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THE DGD0506 IS OBSOLETE.
PLEASE USE THE DGD0506A.

Lead-free Green

DGD0506

HIGH FREQUENCY HALF-BRIDGE GATE DRIVER WITH PROGRAMMABLE DEADTIME IN DFN3030-10

Description

The DGD0506 is a high-frequency half-bridge gate driver capable of driving N-channel MOSFETs in a half-bridge configuration. The floating high-side driver is rated up to 50V.

The DGD0506 logic inputs are compatible with standard TTL and CMOS levels (down to 3.3V) to interface easily with MCUs. UVLO for high-side and low-side will protect a MOSFET with loss of supply. To protect MOSFETs, cross conduction prevention logic prevents the HO and LO outputs being on at the same time.

Fast and well-matched propagation delays allow a higher switching frequency, enabling a smaller, more compact power switching design using smaller associated components. The DGD0506 is offered in the V-DFN3030-10 (Standard) package and operates over an extended -40°C to +125°C temperature range.

Features

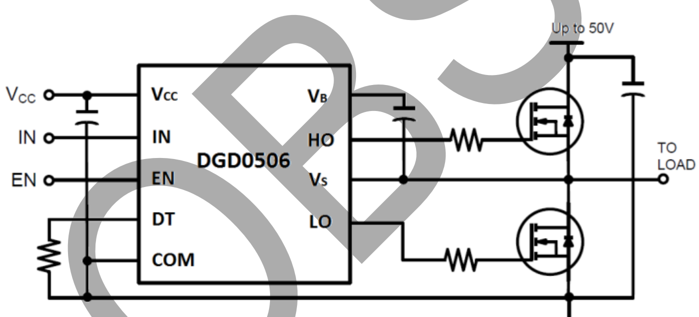
- 50V Floating High-Side Driver
- Drives Two N-Channel MOSFETs in a Half-Bridge Configuration
- 1.25A Source / 2.0A Sink Output Current Capability
- Internal Bootstrap Schottky Diode Included
- Undervoltage Lockout for High-Side and Low-Side Drivers
- Programmable Deadtime to Protect MOSFETs
- Logic Input (IN and EN) 3.3V Capability
- Ultra Low Standby Currents (<1µA)
- Extended Temperature Range: -40°C to +125°C
- **Totally Lead-Free & Fully RoHS Compliant (Notes 1 & 2)**
- **Halogen and Antimony Free. "Green" Device (Note 3)**
- **For automotive applications requiring specific change control (i.e. parts qualified to AEC-Q100/101/104/200, PPAP capable, and manufactured in IATF 16949 certified facilities), please contact us or your local Diodes representative.**
  https://www.diodes.com/quality/product-definitions/

Applications

- DC-DC converters
- Motor controls
- Battery powered hand tools
- eCig devices
- Class-D power amplifiers

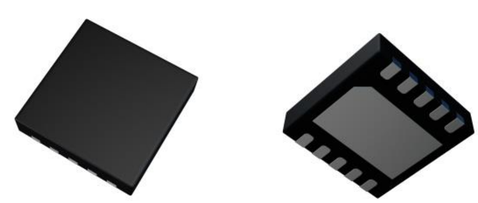
Mechanical Data

- Package: V-DFN3030-10
- Package Material: Molded Plastic. "Green" Molding Compound. UL Flammability Classification Rating 94V-0
- Moisture Sensitivity: Level 3 per J-STD-020
- Terminals: Finish – Matte Tin Finish Solderable per MIL-STD-202, Method 208 (e3)
- Weight: 0.017 grams (Approximate)



Typical Configuration

V-DFN3030-10 (Standard)



Top View   Bottom View

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Ordering Information (Note 4)

Orderable Part Number	Package	Marking	Reel Size (inches)	Tape Width (mm)	Packing	
					Qty.	Carrier
DGD0506FN-7	V-DFN3030-10 (Standard)	DGD0506	7	8	3,000	Reel

Notes: 1. No purposely added lead. Fully EU Directive 2002/95/EC (RoHS), 2011/65/EU (RoHS 2) & 2015/863/EU (RoHS 3) compliant.
2. See https://www.diodes.com/quality/lead-free/ for more information about Diodes Incorporated's definitions of Halogen- and Antimony-free, "Green" and Lead-free.
3. Halogen- and Antimony-free "Green" products are defined as those which contain <900ppm bromine, <900ppm chlorine (<1500ppm total Br + Cl) and <1000ppm antimony compounds.
4. For packaging details, go to our website at https://www.diodes.com/design/support/packaging/diodes-packaging/.

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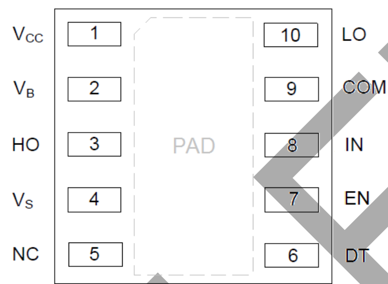
Marking Information

DGD0506 = Product Type Marking Code
YY = Year (ex: 24 = 2024)
WW = Week (01 to 53)

DGD0506 = Product Type Marking Code
YY = Year (ex: 24 = 2024)
WW- = Week (01 to 53)

Pin Diagrams



Top View: V-DFN3030-10 (Standard)

Pin Descriptions

Pin Number	Pin Name	Function
1	V_{CC}	Low-Side and Logic Supply
2	V_B	High-Side Floating Supply
3	HO	High-Side Gate Drive Output
4	V_S	High-Side Floating Supply Return
5	NC	No Connect (No Internal Connection)
6	DT	Deadtime Control
7	EN	Logic Input Enable, a Logic Low turns off Gate Driver
8	IN	Logic Input for High-Side and Low-Side Gate Driver Outputs (HO and LO), in Phase with HO
9	COM	Low-Side and Logic Return
10	LO	Low-Side Gate Drive Output
PAD	Substrate	Connect to COM on PCB

