

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.

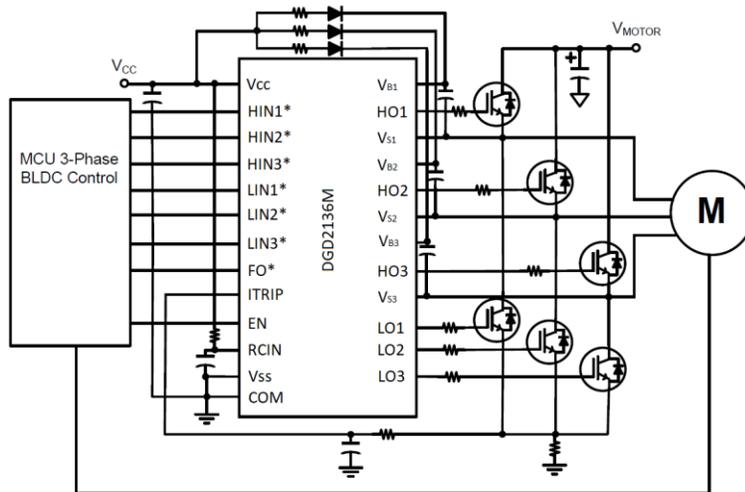
The DGD2136M logic inputs are compatible with standard TTL and CMOS levels (down to 3.3V) for easy interfacing with controlling devices and are enabled low to better function in high noise environments. The driver outputs feature high-pulse current buffers designed for minimum driver cross conduction.

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.

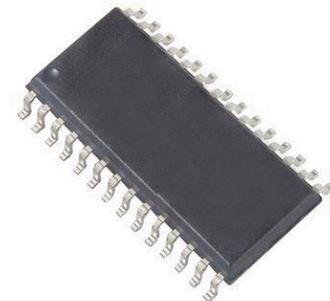
The DGD2136M is offered in SO-28 package and the operating temperature extends from -40°C to +125°C.

Applications

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



Typical Configuration



SO-28

Top View

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](https://www.diodes.com/quality/product-definitions/) or your local Diodes representative.**

Mechanical Data

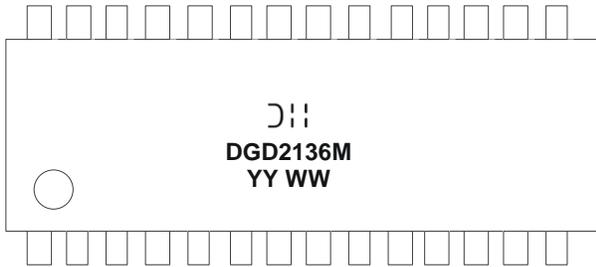
- Case: SO-28 (Type TH)
- Case Material: Molded Plastic. "Green" Molding Compound. UL Flammability Classification Rating 94V-0
- Moisture Sensitivity: Level 3 per J-STD-020
- Terminals: Finish – Matte Tin Plated Leads, Solderable per MIL-STD-202, Method 208 (E3)
- Weight: 0.250 grams (Approximate)

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/>.

