DRV8351-SEP：40V 3 相 BLDC ゲート ドライバ

1 特長

- 40V 三相ハーフブリッジ ゲートドライバ
  - N チャネル MOSFET (NMOS) を駆動
  - ゲートドライバ電源 (GVDD):5-15V
  - MOSFET 電源 (SHx) は最大 40V をサポート
- ターゲット放射線性能
  - SEL、SEB、SET 耐性:LET = 43MeV-cm2/mg (最大値)
  - SET および SEFI 特性:LET = 43MeV-cm2/mg (最大値)
  - すべてのウェハー ロットについて最大 30krad(Si) の吸収線量 (TID) を保証
  - 30krad(Si) まで、吸収線量 (TID) 特性を評価済み
- 宇宙用強化プラスチック (宇宙用 EP):
  - 管理されたベースライン
  - 単一のアセンブリ / テスト施設
  - 単一の製造施設
  - 長期にわたる製品ライフ サイクル
  - 製品のトレーサビリティ
- ブートストラップ ダイオードを内蔵
- 反転および非反転 INLx 入力をサポート
- ブートストラップ ゲート駆動アーキテクチャ
  - 750mA のソース電流
  - 1.5A のシンク電流
- SHx ピンの低リーク電流 (55µA 未満)
- 絶対最大 BSTx 電圧:57.5V
- SHx で -22V までの負の過渡電圧をサポート
- クロス導通防止機能を内蔵
- 200ns の固定デッドタイム挿入
- 3.3V および 5V ロジック入力 (絶対最大定格 20V) をサポート
- 4ns (標準値) の伝搬遅延マッチング
- 小型の TSSOP パッケージ
- パワー ブロックによる効率的なシステム設計
- 保護機能内蔵
  - BST 低電圧誤動作防止 (BSTUV)
  - GVDD 低電圧 (GVDDUV)

2 アプリケーション

防衛、航空宇宙、および医療アプリケーションをサポート

- スラスター ジンバル機構
- アンテナ ポインティング機構
- リアクション ホイール
- 推進剤コントロール バルブ

3 概要

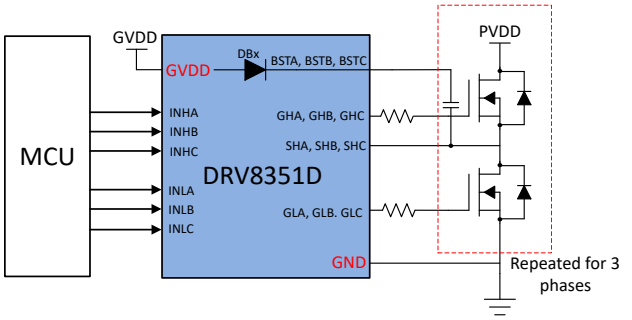
DRV8351-SEP は、ハイサイドおよびローサイド N チャネル パワー MOSFET を駆動できる 3 相ハーフブリッジ ゲート ドライバです。DRV8351-SEPD は、内蔵ブートストラップ ダイオードと外付けコンデンサを使ってハイサイド MOSFET のために適切なゲート駆動電圧を生成します。GVDD は、ローサイド MOSFET のゲート駆動電圧を生成するために使います。このゲート ドライブのアーキテクチャは、最大でソース 750mA、シンク 1.5A のピーク電流をサポートします。

位相ピン SHx は大きな負電圧過渡に耐えます。一方、ハイサイド ゲート ドライバ電源 BSTx および GHx はさらに大きな正電圧過渡 (絶対最大定格電圧 57.5V) に対応できるため、システムの堅牢性を高めることができます。伝搬遅延が短く、遅延マッチング仕様によりデッドタイムの要件が最小化されるため、さらに効率が向上します。GVDD と BST の低電圧誤動作防止による低電圧保護機能がローサイドとハイサイドの両方に備わっています。

製品情報 (1)

部品番号	パッケージ	パッケージ サイズ(2)	本体サイズ (公称)
DRV8351DMPWTSEP	TSSOP (20)	6.50mm × 6.40mm	6.40mm × 4.40mm
DRV8351DIMPWTSEP	TSSOP (20)	6.50mm × 6.40mm	6.40mm × 4.40mm

(1) 利用可能なすべてのパッケージについては、データシートの末尾にある注文情報を参照してください。
(2) パッケージ サイズ (長さ × 幅) は公称値であり、該当する場合はピンも含まれます。



概略回路図 (DRV8351-SEPD)

Table of Contents

4 Device Comparison Table

Device Variants	Package	Integrated Bootstrap Diode	GLx polarity with respect to INLx Input	Deadtime
DRV8351-SEPDI	20-Pin TSSOP	Yes	Inverted	Fixed
DRV8351-SEPD		Yes	Non-Inverted	Fixed

5 Pin Configuration and Functions

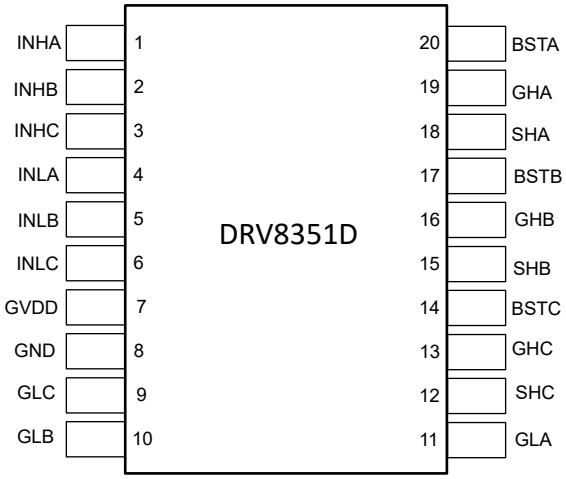


図 5-1. DRV8351-SEPD, DRV8351-SEPDI Package 20-Pin TSSOP Top View

表 5-1. Pin Functions—20-Pin DRV8351-SEP Devices

PIN		TYPE1	DESCRIPTION
NAME	NO.		
BSTA	20	O	Bootstrap output pin. Connect capacitor between BSTA and SHA
BSTB	17	O	Bootstrap output pin. Connect capacitor between BSTB and SHB
BSTC	14	O	Bootstrap output pin. Connect capacitor between BSTC and SHC
GHA	19	O	High-side gate driver output. Connect to the gate of the high-side power MOSFET.
GHB	16	O	High-side gate driver output. Connect to the gate of the high-side power MOSFET.
GHC	13	O	High-side gate driver output. Connect to the gate of the high-side power MOSFET.
GLA	11	O	Low-side gate driver output. Connect to the gate of the low-side power MOSFET.
GLB	10	O	Low-side gate driver output. Connect to the gate of the low-side power MOSFET.
GLC	9	O	Low-side gate driver output. Connect to the gate of the low-side power MOSFET.
INHA	1	I	High-side gate driver control input. This pin controls the output of the high-side gate driver.
INHB	2	I	High-side gate driver control input. This pin controls the output of the high-side gate driver.
INHC	3	I	High-side gate driver control input. This pin controls the output of the high-side gate driver.
INLA	4	I	Low-side gate driver control input. This pin controls the output of the low-side gate driver.
INLB	5	I	Low-side gate driver control input. This pin controls the output of the low-side gate driver.
INLC	6	I	Low-side gate driver control input. This pin controls the output of the low-side gate driver.
GND	8	PWR	Device ground.

表 5-1. Pin Functions—20-Pin DRV8351-SEP Devices (続き)

PIN		TYPE[1]	DESCRIPTION
NAME	NO.		
SHA	18	I	High-side source sense input. Connect to the high-side power MOSFET source.
SHB	15	I	High-side source sense input. Connect to the high-side power MOSFET source.
SHC	12	I	High-side source sense input. Connect to the high-side power MOSFET source.
GVDD	7	PWR	Gate driver power supply input. Connect a X5R or X7R, GVDD-rated ceramic and greater then or equal to 10-uF local capacitance between the GVDD and GND pins.

