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# FAN7391

## High-Current, High & Low-Side, Gate-Drive IC

### Features

- Floating Channels for Bootstrap Operation to +600 V
- Typically 4.5 A / 4.5 A Sourcing / Sinking Current Driving Capability
- Common-Mode dv/dt Noise-Canceling Circuit
- Built-in Under-Voltage Lockout for Both Channels
- Built-in Advanced Input Filter
- Matched Propagation Delay for Both Channels
- Logic ( $V_{SS}$ ) and Power (COM) Ground  $\pm 5$  V Offset
- 3.3 V and 5 V Input Logic Compatible
- Output In-Phase with Input

### Applications

- Plasma Display Panel (PDP) Sustain Driver
- High-Intensity Discharge (HID) Lamp Ballast
- Switching Mode Power Supply (SMPS)
- Motor Driver

### Related Resources

- [AN-6076 — Design and Application Guide of Bootstrap Circuit for High-Voltage Gate-Drive IC](#)
- [AN-9052 — Design Guide for Selection of Bootstrap Components](#)
- [AN-8102 — Recommendations to Avoid Short Pulse Width Issues in HVIC Gate Driver Applications](#)

### Description

The FAN7391 is a monolithic high- and low-side gate-drive IC, which can drive high-speed MOSFETs and IGBTs that operate up to +600 V. It has a buffered output stage with all NMOS transistors designed for high pulse current driving capability and minimum cross-conduction.

Fairchild's high-voltage process and common-mode noise-canceling techniques provide stable operation of the high-side driver under high-dv/dt noise circumstances. An advanced level-shift circuit offers high-side gate driver operation up to  $V_S = -9.8$  V (typical) for  $V_{BS} = 15$  V.

The advanced input filter of HIN provides protection against short-pulsed input signals caused by noise.

The UVLO circuit prevents malfunction when  $V_{DD}$  and  $V_{BS}$  are lower than the specified threshold voltage.

The high-current and low-output voltage-drop feature makes this device suitable for the PDP sustain pulse driver, motor driver, switching mode power supply, and high-power DC-DC converter applications.

14-SOP



### Ordering Information

Part Number	Package	Operating Temperature Range	Packing Method
FAN7391MX	14-SOP	-40°C ~ 125°C	Tape & Reel

