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FAN73896 3-Phase Half-Bridge Gate-Drive IC

Features

- Floating Channel for Bootstrap Operation to +600 V
- Typically 350 mA/650 mA Sourcing/Sinking Current-Driving Capability for All Channels
- Extended Allowable Negative V_S Swing to -9.8 V for Signal Propagation at $V_{DD}=V_{BS}=15$ V
- Output In-Phase with Input Signal
- Over-Current Shutdown Turns Off All Six Drivers
- Matched Propagation Delay for All Channels
- 3.3 V and 5.0 V Input Logic Compatible
- Adjustable Fault-Clear Timing
- Built-in Advanced Input Filter
- Built-in Shoot-Through Prevention Logic
- Built-in Soft Turn-Off Function
- Common-Mode dv/dt Noise-Canceling Circuit
- Built-in UVLO Functions for All Channels

Applications

- 3-Phase Motor Inverter Driver
- Air Conditioner, Washing Machine, Refrigerator, Dish Washer
- Industrial Inverter – Sewing Machine, Power Tool
- General-Purpose Three-Phase Inverter

Description

The FAN73896 is a monolithic three-phase half-bridge gate-drive IC designed for high-voltage, high-speed, driving MOSFETs and IGBTs operating up to +600 V.

Fairchild's high-voltage process and common-mode noise-canceling technique provide stable operation of high-side drivers under high-dv/dt noise circumstances.

An advanced level-shift circuit allows high-side gate driver operation up to $V_S = -9.8$ V (typical) for $V_{BS} = 15$ V.

The protection functions include under-voltage lockout and inverter over-current trip with an automatic fault-clear function. Over-current protection that terminates all six outputs can be derived from an external current-sense resistor. An open-drain fault signal is provided to indicate that an over-current or under-voltage shutdown has occurred. The UVLO circuits prevent malfunction when V_{DD} and V_{BS} are lower than the threshold voltage.

Output drivers typically source and sink 350 mA and 650 mA, respectively; which is suitable for three-phase half-bridge applications in motor drive systems.



Figure 1. 28-SOIC

Ordering Information

| Part Number | Package | Operating Temperature | Packing Method |
|---------------------------|---|-----------------------|----------------|
| FAN73896MX ⁽¹⁾ | 28-Lead, Small Outline Integrated Circuit, (SOIC) | -40 to +125°C | Tape & Reel |

Note:

1. These devices passed wave-soldering test by JESD22A-111.

Typical Application Diagram

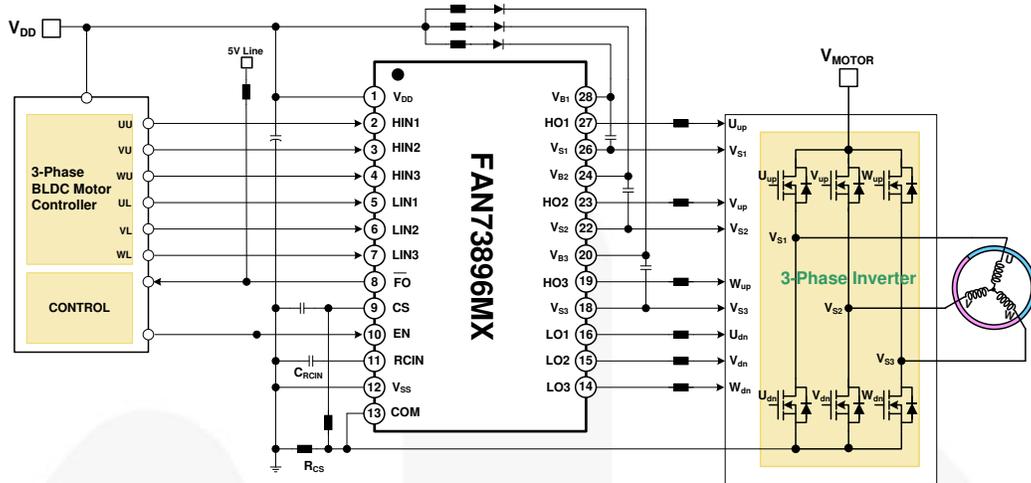


Figure 2. 3-Phase BLDC Motor Drive Application

Internal Block Diagram

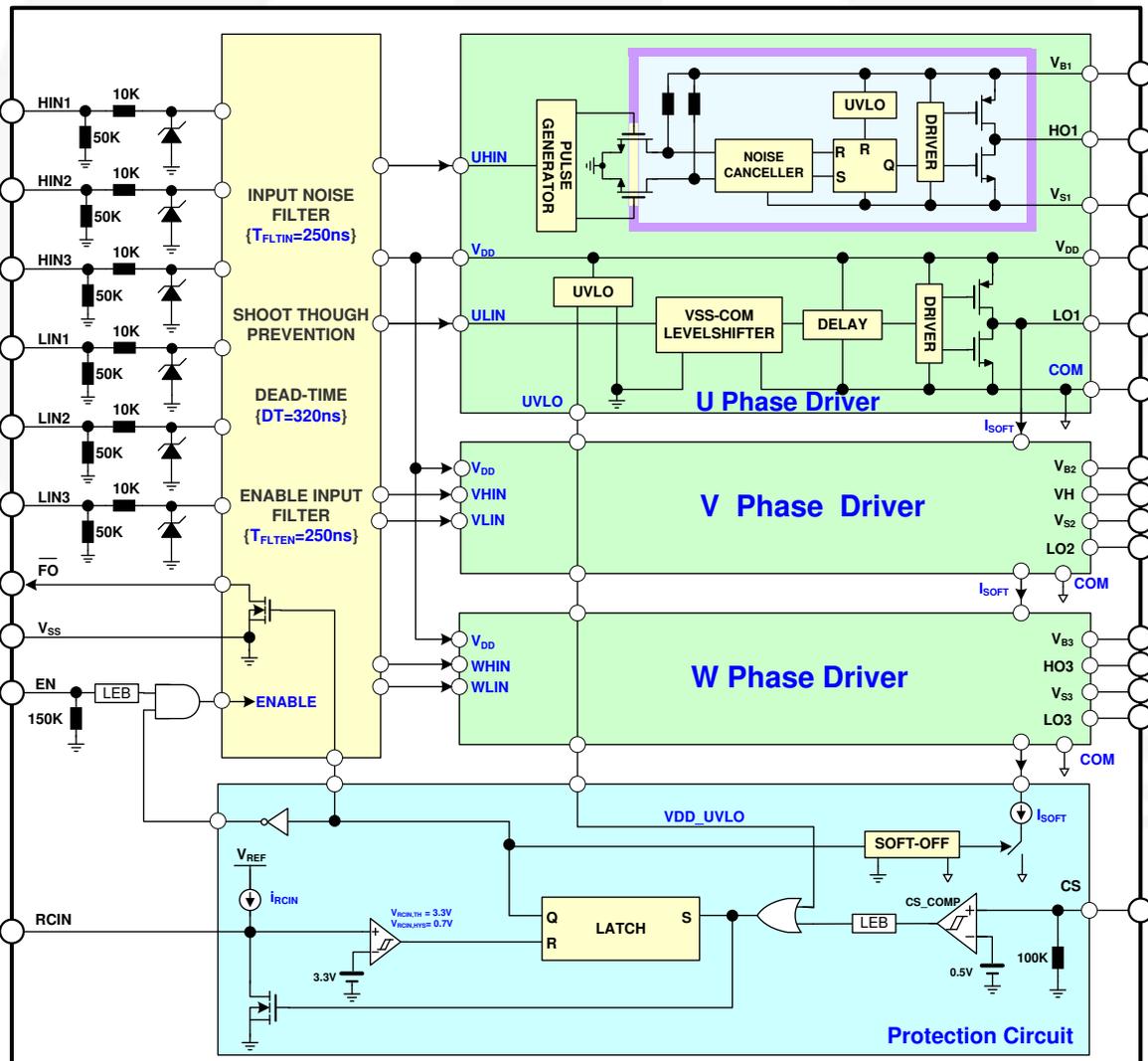


Figure 3. Functional Block Diagram

Pin Configuration

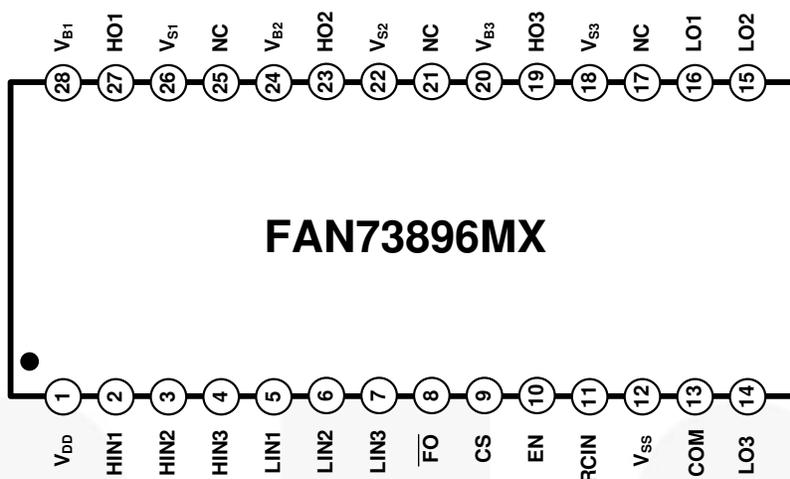


Figure 4. Pin Assignments

Pin Definitions

| Pin | Name | Description |
|------------|-----------------|---|
| 1 | V _{DD} | Logic and low-side gate driver power supply voltage. |
| 2 | HIN1 | Logic Input 1 for high-side gate 1 driver. |
| 3 | HIN2 | Logic Input 2 for high-side gate 2 driver. |
| 4 | HIN3 | Logic Input 3 for high-side gate 3 driver. |
| 5 | LIN1 | Logic Input 1 for low-side gate 1 driver. |
| 6 | LIN2 | Logic Input 2 for low-side gate 2 driver. |
| 7 | LIN3 | Logic Input 3 for low-side gate 3 driver. |
| 8 | FO | Fault output with open drain (indicates over-current and low-side under-voltage). |
| 9 | CS | Analog input for over-current shutdown. |
| 10 | EN | Logic input for shutdown functionality. |
| 11 | RCIN | An external RC network input used to define the fault-clear delay. |
| 12 | V _{SS} | Logic ground. |
| 13 | COM | Low-side driver return. |
| 14 | LO3 | Low-side gate driver 3 output. |
| 15 | LO2 | Low-side gate driver 2 output. |
| 16 | LO1 | Low-side gate driver 1 output. |
| 17, 21, 25 | NC | No connect. |
| 18 | V _{S3} | High-side driver 3 floating supply offset voltage. |
| 19 | HO3 | High-side driver 3 gate driver output. |
| 20 | V _{B3} | High-side driver 3 floating supply. |
| 22 | V _{S2} | High-side driver 2 floating supply offset voltage. |
| 23 | HO2 | High-side driver 2 gate driver output. |
| 24 | V _{B2} | High-side driver 2 floating supply. |
| 26 | V _{S1} | High-side driver 1 floating supply offset voltage. |
| 27 | HO1 | High-side driver 1 gate driver output. |
| 28 | V _{B1} | High-side driver 1 floating supply. |

Absolute Maximum Ratings

Stresses exceeding the Absolute Maximum Ratings may damage the device. The device may not function or be operable above the recommended operating conditions and stressing the parts to these levels is not recommended. In addition, extended exposure to stresses above the recommended operating conditions may affect device reliability. The absolute maximum ratings are stress ratings only. $T_A=25^{\circ}\text{C}$, unless otherwise specified.

| Symbol | Parameter | Min. | Max. | Unit |
|---------------|---|------------------|------------------|-----------------------------|
| V_S | High-Side Floating Offset Voltage | $V_{B1,2,3}-25$ | $V_{B1,2,3}+0.3$ | V |
| V_B | High-Side Floating Supply Voltage | -0.3 | 625.0 | V |
| V_{DD} | Low-Side and Logic-Fixed supply voltage | -0.3 | 25.0 | V |
| V_{HO} | High-Side Floating Output Voltage $V_{HO1,2,3}$ | $V_{S1,2,3}-0.3$ | $V_{B1,2,3}+0.3$ | V |
| V_{LO} | Low-Side Floating Output Voltage $V_{LO1,2,3}$ | -0.3 | $V_{DD}+0.3$ | V |
| V_{IN} | Input Voltage (HINx, LINx, CS, and EN) ⁽²⁾ | -0.3 | 5.5 | V |
| V_{FO} | Fault Output Voltage (\overline{FO}) | -0.3 | $V_{DD}+0.3$ | V |
| dV_S/dt | Allowable Offset Voltage Slew Rate | | ± 50 | V/ns |
| P_D | Power Dissipation ^(3,4) | | 1.4 | W |
| θ_{JA} | Thermal Resistance | | 70 | $^{\circ}\text{C}/\text{W}$ |
| T_J | Junction Temperature | | 150 | $^{\circ}\text{C}$ |
| T_{STG} | Storage Temperature | -55 | 150 | $^{\circ}\text{C}$ |

Notes:

- All input voltage (HINx, LINx, CS, and EN) are referenced to V_{SS} and do not exceed maximum voltage rating.
- Mounted on 76.2 x 114.3 x 1.6 mm PCB (FR-4 glass epoxy material). Refer to the following standards:
JESD51-2: Integral circuit's thermal test method environmental conditions, natural convection;
JESD51-3: Low effective thermal conductivity test board for leaded surface-mount packages.
- Do not exceed maximum power dissipation (P_D) under any circumstances.

Recommended Operating Conditions

The Recommended Operating Conditions table defines the conditions for actual device operation. Recommended operating conditions are specified to ensure optimal performance to the datasheet specifications. Fairchild does not recommend exceeding them or designing to Absolute Maximum Ratings.

| Symbol | Parameter | Min. | Max. | Unit |
|---------------|--|-----------------|-----------------|--------------------|
| $V_{B1,2,3}$ | High-Side Floating Supply Voltage | $V_{S1,2,3}+10$ | $V_{S1,2,3}+20$ | V |
| $V_{S1,2,3}$ | High-Side Floating Supply Offset Voltage | $6-V_{DD}$ | 600 | V |
| V_{DD} | Low-Side and Logic Fixed Supply Voltage | 12 | 20 | V |
| $V_{HO1,2,3}$ | High-Side Output Voltage | $V_{S1,2,3}$ | $V_{B1,2,3}$ | V |
| $V_{LO1,2,3}$ | Low-Side Output Voltage | COM | V_{DD} | V |
| V_{FO} | Fault Output Voltage (\overline{FO}) | V_{SS} | V_{DD} | V |
| V_{CS} | Current-Sense Pin Input Voltage | V_{SS} | 5 | V |
| V_{IN} | Logic Input Voltage (HIN1,2,3 and LIN1,2,3) | V_{SS} | 5 | V |
| COM | Low-Side driver return | -5 | 5 | V |
| T_A | Ambient Temperature | -40 | +125 | $^{\circ}\text{C}$ |

Electrical Characteristics

V_{BIAS} (V_{DD} , $V_{BS1,2,3}$) = 15.0 V and T_A = 25°C unless otherwise specified. The V_{IN} and I_{IN} parameters are referenced to V_{SS} and are applicable to all six channels. The V_O and I_O parameters are referenced to $V_{S1,2,3}$ and COM and are applicable to the respective output leads: HO1,2,3 and LO1,2,3. The V_{DDUV} parameters are referenced to V_{SS} . The V_{BSUV} parameters are referenced to $V_{S1,2,3}$.

