TEXAS INSTRUMENTS

UCC23313

ZHCSK80B – SEPTEMBER 2019 – REVISED OCTOBER 2020

UCC23313 4A 拉电流、5A 灌电流、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
- 最高 33V 输出驱动器电源电压
- 8V (B) 和 12V VCC UVLO 选项
- 轨到轨输出
- 105ns（最大值）传播延迟
- 25ns（最大值）器件间延迟匹配
- 35ns（最大值）脉宽失真度
- 150kV/μs（最小值）共模瞬态抗扰度 (CMTI)
- 隔离栅寿命大于 50 年
- 输入级具有 13V 反极性电压处理能力，支持互锁
- 扩展型 SO-6 封装，爬电距离和间隙大于 8.5mm
- 运行结温 T$_J$：–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

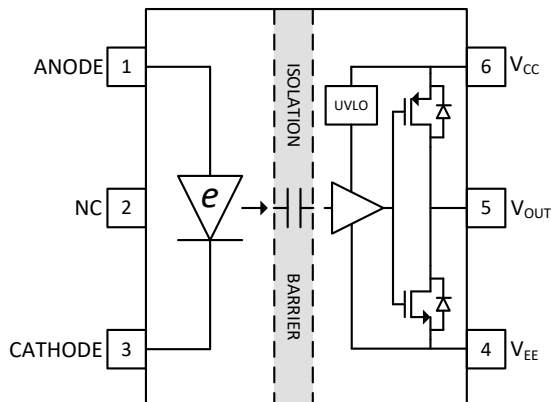## 2 应用

- 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功率 FET。与基于光耦合器的标准栅极驱动器相比，此器件的主要特性可显著提高性能和可靠性，同时在原理图和布局设计中保持引脚对引脚兼容性。性能亮点包括高共模瞬态抗扰度 (CMTI)、低传播延迟和小脉宽失真。严格的过程控制可实现较小的器件间偏移。输入级是仿真二极管 (e-diode)，这意味着与光耦合器栅极驱动器中传统的 LED 相比，可靠性和老化特性更为出色。该器件采用扩展型 SO6 封装，爬电距离和间隙大于 8.5mm，塑封材料（材料组 I）的相对漏电起痕指数 (CTI) 大于 600V。UCC23313 具有高性能和高可靠性，因此非常适合用于所有类型的电机驱动器、光伏逆变器、工业电源和电器。更高的工作温度为传统光耦合器以前无法支持的应用开辟了机会。

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。

功能方框图

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4 Revision History

注：以前版本的页码可能与当前版本的页码不同

Changes from Revision A (October 2019) to Revision B (October 2020)	**Page**
• Added UCC23511B orderble to include 8-V UVLO option..8	

Changes from Revision * (September 2019) to Revision A (October 2019)	**Page**
• Changed Minimum internal gap unit from mm to µm. 6	

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5 Pin Configuration and Function

图 **5-1. UCC23313 Package SO-6 Top View**

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

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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	$I_{F(TRAN)}$ <1us 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 *Thermal Information Section*.

6.2 ESD Ratings

			VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human-body model (HBM), per AEC Q100-002[1]	±4000	V
		Charged-device model (CDM), per AEC Q100-011	±1500	

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

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
V_{CC}	Output Supply Voltage($V_{CC} － V_{EE}$)	10		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	
$R_{\theta JA}$	Junction-to-ambient thermal resistance	126	°C/W
$R_{\theta JC(top)}$	Junction-to-case (top) thermal resistance	66.1	°C/W
$R_{\theta JB}$	Junction-to-board thermal resistance	62.8	°C/W
Ψ_{JT}	Junction-to-top characterization parameter	29.6	°C/W
Ψ_{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.

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6.5 额定功率

参数		测试条件	最小值	典型值	最大值	单位
P_D	输入端和输出端的最大功率耗散[1]	V_{CC} = 20V，I_F = 10mA，10kHz，50% 占空比，方波，180nF 负载，T_A = 25°C			750	mW
P_{D1}	最大输入功率耗散[2]				10	mW
P_{D2}	最大输出功率耗散				740	mW

(1) 超过 25°C 环境温度时会降低 6mW/°C

(2) 建议最大值 P_{D1} = 40mW。绝对最大值 P_{D1} = 55mW

6.6 Insulation Specifications

PARAMETER		TEST CONDITIONS	SPECIFICATION	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 $\leqslant$ 600 V_{RMS}	I-IV	
		Rated mains voltage $\leqslant$ 1000 V_{RMS}	I-III	
DIN V VDE 0884-11 (VDE V 0884-11)[2]				
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[3]	Test method per IEC 62368, 1.2/50 ms waveform, V_{TEST} = 1.6 x V_{IOSM} = 9600 V_{PK} (qualification)	6000	V_{PK}
q_{pd}	Apparent charge[4]	Method a: After I/O safety test subgroup 2/3, V_{ini} = V_{IOTM}, t_{ini} = 60 s; $V_{pd(m)}$ = 1.2 x V_{IORM} = 1188 V_{PK}, t_m = 10 s	$\leqslant$5	pC
		Method a: After environmental tests subgroup 1, V_{ini} = V_{IOTM}, t_{ini} = 60 s; $V_{pd(m)}$ = 1.6 x V_{IORM} = 1584 V_{PK}, t_m = 10 s	$\leqslant$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 x V_{IORM} = 1856V_{PK}, t_m = 1 s	$\leqslant$5	
C_{IO}	Barrier capacitance, input to output[5]	V_{IO} = 0.4 x sin (2 π ft), f = 1 MHz	0.5	pF
R_{IO}	Insulation resistance, input to output[5]	V_{IO} = 500 V, T_A = 25°C	>10^{12}	Ω
		V_{IO} = 500 V, 100°C $\leqslant$ T_A $\leqslant$ 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} = 3750 V_{RMS}, t = 60 s (qualification), V_{TEST} = 1.2 x V_{ISO} = 4500 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) This coupler is suitable for *safe electrical insulation* only within the safety ratings. Compliance with the safety ratings shall be ensured by means of suitable protective circuits.
(3) Testing is carried out in air or oil to determine the intrinsic surge immunity of the isolation barrier.
(4) Apparent charge is electrical discharge caused by a partial discharge (pd).
(5) All pins on each side of the barrier tied together creating a two-pin device.

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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}	
Certificate planned	Certificate planned	Certificate planned

6.8 安全限值

参数		测试条件	最小值	典型值	最大值	单位
I_S	安全输入、输出或电源电流	R_{qJA} = 126°C/W，V_I = 15V，T_J = 150°C，T_A = 25°C			50	mA
		R_{qJA} = 126°C/W，V_I = 30V，T_J = 150°C，T_A = 25°C			25	
P_S	安全输入、输出或总电源	R_{qJA} = 126°C/W，T_J = 150°C，T_A = 25°C			750	mW
T_S	最高安全温度[1]				150	°C

(1) 最高安全温度 T_S 与器件指定的最大结温 T_J 的值相同。I_S 和 P_S 参数分别表示安全电流和安全功率。请勿超出 I_S 和 P_S 的最大限值。这些限值随环境温度 T_A 的变化而变化。"热性能信息"表中的结至空气热阻 R_{qJA} 所属器件安装在引线式表面贴装封装对应的高 K 测试板上。可以使用这些公式计算每个参数的值：$T_J = T_A + R_{qJA} × P$，其中 P 为器件中耗散的功率。$T_{J(max)} = T_S = T_A + R_{qJA} × P_S$，其中 $T_{J(max)}$ 为允许的最大结温。$P_S = I_S × V_I$，其中 VI 为最大输入电源电压。

6.9 Electrical Characteristics

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

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
INPUT						
I_{FLH}	Input forward threshold current low to High	V_{OUT} > 5 V, Cg = 1 nF	1.5	2.8	4	mA
V_F	Input Forward Voltage	I_F =10 mA	1.8	2.1	2.4	V
V_{F_HL}	Threshold input voltage High to low	V < 5 V, Cg = 1 nF	0.9			V
$\triangle V_F / \triangle T$	Temp coefficient of Input forward voltage	I_F =10 mA		1	1.35	mV/°C
V_R	Input Reverse Breakdown voltage	I_R= 10 uA	15			V
C_{IN}	Input Capacitance	F = 0.5 MHz		15		pF
OUTPUT						
I_{OH}	High Level Peak Output Current	I_F = 10 mA, V_{CC} =15V, C_{LOAD}=0.18uF, C_{VDD}=10uF, pulse width <10us	3	4.5		A
I_{OL}	Low Level Peak Output Current	V_F= 0 V, V_{CC} =15V, C_{LOAD}=0.18uF, C_{VDD}=10uF, pulse width <10us	3.5	5.3		A
V_{OH}	High Level Output Voltage	I_F = 10 mA, I_O= -20mA (with respect to VCC)	0.07	0.18	0.36	V
		I_F = 10 mA, I_O= 0 mA		VCC		V
V_{OL}	Low Level Output Voltage	V_F = 0 V, I_O= 20 mA			25	mV
I_{CC_H}	Output Supply Current (Diode On)	I_F = 10 mA, I_O= 0 mA			2.2	mA
I_{CC_L}	Output Supply Current (Diode Off)	V_F = 0 V, I_O= 0 mA			2	mA
UNDER VOLTAGE LOCKOUT, UCC23313 (12-V UVLO Version)						
$UVLO_R$	Under Voltage Lockout VCC rising	V_{CC_Rising}, I_F=10 mA	11	12.5	13.5	V
$UVLO_F$	Under Voltage Lockout VCC falling	$V_{CC\_Falling}$, I_F=10 mA	10	11.5	12.5	V
$UVLO_{HYS}$	UVLO Hysteresis			1.0		V
UNDER VOLTAGE LOCKOUT, UCC23313B (8-V UVLO Version)						
$UVLO_R$	Under Voltage Lockout VCC rising	V_{CC_Rising}, I_F=10 mA	7.8	8.5	9.2	V
$UVLO_F$	Under Voltage Lockout VCC falling	$V_{CC\_Falling}$, I_F=10 mA	7.05	7.75	8.45	V
$UVLO_{HYS}$	UVLO Hysteresis			0.75		V