### Typical Application Circuit

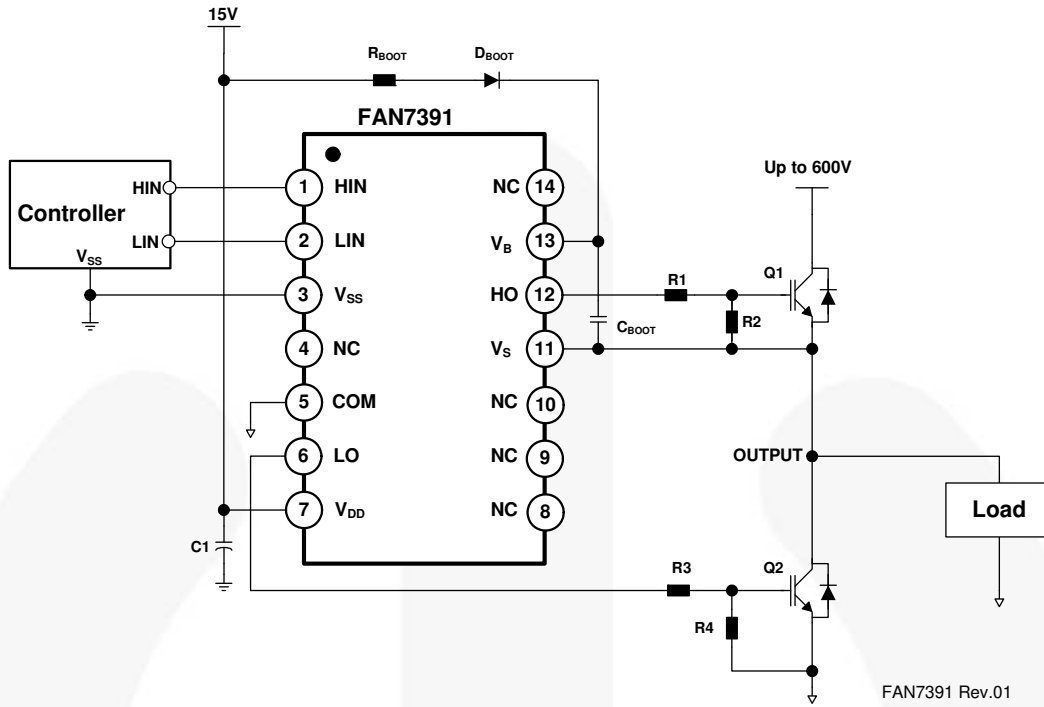


Figure 1. Application Circuit for Half-Bridge

### Internal Block Diagram

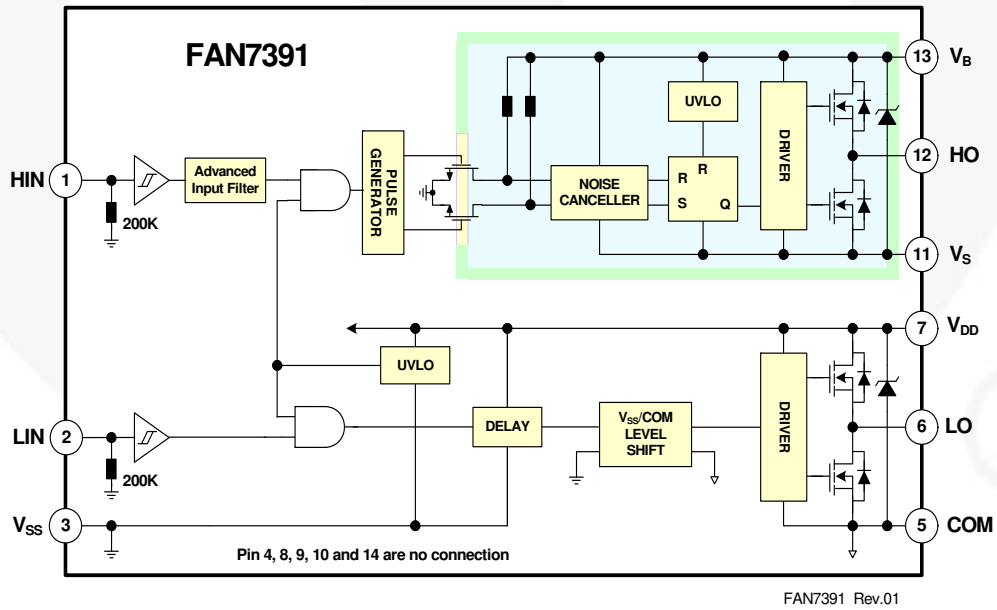


Figure 2. Functional Block Diagram

## Pin Configurations

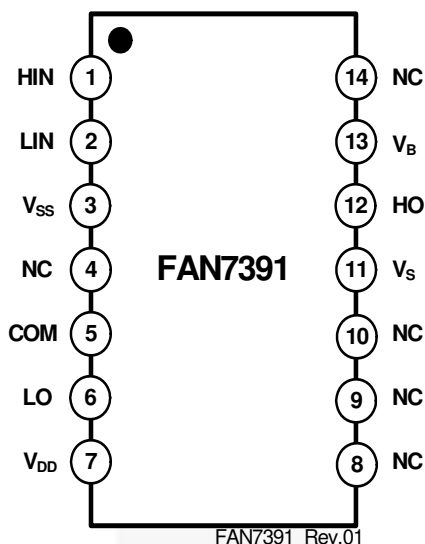


Figure 3. Pin Assignments (Top View)

## Pin Definitions

14-Pin	Name	Description
1	HIN	Logic Input for High-Side Gate Driver Output
2	LIN	Logic Input for Low-Side Gate Driver Output
3	V <sub>SS</sub>	Logic Ground
5	COM	Low-Side Driver Return
6	LO	Low-Side Driver Output
7	V <sub>DD</sub>	Low-Side and Logic Part Supply Voltage
11	V <sub>S</sub>	High-Voltage Floating Supply Return
12	HO	High-Side Driver Output
13	V <sub>B</sub>	High-Side Floating Supply
4, 8, 9, 10, 14	NC	No Connect

## 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	Characteristics	Min.	Max.	Unit
$V_S$	High-Side Floating Supply Offset Voltage	$V_B - V_{SHUNT}$	$V_B + 0.3$	V
$V_B$	High-Side Floating Supply Voltage	-0.3	625.0	V
$V_{HO}$	High-Side Floating Output Voltage, HO Pin	$V_S - 0.3$	$V_B + 0.3$	V
$V_{DD}$	Low-Side and Logic Fixed Supply Voltage	-0.3	$V_{SHUNT}$	V
$V_{LO}$	Low-Side Output Voltage, LO Pin	-0.3	$V_{DD} + 0.3$	V
$V_{IN}$	Logic Input Voltage (HIN and LIN)	$V_{SS} - 0.3$	$V_{DD} + 0.3$	V
$V_{SS}$	Logic Ground	$V_{DD} - 25$	$V_{DD} + 0.3$	V
$dV_S/dt$	Allowable Offset Voltage Slew Rate		50	V/ns
$P_D^{(1)(2)(3)}$	Power Dissipation		1.0	W
$\theta_{JA}$	Thermal Resistance, Junction-to-Ambient		110	$^{\circ}\text{C}/\text{W}$
$T_J$	Junction Temperature		+150	$^{\circ}\text{C}$
$T_{STG}$	Storage Temperature		+150	$^{\circ}\text{C}$

### Notes:

- 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 circuits thermal test method environmental conditions - natural convection; and
  - JESD51-3: Low effective thermal conductivity test board for leaded surface-mount packages.
- Do not exceed  $P_D$  maximum 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
$V_B$	High-Side Floating Supply Voltage	$V_S + 10$	$V_S + 20$	V
$V_S$	High-Side Floating Supply Offset Voltage	$6 - V_{DD}$	600	V
$V_{HO}$	High-Side Output Voltage	$V_S$	$V_B$	V
$V_{DD}$	Low-Side and Logic Supply Voltage	10	20	V
$V_{LO}$	Low-Side Output Voltage	COM	$V_{DD}$	V
$V_{IN}$	Logic Input Voltage (HIN and LIN)	$V_{SS}$	$V_{DD}$	V
$T_A$	Operating Ambient Temperature	-40	+125	$^{\circ}\text{C}$
$PW_{HIN}$	Pulse Width of Logic Input for High-Side Gate Driver	100		ns

## Electrical Characteristics

$V_{BIAS}$  ( $V_{DD}$ ,  $V_{BS}$ )=15.0 V,  $V_S=V_{SS}=COM$ ,  $T_A=25^\circ C$ , unless otherwise specified. The  $V_{IL}$ ,  $V_{IH}$ , and  $I_{IN}$  parameters are referenced to  $V_{SS}/COM$  and are applicable to the respective input signals HIN and LIN. The  $V_O$  and  $I_O$  parameters are referenced to COM and  $V_S$  is applicable to the respective output signals HO and LO.

