

# NCP5111

## High Voltage, High and Low Side Driver

The NCP5111 is a high voltage power gate driver providing two outputs for direct drive of 2 N-channel power MOSFETs or IGBTs arranged in a half-bridge configuration.

It uses the bootstrap technique to ensure a proper drive of the high-side power switch.

### Features

- High Voltage Range: up to 600 V
- $dV/dt$  Immunity  $\pm 50$  V/nsec
- Gate Drive Supply Range from 10 V to 20 V
- High and Low Drive Outputs
- Output Source / Sink Current Capability 250 mA / 500 mA
- 3.3 V and 5 V Input Logic Compatible
- Up to  $V_{CC}$  Swing on Input Pins
- Extended Allowable Negative Bridge Pin Voltage Swing to  $-10$  V for Signal Propagation
- Matched Propagation Delays between Both Channels
- One Input with Internal Fixed Dead Time (650 ns)
- Under  $V_{CC}$  LockOut (UVLO) for Both Channels
- Pin-to-Pin Compatible with Industry Standards
- These are Pb-Free Devices

### Typical Applications

- Half-bridge Power Converters

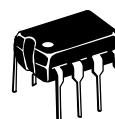


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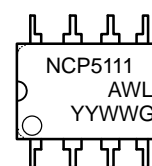
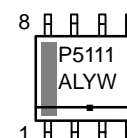


SOIC-8  
D SUFFIX  
CASE 751



PDIP-8  
P SUFFIX  
CASE 626

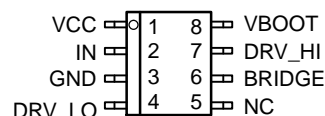
### MARKING DIAGRAMS



NCP5111 = Specific Device Code  
A = Assembly Location  
L or WL = Wafer Lot  
Y or YY = Year  
W or WW = Work Week  
G or ■ = Pb-Free Package

(Note: Microdot may be in either location)

### PINOUT INFORMATION



### ORDERING INFORMATION

Device	Package	Shipping†
NCP5111PG	PDIP-8 (Pb-Free)	50 Units / Rail
NCP5111DR2G	SOIC-8 (Pb-Free)	2500 / Tape & Reel

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specification Brochure, BRD8011/D.

# NCP5111

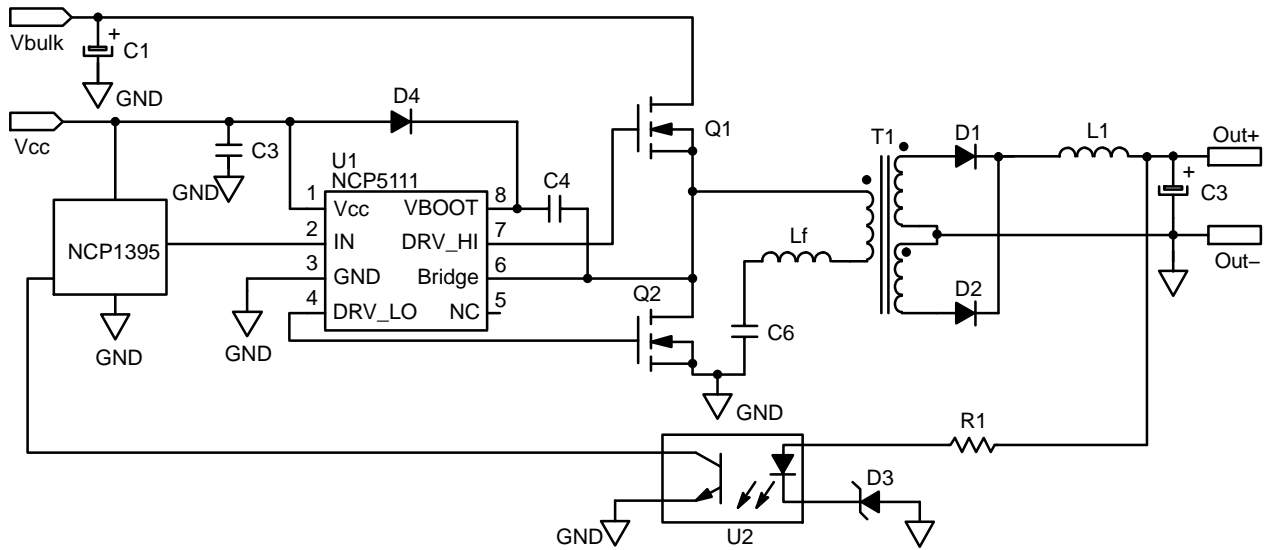


Figure 1. Typical Application Resonant Converter (LLC type)

