3-PHASE HALF-BRIDGE GATE DRIVER IN SO-28

Description

The DGD2136M is a three-phase gate driver IC designed for high-voltage / high-speed applications, driving N-Channel MOSFETs and IGBTs in a half-bridge configuration. High-voltage processing techniques enable the DGD2136M's high-side to switch to 600V in a bootstrap operation.

The DGD2136M logic inputs are compatible with standard TTL and CMOS levels (down to 3.3V) for easy interfacing with controlling devices and are enabled low to better function in high noise environments. The driver outputs feature high-pulse current buffers designed for minimum driver cross conduction.

The DGD2136M offers numerous protection functions. A shoot-through protection logic prevents both outputs from being high when both inputs are high (fault state), an undervoltage lockout for VCC shuts down the respective high-side output. An overcurrent protection will terminate the six outputs. Both the VCC UVLO and the overcurrent protection trip an automatic fault clear with a timing that is adjustable with an external capacitor.

The DGD2136M is offered in SO-28 package and the operating temperature extends from -40°C to +125°C.

Applications

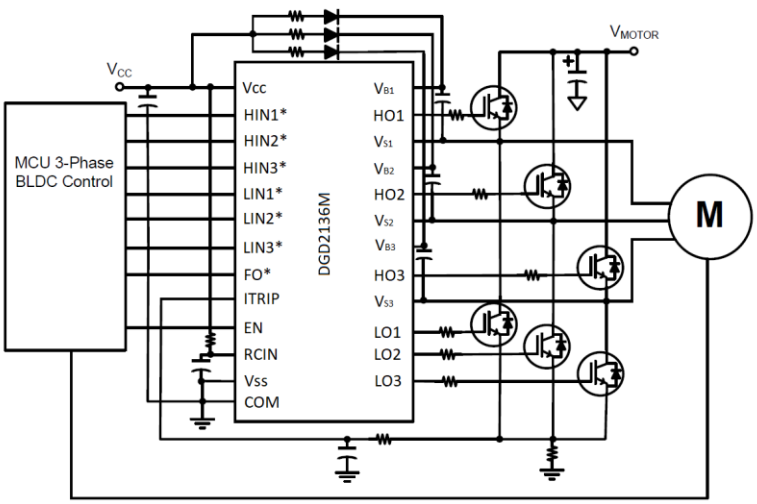
- 3-Phase Motor Inverter Driver
- White Goods – Air Conditioner, Washing Machine, Refrigerator
- Industrial Motor Inverter – Power Tools, Robotics
- General Purpose 3-Phase Inverter

Features

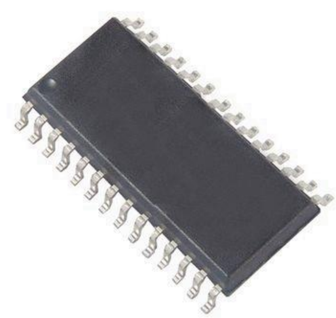
- Three Floating High-Side Drivers in Bootstrap Operation to 600V
- 200mA Source / 350mA Sink Output Current Capability
- Outputs Tolerant to Negative Transients, dV/dt Immune
- Logic Input 3.3V Capability
- Internal Deadtime of 290ns to Protect MOSFETs and IGBTs
- Matched Prop Delay for All Channels
- Outputs Out of Phase with Inputs
- Schmitt Triggered Logic Inputs
- Cross Conduction Prevention Logic
- Undervoltage Lockout for All Channels
- Overcurrent Protection Shuts Down Drivers
- 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-Q100/101/200, PPAP capable, and manufactured in IATF 16949 certified facilities), please contact us or your local Diodes representative.**
  https://www.diodes.com/quality/product-definitions/

Mechanical Data

- Case: SO-28 (Type TH)
- Case Material: Molded Plastic. "Green" Molding Compound. UL Flammability Classification Rating 94V-0
- Moisture Sensitivity: Level 3 per J-STD-020
- Terminals: Finish – Matte Tin Plated Leads, Solderable per MIL-STD-202, Method 208 (e3)
- Weight: 0.250 grams (Approximate)



Typical Configuration



SO-28

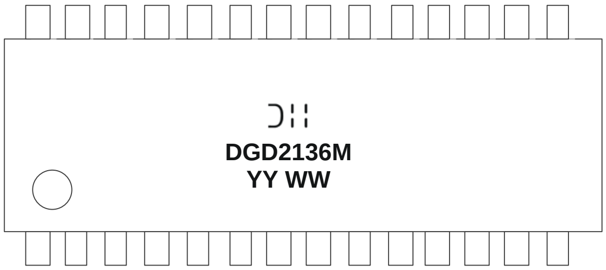
Top View

Ordering Information (Note 4)

Part Number	Marking	Reel Size (inches)	Tape Width (mm)	Quantity per Reel
DGD2136MS28-13	DGD2136M	13	24	1,500

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/.