Symbol	Characteristics	Condition	Min.	Typ.	Max.	Unit
<b>POWER SUPPLY SECTION (<math>V_{DD}</math> AND <math>V_{BS}</math>)</b>						
$V_{DDUV+}$ $V_{BSUV+}$	$V_{DD}$ and $V_{BS}$ Supply Under-Voltage Positive-Going Threshold		8.0	8.8	9.8	V
$V_{DDUV-}$ $V_{BSUV-}$	$V_{DD}$ and $V_{BS}$ Supply Under-Voltage Negative-Going Threshold		7.4	8.3	9.0	
$V_{DDUVH}$ $V_{BSUVH}$	$V_{DD}$ and $V_{BS}$ Supply Under-Voltage Lockout Hysteresis Voltage			0.5		
$I_{LK}$	Offset Supply Leakage Current	$V_B=V_S=600$ V			50	$\mu A$
$I_{QBS}$	Quiescent $V_{BS}$ Supply Current	$V_{IN}=0$ V or 5 V		45	80	
$I_{QDD}$	Quiescent $V_{DD}$ Supply Current	$V_{IN}=0$ V or 5 V		75	110	
$I_{PBS}$	Operating $V_{BS}$ Supply Current	$f_{IN}=20$ kHz, rms value		530	640	$\mu A$
$I_{PDD}$	Operating $V_{DD}$ Supply Current	$f_{IN}=20$ kHz, rms value		530	640	
<b>SHUNT REGULATOR SECTION</b>						
$V_{SHUNT}$	$V_{DD}$ and $V_{BS}$ Shunt Regulator Clamping Voltage	$V_{DD}=\text{Sweep}$ or $V_{BS}=\text{Sweep}$ , $I_{SHUNT}=5$ mA	21	23	25	V
<b>LOGIC INPUT SECTION (HIN, LIN)</b>						
$V_{IH}$	Logic "1" Input Voltage		2.5			V
$V_{IL}$	Logic "0" Input Voltage				1.2	
$I_{IN+}$	Logic "1" Input Bias Current	$V_{IN}=5$ V		25	50	$\mu A$
$I_{IN-}$	Logic "0" Input Bias Current	$V_{IN}=0$ V		1.0	2.0	
$R_{IN}$	Input Pull-Down Resistance		100	200		$k\Omega$
<b>GATE DRIVER OUTPUT SECTION (HO, LO)</b>						
$V_{OH}$	High-Level Output Voltage, $V_{BIAS}-V_O$	No Load			1.0	V
$V_{OL}$	Low-Level Output Voltage, $V_O$	No Load			35	mV
$I_{O+}$	Output High, Short-Circuit Pulsed Current <sup>(4)</sup>	$V_O=0$ V, $V_{IN}=5$ V, $PW<10$ $\mu s$	3.5	4.5		A
$I_{O-}$	Output Low, Short-Circuit Pulsed Current <sup>(4)</sup>	$V_O=15$ V, $V_{IN}=0$ V, $PW<10$ $\mu s$	3.5	4.5		
$V_S$	Allowable Negative $V_S$ Pin Voltage for HIN Signal Propagation to HO			-9.8	-7.0	V
$V_{SS-COM}$	$V_{SS}-COM/COM-V_{SS}$ Voltage Endurability		-5		5	V

### Note:

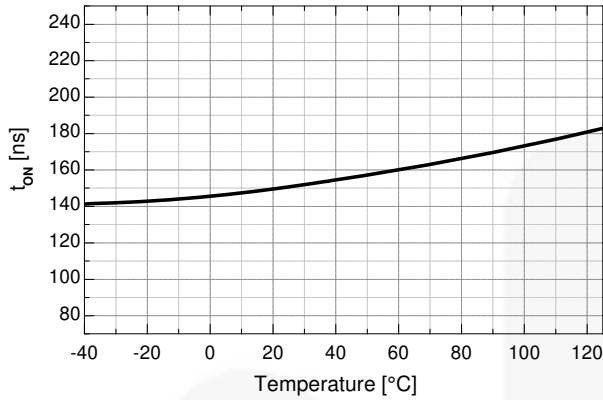
4. This parameter guaranteed by design.

## Dynamic Electrical Characteristics

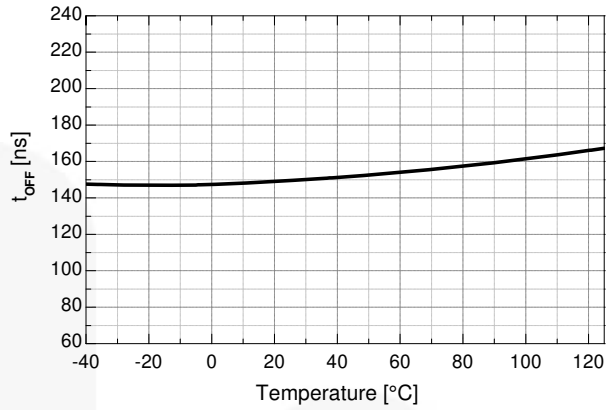
$V_{BIAS}$  ( $V_{DD}$ ,  $V_{BS}$ )=15.0 V,  $V_S=V_{SS}=COM=0$  V,  $C_L=1000$  pF, and  $T_A=25^\circ C$  unless otherwise specified.