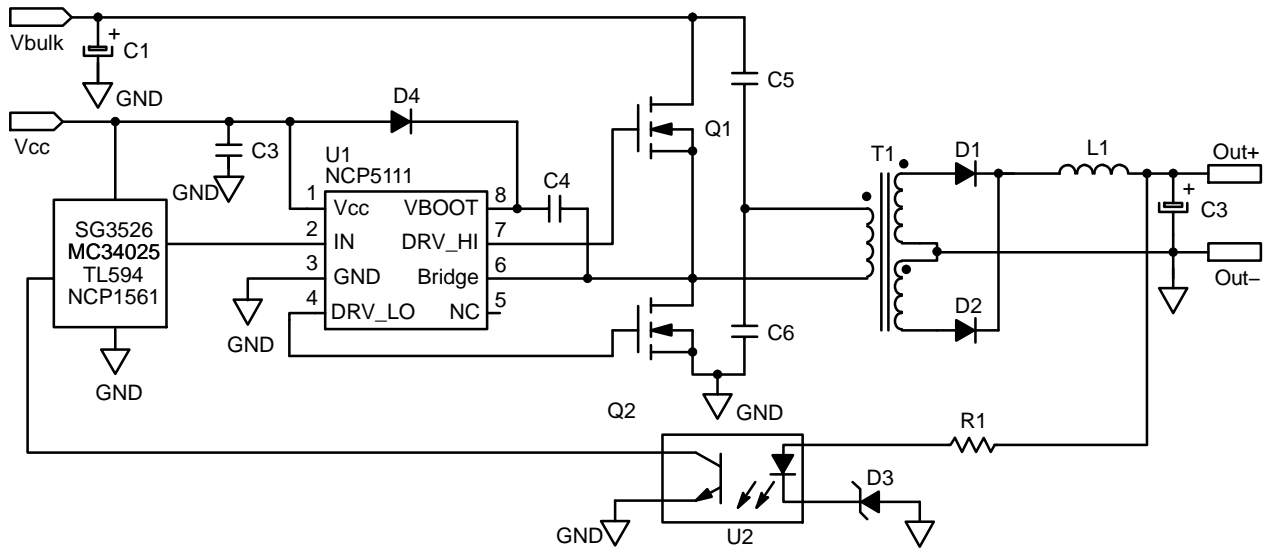


Figure 2. Typical Application Half Bridge Converter

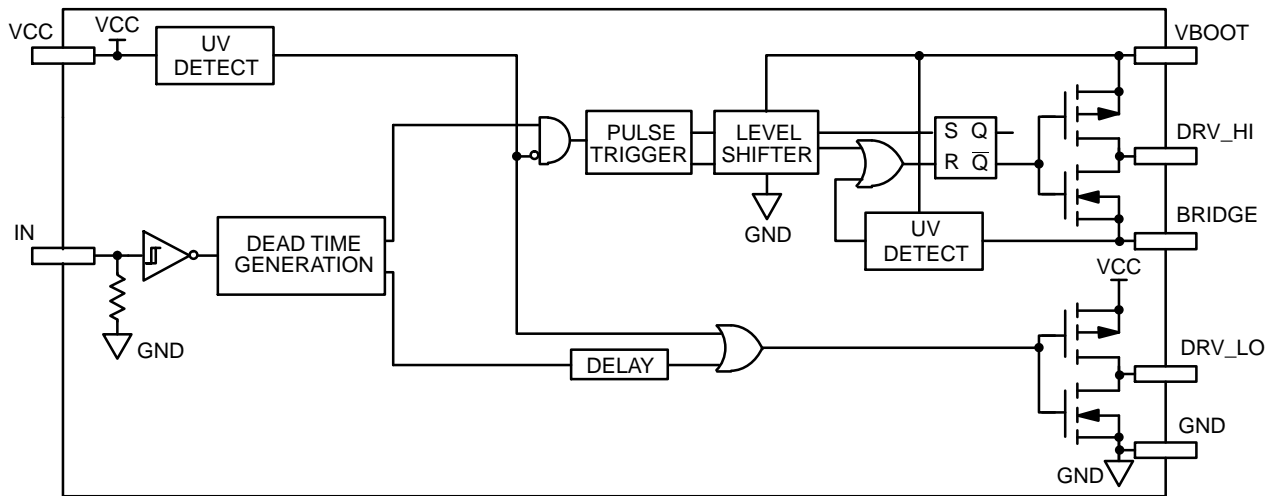


Figure 3. Detailed Block Diagram

# NCP5111

## PIN DESCRIPTIONS

Pin No.	Pin Name	Pin Function
1	VCC	Low side and main power supply
2	IN	Logic Input
3	GND	Ground
4	DRV_LO	Low side gate drive output
5	NC	Not Connected
6	BRIDGE	Bootstrap return or high side floating supply return
7	DRV_HI	High side gate drive output
8	VBOOT	Bootstrap power supply