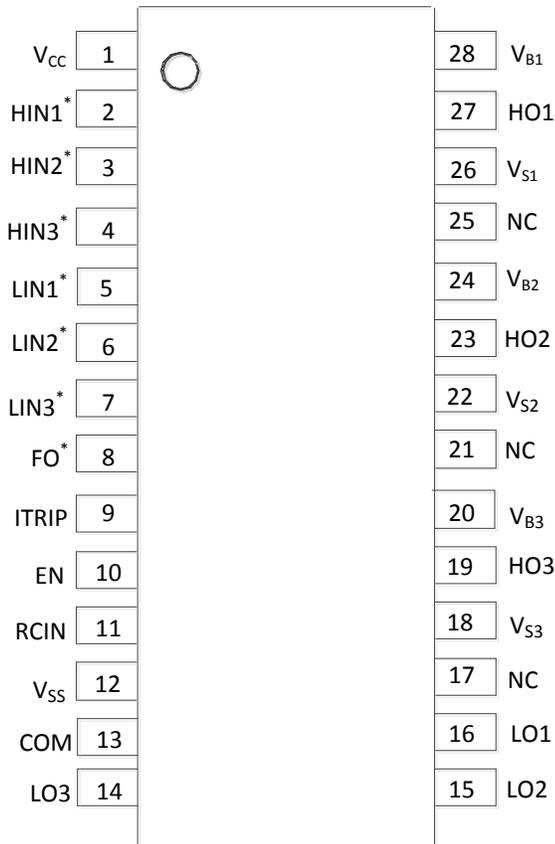
Marking Information



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

Pin Diagrams

Top View

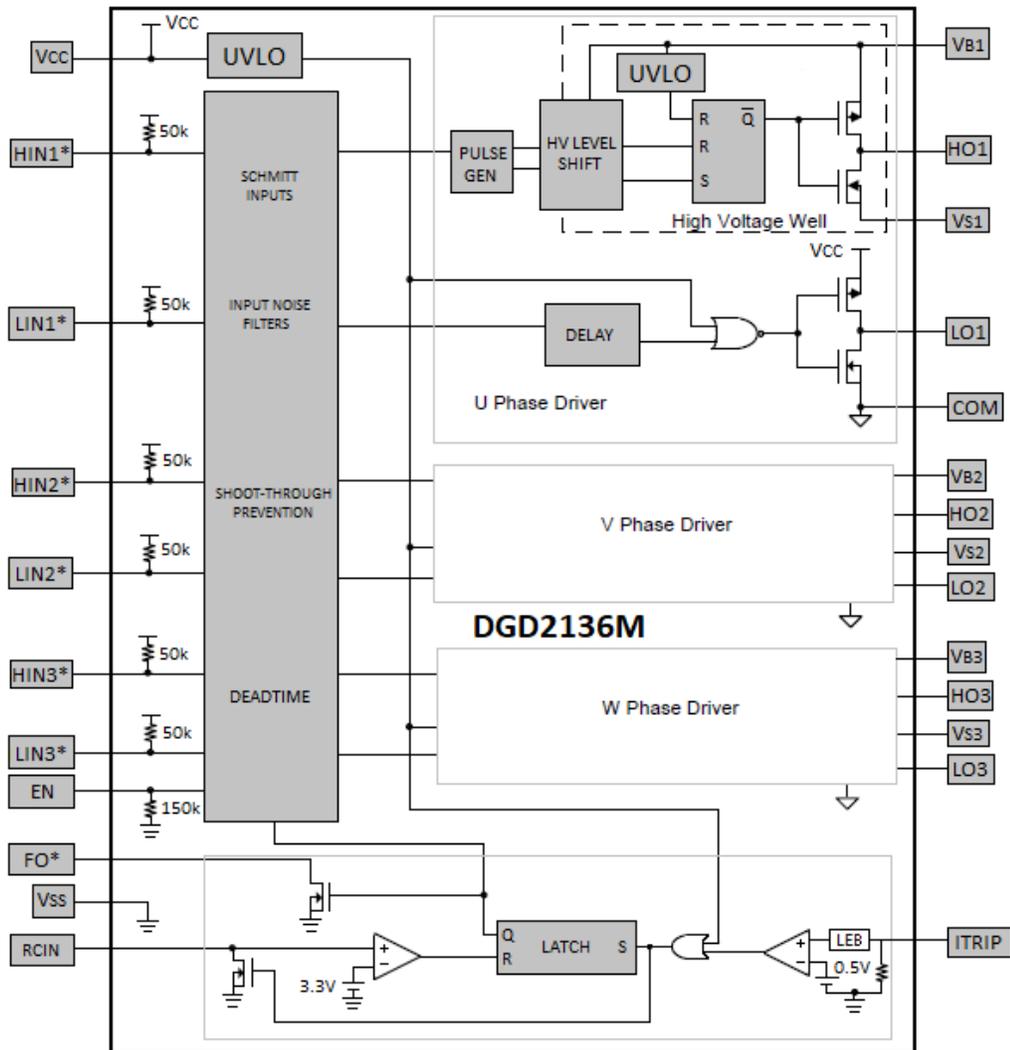


SO-28

Pin Descriptions

| Pin Number | Pin Name | Function |
|------------|---------------------|--|
| 1 | VCC | 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 VCC 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 | VSS | 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 | Vs3, Vs2, Vs1 | High-Side Floating Supply Return |
| 19, 23, 27 | HO3, HO2, HO1 | High-Side Gate Driver Output |
| 20, 24, 28 | Vb3, Vb2, Vb1 | 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 _{θJA} | 60 | °C/W |
| Thermal Resistance, Junction to Case (Note 5) | R _{θJC} | 45 | °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 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 | $I_O = 0\text{mA}$ |
| Low Level Output Voltage, V_O | V_{OL} | — | — | 0.1 | V | $I_O = 0\text{mA}$ |
| Offset Supply Leakage Current | I_{LK} | — | — | 10 | μA | $V_B = V_S = 600\text{V}$ |
| Quiescent V_{BS} Supply Current | I_{BSQ} | 10 | 85 | 130 | μA | $V_{IN} = 0\text{V}$ or 5V , $EN = 0\text{V}$ |
| Quiescent V_{CC} Supply Current | I_{CCQ} | — | 1.1 | 1.6 | mA | $V_{IN} = 0\text{V}$ or 5V , $EN = 0\text{V}$ |
| Logic Input Bias Current (HO = LO = HIGH) | I_{IN+} | — | 130 | 200 | μA | $V_{IN} = 0\text{V}$ |
| Logic Input Bias Current (HO = LO = LOW) | I_{IN-} | — | 3.0 | 20 | μA | $V_{IN} = 5\text{V}$ |
| Logic Enable "1" Input Bias Current | I_{EN+} | — | 33 | 80 | μA | $V_{EN} = 5\text{V}$ |
| Logic Enable "0" Input Bias Current | I_{EN-} | — | — | 2.0 | μA | $V_{EN} = 0\text{V}$ |
| 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 | $V_O = 0\text{V}$, $PW \leq 10\mu\text{s}$ |
| Output Low Short Circuit Pulsed Current | I_{O-} | 250 | 350 | — | mA | $V_O = 15\text{V}$, $PW \leq 10\mu\text{s}$ |
| 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 | $V_{CSIN} = 1\text{V}$ |
| 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 | $V_{CS} = 1\text{V}$, $I_{FO} = 1.5\text{mA}$ |
| RCIN on Resistance | R_{DSRCIN} | 40 | 75 | 110 | Ω | $I_{RCIN} = 1.5\text{mA}$ |
| Fault Output on Resistance | R_{DSFO} | 80 | 130 | 180 | Ω | $I_{FO} = 1.5\text{mA}$ |