6.10 开关特性

除非另有说明，否则所有典型值都是 T_A = 25°C，V_{CC}-V_{EE}= 30V，V_{EE}= GND 条件下的典型值。所有最小值和最大值规格都是建议工作条件（T_J = -40°C 至 150°C，$I_{F(ON)}$ = 7mA 至 16mA，V_{EE} = GND，V_{CC} = 15V 至 30V，$V_{F(OFF)}$ = – 5V 至 0.8V）下的规格

参数		测试条件	最小值	典型值	最大值	单位
t_r	输出信号上升时间				28	ns
t_f	输出信号下降时间	Cg = 1nF F_{SW} = 20kHz，（50% 占空比）VCC = 15V			25	ns
t_{PLH}	传播延迟，从低电平到高电平			70	105	ns
t_{PHL}	传播延迟，从高电平到低电平			70	105	ns
t_{PWD}	脉宽失真度 $\|t_{PHL} – t_{PLH}\|$				35	ns
$t_{sk(pp)}$	任何两个器件之间的器件间传播延迟偏移[1]	Cg = 1nF F_{SW} = 20kHz，（50% 占空比）VCC = 15V，I_F = 10mA			25	ns
t_{UVLO_rec}	UVLO 恢复延迟	V_{CC} 从 0V 上升到 15V		20	30	μs

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除非另有说明，否则所有典型值都是 T_A = 25°C，V_{CC}-V_{EE}= 30V，V_{EE}= GND 条件下的典型值。所有最小值和最大值规格都是建议工作条件（T_J = -40°C 至 150°C，$I_{F(ON)}$ = 7mA 至 16mA，V_{EE} = GND，V_{CC} = 15V 至 30V，$V_{F(OFF)}$ = – 5V 至 0.8V）下的规格

参数		测试条件	最小值	典型值	最大值	单位
CMTI$_H$	共模瞬态抗扰度（输出高电平）	I_F = 10mA，V_{CM} = 1500V，V_{CC} = 30V，T_A = 25ºC	150			kV/µs
CMTI$_L$	共模瞬态抗扰度（输出低电平）	V_F = 0V，V_{CM} = 1500V，V_{CC} = 30V，T_A = 25ºC	150			kV/µs

(1) $t_{sk(pp)}$ 是在特性确保的相同电源电压、温度、输入信号和负载下工作时，在相同方向上开关的不同器件输出之间的传播延迟时间差幅度。

6.11 Insulation Characteristics Curves

图 **6-1. Thermal Derating Curve for Limiting Current per VDE**

图 **6-2. Thermal Derating Curve for Limiting Power per VDE**

English Data Sheet: SLUSDS6
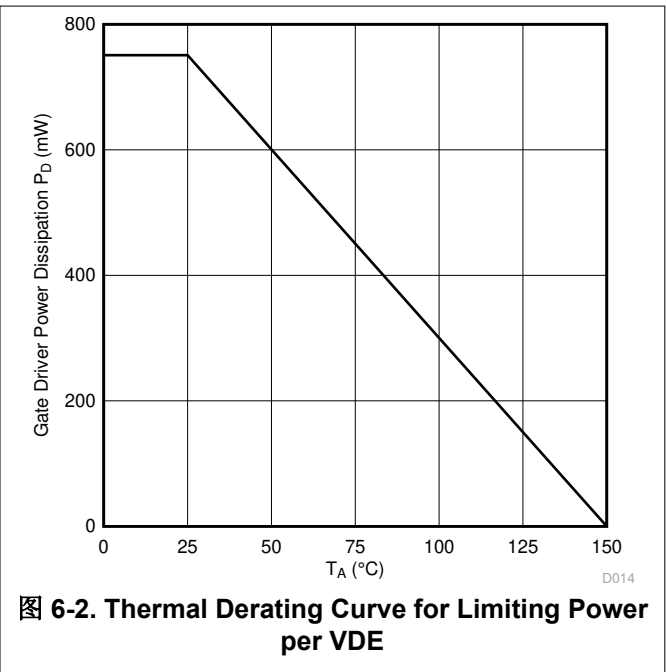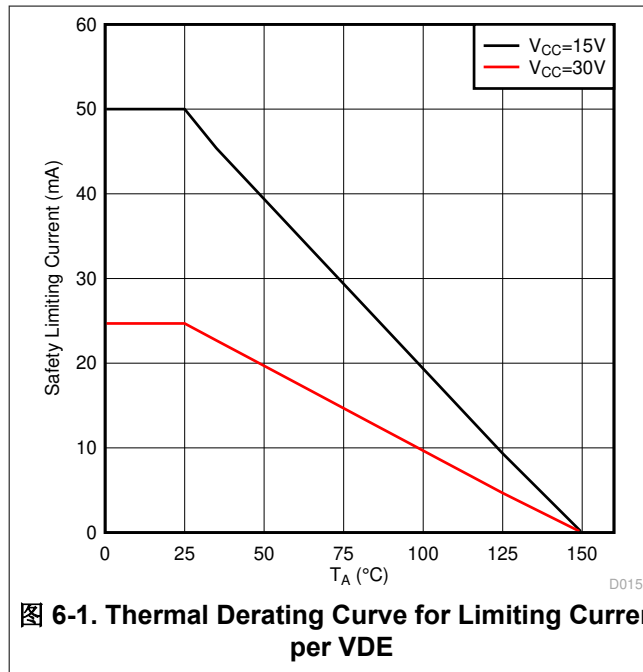
6.12 Typical Characteristics

V_{CC}= 15 V, 1-µF capacitor from V_{CC} to V_{EE}, C_{LOAD} = 1 nF for timing tests and 180nF for I_{OH} and I_{OL} tests, T_J = –40°C to +150°C, (unless otherwise noted)
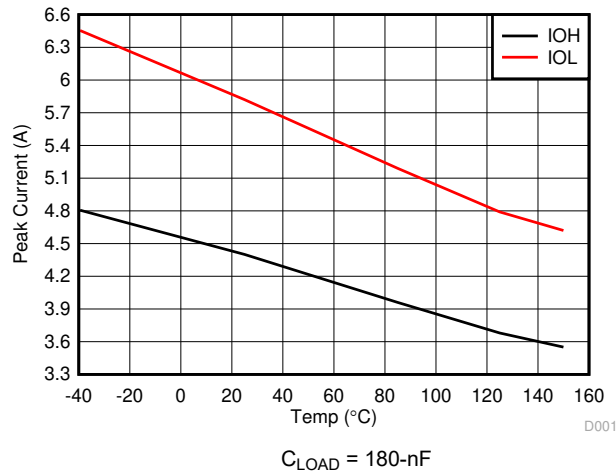
C_{LOAD} = 180-nF

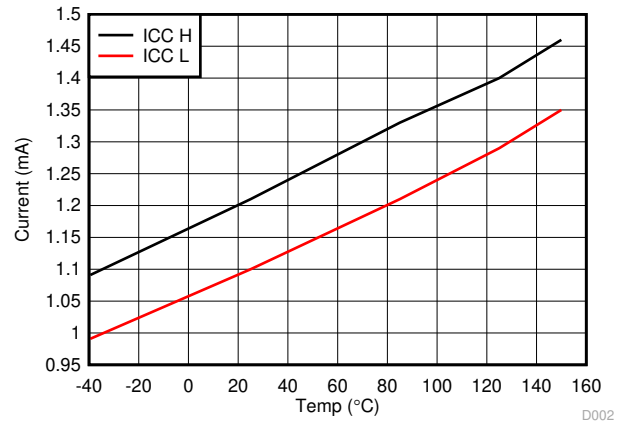图 6-3. Output Drive currents versus Temperature
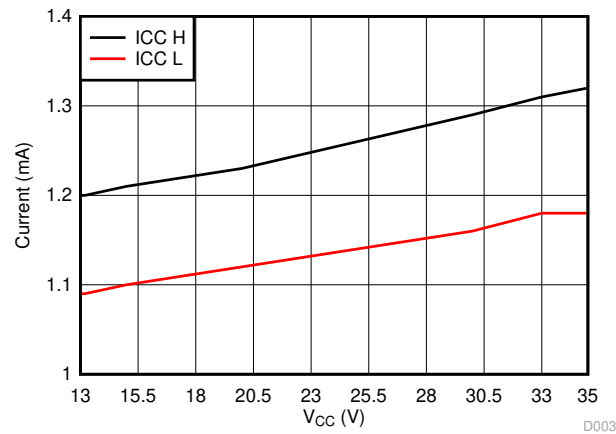
图 6-4. Supply currents versus Temperature