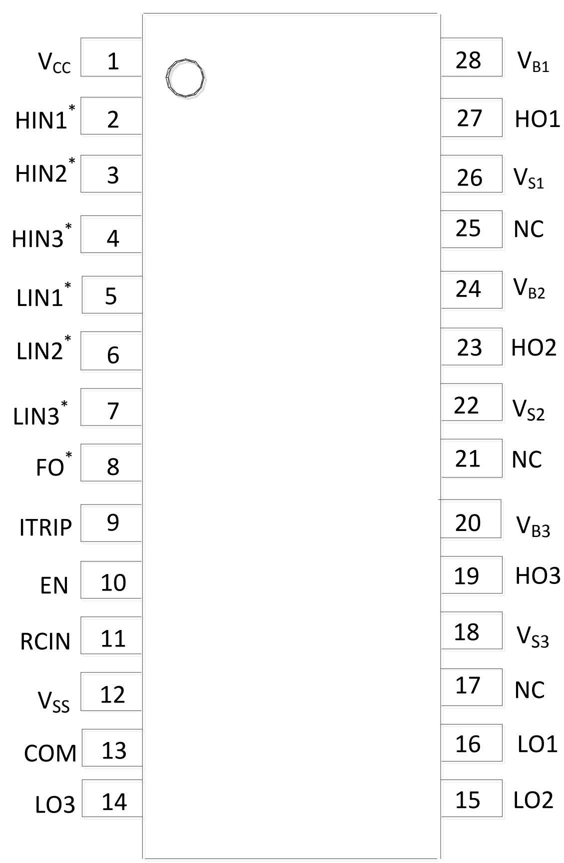
Marking Information



⊃¦¦ = Manufacturer's Marking
DGD2136M = Product Type Marking Code
YY = Year (ex: 21 = 2021)
WW = Week (01 to 53)

Pin Diagrams

Top View

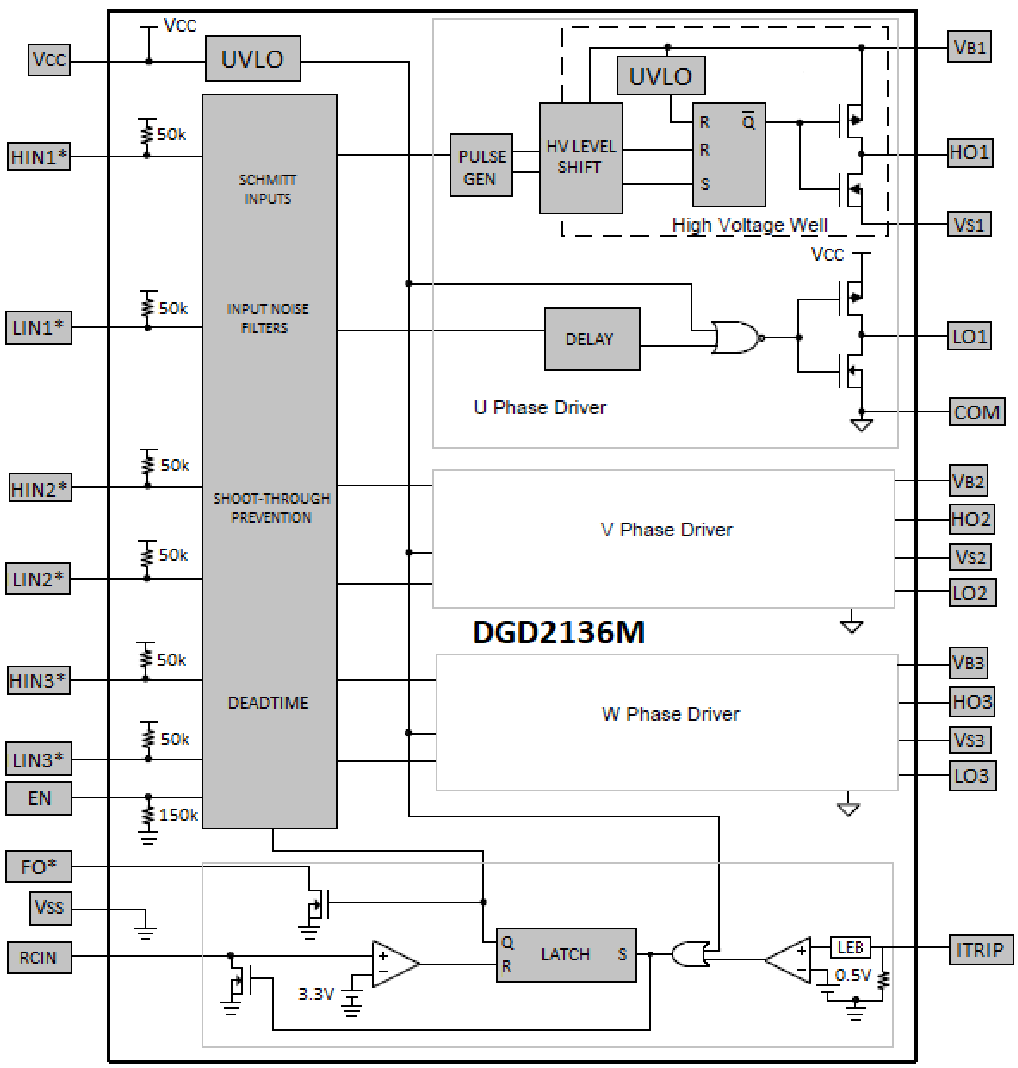


SO-28

Pin Descriptions

Pin Number	Pin Name	Function
1	V_{CC}	Low-Side and Logic Fixed Supply
2, 3, 4	HIN1*, HIN2*, HIN3*	Logic Input for High-Side Gate Driver Output, Out of Phase with HO
5, 6, 7	LIN1*, LIN2*, LIN3*	Logic Input for Low-Side Gate Driver Output, Out of Phase with LO
8	FO*	Fault Output with Open Drain (Fault with Overcurrent and V_{CC} UVLO)
9	ITRIP	Analog Input for Overcurrent Shutdown
10	EN	Logic Input for Functionality, I/O Logic Functions when EN is High
11	RCIN	An External RC Network Input used to Define FAULT CLEAR Delay
12	V_{SS}	Logic Ground
13	COM	Low-Side Driver Return
14, 15, 16	LO3, LO2, LO1	Low-Side Gate Driver Output
17, 21, 25	NC	No Connection (No Internal Connection)
18, 22, 26	V_{S3}, V_{S2}, V_{S1}	High-Side Floating Supply Return
19, 23, 27	HO3, HO2, HO1	High-Side Gate Driver Output
20, 24, 28	V_{B3}, V_{B2}, V_{B1}	High-Side Floating Supply