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, $C_L = 1000\text{pF}$, @ T_A = +25°C, unless otherwise specified.)

| Parameter | Symbol | Min | Typ | Max | Unit | Condition |
|---|--------------|-----|-----|-----|------|--|
| Turn-On Propagation Delay | t_{ON} | 200 | 330 | 460 | ns | $V_S = 0\text{V}$ |
| Turn-Off Propagation Delay | t_{OFF} | 200 | 330 | 460 | ns | $V_S = 0\text{V}$ |
| Turn-On Rise Time | t_r | — | 90 | 150 | ns | $V_S = 0\text{V}$ |
| Turn-Off Fall Time | t_f | — | 35 | 60 | ns | $V_S = 0\text{V}$ |
| 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 $V_{ITRIP} = 1\text{V}$ to FO* turn off |
| Time from ITRIP Triggering to All Gate Outputs Turn Off | t_{ITRIP} | 420 | 615 | 820 | ns | From $V_{ITRIP} = 1\text{V}$ to starting gate turn off |
| Input Filtering Time (HIN*, LIN*, EN) | t_{FLTIN} | — | 250 | — | ns | — |
| Fault Clear Time | t_{FLTCLR} | — | 1.6 | — | ms | $R_{CSIN} = 1\text{nF}$, $R_{RCIN} = 2\text{M}\Omega$ |
| Deadtime | t_{DT} | 200 | 290 | 420 | ns | — |
| Deadtime Matching | t_{DTM} | — | — | 50 | ns | — |
| Output Pulse Width Matching (Note 8) | t_{PM} | — | 50 | 75 | ns | $PW_{IN} > 1\mu\text{s}$ |