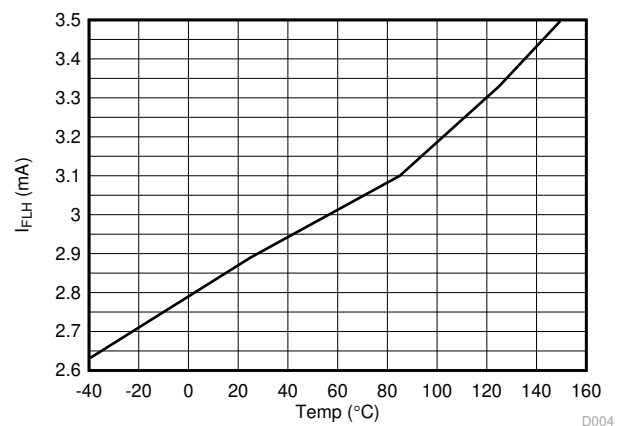图 6-5. Supply current versus Supply Voltage
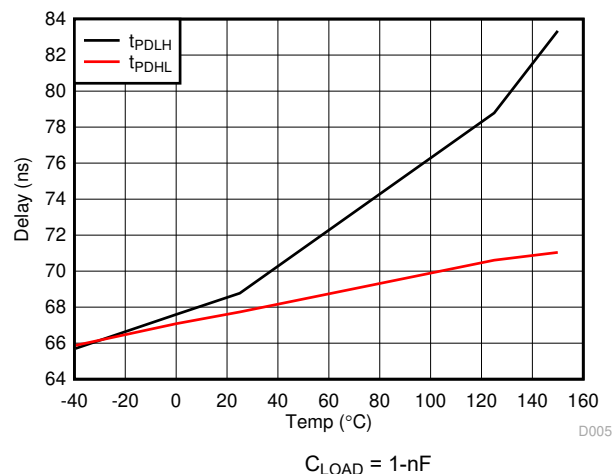
图 6-6. Forward threshold current versus Temperature

C_{LOAD} = 1-nF

图 6-7. Propagation delay versus Temperature

C_{LOAD} = 1-nF
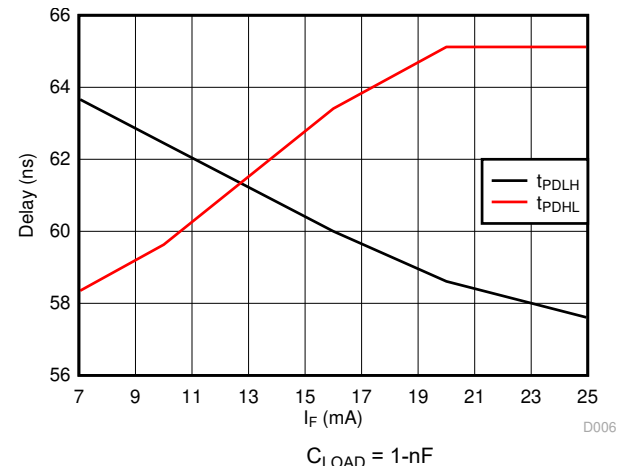
图 6-8. Propagation delay versus Forward current

English Data Sheet: SLUSDS6
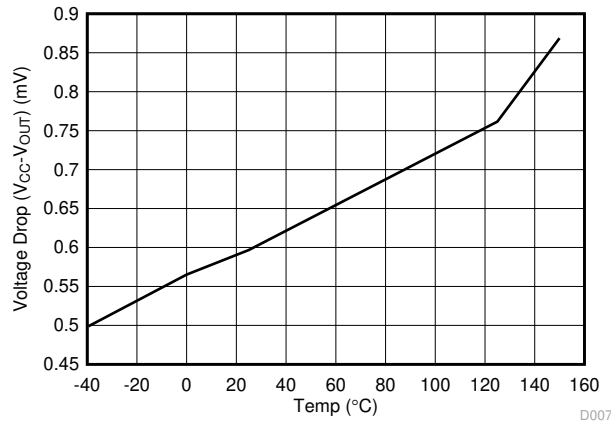
A.　　　　　　　　　　I_{OUT} = 0mA

图 6-9. V_{OH} (No Load) versus Temperature
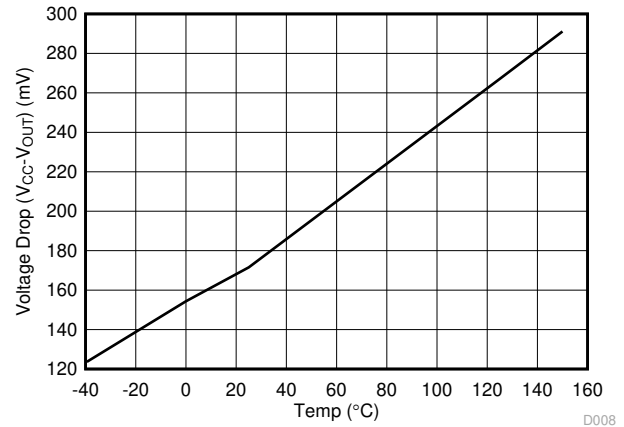
A.　　　　　　　　　　I_{OUT} = 20mA
(sourcing)

图 6-10. V_{OH} (20mA Load) versus Temperature
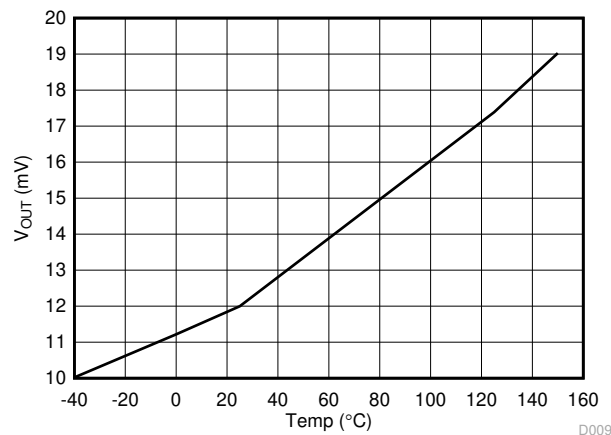
A.　　　　　　　　　　I_{OUT} = 20mA
(sinking)

图 6-11. V_{OL} versus Temperature
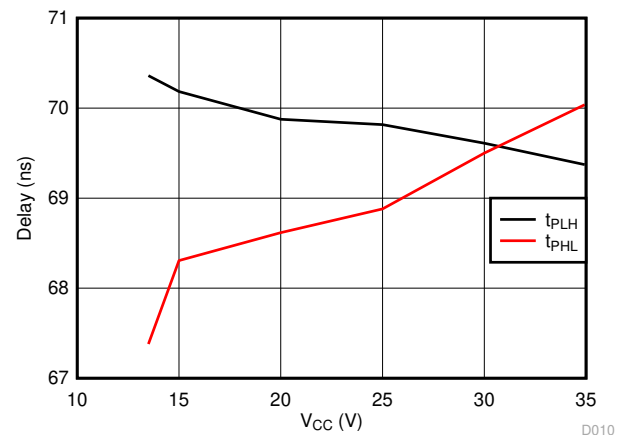
图 6-12. Propagation delay versus Supply voltage
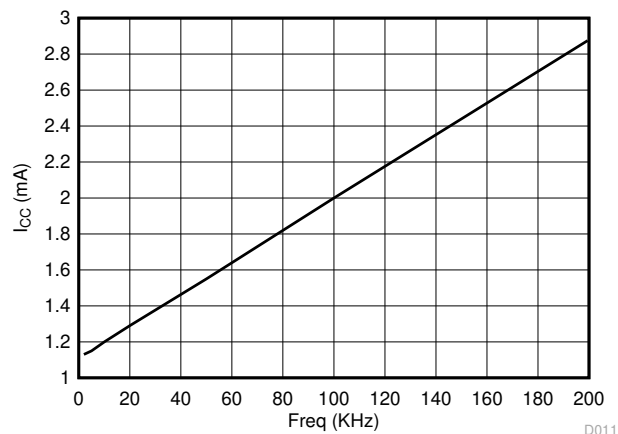
图 6-13. Supply current versus Frequency
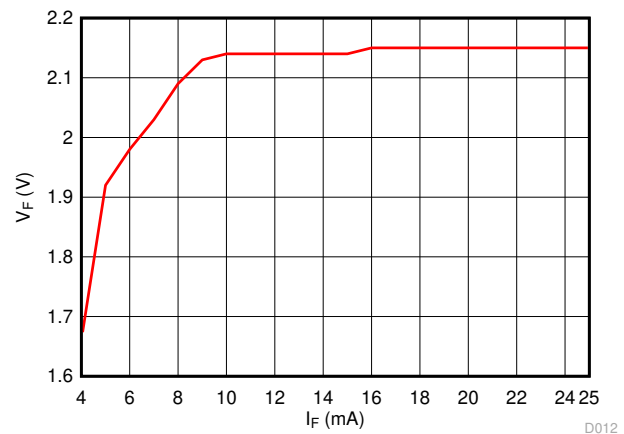
A.　　　　　　　　　　T_A = 25°C

图 6-14. Forward current versus Forward voltage drop
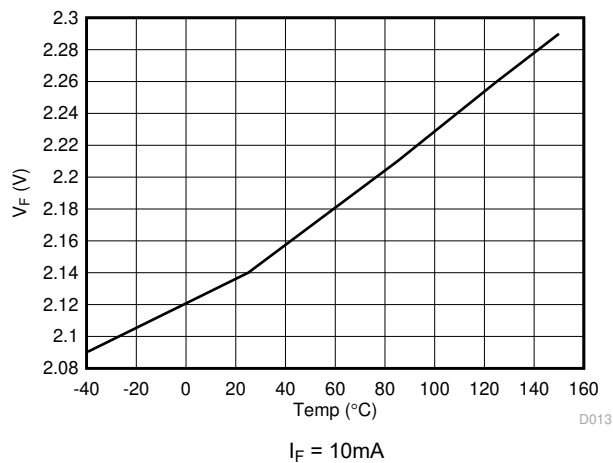
A. $I_F = 10mA$

图 **6-15. Forward voltage drop versus Temperature**

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7 Parameter Measurement Information