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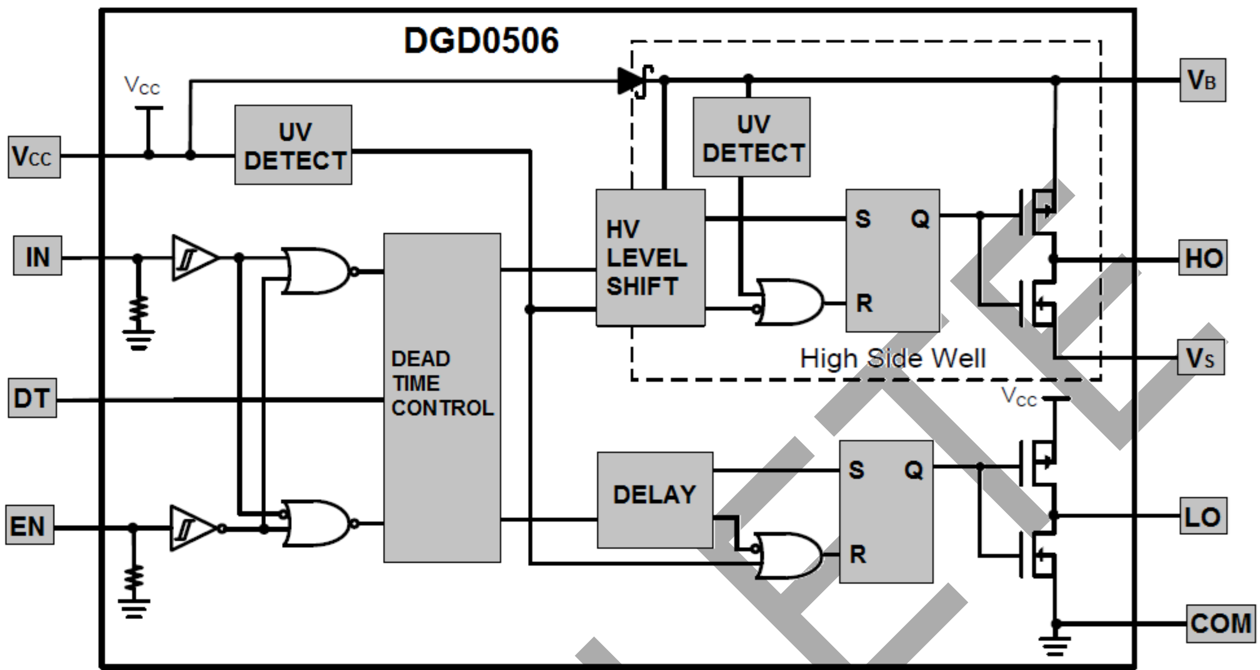
Functional Block Diagram



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Absolute Maximum Ratings (@ T_A = +25°C, unless otherwise specified.)

Characteristic	Symbol	Value	Unit
High-Side Floating Positive Supply Voltage	V_B	-0.3 to +50	V
High-Side Floating Negative Supply Voltage	V_S	V_B-14 to V_B+0.3	V
High-Side Floating Output Voltage	V_{HO}	V_S-0.3 to V_B+0.3	V
Offset Supply Voltage Transient	dV_S / dt	50	V/ns
Logic and Low-Side Fixed Supply Voltage	V_{CC}	-0.3 to +15	V
Low-Side Output Voltage	V_{LO}	-0.3 to V_{CC}+0.3	V
Logic Input Voltage (IN and EN)	V_{IN}	-0.3 to +15	V
Bootstrap Diode Current (Pulsed < 10µs)	I_{BD}	500	mA

Thermal Characteristics (@ T_A = +25°C, unless otherwise specified.)

Characteristic	Symbol	Value	Unit
Power Dissipation Linear Derating Factor (Note 5)	P_D	0.4	W
Thermal Resistance, Junction to Ambient (Note 5)	$R_{\theta JA}$	64	°C/W
Thermal Resistance, Junction to Case (Note 5)	$R_{\theta JC}$	42	°C/W
Operating Temperature	T_J	+150	°C
Lead Temperature (Soldering, 10s)	T_L	+300	
Storage Temperature Range	T_{STG}	-55 to +150	

Note: 5. When mounted on a standard JEDEC 2-layer FR-4 board.

Recommended Operating Conditions

Parameter	Symbol	Min	Max	Unit
High-Side Floating Supply	V_B	V_S + 8	V_S + 14	V
High-Side Floating Supply Offset Voltage	V_S	(Note 6)	50 (Note 7)	V
High-Side Floating Output Voltage	V_{HO}	V_S	V_B	V
Logic and Low Side Fixed Supply Voltage	V_{CC}	8	14	V
Low-Side Output Voltage	V_{LO}	0	V_{CC}	V
Logic Input Voltage (IN and EN)	V_{IN}	0	5	V
Bootstrap Diode Current (Pulsed < 10µs)	I_{BD}	—	400	mA
Ambient Temperature	T_A	-40	+125	°C

Notes: 6. Logic operation for V_S of -5V to +50V.
7. Provided V_B doesn't exceed absolute maximum rating of 50V.

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DC Electrical Characteristics ($V_{CC} = V_{BS}$ = 12V, COM = V_S = 0V, @ T_A = +25°C, unless otherwise specified.) (Note 8)

Parameter	Symbol	Min	Typ	Max	Unit	Condition
Logic "1" Input Voltage	V_{IH}	2.4	—	—	V	—
Logic "0" Input Voltage	V_{IL}	—	—	0.8	V	—
Enable Logic "1" Input Voltage	V_{ENIH}	1.5	—	—	V	—
Enable Logic "0" Input Voltage	V_{ENIL}	—	—	0.7	V	—
Input Voltage Hysteresis	V_{INHYS}	—	0.6	—	V	—
High Level Output Voltage, V_{BIAS} - V_O	V_{OH}	—	0.45	0.6	V	I_{O+} = 100mA
Low Level Output Voltage, V_O	V_{OL}	—	0.15	0.22	V	I_{O-} = 100mA
Offset Supply Leakage Current	I_{LK}	—	10	50	µA	$V_B = V_S$ = 50V
V_{CC} Shutdown Supply Current	I_{CCSD}	—	0	1	µA	V_{IN} = 0V or 5V, V_{EN} = 0V
V_{CC} Quiescent Supply Current	I_{CCQ}	—	0.32	0.5	mA	V_{IN} = 0V or 5V, R_{DT} = 100kΩ
V_{CC} Operating Supply Current	I_{CCOP}	—	2.1	—	mA	fs = 500kHz
V_{BS} Quiescent Supply Current	I_{BSQ}	—	62	100	µA	V_{IN} = 0V or 5V
V_{BS} Operating Supply Current	I_{BSOP}	—	1.1	—	mA	fs = 500kHz
Logic "1" Input Bias Current	I_{IN+}	—	25	60	µA	V_{IN} = 5V
Logic "0" Input Bias Current	I_{IN-}	—	0	1	µA	V_{IN} = 0V
V_{BS} Supply Undervoltage Positive Going Threshold	V_{BSUV+}	5.9	6.9	7.9	V	—
V_{BS} Supply Undervoltage Negative Going Threshold	V_{BSUV-}	5.6	6.6	7.6	V	—
V_{CC} Supply Undervoltage Positive Going Threshold	V_{CCUV+}	5.9	6.9	7.9	V	—
V_{CC} Supply Undervoltage Negative Going Threshold	V_{CCUV-}	5.6	6.6	7.6	V	—
Output High Short-Circuit Pulsed Current	I_{O+}	0.9	1.25	—	A	V_O = 0V, PW ≤ 10µs
Output Low Short-Circuit Pulsed Current	I_{O-}	1.5	2.0	—	A	V_O = 15V, PW ≤ 10µs
Forward Voltage of Bootstrap Diode	V_{F1}	—	0.27	—	V	I_F = 100µA
Forward Voltage of Bootstrap Diode	V_{F2}	—	0.8	—	V	I_F = 100mA, PW ≤ 10ms