## MAXIMUM RATINGS

Rating	Symbol	Value	Unit
$V_{CC}$	Main power supply voltage	-0.3 to 20	V
$V_{CC\_transient}$	Main transient power supply voltage: $I_{V_{CC\_max}} = 5 \text{ mA}$ during 10 ms	23	V
$V_{BRIDGE}$	VHV: High Voltage BRIDGE pin	-1 to 600	V
$V_{BRIDGE}$	Allowable Negative Bridge Pin Voltage for IN_LO Signal Propagation to DRV_LO	-10	V
$V_{BOOT-V_{BRIDGE}}$	VHV: Floating supply voltage	-0.3 to 20	V
$V_{DRV\_HI}$	VHV: High side output voltage	$V_{BRIDGE} - 0.3$ to $V_{BOOT} + 0.3$	V
$V_{DRV\_LO}$	Low side output voltage	-0.3 to $V_{CC} + 0.3$	V
$dV_{BRIDGE}/dt$	Allowable output slew rate	50	V/ns
$V_{IN}$	Inputs IN	-1.0 to $V_{CC} + 0.3$	V
	ESD Capability: – HBM model (all pins except pins 6–7–8) – Machine model (all pins except pins 6–7–8)	2 200	kV V
	Latchup capability per JEDEC JESD78		
$R_{\theta JA}$	Power dissipation and Thermal characteristics PDIP–8: Thermal Resistance, Junction–to–Air SO–8: Thermal Resistance, Junction–to–Air	100 178	°C/W
$T_{J\_max}$	Maximum Operating Junction Temperature	+150	°C

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

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**ELECTRICAL CHARACTERISTIC** ( $V_{CC} = V_{boot} = 15\text{ V}$ ,  $V_{GND} = V_{bridge}$ ,  $-40^{\circ}\text{C} < T_J < 125^{\circ}\text{C}$ , Outputs loaded with 1 nF)

Rating	Symbol	$T_J -40^{\circ}\text{C to }125^{\circ}\text{C}$			Units
		Min	Typ	Max	

## OUTPUT SECTION

Output high short circuit pulsed current $V_{DRV} = 0\text{ V}$ , $PW \leq 10\ \mu\text{s}$ (Note 1)	$I_{DRVsource}$	–	250	–	mA
Output low short circuit pulsed current $V_{DRV} = V_{CC}$ , $PW \leq 10\ \mu\text{s}$ (Note 1)	$I_{DRVsink}$	–	500	–	mA
Output resistor (Typical value @ $25^{\circ}\text{C}$ ) Source	$R_{OH}$	–	30	60	$\Omega$
Output resistor (Typical value @ $25^{\circ}\text{C}$ ) Sink	$R_{OL}$	–	10	20	$\Omega$
High level output voltage, $V_{BIAS} - V_{DRV\_XX}$ @ $I_{DRV\_XX} = 20\text{ mA}$	$V_{DRV\_H}$	–	0.7	1.6	V
Low level output voltage $V_{DRV\_XX}$ @ $I_{DRV\_XX} = 20\text{ mA}$	$V_{DRV\_L}$	–	0.2	0.6	V

## DYNAMIC OUTPUT SECTION

Turn-on propagation delay ( $V_{bridge} = 0\text{ V}$ ) (Note 2)	$t_{ON}$	–	750	1170	ns
Turn-off propagation delay ( $V_{bridge} = 0\text{ V}$ or $50\text{ V}$ ) (Notes 2 and 3)	$t_{OFF}$	–	100	170	ns
Output voltage rise time (from 10% to 90% @ $V_{CC} = 15\text{ V}$ ) with 1 nF load	$t_r$	–	85	160	ns
Output voltage fall time (from 90% to 10% @ $V_{CC} = 15\text{ V}$ ) with 1 nF load	$t_f$	–	35	75	ns
Propagation delay matching between the High side and the Low side @ $25^{\circ}\text{C}$ (Note 4)	$\Delta t$	–	30	60	ns
Internal fixed dead time (Note 5)	DT	400	650	1000	ns