| Symbol | Parameter | Condition | Min. | Typ. | Max. | Unit |
|--|---|--|------|------|------|------------|
| Low-Side Power Supply Section | | | | | | |
| I_{QDD} | Quiescent V_{DD} Supply Current | $V_{LIN1,2,3}=0$ V or 5V, EN=0 V | | 250 | 400 | μ A |
| I_{PDD} | Operating V_{DD} Supply Current | $C_{LOAD}=1$ nF, $f_{LIN1,2,3}=20$ kHz, rms Value | | 550 | 750 | μ A |
| V_{DDUV+} | V_{DD} Supply Under-Voltage Positive-Going Threshold | $V_{DD}=\text{Sweep}$ | 9.7 | 11.0 | 12.0 | V |
| V_{DDUV-} | V_{DD} Supply Under-Voltage Negative-Going Threshold | $V_{DD}=\text{Sweep}$ | 9.2 | 10.5 | 11.4 | V |
| V_{DDHYS} | V_{DD} Supply Under-Voltage Lockout Hysteresis | $V_{DD}=\text{Sweep}$ | | 0.5 | | V |
| Bootstrapped Power Supply Section | | | | | | |
| V_{BSUV+} | V_{BS} Supply Under-Voltage Positive-Going Threshold | $V_{BS1,2,3}=\text{Sweep}$ | 9.7 | 11.0 | 12.0 | V |
| V_{BSUV-} | V_{BS} Supply Under-Voltage Negative-Going Threshold | $V_{BS1,2,3}=\text{Sweep}$ | 9.2 | 10.5 | 11.4 | V |
| V_{BSHYS} | V_{BS} Supply Under-Voltage Lockout Hysteresis | $V_{BS1,2,3}=\text{Sweep}$ | | 0.5 | | V |
| I_{LK} | Offset Supply Leakage Current | $V_{B1,2,3}=V_{S1,2,3}=600$ V | | | 10 | μ A |
| I_{QBS} | Quiescent V_{BS} Supply Current | $V_{HIN1,2,3}=0$ V or 5 V, EN=0 V | 10 | 50 | 80 | μ A |
| I_{PBS} | Operating V_{BS} Supply Current | $C_{LOAD}=1$ nF, $f_{HIN1,2,3}=20$ kHz, rms Value | 200 | 320 | 480 | μ A |
| Gate Driver Output Section | | | | | | |
| V_{OH} | High-Level Output Voltage, $V_{BIAS}-V_O$ | $I_O=0$ mA (No Load) | | | 100 | mV |
| V_{OL} | Low-Level Output Voltage, V_O | $I_O=0$ mA (No Load) | | | 100 | mV |
| I_{O+} | Output HIGH Short-Circuit Pulse Current ⁽⁵⁾ | $V_O=15$ V, $V_{IN}=0$ V with $PW \leq 10$ μ s | 250 | 350 | | mA |
| I_{O-} | Output LOW Short-Circuit Pulse Current ⁽⁵⁾ | $V_O=0$ V, $V_{IN}=5$ V with $PW \leq 10$ μ s | 500 | 650 | | mA |
| V_S | Allowable Negative V_S Pin Voltage for HIN Signal Propagation to HO | | | -9.8 | -9.0 | V |
| Logic Input Section | | | | | | |
| V_{IH} | Logic "1" Input Voltage HIN1,2,3, LIN1,2,3 | | 2.5 | | | V |
| V_{IL} | Logic "0" Input Voltage HIN1,2,3, LIN1,2,3 | | | | 0.8 | V |
| I_{IN+} | Logic Input Bias Current (HO=LO=HIGH) | $V_{IN}=5$ V | 77 | 100 | 143 | μ A |
| I_{IN-} | Logic Input Bias Current (HO=LO=LOW) | $V_{IN}=0$ V | | | 2 | μ A |
| R_{IN} | Logic Input Pull-Down Resistance | | 35 | 50 | 65 | K Ω |
| Enable Control Section (EN) | | | | | | |
| V_{EN+} | Enable Positive-Going Threshold Voltage | | 2.5 | | | V |
| V_{EN-} | Enable Negative-Going Threshold Voltage | | | | 0.8 | V |
| I_{EN+} | Logic Enable "1" Input Bias Current | $V_{EN}=5$ V (Pull-Down=150 K Ω) | 15 | 33 | 50 | μ A |
| I_{EN-} | Logic Enable "0" Input Bias Current | $V_{EN}=0$ V | | | 2 | μ A |
| R_{EN} | Logic Input Pull-Down Resistance | | 100 | 150 | 333 | K Ω |

Electrical Characteristics

V_{BIAS} (V_{DD} , $V_{BS1,2,3}$) = 15.0 V and T_A = 25°C unless otherwise specified. The V_{IN} and I_{IN} parameters are referenced to V_{SS} and are applicable to all six channels. The V_O and I_O parameters are referenced to $V_{S1,2,3}$ and COM and are applicable to the respective output leads: HO1,2,3 and LO1,2,3. The V_{DDUV} parameters are referenced to V_{SS} . The V_{BSUV} parameters are referenced to $V_{S1,2,3}$.

| Symbol | Parameter | Condition | Min. | Typ. | Max. | Unit |
|--|--|-------------------------------|------|------|------|----------|
| Over-Current Protection Section | | | | | | |
| V_{CSTH+} | Over-Current Detect Positive Threshold | | 450 | 500 | 550 | mV |
| V_{CSTH-} | Over-Current Detect Negative Threshold | | | 440 | | mV |
| V_{CSHYS} | Over-Current Detect Hysteresis | | | 60 | | mV |
| I_{CSIN} | Short-Circuit Input Current | $V_{CSIN}=1$ V | 5 | 10 | 15 | μ A |
| I_{SOFT} | Soft Turn-Off Sink Current | | 25 | 40 | 55 | mA |
| Fault Output Section | | | | | | |
| $V_{RCINTH+}$ | RCIN Positive-Going Threshold Voltage | | 2.7 | 3.3 | 3.9 | V |
| $V_{RCINTH-}$ | RCIN Negative-Going Threshold Voltage ⁽⁵⁾ | | | 2.6 | | V |
| $V_{RCINHYS}$ | RCIN Hysteresis Voltage ⁽⁵⁾ | | | 0.7 | | V |
| I_{RCIN} | RCIN Internal Current Source | $C_{RCIN}=2$ nF | 3 | 5 | 7 | μ A |
| V_{FOL} | Fault Output Low Level Voltage | $V_{CS}=1$ V, $I_{FO}=1.5$ mA | | 0.2 | 0.5 | V |
| R_{DSRCIN} | RCIN On Resistance | $I_{RCIN}=1.5$ mA | 50 | 75 | 100 | Ω |
| R_{DSFO} | Fault Output On Resistance | $I_{FO}=1.5$ mA | 90 | 130 | 170 | Ω |

Note:

5. These parameters are guaranteed by design.

Dynamic Electrical Characteristics

$T_A=25^\circ\text{C}$, V_{BIAS} (V_{DD} , $V_{BS1,2,3}$) = 15.0 V, $V_{S1,2,3}$ = COM, $C_{RCIN}=2$ nF, and C_{Load} = 1000 pF unless otherwise specified.

| Symbol | Parameter | Conditions | Min. | Typ. | Max. | Unit |
|--------------|---|---|------|------|------|------|
| t_{ON} | Turn-On Propagation Delay | $V_{LIN1,2,3}=V_{HIN1,2,3}=5$ V, $V_{S1,2,3}=0$ V | 350 | 500 | 650 | ns |
| t_{OFF} | Turn-Off Propagation Delay | $V_{LIN1,2,3}=V_{HIN1,2,3}=0$ V, $V_{S1,2,3}=0$ V | 350 | 500 | 650 | ns |
| t_R | Turn-On Rise Time | $V_{LIN1,2,3}=V_{HIN1,2,3}=5$ V | 20 | 50 | 100 | ns |
| t_F | Turn-Off Fall Time | $V_{LIN1,2,3}=V_{HIN1,2,3}=0$ V | 10 | 30 | 80 | ns |
| t_{EN} | Enable LOW to Output Shutdown Delay | | 400 | 500 | 600 | ns |
| t_{CSBLT} | CS Pin Leading-Edge Blanking Time | | 400 | 650 | 850 | ns |
| t_{CSFO} | Time from CS Triggering to \overline{FO} | From $V_{CSC}=1$ V to \overline{FO} Turn-Off | | 850 | 1300 | ns |
| t_{CSOFF} | Time from CS Triggering to low-side Gate Outputs Turn-Off | From $V_{CSC}=1$ V to Starting Gate Turn-Off | | 850 | 1300 | ns |
| t_{FLTIN} | Input Filtering Time ⁽⁶⁾ ($HINx$, $LINx$, EN) | | 170 | 250 | 330 | ns |
| t_{FLTCLR} | Fault-Clear Time | | | 1.30 | 2.35 | ms |
| DT | Dead Time | | 230 | 320 | 400 | ns |
| MDT | Dead-Time Matching (All Six Channels) ⁽⁷⁾ | | | | 50 | ns |
| MT | Delay Matching (All Six Channels) ⁽⁸⁾ | | | | 50 | ns |
| PM | Output Pulse-Width Matching ⁽⁹⁾ | $PW_{IN} > 1$ μ s | | 50 | 100 | ns |

Notes:

- The minimum width of the input pulse should exceed 500 ns to ensure the filtering time of the input filter is exceeded.
- MDT is defined as $|DT1-DT2|$ referenced to 0.
- MT is defined as an absolute value of matching delay time between High-side and Low-side.
- PM is defined as an absolute value of matching pulse-width between Input and Output.