1. PWR = power, I = input, O = output, NC = no connection

6 Specifications

6.1 Absolute Maximum Ratings

over operating temperature range (unless otherwise noted)(1)

		MIN	MAX	UNIT
Gate driver regulator pin voltage	GVDD	-0.3	15	V
Bootstrap pin voltage	BSTx	-0.3	57.5	V
Bootstrap pin voltage	BSTx with respect to SHx	-0.3	15	V
Logic pin voltage	INHx, INLx	-0.3	V_{GVDD}+0.3	V
High-side gate drive pin voltage	GHx	-22	55	V
High-side gate drive pin voltage	GHx with respect to SHx	-0.3	15	V
Transient 500-ns high-side gate drive pin voltage	GHx with respect to SHx	-5	15	V
Low-side gate drive pin voltage	GLx	-0.3	V_{GVDD}+0.3	V
Transient 500-ns low-side gate drive pin voltage	GLx	-5	V_{GVDD}+0.3	V
High-side source pin voltage	SHx	-22	42.5	V
Ambient temperature, T_A		–55	125	°C
Junction temperature, T_J		–55	150	°C
Storage temperature, T_{stg}		–65	150	°C

(1) Operation outside the Absolute Maximum Ratings may cause permanent device damage. Absolute Maximum Ratings do not imply functional operation of the device at these or any other conditions beyond those listed under Recommended Operating Conditions. If used outside the Recommended Operating Conditions but within the Absolute Maximum Ratings, the device may not be fully functional, and this may affect device reliability, functionality, performance, and shorten the device lifetime

6.2 ESD Ratings Comm

			VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human body model (HBM), per ANSI/ESDA/JEDEC JS-001(1)	±1000	V
		Charged device model (CDM), per JEDEC specification JESD22-C101(2)	±250	

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

6.3 Recommended Operating Conditions

over operating temperature range (unless otherwise noted)

			MIN	NOM	MAX	UNIT
V_{GVDD}	Power supply voltage	GVDD	5		15	V
V_{SHx}	High-side source pin voltage	SHx	-2		40	V
V_{SHx}	Transient 2µs high-side source pin voltage	SHx	-22		40	V
V_{BST}	Bootstrap pin voltage	BSTx	5		55	V
V_{BST}	Bootstrap pin voltage	BSTx with respect to SHx	5		15	V
V_{IN}	Logic input voltage	INHx, INLx	0		GVDD	V
f_{PWM}	PWM frequency	INHx, INLx	0		100	kHz
V_{SHSL}	Slew rate on SHx pin				2	V/ns
C_{BOOT} (1)	Capacitor between BSTx and SHx				1	µF
T_A	Operating ambient temperature		–55		125	°C
T_J	Operating junction temperature		–55		150	°C

(1) Current flowing through boot diode (D_{BOOT}) needs to be limited for C_{BOOT} > 1µF

6.4 Thermal Information

THERMAL METRIC(1)		DRV8351-SEP PW (TSSOP) 20 PINS	UNIT
$R_{\theta JA}$	Junction-to-ambient thermal resistance	97.4	°C/W
$R_{\theta JC(top)}$	Junction-to-case (top) thermal resistance	38.3	°C/W
$R_{\theta JB}$	Junction-to-board thermal resistance	48.8	°C/W
Ψ_{JT}	Junction-to-top characterization parameter	4.3	°C/W
Ψ_{JB}	Junction-to-board characterization parameter	48.4	°C/W
$R_{\theta JC(bot)}$	Junction-to-case (bottom) thermal resistance	N/A	°C/W

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

6.5 Electrical Characteristics

4.8 V ≤ V_{GVDD} ≤ 20 V, –55°C ≤ T_J ≤ 150°C (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
POWER SUPPLIES (GVDD, BSTx)						
I_{GVDD}	GVDD standby mode current	INHx = INLX = 0; V_{BSTx} = V_{GVDD}	400	800	1500	µA
	GVDD active mode current	INHx = INLX = Switching @20kHz; V_{BSTx} = V_{GVDD}; NO FETs connected	400	825	1500	µA
IL_{BSx}	Bootstrap pin leakage current	V_{BSTx} = V_{SHx} = 40V; V_{GVDD} = 0V	2	7	13	µA
IL_{BS_TRAN}	Bootstrap pin active mode transient leakage current	INHx = Switching@20kHz	30	105	220	µA
IL_{BS_DC}	Bootstrap pin active mode leakage static current	INHx = High	30	85	150	µA
IL_{SHx}	High-side source pin leakage current	INHx = INLX = 0; V_{BSTx} - V_{SHx} = 12V; V_{SHx} = 0 to 40V	30	55	90	µA
LOGIC-LEVEL INPUTS (INHx, INLx, MODE)						
V_{IL}	Input logic low voltage	INLx, INHx pins			0.8	V
V_{HYS}	Input hysteresis	INLx, INHx pins	40	100	260	mV
I_{IL_INLx}	INLx Input logic low current	V_{PIN} (Pin Voltage) = 0 V; INLx in non-inverting mode	-1	0	1	µA
I_{IH_INLx}	INLx Input logic high current	V_{PIN} (Pin Voltage) = 5 V; INLx in non-inverting mode	5	20	30	µA
I_{IL}	INHx Input logic low current	V_{PIN} (Pin Voltage) = 0 V;	-1	0	1	µA
I_{IH}	INHx Input logic high current	V_{PIN} (Pin Voltage) = 5 V;	5	20	30	µA
R_{PD_INHx}	INHx Input pulldown resistance	To GND	120	200	280	kΩ
R_{PD_INLx}	INLx Input pulldown resistance	To GND, INLx in non-inverting mode	120	200	280	kΩ
R_{PD_MODE}	MODE Input pulldown resistance	To GND	120	200	280	kΩ
GATE DRIVERS (GHx, GLx, SHx, SLx)						
V_{GHx_LO}	High-side gate drive low level voltage	I_{GLx} = -100 mA; V_{GVDD} = 12V; No FETs connected	0	0.15	0.35	V
V_{GHx_HI}	High-side gate drive high level voltage (V_{BSTx} - V_{GHx})	I_{GHx} = 100 mA; V_{GVDD} = 12V; No FETs connected	0.3	0.6	1.2	V
V_{GLx_LO}	Low-side gate drive low level voltage	I_{GLx} = -100 mA; V_{GVDD} = 12V; No FETs connected	0	0.15	0.35	V
V_{GLx_HI}	Low-side gate drive high level voltage (V_{GVDD} - V_{GHx})	I_{GHx} = 100 mA; V_{GVDD} = 12V; No FETs connected	0.3	0.6	1.2	V
I_{DRIVEP_HS}	High-side peak source gate current	GHx-SHx = 12V	400	750	1200	mA
I_{DRIVEN_HS}	High-side peak sink gate current	GHx-SHx = 0V	850	1500	2100	mA