Note: 8. The V_{IN} and I_{IN} parameters are applicable to the two logic pins: IN and EN. The V_O and I_O parameters are applicable to the respective output pins: HO and LO.

AC Electrical Characteristics ($V_{CC} = V_{BS}$ = 12V, COM = V_S = 0V, C_L = 1000pF, @ T_A = +25°C, unless otherwise specified.)

Parameter	Symbol	Min	Typ	Max	Unit	Condition
Turn-On Propagation Delay, HO & LO	t_{ON}	65	96	125	ns	R_{DT} = 10kΩ
		350	463	580	ns	R_{DT} = 100kΩ
Turn-Off Propagation Delay, HO & LO	t_{OFF}	—	22	56	ns	—
Turn-On Rise Time	t_R	—	17	35	ns	—
Turn-Off Fall Time	t_F	—	12	25	ns	—
Delay Matching	t_{DM}	—	—	50	ns	—
Deadtime: $t_{DT\ LO\text{-}HO}$ & $t_{DT\ HO\text{-}LO}$	t_{DT}	40	70	100	ns	R_{DT} = 10kΩ
		300	430	560	ns	R_{DT} = 100kΩ
Deadtime Matching	t_{MDT}	—	—	50	ns	R_{DT} = 100kΩ

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Timing Waveforms

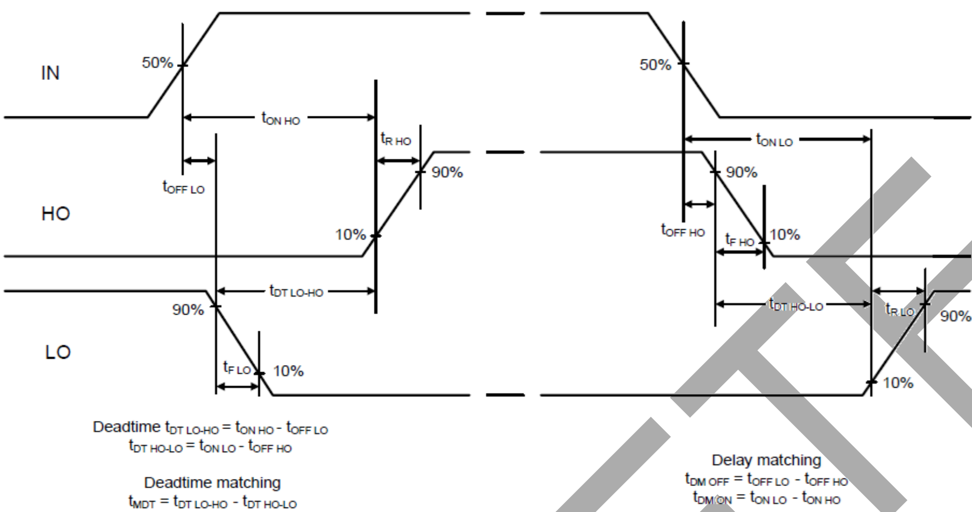

Figure 1. Switching Time Waveform Definitions

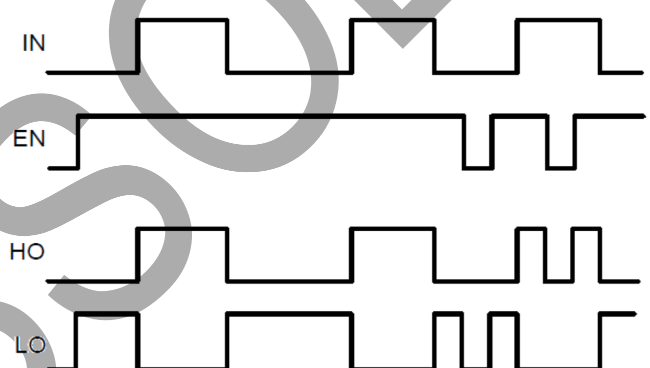

Figure 2. Input / Output Timing Diagram

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Typical Performance Characteristics (VCC = 12V, @ TA = +25°C, unless otherwise specified.)