Functional Block Diagram



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

Characteristic	Symbol	Value	Unit
High-Side Floating Supply Voltage	V_B	-0.3 to +624	V
High-Side Floating Supply Offset Voltage	V_S	V_B-24 to V_B+0.3	V
High-Side Floating Output Voltage	V_{HO}	V_S-0.3 to V_B+0.3	V
Low-Side Output Voltage	V_{LO}	-0.3 to V_{CC}+0.3	V
Offset Supply Voltage Transient	dV_S / dt	50	V/ns
Low-Side Fixed Supply Voltage	V_{CC}	-0.3 to +24	V
Logic Input Voltage (HIN*, LIN*, ITRIP, EN and FO*)	V_{IN}	-0.3 to +5.5	V

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

Characteristic	Symbol	Value	Unit
Power Dissipation Linear Derating Factor (Note 5)	P_D	2.3	W
Thermal Resistance, Junction to Ambient (Note 5)	$R_{\theta JA}$	60	°C/W
Thermal Resistance, Junction to Case (Note 5)	$R_{\theta JC}$	45	°C/W
Operating Temperature	T_J	+150	°C
Lead Temperature (Soldering, 10s)	T_L	+300	°C
Storage Temperature Range	T_{STG}	-55 to +150	°C

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 Absolute Voltage	V_B	V_S + 10	V_S + 20	V
High-Side Floating Supply Offset Voltage	V_S	(Note 6)	600	V
High-Side Floating Output Voltage	V_{HO}	V_S	V_B	V
Low-Side Fixed Supply Voltage	V_{CC}	10	20	V
Low-Side Output Voltage	V_{LO}	COM	V_{CC}	V
Logic Input Voltage (HIN*, LIN*, ITRIP & EN)	V_{IN}	V_{SS}	5	V
Fault Output Voltage	V_{FO}	V_{SS}	V_{CC}	V
Logic Ground	V_{SS}	-5	5	V
Ambient Temperature	T_A	-40	+125	°C

Note: 6. Logic operation for V_S of -5V to +600V.

DC Electrical Characteristics (V_{BIAS} (V_{CC}, V_{BS}) = 15V, @T_A = +25°C, unless otherwise specified.) (Note 7)

Parameter	Symbol	Min	Typ	Max	Unit	Condition
Logic "0" Input Voltage	V_{IH}	2.4	—	—	V	—
Logic "1" Input Voltage	V_{IL}	—	—	0.8	V	—
High Level Output Voltage, V_{BIAS} - V_O	V_{OH}	—	—	0.1	V	I_O = 0mA
Low Level Output Voltage, V_O	V_{OL}	—	—	0.1	V	I_O = 0mA
Offset Supply Leakage Current	I_{LK}	—	—	10	µA	V_B = V_S = 600V
Quiescent V_{BS} Supply Current	I_{BSQ}	10	85	130	µA	V_{IN} = 0V or 5V, EN = 0V
Quiescent V_{CC} Supply Current	I_{CCQ}	—	1.1	1.6	mA	V_{IN} = 0V or 5V, EN = 0V
Logic Input Bias Current (HO = LO = HIGH)	I_{IN+}	—	130	200	µA	V_{IN} = 0V
Logic Input Bias Current (HO = LO = LOW)	I_{IN-}	—	3.0	20	µA	V_{IN} = 5V
Logic Enable "1" Input Bias Current	I_{EN+}	—	33	80	µA	V_{EN} = 5V
Logic Enable "0" Input Bias Current	I_{EN-}	—	—	2.0	µA	V_{EN} = 0V
V_{BS} Supply Undervoltage Positive Going Threshold	V_{BSUV+}	7.6	8.9	9.9	V	—
V_{BS} Supply Undervoltage Negative Going Threshold	V_{BSUV-}	7.1	8.3	9.4	V	—
V_{CC} Supply Undervoltage Positive Going Threshold	V_{CCUV+}	7.6	8.9	9.9	V	—
V_{CC} Supply Undervoltage Negative Going Threshold	V_{CCUV-}	7.1	8.3	9.4	V	—
Output High Short Circuit Pulsed Current	I_{O+}	120	200	—	mA	V_O = 0V, PW ≤ 10µs
Output Low Short Circuit Pulsed Current	I_{O-}	250	350	—	mA	V_O = 15V, PW ≤ 10µs
Overcurrent Detect Positive Threshold	V_{ITH+}	400	500	600	mV	—
Overcurrent Detect Negative Threshold	V_{ITH-}	340	420	500	mV	—
Short-Circuit Input Current	I_{CSIN}	6.0	11	16	µA	V_{CSIN} = 1V
RCIN Positive Going Threshold Voltage	$V_{RCINTH+}$	7.0	8.4	9.8	V	—
RCIN Negative Going Threshold Voltage	$V_{RCINTH-}$	—	5.0	—	V	—
Fault Output Low Level Voltage	V_{FOL}	—	0.2	0.5	V	V_{CS} = 1V, I_{FO} = 1.5mA
RCIN on Resistance	R_{DSRCIN}	40	75	110	Ω	I_{RCIN} = 1.5mA
Fault Output on Resistance	R_{DSFO}	80	130	180	Ω	I_{FO} = 1.5mA

Note: 7. The V_{IN}, V_{TH} and I_{IN} parameters are referenced to V_{SS} and are applicable to all six channels (HIN1*, 2*, 3* and LIN1*, 2*, 3*). The V_O and I_O parameters are applicable to the output pins (HO1, 2, 3 and LO1, 2, 3) and are referenced to COM.

AC Electrical Characteristics (V_{BIAS} (V_{CC}, V_{BS}) = 15V, C_L = 1000pF, @T_A = +25°C, unless otherwise specified.)