4.8 V ≤ V_{GVDD} ≤ 20 V, –55°C ≤ T_J ≤ 150°C (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
I_{DRIVEP_LS}	Low-side peak source gate current	GLx = 12V	400	750	1200	mA
I_{DRIVEN_LS}	Low-side peak sink gate current	GLx = 0V	850	1500	2100	mA
t_{PD}	Input to output propagation delay	INHx, INLx to GHx, GLx; V_{GVDD} = V_{BSTx} - V_{SHx} > 8V; SHx = 0V, No load on GHx and GLx	70	125	180	ns
t_{PD_match}	Matching propagation delay per phase	GHx turning OFF to GLx turning ON, GLx turning OFF to GHx turning ON; V_{GVDD} = V_{BSTx} - V_{SHx} > 8V; SHx = 0V, No load on GHx and GLx	-30	±4	30	ns
t_{PD_match}	Matching propagation delay phase to phase	GHx/GLx turning ON to GHy/GLy turning ON, GHx/GLx turning OFF to GHy/GLy turning OFF; V_{GVDD} = V_{BSTx} - V_{SHx} > 8V; SHx = 0V, No load on GHx and GLx	-30	±4	30	ns
t_{R_GLx}	GLx rise time (10% to 90%)	C_{LOAD} = 1000 pF; V_{GVDD} = V_{BSTx} - V_{SHx} > 8V; SHx = 0V	10	24	50	ns
t_{R_GHx}	GHx rise time (10% to 90%)	C_{LOAD} = 1000 pF; V_{GVDD} = V_{BSTx} - V_{SHx} > 8V; SHx = 0V	10	24	50	ns
t_{F_GLx}	GLx fall time (90% to 10%)	C_{LOAD} = 1000 pF; V_{GVDD} = V_{BSTx} - V_{SHx} > 8V; SHx = 0V	5	12	30	ns
t_{F_GHx}	GHx fall time (90% to 10%)	C_{LOAD} = 1000 pF; V_{GVDD} = V_{BSTx} - V_{SHx} > 8V; SHx = 0V	5	12	30	ns
t_{DEAD}	Gate drive dead time		150	215	280	ns
t_{PW_MIN}	Minimum input pulse width on INHx, INLx that changes the output on GHx, GLx		40	70	150	ns
BOOTSTRAP DIODES						
V_{BOOTD}	Bootstrap diode forward voltage	I_{BOOT} = 100 µA	0.45	0.7	0.85	V
		I_{BOOT} = 100 mA	2	2.3	3.1	V
R_{BOOTD}	Bootstrap dynamic resistance ($\Delta V_{BOOTD}/\Delta I_{BOOT}$)	I_{BOOT} = 100 mA and 80 mA	11	15	25	Ω
PROTECTION CIRCUITS						
V_{GVDDUV}	Gate Driver Supply undervoltage lockout (GVDDUV)	Supply rising	4.45	4.6	4.7	V
		Supply falling	4.2	4.35	4.4	V
V_{GVDDUV_HYS}	Gate Driver Supply UV hysteresis	Rising to falling threshold	250	280	310	mV
t_{GVDDUV}	Gate Driver Supply undervoltage deglitch time		5	10	13	µs
V_{BSTUV}	Boot Strap undervoltage lockout (V_{BSTx} - V_{SHx})	Supply rising	3.6	4.2	4.8	V
	Boot Strap undervoltage lockout (V_{BSTx} - V_{SHx})	Supply falling	3.5	4	4.5	V
V_{BSTUV_HYS}	Bootstrap UV hysteresis	Rising to falling threshold		200		mV
t_{BSTUV}	Bootstrap undervoltage deglitch time		6	10	22	µs

6.6 Timing Diagrams

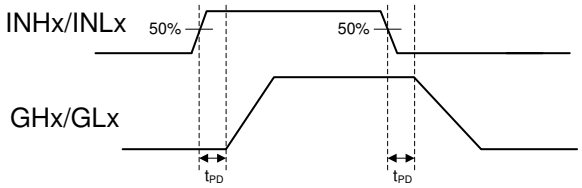


図 6-1. Propagation Delay(t_{PD})

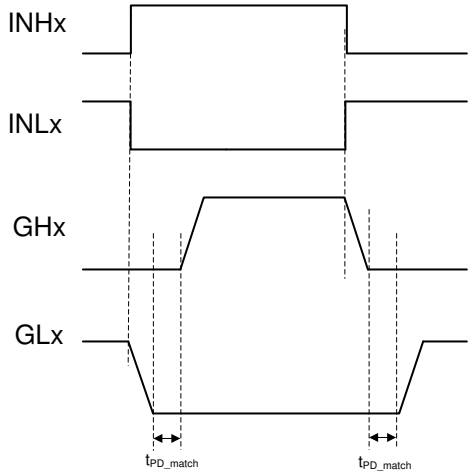


図 6-2. Propagation Delay Match (t_{PD_match})

6.7 Typical Characteristics

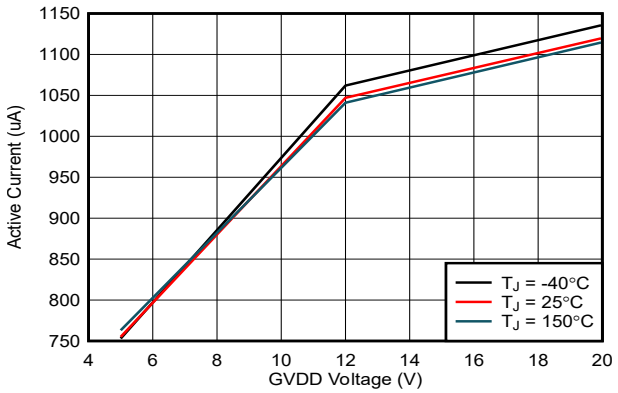


図 6-3. Supply Current Over GVDD Voltage

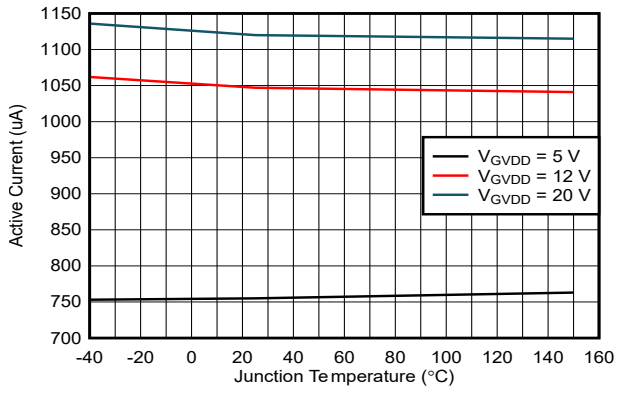


図 6-4. Supply Current Over Temperature

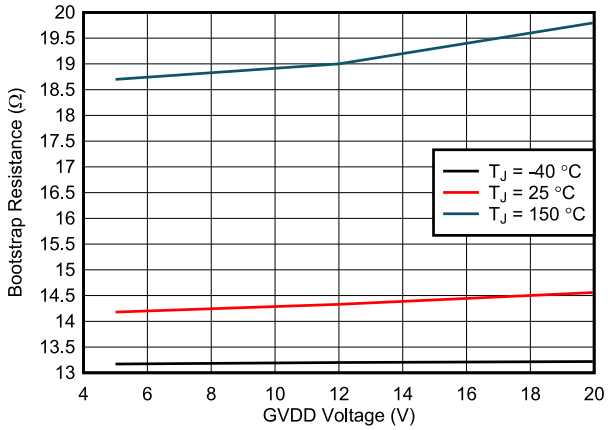


図 6-5. Bootstrap Resistance Over GVDD Voltage

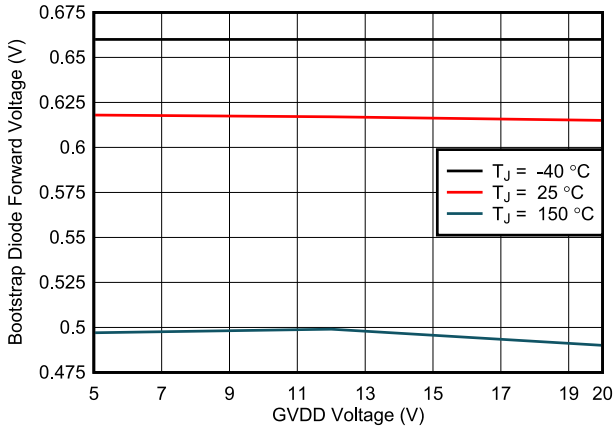


図 6-6. Bootstrap Diode Forward Voltage over GVDD Voltage

7 Detailed Description

7.1 Overview

The DRV8351-SEP family of devices are gate drivers for three-phase motor drive applications. These devices decrease system component count, saves PCB space and cost by integrating three independent half-bridge gate drivers and optional bootstrap diodes.

DRV8351-SEP supports external N-channel high-side and low-side power MOSFETs and can drive 750mA source, 1.5A sink peak currents with a total combined 30mA average output current. The DRV8351-SEP family of devices are available in 0.65mm pitch TSSOP surface-mount packages. The TSSOP body size is 6.5 × 4.4mm (0.65mm pin pitch) for the 20-pin package.