## INPUT SECTION

Low level input voltage threshold	$V_{IN}$	–	–	0.8	V
Input pull-down resistor ( $V_{IN} < 0.5\text{ V}$ )	$R_{IN}$	–	200	–	k $\Omega$
High level input voltage threshold	$V_{IN}$	2.3	–	–	V
Logic "1" input bias current @ $V_{IN} = 5\text{ V}$ @ $25^{\circ}\text{C}$	$I_{IN+}$	–	5	25	$\mu\text{A}$
Logic "0" input bias current @ $V_{IN} = 0\text{ V}$ @ $25^{\circ}\text{C}$	$I_{IN-}$	–	–	2.0	$\mu\text{A}$

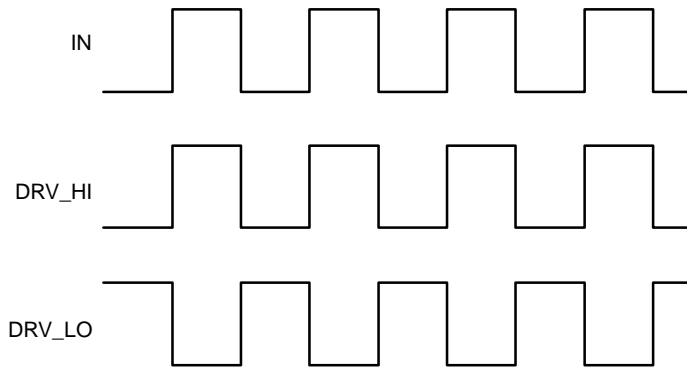
## SUPPLY SECTION

Vcc UV Start-up voltage threshold	$V_{cc\_stup}$	8.0	8.9	9.9	V
Vcc UV Shut-down voltage threshold	$V_{cc\_shtdwn}$	7.3	8.2	9.1	V
Hysteresis on Vcc	$V_{cc\_hyst}$	0.3	0.7	–	V
Vboot Start-up voltage threshold reference to bridge pin ( $V_{boot\_stup} = V_{boot} - V_{bridge}$ )	$V_{boot\_stup}$	8.0	8.9	9.9	V
Vboot UV Shut-down voltage threshold	$V_{boot\_shtdwn}$	7.3	8.2	9.1	V
Hysteresis on Vboot	$V_{boot\_shtdwn}$	0.3	0.7	–	V
Leakage current on high voltage pins to GND ( $V_{BOOT} = V_{BRIDGE} = DRV\_HI = 600\text{ V}$ )	$I_{HV\_LEAK}$	–	5	40	$\mu\text{A}$
Consumption in active mode ( $V_{CC} = V_{boot}$ , $f_{sw} = 100\text{ kHz}$ and 1 nF load on both driver outputs)	ICC1	–	4	5	mA
Consumption in inhibition mode ( $V_{CC} = V_{boot}$ )	ICC2	–	250	400	$\mu\text{A}$
Vcc current consumption in inhibition mode	ICC3	–	200	–	$\mu\text{A}$
Vboot current consumption in inhibition mode	ICC4	–	50	–	$\mu\text{A}$

1. Parameter guaranteed by design.
2.  $T_{ON} = T_{OFF} + DT$ .
3. Turn-off propagation delay @  $V_{bridge} = 600\text{ V}$  is guaranteed by design.
4. See characterization curve for  $\Delta t$  parameters variation on the full range temperature.
5. Timing diagram definition see: Figure 5 and Figure 6.