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

Timing Waveforms

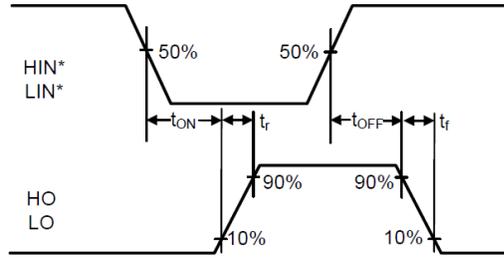


Figure 1. Switching Time Waveform Definitions

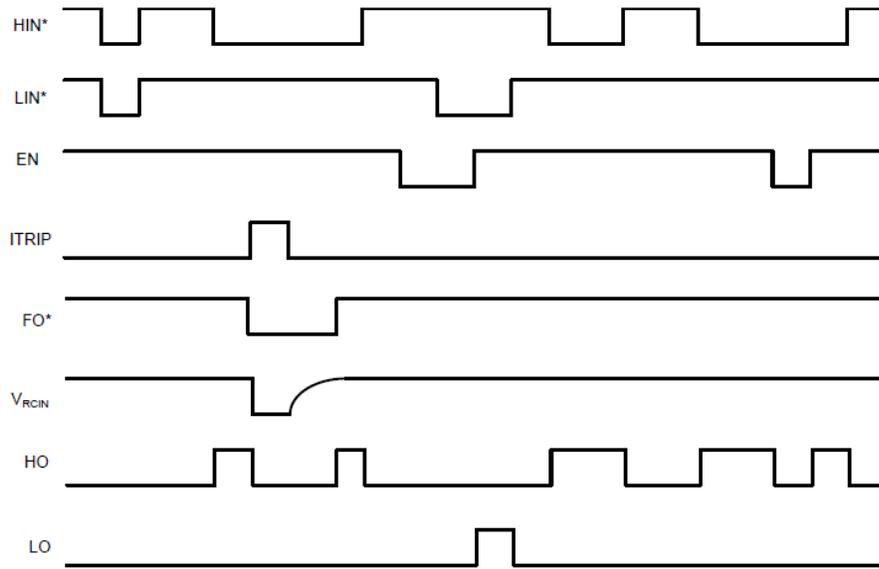


Figure 2. Input/Output Timing Diagram

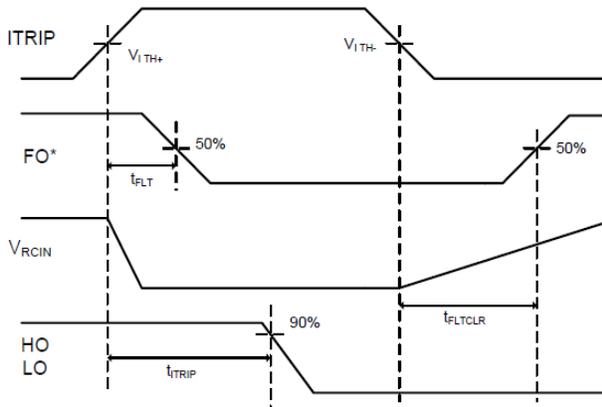
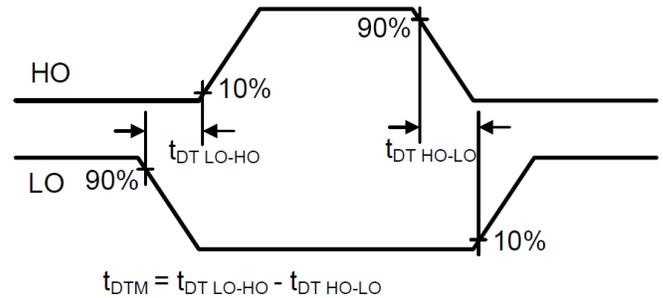