Symbol	Characteristics	Test Condition	Min.	Typ.	Max.	Unit
$t_{on}$	Turn-On Propagation Delay	$V_S=0$ V		150	220	ns
$t_{off}$	Turn-Off Propagation Delay	$V_S=0$ V		150	220	
MT	Delay Matching, HS & LS Turn-On/Off			15	50	
$t_r$	Turn-On Rise Time			25	50	
$t_f$	Turn-Off Fall Time			20	45	

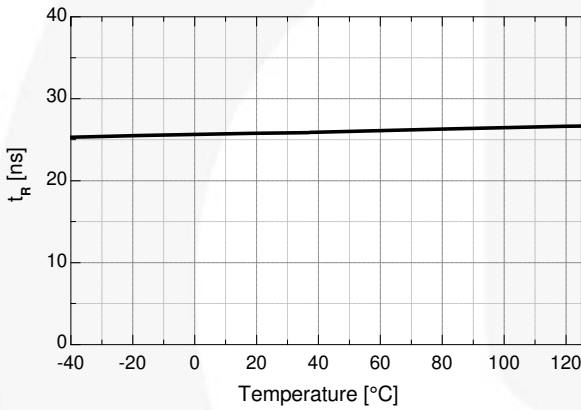
## Typical Characteristics



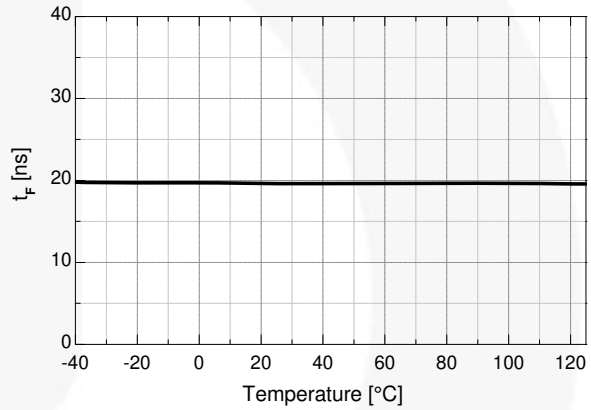
**Figure 4. Turn-On Propagation Delay vs. Temperature**



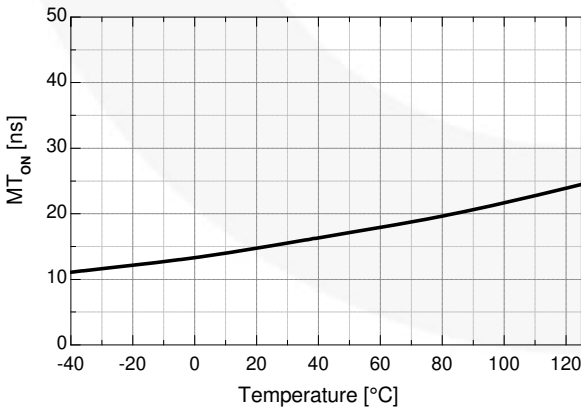
**Figure 5. Turn-Off Propagation Delay vs. Temperature**



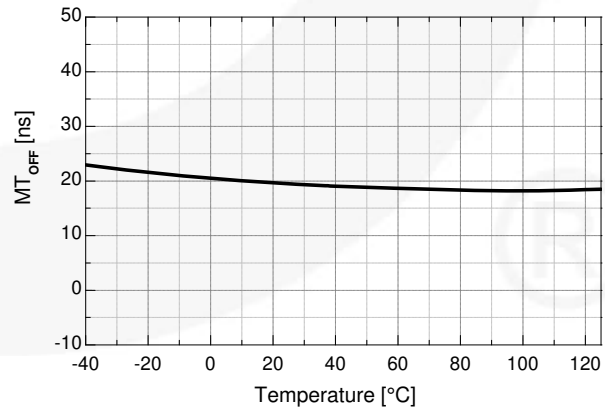
**Figure 6. Turn-On Rise Time vs. Temperature**



**Figure 7. Turn-Off Fall Time vs. Temperature**



**Figure 8. Turn-On Delay Matching vs. Temperature**



**Figure 9. Turn-Off Delay Matching vs. Temperature**



Typical Characteristics (Continued)