Parameter	Symbol	Min	Typ	Max	Unit	Condition
Turn-On Propagation Delay	t_{ON}	200	330	460	ns	V_S = 0V
Turn-Off Propagation Delay	t_{OFF}	200	330	460	ns	V_S = 0V
Turn-On Rise Time	t_r	—	90	150	ns	V_S = 0V
Turn-Off Fall Time	t_f	—	35	60	ns	V_S = 0V
Delay Matching	t_{DM}	—	—	50	ns	—
Enable Low to Output Shutdown Delay	t_{EN}	225	330	425	ns	—
ITRIP Pin Leading-Edge Blanking Time	t_{BLT}	200	300	400	ns	—
Time from ITRIP Triggering to FO*	t_{FLT}	360	550	760	ns	From V_{ITRIP} = 1V to FO* turn off
Time from ITRIP Triggering to All Gate Outputs Turn Off	t_{ITRIP}	420	615	820	ns	From V_{ITRIP} = 1V to starting gate turn off
Input Filtering Time (HIN*, LIN*, EN)	t_{FLTIN}	—	250	—	ns	—
Fault Clear Time	t_{FLTCLR}	—	1.6	—	ms	C_{RCIN} = 1nF, R_{RCIN} = 2MΩ
Deadtime	t_{DT}	200	290	420	ns	—
Deadtime Matching	t_{DTM}	—	—	50	ns	—
Output Pulse Width Matching (Note 8)	t_{PM}	—	50	75	ns	PW_{IN} > 1µs

Note: 8. t_{PM} is defined as $PW_{IN} – PW_{OUT}$.

Timing Waveforms

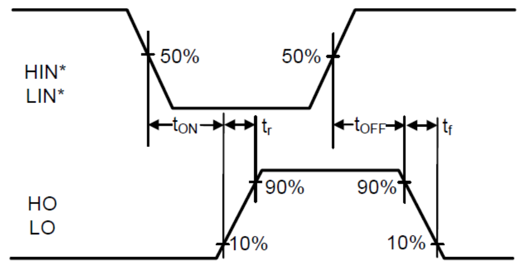


Figure 1. Switching Time Waveform Definitions

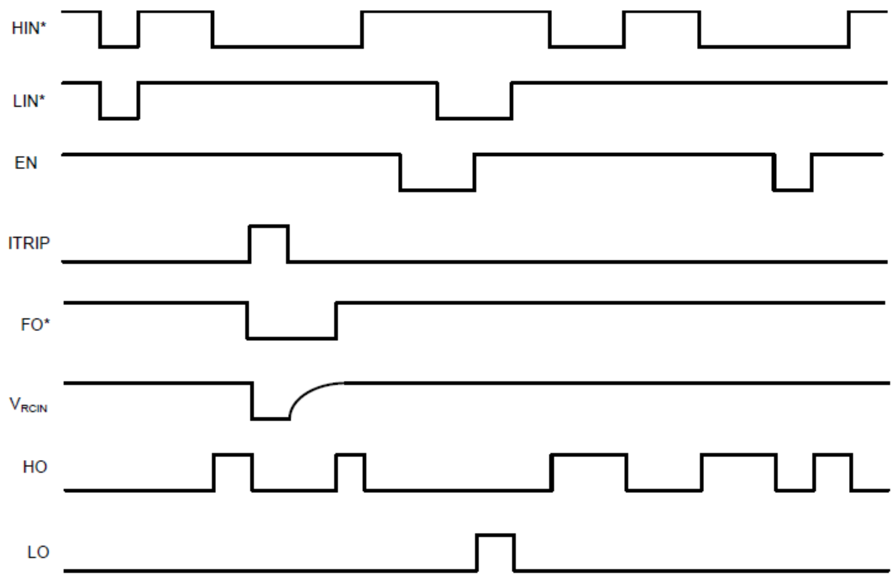


Figure 2. Input/Output Timing Diagram

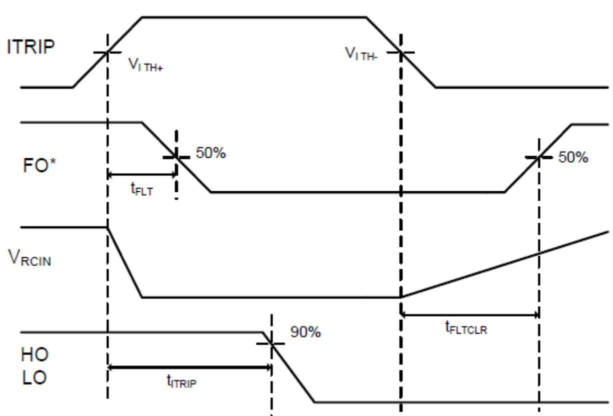


Figure 3. Overcurrent Timing Definitions

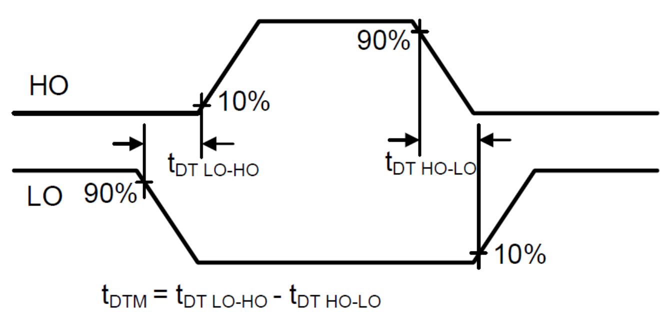


Figure 4. Deadtime Waveform Definitions

Typical Performance Characteristics (V_{CC} = 15V, @T_A = +25°C, unless otherwise specified.)

