to 0V.

8.3.2 Input Stage

The input stage of UCC23313 is simply the e-diode and therefore has an Anode (Pin 1) and a Cathode (Pin 3). Pin 2 has no internal connection and can be left open or connected to ground. The input stage does not have a power and ground pin. When the e-diode is forward biased by applying a positive voltage to the Anode with respect to the Cathode, a forward current I_F flows into the e-diode. The forward voltage drop across the e-diode is 2.1V (typ). An external resistor should be used to limit the forward current. The recommended range for the forward current is 7mA to 16mA. When I_F exceeds the threshold current I_{FLH} (2.8mA typ.) a high frequency signal is transmitted across the isolation barrier through the high voltage SiO_2 capacitors. The HF signal is detected by the receiver and V_{OUT} is driven high. See [Selecting the Input Resistor](#) for information on selecting the input resistor. The dynamic impedance of the e-diode is very small ($<1.0\Omega$) and the temperature coefficient of the e-diode forward voltage drop is $<1.35\text{mV}/^\circ\text{C}$. This leads to excellent stability of the forward current I_F across all operating conditions. If the Anode voltage drops below $V_{F_{HL}}$ (0.9V), or reverse biased, the gate driver output is driven low. The reverse breakdown voltage of the e-diode is $>15\text{V}$. So for normal operation, a reverse bias of up to 13V is allowed. The large reverse breakdown voltage of the e-diode enables UCC23313 to be operated in interlock architecture (see example in [图 21](#)) where V_{SUP} can be as high as 12V. The system designer has the flexibility to choose a 3.3V, 5.0V or up to 12V PWM signal source to drive the input stage of UCC23313 using an appropriate input resistor. The example shows two gate drivers driving a set of IGBTs. The inputs of the gate drivers are connected as shown and driven by two buffers that are controlled by the MCU. Interlock architecture prevents both the e-diodes from being "ON" at the same time, preventing shoot through in the IGBTs. It also ensures that if both PWM signals are erroneously stuck high (or low) simultaneously, both gate driver outputs will be driven low.

Feature Description (接下页)

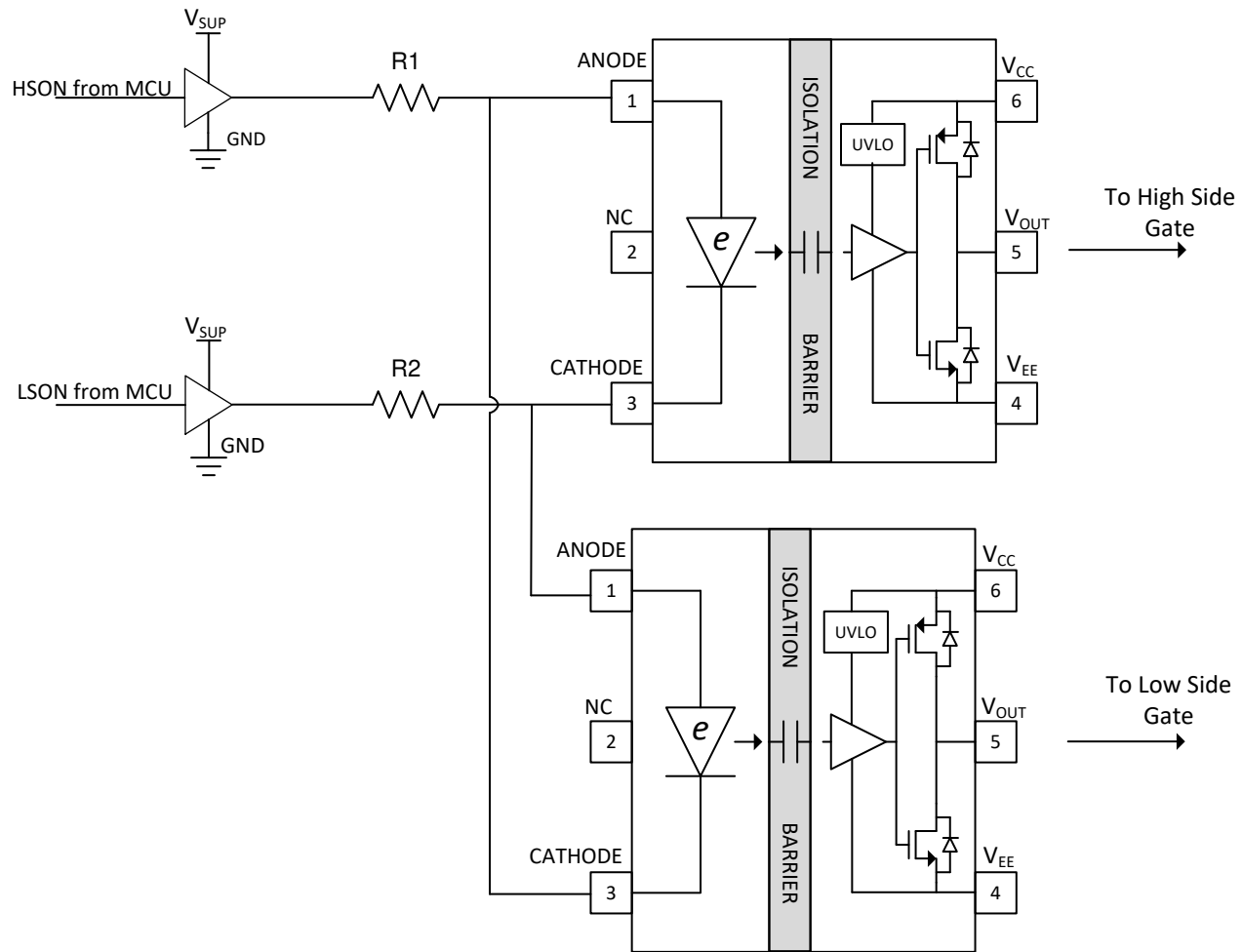


图 21. Interlock

8.3.3 Output Stage

The output stages of the UCC23313 family feature a pullup structure that delivers the highest peak-source current when it is most needed which is during the Miller plateau region of the power-switch turnon transition (when the power-switch drain or collector voltage experiences dV/dt). The output stage pullup structure features a P-channel MOSFET and an additional pull-up N-channel MOSFET in parallel. The function of the N-channel MOSFET is to provide a brief boost in the peak-sourcing current, enabling fast turnon. Fast turnon is accomplished by briefly turning on the N-channel MOSFET during a narrow instant when the output is changing states from low to high. The on-resistance of this N-channel MOSFET (R_{NMOS}) is approximately $5.1\ \Omega$ when activated.

表 1. UCC23313 On-Resistance

R_{NMOS}	R_{OH}	R_{OL}	UNIT
5.1	9.5	0.40	Ω

The R_{OH} parameter is a DC measurement and is representative of the on-resistance of the P-channel device only. This parameter is only for the P-channel device because the pullup N-channel device is held in the OFF state in DC condition and is turned on only for a brief instant when the output is changing states from low to high. Therefore, the effective resistance of the UCC23313 pullup stage during this brief turnon phase is much lower than what is represented by the R_{OH} parameter, yielding a faster turn on. The turnon-phase output resistance is the parallel combination $R_{OH} \parallel R_{NMOS}$.

The pulldown structure in the UCC23313 is simply composed of an N-channel MOSFET. The output voltage swing between V_{CC} and V_{EE} provides rail-to-rail operation because of the MOS-out stage which delivers very low dropout.