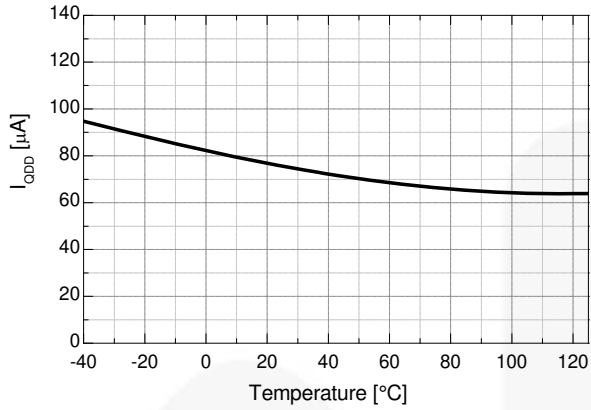


Figure 10. Quiescent  $V_{DD}$  Supply Current vs. Temperature

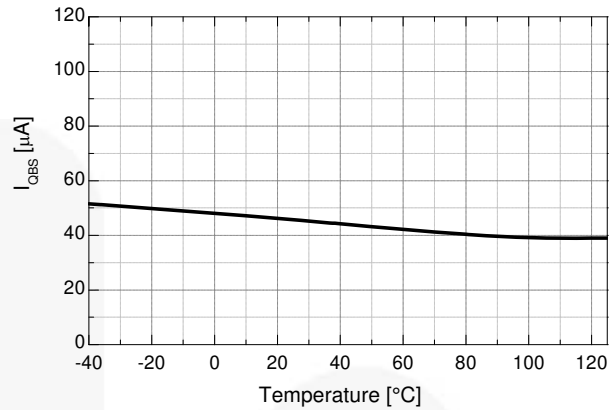


Figure 11. Quiescent  $V_{BS}$  Supply Current vs. Temperature

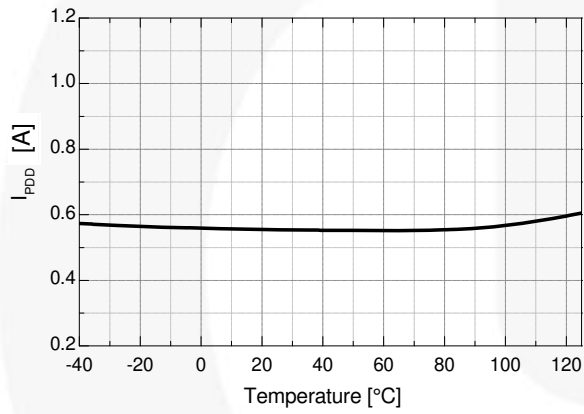


Figure 12. Operating  $V_{DD}$  Supply Current vs. Temperature

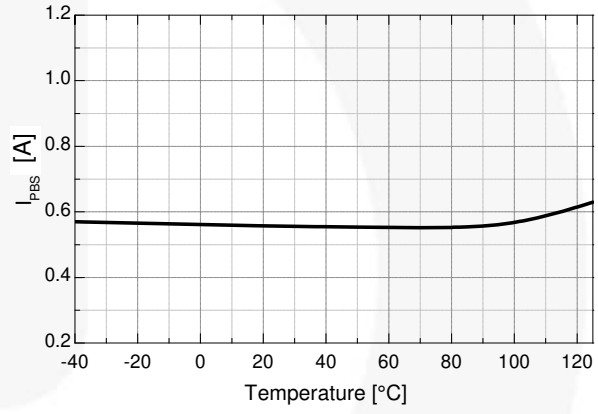


Figure 13. Operating  $V_{BS}$  Supply Current vs. Temperature

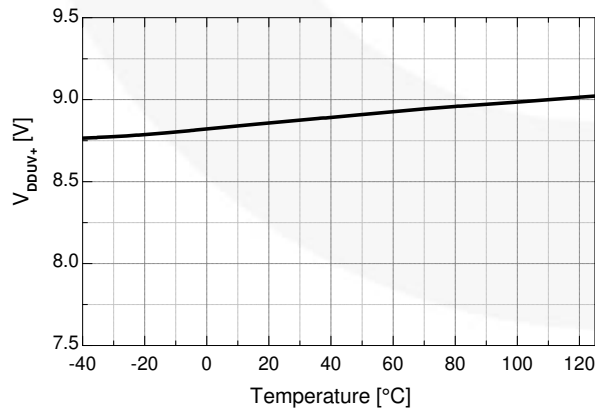


Figure 14.  $V_{DD}$  UVLO+ vs. Temperature

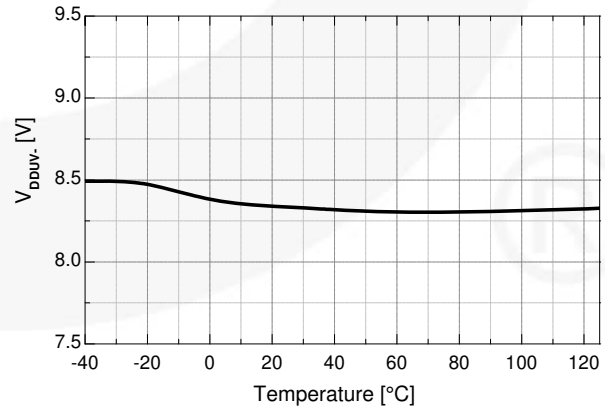


Figure 15.  $V_{DD}$  UVLO- vs. Temperature

Typical Characteristics (Continued)