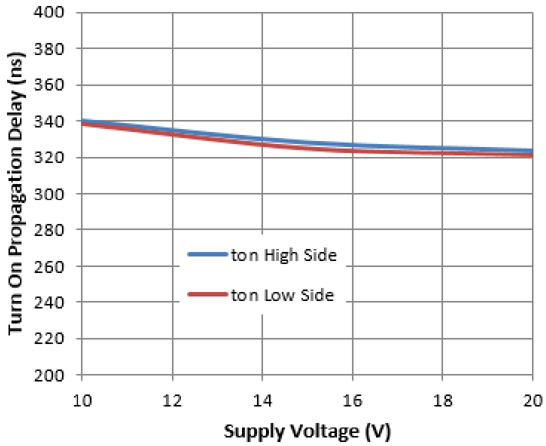


Figure 5. Turn-on Propagation Delay vs. Supply Voltage

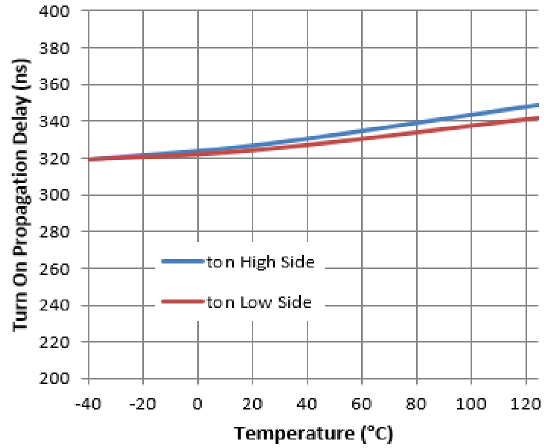


Figure 6. Turn-on Propagation Delay vs. Temperature

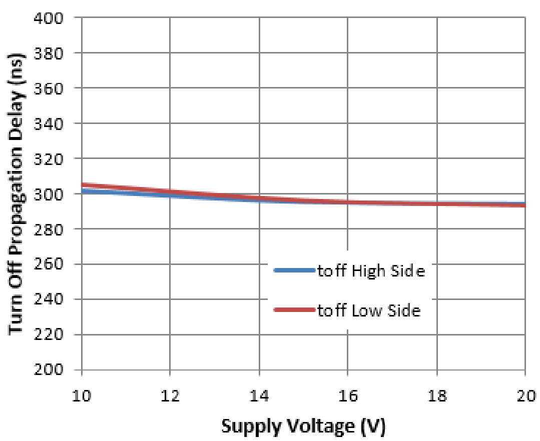


Figure 7. Turn-off Propagation Delay vs. Supply Voltage

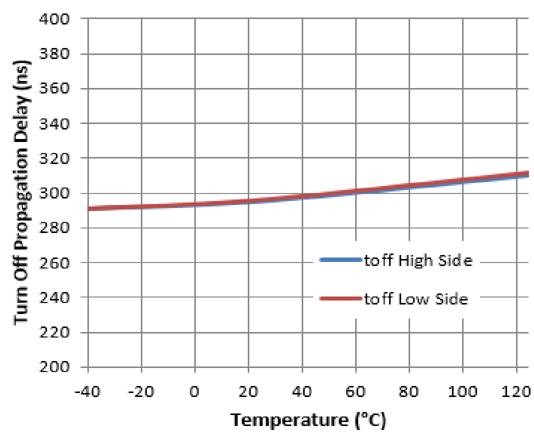


Figure 8. Turn-off Propagation Delay vs. Temperature

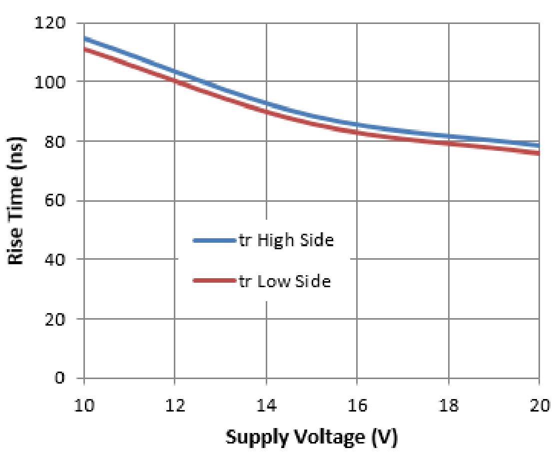


Figure 9. Rise Time vs. Supply Voltage

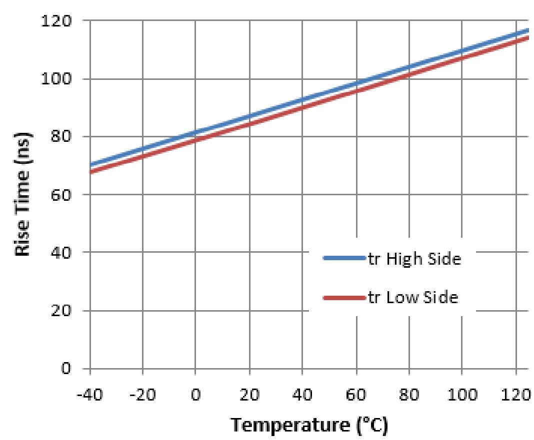


Figure 10. Rise Time vs. Temperature

Typical Performance Characteristics (continued)