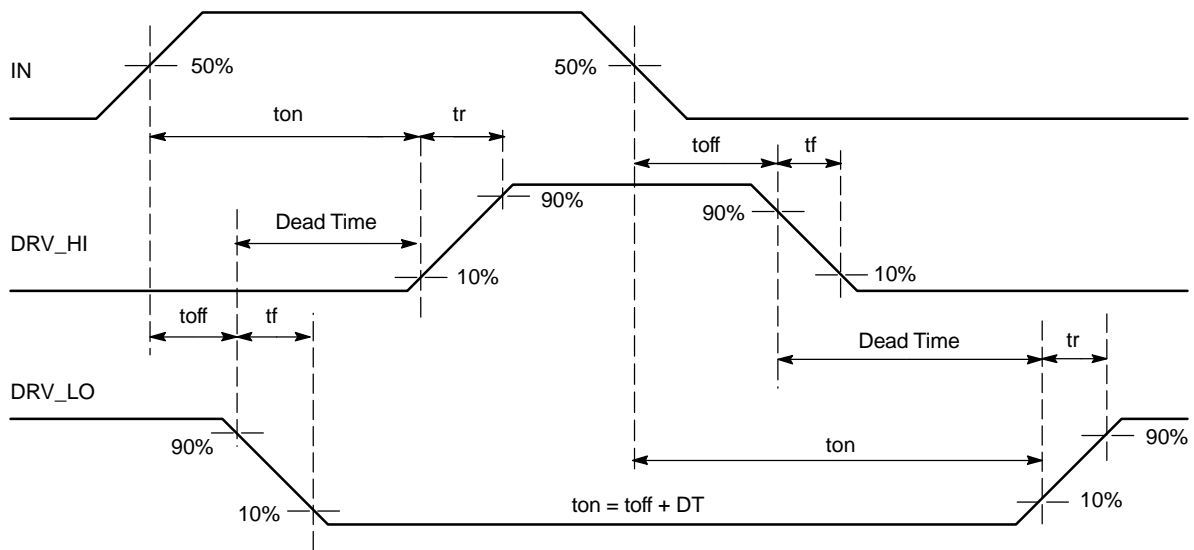
Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

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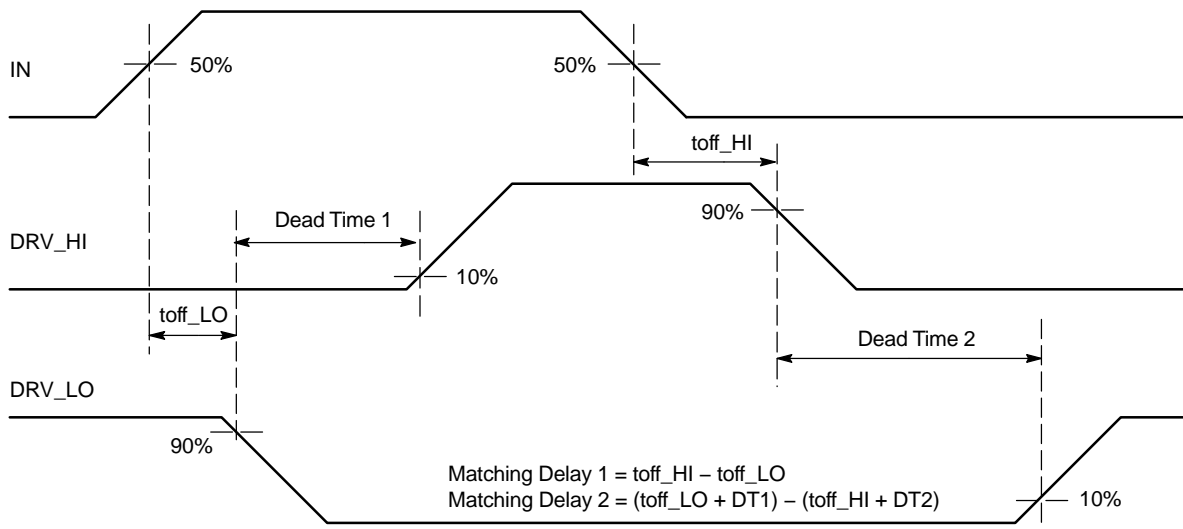


Note: DRV\_HI output is in phase with the input.

**Figure 4. Input/Output Timing Diagram**



**Figure 5. Timing Definitions**



**Figure 6. Matching Propagation Delay**

CHARACTERIZATION CURVES

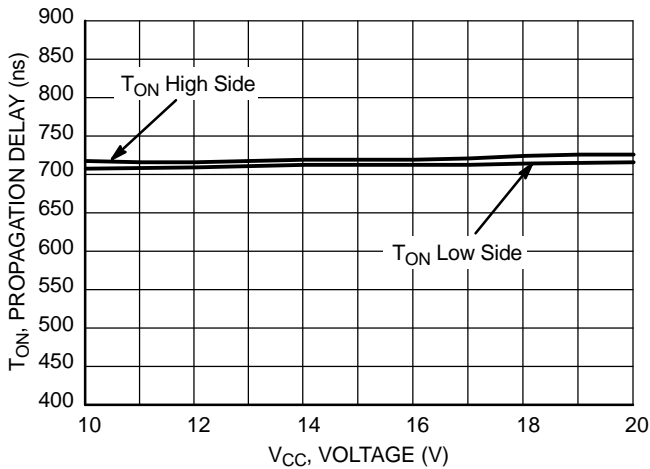


Figure 7. Turn ON Propagation Delay vs. Supply Voltage ( $V_{CC} = V_{BOOT}$ )

