TEXAS INSTRUMENTS
ISO5452-Q1
JAJSCI8 – SEPTEMBER 2016

ISO5452-Q1 高CMTI 2.5A/5A絶縁型IGBT、MOSFETゲート・ドライバ、分割出力およびアクティブ安全機能搭載

1 特長

- 車載アプリケーションに対応
- 下記内容でAEC-Q100認定済み：
  - デバイス温度グレード 1: 動作時周囲温度 –40℃～125℃ 範囲
  - デバイスHBM分類レベル3A
  - デバイスCDM分類レベルC6
- 同相過渡耐圧(CMTI): 50kV/µs (最小値)、100kV/µs (標準値)
  (V_{CM} = 1500V)
- 分割出力により2.5Aのピーク・ソースおよび5Aのピーク・シンク電流を供給
- 短い伝搬遅延: 76ns (標準値)、110ns (最大値)
- 2Aのアクティブ・ミラー・クランプ
- 出力短絡クランプ
- 短絡時のソフト電源オフ(STO)機能
- 不飽和化検出時のフォルト・アラームは$\overline{FLT}$により通知され、$\overline{RST}$によりリセット
- 入出力低電圧誤動作防止(UVLO)、レディ(RDY)ピンによる標示付き
- 低電源またはフローティング入力時のアクティブ出力プルダウンおよびデフォルトLOW出力
- 入力電源電圧: 2.25V～5.5V
- 出力ドライバ供給電圧: 15V～30V
- CMOS互換の入力
- 20ns未満の入力パルスと過渡ノイズを除去
- 絶縁サージ耐久電圧: 10000V_{PK}
- 安全性および規制の認定
  - 8000V_{PK} V_{IOTM}および1420V_{PK} V_{IORM}の、DIN V VDE V 0884-10 (VDE V 0884-10):2006-12準拠の強化絶縁
  - UL1577準拠で5700V_{RMS}において1分間の絶縁
  - CSA Component Acceptance Notice 5A、IEC-60950-1、およびIEC 60601-1最終機器標準
  - EN 61010-1およびEN 60950-1準拠のTUV認定
  - GB4943.1-2011 CQC認定
  - UL、VDE、CQC、TUV準拠の認定は完了、CSAは計画中

2 アプリケーション

- 次のような用途の絶縁IGBTおよびMOSFETドライブ:
  - HEVおよびEVの電源モジュール
  - 産業用モータ制御ドライブ
  - 産業用電源
  - ソーラー・インバータ
  - 誘導加熱

3 概要

ISO5452-Q1デバイスは、5.7kV_{RMS}、IGBTおよびMOSFET用の強化絶縁ゲート・ドライバで、分割出力のOUTHとOUTLがあり、2.5Aのソース電流と5Aのシンク電流を供給できます。入力側は、単一の2.25V～5.5V電源で動作します。出力側は、最低15V、最高30Vの電源を供給できます。

2つの相補CMOS入力により、ゲート・ドライバの出力状態が制御されます。伝搬時間が76nsと短いため、出力ステージを正確に制御できます。

内部不飽和化(DESAT)フォルト検出により、IGBTが過電流状況にあることが認識されます。DESATが検出されると、ミュート・ロジックによりアイソレータの出力がただちにブロックされ、ソフト電源オフ手順が開始されて、OUTHピンがディセーブルされ、OUTLピンが2µsの間LOWになります。

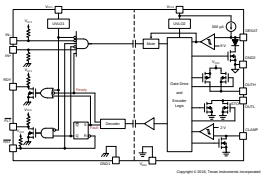
OUTLピンが、負の方向に最も大きい供給電圧であるV_{EE2}との比較で2Vに達すると、ゲート・ドライバ出力がV_{EE2}の電位に強制的に設定され、IGBTはただちにオフになります。

製品情報(1)

型番	パッケージ	本体サイズ(公称)
ISO5452-Q1	SOIC (16)	10.30mm×7.50mm

(1) 提供されているすべてのパッケージについては、巻末の注文情報を参照してください。

機能ブロック図



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4 改訂履歴

日付	改訂内容	注
2016年9月	*	初版

5 概要（続き）

不飽和化がアクティブのとき、絶縁バリアを通してフォルト信号が送信され、入力側の$\overline{\text{FLT}}$出力がLOWになって、アイソレータ入力がブロックされます。ソフト電源オフ期間の間は、ミュート・ロジックがアクティブになります。$\overline{\text{FLT}}$出力状況はラッチされ、RDYピンがHIGHに移行した後でのみ、$\overline{\text{RST}}$入力のLOWアクティブ・パルスを使用してリセット可能です。

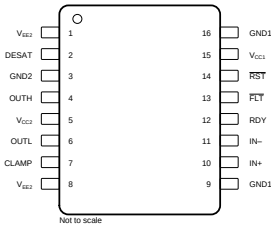
バイポーラ電源による通常動作時にIGBTがオフになると、出力はV_{EE2}にハード・クランプされます。出力電源がユニポーラの場合、アクティブなミラー・クランプを使用でき、低インピーダンスのパスを通してミラー電流をシンクできるため、高電圧の過渡状況でIGBTが動的にオンになることが防止されます。

ゲート・ドライバの動作準備は、入力側と出力側の電源を監視する2つの低電圧誤動作防止回路により制御されます。いずれかの側の電源が不十分な場合はRDY出力がLOWになり、そうでない場合はこの出力がHIGHになります。

ISO5452-Q1は、16ピンのSOICパッケージで供給されます。デバイスの動作は、-40℃～125℃の周囲温度範囲について規定されています。

6 Pin Configuration and Function

DW Package
16-Pin SOIC
Top View



Pin Functions

PIN		I/O	DESCRIPTION
NAME	NO.		
V_{EE2}	1, 8	-	Output negative supply. Connect to GND2 for Unipolar supply application.
DESAT	2	I	Desaturation voltage input
GND2	3	-	Gate drive common. Connect to IGBT emitter.
OUTH	4	O	Positive gate drive voltage output
V_{CC2}	5	-	Most positive output supply potential.
OUTL	6	O	Negative gate drive voltage output
CLAMP	7	O	Miller clamp output
GND1	9, 16	-	Input ground
IN+	10	I	Non-inverting gate drive voltage control input
IN-	11	I	Inverting gate drive voltage control input
RDY	12	O	Power-good output, active high when both supplies are good.
$\overline{\text{FLT}}$	13	O	Fault output, low-active during DESAT condition
$\overline{\text{RST}}$	14	I	Reset input, apply a low pulse to reset fault latch.
V_{CC1}	15	-	Positive input supply (2.25 V to 5.5 V)

7 Specifications

7.1 Absolute Maximum Ratings(1)

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

			MIN	MAX	UNIT
V_{CC1}	Supply voltage input side		GND1 - 0.3	6	V
V_{CC2}	Positive supply voltage output side	(V_{CC2} – GND2)	–0.3	35	V
V_{EE2}	Negative supply voltage output side	(V_{EE2} – GND2)	–17.5	0.3	V
$V_{(SUP2)}$	Total supply output voltage	(V_{CC2} - V_{EE2})	–0.3	35	V
$V_{(OUTH)}$	Positive gate driver output voltage		V_{EE2} - 0.3	V_{CC2} + 0.3	V
$V_{(OUTL)}$	Negative gate driver output voltage		V_{EE2} - 0.3	V_{CC2} + 0.3	V
$I_{(OUTH)}$	Gate driver high output current	Gate driver high output current (max pulse width = 10 μs, max duty cycle = 0.2%)		2.7	A
$I_{(OUTL)}$	Gate driver low output current			5.5	A
$V_{(LIP)}$	Voltage at IN+, IN-, $\overline{FLT}$, RDY, $\overline{RST}$		GND1 - 0.3	V_{CC1} + 0.3	V
$I_{(LOP)}$	Output current of $\overline{FLT}$, RDY			10	mA
$V_{(DESAT)}$	Voltage at DESAT		GND2 - 0.3	V_{CC2} + 0.3	V
$V_{(CLAMP)}$	Clamp voltage		V_{EE2} - 0.3	V_{CC2} + 0.3	V
T_J	Junction temperature		–40	150	°C
T_{STG}	Storage temperature		-65	150	°C

(1) Stresses beyond those listed under absolute maximum ratings may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any conditions beyond those indicated under recommended operating conditions is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability

7.2 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.

7.3 Recommended Operating Conditions

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

		MIN	NOM	MAX	UNIT
V_{CC1}	Supply voltage input side	2.25		5.5	V
V_{CC2}	Positive supply voltage output side (V_{CC2} – GND2)	15		30	V
V_{EE2}	Negative supply voltage output side (V_{EE2} – GND2)	–15		0	V
$V_{(SUP2)}$	Total supply voltage output side (V_{CC2} – V_{EE2})	15		30	V
V_{IH}	High-level input voltage (IN+, IN-, $\overline{RST}$)	0.7 x V_{CC1}		V_{CC1}	V
V_{IL}	Low-level input voltage (IN+, IN-, $\overline{RST}$)	0		0.3 x V_{CC1}	V
t_{UI}	Pulse width at IN+, IN- for full output (C_{LOAD} = 1nF)	40			ns
t_{RST}	Pulse width at $\overline{RST}$ for resetting fault latch	800			ns
T_A	Ambient temperature	-40		125	°C

7.4 Thermal Information

THERMAL METRIC(1)		DW (SOIC) 16 PINS	UNIT
$R_{\theta JA}$	Junction-to-ambient thermal resistance	99.6	°C/W
$R_{\theta JC(top)}$	Junction-to-case (top) thermal resistance	48.5	
$R_{\theta JB}$	Junction-to-board thermal resistance	56.5	
ψ_{JT}	Junction-to-top characterization parameter	29.2	
ψ_{JB}	Junction-to-board characterization parameter	56.5	

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

7.5 Power Rating

			VALUE	UNIT
P_D	Maximum power dissipation(1)	V_{CC1} = 5.5-V, V_{CC2} = 30-V, T_A = 25°C	1255	mW
P_{ID}	Maximum Input power dissipation	V_{CC1} = 5.5-V, V_{CC2} = 30-V, T_A = 25°C	175	
P_{OD}	Maximum Output power dissipation	V_{CC1} = 5.5-V, V_{CC2} = 30-V, T_A = 25°C	1080	

(1) Full chip power dissipation is de-rated 10.04 mW/°C beyond 25°C ambient temperature. At 125°C ambient temperature, a maximum of 251 mW total power dissipation is allowed. Power dissipation can be optimized depending on ambient temperature and board design, while ensuring that Junction temperature does not exceed 150°C.

7.6 Insulation Characteristics

PARAMETER		TEST CONDITIONS	SPECIFICATION	UNIT
CLR	External clearance(1)	Shortest terminal-to-terminal distance through air	>8	mm
CPG	External creepage(1)	Shortest terminal-to-terminal distance across the package surface	>8	mm
DTI	Distance through the insulation	Minimum internal gap (internal clearance)	>21	µm
CTI	Tracking resistance (comparative tracking index)	DIN EN 60112 (VDE 0303-11); IEC 60112;	>600	V
	Material Group	According to IEC 60664-1; UL 746A	I	
	Overvoltage category (according to IEC 60664-1)	Rated Mains Voltage ≤ 300 V_{RMS}	I-IV	
		Rated Mains Voltage ≤ 600 V_{RMS}	I-III	
		Rated Mains Voltage ≤ 1000 V_{RMS}	I-II	
DIN V VDE V 0884-10 (VDE V 0884-10):2006-12(2)				
V_{IORM}	Maximum repetitive peak isolation voltage	AC voltage (bipolar)	1420	V_{PK}
V_{IOWM}	Maximum isolation working voltage	AC voltage. Time dependent dielectric breakdown (TDDB) Test, see Figure 1	1000	V_{RMS}
		DC voltage	1420	V_{DC}
V_{IOTM}	Maximum Transient isolation voltage	V_{TEST} = V_{IOTM}, t = 60 sec (qualification), t = 1 sec (100% production)	8000	V_{PK}
V_{IOSM}	Maximum surge isolation voltage(3)	Test method per IEC 60065, 1.2/50 µs waveform, V_{TEST} = 1.6 x V_{IOSM} = 10000 V_{PK} (qualification)(3)	6250	
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 × V_{IORM} = 1704 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} = 2272 V_{PK} , t_m = 10 s	≤5	
		Method b1: At routine test (100% production) and preconditioning (type test) V_{ini} = V_{IOTM}, t_{ini} = 60 s; $V_{pd(m)}$ = 1.875× V_{IORM} = 2663 V_{PK} , t_m = 10 s	≤5	
R_{IO}	Isolation resistance, input to output(5)	V_{IO} = 500 V, T_A = 25°C	> 10^{12}	Ω
		V_{IO} = 500 V, 100°C ≤ T_A ≤ 125°C	> 10^{11}	Ω
		V_{IO} = 500 V at T_S = 150°C	> 10^9	Ω
C_{IO}	Barrier capacitance, input to output(5)	V_{IO} = 0.4 x sin (2πft), f = 1 MHz	1	pF
	Pollution degree		2	
UL 1577				
V_{ISO}	Withstanding Isolation voltage	V_{TEST} = V_{ISO}, t = 60 sec (qualification), V_{TEST} = 1.2 × V_{ISO} = 6840 V_{RMS}, t = 1 sec (100% production)	5700	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 and/or ribs on a printed circuit board are used to help increase these specifications.
(2) This coupler is suitable for basic electrical insulation only within the maximum operating 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-terminal device

7.7 Safety Limiting Values

Safety limiting intends to prevent potential damage to the isolation barrier upon failure of input or output circuitry. A failure of the I/O can allow low resistance to ground or the supply and, without current limiting, dissipate sufficient power to overheat the die and damage the isolation barrier, potentially leading to secondary system failures.

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
I_S	Safety input, output or supply current	θ_{JA} = 99.6°C/W, V_I = 2.75 V, T_J = 150°C, T_A = 25°C			456	mA
		θ_{JA} = 99.6°C/W, V_I = 3.6 V, T_J = 150°C, T_A = 25°C			346	
		θ_{JA} = 99.6°C/W, V_I = 5.5 V, T_J = 150°C, T_A = 25°C			228	
		θ_{JA} = 99.6°C/W, V_I = 15 V, T_J = 150°C, T_A = 25°C			484	
		θ_{JA} = 99.6°C/W, V_I = 30 V, T_J = 150°C, T_A = 25°C			42	
P_S	Safety input, output, or total power	θ_{JA} = 99.6°C/W, T_J = 150°C, T_A = 25°C			1255(1)	
T_S	Maximum ambient safety temperature				150	°C

(1) Input, output, or the sum of input and output power should not exceed this value

7.8 Safety-Related Certifications

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

VDE	CSA	UL	CQC	TUV
Certified according to DIN V VDE V 0884-10 (VDE V 0884-10):2006-12 and DIN EN 60950-1 (VDE 0805 Teil 1):2011-01	Plan to certify under CSA Component Acceptance Notice 5A, IEC 60950-1 and IEC 60601-1	Certified according to UL 1577 Component Recognition Program	Certified according to GB 4943.1-2011	Certified according to EN 61010-1:2010 (3rd Ed) and EN 60950-1:2006/A11:2009/A1:2010/A12:2011/A2:2013
Reinforced Insulation Maximum Transient isolation voltage, 8000 V_{PK}; Maximum surge isolation voltage, 6250 V_{PK}, Maximum repetitive peak isolation voltage, 1420 V_{PK}	Isolation Rating of 5700 V_{RMS}; Reinforced insulation per CSA 60950- 1- 07+A1+A2 and IEC 60950-1 (2nd Ed.), 800 V_{RMS} max working voltage (pollution degree 2, material group I) ; 2 MOPP (Means of Patient Protection) per CSA 60601-1:14 and IEC 60601-1 Ed. 3.1, 250 V_{RMS} (354 V_{PK}) max working voltage	Single Protection, 5700 V_{RMS} (1)	Reinforced Insulation, Altitude ≤ 5000m, Tropical climate, 400 V_{RMS} maximum working voltage	5700 V_{RMS} Reinforced insulation per EN 61010-1:2010 (3rd Ed) up to working voltage of 600 V_{RMS} 5700 V_{RMS} Reinforced insulation per EN 60950-1:2006/A11:2009/A1:2010/A12:2011/A2:2013 up to working voltage of 800 V_{RMS}
Certification completed Certificate number: 40040142	Certification planned	Certification completed File number: E181974	Certification completed Certificate number: CQC16001141761	Certification completed Client ID number: 77311

(1) Production tested ≥ 6840 V_{RMS} for 1 second in accordance with UL 1577.