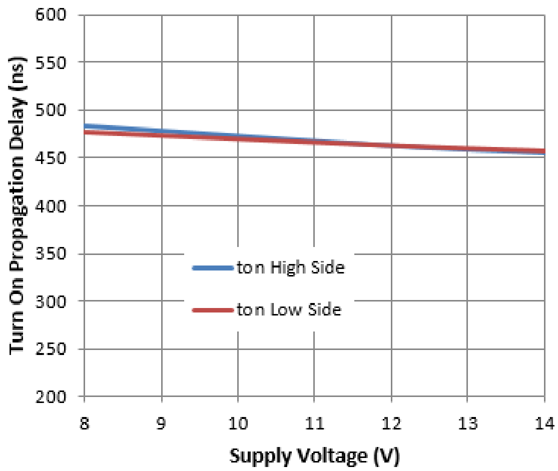

Figure 3. Turn-on Propagation Delay vs. Supply Voltage

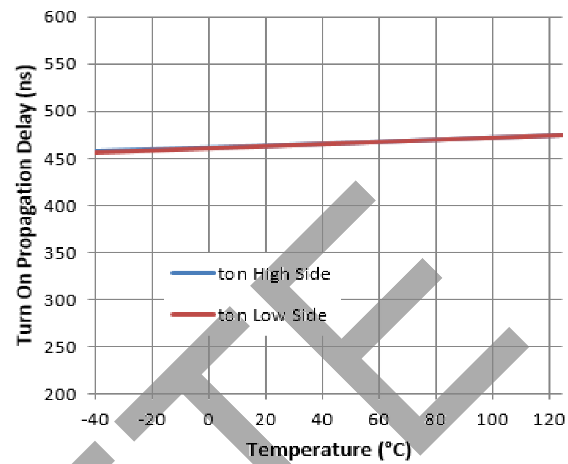

Figure 4. Turn-on Propagation Delay vs. Temperature

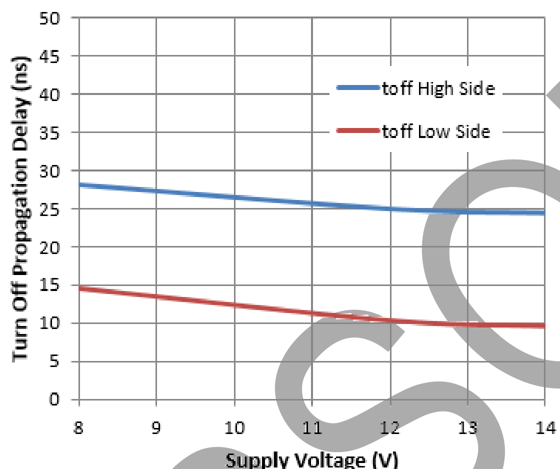

Figure 5. Turn-off Propagation Delay vs. Supply Voltage

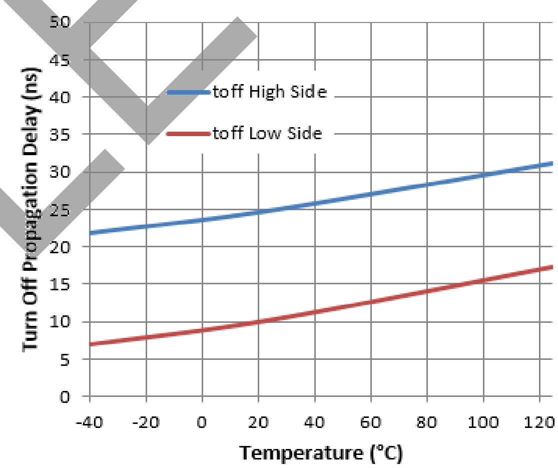

Figure 6. Turn-off Propagation Delay vs. Temperature

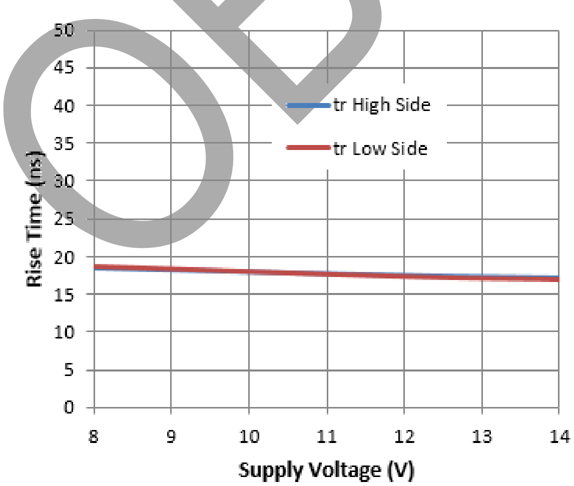

Figure 7. Rise Time vs. Supply Voltage

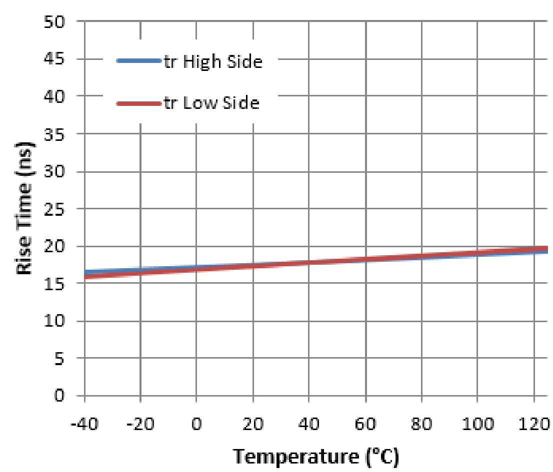

Figure 8. Rise Time vs. Temperature

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Typical Performance Characteristics (continued)