7.1 Propagation Delay, rise time and fall time

图 7-1 shows the propagation delay from the input forward current I_F, to V_{OUT}. This figures also shows the circuit used to measure the rise (t_r) and fall (t_f) times and the propagation delays t_{PDLH} and t_{PDHL}.
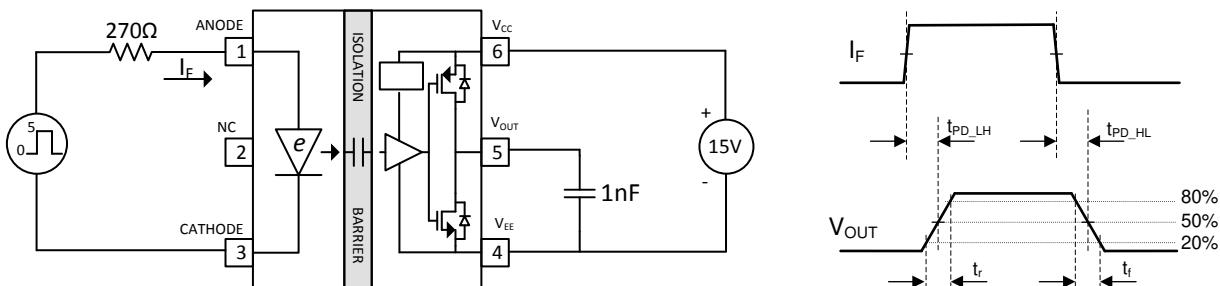
图 7-1. I_F to V_{OUT} Propagation Delay, Rise Time and Fall Time

7.2 I_{OH} and I_{OL} testing

图 7-2 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.
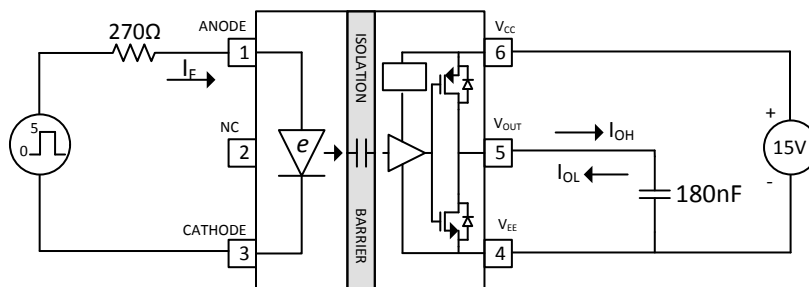
图 7-2. I_{OH} and I_{OL}

7.3 CMTI Testing

图 7-3 is the simplified diagram of the CMTI testing. Common mode voltage is set to 1500V. The test is performed with I_F = 6mA (VOUT= High) and I_F = 0mA (V_{OUT} = LOW). The diagram also shows the fail criteria for both cases. During the application on the CMTI pulse with I_F = 6mA, if V_{OUT} drops from VCC to ½VCC it is considered as a failure. With I_F= 0mA, if V_{OUT} rises above 1V, it is considered as a failure.
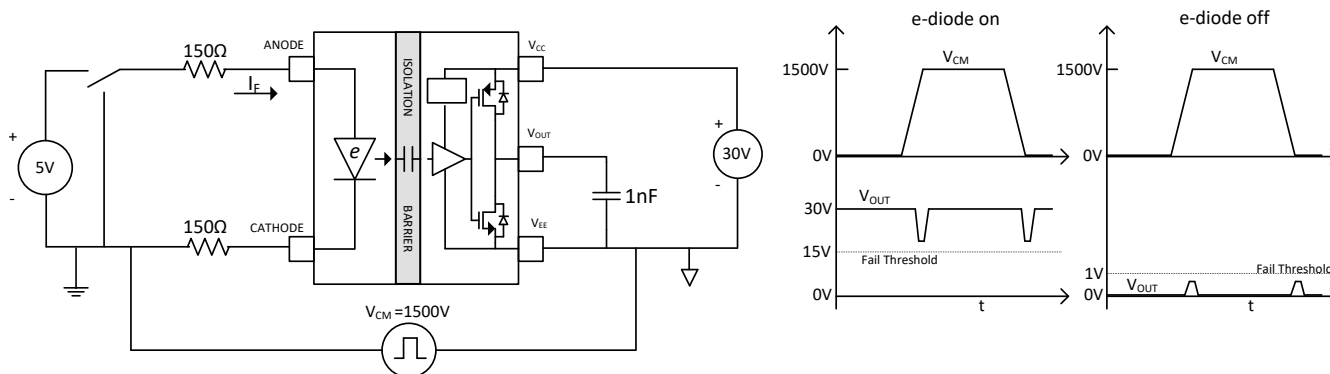
图 7-3. CMTI Test Circuit for UCC23313

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 700-V_{RMS}, 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 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.

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 8-1). 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 8-2 shows conceptual detail of how the OOK scheme works.

8.2 Functional Block Diagram
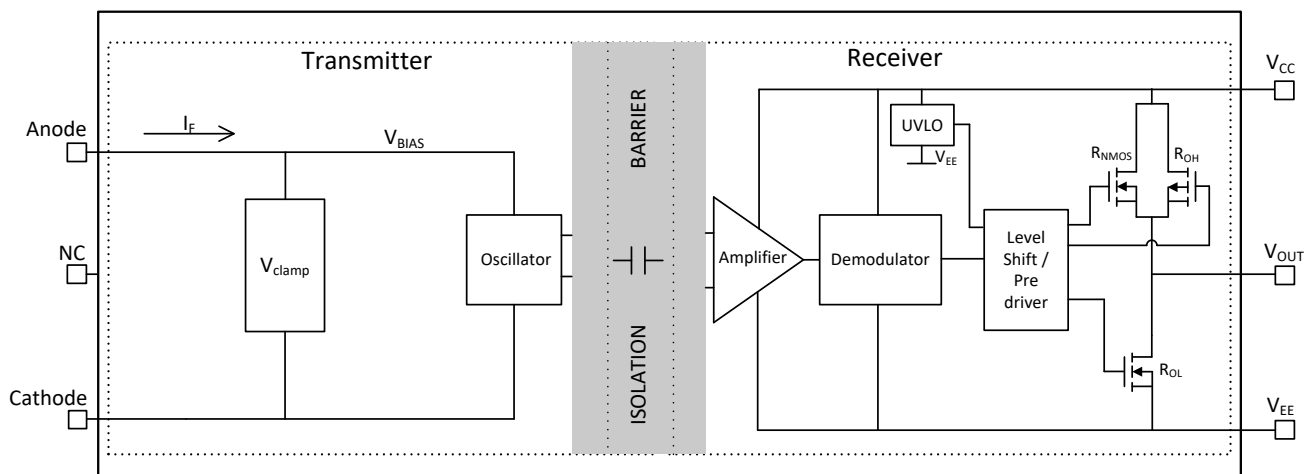
图 8-1. Conceptual Block Diagram of a Isolated Gate Driver with an Opto Emulated Input Stage (SO6 pkg)
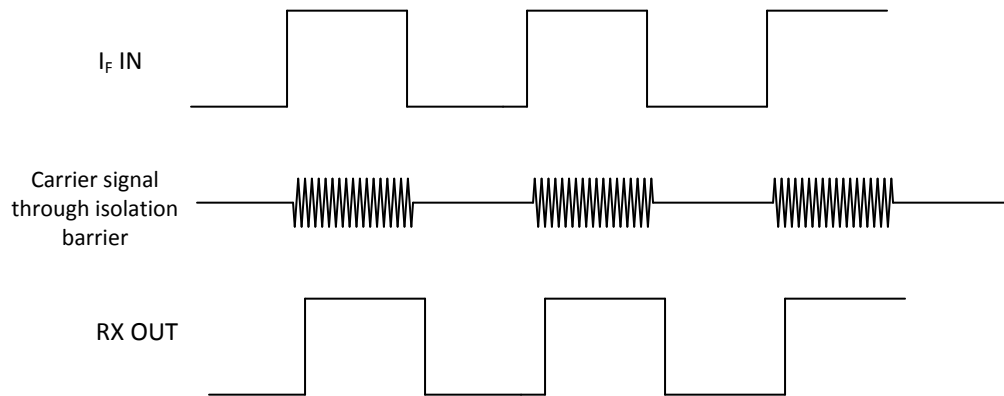
图 8-2. On-Off Keying (OOK) Based Modulation Scheme