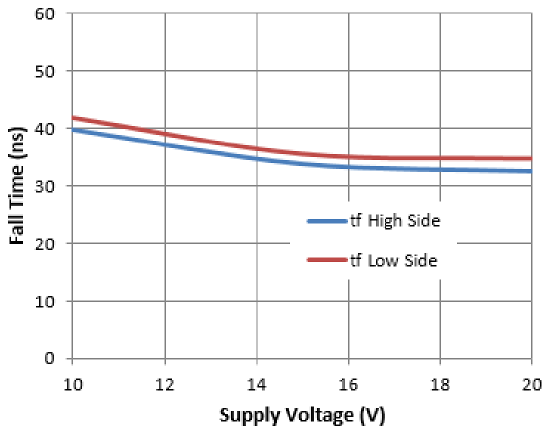


Figure 11. Fall Time vs. Supply Voltage

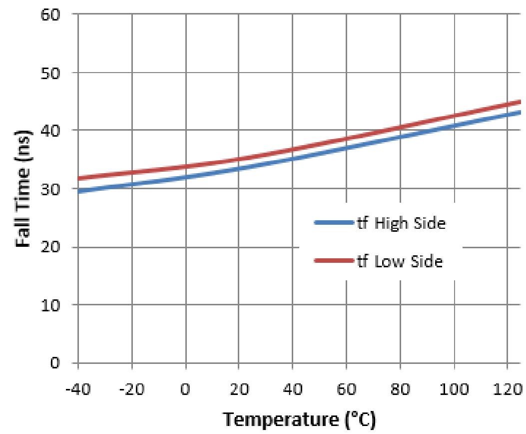


Figure 12. Fall Time vs. Temperature

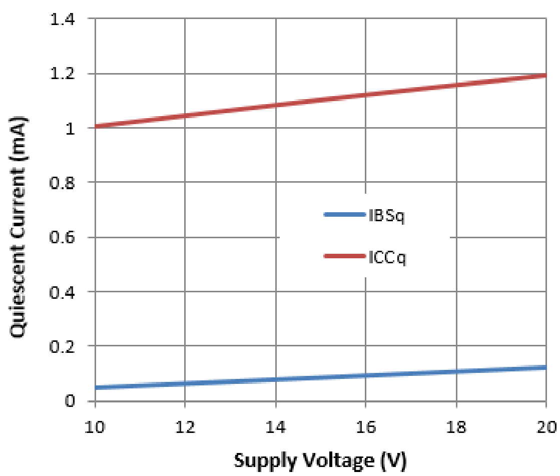


Figure 13. Quiescent Current vs. Supply Voltage

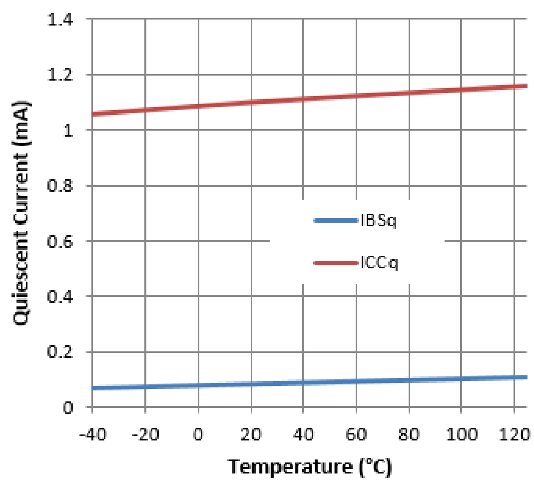


Figure 14. Quiescent Current vs. Temperature

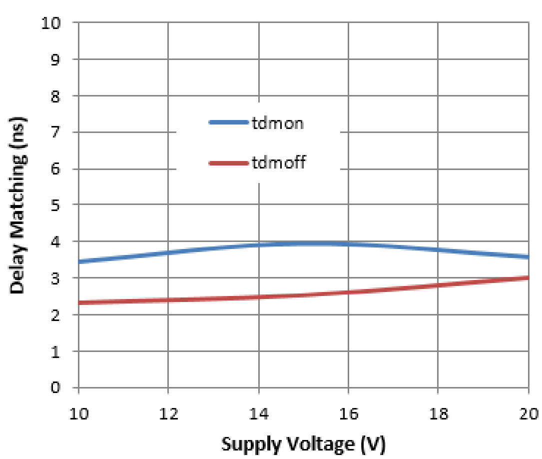


Figure 15. Delay Matching vs. Supply Voltage

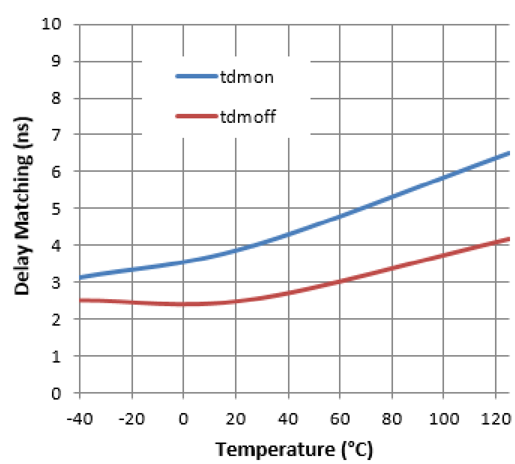


Figure 16. Delay Matching vs. Temperature

Typical Performance Characteristics (continued)