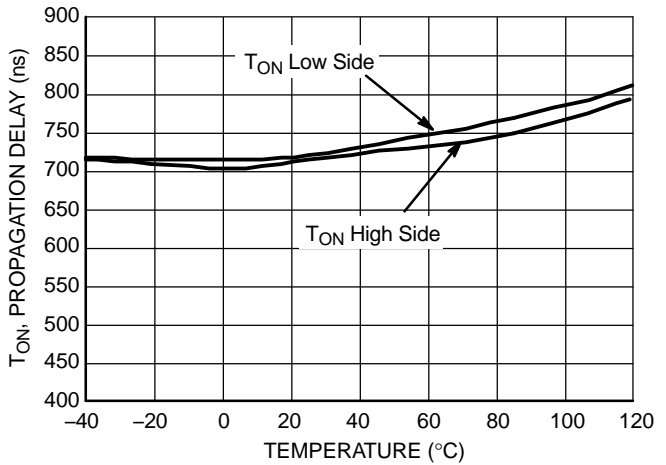


Figure 8. Turn ON Propagation Delay vs. Temperature

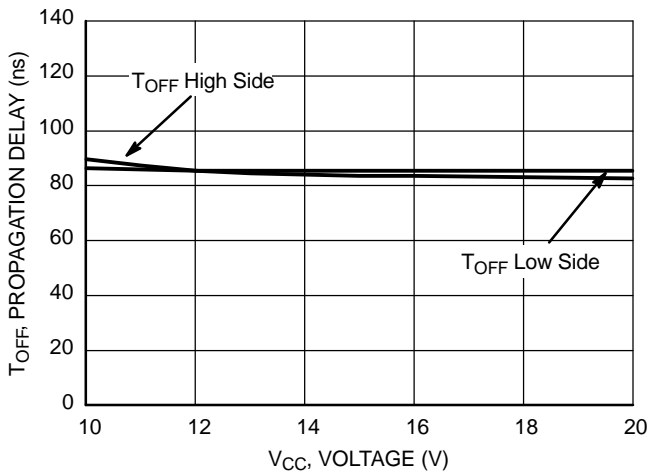


Figure 9. Turn OFF Propagation Delay vs. Supply Voltage ( $V_{CC} = V_{BOOT}$ )