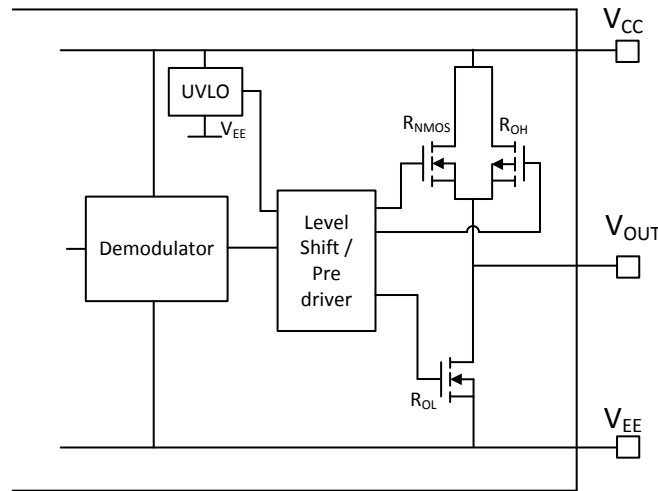


图 22. Output Stage

8.3.4 Protection Features

8.3.4.1 Undervoltage Lockout (UVLO)

UVLO function is implemented for V_{CC} and V_{EE} pins to prevent an under-driven condition on IGBTs and MOSFETs. When V_{CC} is lower than $UVLO_R$ at device start-up or lower than $UVLO_F$ after start-up, the voltage-supply UVLO feature holds the effected output low, regardless of the input forward current as shown in 表 2. The V_{CC} UVLO protection has a hysteresis feature ($UVLO_{hys}$). This hysteresis prevents chatter when the power supply produces ground noise which allows the device to permit small drops in bias voltage, which occurs when the device starts switching and operating current consumption increases suddenly.

When V_{CC} drops below $UVLO_F$, a delay, t_{UVLO_rec} occurs on the output when the supply voltage rises above $UVLO_R$ again.

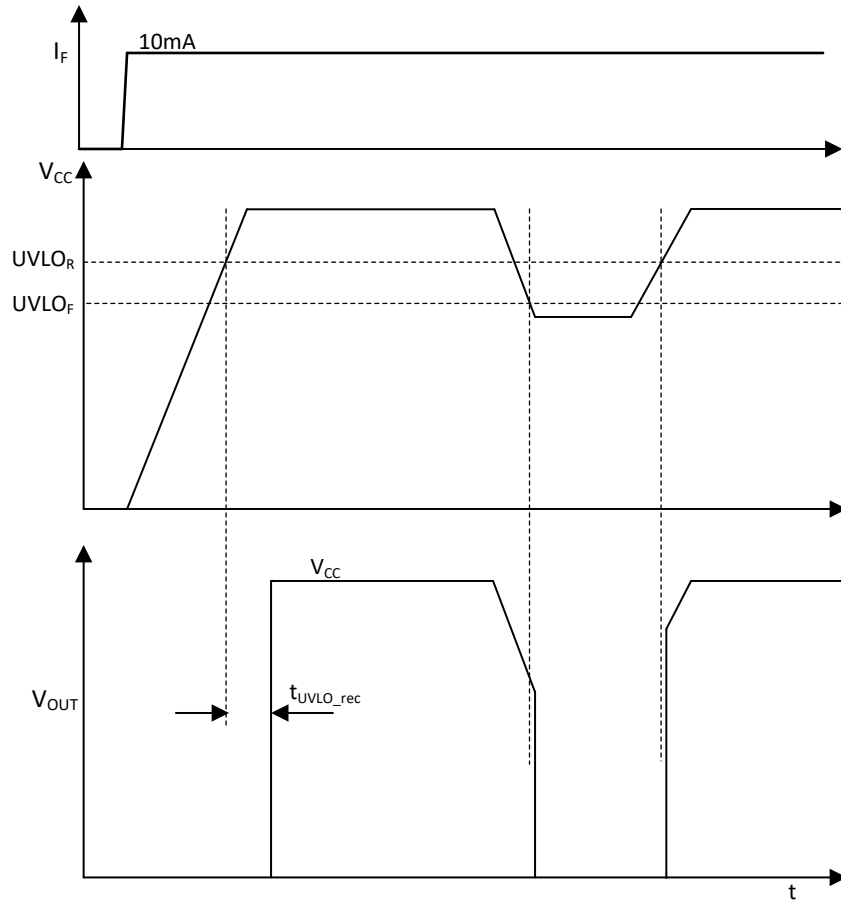


图 23. UVLO functionality

8.3.4.2 Active Pulldown

The active pull-down function is used to pull the IGBT or MOSFET gate to the low state when no power is connected to the V_{CC} supply. This feature prevents false IGBT and MOSFET turn-on by clamping V_{OUT} pin to approximately 2V.

When the output stage of the driver is in an unbiased condition (V_{CC} floating), the driver outputs (see 图 22) are held low by an active clamp circuit that limits the voltage rise on the driver outputs. In this condition, the upper PMOS & NMOS are held off while the lower NMOS gate is tied to the driver output through an internal 500-k Ω resistor. In this configuration, the lower NMOS device effectively clamps the output (V_{OUT}) to less than 2V.

8.3.4.3 Short-Circuit Clamping

The short-circuit clamping function is used to clamp voltages at the driver output and pull the output pin V_{OUT} slightly higher than the V_{CC} voltage during short-circuit conditions. The short-circuit clamping function helps protect the IGBT or MOSFET gate from overvoltage breakdown or degradation. The short-circuit clamping function is implemented by adding a diode connection between the dedicated pins and the V_{CC} pin inside the driver. The internal diodes can conduct up to 500-mA current for a duration of 10 μ s and a continuous current of 20 mA. Use external Schottky diodes to improve current conduction capability as needed.

8.4 Device Functional Modes

表 2 lists the functional modes for UCC23313

表 2. Function Table for UCC23313 with VCC Rising

e-diode	VCC	V _{OUT}
OFF ($I_F < I_{FLH}$)	0V - 33V	Low
ON ($I_F > I_{FLH}$)	0V - UVLO _R	Low
ON ($I_F > I_{FLH}$)	UVLO _R - 33V	High

表 3. Function Table for UCC23313 with VCC Falling

e-diode	VCC	V _{OUT}
OFF ($I_F < I_{FLH}$)	0V - 33V	Low
ON ($I_F > I_{FLH}$)	UVLO _F - 0V	Low
ON ($I_F > I_{FLH}$)	33V - UVLO _F	High

8.4.1 ESD Structure

图 24 shows the multiple diodes involved in the ESD protection components of the UCC23313 device . This provides pictorial representation of the absolute maximum rating for the device.