The safety-limiting constraint is the absolute-maximum junction temperature specified in the *Absolute Maximum Ratings* table. The power dissipation and junction-to-air thermal impedance of the device installed in the application hardware determines the junction temperature. The assumed junction-to-air thermal resistance in the *Thermal Information* table is that of a device installed in the High-K Test Board for Leaded Surface-Mount Packages. The power is the recommended maximum input voltage times the current. The junction temperature is then the ambient temperature plus the power times the junction-to-air thermal resistance.

7.9 Electrical Characteristics

Over recommended operating conditions unless otherwise noted. All typical values are at T_A = 25°C, V_{CC1} = 5 V, V_{CC2} – GND2 = 15 V, GND2 – V_{EE2} = 8 V

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
VOLTAGE SUPPLY						
$V_{IT+(UVLO1)}$	Positive-going UVLO1 threshold voltage input side (V_{CC1} – GND1)				2.25	V
$V_{IT-(UVLO1)}$	Negative-going UVLO1 threshold voltage input side (V_{CC1} – GND1)		1.7			V
$V_{HYS(UVLO1)}$	UVLO1 Hysteresis voltage (V_{IT+} – $V_{IT–}$) input side			0.2		V
$V_{IT+(UVLO2)}$	Positive-going UVLO2 threshold voltage output side (V_{CC2} – GND2)			12	13	V
$V_{IT-(UVLO2)}$	Negative-going UVLO2 threshold voltage output side (V_{CC2} – GND2)		9.5	11		V
$V_{HYS(UVLO2)}$	UVLO2 Hysteresis voltage (V_{IT+} – $V_{IT–}$) output side			1		V
I_{Q1}	Input supply quiescent current			2.8	4.5	mA
I_{Q2}	Output supply quiescent current			3.6	6	mA
LOGIC I/O						
$V_{IT+(IN,\overline{RST})}$	Positive-going input threshold voltage (IN+, IN-, $\overline{RST}$)				0.7 x V_{CC1}	V
$V_{IT-(IN,\overline{RST})}$	Negative-going input threshold voltage (IN+, IN-, $\overline{RST}$)		0.3 x V_{CC1}			V
$V_{HYS(IN,\overline{RST})}$	Input hysteresis voltage (IN+, IN-, $\overline{RST}$)			0.15 x V_{CC1}		V
I_{IH}	High-level input leakage at (IN+) (1)	IN+ = V_{CC1}		100		µA
I_{IL}	Low-level input leakage at (IN-, $\overline{RST}$) (2)	IN- = GND1, $\overline{RST}$ = GND1		-100		µA
I_{PU}	Pull-up current of $\overline{FLT}$, RDY	$V_{(RDY)}$ = GND1, $V_{(FLT)}$ = GND1		100		µA
V_{OL}	Low-level output voltage at $\overline{FLT}$, RDY	$I_{(FLT)}$ = 5 mA			0.2	V
GATE DRIVER STAGE						
$V_{(OUTPD)}$	Active output pull-down voltage	$I_{(OUTH/L)}$ = 200 mA, V_{CC2} = open			2	V
$V_{(OUTH)}$	High-level output voltage	$I_{(OUTH)}$ = –20 mA	V_{CC2} - 0.5	V_{CC2} - 0.24		V
$V_{(OUTL)}$	Low-level output voltage	$I_{(OUTL)}$ = 20 mA		V_{EE2} + 13	V_{EE2} + 50	mV
$I_{(OUTH)}$	High-level output peak current	IN+ = high, IN- = low, $V_{(OUTH)}$ = V_{CC2} - 15 V	1.5	2.5		A
$I_{(OUTL)}$	Low-level output peak current	IN+ = low, IN- = high, $V_{(OUTL)}$ = V_{EE2} + 15 V	3.4	5		A
$I_{(OLF)}$	Low level output current during fault condition			130		mA
ACTIVE MILLER CLAMP						
$V_{(CLP)}$	Low-level clamp voltage	$I_{(CLP)}$ = 20 mA		V_{EE2} + 0.015	V_{EE2} + 0.08	V
$I_{(CLP)}$	Low-level clamp current	$V_{(CLAMP)}$ = V_{EE2} + 2.5 V	1.6	2.5	3.3	A
$V_{(CLTH)}$	Clamp threshold voltage		1.6	2.1	2.5	V
SHORT CIRCUIT CLAMPING						
$V_{(CLP\_OUTH)}$	Clamping voltage (V_{OUTH} - V_{CC2})	IN+ = high, IN- = low, t_{CLP} = 10 µs, $I_{(OUTH)}$ = 500 mA		1,1	1.3	V
$V_{(CLP\_OUTL)}$	Clamping voltage (V_{OUTL} - V_{CC2})	IN+ = high, IN- = low, t_{CLP} = 10 µs, $I_{(OUTL)}$ = 500 mA		1.3	1.5	V
$V_{(CLP\_CLAMP)}$	Clamping voltage (V_{CLP} - V_{CC2})	IN+ = high, IN- = low, t_{CLP} = 10 µs, $I_{(CLP)}$ = 500 mA		1.3		V
	Clamping voltage at CLAMP	IN+ = High, IN- = Low, $I_{(CLP)}$ = 20 mA		0.7	1.1	V
$V_{(CLP\_OUTL)}$	Clamping voltage at OUTL (V_{CLP} - V_{CC2})	IN+ = High, IN- = Low, $I_{(OUTL)}$ = 20 mA		0.7	1.1	V
DESAT PROTECTION						
$I_{(CHG)}$	Blanking capacitor charge current	$V_{(DESAT)}$ - GND2 = 2 V	0.42	0.5	0.58	mA
$I_{(DCHG)}$	Blanking capacitor discharge current	$V_{(DESAT)}$ - GND2 = 6 V	9	14		mA

(1) I_{IH} for IN-, $\overline{RST}$ pin is zero as they are pulled high internally.
(2) I_{IL} for IN+ is zero, as it is pulled low internally.

Electrical Characteristics (continued)

Over recommended operating conditions unless otherwise noted. All typical values are at T_A = 25°C, V_{CC1} = 5 V, V_{CC2} – GND2 = 15 V, GND2 – V_{EE2} = 8 V

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$V_{(DSTH)}$	DESAT threshold voltage with respect to GND2		8.3	9	9.5	V
$V_{(DSL)}$	DESAT voltage with respect to GND2, when OUTH/L is driven low		0.4		1	V

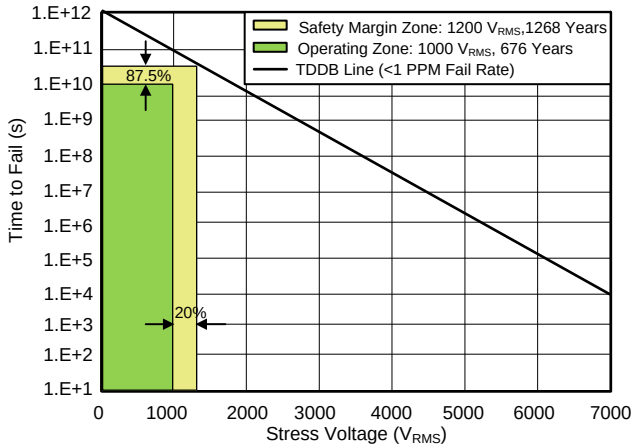
7.10 Switching Characteristics

Over recommended operating conditions unless otherwise noted. All typical values are at T_A = 25°C, V_{CC1} = 5 V, V_{CC2} – GND2 = 15 V, GND2 – V_{EE2} = 8 V

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
t_r	Output signal rise time	C_{LOAD} = 1 nF	see Figure 44, Figure 45 and Figure 46	12	18	35	ns
t_f	Output signal fall time			12	20	37	ns
t_{PLH}, t_{PHL}	Propagation Delay				76	110	ns
t_{sk-p}	Pulse Skew $\lvert t_{PHL} - t_{PLH} \rvert$					20	ns
t_{sk-pp}	Part-to-part skew					30 (1)	ns
t_{GF}	Glitch filter on IN+, IN-, $\overline{RST}$			20	30	40	ns
$t_{DS\ (90\%)}$	DESAT sense to 90% $V_{OUTH/L}$ delay	C_{LOAD} = 10 nF			553	760	ns
$t_{DS\ (10\%)}$	DESAT sense to 10% $V_{OUTH/L}$ delay				2	3.5	µs
$t_{DS\ (GF)}$	DESAT glitch filter delay	C_{LOAD} = 1 nF			330		ns
$t_{DS\ (\overline{FLT})}$	DESAT sense to $\overline{FLT}$-low delay	see Figure 46				1.4	µs
t_{LEB}	Leading edge blanking time	see Figure 44 and Figure 45		310	400	480	ns
$t_{GF(RSTFLT)}$	Glitch filter on $\overline{RST}$ for resetting $\overline{FLT}$			300		800	ns
C_I	Input capacitance (2)	$V_I = V_{CC1}/2 + 0.4 \times \sin(2\pi ft)$, f = 1 MHz, V_{CC1} = 5 V			2		pF
CMTI	Common-mode transient immunity	V_{CM} = 1500 V, see Figure 47		50	100		kV/µs

(1) Measured at same supply voltage and temperature condition
(2) Measured from input pin to ground.

7.11 Safety and Insulation Characteristics Curves



T_A upto 150°C Stress-voltage frequency = 60 Hz

Figure 1. Reinforced High-Voltage Capacitor Life Time Projection

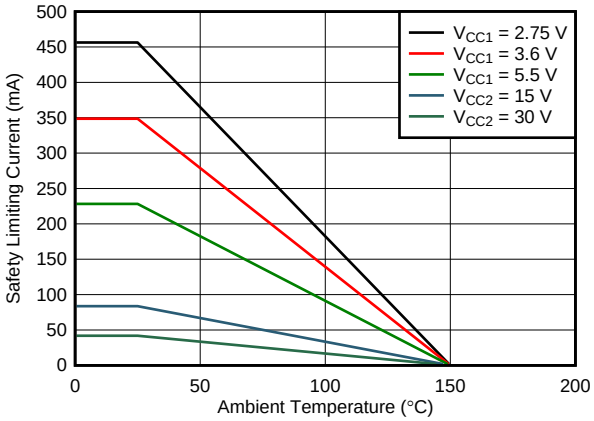


Figure 2. Thermal Derating Curve for Safety Limiting Current per VDE

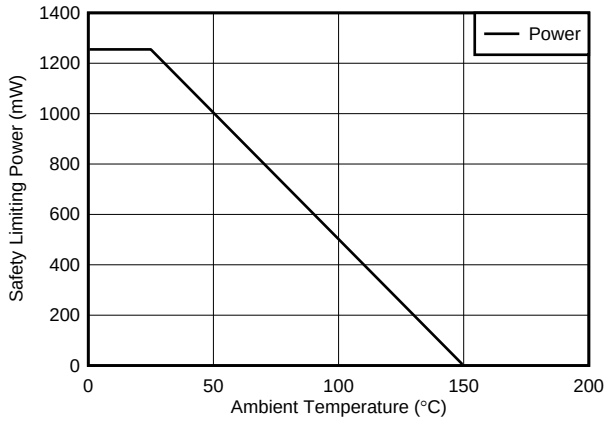


Figure 3. Thermal Derating Curve for Safety Limiting Power per VDE

7.12 Typical Characteristics

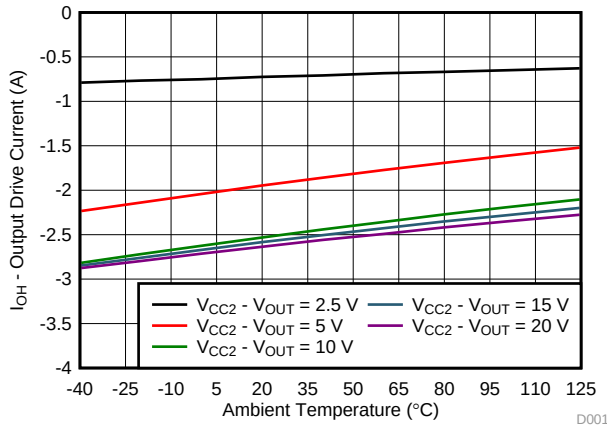


Figure 4. Output High Drive Current vs Temperature

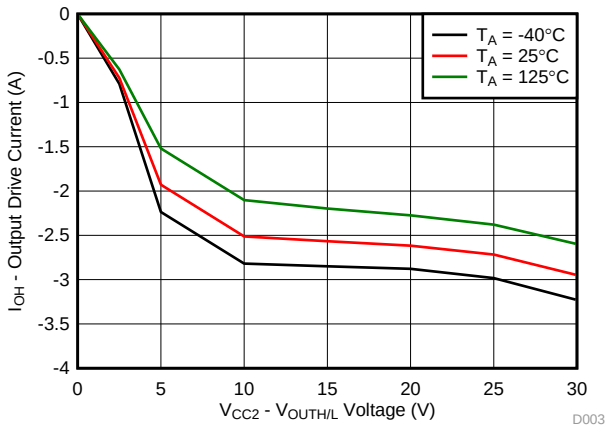


Figure 5. Output High Drive Current vs Output Voltage

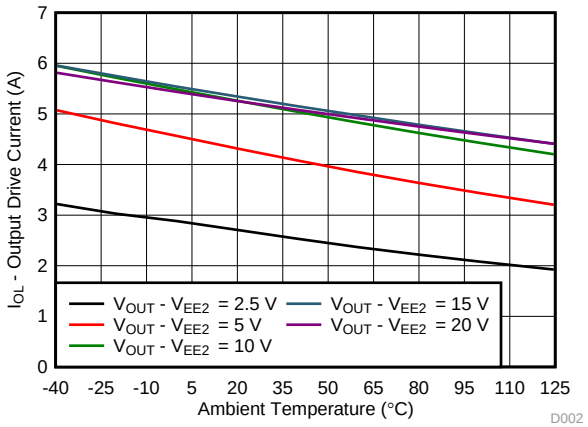


Figure 6. Output Low Drive Current vs Temperature

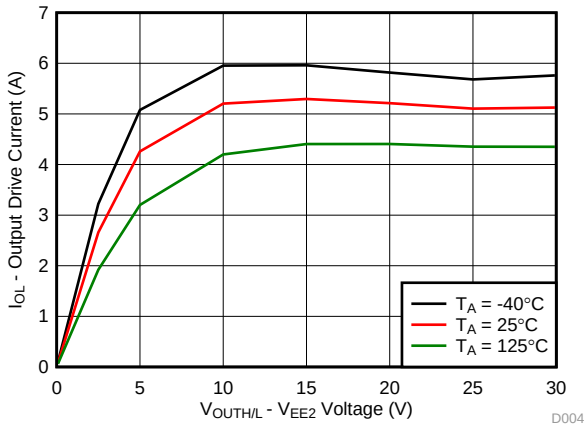
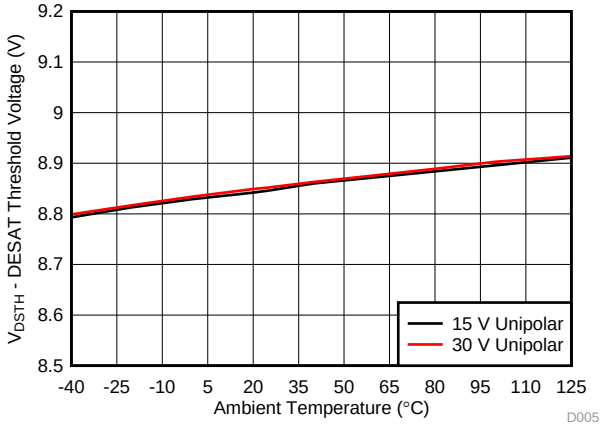