7.2 Functional Block Diagram

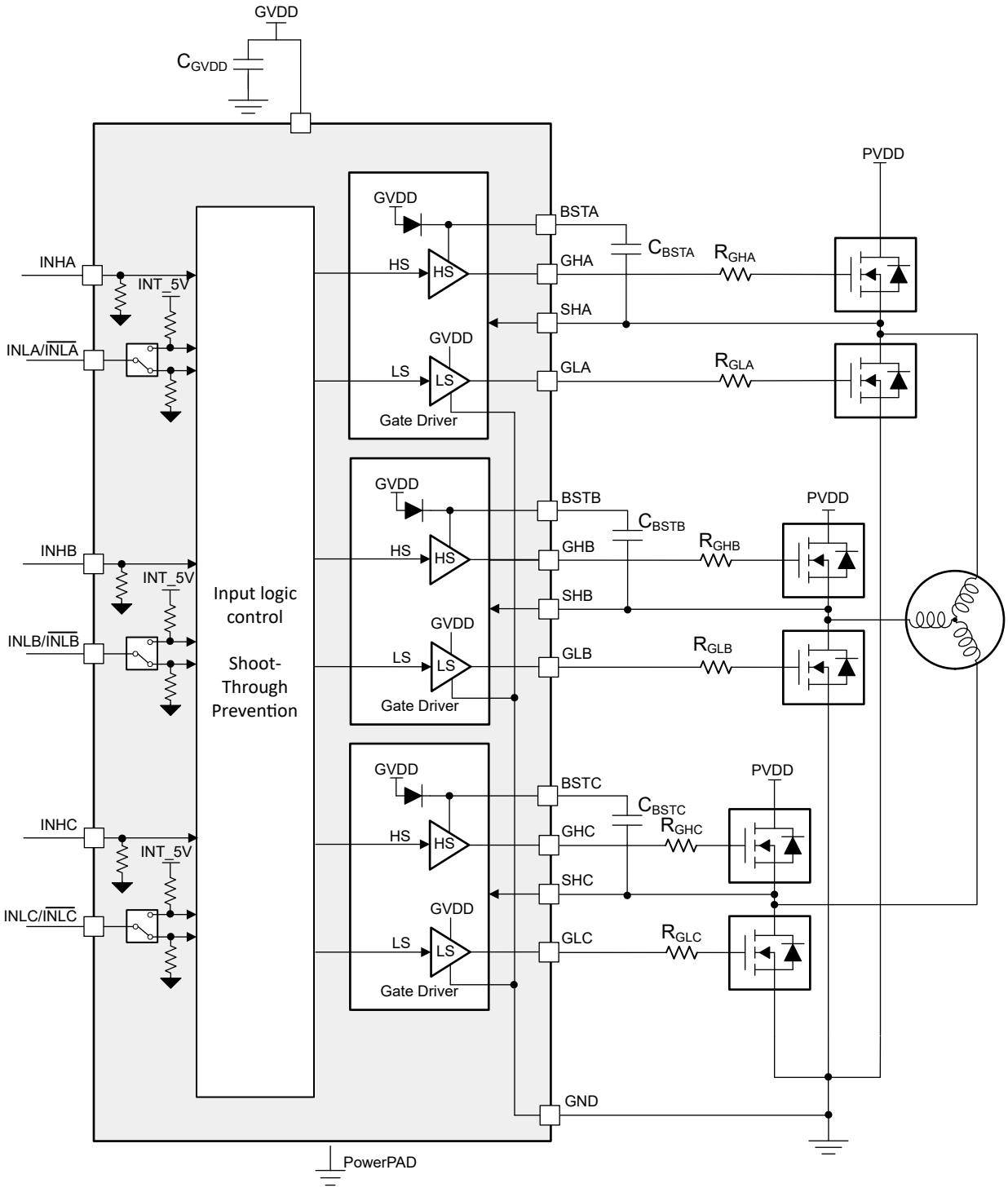


図 7-1. Block Diagram for DRV8351-SEPD

7.3 Feature Description

7.3.1 Three BLDC Gate Drivers

The DRV8351-SEP integrates three half-bridge gate drivers, each capable of driving high-side and low-side N-channel power MOSFETs. Input on GVDD provides the gate bias voltage for the low-side MOSFETs. The high voltage is generated using bootstrap capacitors and GVDD supply. The half-bridge gate drivers can be used in combination to drive a three-phase motor or separately to drive other types of loads.

7.3.1.1 Gate Driver Timings

7.3.1.1.1 Propagation Delay

The propagation delay time (t_{pd}) is measured as the time between an input logic edge to a detected output change. This time has two parts consisting of the input deglitcher delay and the delay through the analog gate drivers.

The input deglitcher prevents high-frequency noise on the input pins from affecting the output state of the gate drivers. The analog gate drivers have a small delay that contributes to the overall propagation delay of the device.

7.3.1.1.2 Deadtime and Cross-Conduction Prevention

In the DRV8351-SEP, high-side and low-side inputs operate independently, with an exception to prevent cross conduction when high and low side are turned ON at the same time. The DRV8351-SEP turns OFF high-side and low-side output to prevent shoot through when both high-side and low-side inputs are at logic HIGH at the same time.

In DRV8351D-SEP, fixed deadtime of 200 ns (typical value) is inserted to prevent high and low side gate output turning ON at same time.

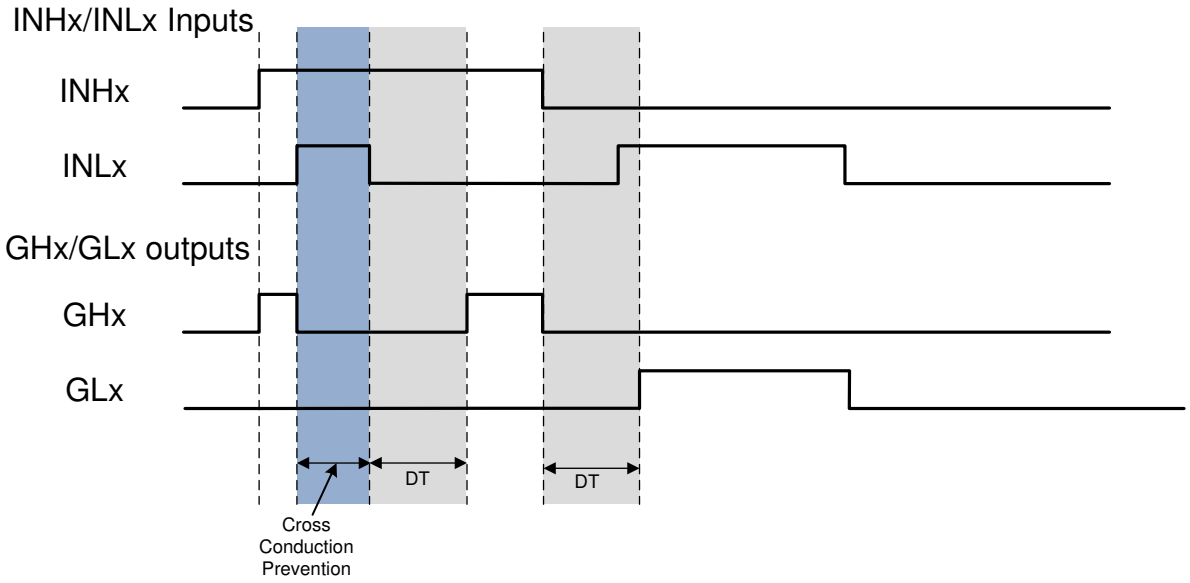


図 7-2. Cross Conduction Prevention and Deadtime Insertion

7.3.1.2 Mode (Inverting and non inverting INLx)

The DRV8351-SEP has flexibility of accepting different kind of inputs on INLx. In DRV8351-SEP, there are different device options available for inverting and non inverting inputs (see セクション 4).