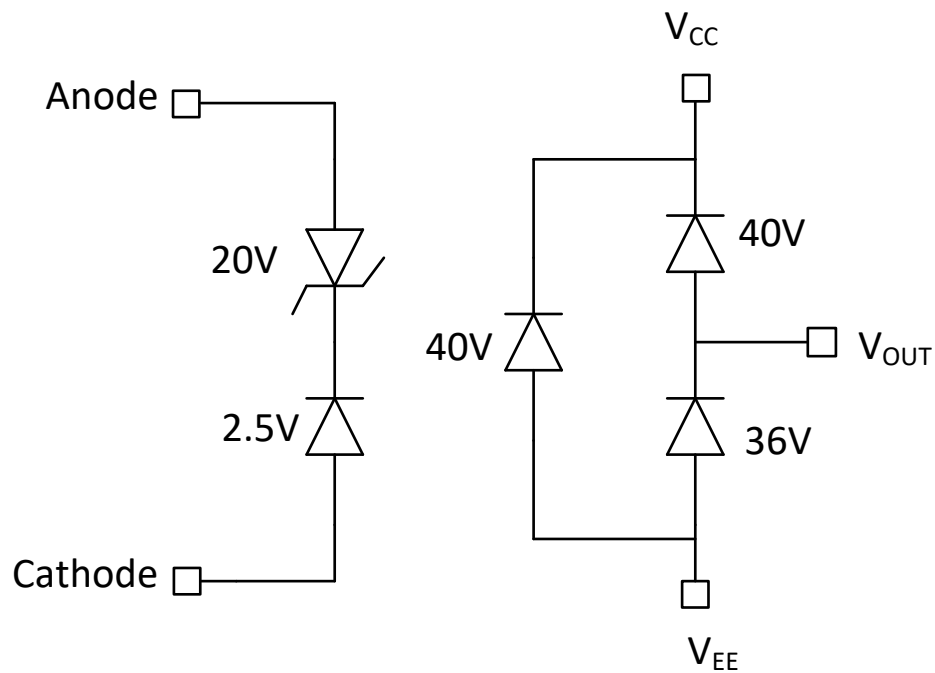


图 24. ESD Structure

9 Application and Implementation

注

Information in the following applications sections is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI's customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation to confirm system functionality.

9.1 Application Information

UCC23313 is a single channel, isolated gate driver with opto-compatible input for power semiconductor devices, such as MOSFETs, IGBTs, or SiC MOSFETs. It is intended for use in applications such as motor control, industrial inverters, and switched-mode power supplies. It differs from standard opto isolated gate drivers as it does not have an LED input stage. Instead of an LED, it has an emulated diode (e-diode). To turn the e-diode "ON", a forward current in the range of 7mA to 16mA should be driven into the Anode. This will drive the gate driver output High and turn on the power FET. Typically, MCU's are not capable of providing the required forward current. Hence a buffer has to be used between the MCU and the input stage of UCC23313. Typical buffer power supplies are either 5V or 3.3V. A resistor is needed between the buffer and the input stage of UCC23313 to limit the current. It is simple, but important to choose the right value of resistance. The resistor tolerance, buffer supply voltage tolerance and output impedance of the buffer, have to be considered in the resistor selection. This will ensure that the e-diode forward current stays within the recommended range of 7mA to 16mA. Detailed design recommendations are given in the [Application Information](#). The current driven input stage offers excellent noise immunity that is need in high power motor drive systems, especially in cases where the MCU cannot be located close to the isolated gate driver. UCC23313 offers best in class CMTI performance of >150kV/us at 1500V common mode voltages.

The e-diode is capable of 25mA continuous in the forward direction. The forward voltage drop of the e-diode has a very tight part to part variation (1.8V min to 2.4V max). The temperature coefficient of the forward drop is <1.35mV/°C. The dynamic impedance of the e-diode in the forward biased region is ~1Ω. All of these factors contribute in excellent stability of the e-diode forward current. To turn the e-diode "OFF", the Anode - Cathode voltage should be <0.8V, or I_F should be < I_{FLH} . The e-diode can also be reverse biased up to 5V (7V abs max) in order to turn it off and bring the gate driver output low.

The output power supply for UCC23313 can be as high as 33V (35V abs max). The output power supply can be configured externally as a single isolated supply up to 33V or isolated bipolar supply such that $V_{CC}-V_{EE}$ does not exceed 33V, or it can be bootstrapped (with external diode & capacitor) if the system uses a single power supply with respect to the power ground. Typical quiescent power supply current from V_{CC} is 1.2mA (max 2.2mA).

9.2 Typical Application

The circuit in 图 25, shows a typical application for driving IGBTs.

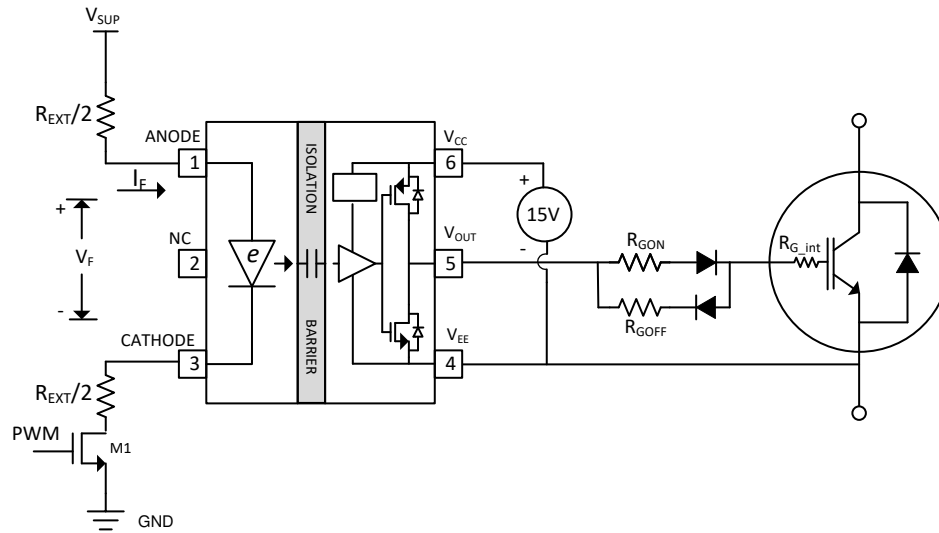


图 25. Typical Application Circuit for UCC23313 to Drive IGBT

9.2.1 Design Requirements

表 4 lists the recommended conditions to observe the input and output of the UCC23313 gate driver.

表 4. UCC23313 Design Requirements

PARAMETER	VALUE	UNIT
V_{CC}	15	V
I_F	10	mA
Switching frequency	8	kHz

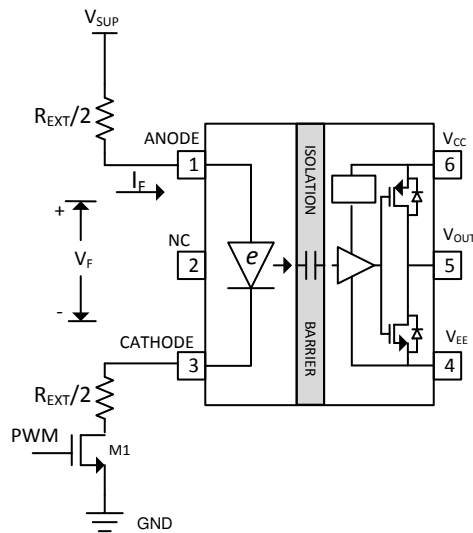
9.2.2 Detailed Design Procedure

9.2.2.1 Selecting the Input Resistor

The input resistor limits the current that flows into the e-diode when it is forward biased. The threshold current I_{FLH} is 2.5mA typ. The recommended operating range for the forward current is 7mA to 16mA (e-diode ON). All the electrical specifications are guaranteed in this range. The resistor should be selected such that for typical operating conditions, I_F is 10mA. Following are the list of factors that will affect the exact value of this current:

1. Supply Voltage V_{SUP} variation
2. Manufacturer's tolerance for the resistor and variation due to temperature
3. e-diode forward voltage drop variation (at $I_F=10mA$, $V_F=$ typ 2.1V, min 1.8V, max 2.4V, with a temperature coefficient $<1.35mV/^{\circ}C$ and dynamic impedance $<1\Omega$)