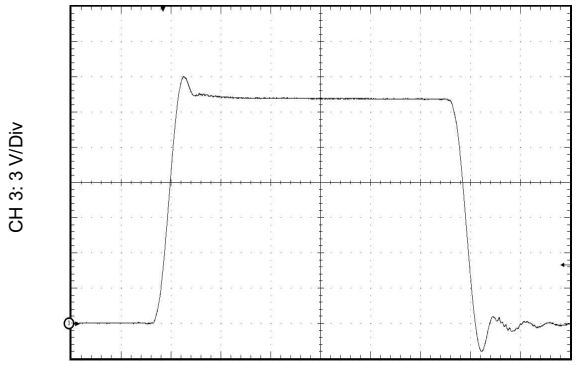
Figure 7. Output Low Drive Current vs Output Voltage



Unipolar: V_{CC2} - V_{EE2} = V_{CC2} - GND2

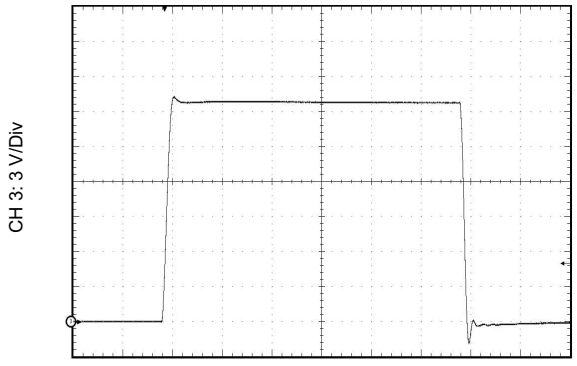
Figure 8. DESAT Threshold Voltage vs Temperature

Typical Characteristics (continued)



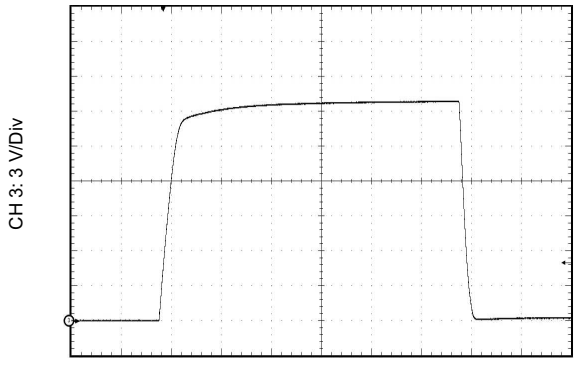
50 ns / Div
C_L = 1 nF R_{GH} = 0 Ω R_{GL} = 0 Ω
V_{CC2} - V_{EE2} = V_{CC2} - GND2 = 20 V

Figure 9. Output Transient Waveform



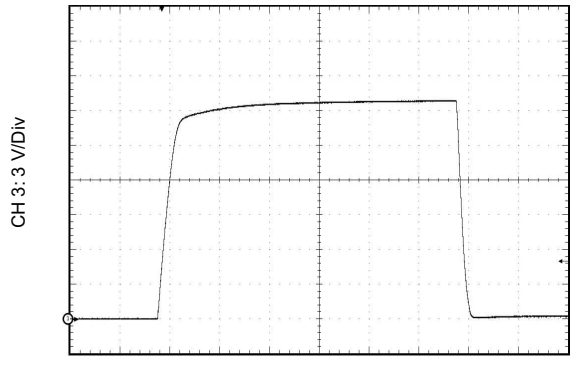
500 ns / Div
C_L = 10 nF R_{GH} = 0 Ω R_{GL} = 0 Ω
V_{CC2} - V_{EE2} = V_{CC2} - GND2 = 20 V

Figure 10. Output Transient Waveform



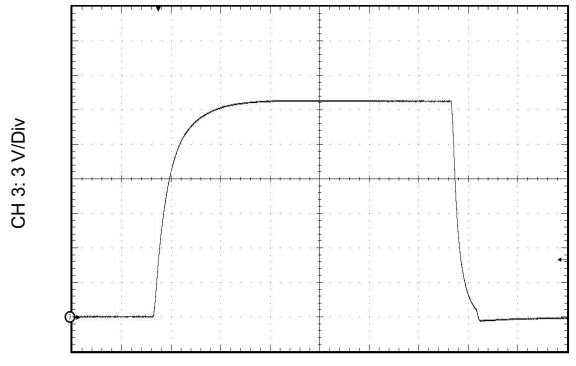
2 μs / Div
C_L = 100 nF R_{GH} = 0 Ω R_{GL} = 0 Ω
V_{CC2} - V_{EE2} = V_{CC2} - GND2 = 20 V

Figure 11. Output Transient Waveform



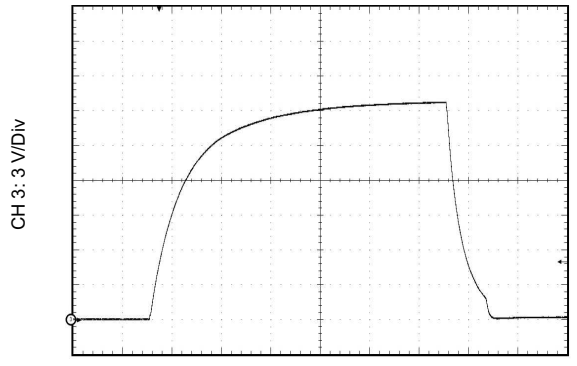
50 ns / Div
C_L = 1 nF R_{GH} = 10 Ω R_{GL} = 5Ω
V_{CC2} - V_{EE2} = V_{CC2} - GND2 = 20 V

Figure 12. Output Transient Waveform



500 ns / Div
C_L = 10 nF R_{GH} = 10 Ω R_{GL} = 5Ω
V_{CC2} - V_{EE2} = V_{CC2} - GND2 = 20 V

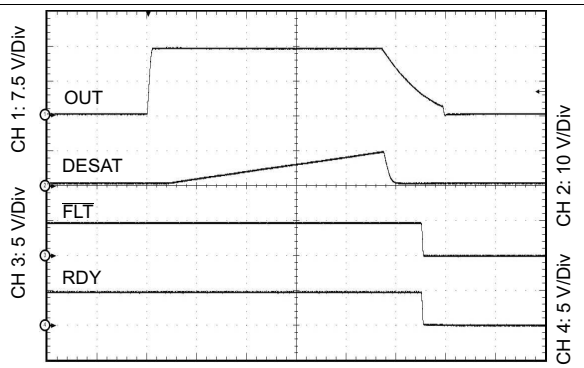
Figure 13. Output Transient Waveform



2 μs / Div
C_L = 100 nF R_{GH} = 10 Ω R_{GL} = 5Ω
V_{CC2} - V_{EE2} = V_{CC2} - GND2 = 20 V

Figure 14. Output Transient Waveform

Typical Characteristics (continued)

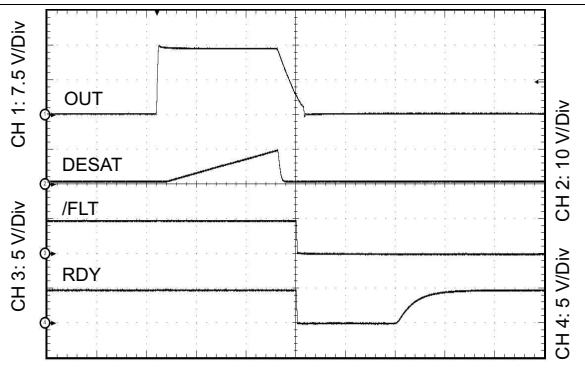


1 µs/Div

C_L = 10 nF R_{GH} = 0 Ω R_{GL} = 0 Ω

V_{CC2} - V_{EE2} = V_{CC2} - GND2 = 15 V DESAT = 220pF

Figure 15. Output Transient Waveform DESAT, RDY and $\overline{FLT}$

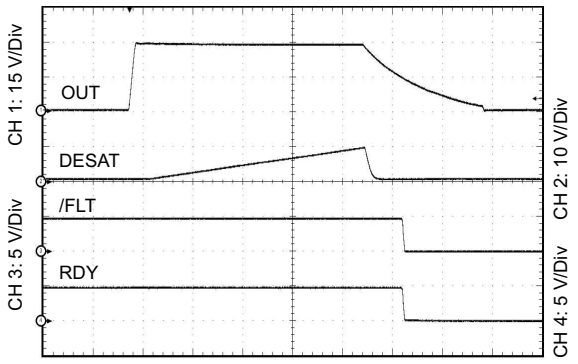


2 µs / Div

C_L = 10 nF R_{GH} = 0 Ω R_{GL} = 0 Ω

V_{CC2} - V_{EE2} = V_{CC2} - GND2 = 15 V DESAT = 220pF

Figure 16. Output Transient Waveform DESAT, RDY and $\overline{FLT}$

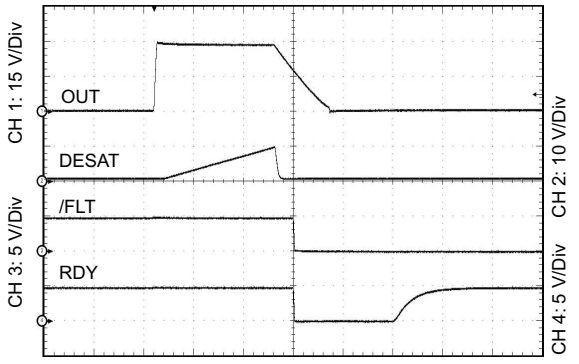


1 µs / Div

C_L = 10 nF R_{GH} = 0 Ω R_{GL} = 0 Ω

V_{CC2} - V_{EE2} = V_{CC2} - GND2 = 30 V DESAT = 220pF

Figure 17. Output Transient Waveform DESAT, RDY and $\overline{FLT}$

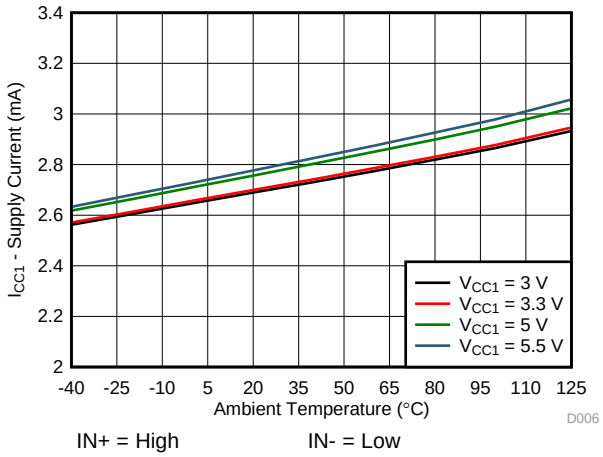


2 µs / Div

C_L = 10 nF R_{GH} = 0 Ω R_{GL} = 0 Ω

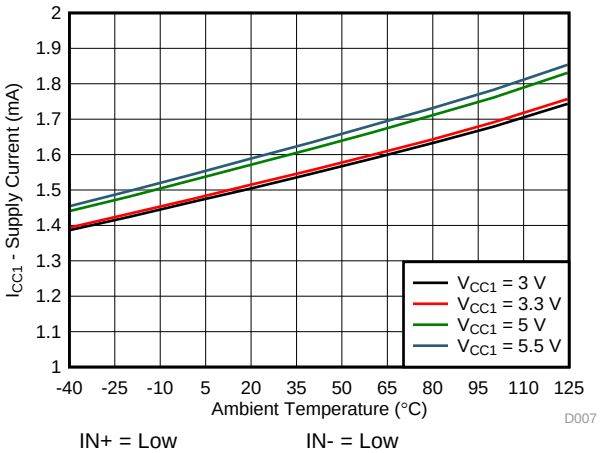
V_{CC2} - V_{EE2} = V_{CC2} - GND2 = 30 V DESAT = 220pF

Figure 18. Output Transient Waveform DESAT, RDY and $\overline{FLT}$



IN+ = High IN- = Low

Figure 19. I_{CC1} Supply Current vs Temperature



IN+ = Low IN- = Low

Figure 20. I_{CC1} Supply Current vs Temperature

Typical Characteristics (continued)

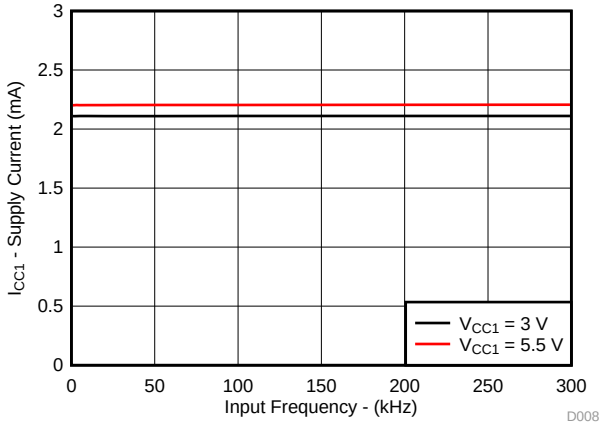
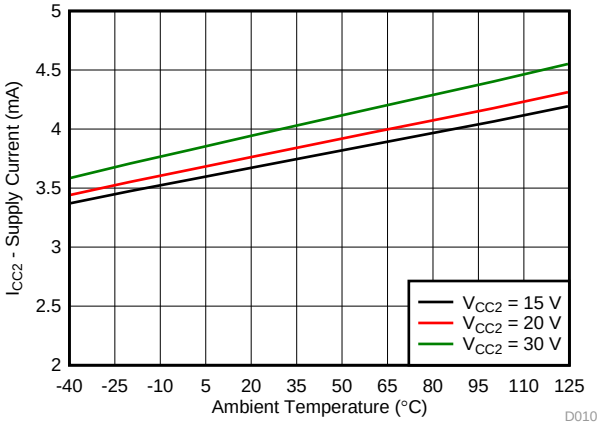
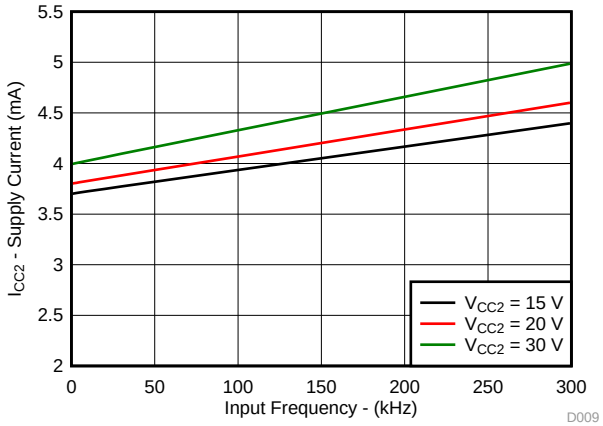