Figure 3. Overcurrent Timing Definitions



$$t_{DTM} = t_{DT\ LO-HO} - t_{DT\ HO-LO}$$

Figure 4. Deadtime Waveform Definitions

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

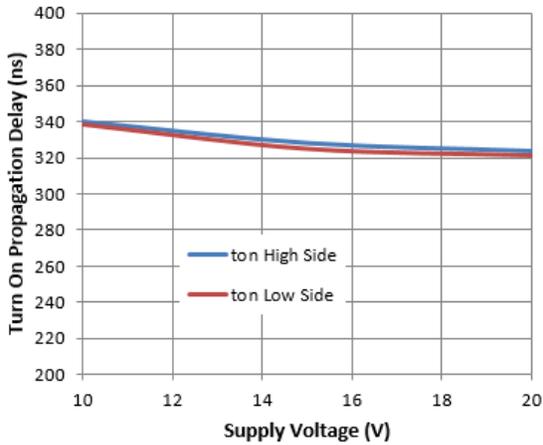


Figure 5. Turn-on Propagation Delay vs. Supply Voltage

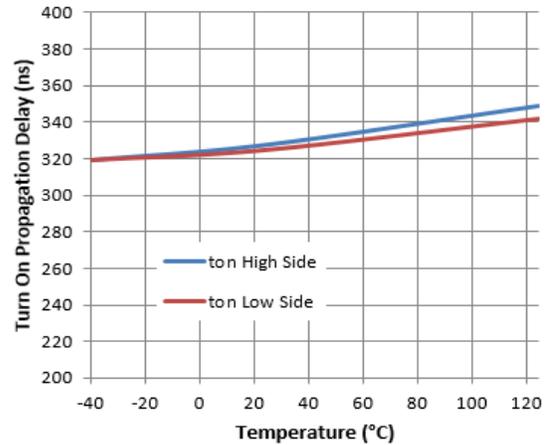


Figure 6. Turn-on Propagation Delay vs. Temperature

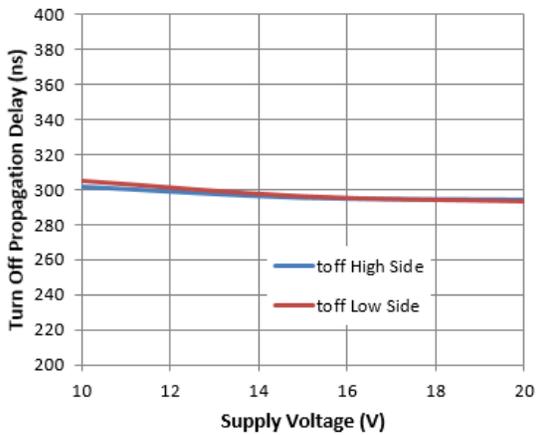


Figure 7. Turn-off Propagation Delay vs. Supply Voltage

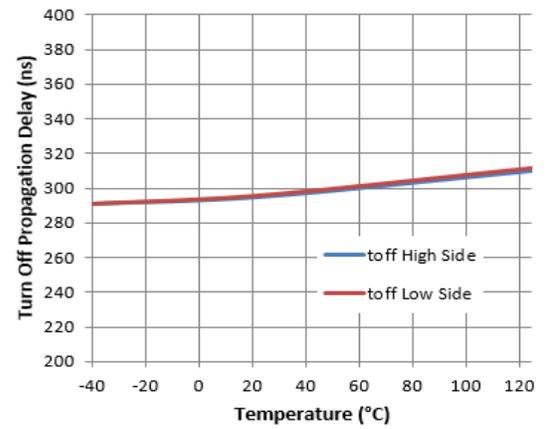


Figure 8. Turn-off Propagation Delay vs. Temperature

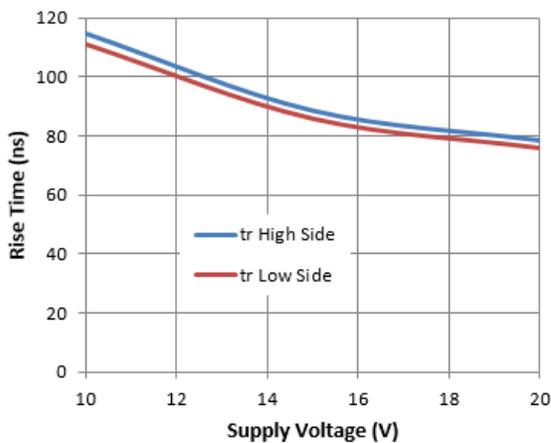


Figure 9. Rise Time vs. Supply Voltage

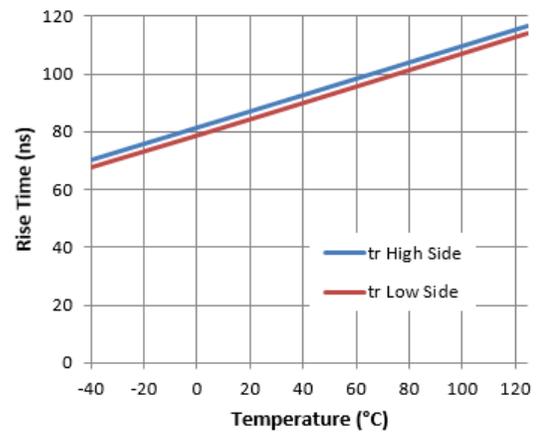


Figure 10. Rise Time vs. Temperature

Typical Performance Characteristics (continued)