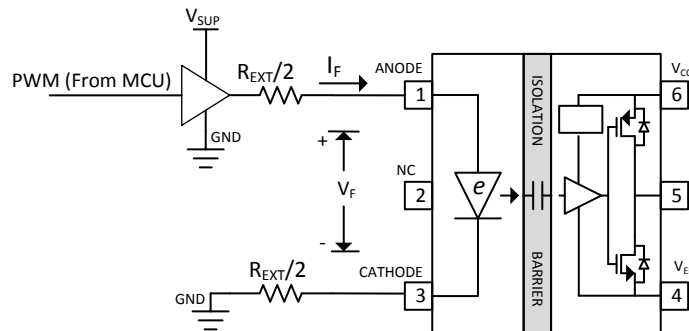
See 图 26 for the schematic using a single NMOS and split resistor combination to drive the input stage of UCC23313. The input resistor can be selected using the equation shown.



$$R_{EXT} = \frac{V_{SUP} - V_F}{I_F} - R_{M1}$$

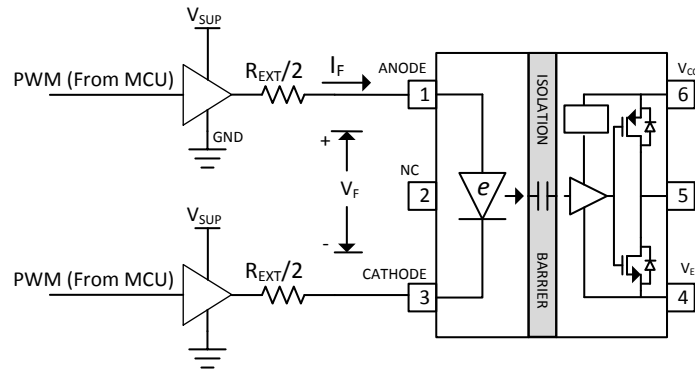
图 26. Configuration 1: Driving the input stage of UCC23313 with a single NMOS and split resistors

Driving the input stage of UCC23313 using a single buffer is shown in 图 27 and using 2 buffers is shown in 图 28



$$R_{EXT} = \frac{V_{SUP} - V_F}{I_F} - R_{OH_buf}$$

图 27. Configuration 2: Driving the input stage of UCC23313 with one Buffer and split resistors



$$R_{EXT} = \frac{V_{SUP} - V_F}{I_F} - (R_{OH_buf} + R_{OL_buf})$$

图 28. Configuration 3: Driving the input stage of UCC23313 with 2 buffers and split resistors

表 5 shows the range of values for R_{EXT} for the 3 different configurations shown in 图 26, 图 27 and 图 28. The assumptions used in deriving the range for R_{EXT} are as follows:

1. Target forward current I_F is 7mA min, 10mA typ and 16mA max
2. e-diode forward voltage drop is 1.8V to 2.4V
3. V_{SUP} (Buffer supply voltage) is 5V with $\pm 5\%$ tolerance
4. Manufacturer's tolerance for R_{EXT} is 1%
5. NMOS resistance is 0.25Ω to 1.0Ω (for configuration 1)
6. R_{OH} (buffer output impedance in output "High" state) is 13Ω min, 18Ω typ and 22Ω max
7. R_{OL} (buffer output impedance in "Low" state) is 10Ω min, 14Ω typ and 17Ω max

表 5. R_{EXT} Values to Drive The Input Stage

Configuration	$R_{EXT} \Omega$		
	Min	Typ	Max
Single NMOS and R_{EXT}	218	290	331
Single Buffer and R_{EXT}	204	272	311
Two Buffers and R_{EXT}	194	259	294

9.2.2.2 Gate-Driver Output Resistor

The external gate-driver resistors, $R_{G(ON)}$ and $R_{G(OFF)}$ are used to:

1. Limit ringing caused by parasitic inductances and capacitances
2. Limit ringing caused by high voltage or high current switching dv/dt , di/dt , and body-diode reverse recovery
3. Fine-tune gate drive strength, specifically peak sink and source current to optimize the switching loss
4. Reduce electromagnetic interference (EMI)

The output stage has a pull up structure consisting of a P-channel MOSFET and an N-channel MOSFET in parallel. The combined peak source current is 4.6 A Use 公式 1 to estimate the peak source current as an example.

(1)

$$I_{OH} = \min \left[4.5A, \frac{V_{CC}}{(R_{NMOS} || R_{OH} + R_{GON} + R_{GFETINT})} \right]$$

where

- R_{GON} is the external turnon resistance.
- R_{GFET_int} is the power transistor internal gate resistance, found in the power transistor data sheet. We will assume 0Ω for our example
- I_{OH} is the peak source current which is the minimum value between 4.6A, the gate-driver peak source current, and the calculated value based on the gate-drive loop resistance. (2)

In this example, the peak source current is approximately 1.8A as calculated in 公式 3.

$$I_{OH} = \min \left[4.5A, \frac{15}{(5.1\Omega || 9.5\Omega + 5\Omega + 0\Omega)} \right] = 1.8A \quad (3)$$

Similarly, use 公式 4 to calculate the peak sink current.

$$I_{OL} = \min \left[5.3A, \frac{V_{CC}}{(R_{OL} + R_{GOFF} + R_{GFET_INT})} \right]$$

where

- R_{GOFF} is the external turnoff resistance.
- I_{OL} is the peak sink current which is the minimum value between 5.7A, the gate-driver peak sink current, and the calculated value based on the gate-drive loop resistance. (4)

In this example, the peak sink current is the minimum of 公式 5 and 5.7A.

$$I_{OL} = \min \left[5.3A, \frac{15}{(0.4\Omega + 10\Omega + 0\Omega)} \right] = 1.44A \quad (5)$$

注

The estimated peak current is also influenced by PCB layout and load capacitance. Parasitic inductance in the gate-driver loop can slow down the peak gate-drive current and introduce overshoot and undershoot. Therefore, TI strongly recommends that the gate-driver loop should be minimized. Conversely, the peak source and sink current is dominated by loop parasitics when the load capacitance (C_{ISS}) of the power transistor is very small (typically less than 1 nF) because the rising and falling time is too small and close to the parasitic ringing period.

9.2.2.3 Estimate Gate-Driver Power Loss

The total loss, P_G , in the gate-driver subsystem includes the power losses (P_{GD}) of the UCC23313 device and the power losses in the peripheral circuitry, such as the external gate-drive resistor.

The P_{GD} value is the key power loss which determines the thermal safety-related limits of the UCC23313 device, and it can be estimated by calculating losses from several components.

The first component is the static power loss, P_{GDQ} , which includes power dissipated in the input stage (P_{GDQ_IN}) as well as the quiescent power dissipated in the output stage (P_{GDQ_OUT}) when operating with a certain switching frequency under no load. P_{GDQ_IN} is determined by I_F and V_F and is given by 公式 6. The P_{GDQ_OUT} parameter is measured on the bench with no load connected to V_{OUT} pin at a given V_{CC} , switching frequency, and ambient temperature. In this example, V_{CC} is 15 V. The current on the power supply, with PWM switching at 10 kHz, is measured to be $I_{CC} = 1.33$ mA. Therefore, use 公式 7 to calculate P_{GDQ_OUT} .

$$P_{GDQ_IN} = \frac{1}{2} * V_F * I_F \quad (6)$$

$$P_{GDQ_OUT} = V_{CC} * I_{CC} \quad (7)$$

The total quiescent power (without any load capacitance) dissipated in the gate driver is given by the sum of 公式 6 and 公式 7 as shown in 公式 8

$$P_{GDQ} = P_{GDQ_IN} + P_{GDQ_OUT} = 10 \text{ mW} + 20\text{mW} = 30\text{mW}$$

(8)

The second component is the switching operation loss, P_{GDSW} , with a given load capacitance which the driver charges and discharges the load during each switching cycle. Use 公式 9 to calculate the total dynamic loss from load switching, P_{GSW} .

$$P_{GSW} = V_{CC2} \times Q_G \times f_{SW}$$

where

- Q_G is the gate charge of the power transistor at V_{CC} .