Figure 21. I_{CC1} Supply Current vs Input Frequency



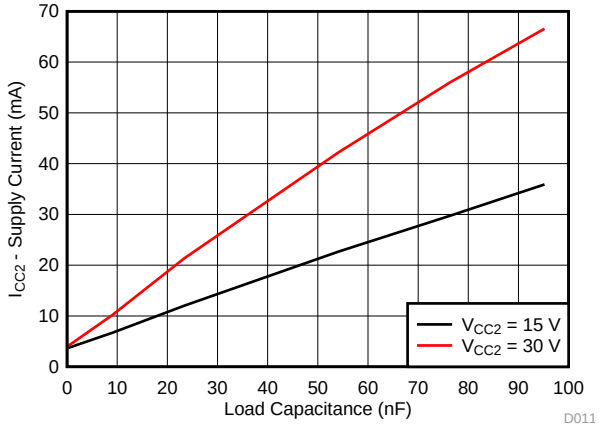
Input frequency = 1 kHz

Figure 22. I_{CC2} Supply Current vs Temperature



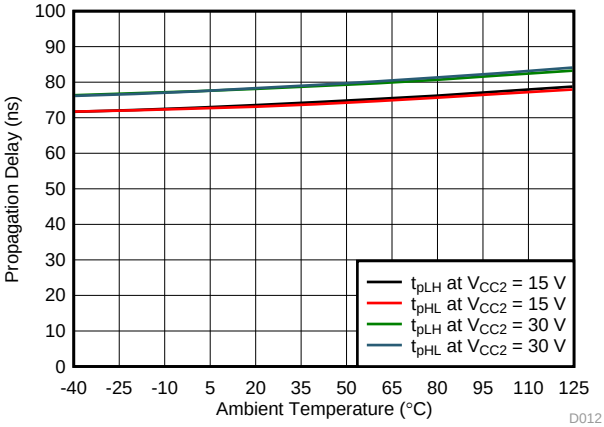
No C_L

Figure 23. I_{CC2} Supply Current vs Input Frequency



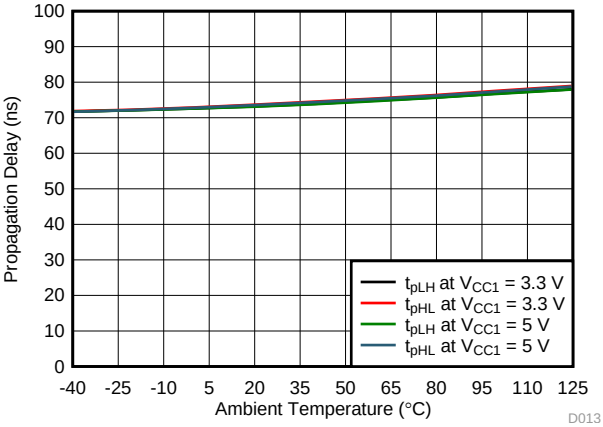
R_{GH} = 10 Ω R_{GL} = 5 Ω, 20 kHz

Figure 24. I_{CC2} Supply Current vs Load Capacitance



C_L = 1 nF R_{GH} = 0 Ω R_{GL} = 0 Ω
V_{CC1} = 5 V

Figure 25. Propagation Delay vs Temperature



C_L = 1 nF R_{GH} = 0 Ω R_{GL} = 0 Ω
V_{CC2} = 15 V

Figure 26. Propagation Delay vs Temperature

Typical Characteristics (continued)

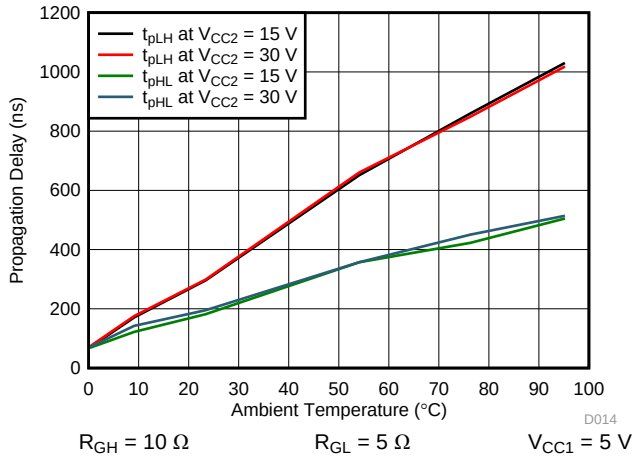


Figure 27. Propagation Delay vs Load Capacitance

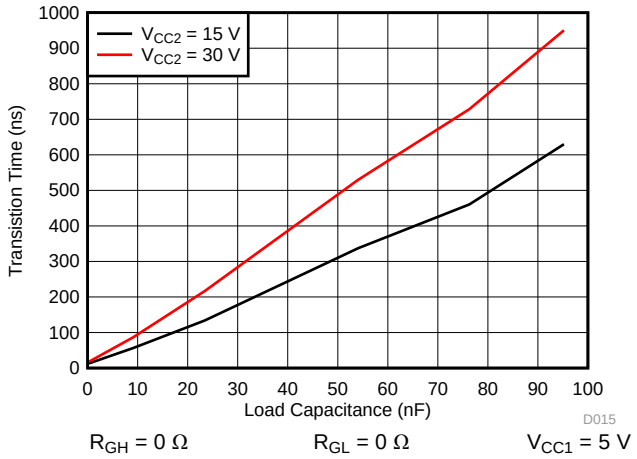


Figure 28. t_r Rise Time vs Load Capacitance

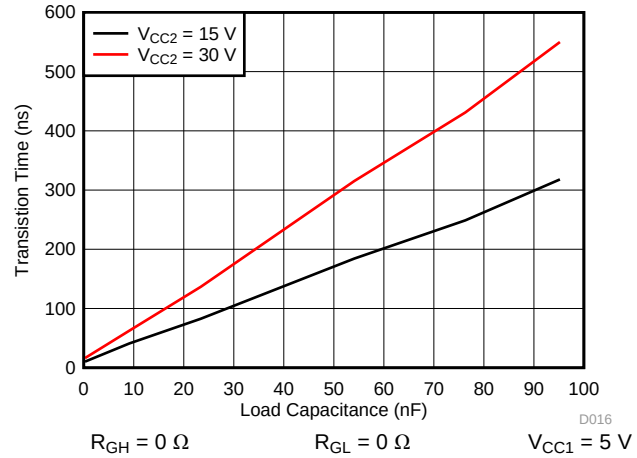


Figure 29. t_f Fall Time v. Load Capacitance

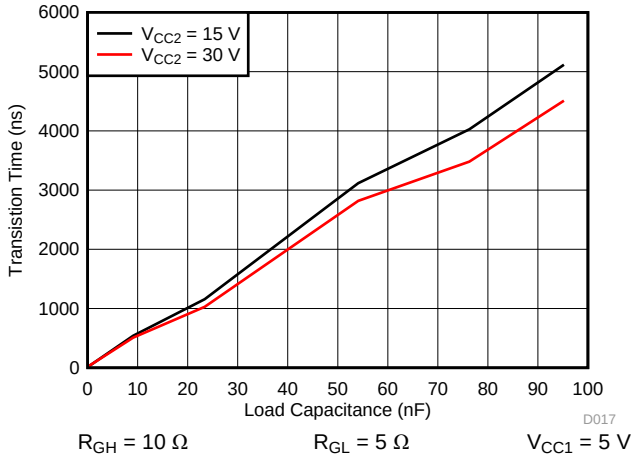


Figure 30. t_r Rise Time vs Load Capacitance

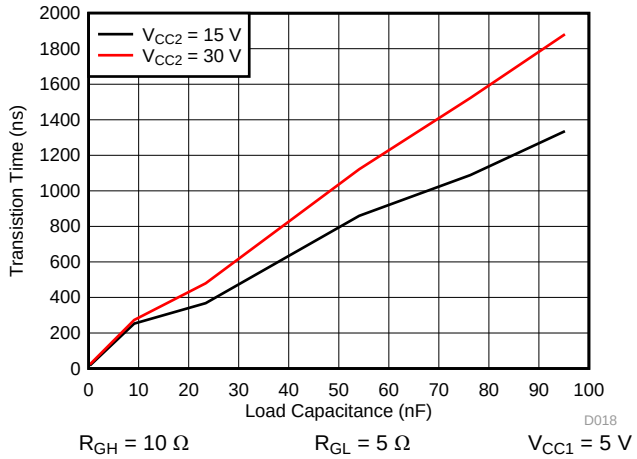


Figure 31. t_f Fall Time vs Load Capacitance

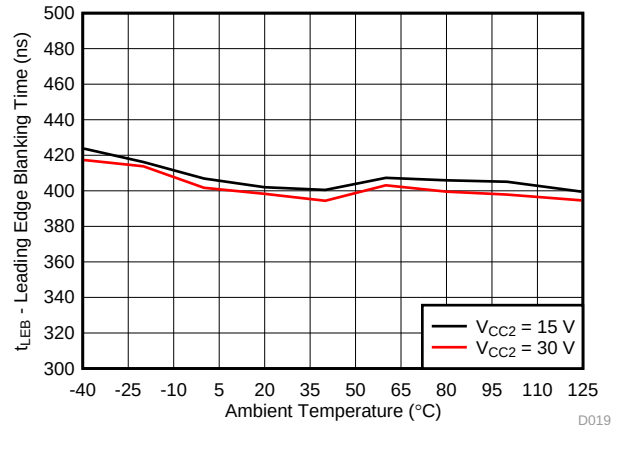


Figure 32. Leading Edge Blanking Time With Temperature

Typical Characteristics (continued)

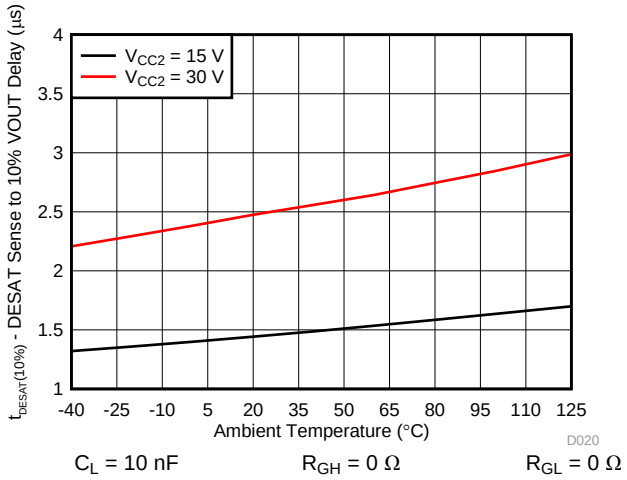


Figure 33. DESAT Sense to $V_{OUTH/L}$ 10% Delay vs Temperature

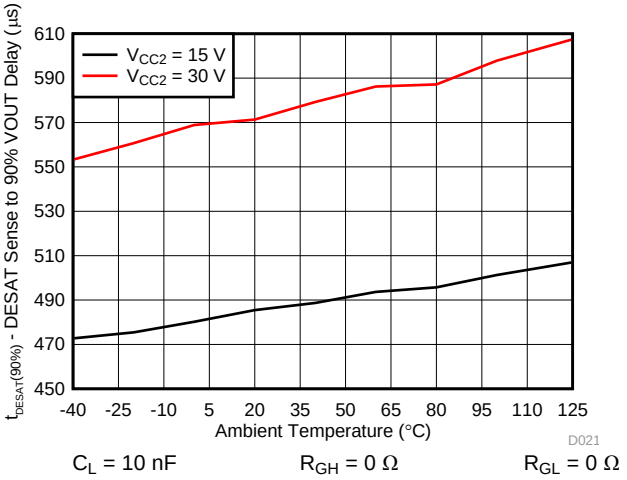


Figure 34. DESAT Sense to $V_{OUTH/L}$ 90% Delay vs Temperature

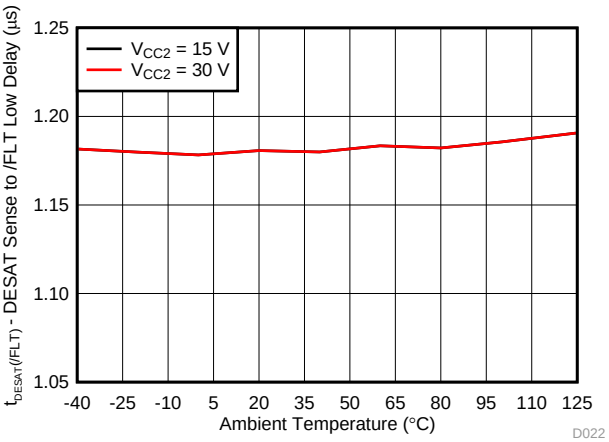


Figure 35. DESAT Sense to Fault Low Delay vs Temperature

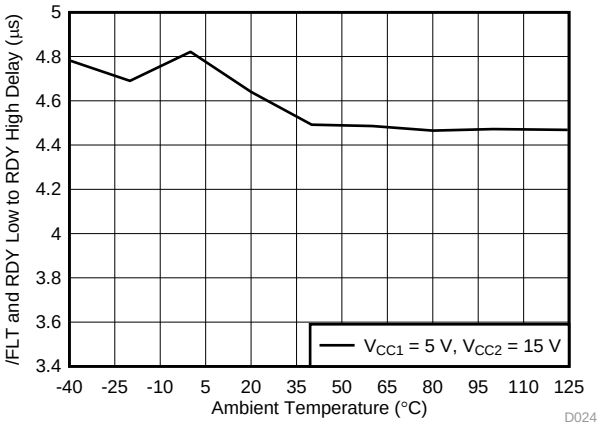


Figure 36. Fault and RDY Low to RDY High Delay vs Temperature

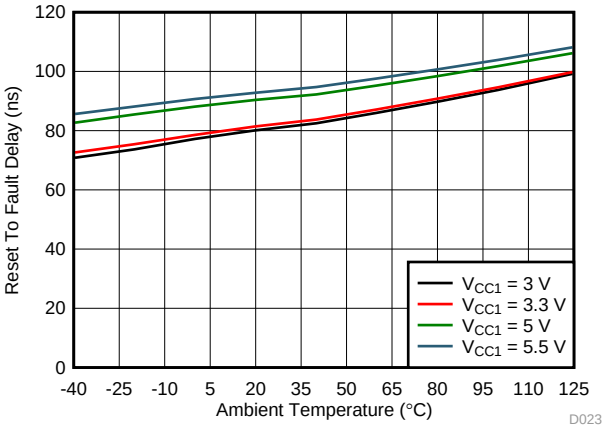


Figure 37. Reset to Fault Delay Across Temperature

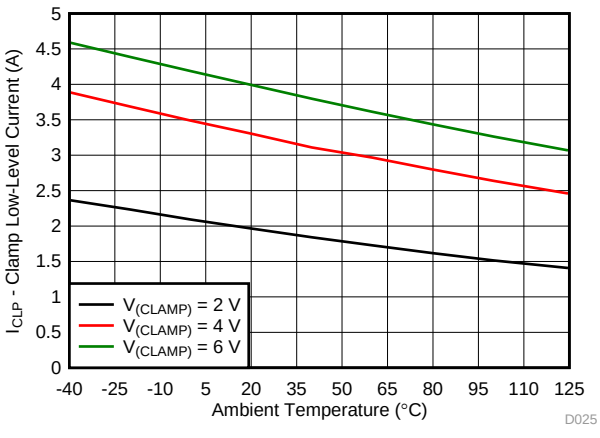


Figure 38. Miller Clamp Current vs Temperature

Typical Characteristics (continued)