Typical Characteristics

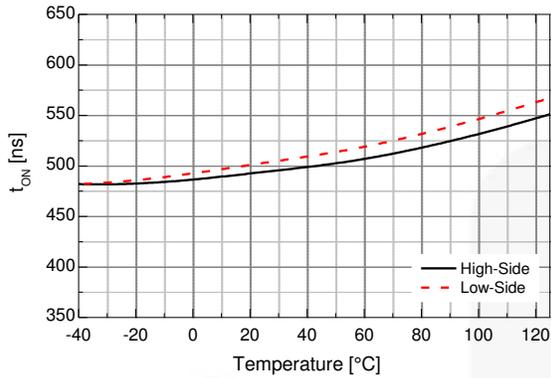


Figure 5. Turn-On Propagation Delay vs. Temperature

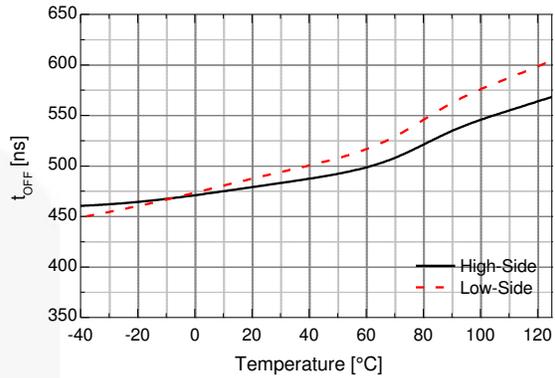


Figure 6. Turn-Off Propagation Delay vs. Temperature

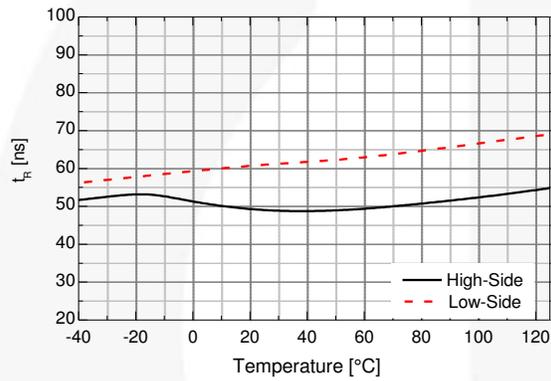


Figure 7. Turn-On Rise Time vs. Temperature

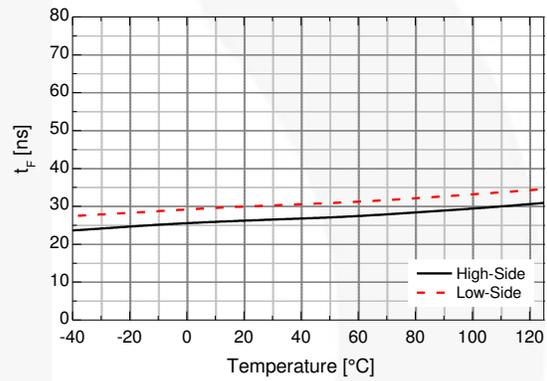


Figure 8. Turn-Off Fall Time vs. Temperature

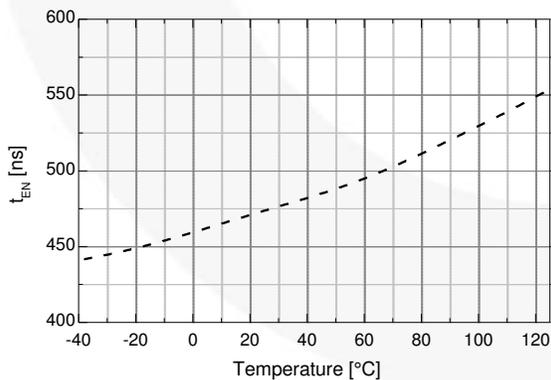


Figure 9. Enable LOW to Output Shutdown Delay vs. Temperature

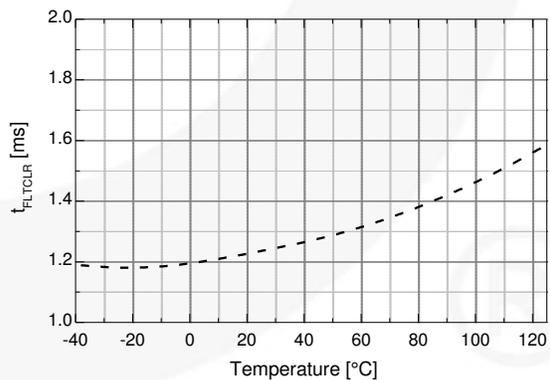


Figure 10. Fault-Clear Time vs. Temperature

Typical Characteristics (Continued)

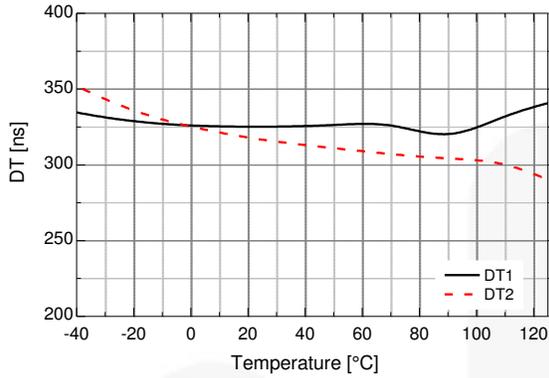


Figure 11. Dead Time vs. Temperature

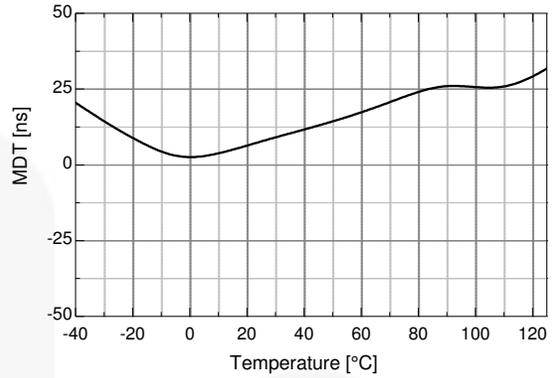


Figure 12. Dead-Time Matching vs. Temperature

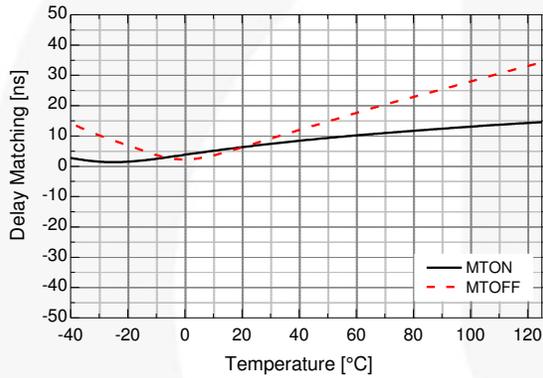


Figure 13. Delay Matching vs. Temperature

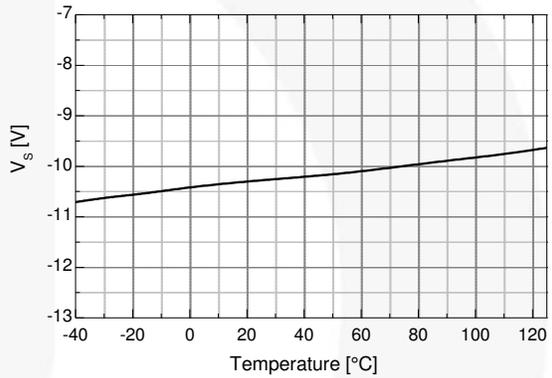


Figure 14. Allowable Negative V_s Voltage vs. Temperature

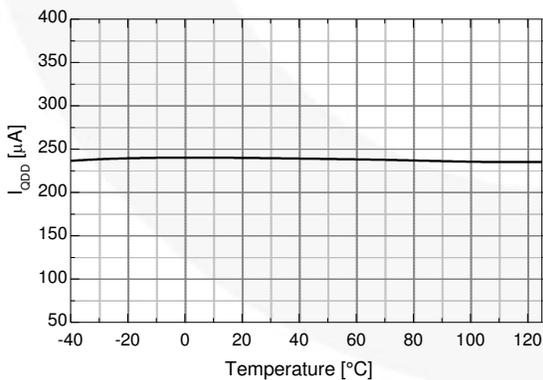


Figure 15. Quiescent V_{DD} Supply Current vs. Temperature

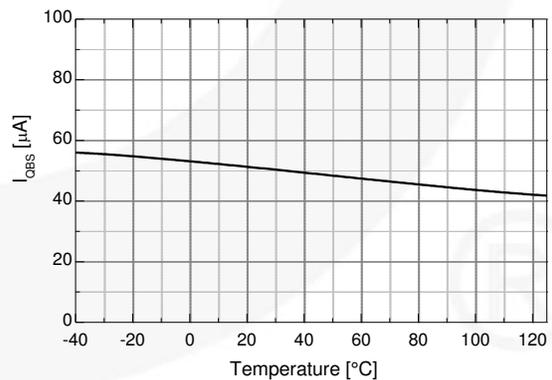


Figure 16. Quiescent V_{BS} Supply Current vs. Temperature

Typical Characteristics (Continued)