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 10 V to 33 V. 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 节 9.2.2.1 for information on selecting the input resistor. The dynamic impedance of the e-diode is very small(<1.0Ω) and the temperature coefficient of the e-diode forward voltage drop is <1.35mV/°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 >15V. 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 8-3) 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.
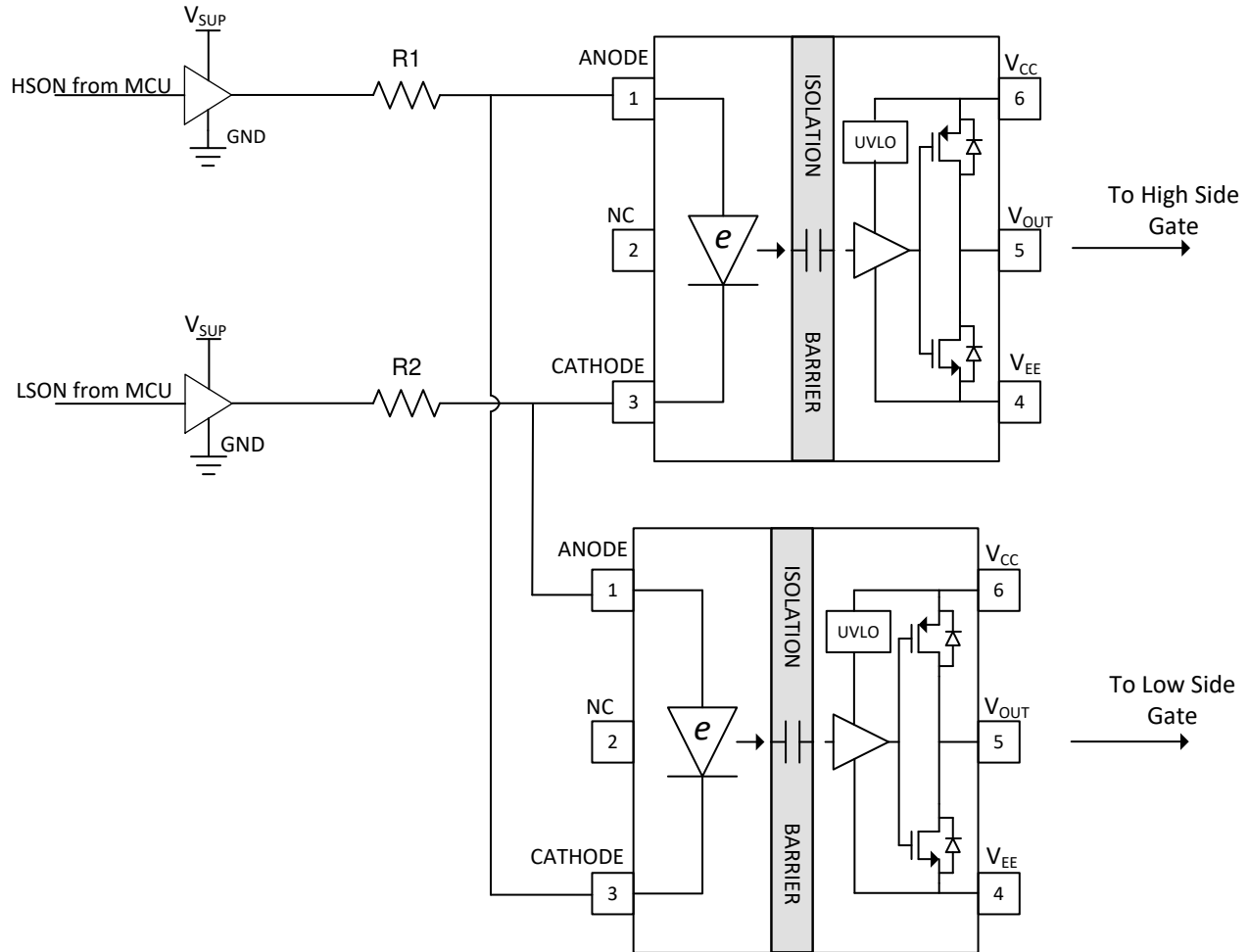
图 8-3. Interlock

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 Ω when activated.

表 8-1. 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} || 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.
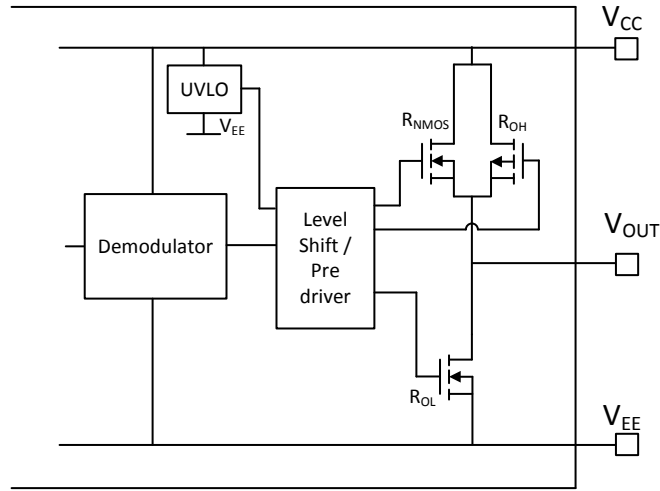
图 8-4. Output Stage

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 8-2. 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.
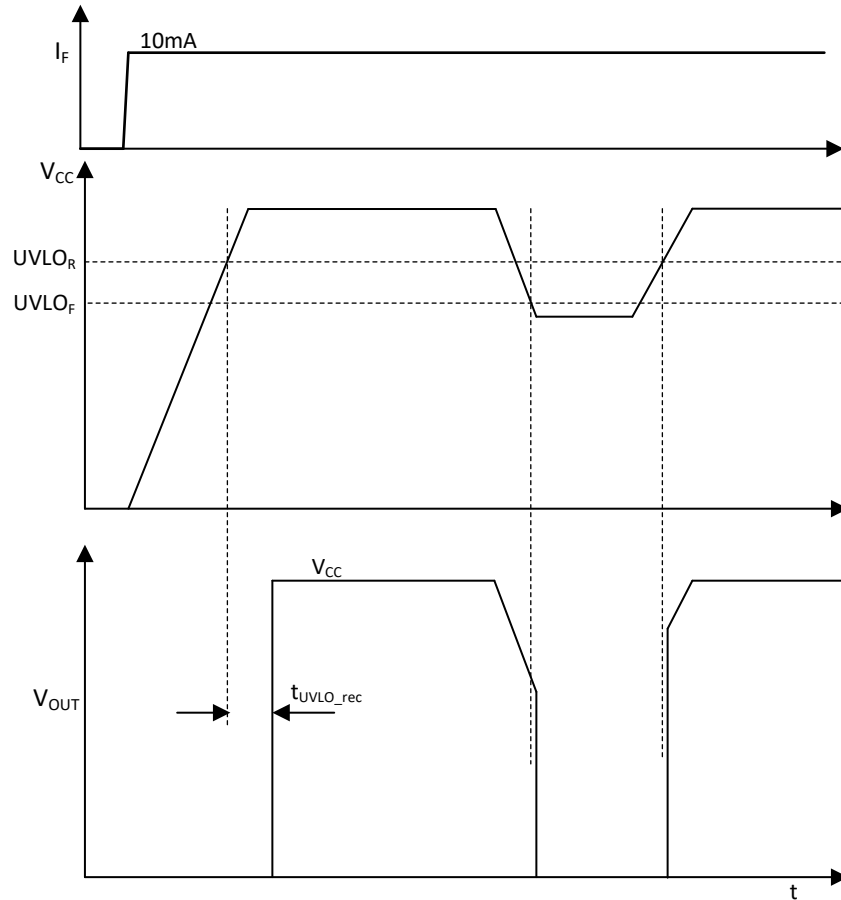
图 8-5. UVLO functionality

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 8-4) 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-kΩ 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 µs and a continuous current of 20 mA. Use external Schottky diodes to improve current conduction capability as needed.

8.4 Device Functional Modes

表 8-2 lists the functional modes for UCC23313

表 8-2. 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 8-3. 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 8-6 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.
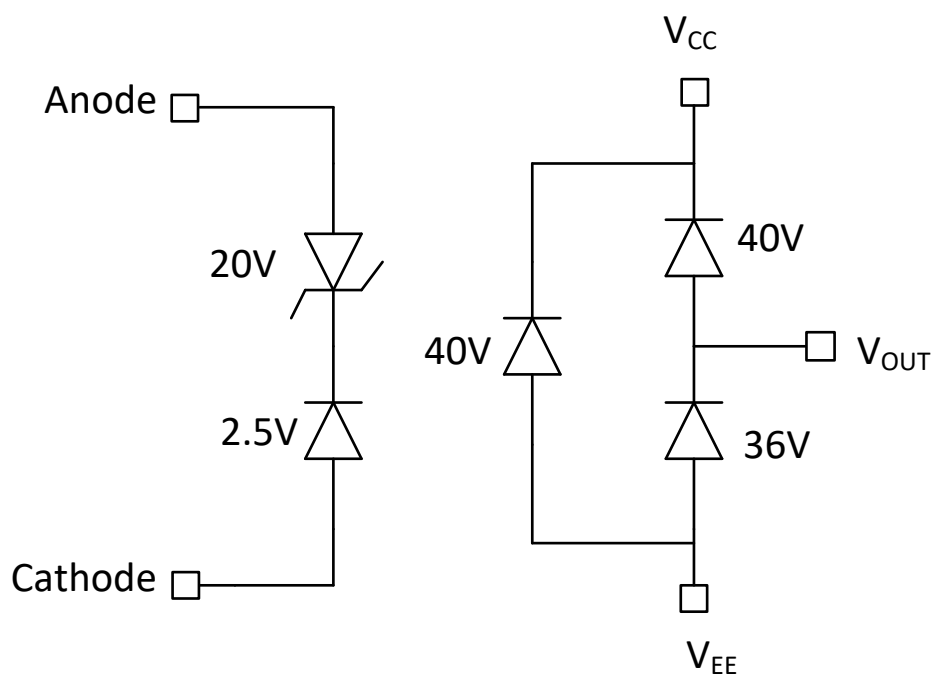
图 8-6. ESD Structure

9 Application and Implementation

备注

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

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 节 9.1. 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).