(9)

So, for this example application the total dynamic loss from load switching is approximately 18 mW as calculated in 公式 10.

$$P_{GSW} = 15 \text{ V} \times 120 \text{ nC} \times 10 \text{ kHz} = 18 \text{ mW}$$

(10)

Q_G represents the total gate charge of the power transistor switching 520 V at 50 A, and is subject to change with different testing conditions. The UCC23313 gate-driver loss on the output stage, P_{GDO} , is part of P_{GSW} . P_{GDO} is equal to P_{GSW} if the external gate-driver resistance and power-transistor internal resistance are 0 Ω , and all the gate driver-loss will be dissipated inside the UCC23313. If an external turn-on and turn-off resistance exists, the total loss is distributed between the gate driver pull-up/down resistance, external gate resistance, and power-transistor internal resistance. Importantly, the pull-up/down resistance is a linear and fixed resistance if the source/sink current is not saturated to 4.6A/5.7A, however, it will be non-linear if the source/sink current is saturated. Therefore, P_{GDO} is different in these two scenarios.

Case 1 - Linear Pull-Up/Down Resistor:

$$P_{GDO} = \frac{P_{GSW}}{2} \left[\frac{R_{OH} || R_{NMOS}}{R_{OH} || R_{NMOS} + R_{GON} + R_{GFET_int}} + \frac{R_{OL}}{R_{OL} + R_{GOFF} + R_{GFET_int}} \right]$$

(11)

In this design example, all the predicted source and sink currents are less than 4.6 A and 5.7 A, therefore, use 公式 11 to estimate the UCC23313 gate-driver loss.

$$P_{GDO} = \frac{18 \text{ mW}}{2} \left[\frac{9.5\Omega || 5.1\Omega}{9.5\Omega || 5.1\Omega + 5.1\Omega + 0\Omega} + \frac{0.4\Omega}{0.4\Omega + 10\Omega + 0\Omega} \right] = 3.9 \text{ mW}$$

(12)

Case 2 - Nonlinear Pull-Up/Down Resistor:

$$P_{GDO} = f_{sw} \times \left[4.5\text{A} \times \int_0^{T_{R_Sys}} (V_{CC} - V_{OUT}(t)) dt + 5.3\text{A} \times \int_0^{T_{F_Sys}} V_{OUT}(t) dt \right]$$

where

- $V_{OUT(t)}$ is the gate-driver OUT pin voltage during the turnon and turnoff period. In cases where the output is saturated for some time, this value can be simplified as a constant-current source (4.6 A at turnon and 5.7 A at turnoff) charging or discharging a load capacitor. Then, the $V_{OUT(t)}$ waveform will be linear and the T_{R_Sys} and T_{F_Sys} can be easily predicted.

(13)

For some scenarios, if only one of the pullup or pulldown circuits is saturated and another one is not, the P_{GDO} is a combination of case 1 and case 2, and the equations can be easily identified for the pullup and pulldown based on this discussion.

Use 公式 14 to calculate the total gate-driver loss dissipated in the UCC23313 gate driver, P_{GD} .

$$P_{GD} = P_{GDQ} + P_{GDO} = 30\text{mW} + 3.9\text{mW} = 33.9\text{mW}$$

(14)

9.2.2.4 Estimating Junction Temperature

Use 公式 15 to estimate the junction temperature (T_J) of UCC23313.

$$T_J = T_C + \Psi_{JT} \times P_{GD}$$

where

- T_C is the UCC23313 case-top temperature measured with a thermocouple or some other instrument.
- Ψ_{JT} is the junction-to-top characterization parameter from the table. (15)

Using the junction-to-top characterization parameter (Ψ_{JT}) instead of the junction-to-case thermal resistance ($R_{\theta JC}$) can greatly improve the accuracy of the junction temperature estimation. The majority of the thermal energy of most ICs is released into the PCB through the package leads, whereas only a small percentage of the total energy is released through the top of the case (where thermocouple measurements are usually conducted). The $R_{\theta JC}$ resistance can only be used effectively when most of the thermal energy is released through the case, such as with metal packages or when a heat sink is applied to an IC package. In all other cases, use of $R_{\theta JC}$ will inaccurately estimate the true junction temperature. The Ψ_{JT} parameter is experimentally derived by assuming that the dominant energy leaving through the top of the IC will be similar in both the testing environment and the application environment. As long as the recommended layout guidelines are observed, junction temperature estimations can be made accurately to within a few degrees Celsius.

9.2.2.5 Selecting V_{CC} Capacitor

Bypass capacitors for V_{CC} is essential for achieving reliable performance. TI recommends choosing low-ESR and low-ESL, surface-mount, multi-layer ceramic capacitors (MLCC) with sufficient voltage ratings, temperature coefficients, and capacitance tolerances. A 50-V, 10- μ F MLCC and a 50-V, 0.22- μ F MLCC are selected for the C_{VCC} capacitor. If the bias power supply output is located a relatively long distance from the V_{CC} pin, a tantalum or electrolytic capacitor with a value greater than 10 μ F should be used in parallel with C_{VCC} .

注

DC bias on some MLCCs will impact the actual capacitance value. For example, a 25-V, 1- μ F X7R capacitor is measured to be only 500 nF when a DC bias of 15- V_{DC} is applied.

10 Power Supply Recommendations

The recommended input supply voltage (V_{CC}) for the UCC23313 device is from 13.2 V to 33 V. The lower limit of the range of output bias-supply voltage (V_{CC}) is determined by the internal UVLO protection feature of the device. V_{CC} voltage should not fall below the UVLO threshold for normal operation, or else the gate-driver outputs can become clamped low for more than 20 μ s by the UVLO protection feature. The higher limit of the V_{CC} range depends on the maximum gate voltage of the power device that is driven by the UCC23313 device, and should not exceed the recommended maximum V_{CC} of 33 V. A local bypass capacitor should be placed between the V_{CC} and V_{EE} pins, with a value of 220-nF to 10- μ F for device biasing. TI recommends placing an additional 100-nF capacitor in parallel with the device biasing capacitor for high frequency filtering. Both capacitors should be positioned as close to the device as possible. Low-ESR, ceramic surface-mount capacitors are recommended.

If only a single, primary-side power supply is available in an application, isolated power can be generated for the secondary side with the help of a transformer driver such as Texas Instruments' [SN6501](#) or [SN6505A](#). For such applications, detailed power supply design and transformer selection recommendations are available in [SN6501 Transformer Driver for Isolated Power Supplies data sheet](#) and [SN6505A Low-Noise 1-A Transformer Drivers for Isolated Power Supplies data sheet](#).