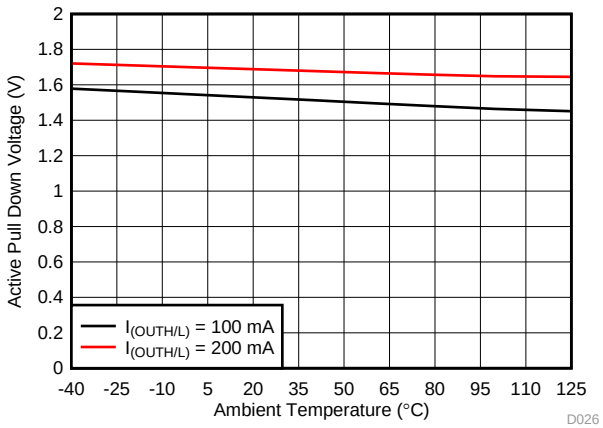


Figure 39. Active Pull Down Voltage vs Temperature

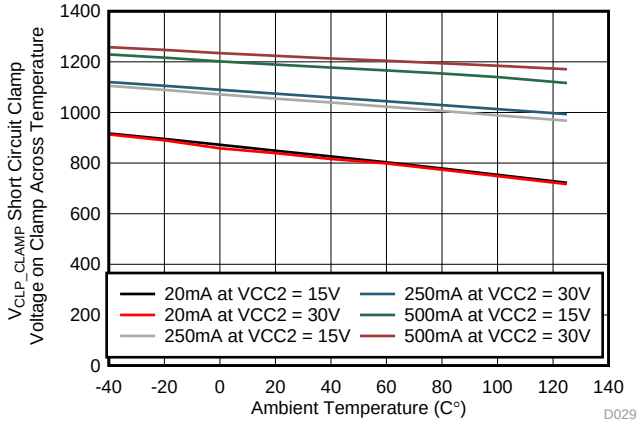


Figure 40. V_{CLP_CLAMP} - Short Circuit Clamp Voltage on Clamp Across Temperature

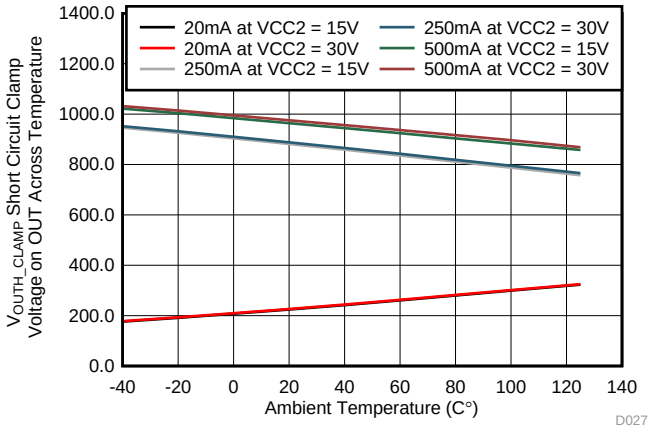


Figure 41. V_{OUTH_CLAMP} - Short Circuit Clamp Voltage on OUTH Across Temperature

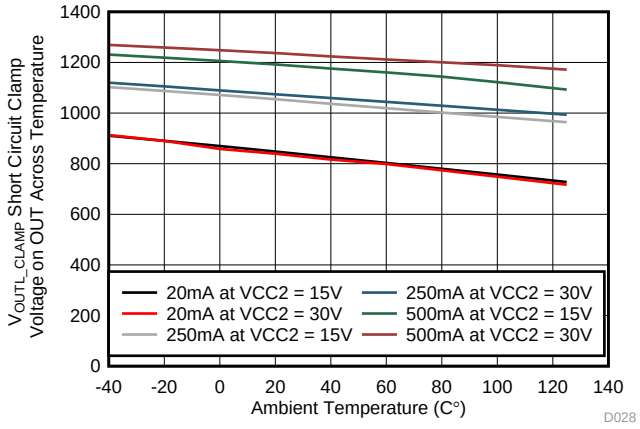
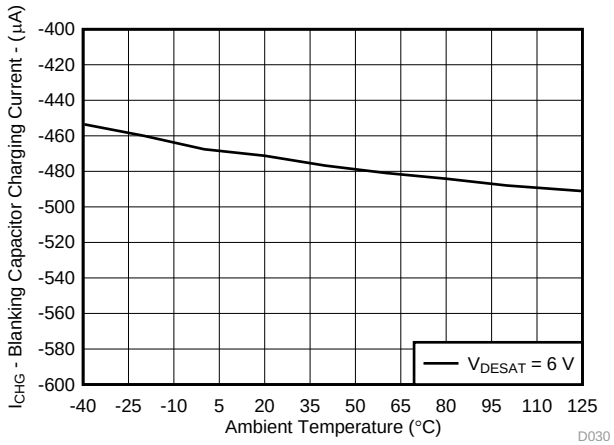


Figure 42. V_{OUTL_CLAMP} - Short Circuit Clamp Voltage on OUTL Across Temperature



V_{CC2} = 15 V DESAT = 6 V

Figure 43. Blanking Capacitor Charging Current vs Temperature

8 Parameter Measurement Information

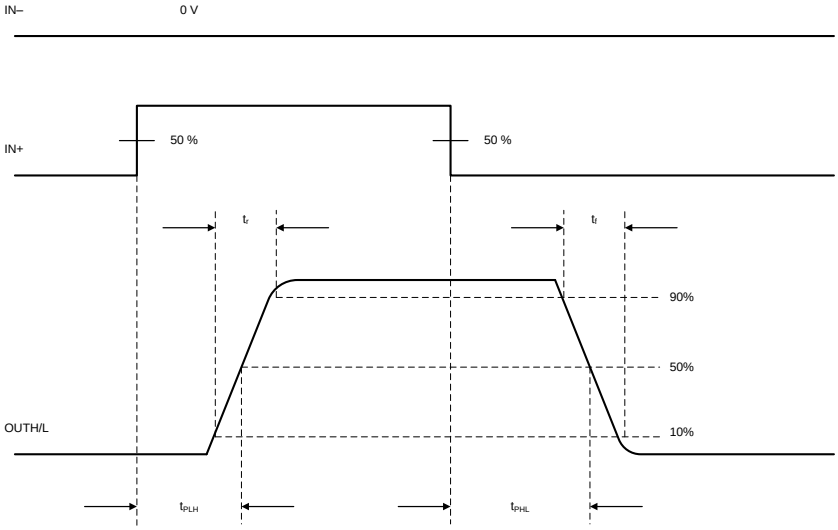


Figure 44. OUTH/L Propagation Delay, Non-Inverting Configuration

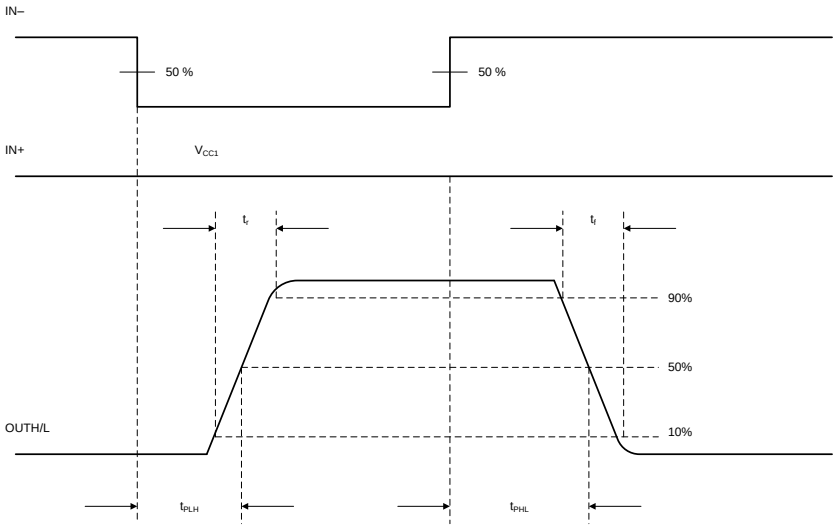


Figure 45. OUTH/L Propagation Delay, Inverting Configuration

Parameter Measurement Information (continued)

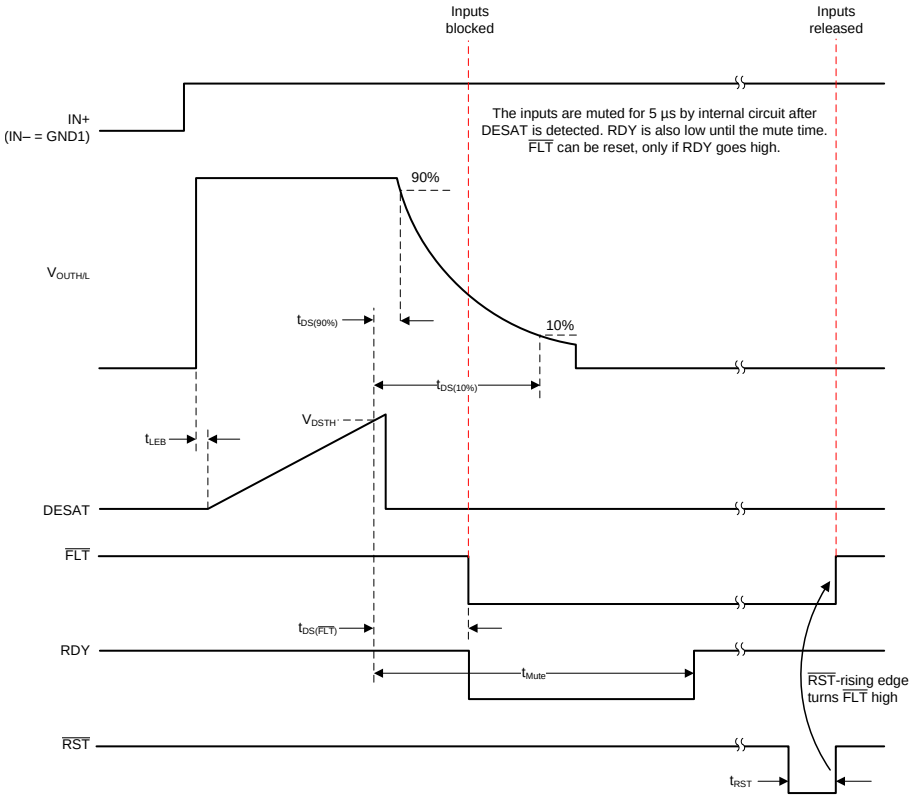


Figure 46. DESAT, OUTH/L, FLT, RST Delay

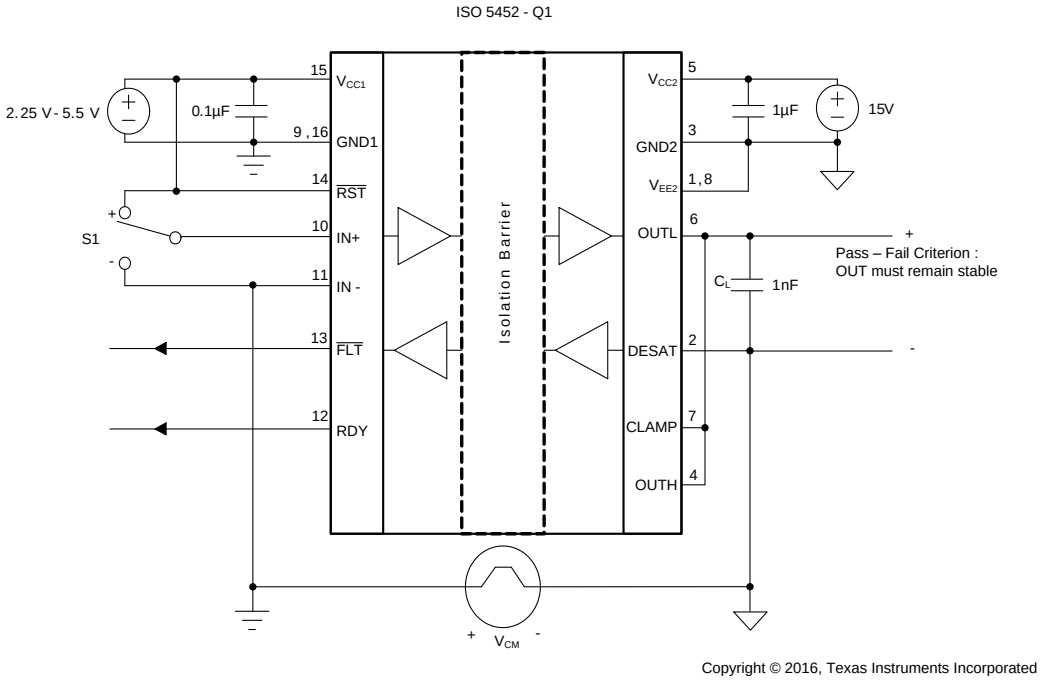


Figure 47. Common-Mode Transient Immunity Test Circuit

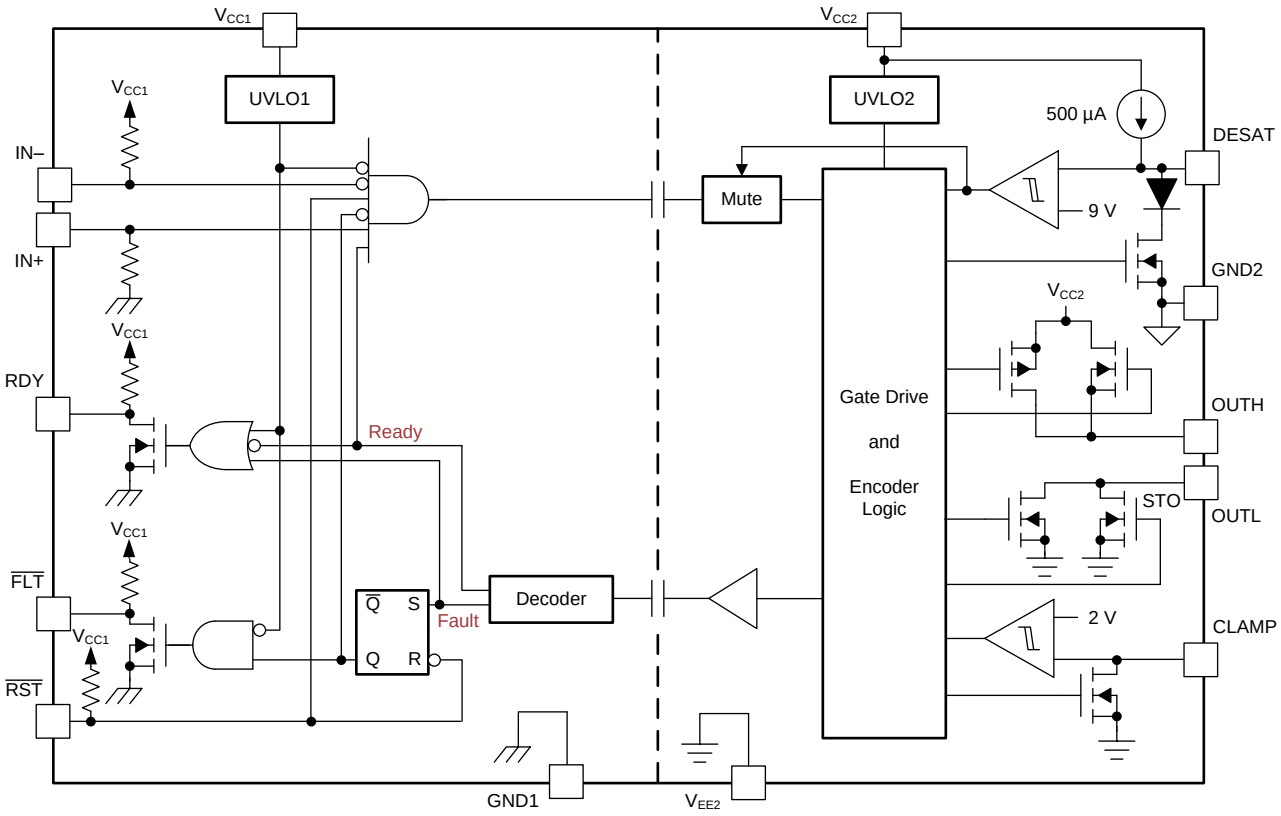
9 Detailed Description

9.1 Overview

The ISO5452-Q1 is an isolated gate driver for IGBTs and MOSFETs. Input CMOS logic and output power stage are separated by a Silicon dioxide (SiO_2) capacitive isolation.