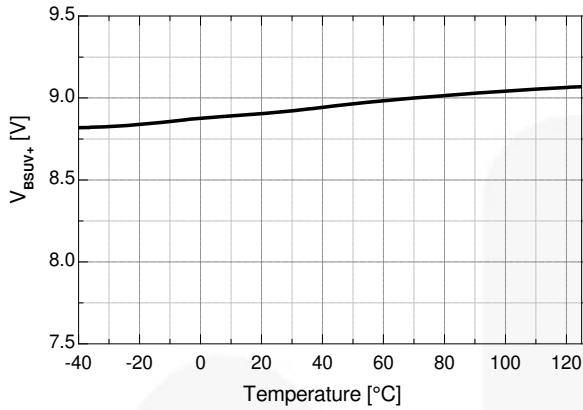


Figure 16.  $V_{BS}$  UVLO+ vs. Temperature

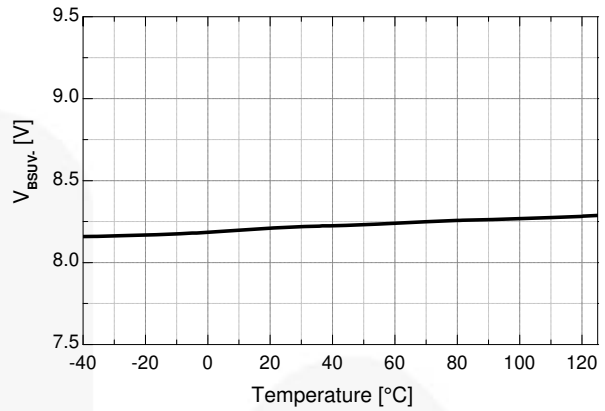


Figure 17.  $V_{BS}$  UVLO- vs. Temperature

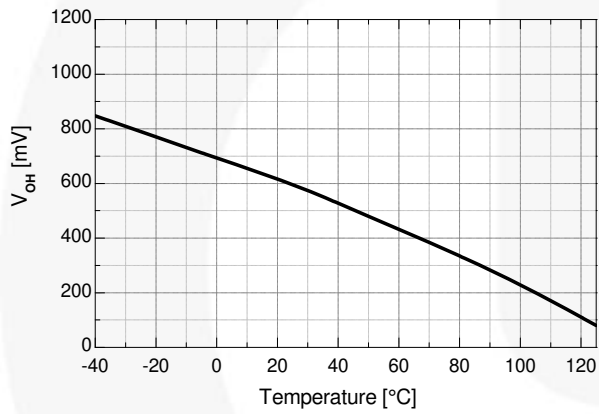


Figure 18. High-Level Output Voltage vs. Temperature

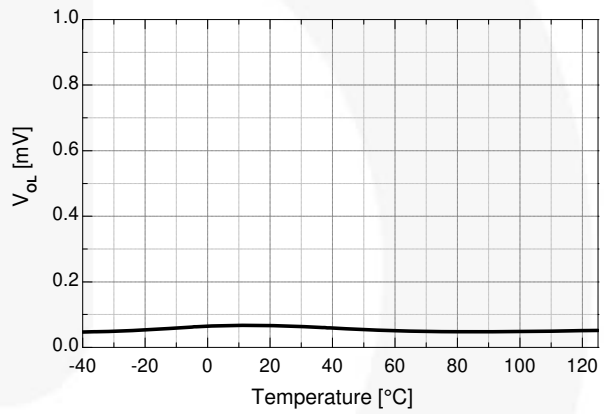


Figure 19. Low-Level Output Voltage vs. Temperature

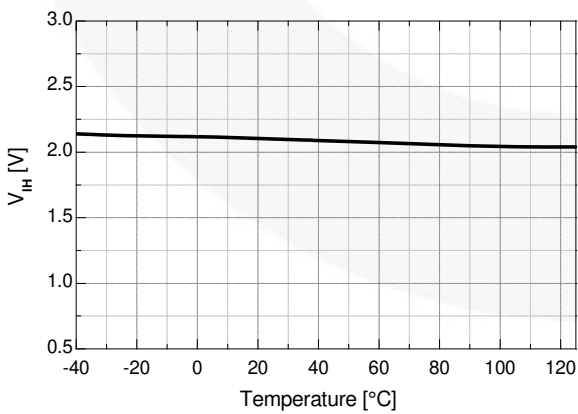


Figure 20. Logic HIGH Input Voltage vs. Temperature

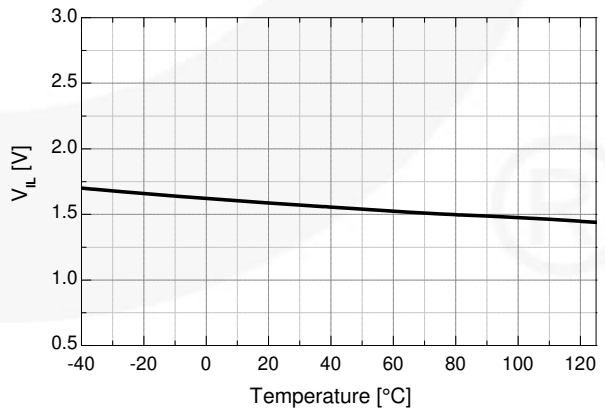


Figure 21. Logic LOW Input Voltage vs. Temperature

Typical Characteristics (Continued)