11 Layout

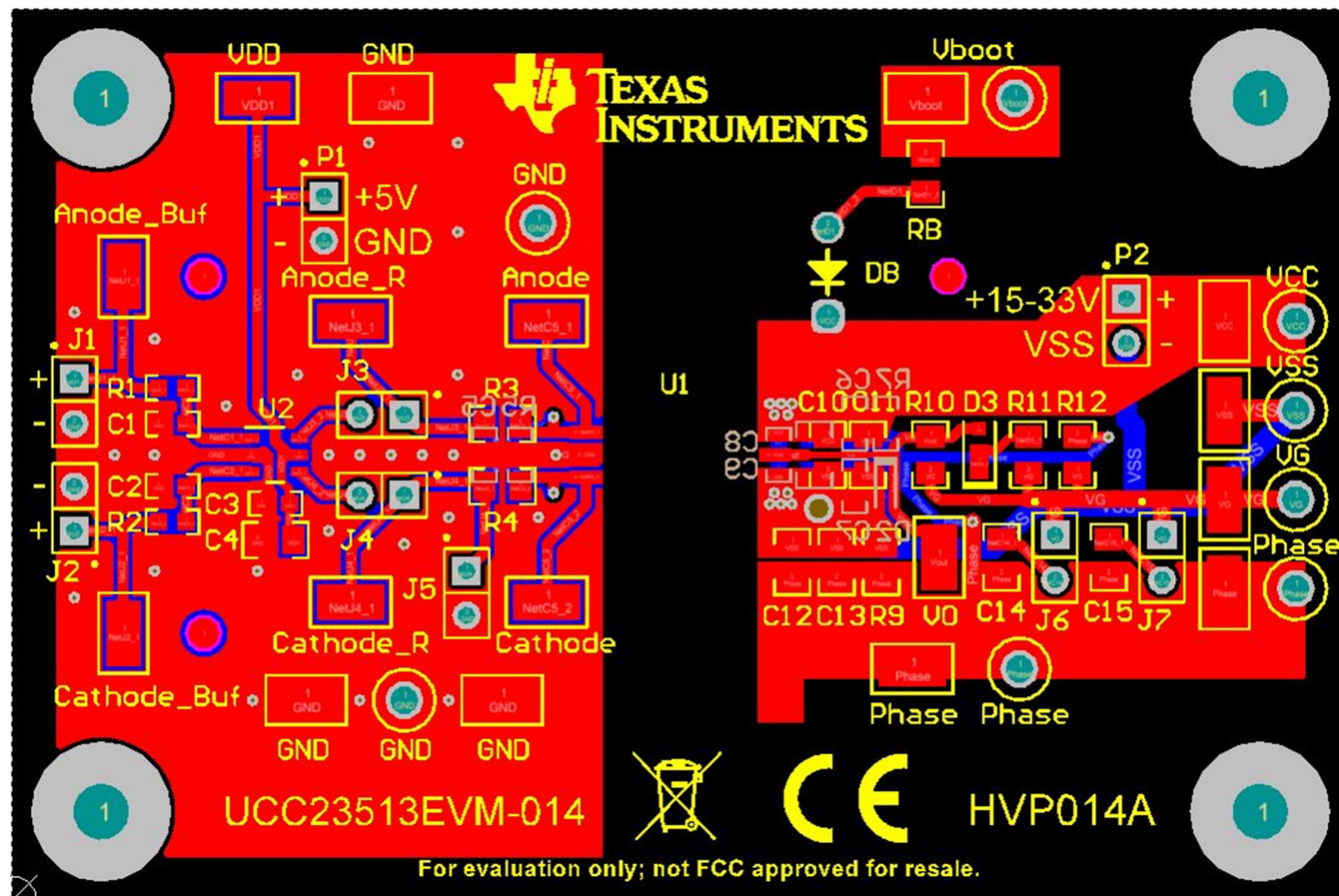
11.1 Layout Guidelines

Designers must pay close attention to PCB layout to achieve optimum performance for the UCC23313. Some key guidelines are:

- Component placement:
 - Low-ESR and low-ESL capacitors must be connected close to the device between the V_{CC} and V_{EE} pins to bypass noise and to support high peak currents when turning on the external power transistor.
 - To avoid large negative transients on the V_{EE} pins connected to the switch node, the parasitic inductances between the source of the top transistor and the source of the bottom transistor must be minimized.
- Grounding considerations:
 - Limiting the high peak currents that charge and discharge the transistor gates to a minimal physical area is essential. This limitation decreases the loop inductance and minimizes noise on the gate terminals of the transistors. The gate driver must be placed as close as possible to the transistors.
- High-voltage considerations:
 - To ensure isolation performance between the primary and secondary side, avoid placing any PCB traces or copper below the driver device. A PCB cutout or groove is recommended in order to prevent contamination that may compromise the isolation performance.
- Thermal considerations:
 - A large amount of power may be dissipated by the UCC23313 if the driving voltage is high, the load is heavy, or the switching frequency is high. Proper PCB layout can help dissipate heat from the device to the PCB and minimize junction-to-board thermal impedance (θ_{JB}).
 - Increasing the PCB copper connecting to the V_{CC} and V_{EE} pins is recommended, with priority on maximizing the connection to V_{EE} . However, the previously mentioned high-voltage PCB considerations must be maintained.
 - If the system has multiple layers, TI also recommends connecting the V_{CC} and V_{EE} pins to internal ground or power planes through multiple vias of adequate size. These vias should be located close to the IC pins to maximize thermal conductivity. However, keep in mind that no traces or coppers from different high voltage planes are overlapping.

11.2 Layout Example

图 29 shows a PCB layout example with the signals and key components labeled.



(1) No PCB traces or copper are located between the primary and secondary side, which ensures isolation performance.

图 29. Layout Example

Layout Example (接下页)

图 30 和 图 31 显示顶层和底层走线和铜箔。

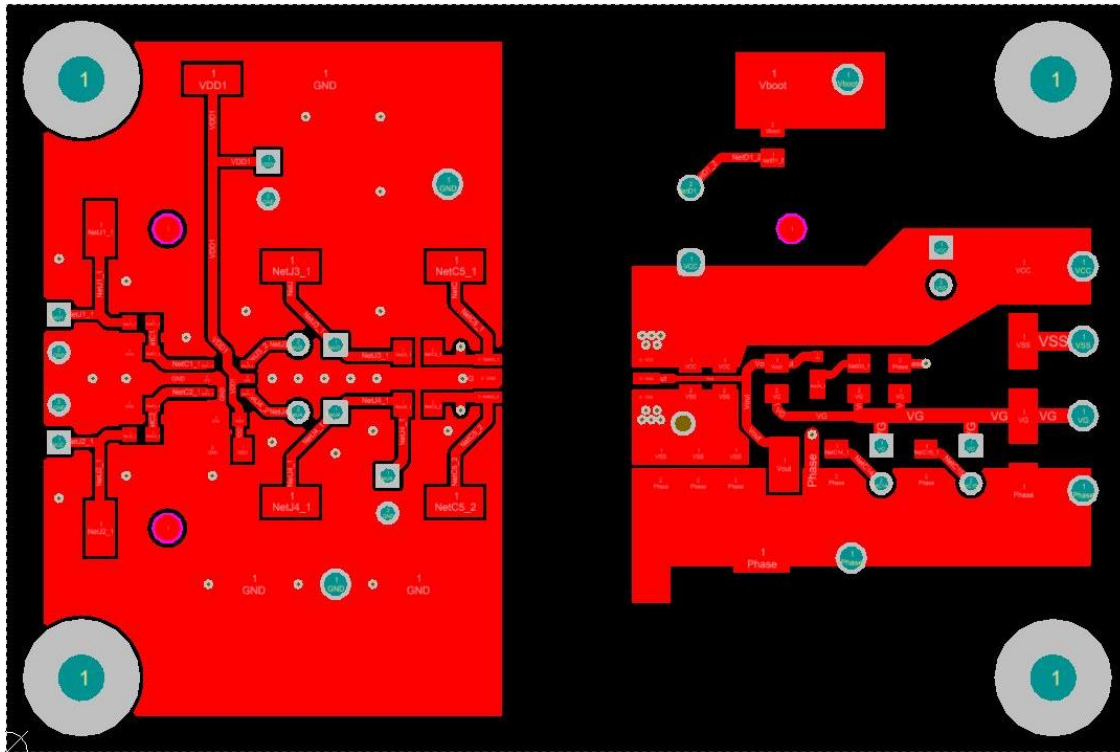


图 30. Top-Layer Traces and Copper

Layout Example (接下页)