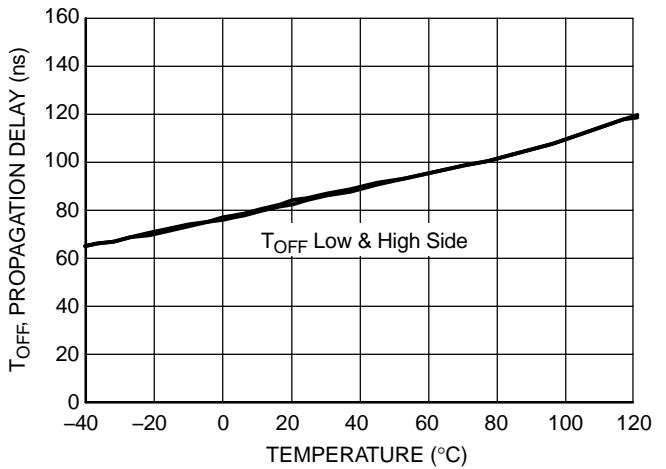


Figure 10. Turn OFF Propagation Delay vs. Temperature

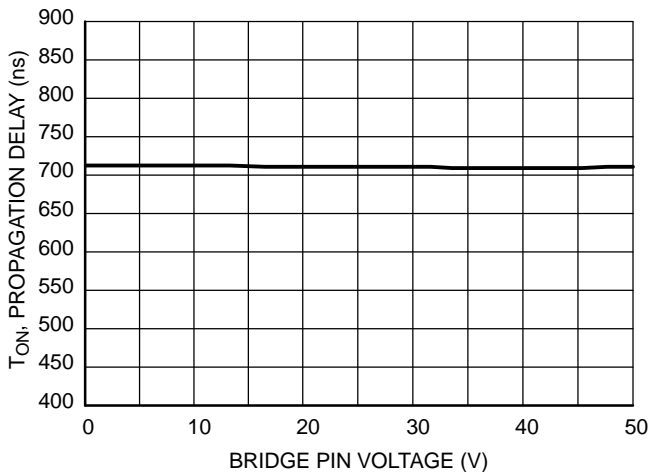


Figure 11. High Side Turn ON Propagation Delay vs.  $V_{BRIDGE}$  Voltage

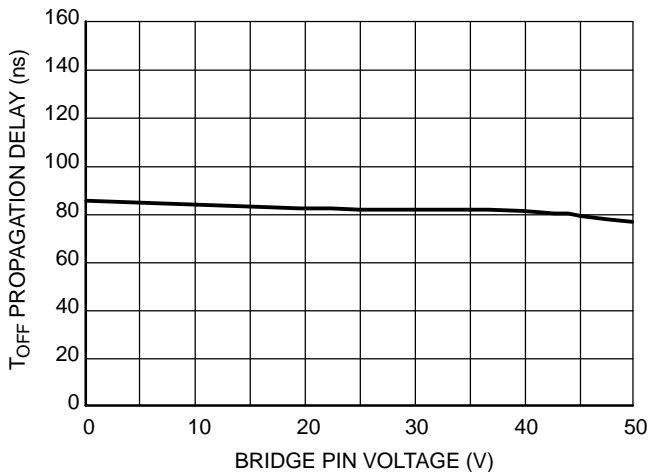


Figure 12. High Side Turn OFF Propagation Delay vs.  $V_{BRIDGE}$  Voltage

CHARACTERIZATION CURVES

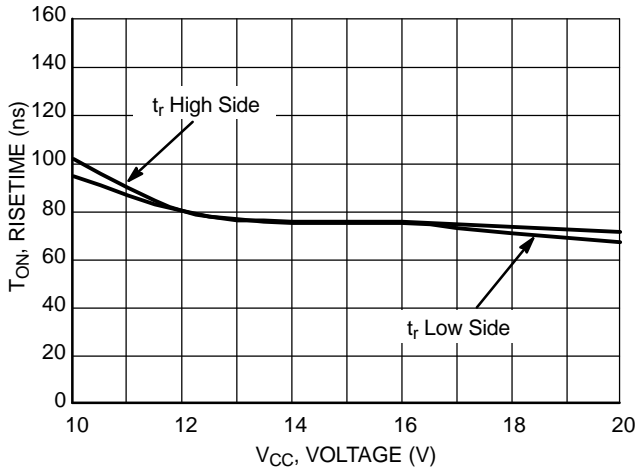


Figure 13. Turn ON Risetime vs. Supply Voltage ( $V_{CC} = V_{BOOT}$ )

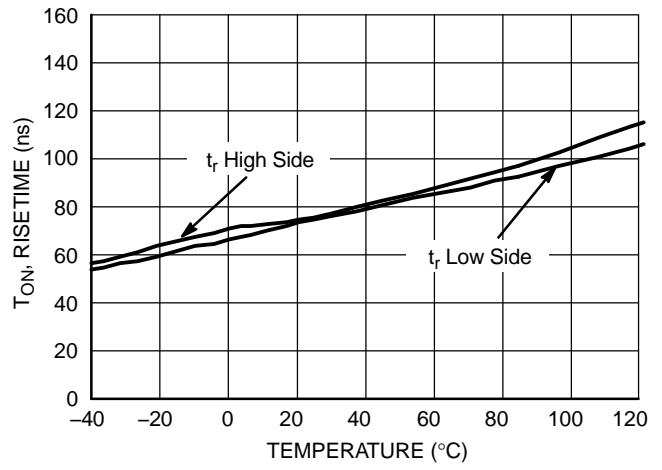


Figure 14. Turn ON Risetime vs. Temperature

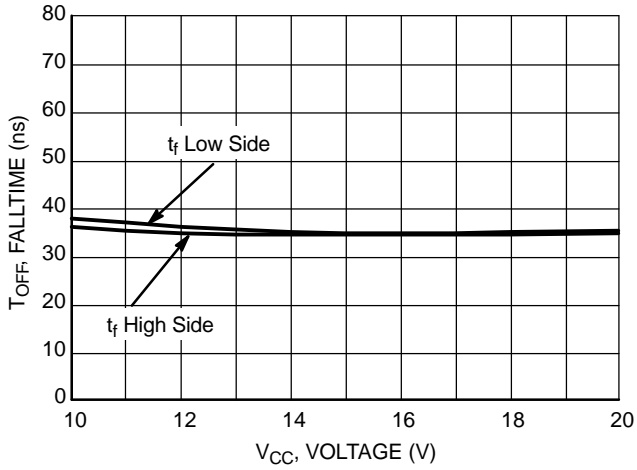


Figure 15. Turn OFF Falltime vs. Supply Voltage ( $V_{CC} = V_{BOOT}$ )