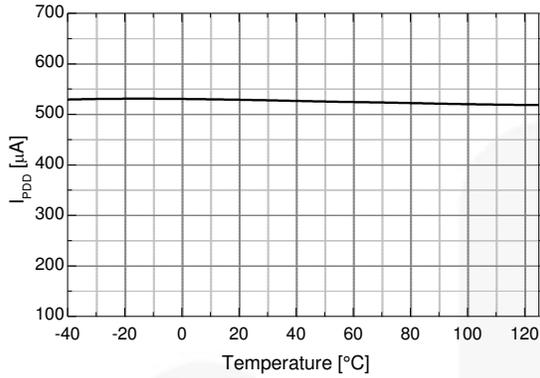


Figure 17. Operating V_{DD} Supply Current vs. Temperature

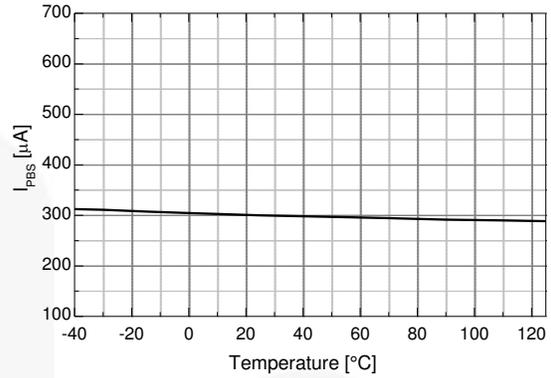


Figure 18. Operating V_{BS} Supply Current vs. Temperature

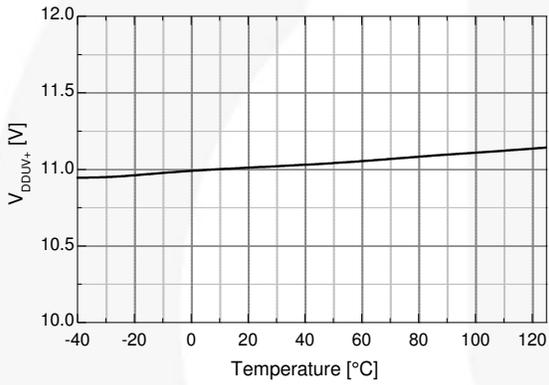


Figure 19. V_{DD} UVLO+ vs. Temperature

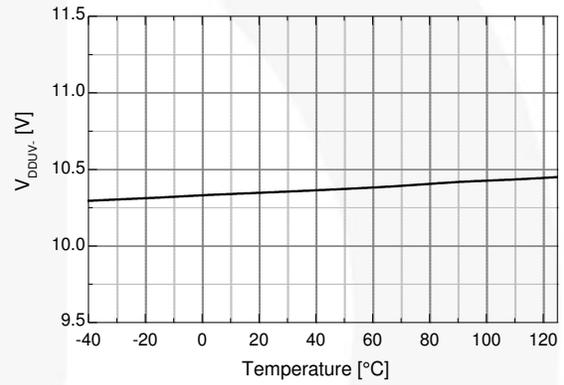


Figure 20. V_{DD} UVLO- vs. Temperature

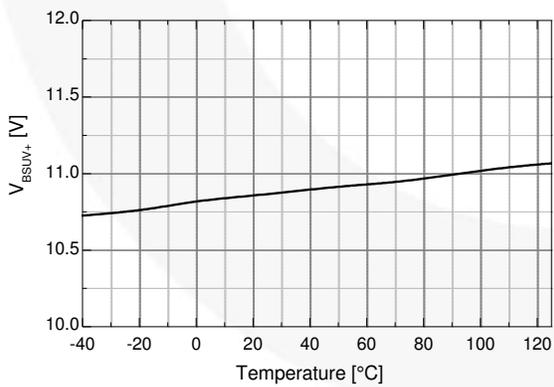


Figure 21. V_{BS} UVLO+ vs. Temperature

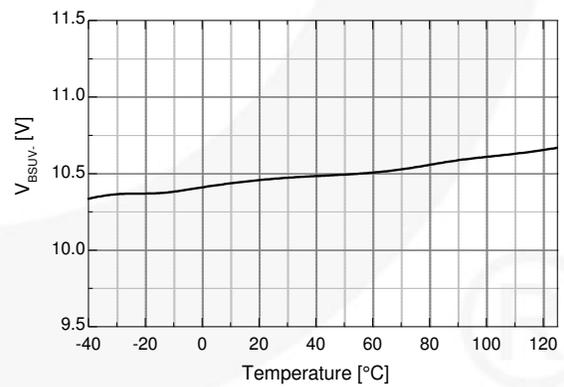


Figure 22. V_{BS} UVLO- vs. Temperature

Typical Characteristics (Continued)