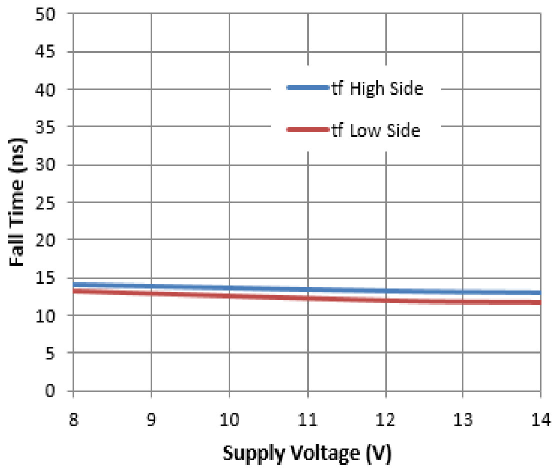

Figure 9. Fall Time vs. Supply Voltage

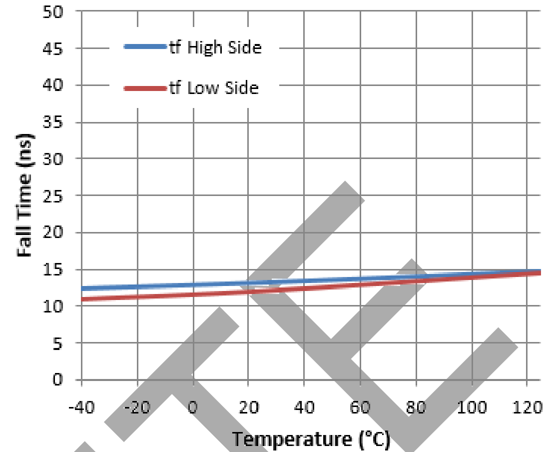

Figure 10. Fall Time vs. Temperature

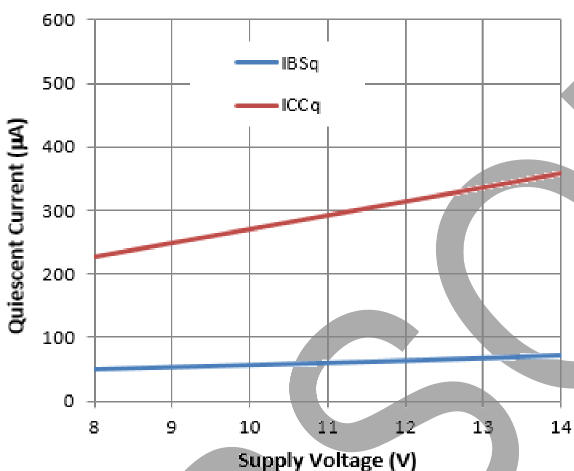

Figure 11. Quiescent Current vs. Supply Voltage

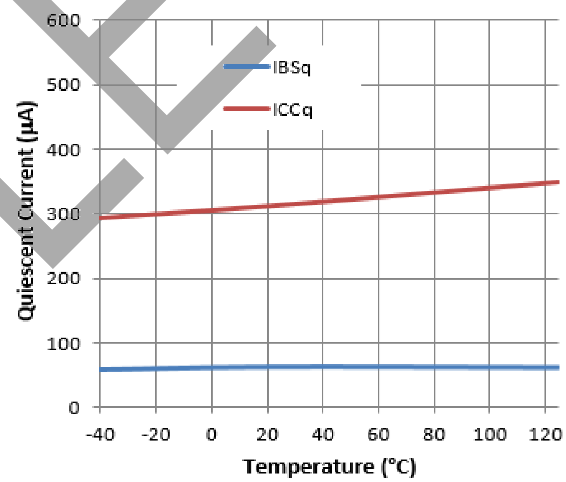

Figure 12. Quiescent Current vs. Temperature

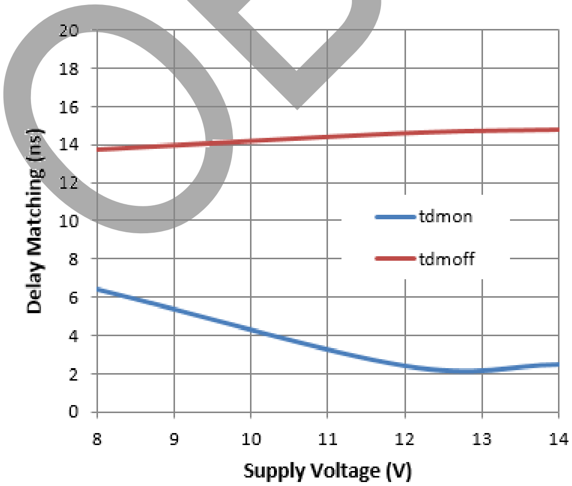

Figure 13. Delay Matching vs. Supply Voltage

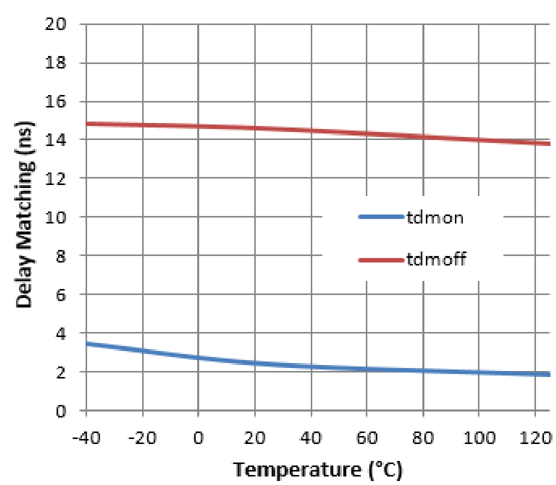

Figure 14. Delay Matching vs. Temperature

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Typical Performance Characteristics (continued)