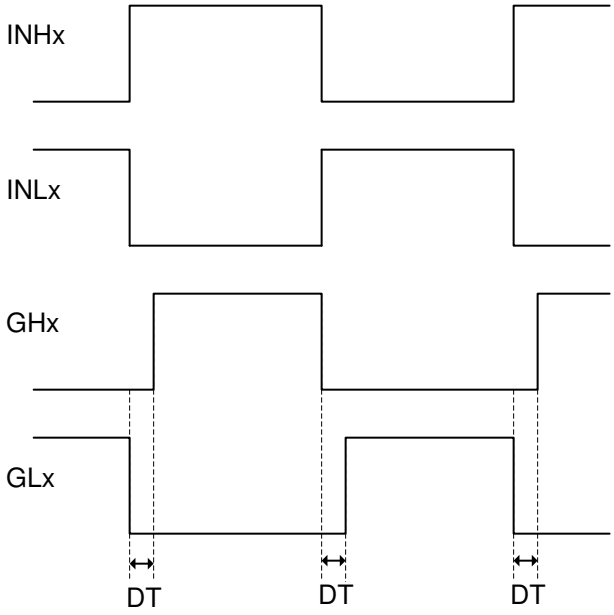


図 7-3. Non-Inverted INLx inputs

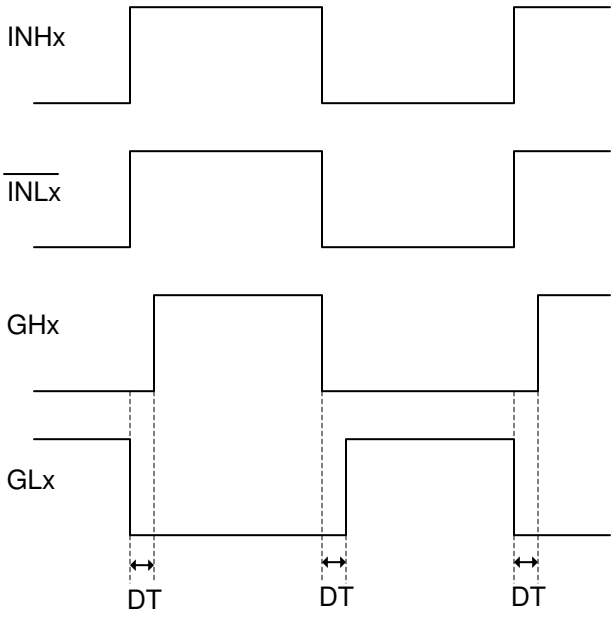


図 7-4. Inverted INLx inputs

7.3.2 Pin Diagrams

図 7-5 shows the input structure for the logic level pins INHx, INLx. INHx and non-inverted INLx has passive pull down, so when inputs are floating the output the gate driver will be pulled low. 図 7-6 shows the input structure for the inverted INLx pins. The inverted INLx has passive pull up, so when inputs are floating the output of the low-side gate driver will be pulled low.

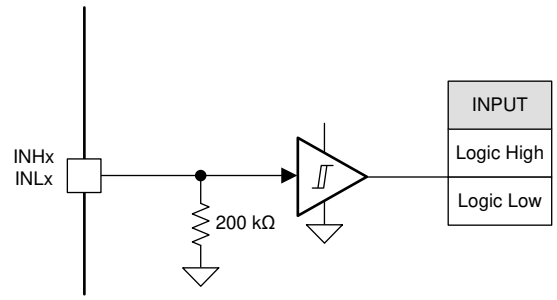


図 7-5. INHx and non-inverted INLx Logic-Level Input Pin Structure

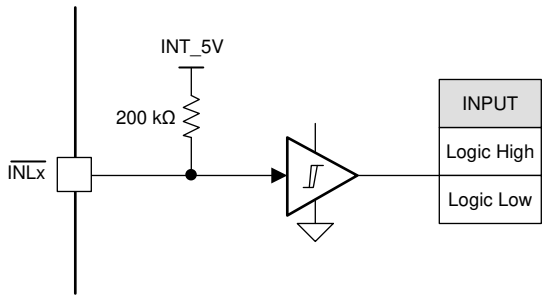


図 7-6. Inverted INLx Logic-Level Input Pin Structure

7.3.3 Gate Driver Protective Circuits

The DRV8351-SEP is protected against BSTx undervoltage and GVDD undervoltage events.

表 7-1. Fault Action and Response

FAULT	CONDITION	GATE DRIVER	RECOVERY
V_{BSTx} undervoltage (BSTUV)	$V_{BSTx} < V_{BSTUV}$	GHx - Hi-Z	Automatic: $V_{BSTx} > V_{BSTUV}$ and low to high PWM edge detected on INHx pin
GVDD undervoltage (GVDDUV)	$V_{GVDD} < V_{GVDDUV}$	Hi-Z	Automatic: $V_{GVDD} > V_{GVDDUV}$

7.3.3.1 V_{BSTx} Undervoltage Lockout (BSTUV)

The DRV8351-SEP has separate voltage comparator to detect undervoltage condition for each phases. If at any time the voltage on the BSTx pin falls lower than the V_{BSTUV} threshold, high side external MOSFETs of that particular phase is disabled by disabling (Hi-Z) GHx pin. Normal operation starts again when the BSTUV condition clears and low to high PWM edge is detected on INHx input of the same phase that BSTUV condition was detected. BSTUV protection ensures that high-side MOSFETs are not driven when the BSTx pins has lower value.

7.3.3.2 GVDD Undervoltage Lockout (GVDDUV)

If at any time the voltage on the GVDD pin falls lower than the V_{GVDDUV} threshold voltage, all of the external MOSFETs are disabled. Normal operation starts again when the GVDDUV condition clears. GVDDUV protection ensures that external MOSFETs are not driven when the GVDD input is at lower value.

7.4 Device Functional Modes

The DRV8351-SEP is in operating (active) mode, whenever the GVDD and BST pins are higher than the UV threshold (GVDD > $V_{GVDDUV}$and V_{BSTX} > V_{BSTUV}). In active mode, the gate driver output GHx and GLX will follow respective inputs INHx and INLx.

8 Application and Implementation

注

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

8.1 Application Information

The DRV8351-SEP family of devices is primarily used in applications for three-phase brushless DC motor control. The design procedures in the *セクション 8.2* section highlight how to use and configure the DRV8351-SEP.

8.2 Typical Application

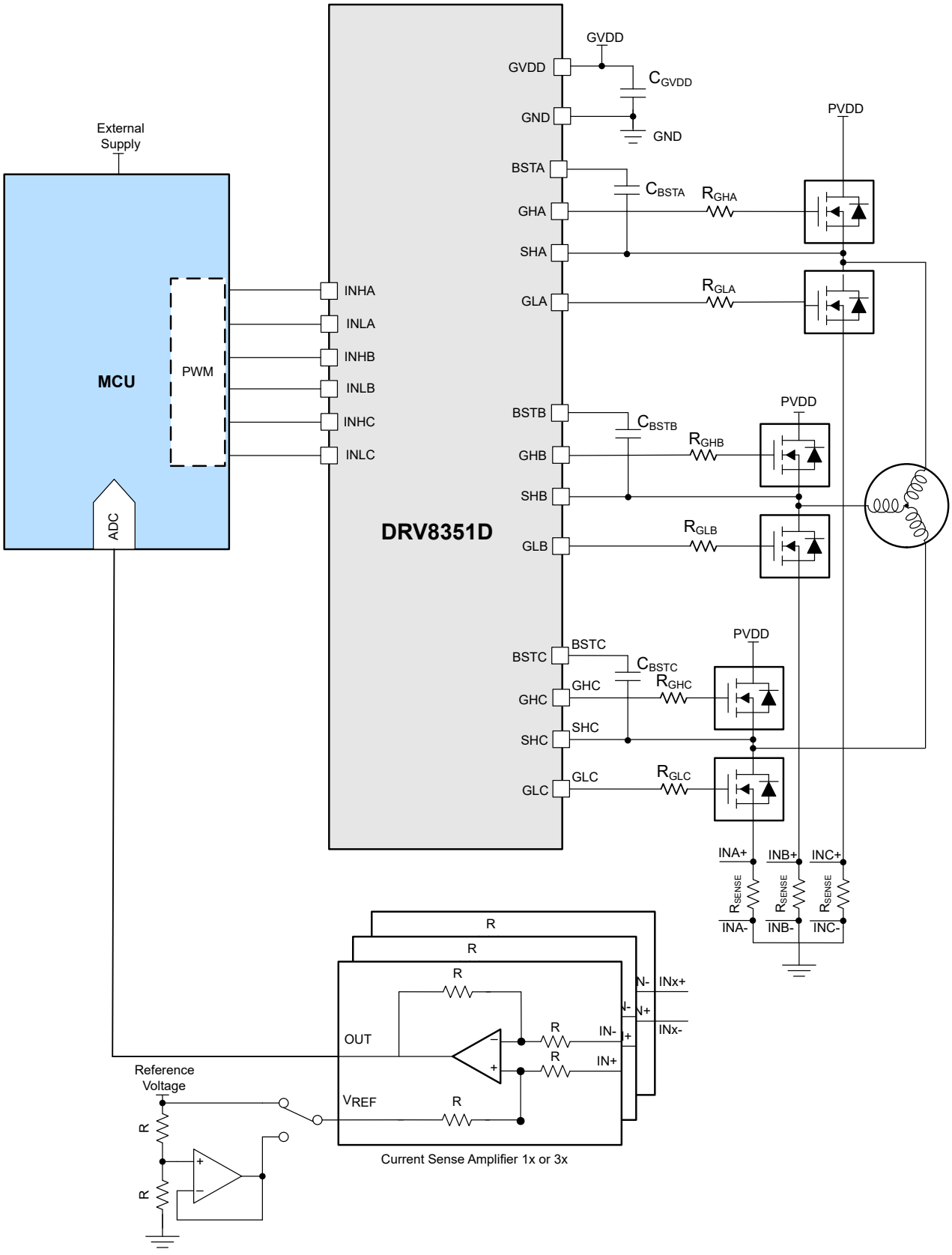


図 8-1. Application Schematic

8.2.1 Design Requirements

表 8-1 lists the example design input parameters for system design.