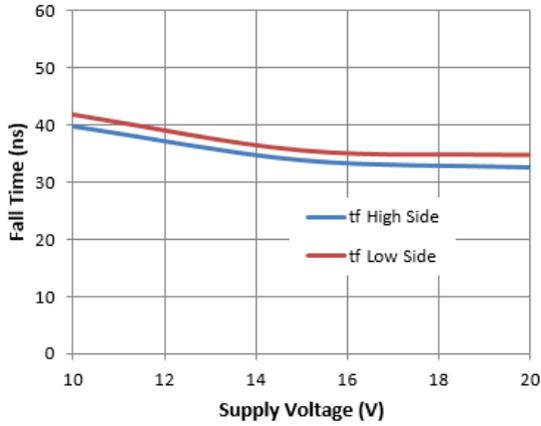


Figure 11. Fall Time vs. Supply Voltage

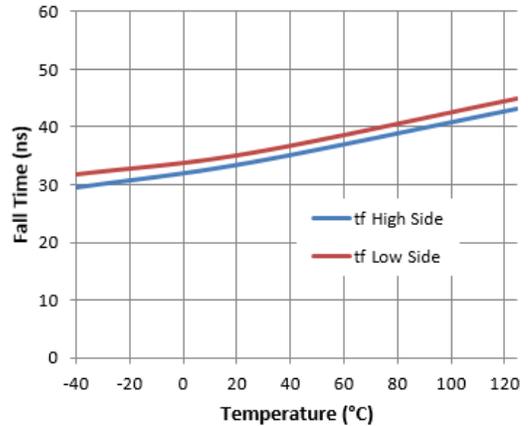


Figure 12. Fall Time vs. Temperature

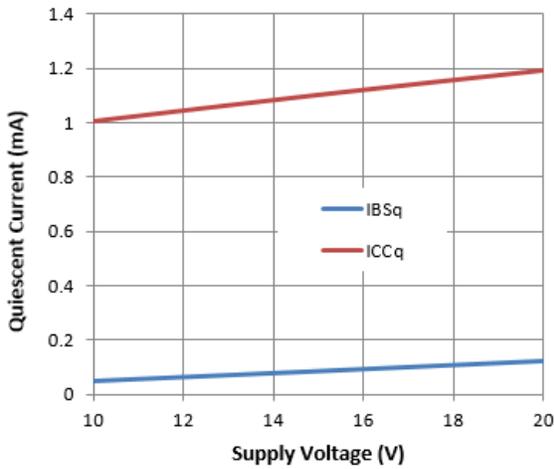


Figure 13. Quiescent Current vs. Supply Voltage

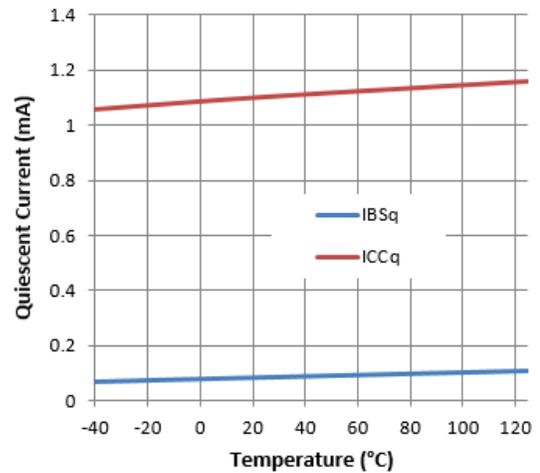


Figure 14. Quiescent Current vs. Temperature

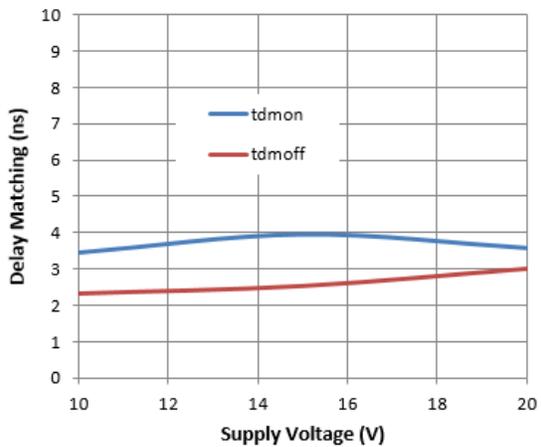


Figure 15. Delay Matching vs. Supply Voltage

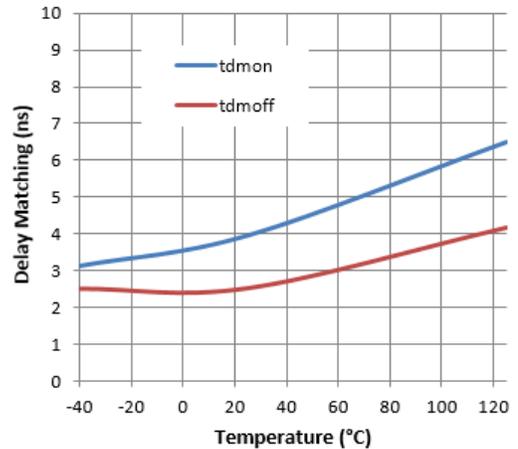


Figure 16. Delay Matching vs. Temperature

Typical Performance Characteristics (continued)