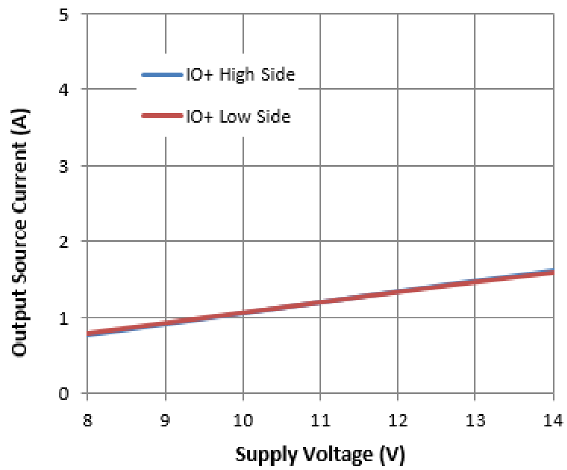

Figure 15. Output Source Current vs. Supply Voltage

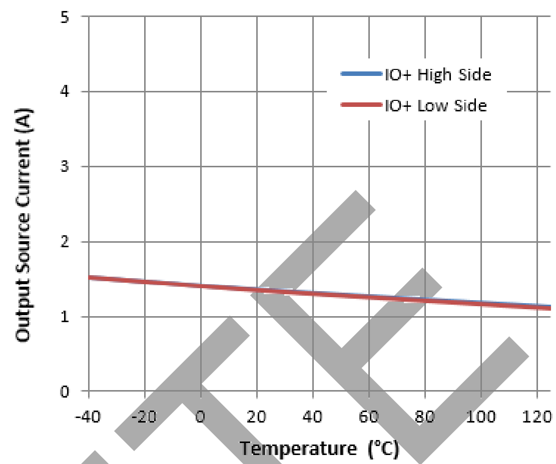

Figure 16. Output Source Current vs. Temperature

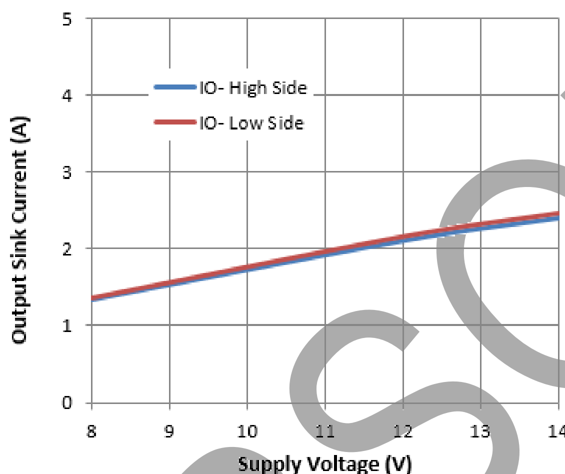

Figure 17. Output Sink Current vs. Supply Voltage

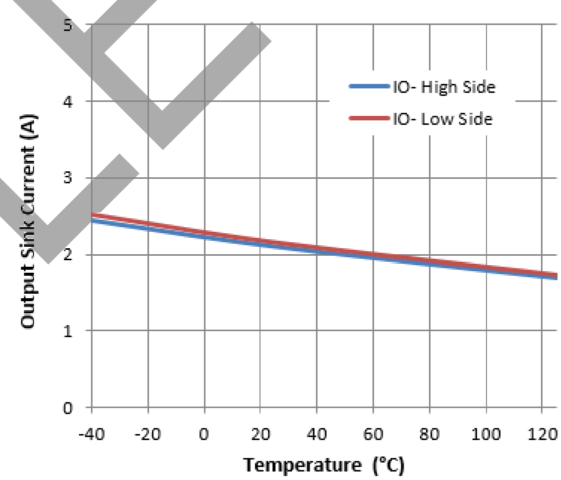

Figure 18. Output Sink Current vs. Temperature

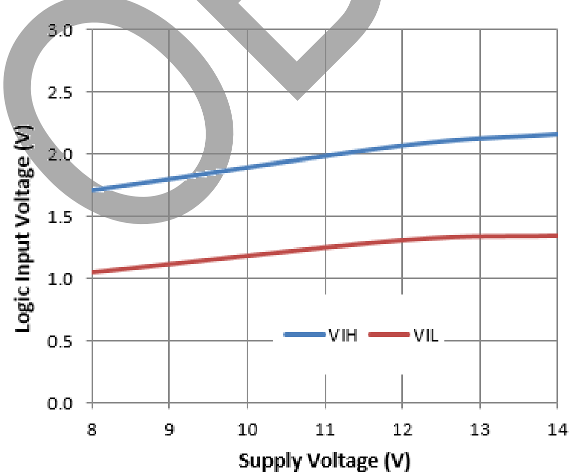

Figure 19. Logic Input Voltage vs. Supply Voltage

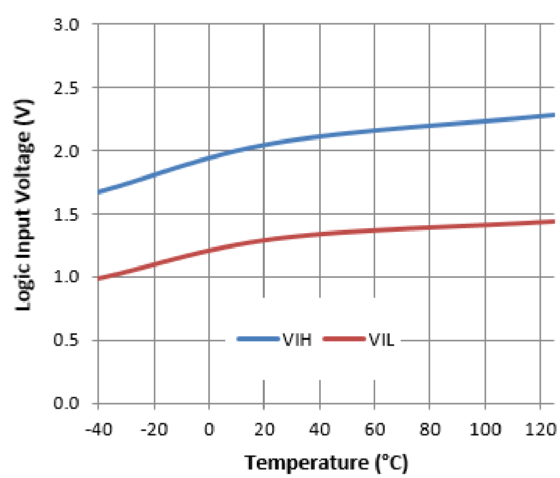

Figure 20. Logic Input Voltage vs. Temperature

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Typical Performance Characteristics (continued)