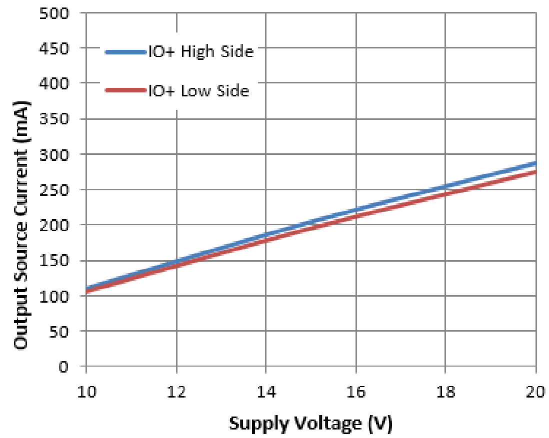


Figure 17. Output Source Current vs. Supply Voltage

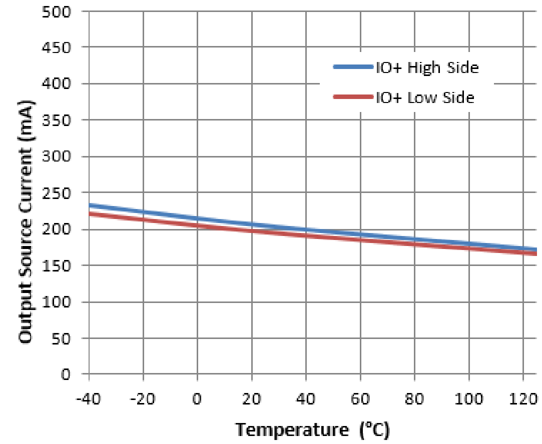


Figure 18. Output Source Current vs. Temperature

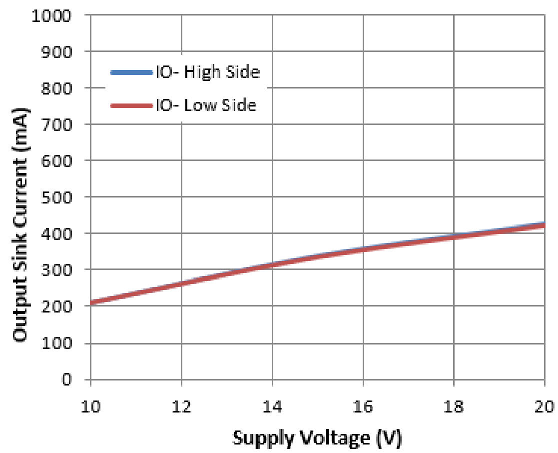


Figure 19. Output Sink Current vs. Supply Voltage

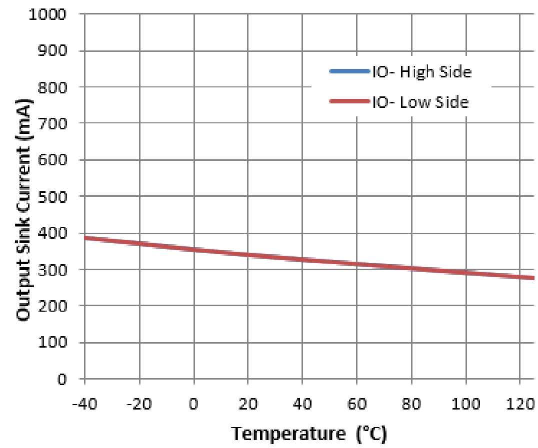


Figure 20. Output Sink Current vs. Temperature

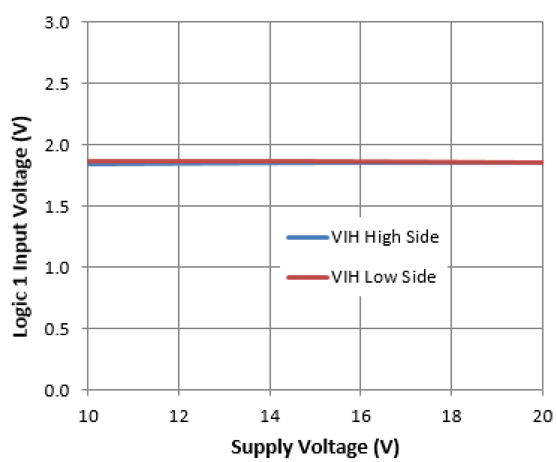


Figure 21. Logic 1 Input Voltage vs. Supply Voltage

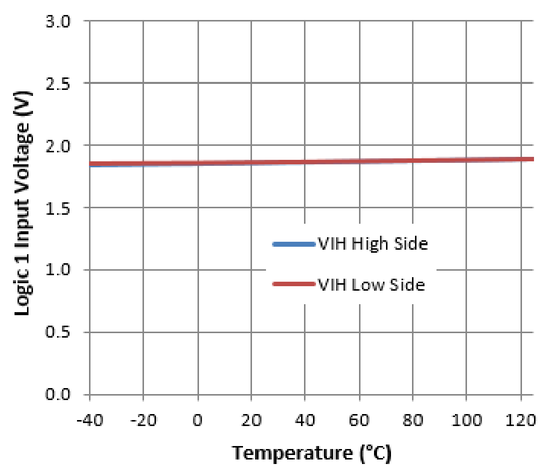


Figure 22. Logic 1 Input Voltage vs. Temperature

Typical Performance Characteristics (continued)