The IO circuitry on the input side interfaces with a micro controller and consists of gate drive control and RESET ($\overline{RST}$) inputs, READY (RDY) and FAULT ($\overline{FLT}$) alarm outputs. The power stage consists of power transistors to supply 2.5-A pull-up and 5-A pull-down currents to drive the capacitive load of the external power transistors, as well as DESAT detection circuitry to monitor IGBT collector-emitter overvoltage under short circuit events. The capacitive isolation core consists of transmit circuitry to couple signals across the capacitive isolation barrier, and receive circuitry to convert the resulting low-swing signals into CMOS levels. The ISO5452-Q1 also contains under voltage lockout circuitry to prevent insufficient gate drive to the external IGBT, and active output pull-down feature which ensures that the gate-driver output is held low, if the output supply voltage is absent. The ISO5452-Q1 also has an active Miller clamp function which can be used to prevent parasitic turn-on of the external power transistor, due to Miller effect, for unipolar supply operation.

9.2 Functional Block Diagram



9.3 Feature Description

9.3.1 Supply and active Miller clamp

The ISO5452-Q1 supports both bipolar and unipolar power supply with active Miller clamp.

For operation with bipolar supplies, the IGBT is turned off with a negative voltage on its gate with respect to its emitter. This prevents the IGBT from unintentionally turning on because of current induced from its collector to its gate due to Miller effect. In this condition it is not necessary to connect CLAMP output of the gate driver to the IGBT gate, but connecting CLAMP output of the gate driver to the IGBT gate is also not an issue. Typical values of V_{CC2} and V_{EE2} for bipolar operation are 15 V and -8 V with respect to GND2.

For operation with unipolar supply, typically, V_{CC2} is connected to 15 V with respect to GND2, and V_{EE2} is connected to GND2. In this use case, the IGBT can turn-on due to additional charge from IGBT Miller capacitance caused by a high voltage slew rate transition on the IGBT collector. To prevent IGBT to turn on, the CLAMP pin is connected to IGBT gate and Miller current is sinked through a low impedance CLAMP transistor.

Miller CLAMP is designed for miller current up to 2 A. When the IGBT is turned-off and the gate voltage transitions below 2 V the CLAMP current output is activated.

9.3.2 Active Output Pull-down

The Active output pull-down feature ensures that the IGBT gate OUTH/L is clamped to V_{EE2} to ensure safe IGBT off-state, when the output side is not connected to the power supply.

9.3.3 Undervoltage Lockout (UVLO) with Ready (RDY) Pin Indication Output

Undervoltage Lockout (UVLO) ensures correct switching of IGBT. The IGBT is turned-off, if the supply V_{CC1} drops below $V_{IT-(UVLO1)}$, irrespective of IN+, IN- and RST input till V_{CC1} goes above $V_{IT+(UVLO1)}$.

In similar manner, the IGBT is turned-off, if the supply V_{CC2} drops below $V_{IT-(UVLO2)}$, irrespective of IN+, IN- and RST input till V_{CC2} goes above $V_{IT+(UVLO2)}$.

Ready (RDY) pin indicates status of input and output side Under Voltage Lock-Out (UVLO) internal protection feature. If either side of device have insufficient supply (V_{CC1} or V_{CC2}), the RDY pin output goes low; otherwise, RDY pin output is high. RDY pin also serves as an indication to the micro-controller that the device is ready for operation.

9.3.4 Soft Turn-Off, Fault ($\overline{\text{FLT}}$) and Reset ($\overline{\text{RST}}$)

During IGBT overcurrent condition, a Mute logic initiates a soft-turn-off procedure which disables, OUTH, and pulls OUTL to low over a time span of 2 μs. When desaturation is active, a fault signal is sent across the isolation barrier pulling the $\overline{\text{FLT}}$ output at the input side low and blocking the isolator input. Mute logic is activated through the soft-turn-off period. The $\overline{\text{FLT}}$ output condition is latched and can be reset only after RDY goes high, through a low-active pulse at the $\overline{\text{RST}}$ input. $\overline{\text{RST}}$ has an internal filter to reject noise and glitches. By asserting $\overline{\text{RST}}$ for atleast the specified minimum duration (800ns), device input logic can be enabled or disabled.

9.3.5 Short Circuit Clamp

Under short circuit events it is possible that currents are induced back into the gate-driver OUTH/L and CLAMP pins due to parasitic Miller capacitance between the IGBT collector and gate terminals. Internal protection diodes on OUTH/L and CLAMP help to sink these currents while clamping the voltages on these pins to values slightly higher than the output side supply.

9.4 Device Functional Modes

In ISO5452-Q1 OUTH/L to follow IN+ in normal functional mode, $\overline{RST}$ and RDY needs to be in high state.

Table 1. Function Table(1)

V_{CC1}	V_{CC2}	IN+	IN-	$\overline{RST}$	RDY	OUTH/L
PU	PD	X	X	X	Low	Low
PD	PU	X	X	X	Low	Low
PU	PU	X	X	Low	High	Low
PU	Open	X	X	X	Low	Low
PU	PU	Low	X	X	High	Low
PU	PU	X	High	X	High	Low
PU	PU	High	Low	High	High	High

(1) PU: Power Up (V_{CC1} ≥ 2.25-V, V_{CC2} ≥ 13-V), PD: Power Down (V_{CC1} ≤ 1.7-V, V_{CC2} ≤ 9.5-V), X: Irrelevant

10 Application and Implementation

NOTE

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.

10.1 Application Information

The ISO5452-Q1 is an isolated gate driver for power semiconductor devices such as IGBTs and MOSFETs. It is intended for use in applications such as motor control, industrial inverters and switched mode power supplies. In these applications, sophisticated PWM control signals are required to turn the power devices on and off, which at the system level eventually may determine, for example, the speed, position, and torque of the motor or the output voltage, frequency and phase of the inverter. These control signals are usually the outputs of a micro controller, and are at low voltage levels such as 2.5 V, 3.3 V or 5 V. The gate controls required by the MOSFETs and IGBTs, on the other hand, are in the range of 30-V (using Unipolar Output Supply) to 15-V (using Bipolar Output Supply), and need high current capability to be able to drive the large capacitive loads offered by those power transistors. Not only that, the gate drive needs to be applied with reference to the Emitter of the IGBT (Source for MOSFET), and by construction, the Emitter node in a gate drive system may swing between 0 to the DC bus voltage, that can be several 100s of volts in magnitude.

The ISO5452-Q1 is thus used to level shift the incoming 2.5-V, 3.3-V and 5-V control signals from the microcontroller to the 30-V (using Unipolar Output Supply) to 15-V (using Bipolar Output Supply) drive required by the power transistors while ensuring high-voltage isolation between the driver side and the microcontroller side.

10.2 Typical Applications

Figure 48 shows the typical application of a three-phase inverter using six ISO5452-Q1 isolated gate drivers. Three-phase inverters are used for variable-frequency drives to control the operating speed and torque of AC motors and for high power applications such as High-Voltage DC (HVDC) power transmission.

The basic three-phase inverter consists of six power switches, and each switch is driven by one . The switches are driven on and off at high switching frequency with specific patterns that to converter dc bus voltage to three-phase AC voltages.

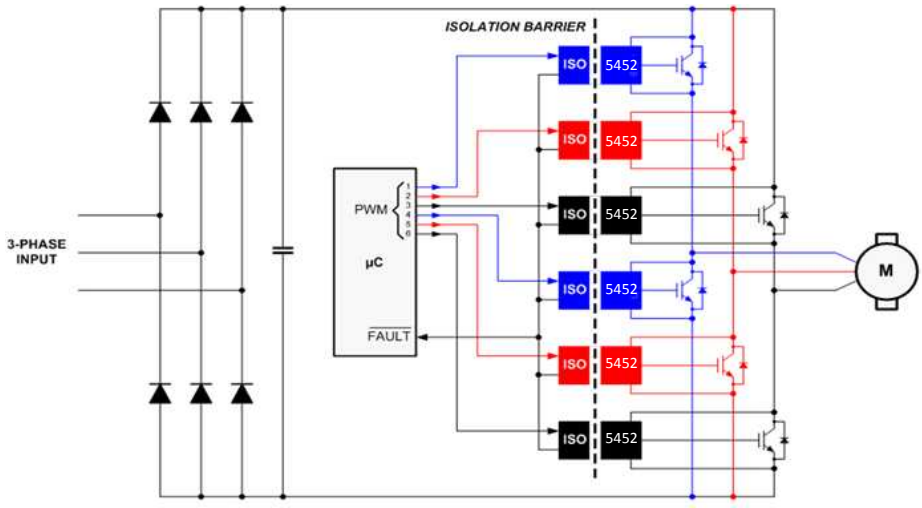


Figure 48. Typical Motor Drive Application

Typical Applications (continued)

10.2.1 Design Requirements

Unlike optocoupler based gate drivers which need external current drivers and biasing circuitry to provide the input control signals, the input control to the ISO5452-Q1 is CMOS and can be directly driven by the microcontroller. Other design requirements include decoupling capacitors on the input and output supplies, a pullup resistor on the common drain $\overline{FLT}$ output signal and $\overline{RST}$ input signal, and a high-voltage protection diode between the IGBT collector and the DESAT input. Further details are explained in the subsequent sections. Table 2 shows the allowed range for Input and Output supply voltage, and the typical current output available from the gate-driver.

Table 2. Design Parameters

PARAMETER	VALUE
Input supply voltage	2.25-V to 5.5-V
Unipolar output supply voltage (V_{CC2} - GND2 = V_{CC2} - V_{EE2})	15-V to 30-V
Bipolar output supply voltage (V_{CC2} - V_{EE2})	15-V to 30-V
Bipolar output supply voltage (GND2 - V_{EE2})	0-V to 15-V
Output current	2.5-A

10.2.2 Detailed Design Procedure

10.2.2.1 Recommended ISO5452-Q1 Application Circuit

The ISO5452-Q1 has both, inverting and non-inverting gate control inputs, an active low reset input, and an open drain fault output suitable for wired-OR applications. The recommended application circuit in Figure 49 illustrates a typical gate driver implementation with Unipolar Output Supply and Figure 50 illustrates a typical gate driver implementation with Bipolar Output Supply using the ISO5452-Q1.

A 0.1-µF bypass capacitor, recommended at input supply pin V_{CC1} and 1-µF bypass capacitor, recommended at output supply pin V_{CC2}, provide the large transient currents necessary during a switching transition to ensure reliable operation. The 220 pF blanking capacitor disables DESAT detection during the off-to-on transition of the power device. The DESAT diode (D_{DST}) and its 1-kΩ series resistor are external protection components. The R_G gate resistor limits the gate charge current and indirectly controls the IGBT collector voltage rise and fall times. The open-drain $\overline{FLT}$ output and RDY output has a passive 10-kΩ pull-up resistor. In this application, the IGBT gate driver is disabled when a fault is detected and will not resume switching until the micro-controller applies a reset signal.

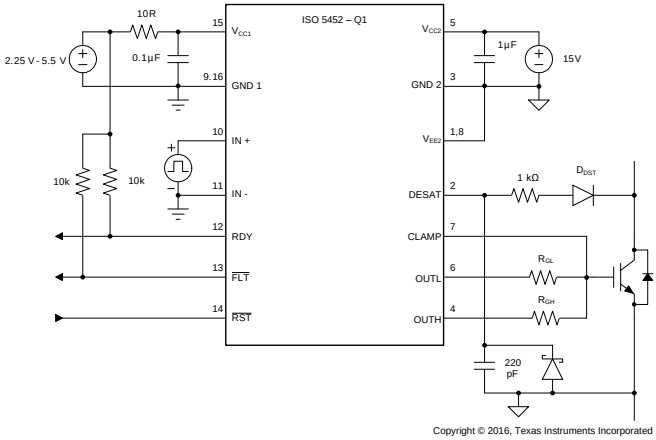


Figure 49. Unipolar Output Supply

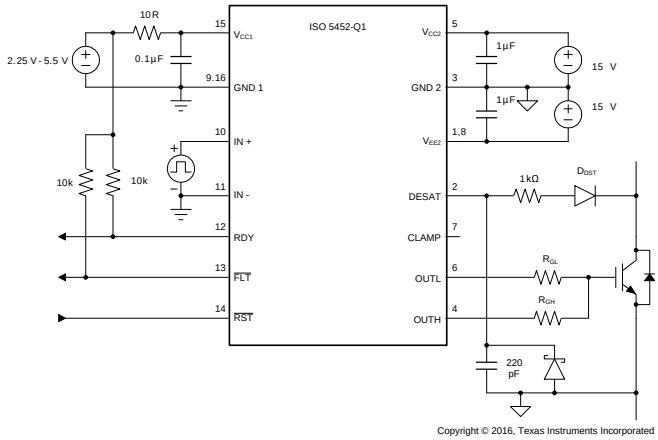


Figure 50. Bipolar Output Supply

10.2.2.2 $\overline{FLT}$ and RDY Pin Circuitry

There is 50-kΩ pull-up resistor internally on $\overline{FLT}$ and RDY pins. The $\overline{FLT}$ and RDY pin is an open-drain output. A 10-kΩ pull-up resistor can be used to make it faster rise and to provide logic high when $\overline{FLT}$ and RDY is inactive, as shown in Figure 51.

Fast common mode transients can inject noise and glitches on $\overline{FLT}$ and RDY pins due to parasitic coupling. This is dependent on board layout. If required, additional capacitance (100 pF to 300 pF) can be included on the $\overline{FLT}$ and RDY pins.

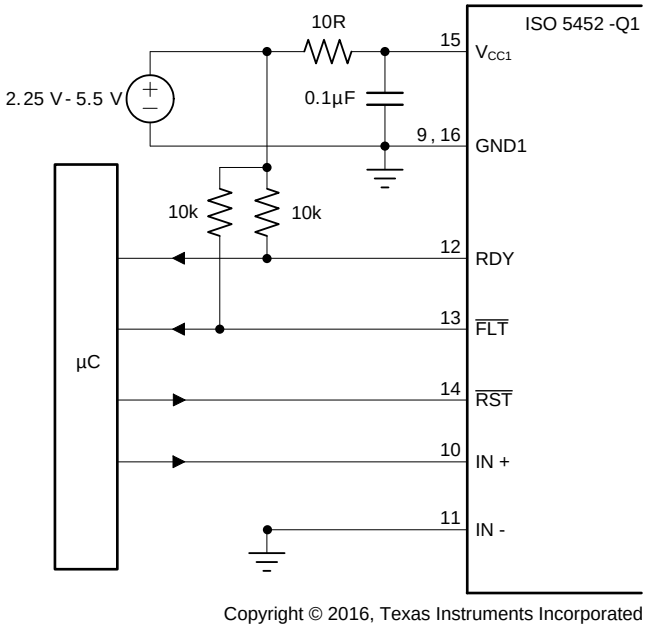


Figure 51. $\overline{FLT}$ and RDY Pin Circuitry for High CMTI

10.2.2.3 Driving the Control Inputs

The amount of common-mode transient immunity (CMTI) can be curtailed by the capacitive coupling from the high-voltage output circuit to the low-voltage input side of the ISO5452-Q1. For maximum CMTI performance, the digital control inputs, IN+ and IN-, must be actively driven by standard CMOS, push-pull drive circuits. This type of low-impedance signal source provides active drive signals that prevent unwanted switching of the ISO5452-Q1 output under extreme common-mode transient conditions. Passive drive circuits, such as open-drain configurations using pull-up resistors, must be avoided. There is a 20 ns glitch filter which can filter a glitch up to 20 ns on IN+ or IN-.