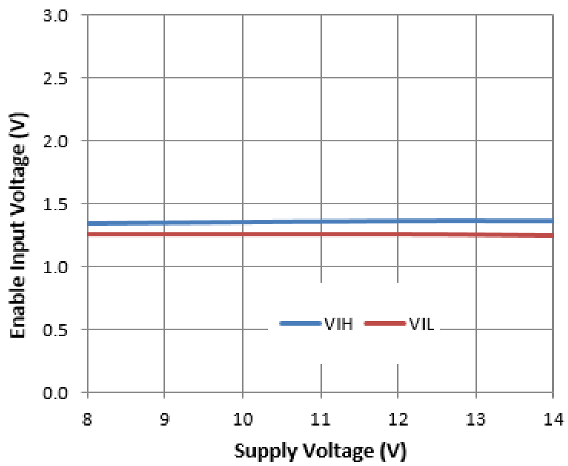

Figure 21. Enable Input Voltage vs. Supply Voltage

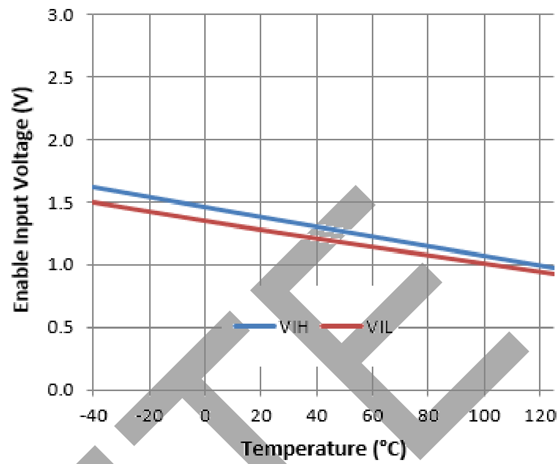

Figure 22. Enable Input Voltage vs. Temperature

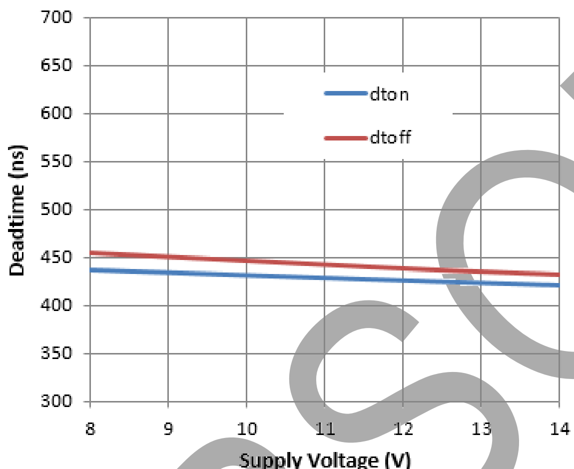

Figure 23. Deadtime vs. Supply Voltage

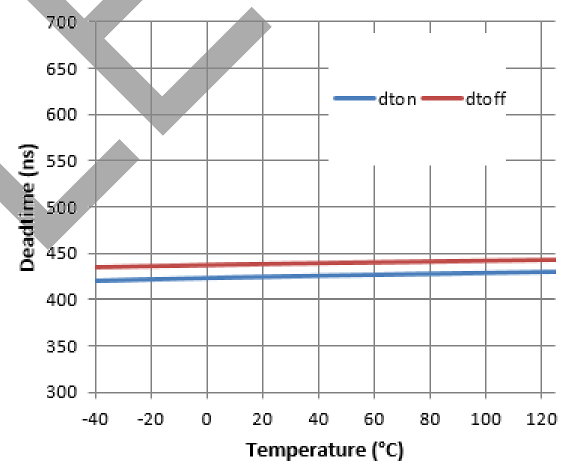

Figure 24. Deadtime vs. Temperature

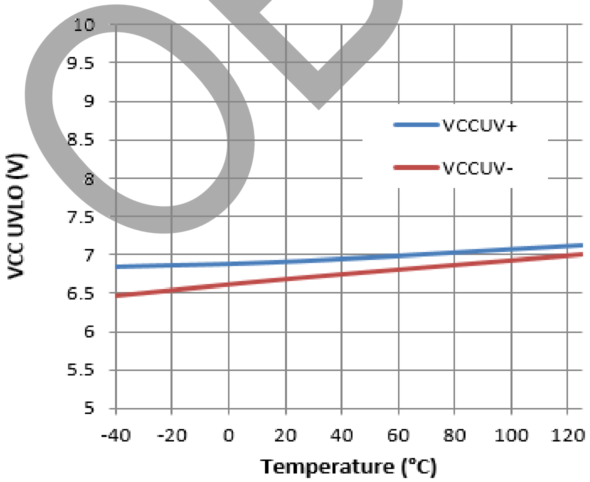

Figure 25. VCC UVLO vs. Temperature

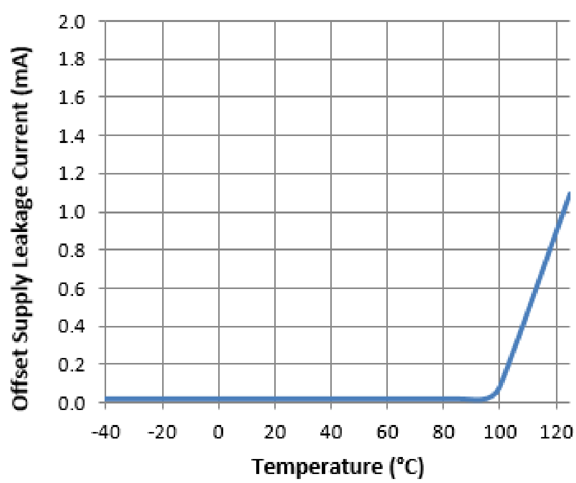

Figure 26. Offset Supply Leakage Current vs. Temperature

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Application Information

Bootstrap Capacitor Selection

The capacitance of the bootstrap capacitor should be high enough to provide the charge required by the gate of the high side MOSFET with only a minimal loss of voltage across it. As a general guideline, it is recommended to make sure the charge stored by the bootstrap capacitor is about 50 times more than the required gate charge at operating V_{CC} (usually about 10V to 12V).

The formula to calculate the change in V_{BS} to provide a certain amount of gate charge is shown below;

Q = C * V where Q is the gate charge required by the external MOSFET to raise its gate voltage to 10V. C is the bootstrap capacitance and V is the voltage drop across the Vbs.

Example: To switch a high side MOSFET that requires 20nC of gate charge to raise its gate voltage to 10V, the capacitor size can be calculated as below;

$Q_{G(MOSFET)} = C_{(BOOTSTRAP)} * \Delta V_{BS}$;

ΔV_{BS} = voltage drop acorss the bootstrap capacitor while providing the required gate charge.

In this example, let's say the acceptable ΔV_{BS} is 200mV.

The required bootstrap capacitor for the job is;

$C_{(BOOTSTRAP)} = Q_{G(MOSFET)} / \Delta V_{BS}$ = 20nC/200mV = 100nF

Bootstrap Diode Current

The DGD0506 comes with an integrated bootstrap Schottky diode. The forward characteristics of the diode is shown in the figure 27. The maximum recommended operating current is 400mA pulsed. Under steady state conditions the only current flowing through the internal diode is the charge current required by the high-side MOSFET's gate capacitance, however, it is important to cover applications where the inrush current exceeds this rating. In such applications to limit the current flowing through the internal diode to the recommended value, two techniques are suggested as shown in figures 28 and 29.

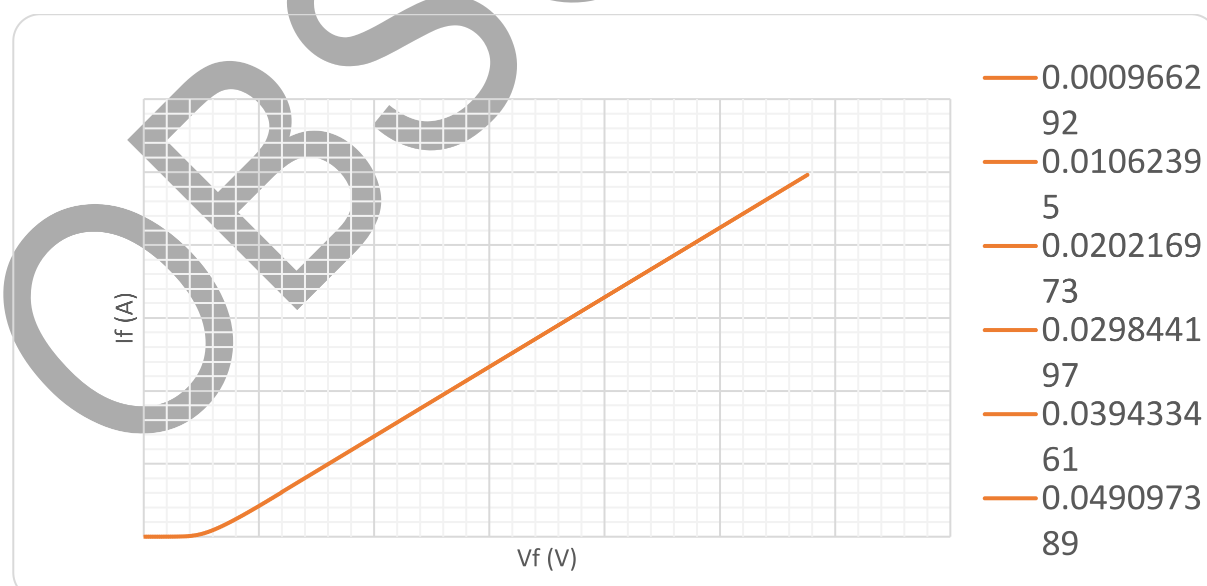

Figure 27. DGD0506 'Internal Diode + Internal Resistor' V_F vs. I_F

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Application Information (continued)

Pre-Bias Resistor between Vs and COM

This technique eliminates the inrush current, altogether, by pre-charging the capacitor to a value close to V_{CC} before the DGD0506 is enabled and an input signal is applied. By pre-charging the capacitor to V_{CC} only a small steady state current flows through the internal diode eliminating the need for any external diode. The recommended range for the Rs is 10kΩ to 100kΩ.