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9.2 Typical Application

The circuit in 图 9-1, shows a typical application for driving IGBTs.
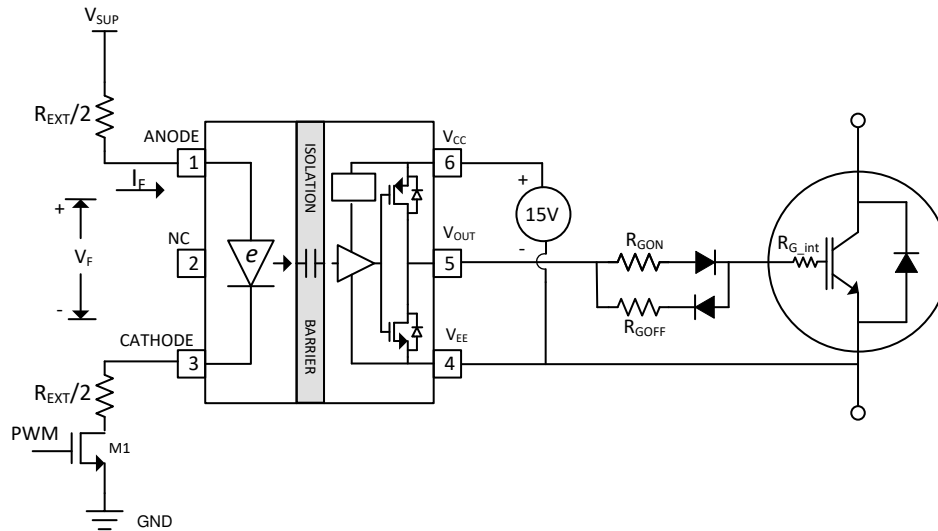

图 9-1. Typical Application Circuit for UCC23313 to Drive IGBT

9.2.1 Design Requirements

表 9-1 lists the recommended conditions to observe the input and output of the UCC23313 gate driver.

表 9-1. UCC23313 Design Requirements

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

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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 2.8 mA typ. The recommended operating range for the forward current is 7 mA to 16 mA (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 10 mA. 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=10 mA, V_F= typ 2.1 V, min 1.8 V, max 2.4 V, with a temperature coefficient < 1.35 mV/°C and dynamic impedance < 1 Ω)

See 图 9-2 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.
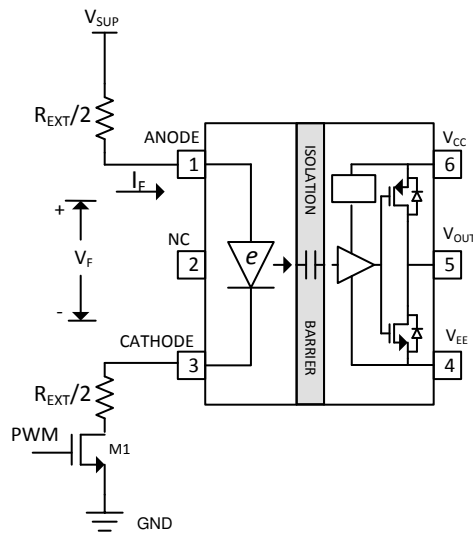
$$R_{EXT} = \frac{V_{SUP} - V_F}{I_F} - R_{M1}$$

图 9-2. 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 9-3 and using 2 buffers is shown in 图 9-4
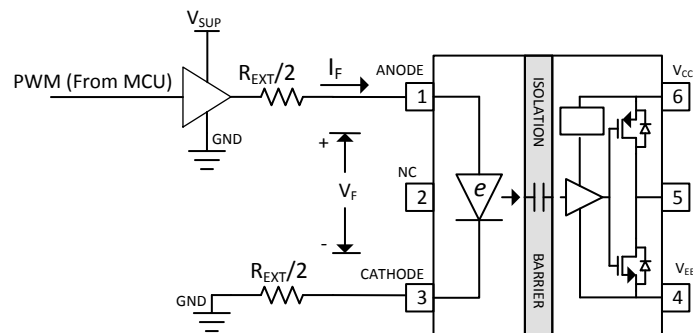
$$R_{EXT} = \frac{V_{SUP} - V_F}{I_F} - R_{OH\_buf}$$

图 9-3. 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 9-4. Configuration 3: Driving the input stage of UCC23313 with 2 buffers and split resistors

表 9-2 shows the range of values for R_{EXT} for the 3 different configurations shown in 图 9-2, 图 9-3 and 图 9-4.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 ±5% tolerance
4. Manufacturer's tolerance for R_{EXT} is 1%
5. NMOS resistance is $0.25\,\Omega$ to $1.0\,\Omega$ (for configuration 1)
6. R_{OH}(buffer output impedance in output "High" state) is $13\,\Omega$ min, $18\,\Omega$ typ and $22\,\Omega$ max
7. R_{OL}(buffer output impedance in "Low" state) is $10\,\Omega$ min, $14\,\Omega$ typ and $17\,\Omega$ max

表 9-2. R_{EXT} Values to Drive The Input Stage

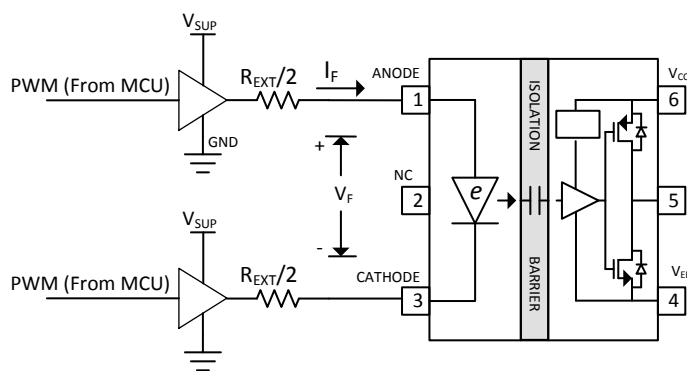| Configuration	R_{EXT} Ω		
	Min	Typ	Max
Single NMOS and R_{EXT}	218	290	331
Single Buffer and R_{EXT}	204	272	311
Two Buffers and R_{EXT}	194	259	294

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 4.5 A Use 方程式 1 to estimate the peak source current as an example.

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

(1)

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 $0\,\Omega$ for our example
- I_{OH} is the peak source current which is the minimum value between 4.5A, the gate-driver peak source current, and the calculated value based on the gate-drive loop resistance.
- V_{GDF} is the forward voltage drop for each of the diodes in series with R_{GON} and R_{GOFF}. The diode drop for this example is 0.7 V.

In this example, the peak source current is approximately 1.7A as calculated in 方程式 2.

$$I_{OH} = \min\left[4.5A, \frac{15 - 0.7}{(5.1\Omega||9.5\Omega \,+\, 5\Omega + 0\Omega)}\right] = 1.72A$$

(2)

Similarly, use 方程式 3 to calculate the peak sink current.

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

(3)

where

- R_{GOFF} is the external turnoff resistance.
- I_{OL} is the peak sink current which is the minimum value between 5.3A, the gate-driver peak sink current, and the calculated value based on the gate-drive loop resistance.

In this example, the peak sink current is the minimum of 方程式 4 and 1.38A.

$$I_{OL} = \min\left[5.3A, \frac{15 - 0.7}{(0.4\Omega \,+\, 10\Omega + 0\Omega)}\right] = 1.38A$$

(4)

The diodes shown in series with each, R_{GON} and R_{GOFF}, in 图 9-1 ensure the gate drive current flows through the intended path, respectively, during turn-on and turn-off. Note that the diode forward drop will reduce the voltage level at the gate of the power switch. To achieve rail-to-rail gate voltage levels, add a resistor from the V_{OUT} pin to the power switch gate, with a resistance value approximately 20 times higher than R_{GON} and R_{GOFF}. For the examples described in this section, a good choice is $100\,\Omega$ to $200\,\Omega$.

备注

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 方程式 5. 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 方程式 6 to calculate P_{GDQ_OUT}.

$$P_{GDQ\_IN} = \frac{1}{2} * V_F * I_F$$

(5)

$$P_{GDQ\_OUT} = V_{CC} * I_{CC}$$

(6)

The total quiescent power (without any load capacitance) dissipated in the gate driver is given by the sum of 方程式 5 and 方程式 6 as shown in 方程式 7

$$P_{GDQ} = P_{GDQ\_IN} + P_{GDQ\_OUT} = 10 \text{ mW} + 20\text{mW} = 30\text{mW}$$

(7)

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 方程式 8 to calculate the total dynamic loss from load switching, P_{GSW}.

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

(8)

where

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

So, for this example application the total dynamic loss from load switching is approximately 18 mW as calculated in 方程式 9.

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

(9)

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 4.5A/5.3A, 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:

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

(10)

In this design example, all the predicted source and sink currents are less than 4.5 A and 5.3 A, therefore, use 方程式 10 to estimate the UCC23313 gate-driver loss.

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

(11)

Case 2 - Nonlinear Pull-Up/Down Resistor:

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

(12)

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 (4.5 A at turnon and 5.3 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.

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 方程式 13 to calculate the total gate-driver loss dissipated in the UCC23313 gate driver, P_{GD}.

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

(13)

9.2.2.4 Estimating Junction Temperature

Use 方程式 14 to estimate the junction temperature (T_J) of UCC23313.

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

(14)

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.

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-μF MLCC and a 50-V, 0.22-μF 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 μF should be used in parallel with C_{VCC}.

备注

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

English Data Sheet: SLUSDS6

10 Power Supply Recommendations

The recommended input supply voltage (V_{CC}) for the UCC23313 device is from 10 V or 14 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 μs 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-μF 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.

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English Data Sheet: SLUSDS6

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 11-1 shows a PCB layout example with the signals and key components labeled.