10.2.2.4 Local Shutdown and Reset

In applications with local shutdown and reset, the $\overline{FLT}$ output of each gate driver is polled separately, and the individual reset lines are asserted low independently to reset the motor controller after a fault condition.

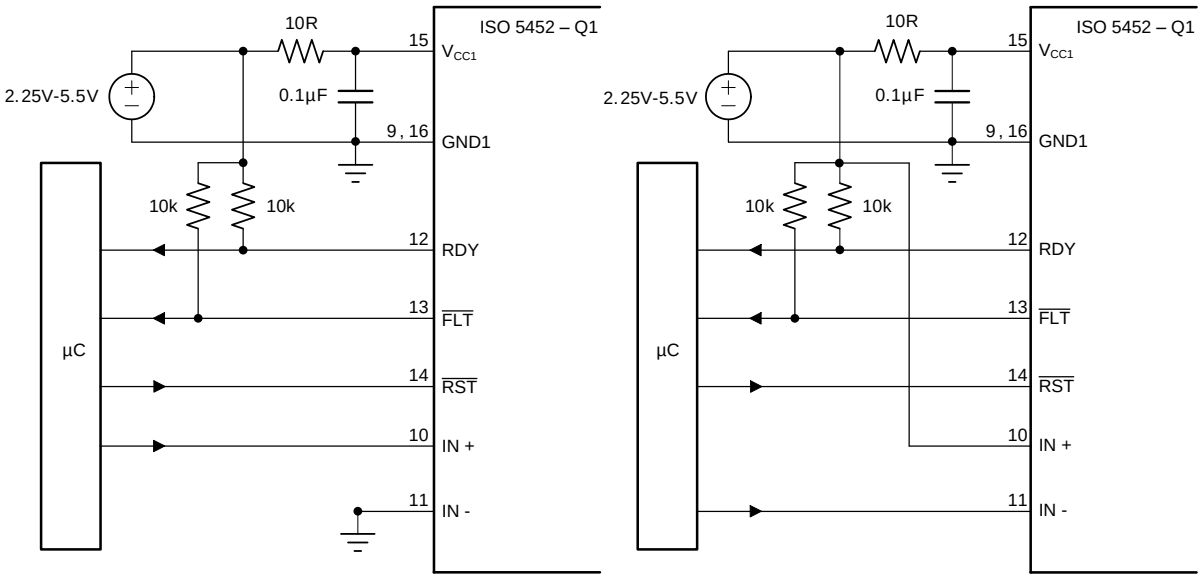


Figure 52. Local Shutdown and Reset for Noninverting (left) and Inverting Input Configuration (right)

10.2.2.5 Global-Shutdown and Reset

When configured for inverting operation, the ISO5452-Q1 can be configured to shutdown automatically in the event of a fault condition by tying the $\overline{FLT}$ output to IN+. For high reliability drives, the open drain $\overline{FLT}$ outputs of multiple ISO5452-Q1 devices can be wired together forming a single, common fault bus for interfacing directly to the micro-controller. When any of the six gate drivers of a three-phase inverter detects a fault, the active low $\overline{FLT}$ output disables all six gate drivers simultaneously.

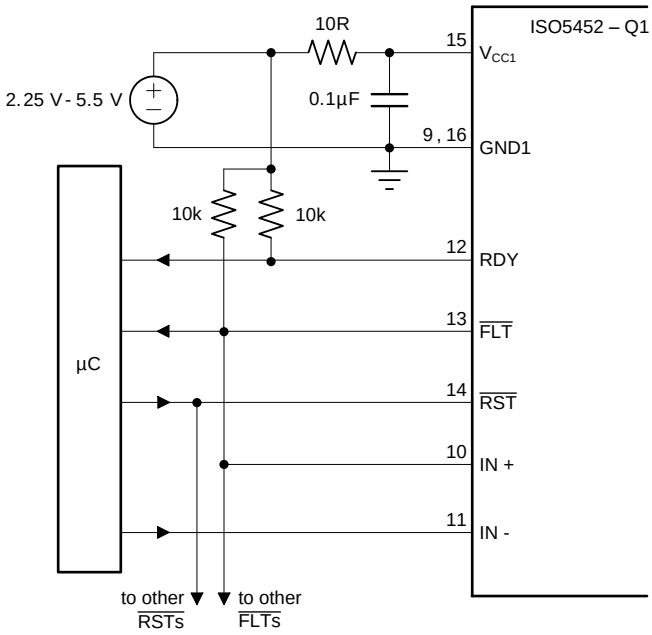


Figure 53. Global Shutdown with Inverting Input Configuration

10.2.2.6 Auto-Reset

In this case, the gate control signal at IN+ is also applied to the $\overline{\text{RST}}$ input to reset the fault latch every switching cycle. Incorrect $\overline{\text{RST}}$ makes output go low. A fault condition, however, the gate driver remains in the latched fault state until the gate control signal changes to the 'gate low' state and resets the fault latch.

If the gate control signal is a continuous PWM signal, the fault latch will always be reset before IN+ goes high again. This configuration protects the IGBT on a cycle by cycle basis and automatically resets before the next 'on' cycle.

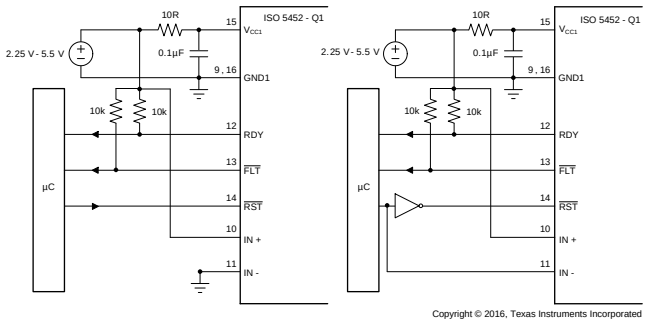


Figure 54. Auto Reset for Non-inverting and Inverting Input Configuration

10.2.2.7 DESAT Pin Protection

Switching inductive loads causes large instantaneous forward voltage transients across the freewheeling diodes of IGBTs. These transients result in large negative voltage spikes on the DESAT pin which draw substantial current out of the device. To limit this current below damaging levels, a 100-Ω to 1-kΩ resistor is connected in series with the DESAT diode.

Further protection is possible through an optional Schottky diode, whose low forward voltage assures clamping of the DESAT input to GND2 potential at low voltage levels.

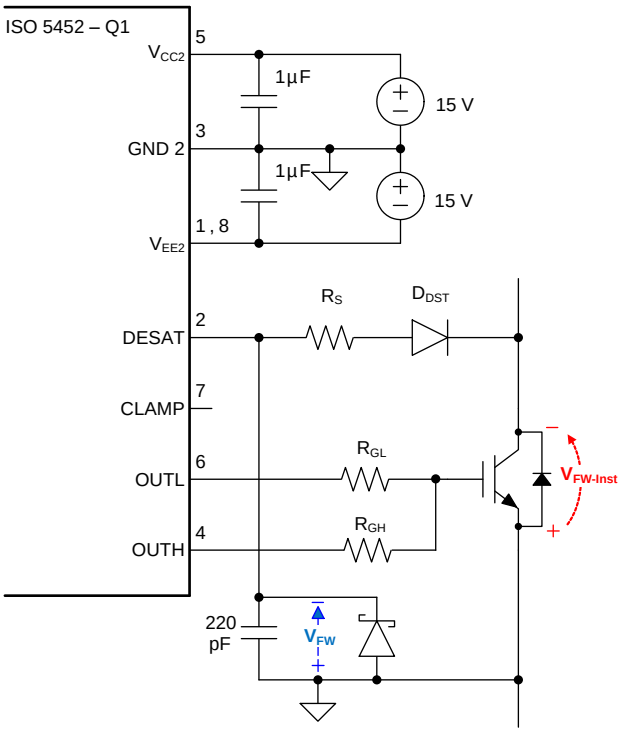


Figure 55. DESAT Pin Protection with Series Resistor and Schottky Diode

10.2.2.8 DESAT Diode and DESAT Threshold

The DESAT diode's function is to conduct forward current, allowing sensing of the IGBT's saturated collector-to-emitter voltage, $V_{(DESAT)}$, (when the IGBT is "on") and to block high voltages (when the IGBT is "off"). During the short transition time when the IGBT is switching, there is commonly a high dV_{CE}/dt voltage ramp rate across the IGBT. This results in a charging current $I_{CHARGE} = C_{(D\text{-}DESAT)} \times d_{VCE}/dt$, charging the blanking capacitor. $C_{(D\text{-}DESAT)}$ is the diode capacitance at DESAT.

To minimize this current and avoid false DESAT triggering, fast switching diodes with low capacitance are recommended. As the diode capacitance builds a voltage divider with the blanking capacitor, large collector voltage transients appear at DESAT attenuated by the ratio of $1+ C_{(BLANK)} / C_{(D\text{-}DESAT)}$.

Because the sum of the DESAT diode forward-voltage and the IGBT collector-emitter voltage make up the voltage at the DESAT-pin, $V_F + V_{CE} = V_{(DESAT)}$, the V_{CE} level, which triggers a fault condition, can be modified by adding multiple DESAT diodes in series: $V_{CE\text{-}FAULT(TH)} = 9\ V – n \times VF$ (where n is the number of DESAT diodes).

When using two diodes instead of one, diodes with half the required maximum reverse-voltage rating may be chosen.

10.2.2.9 Determining the Maximum Available, Dynamic Output Power, P_{OD-max}

The ISO5452-Q1 maximum allowed total power consumption of P_D = 251 mW consists of the total input power, P_{ID}, the total output power, P_{OD}, and the output power under load, P_{OL}:

$$P_D = P_{ID} + P_{OD} + P_{OL} \quad (1)$$

With:

$$P_{ID} = V_{CC1\text{-}max} \times I_{CC1\text{-}max} = 5.5\ V \times 4.5\ mA = 24.75\ mW \quad (2)$$

and:

$$P_{OD} = (V_{CC2} - V_{EE2}) \times I_{CC2\text{-}max} = (15V - (-8V)) \times 6\ mA = 138\ mW \quad (3)$$

then:

$$P_{OL} = P_D - P_{ID} - P_{OD} = 251\ mW - 24.75\ mW - 138\ mW = 88.25\ mW \quad (4)$$

In comparison to P_{OL}, the actual dynamic output power under worst case condition, P_{OL-WC}, depends on a variety of parameters:

$$P_{OL-WC} = 0.5 \times f_{INP} \times Q_G \times (V_{CC2} - V_{EE2}) \times \left(\frac{r_{on-max}}{r_{on-max} + R_G} + \frac{r_{off-max}}{r_{off-max} + R_G} \right)$$

where

- f_{INP} = signal frequency at the control input IN+
- Q_G = power device gate charge
- V_{CC2} = positive output supply with respect to GND2
- V_{EE2} = negative output supply with respect to GND2
- r_{on-max} = worst case output resistance in the on-state: 4Ω
- $r_{off-max}$ = worst case output resistance in the off-state: 2.5Ω
- R_G = gate resistor (5)

Once R_G is determined, Equation 5 is to be used to verify whether $P_{OL-WC} < P_{OL}$. Figure 56 shows a simplified output stage model for calculating P_{OL-WC}.

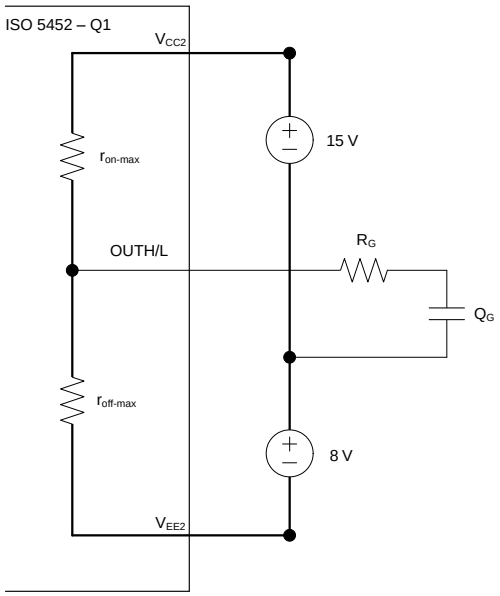


Figure 56. Simplified Output Model for Calculating P_{OL-WC}

10.2.2.10 Example

This examples considers an IGBT drive with the following parameters:

I_{ON-PK} = 2 A, Q_G = 650 nC, f_{INP} = 20 kHz, V_{CC2} = 15V, V_{EE2} = –8 V (6)

Apply the value of the gate resistor R_G = 10 Ω.

Then, calculating the worst-case output power consumption as a function of R_G, using Equation 5 r_{on-max} = worst case output resistance in the on-state: 4 Ω, $r_{off-max}$ = worst case output resistance in the off-state: 2.5 Ω, R_G = gate resistor yields

$$P_{OL-WC} = 0.5 \times 20\ \text{kHz} \times 650\ \text{nC} \times (15\ \text{V} - (-8\ \text{V})) \times \left(\frac{4\ \Omega}{4\ \Omega + 10\ \Omega} + \frac{2.5\ \Omega}{2.5\ \Omega + 10\ \Omega} \right) = 72.61\ \text{mW} \quad (7)$$

Because P_{OL-WC} = 72.61 mW is below the calculated maximum of P_{OL} = 88.25 mW, the resistor value of R_G = 10 Ω is suitable for this application.

10.2.2.11 Higher Output Current Using an External Current Buffer

To increase the IGBT gate drive current, a non-inverting current buffer (such as the npn/pnp buffer shown in Figure 57) may be used. Inverting types are not compatible with the desaturation fault protection circuitry and must be avoided. The MJD44H11/MJD45H11 pair is appropriate for currents up to 8 A, the D44VH10/ D45VH10 pair for up to 15 A maximum.