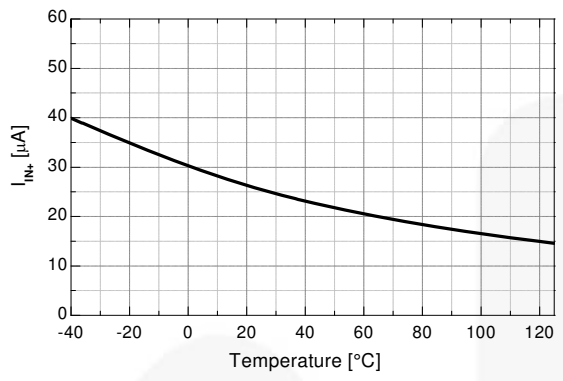


Figure 22. Logic Input High Bias Current vs. Temperature

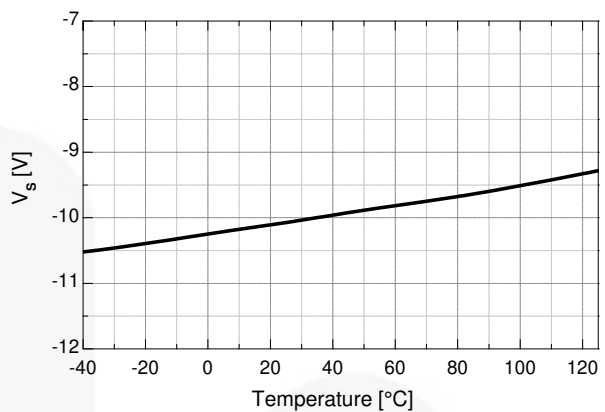


Figure 23. Allowable Negative  $V_S$  Voltage vs. Temperature

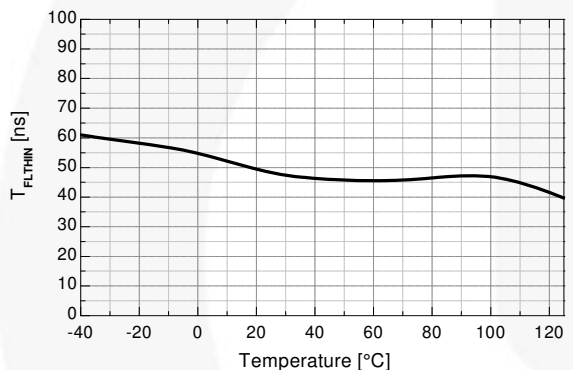


Figure 24. Input Filtering Time of HIN vs. Temperature

## Switching Time Definitions

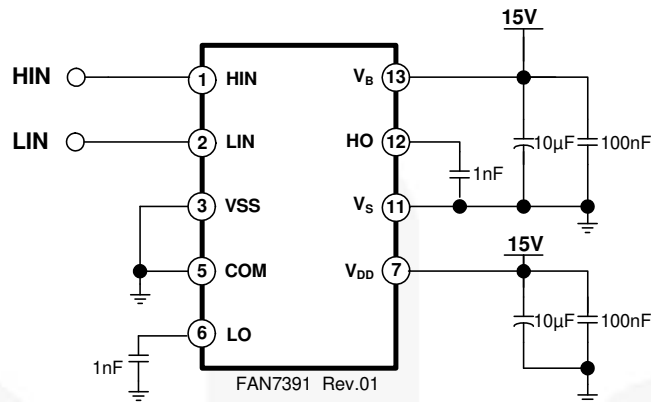


Figure 25. Switching Time Test Circuit (Referenced 14-SOP)

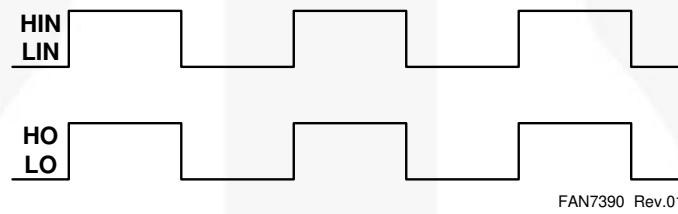


Figure 26. Input / Output Timing Diagram

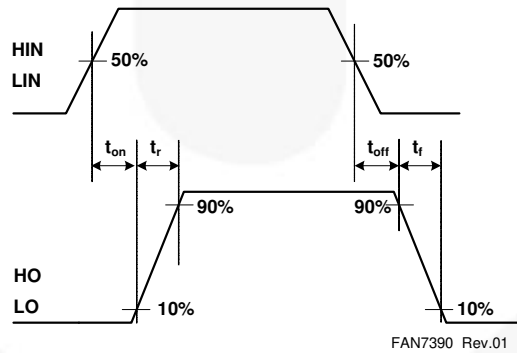


Figure 27. Switching Time Waveform Definitions

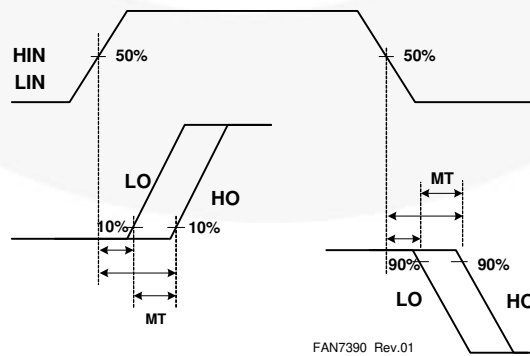


Figure 28. Delay Matching Waveform Definitions

## Applications Information

### 1. Advanced Input Noise Filter

Figure 29 shows the input noise filter method, which has symmetry duration between the input signal ( $t_{\text{INPUT}}$ ) and the output signal ( $t_{\text{OUTPUT}}$ ) and helps to reject noise spikes and short pulses. This input filter is applied to the HIN. The upper pair of waveforms (Example A) shows an input signal duration ( $t_{\text{INPUT}}$ ) much longer than input filter time ( $t_{\text{FLTHIN}}$ ); it is approximately the same duration between the input signal time ( $t_{\text{INPUT}}$ ) and the output signal time ( $t_{\text{OUTPUT}}$ ). The lower pair of waveforms (Example B) shows an input signal time ( $t_{\text{INPUT}}$ ) slightly longer than input filter time ( $t_{\text{FLTHIN}}$ ); it is approximately the same duration between input signal time ( $t_{\text{INPUT}}$ ) and the output signal time ( $t_{\text{OUTPUT}}$ ).

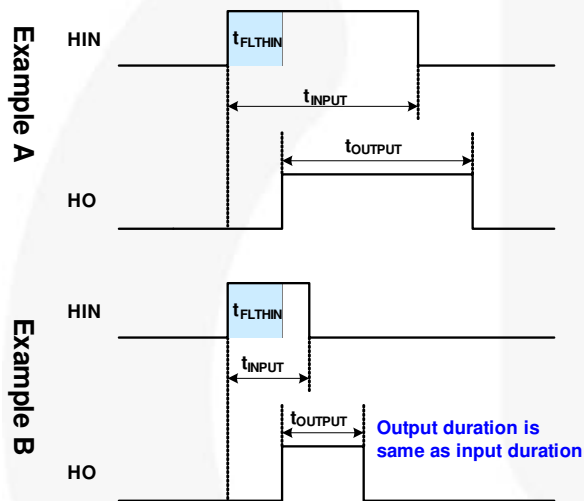


Figure 29. Input Noise Filter Definition

### 2. Short-Pulsed Input Noise Rejection Method

The Advanced input filter circuitry provides protection against short-pulsed input signals caused by noise. If the input signal duration is less than input filter time ( $t_{\text{FLTHIN}}$ ), the output does not change states.

Example A and B of the Figure 30 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.