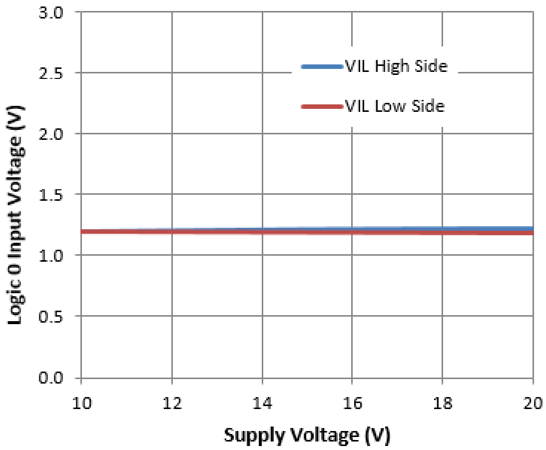


Figure 23. Logic 0 Input Voltage vs. Supply Voltage

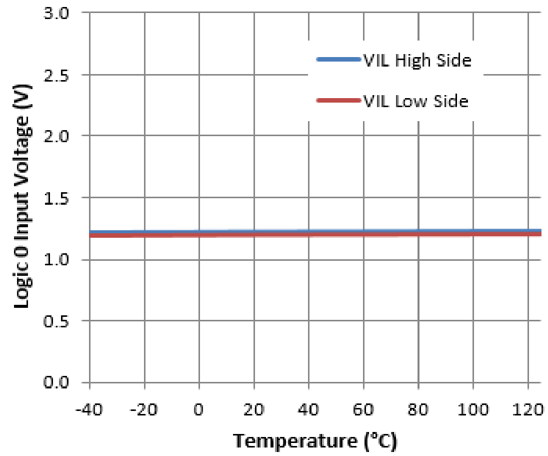


Figure 24. Logic 0 Input Voltage vs. Temperature

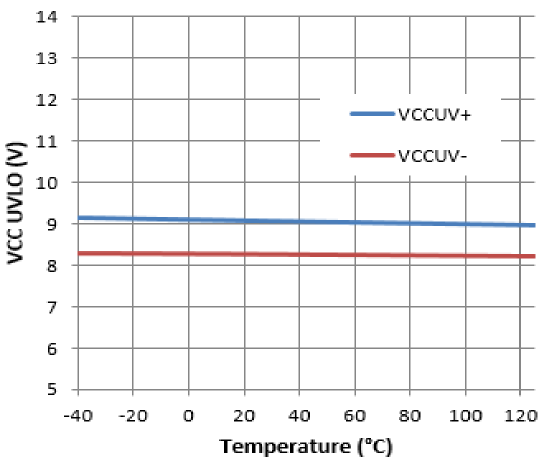


Figure 25. VCC UVLO vs. Temperature

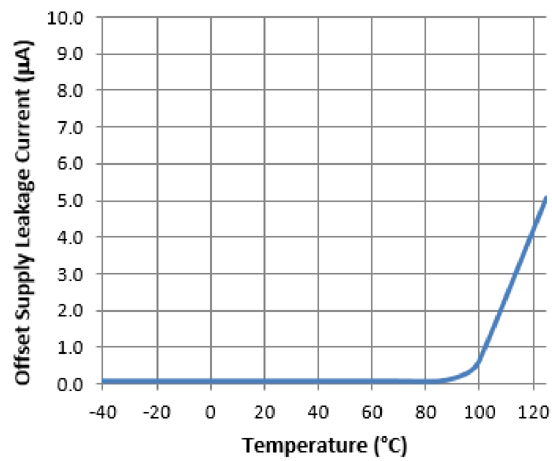
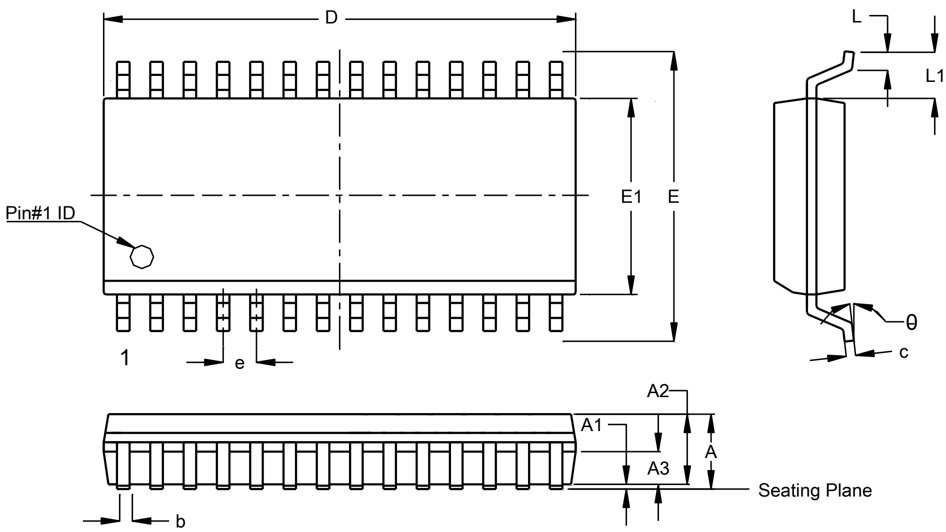


Figure 26. Offset Supply Leakage Current vs. Temperature

Package Outline Dimensions

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

SO-28 (Type TH)

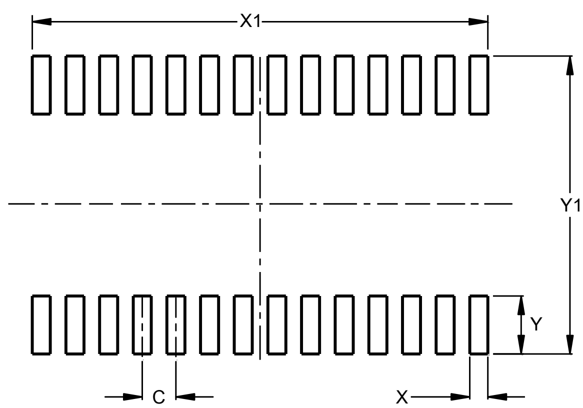


SO-28 (Type TH)			
Dim	**Min**	**Max**	**Typ**
A	--	2.65	--
A1	0.10	0.30	--
A2	2.25	2.35	2.30
A3	0.97	1.07	1.02
b	0.39	0.48	--
c	0.25	0.31	--
D	17.80	18.20	18.00
E	10.10	10.50	10.30
E1	7.30	7.70	7.50
e	1.27 BSC		
L	0.70	1.00	--
L1	1.40 BSC		
θ	0°	8°	--
All Dimensions in mm			

Suggested Pad Layout

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

SO-28 (Type TH)



Dimensions	Value (in mm)
C	1.270
X	0.680
X1	17.190
Y	2.200
Y1	11.300

Note: For high voltage applications, the appropriate industry sector guidelines should be considered with regards to creepage and clearance distances between device Terminals and PCB tracking.