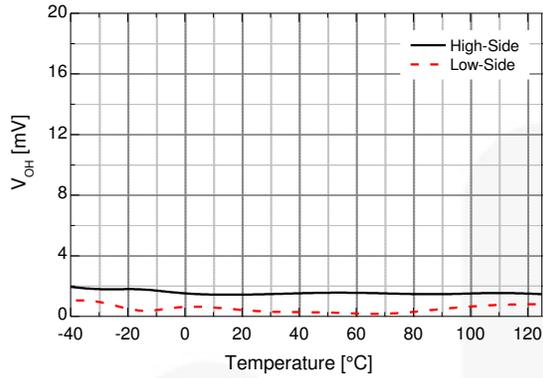


Figure 23. High-Level Output Voltage vs. Temperature

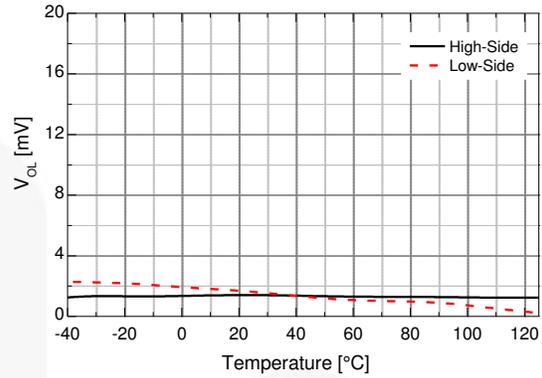


Figure 24. Low-Level Output Voltage vs. Temperature

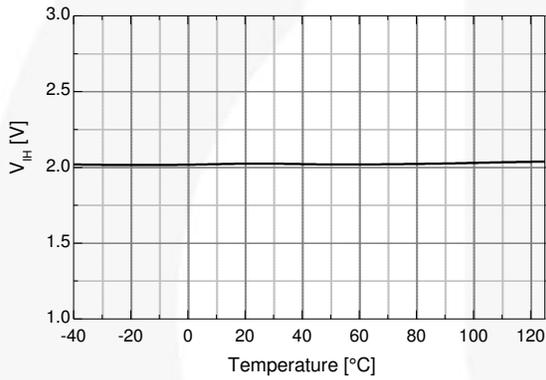


Figure 25. Logic HIGH Input Voltage vs. Temperature

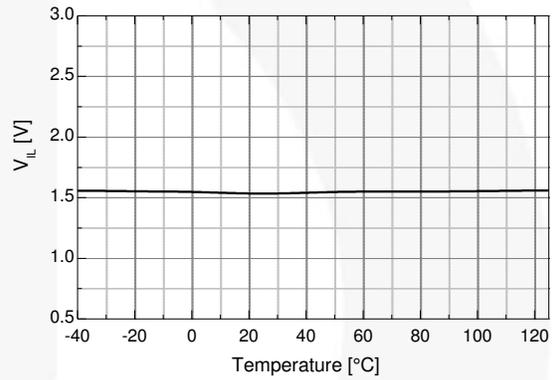


Figure 26. Logic LOW Input Voltage vs. Temperature

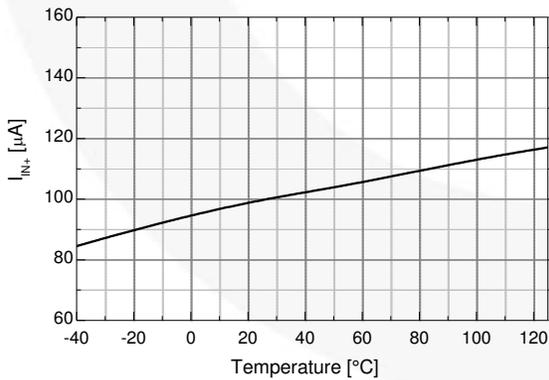


Figure 27. Logic Input HIGH Bias Current vs. Temperature

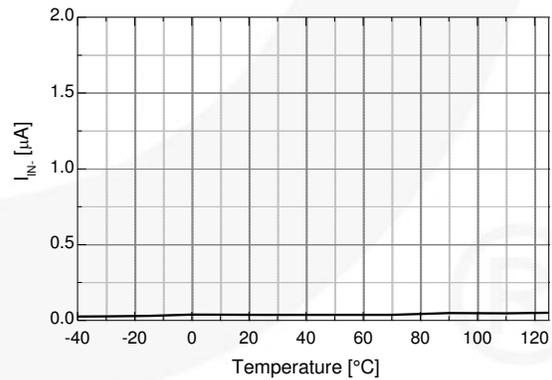


Figure 28. Logic Input LOW Bias Current vs. Temperature

Typical Characteristics (Continued)