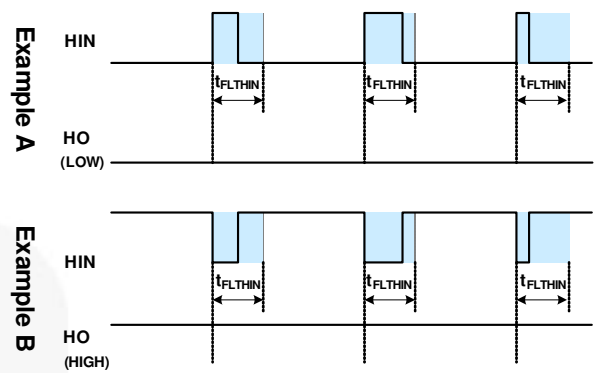


Figure 30. Noise Rejecting Input Filter Definition

Figure 31 shows the characteristics of the input filters while receiving narrow ON and OFF pulses. If input signal pulse duration,  $PW_{\text{HIN}}$ , is less than input filter time,  $t_{\text{FLTHIN}}$ ; the output pulse,  $PW_{\text{HO}}$ , is zero. The input signal is rejected by input filter. Once the input signal pulse duration,  $PW_{\text{HIN}}$ , exceeds input filter time,  $t_{\text{FLTHIN}}$ , the output pulse durations,  $PW_{\text{HO}}$ , matches the input pulse durations,  $PW_{\text{HIN}}$ . FAN7391 input filter time,  $t_{\text{FLTHIN}}$ , is about 50ns for the high-side outputs.

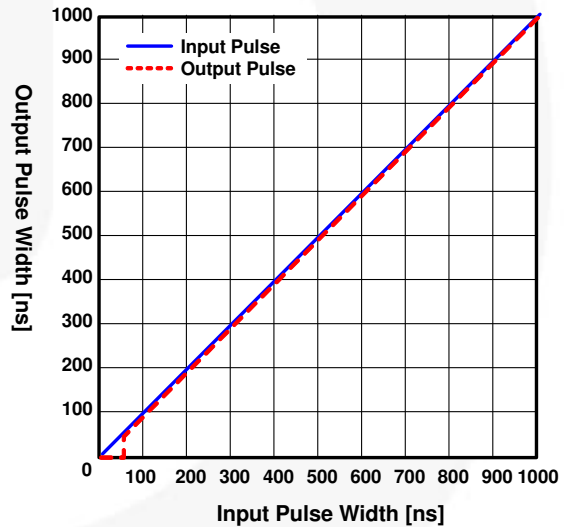


Figure 31. Input Filter Characteristic of Narrow ON

Package Dimensions

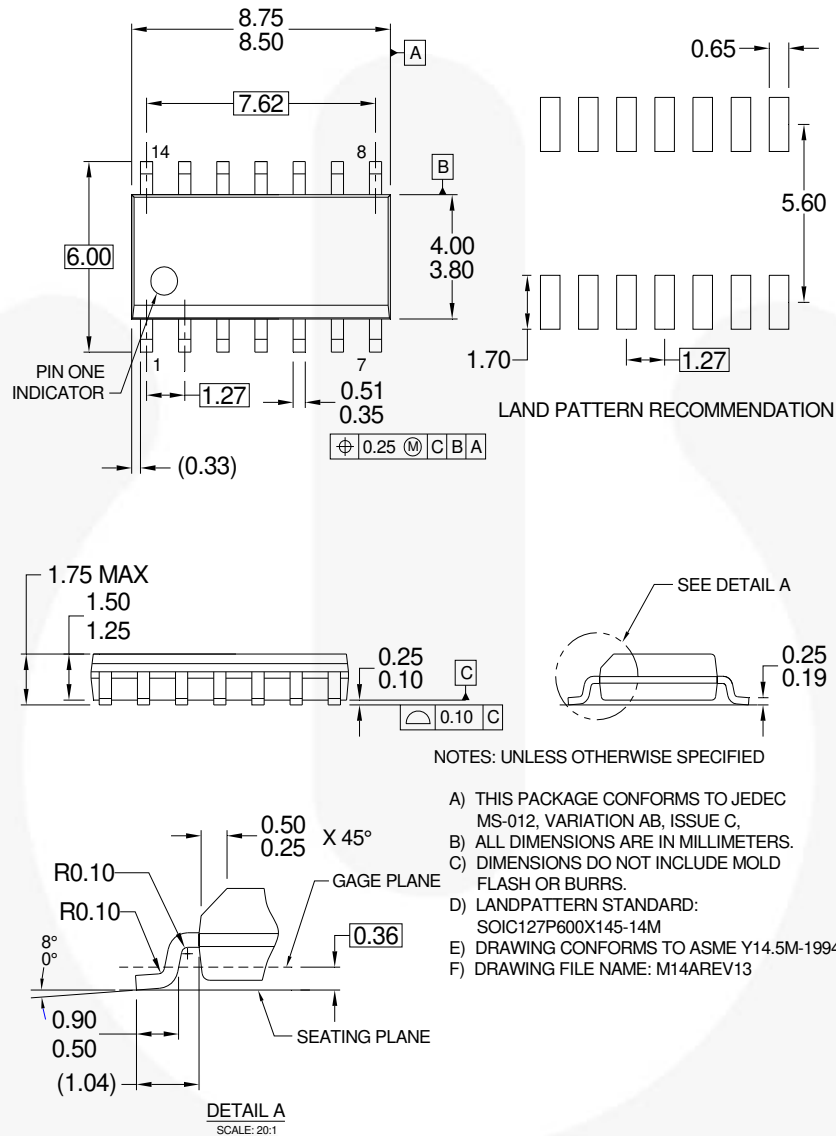


Figure 32. 14-Lead, Small Outline Package (SOP)

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| Build it Now™   | GreenBridge™                                   | Programmable Active Droop™  | TinyCalc™   |
| CorePLUS™   | Green FPS™                                     | QFET®   | TinyLogic®  |
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