表 8-1. Design Parameters

EXAMPLE DESIGN PARAMETER	REFERENCE	EXAMPLE VALUE
MOSFET	-	CSD19532Q5B
Gate Supply Voltage	V_{GVDD}	12V
Gate Charge	Q_G	48nC

8.2.2 Bootstrap Capacitor and GVDD Capacitor Selection

The bootstrap capacitor must be sized to maintain the bootstrap voltage above the undervoltage lockout for normal operation. 式 1 calculates the maximum allowable voltage drop across the bootstrap capacitor:

$$\Delta V_{BSTX} = V_{GVDD} - V_{BOOTD} - V_{BSTUV} \quad (1)$$

=12V – 0.85V – 4.5V = 6.65V

where

- V_{GVDD} is the supply voltage of the gate drive
- V_{BOOTD} is the forward voltage drop of the bootstrap diode
- V_{BSTUV} is the threshold of the bootstrap undervoltage lockout

In this example the allowed voltage drop across bootstrap capacitor is 6.65V. It is generally recommended that ripple voltage on both the bootstrap capacitor and GVDD capacitor should be minimized as much as possible. Many commercial, industrial, and automotive applications use ripple values between 0.5V to 1V.

The total charge needed per switching cycle can be estimated with 式 2:

$$Q_{TOT} = Q_G + \frac{IL_{BS\_TRANS}}{f_{SW}} \quad (2)$$

=48nC + 220µA/20kHz = 50nC + 11nC = 59nC

where

- Q_G is the total MOSFET gate charge
- I_{LBS_TRAN} is the bootstrap pin leakage current
- f_{SW} is the is the PWM frequency

The minimum bootstrap capacitor an then be estimated as below assuming 1V ΔV_{BSTx}:

$$C_{BST\_MIN} = {Q_{TOT}}/{\Delta V_{BSTX}} \quad (3)$$

= 59nC / 1V = 59nF

The calculated value of the minimum bootstrap capacitor is 59nF. It should be noted that this value of capacitance is needed at full bias voltage. In practice, the value of the bootstrap capacitor must be greater than the calculated value to allow for situations where the power stage may skip pulse due to various transient conditions. It is recommended to use a 100nF bootstrap capacitor in this example. It is also recommended to include enough margin and place the bootstrap capacitor as close to the BSTx and SHx pins as possible.

$$C_{GVDD} \geq 10 \times C_{BSTX} \quad (4)$$

= 10*100nF= 1µF

For this example application choose 1µF C_{GVDD} capacitor. Choose a capacitor with a voltage rating at least twice the maximum voltage that it will be exposed to because most ceramic capacitors lose significant capacitance when biased. This value also improves the long term reliability of the system.

8.2.3 Application Curves

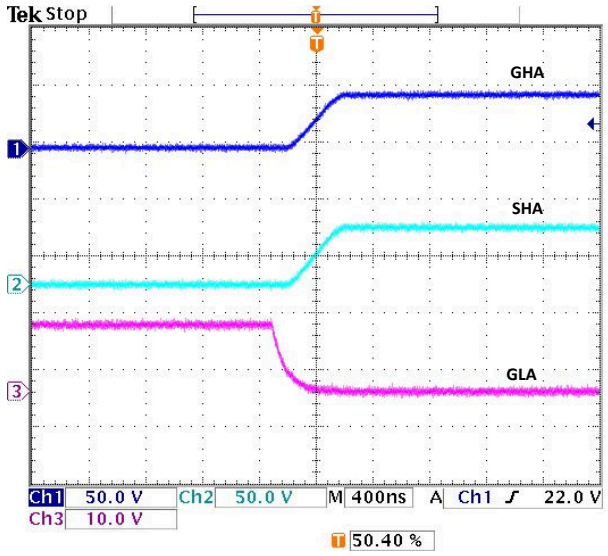


図 8-2. Gate voltages, SHx rising with 15ohm gate resistor and CSD19532Q5B MOSFET

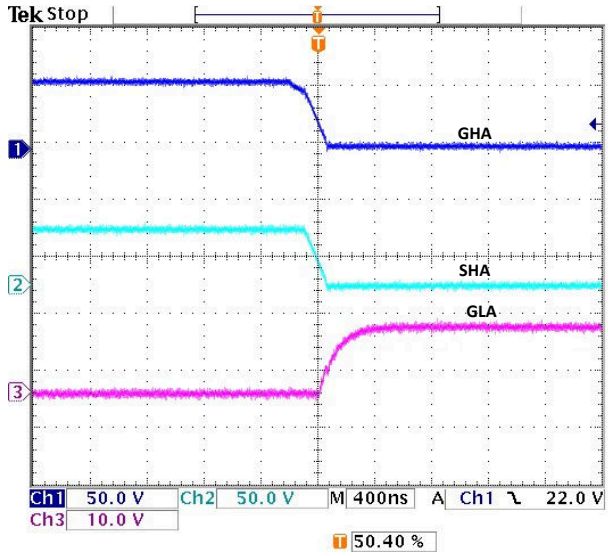


図 8-3. Gate voltages, SHx falling with 15ohm gate resistor and CSD19532Q5B MOSFET

9 Power Supply Recommendations

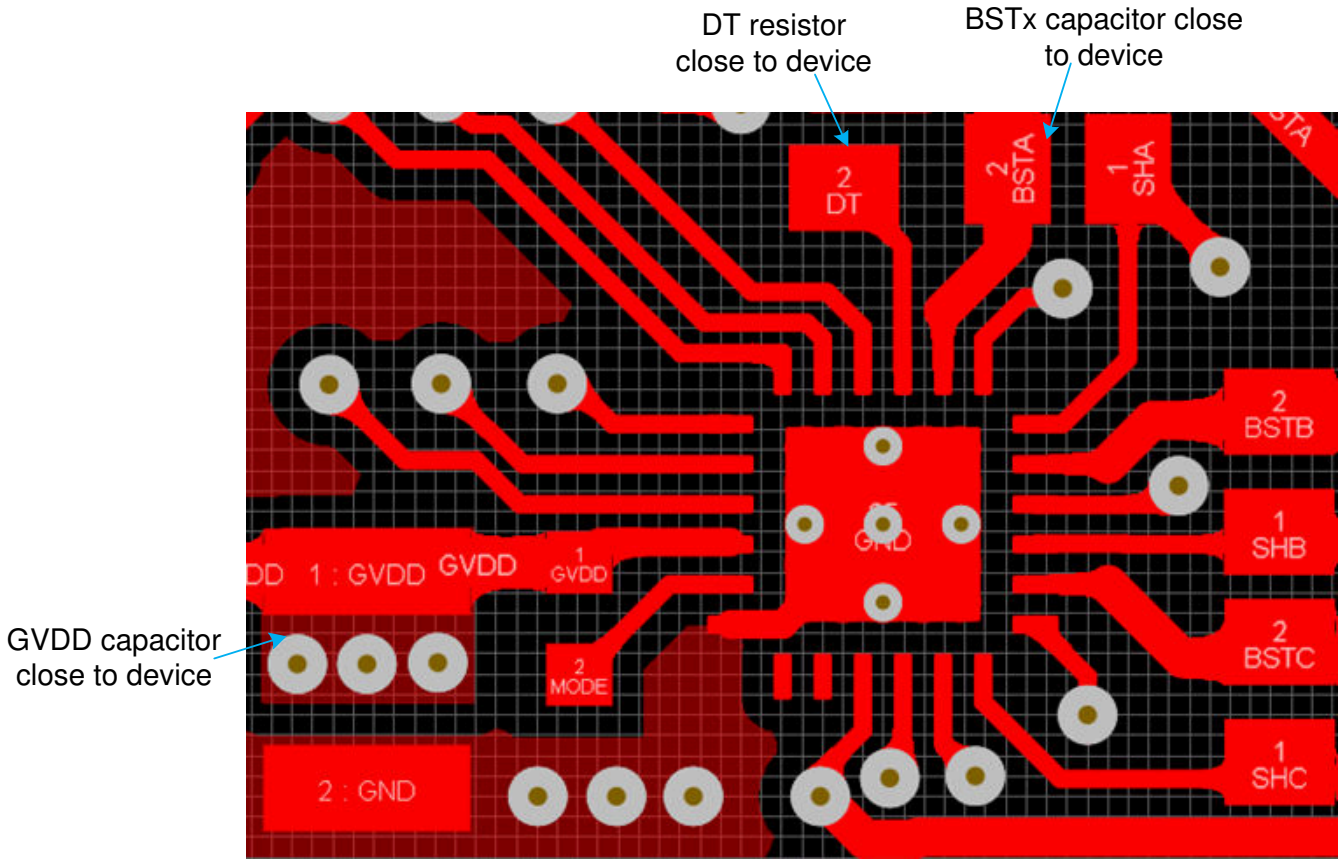
The DRV8351-SEP is designed to operate from an input voltage supply (GVDD) range from 4.8V to 15V. A local bypass capacitor should be placed between the GVDD and GND pins. This capacitor should be located as close to the device as possible. A low ESR, ceramic surface mount capacitor is recommended. It is recommended to use two capacitors across GVDD and GND: a low capacitance ceramic surface-mount capacitor for high frequency filtering placed very close to GVDD and GND pin, and another high capacitance value surface mount capacitor for device bias requirements. Similarly, the current pulses delivered by the GHx pins are sourced from the BSTx pins. Therefore, a capacitor across the BSTx to SHx is recommended, it should be a high enough capacitance value capacitor to deliver GHx pulses.