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

图 11-1. Layout Example

图 11-2 and 图 11-3 show the top and bottom layer traces and copper.
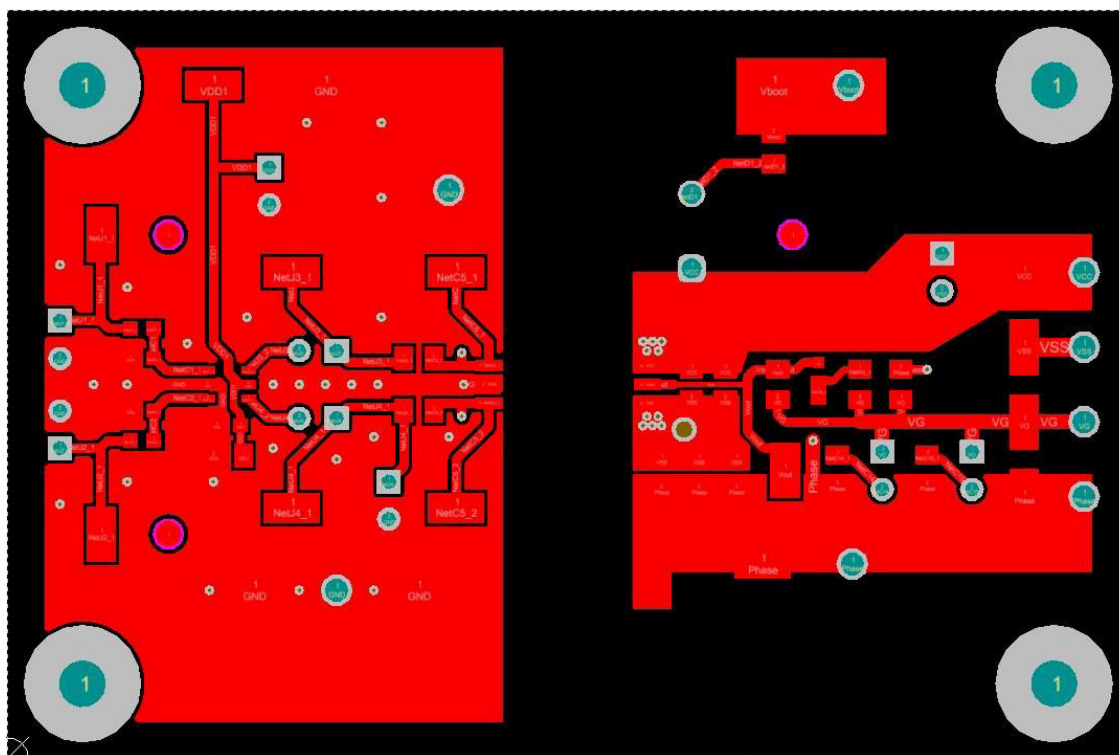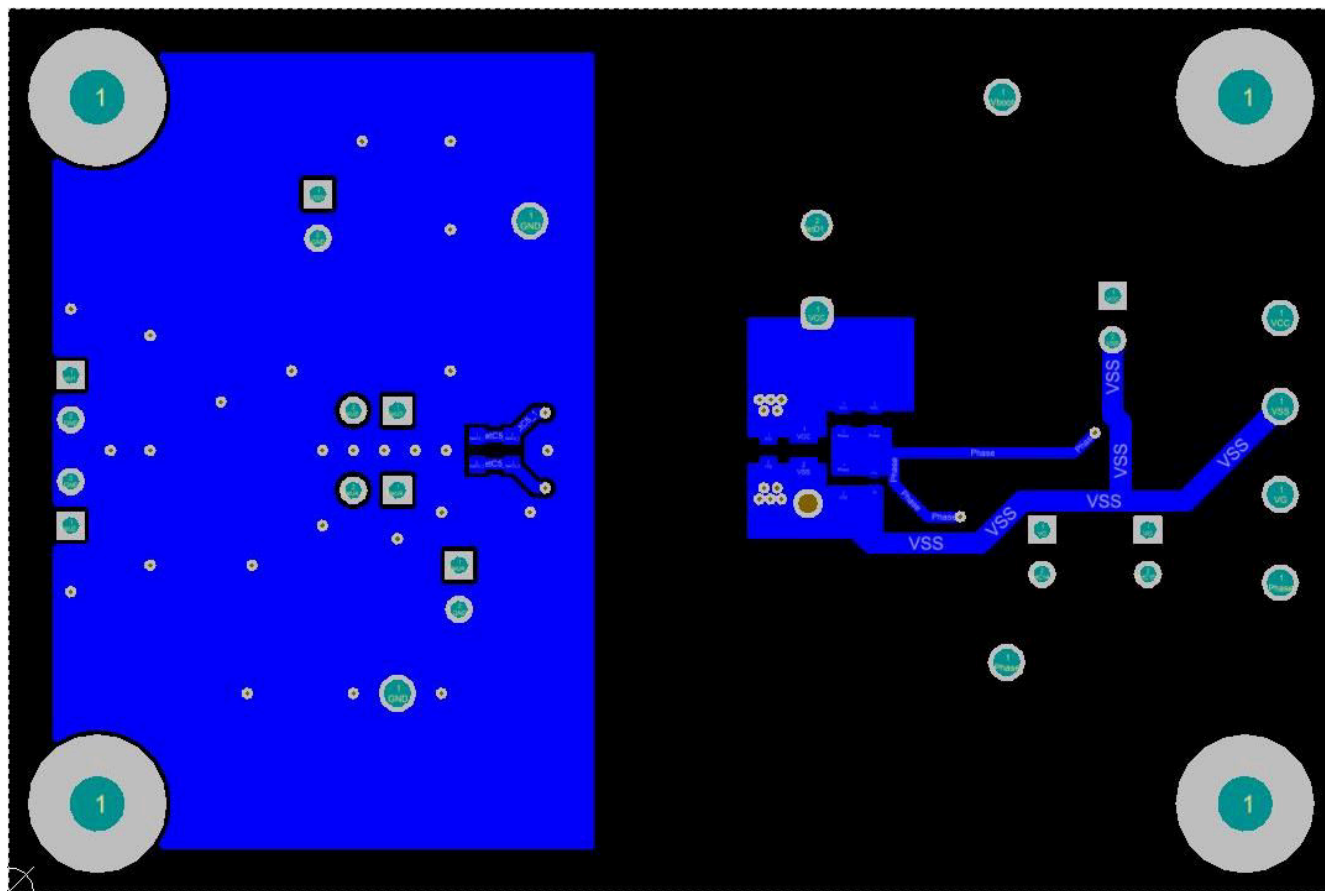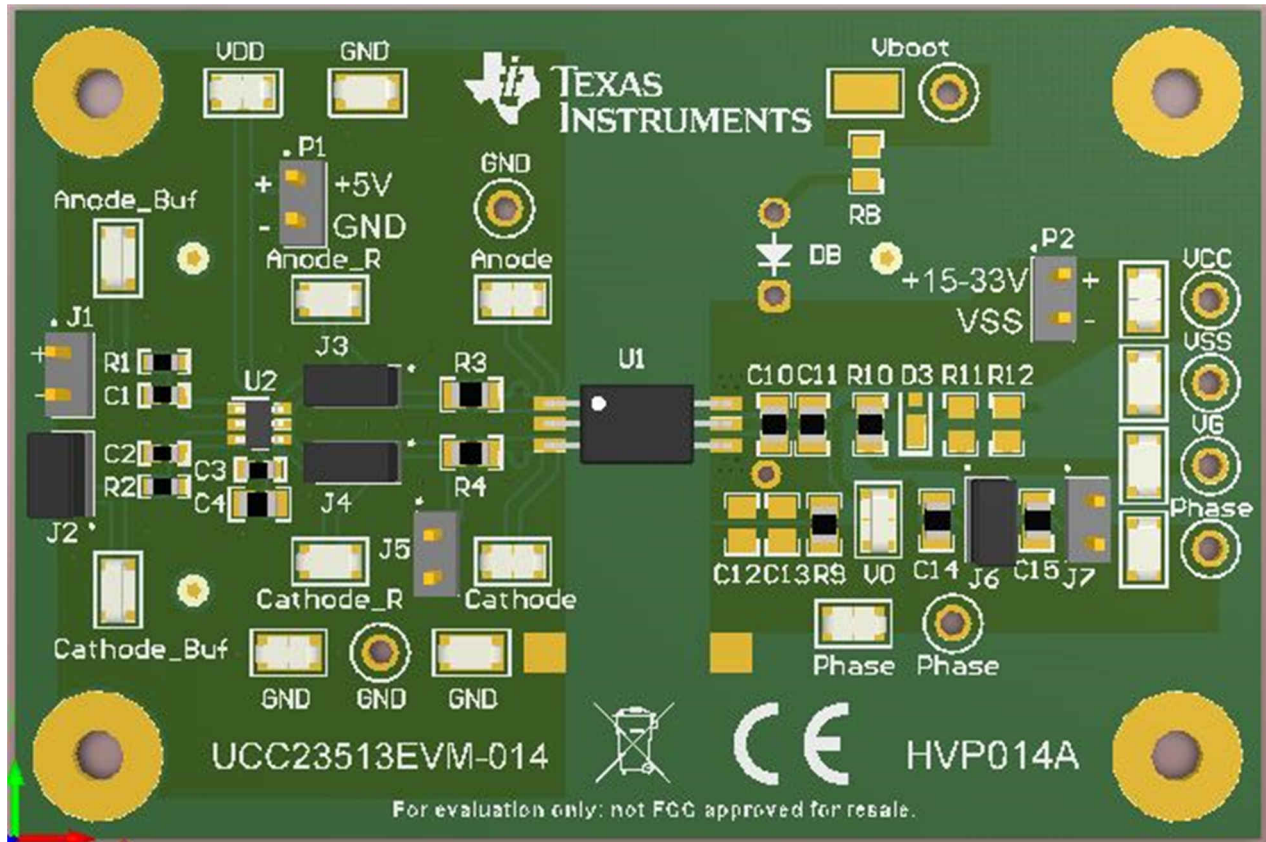
English Data Sheet: SLUSDS6

图 **11-2. Top-Layer Traces and Copper**

图 11-3. Bottom-Layer Traces and Copper (Flipped)

图 11-4 shows the 3D layout of the top view of the PCB.