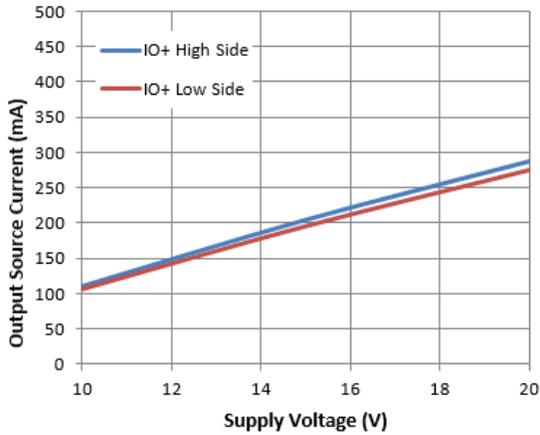


Figure 17. Output Source Current vs. Supply Voltage

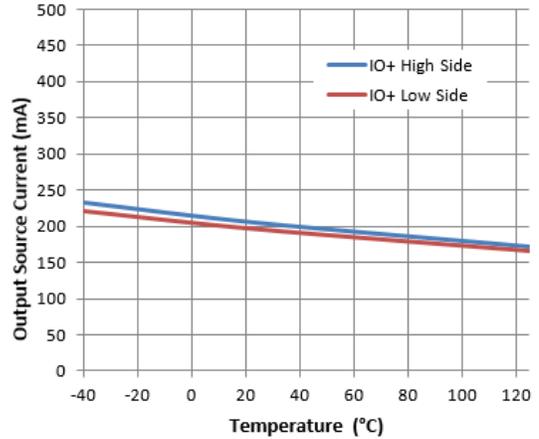


Figure 18. Output Source Current vs. Temperature

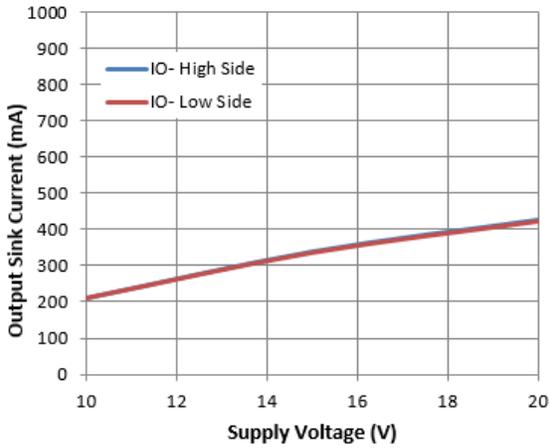


Figure 19. Output Sink Current vs. Supply Voltage

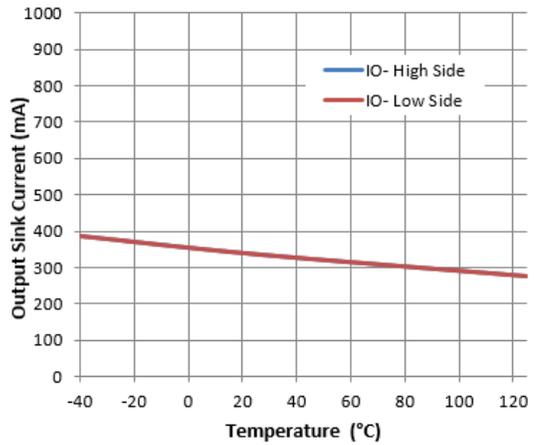


Figure 20. Output Sink Current vs. Temperature

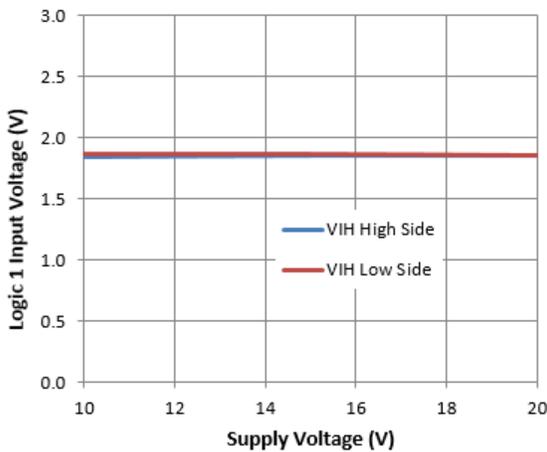


Figure 21. Logic 1 Input Voltage vs. Supply Voltage

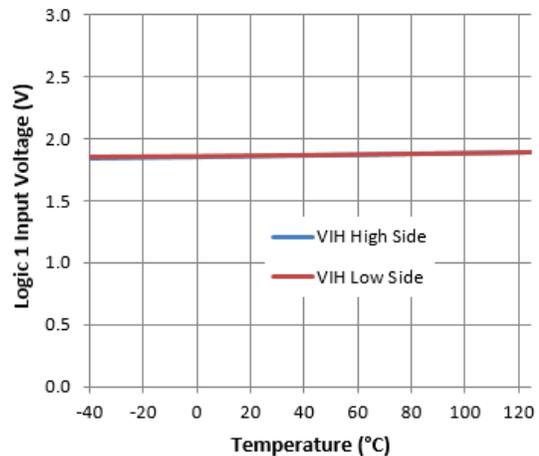


Figure 22. Logic 1 Input Voltage vs. Temperature

Typical Performance Characteristics (continued)