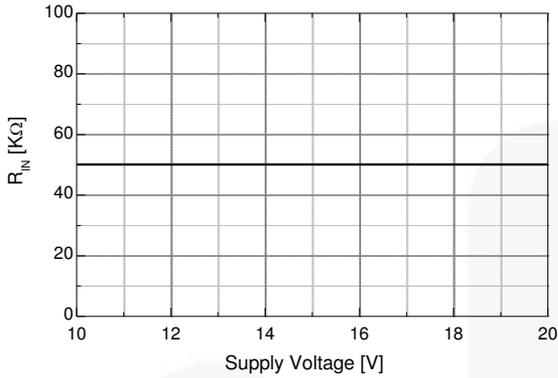


Figure 29. Input Pull-Down Resistance vs. Supply Voltage

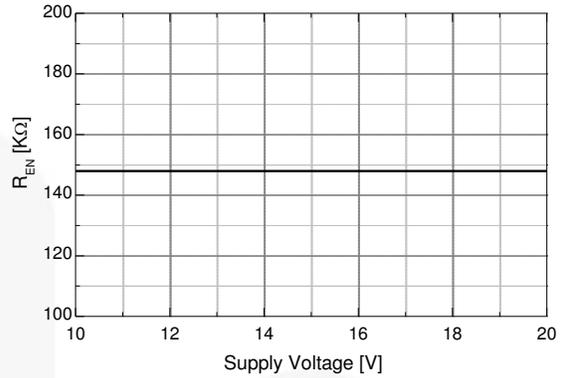


Figure 30. Enable Pin Pull-Down Resistance vs. Supply Voltage

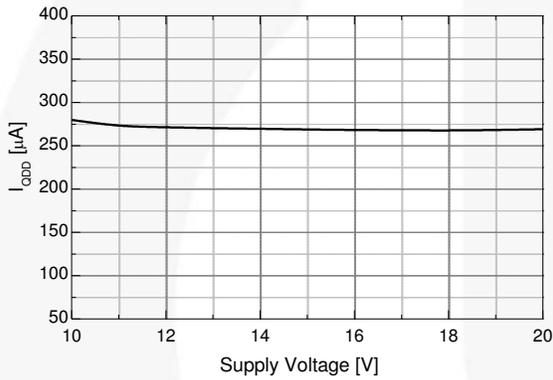


Figure 31. Quiescent V_{DD} Supply Current vs. Supply Voltage

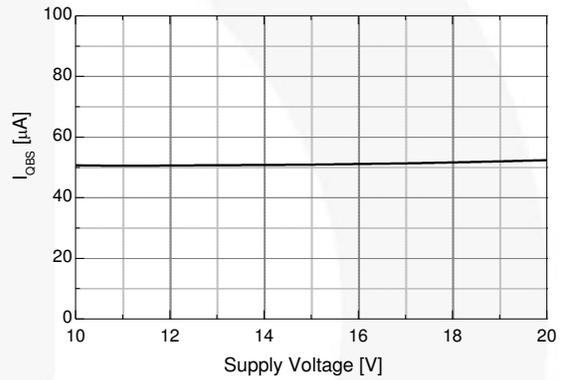


Figure 32. Quiescent V_{BS} Supply Current vs. Supply Voltage

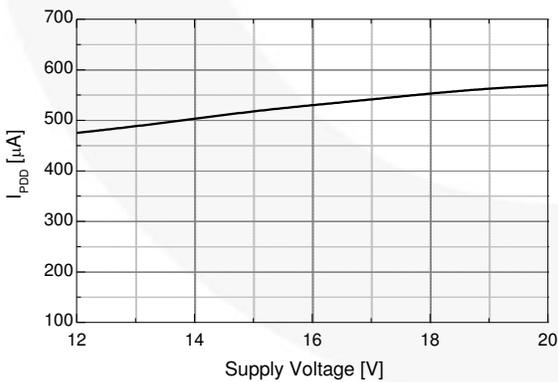


Figure 33. Operating V_{DD} Supply Current vs. Supply Voltage

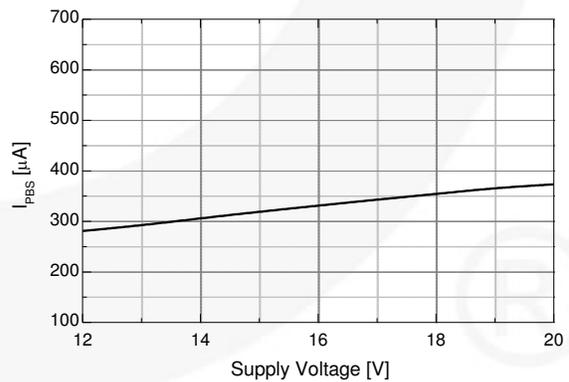


Figure 34. Operating V_{BS} Supply Current vs. Supply Voltage

Switching Time Definitions

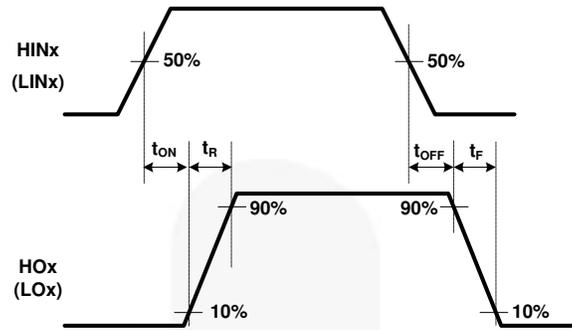


Figure 35. Switching Time Waveform Definitions

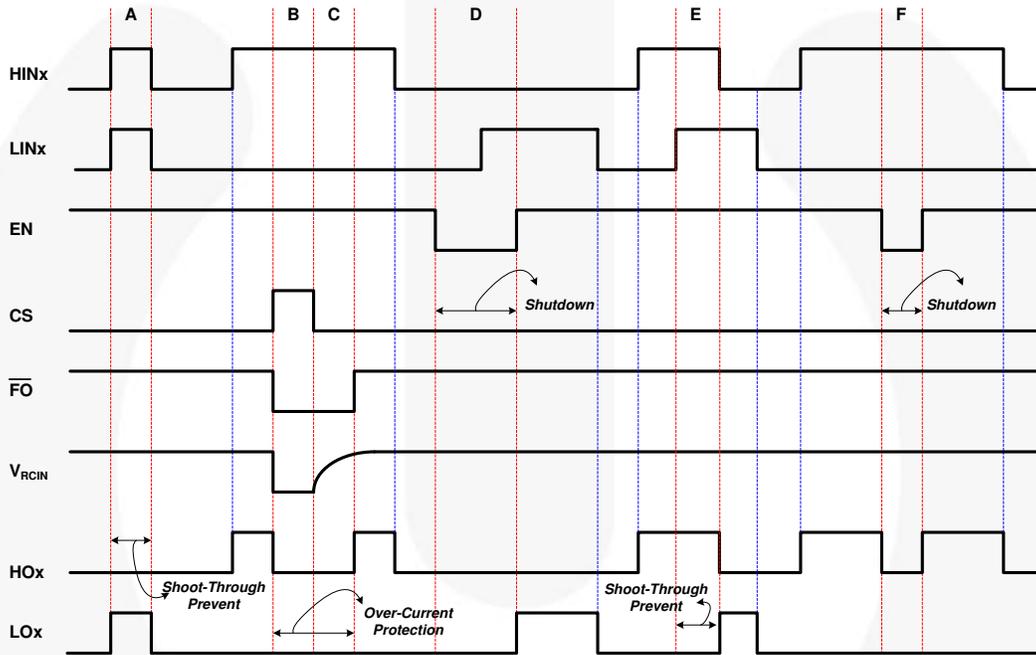


Figure 36. Input / Output Timing Diagram

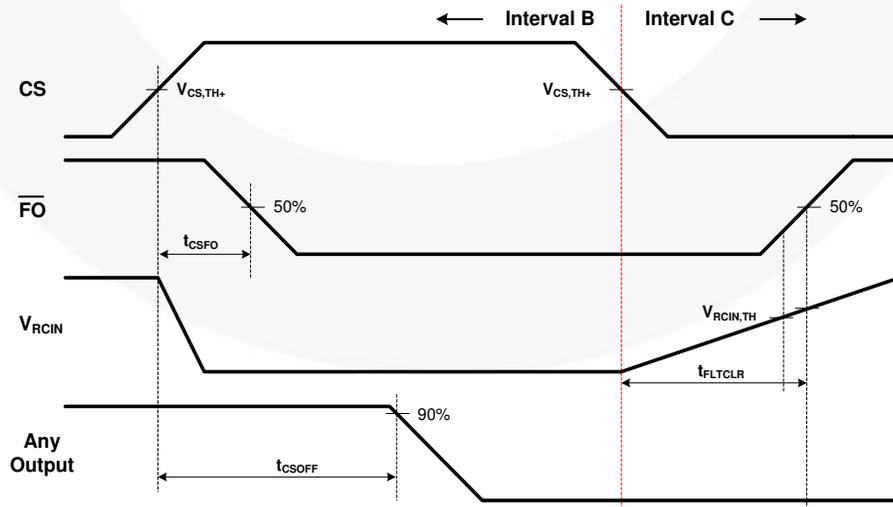


Figure 37. Detailed View of B and C Intervals During Over-Current Protection

Applications Information

1. Dead Time

Dead time is automatically inserted whenever the dead time of the external two input signals (between HINx and LINx signals) is shorter than internal fixed dead times (DT1 and DT2). Otherwise, external dead times larger than internal dead times are not modified by the gate driver and internal dead-time waveform definition is shown in Figure 38.

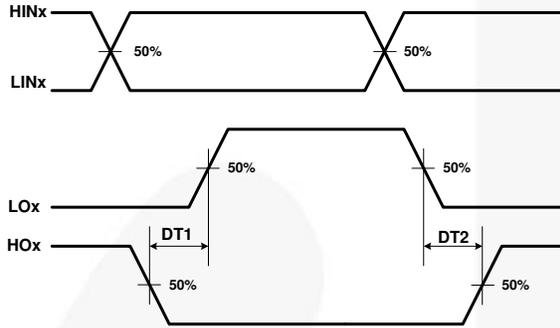


Figure 38. Internal Dead-Time Definitions

2. Protection Function

2.1 Fault Out (\overline{FO}) and Under-Voltage Lockout

The high- and low-side drivers include under-voltage lockout (UVLO) protection circuitry that monitors the supply voltage for V_{DD} and V_{BS} independently. It can be designed to prevent malfunction when V_{DD} and V_{BS} are lower than the specified threshold voltage. The UVLO hysteresis prevents chattering during power-supply transitions. Moreover, the fault signal (power supply voltage \overline{FO}) goes to LOW state to operate reliably during power-on events when the power supply (V_{DD}) is below the under-voltage lockout high threshold voltage for the circuit (during $t_1 \sim t_2$). The UVLO circuit is not otherwise activated; shown Figure 39.

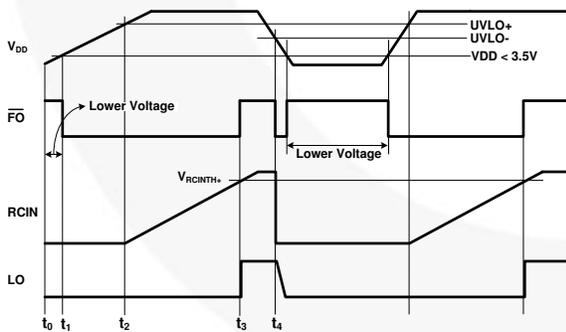
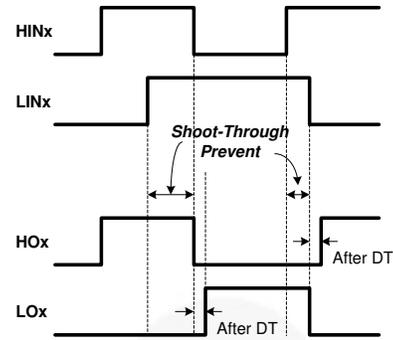


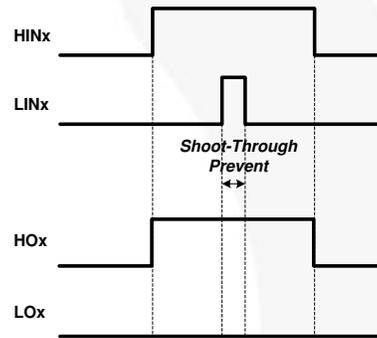
Figure 39. Waveforms for Under-Voltage Lockout

2.2 Shoot-Through Protection

The shoot-through protection circuitry prevents both high- and low-side switches from conducting at the same time, as shown Figure 40.



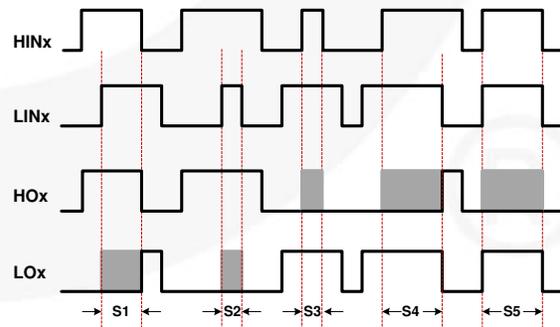
Example A



Example B

Figure 40. Shoot-Through Protection

An interlock function is a device used to prevent both high- and low-side switches from conducting at the same time as shown in Figure 41. In most applications an interlock is used to help prevent a device from harming its operator or damaging itself by when two input signals of a same leg are activated simultaneously, only one output is activated.



- S1 : High-side first → First input output mode
- S2 : Low-side noise → No LOx output mode
- S3 : High-side noise → No HOx output mode
- S4 : Low-side first → First input output mode
- S5 : In-phase mode → No HOx output

Figure 41. Interlock Function

2.3 Enable Input

When the EN pin is in HIGH state, the gate driver operates normally. When a condition occurs that should shut down the gate driver, the EN pin should be LOW. The enable circuitry has an input filter; the minimum input duration is specified by t_{FLTIN} (typically 250 ns).