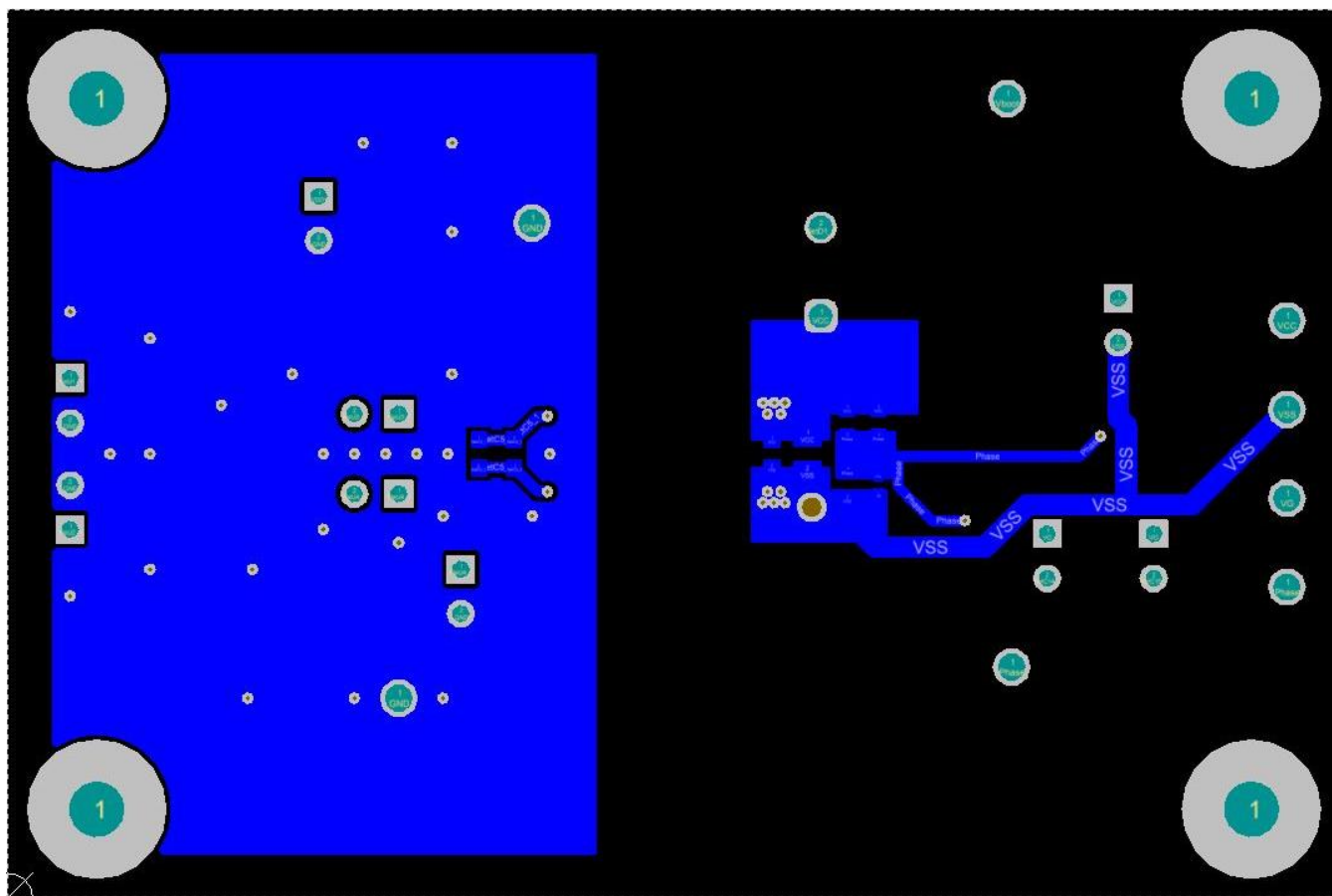
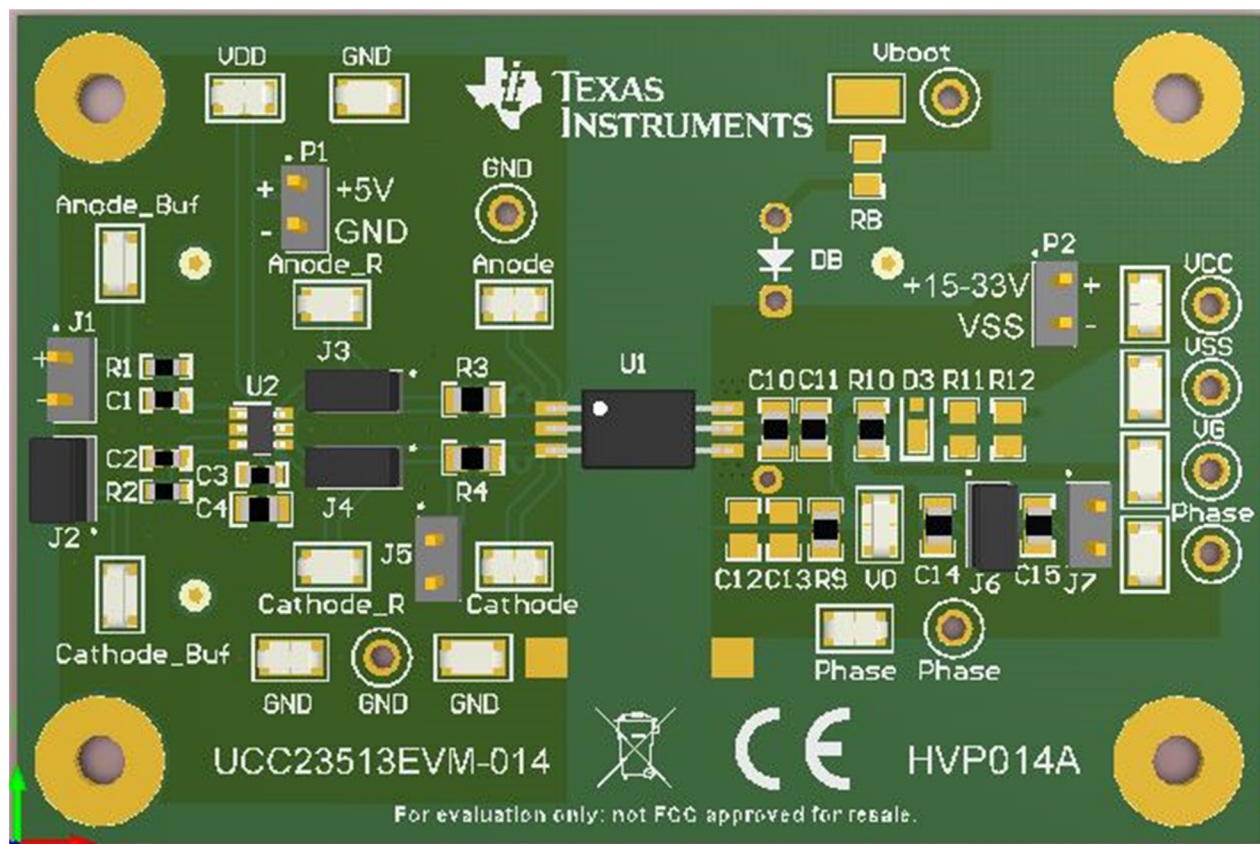


图 31. Bottom-Layer Traces and Copper (Flipped)

Layout Example (接下页)

图 32 shows the 3D layout of the top view of the PCB.