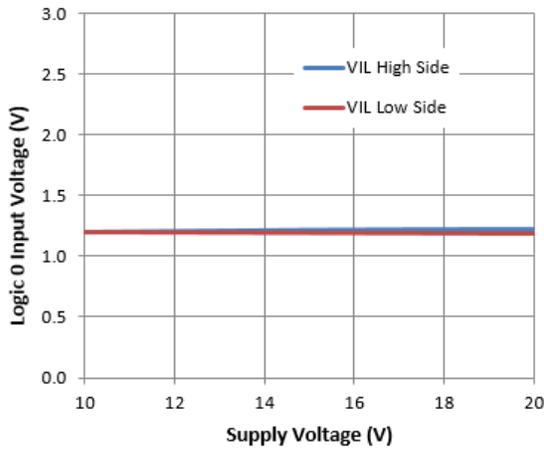


Figure 23. Logic 0 Input Voltage vs. Supply Voltage

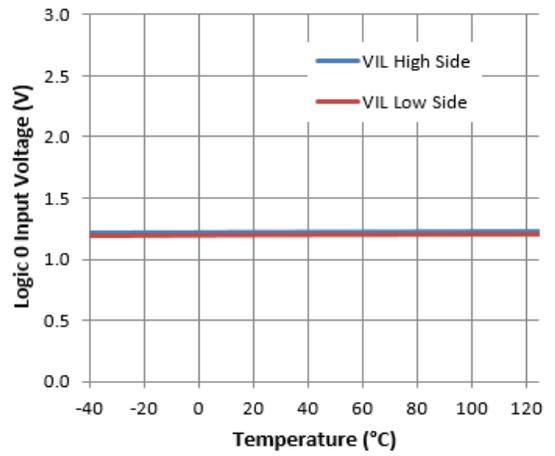


Figure 24. Logic 0 Input Voltage vs. Temperature

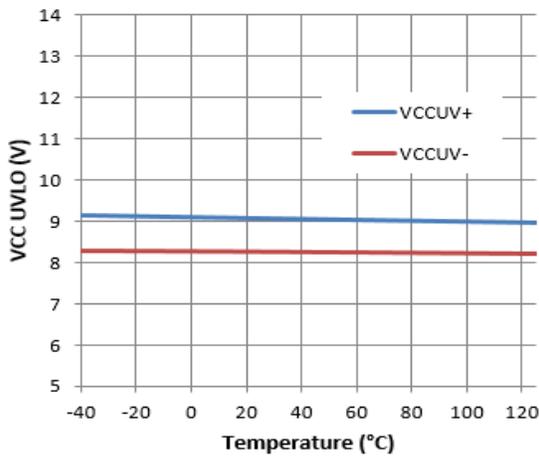


Figure 25. VCC UVLO vs. Temperature

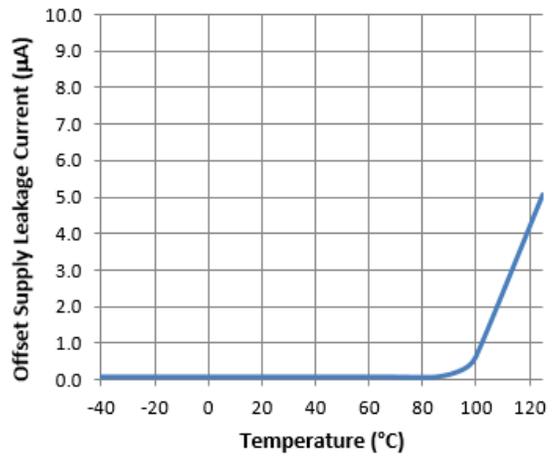
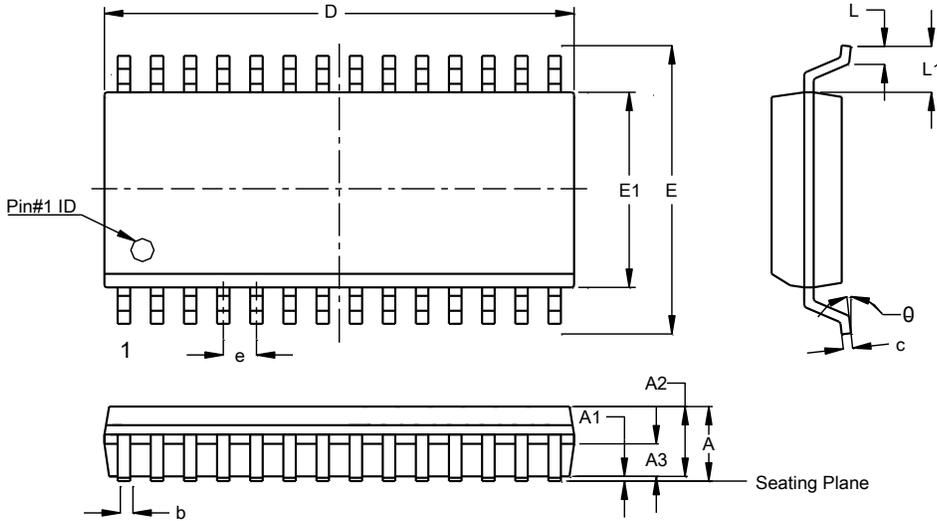


Figure 26. Offset Supply Leakage Current vs. Temperature

Package Outline Dimensions

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

SO-28 (Type TH)

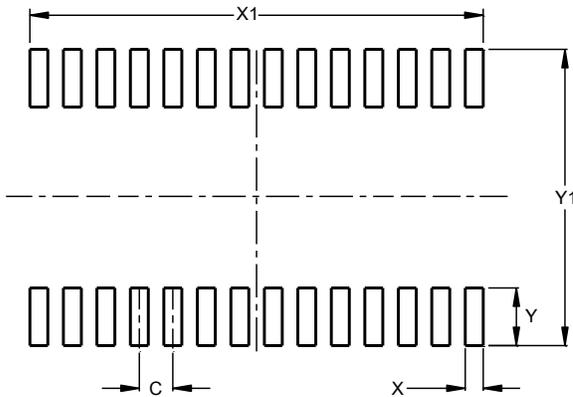


| SO-28 (Type TH) | | | |
|----------------------|----------|-------|-------|
| Dim | Min | Max | Typ |
| A | -- | 2.65 | -- |
| A1 | 0.10 | 0.30 | -- |
| A2 | 2.25 | 2.35 | 2.30 |
| A3 | 0.97 | 1.07 | 1.02 |
| b | 0.39 | 0.48 | -- |
| c | 0.25 | 0.31 | -- |
| D | 17.80 | 18.20 | 18.00 |
| E | 10.10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

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