External Diode and Resistor

To enable appropriate current sharing and limit the internal bootstrap current to less than 400mA, a Schottky diode must be used as an external diode. The voltage drop across the external diode and resistor must be limited to 2.4V, to limit the internal diode's current share to <400mA. Hence it is important to choose an appropriate external diode and resistor combination. At any observed inrush current peak, it is important that the combined voltage drop of the external resistor and diode is less than 2.4V.

For internal diode current to be < 400mA; (I_{INRUSH} * R_{EXT}) + (Vf_{EXT} @ I_{INRUSH}) < 2.4V.

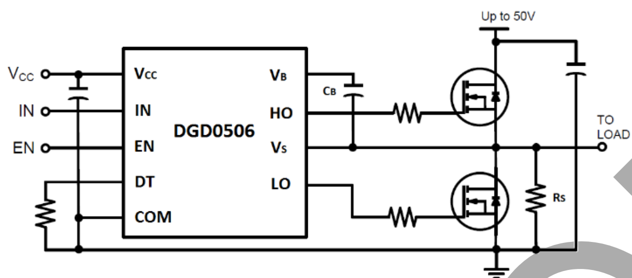

Figure 28. Inrush current is greatly limited by pre-charging the boost-strap Capacitor through Rs

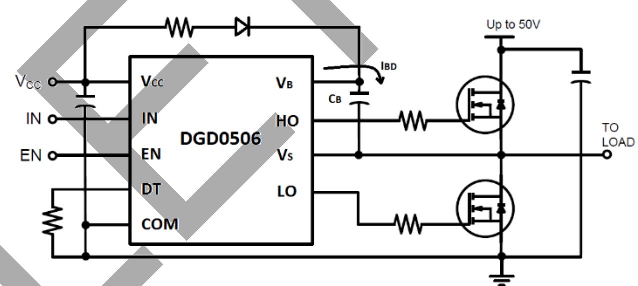

Figure 29. Current into the boost-strap capacitance is shared between the external diode and the internal Diode

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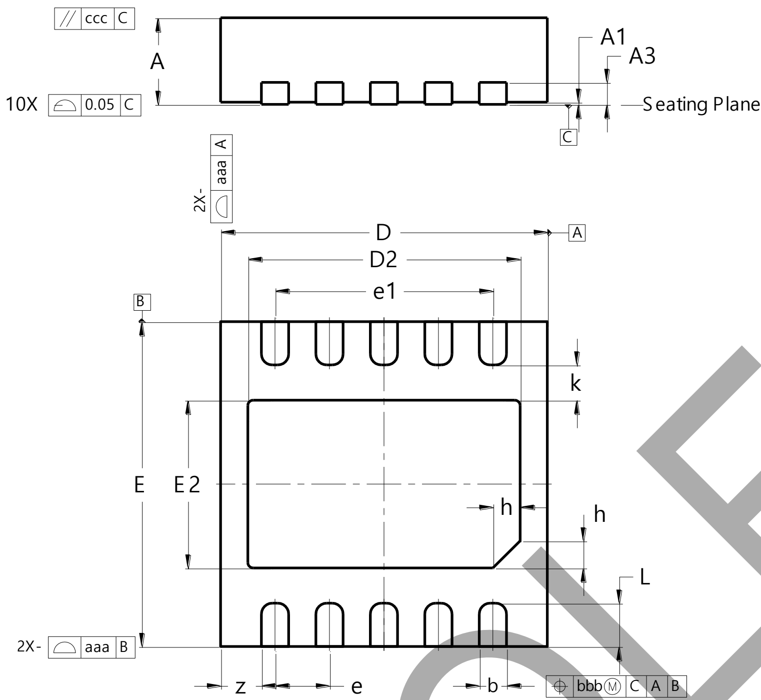
Package Outline Dimensions

Please see http://www.diodes.com/package-outlines.html for the latest version.

V-DFN3030-10 (Standard)

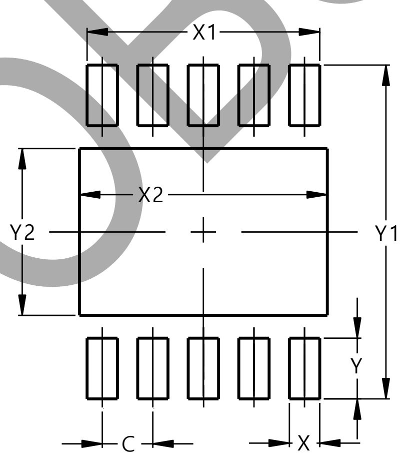


V-DFN3030-10 (Standard)			
Dim	**Min**	**Max**	**Typ**
A	0.70	0.85	0.80
A1	0.00	0.05	0.02
A3	--	--	0.203
b	0.18	0.30	0.25
D	2.90	3.10	3.00
D2	2.40	2.60	2.50
e	0.50BSC		
e1	2.00BSC		
E	2.90	3.10	3.00
E2	1.45	1.65	1.55
h	0.20	0.30	0.25
k	--	--	0.325
L	0.30	0.50	0.40
z	--	--	0.325
aaa	0.250		
bbb	0.100		
ccc	0.050		
All Dimensions in mm			

Suggested Pad Layout

Please see http://www.diodes.com/package-outlines.html for the latest version.

V-DFN3030-10 (Standard)



Dimensions	Value (in mm)
C	0.500
X	0.300
X1	2.300
X2	2.600
Y	0.600
Y1	3.300
Y2	1.650

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