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

图 **11-4. 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 Mechanical, Packaging, and Orderable Information

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

PACKAGING INFORMATION

Orderable part number	Status (1)	Material type (2)	Package | Pins	Package qty | Carrier	RoHS (3)	Lead finish/ Ball material (4)	MSL rating/ Peak reflow (5)	Op temp (°C)	Part marking (6)
UCC23313BDWY	Obsolete	Production	SOIC (DWY) | 6	-	-	Call TI	Call TI	-40 to 125	UC23313B
UCC23313BDWYR	Active	Production	SOIC (DWY) | 6	850 | LARGE T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	UC23313B
UCC23313BDWYR.A	Active	Production	SOIC (DWY) | 6	850 | LARGE T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	UC23313B
UCC23313BDWYR.B	Active	Production	SOIC (DWY) | 6	850 | LARGE T&R	-	Call TI	Call TI	-40 to 125	
UCC23313DWY	Obsolete	Production	SOIC (DWY) | 6	-	-	Call TI	Call TI	-40 to 125	UCC23313
UCC23313DWYR	Active	Production	SOIC (DWY) | 6	850 | LARGE T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	UCC23313
UCC23313DWYR.A	Active	Production	SOIC (DWY) | 6	850 | LARGE T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	UCC23313
UCC23313DWYR.B	Active	Production	SOIC (DWY) | 6	850 | LARGE T&R	-	Call TI	Call TI	-40 to 125	

(1) Status: For more details on status, see our product life cycle.

(2) Material type: When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

(3) RoHS values: Yes, No, RoHS Exempt. See the TI RoHS Statement for additional information and value definition.

(4) Lead finish/Ball material: Parts 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.

(5) MSL rating/Peak reflow: The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

(6) Part marking: There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

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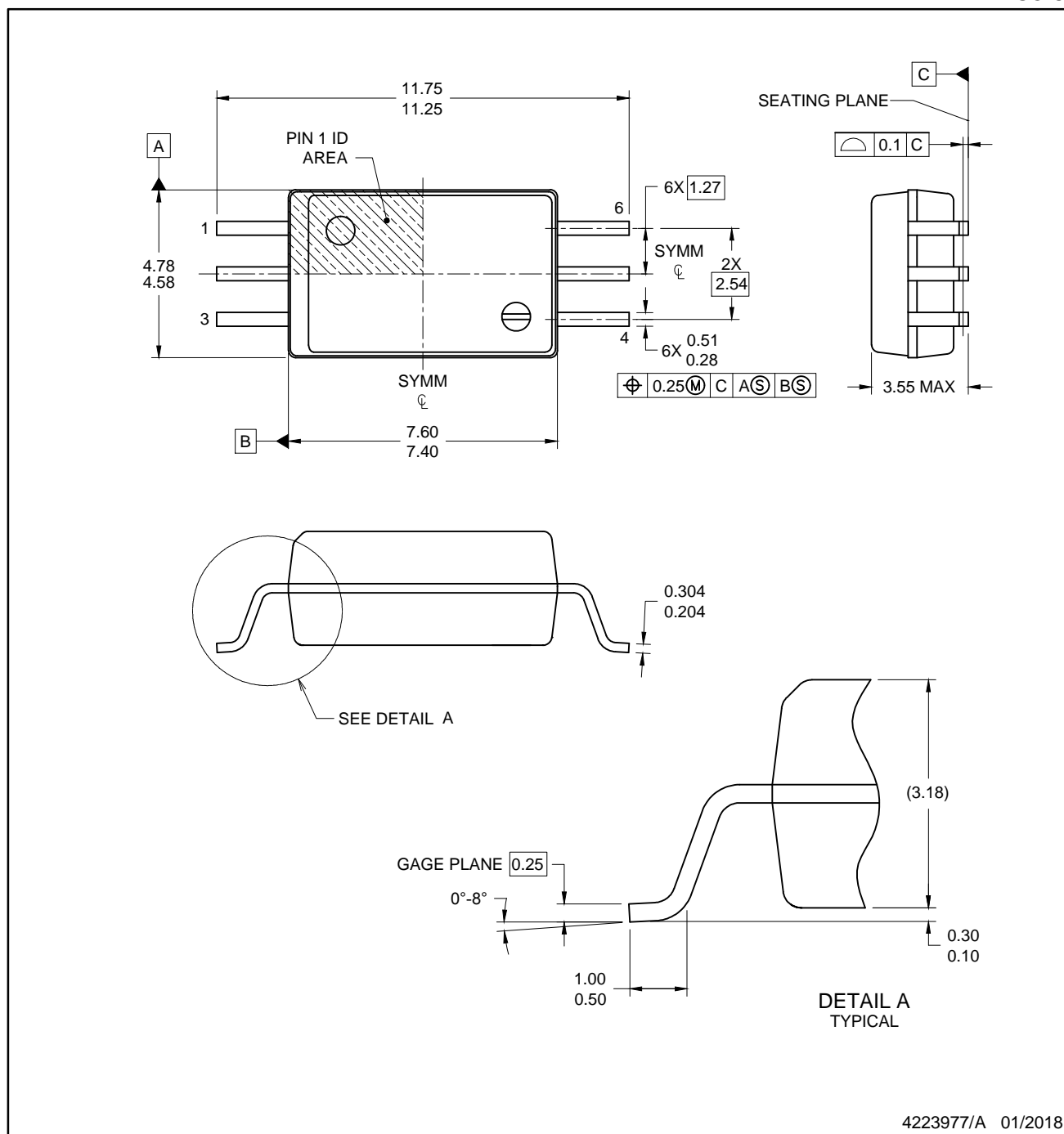
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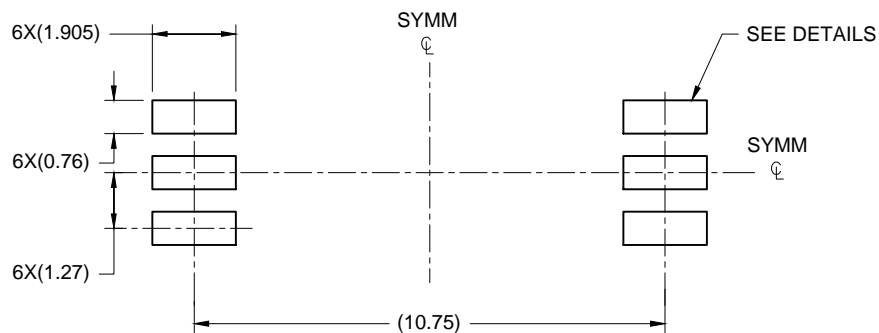**OTHER QUALIFIED VERSIONS OF UCC23313 :**

● Automotive : UCC23313-Q1

NOTE: Qualified Version Definitions:

● Automotive - Q100 devices qualified for high-reliability automotive applications targeting zero defects

SEATING PLANE

C

⌀ 0.1 C

11.75
11.25

PIN 1 ID
AREA

A

1

6

6X 1.27

SYMM
℄

2X
2.54

4.78
4.58

3

4

6X 0.51
0.28

SYMM
℄

⊕ 0.25Ⓜ C AⓈ BⓈ

3.55 MAX

B

7.60
7.40

SEE DETAIL A

0.304
0.204

GAGE PLANE 0.25

0°-8°

(3.18)

0.30
0.10

1.00
0.50

DETAIL A
TYPICAL

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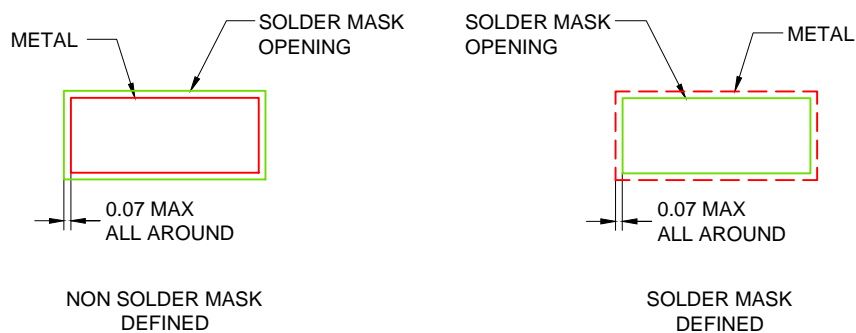
NOTES:

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.

SOIC

6X(1.905)

SYMM

SEE DETAILS

6X(0.76)

SYMM

6X(1.27)

(10.75)

LAND PATTERN EXAMPLE
SCALE:6X

METAL

SOLDER MASK
OPENING

SOLDER MASK
OPENING

METAL

0.07 MAX
ALL AROUND

0.07 MAX
ALL AROUND

NON SOLDER MASK
DEFINED

SOLDER MASK
DEFINED

SOLDER MASK DETAAILS
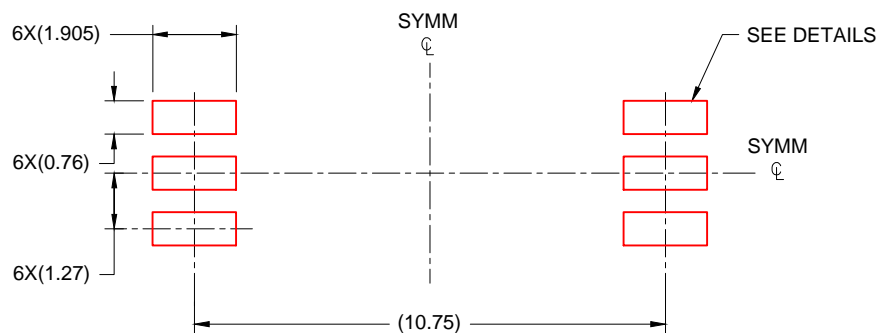
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NOTES: (continued)

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

6X(1.905)

SYMM

SEE DETAILS

SYMM

6X(0.76)

6X(1.27)

(10.75)

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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