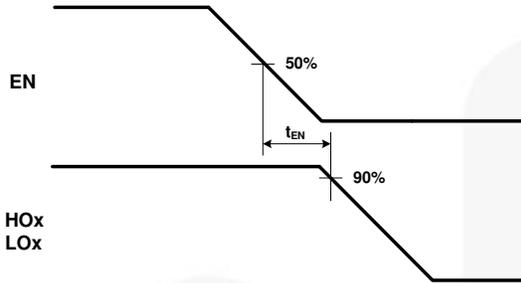


Figure 42. Output Enable Timing Waveform

2.4 Fault-Out (\overline{FO}) and Over-Current Protection

FAN73896 provides an integrated fault output (\overline{FO}) and an adjustable fault-clear timer (t_{FLTCLR}). There are two situations that cause the gate driver to report a fault via the \overline{FO} pin. The first is an under-voltage condition of low-side gate driver supply voltage (V_{DD}) and the second is when the current-sense pin (CS) recognizes a fault. If a fault condition occurs, the \overline{FO} pin is internally pulled to COM, the fault-clear timer is activated, and all outputs (HO1, 2, 3 and LO1, 2, 3) of the gate driver are turned off. The fault output stays LOW until the fault condition has been removed and the fault-clear timer expires. Once the fault-clear timer expires, the voltage on the \overline{FO} pin returns to pull-up voltage.

The fault-clear time (t_{FLTCLR}) is determined by an internal current source ($I_{RCIN}=5 \mu A$) and an external C_{RCIN} at the RCIN pin, as shown as:

$$t_{FLTCLR} = \frac{C_{RCIN} \times V_{RCIN,TH}}{I_{RCIN}} [s] \quad (1)$$

The R_{DSRCIN} of the MOSFET is a characteristic discharge curve with respect to the external capacitor C_{RCIN} . The time constant is defined by the external capacitor C_{RCIN} and the R_{DSRCIN} of the MOSFET.

The output of current-sense comparator (CS_COMP) passes a noise filter, which inhibits an over-current shutdown caused by parasitic voltage spikes of V_{CS} .

This corresponds to a voltage level at the comparator of $V_{CSTH+} - V_{CSHYS} = 500 \text{ mV} - 60 \text{ mV} = 440 \text{ mV}$, where $V_{CSHYS}=60 \text{ mV}$ is the hysteresis of the current comparator (CS_COMP), as shown in Figure 43.

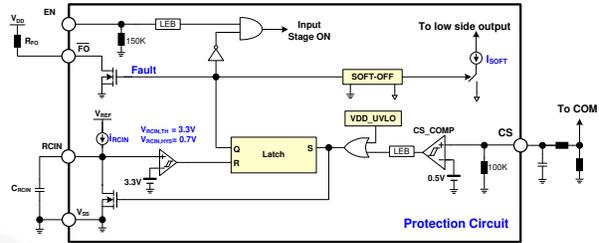


Figure 43. Over-Current Protection

Figure 44 shows the waveform definitions of RCIN, \overline{FO} , and the low-side driver; which uses a soft turn-off method when an under-voltage condition of the low-side gate driver supply voltage (V_{DD}) or the current-sense pin (CS) recognizes a fault. If a fault condition occurs, the \overline{FO} Pin is internally pulled to COM and all outputs (HO1,2,3 and LO1,2,3) of the gate driver are turned off. Low-side outputs decline linearly by the internal sink current source ($I_{SOFT}=40\text{mA}$) for soft turn-off, as shown in Figure 44.

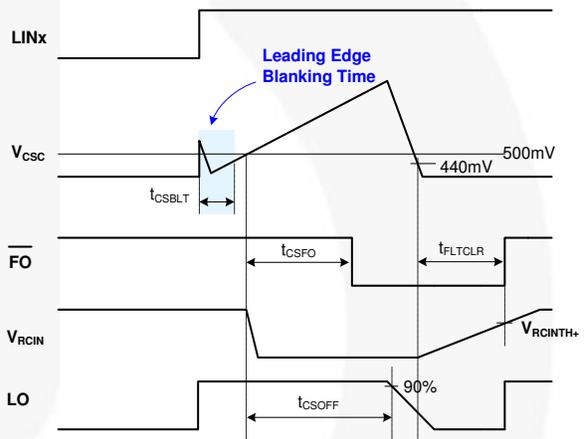


Figure 44. RCIN and Fault-Clear Waveform Definition

3. Noise Filter

3.1 Input Noise Filter

Figure 45 shows the input noise filter method, which has symmetry duration between the input signal (t_{INPUT}) and the output signal (t_{OUTPUT}) and helps to reject noise spikes and short pulses. This input filter is applied to the HINx, LINx, and EN inputs. The upper pair of waveforms (Example A) shows input signal duration (t_{INPUT}) much longer than input filter time (t_{FLTIN}); it is approximately the same duration between the input signal time (t_{INPUT}) and the output signal time (t_{OUTPUT}). The lower pair of waveforms (Example B) shows an input signal time (t_{INPUT}) slightly longer than input filter time (t_{FLTIN}); it is approximately the same duration between input signal time (t_{INPUT}) and the output signal time (t_{OUTPUT}).

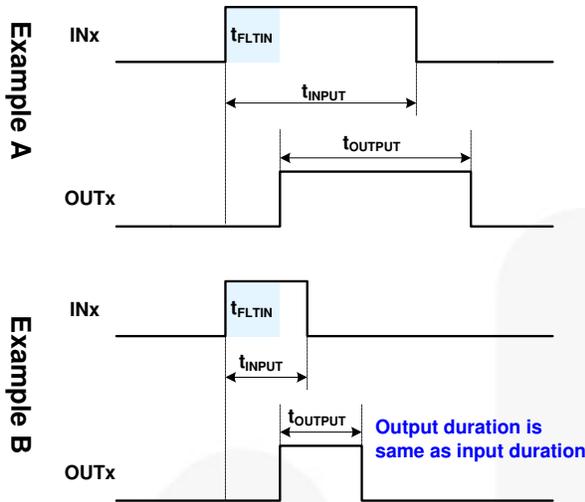


Figure 45. Input Noise Filter Definition

3.2. Short-Pulsed Input Noise Rejection Method

The input filter circuitry provides protection against short-pulsed input signals (H_{INx} , L_{INx} , and EN) on the input signal lines by applied noise signal.

If the input signal duration is less than input filter time (t_{FLTIN}), the output does not change states.

Example A and B of the Figure 46 show the input and output waveforms with short-pulsed noise spikes with a duration less than input filter time; the output does not change states.

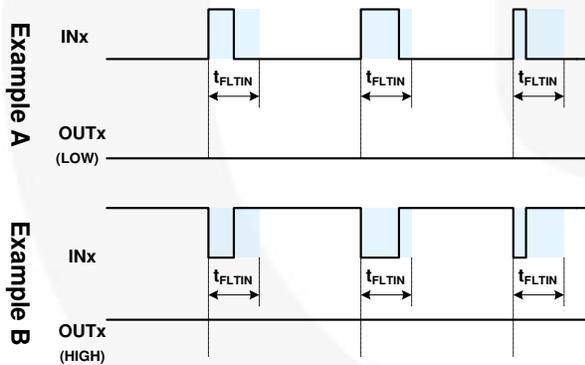


Figure 46. Noise Rejecting Input Filter Definition

Figure 47 shows the characteristics of the input filters while receiving narrow ON and OFF pulses. If input signal pulse duration, PW_{IN} , is less than input filter time, t_{FLTIN} ; the output pulse, PW_{OUT} , is zero. The input signal is rejected by input filter. Once the input signal pulse duration, PW_{IN} , exceeds input filter time, t_{FLTIN} , the output pulse durations, PW_{OUT} , matches the input pulse durations, PW_{IN} . FAN73896 input filter time, t_{FLTIN} , is about 250 ns for the high- and low-side outputs.

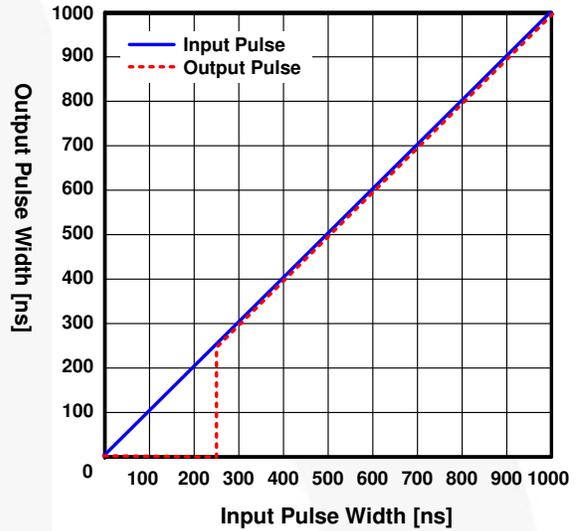


Figure 47. Input Filter Characteristic of Narrow ON

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