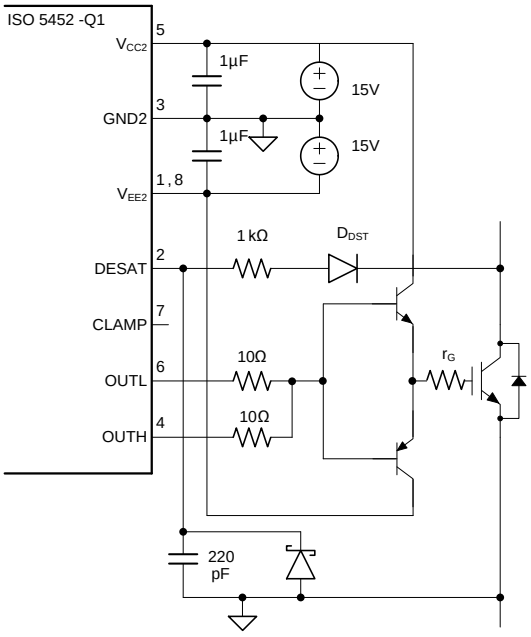
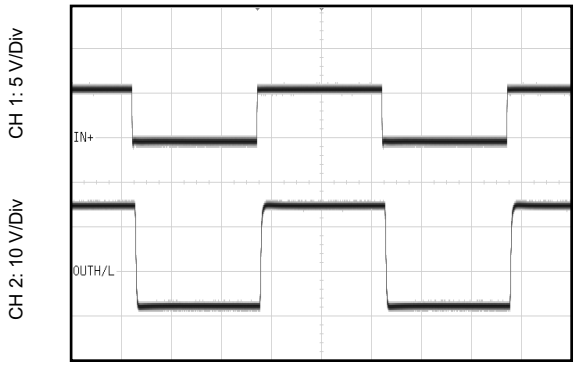


Figure 57. Current Buffer for Increased Drive Current

10.2.3 Application Curve



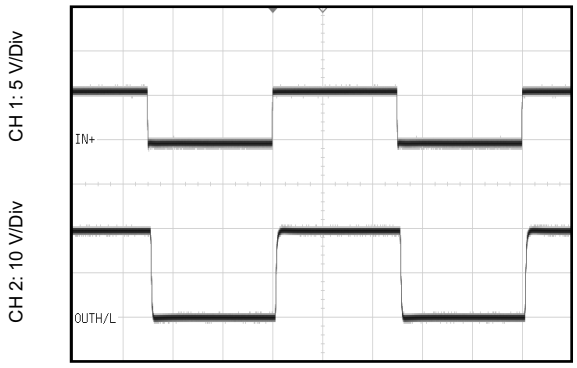
5 µs/Div

C_L = 1 nF R_{GH} = 10 Ω R_{GL} = 10 Ω

V_{CC2} - GND2 = 15 V GND2 - V_{EE2} = 8 V

(V_{CC2} - V_{EE2} = 23 V)

Figure 58. Normal Operation - Bipolar Supply



5 µs/Div

C_L = 1 nF R_{GH} = 10 Ω R_{GL} = 10 Ω

V_{CC2} - V_{EE2} = V_{CC2} - GND2 = 20 V

Figure 59. Normal Operation - Unipolar Supply

11 Power Supply Recommendations

To ensure reliable operation at all data rates and supply voltages, a 0.1-μF bypass capacitor is recommended at input supply pin V_{CC1} and 1-μF bypass capacitor is recommended at output supply pin V_{CC2}. The capacitors should be placed as close to the supply pins as possible. Recommended placement of capacitors needs to be 2-mm maximum from input and output power supply pin (V_{CC1} and V_{CC2}).

12 Layout

12.1 Layout Guidelines

A minimum of four layers is required to accomplish a low EMI PCB design (see Figure 60). Layer stacking should be in the following order (top-to-bottom): high-current or sensitive signal layer, ground plane, power plane and low-frequency signal layer.

- Routing the high-current or sensitive traces on the top layer avoids the use of vias (and the introduction of their inductances) and allows for clean interconnects between the gate driver and the microcontroller and power transistors. Gate driver control input, Gate driver output OUTH/L and DESAT should be routed in the top layer.
- Placing a solid ground plane next to the sensitive signal layer provides an excellent low-inductance path for the return current flow. On the driver side, use GND2 as the ground plane.
- Placing the power plane next to the ground plane creates additional high-frequency bypass capacitance of approximately 100 pF/inch^2. On the gate-driver V_{EE2} and V_{CC2} can be used as power planes. They can share the same layer on the PCB as long as they are not connected together.
- Routing the slower speed control signals on the bottom layer allows for greater flexibility as these signal links usually have margin to tolerate discontinuities such as vias.

For more detailed layout recommendations, including placement of capacitors, impact of vias, reference planes, routing etc. see Application Note SLLA284, *Digital Isolator Design Guide*.

12.2 PCB Material

For digital circuit boards operating at less than 150 Mbps, (or rise and fall times greater than 1 ns), and trace lengths of up to 10 inches, 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.

12.3 Layout Example

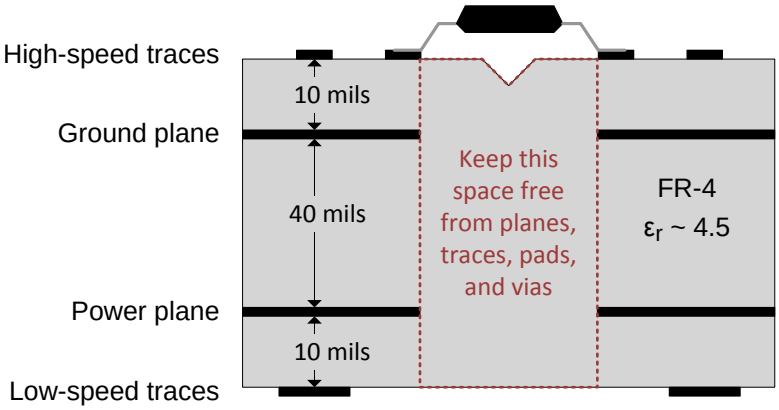


Figure 60. Recommended Layer Stack

13 デバイスおよびドキュメントのサポート

13.1 ドキュメントのサポート

13.1.1 関連資料

関連資料については、以下をを参照してください：

- 『*ISO5852S評価モジュール(EVM)ユーザー・ガイド*』、SLLU207
- 『*デジタル・アイソレータ設計ガイド*』、SLLA284
- 『*絶縁の用語集*』(SLLA353)

13.2 ドキュメントの更新通知を受け取る方法

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13.3 コミュニティ・リソース

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13.6 Glossary

SLYZ022 — *TI Glossary*.

This glossary lists and explains terms, acronyms, and definitions.

14 メカニカル、パッケージ、および注文情報

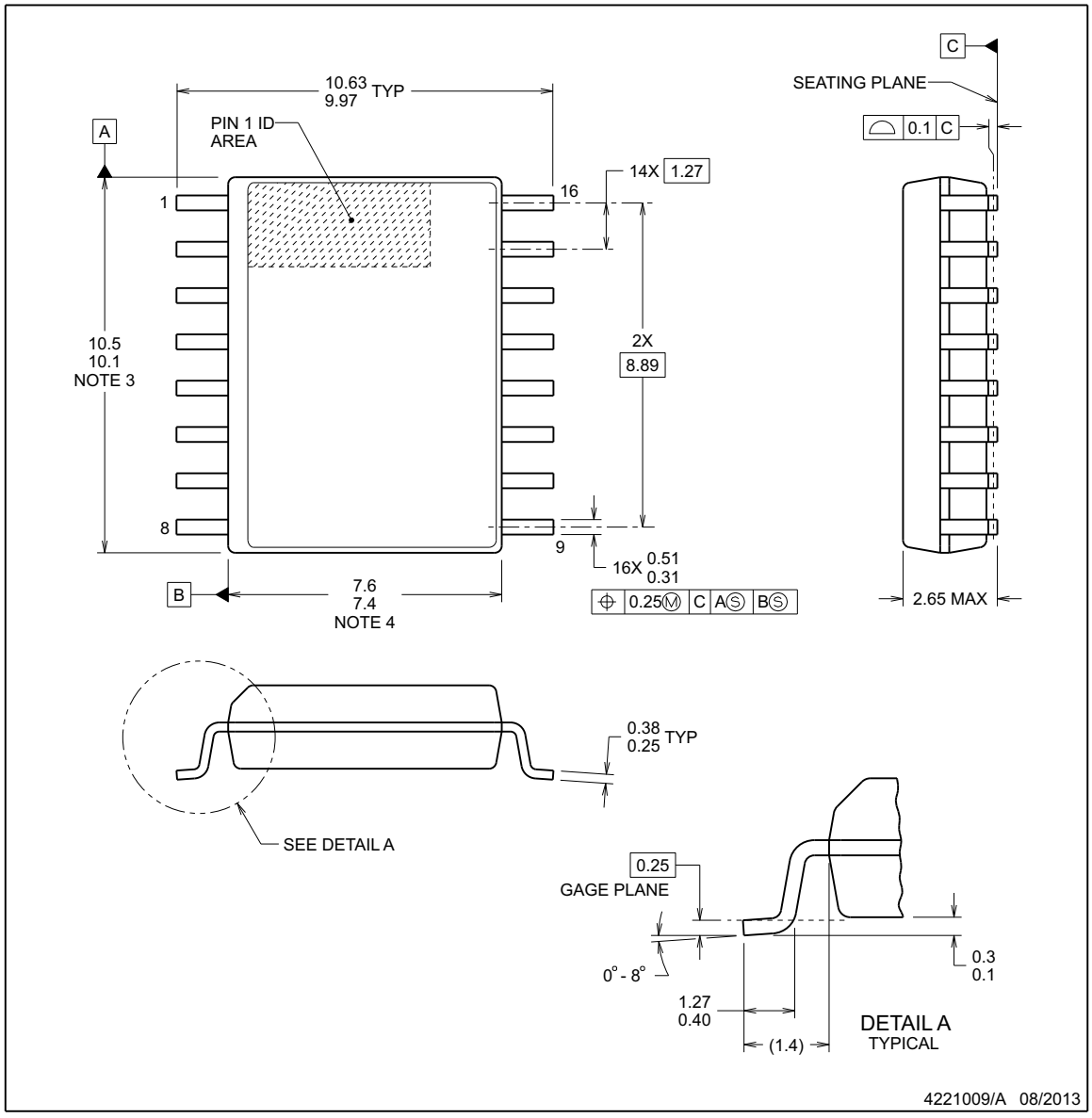
以降のページには、メカニカル、パッケージ、および注文に関する情報が記載されています。この情報は、そのデバイスについて利用可能な最新のデータです。このデータは予告なく変更されることがあり、ドキュメントが改訂される場合もあります。本データシートのブラウザ版を使用されている場合は、画面左側の説明をご覧ください。

PACKAGE OUTLINE

DW0016B

SOIC - 2.65 mm max height

SOIC



NOTES:

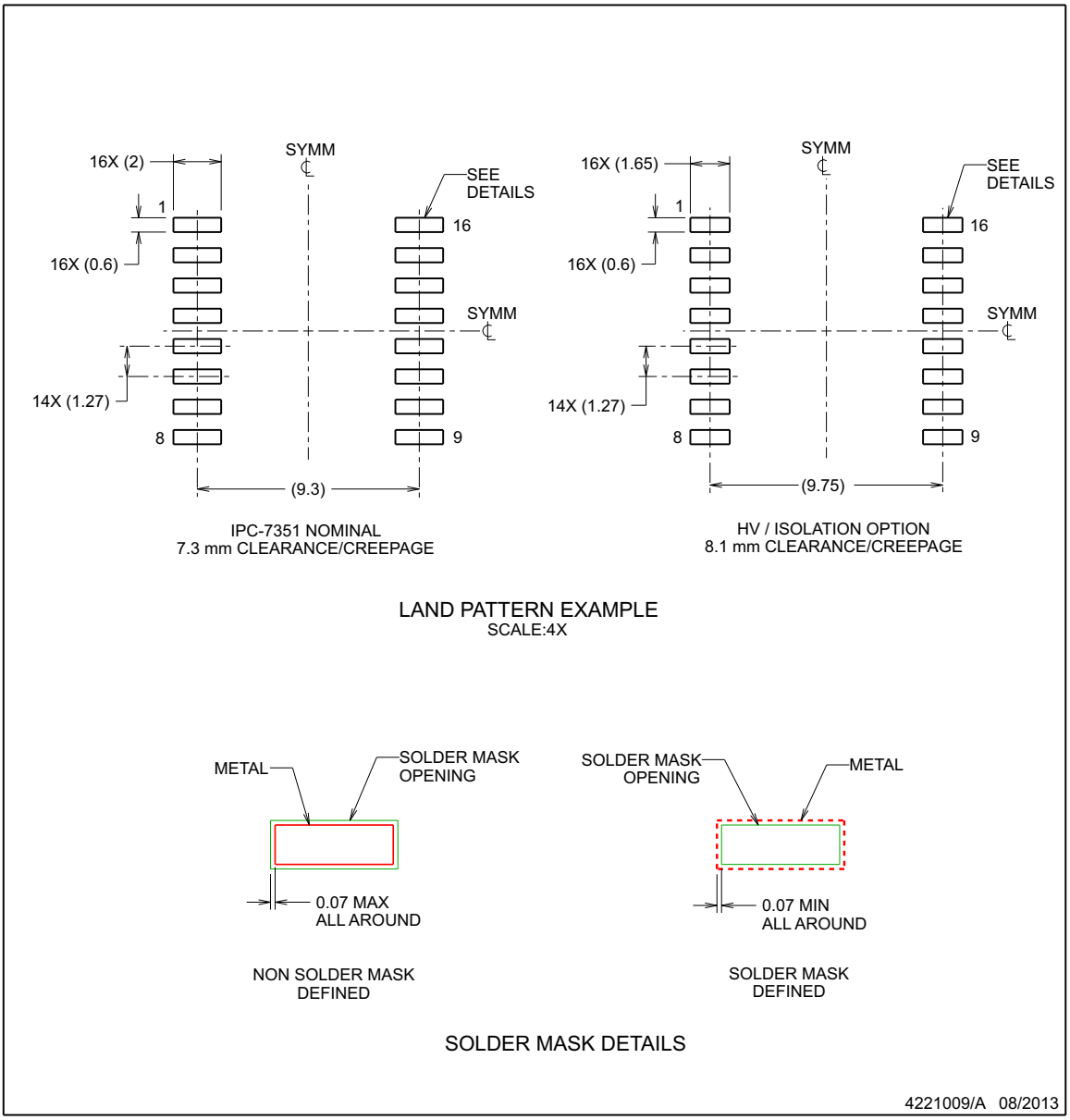
1. All linear dimensions are in millimeters. Dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm, per side.
4. This dimension does not include interlead flash. Interlead flash shall not exceed 0.25 mm, per side.
5. Reference JEDEC registration MO-013, variation AA.

EXAMPLE BOARD LAYOUT

DW0016B

SOIC - 2.65 mm max height

SOIC



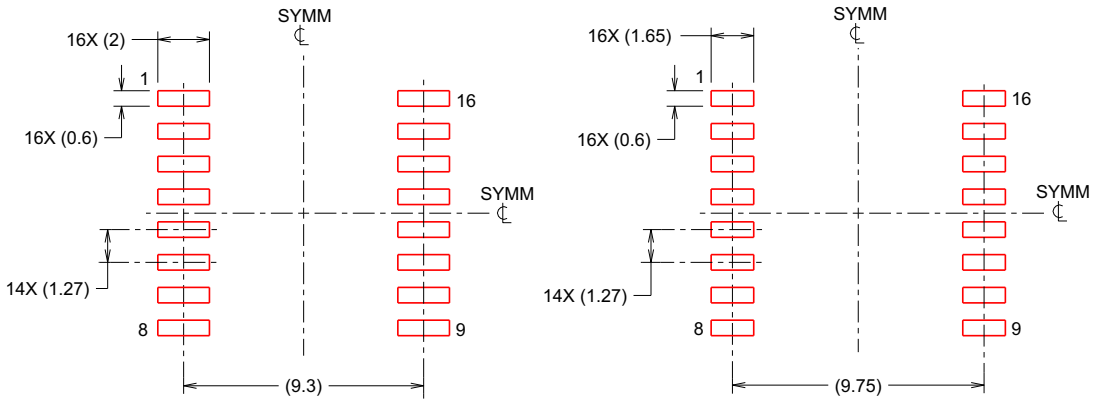
NOTES: (continued)

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

EXAMPLE STENCIL DESIGN

DW0016B — SOIC - 2.65 mm max height

SOIC



IPC-7351 NOMINAL
7.3 mm CLEARANCE/CREEPAGE

HV / ISOLATION OPTION
8.1 mm CLEARANCE/CREEPAGE

SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL
SCALE:4X

4221009/A 08/2013

NOTES: (continued)

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

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
ISO5452QDWQ1	LIFEBUY	SOIC	DW	16	40	RoHS & Green	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	ISO5452Q	
ISO5452QDWRQ1	ACTIVE	SOIC	DW	16	2000	RoHS & Green	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	ISO5452Q	Samples

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

(2) **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.

OTHER QUALIFIED VERSIONS OF ISO5452-Q1 :

- Catalog : ISO5452

NOTE: Qualified Version Definitions:

- Catalog - TI's standard catalog product

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郵送先住所：Texas Instruments, Post Office Box 655303, Dallas, Texas 75265