10 Layout

10.1 Layout Guidelines

- Low ESR/ESL capacitors must be connected close to the device between GVDD and GND and between BSTx and SHx pins to support high peak currents drawn from GVDD and BSTx pins during the turn-on of the external MOSFETs.
- To prevent large voltage transients at the drain of the top MOSFET, a low ESR electrolytic capacitor and a good quality ceramic capacitor must be connected between the high side MOSFET drain and ground.
- In order to avoid large negative transients on the switch node (SHx) pin, the parasitic inductances between the source of the high-side MOSFET and the source of the low-side MOSFET must be minimized.
- In order to avoid unexpected transients, the parasitic inductance of the GHx, SHx, and GLx connections must be minimized. Minimize the trace length and number of vias wherever possible. Minimum 10mil and typical 15mil trace width is recommended.
- Place the gate driver as close to the MOSFETs as possible. Confine the high peak currents that charge and discharge the MOSFET gates to a minimal physical area by reducing trace length. This confinement decreases the loop inductance and minimize noise issues on the gate terminals of the MOSFETs.
- Refer to sections *General Routing Techniques and MOSFET Placement and Power Stage Routing* in Application Report

10.2 Layout Example



11 Device and Documentation Support

11.1 ドキュメントの更新通知を受け取る方法

ドキュメントの更新についての通知を受け取るには、www.tij.co.jp のデバイス製品フォルダを開いてください。[通知] をクリックして登録すると、変更されたすべての製品情報に関するダイジェストを毎週受け取ることができます。変更の詳細については、改訂されたドキュメントに含まれている改訂履歴をご覧ください。

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ESD による破損は、わずかな性能低下からデバイスの完全な故障まで多岐にわたります。精密な IC の場合、パラメータがわずかに変化するだけで公表されている仕様から外れる可能性があるため、破損が発生しやすくなっています。

11.5 用語集

テキサス・インスツルメンツ用語集　　この用語集には、用語や略語の一覧および定義が記載されています。

12 Revision History

資料番号末尾の英字は改訂を表しています。その改訂履歴は英語版に準じています。

DATE	REVISION	NOTES
December 2024	*	Initial Release

13 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 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
DRV8351DIMPWTSEP	ACTIVE	TSSOP	PW	20	250	RoHS & Green	NIPDAU	Level-2-260C-1 YEAR	-55 to 125	8351DIM	Samples
V62/24612-01XE	ACTIVE	TSSOP	PW	20	250	RoHS & Green	NIPDAU	Level-2-260C-1 YEAR	-55 to 125	8351DIM	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.

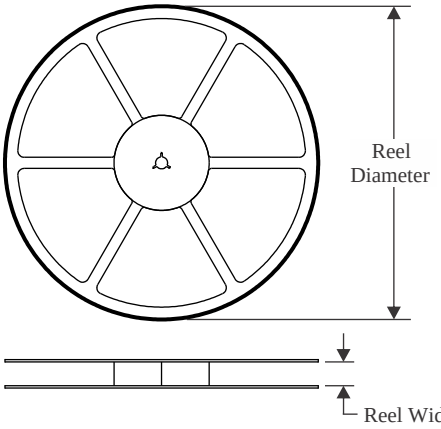
(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(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.

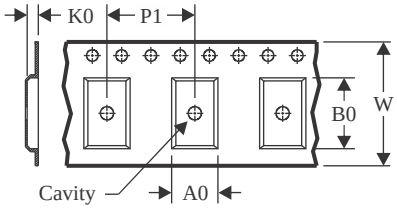
(6) Lead finish/Ball material - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

TAPE AND REEL INFORMATION

REEL DIMENSIONS

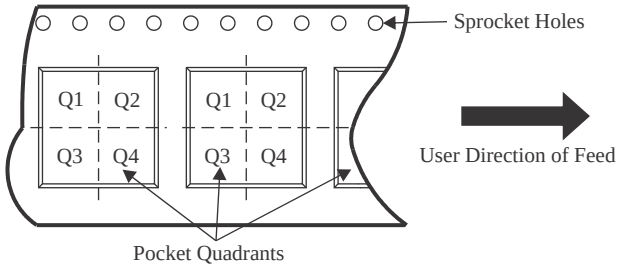


TAPE DIMENSIONS



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

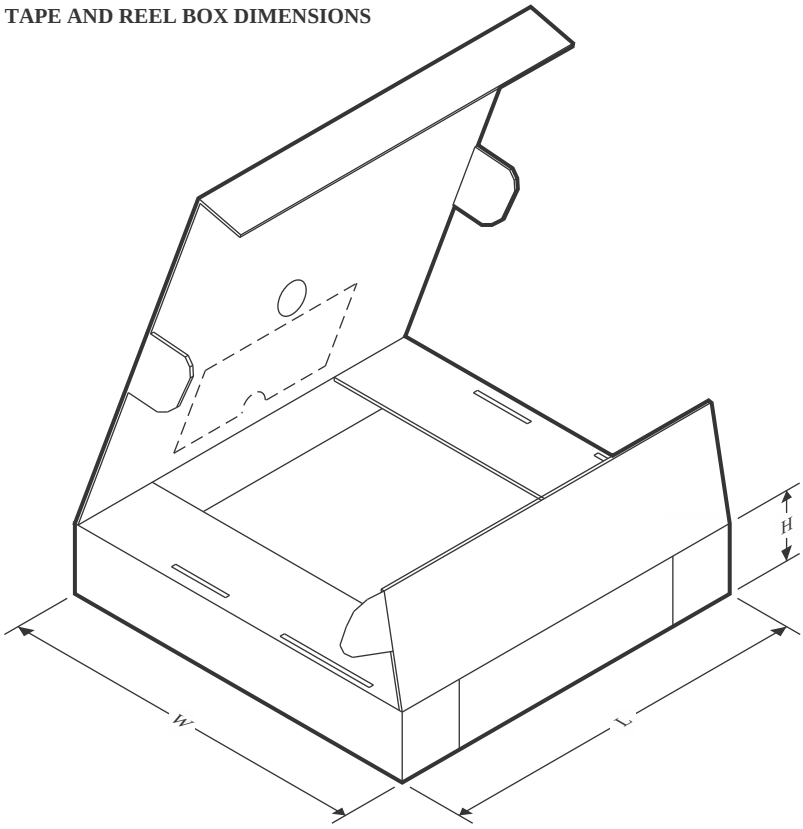
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
DRV8351DIMPWTSEP	TSSOP	PW	20	250	330.0	16.4	6.95	7.1	1.6	8.0	16.0	Q1

TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

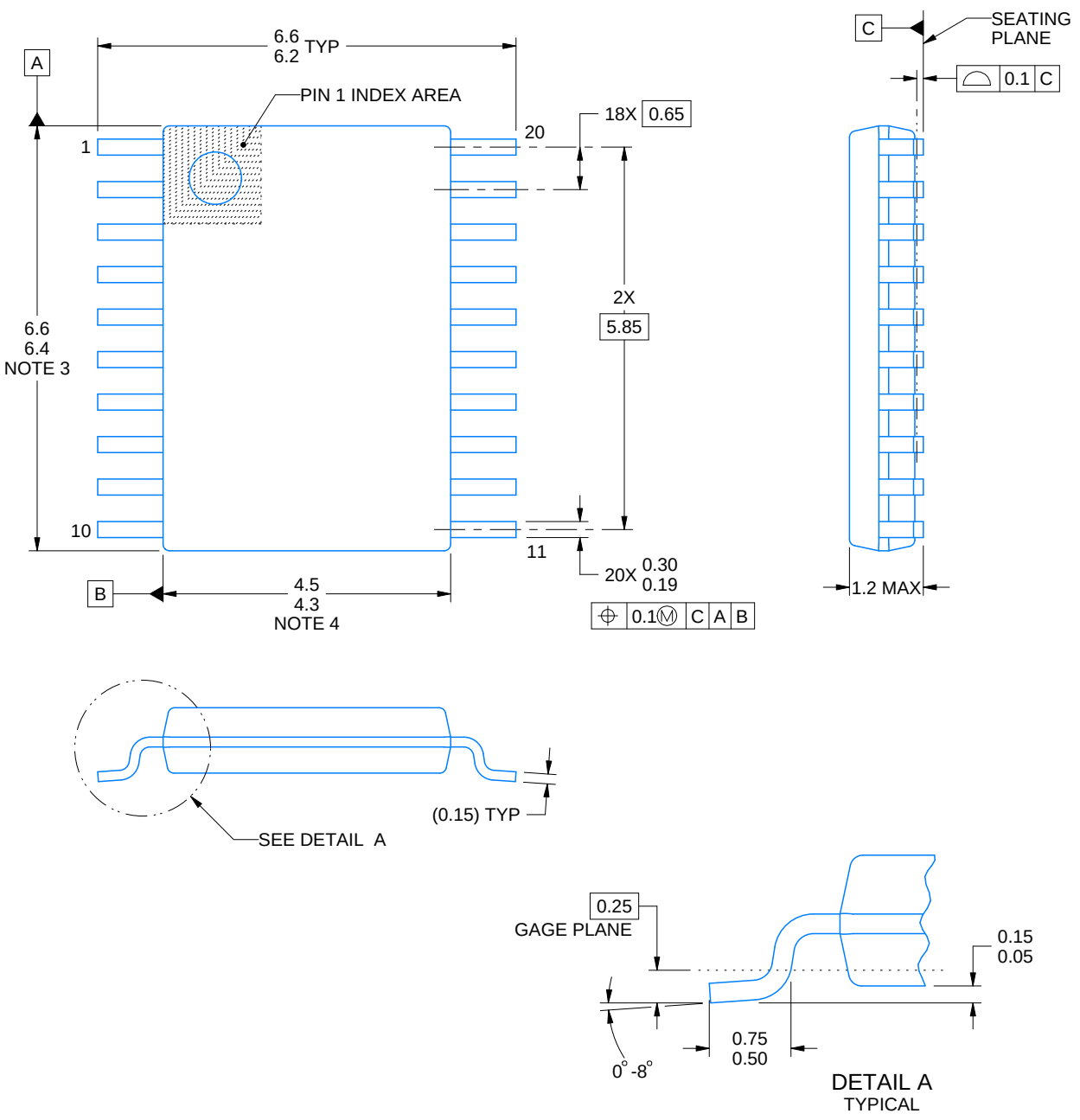
Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
DRV8351DIMPWTSEP	TSSOP	PW	20	250	353.0	353.0	32.0

PACKAGE OUTLINE

PW0020A

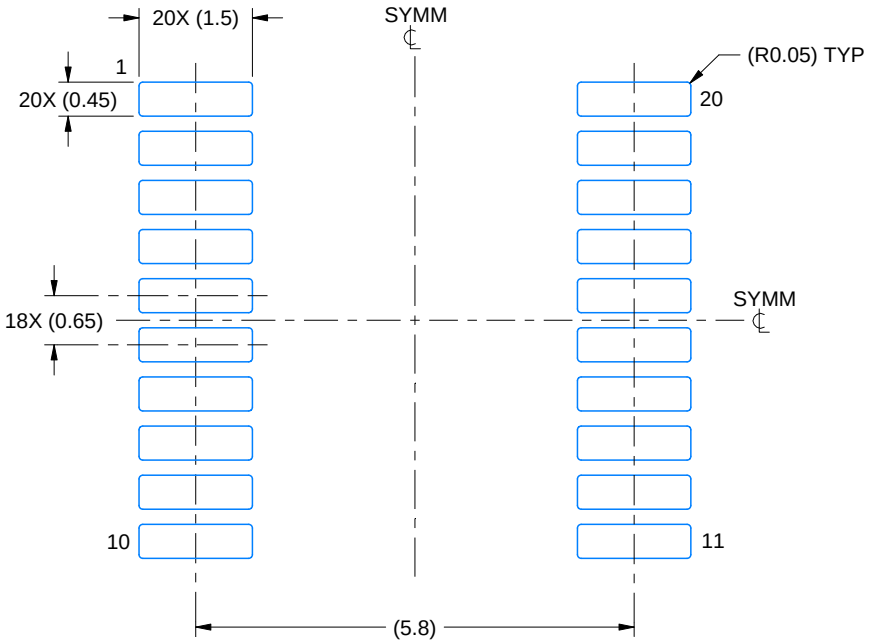
TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



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 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-153.



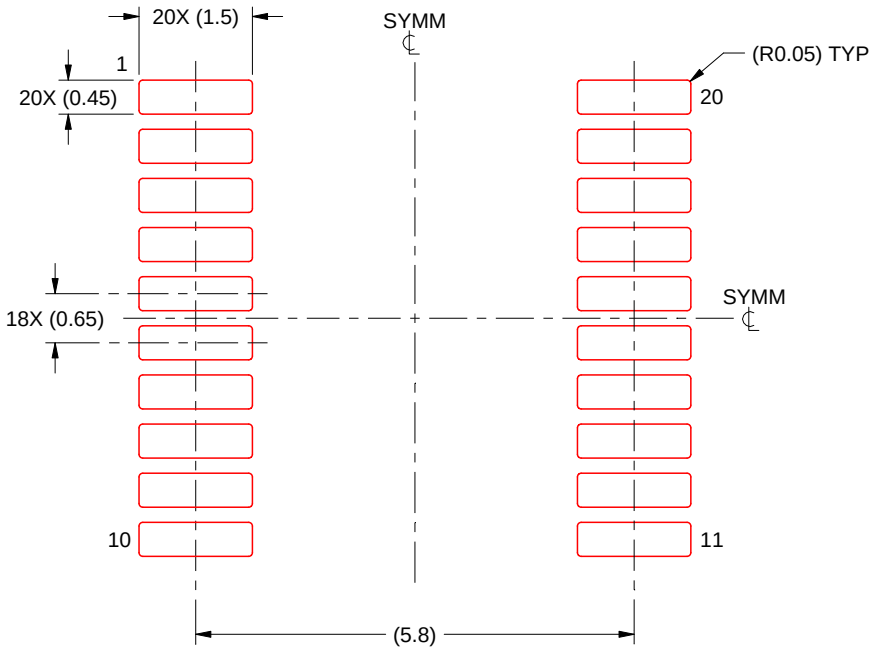
LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE: 10X

SOLDER MASK DETAILS

4220206/A 02/2017

NOTES: (continued)

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



SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL
SCALE: 10X

4220206/A 02/2017

NOTES: (continued)

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

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