(1) The location of the PCB cutout between primary side and secondary sides ensures isolation performance.

图 32. 3-D PCB View

11.3 PCB Material

Use standard FR-4 UL94V-0 printed circuit board. This PCB is preferred over cheaper alternatives because of lower dielectric losses at high frequencies, less moisture absorption, greater strength and stiffness, and the self-extinguishing flammability-characteristics.

12 机械、封装和可订购信息

以下页面包含机械、封装和可订购信息。这些信息是指定器件的最新可用数据。数据如有变更，恕不另行通知，且不会对此文档进行修订。如需获取此数据表的浏览器版本，请查阅左侧的导航栏。

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PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead finish/ Ball material (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
UCC23313BDWY	ACTIVE	SOIC	DWY	6	100	RoHS & Green	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	UC23313B	Samples
UCC23313BDWYR	ACTIVE	SOIC	DWY	6	850	RoHS & Green	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	UC23313B	Samples
UCC23313DWY	ACTIVE	SOIC	DWY	6	100	RoHS & Green	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	UCC23313	Samples
UCC23313DWYR	ACTIVE	SOIC	DWY	6	850	RoHS & Green	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	UCC23313	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.

OBSELETE: TI has discontinued the production of the device.

⁽²⁾ **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".

RoHS Exempt: TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.

Green: TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

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

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

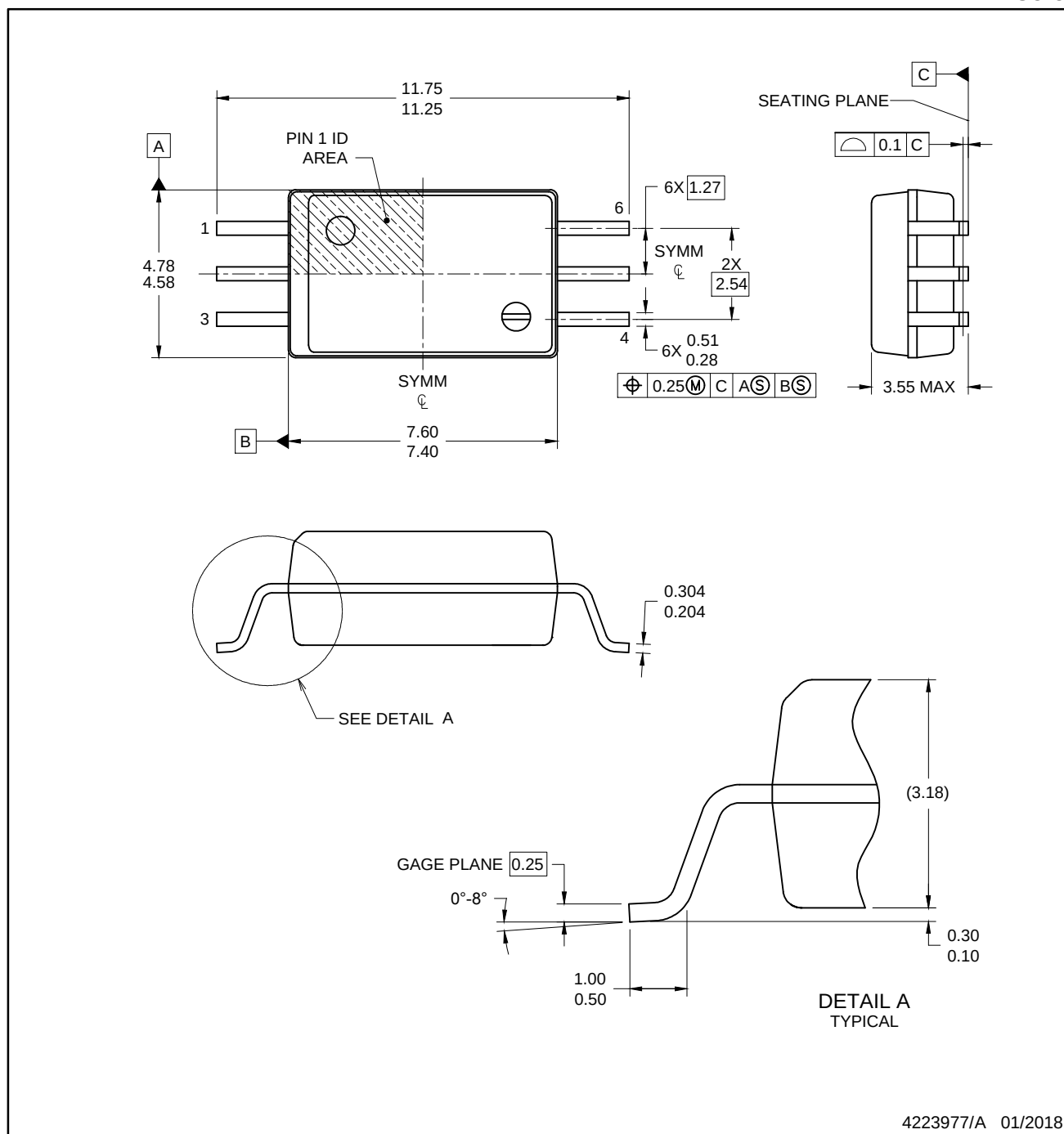
⁽⁵⁾ Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "-" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

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

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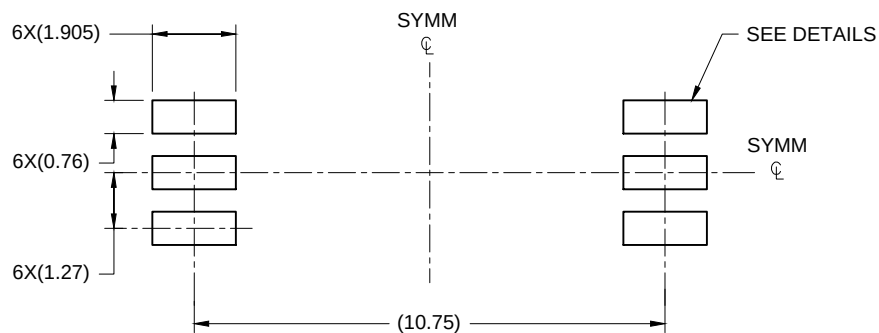
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NOTES:

1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 per side.
4. This dimension does not include interlead flash. Interlead flash shall not exceed 0.70 per side.



LAND PATTERN EXAMPLE
SCALE:6X



SOLDER MASK DETAILS

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NOTES: (continued)

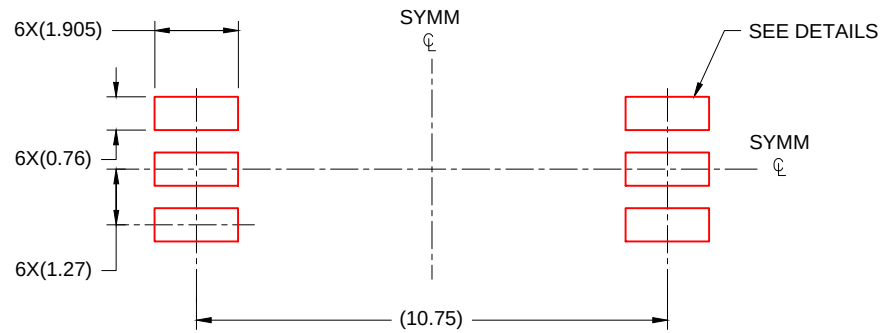
5. Publication IPC-7351 may have alternate designs.
6. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

EXAMPLE STENCIL DESIGN

DWY0006A

SOIC - 3.55 mm max height

SOIC



SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL
SCALE: 6X

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NOTES: (continued)

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

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