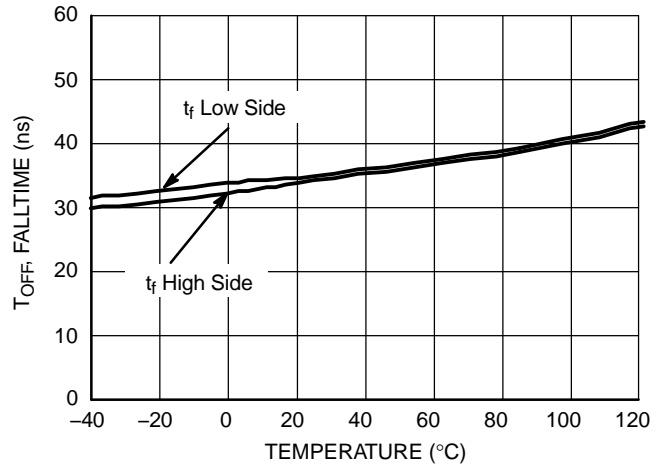


Figure 16. Turn OFF Falltime vs. Temperature

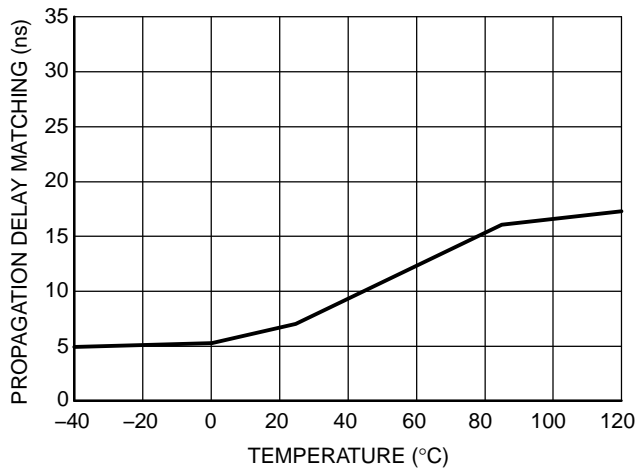


Figure 17. Propagation Delay Matching Between High Side and Low Side Driver vs. Temperature

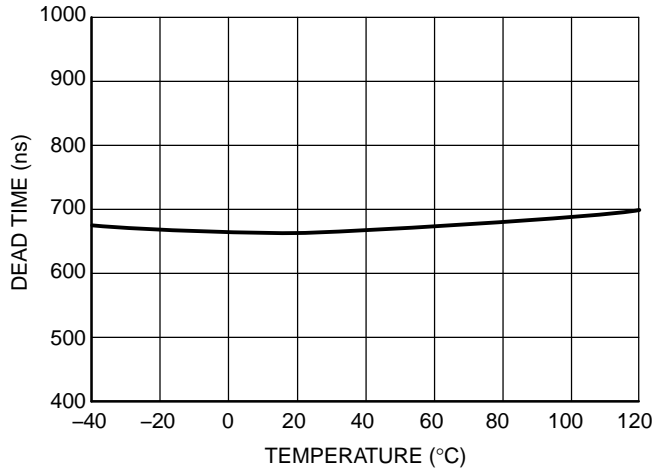


Figure 18. Dead Time vs. Temperature

CHARACTERIZATION CURVES

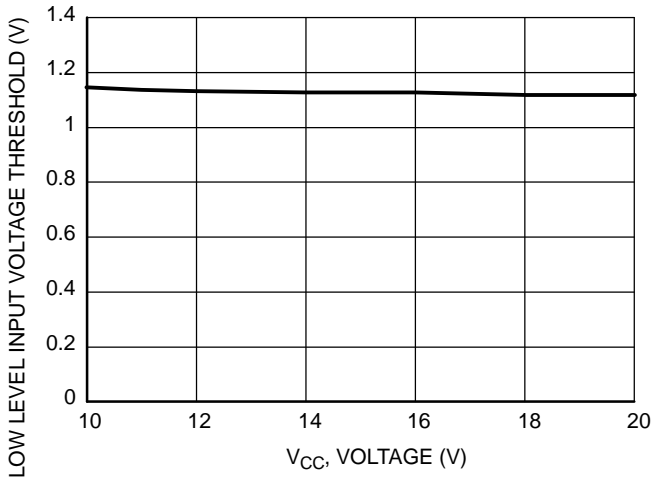


Figure 19. Low Level Input Voltage Threshold vs. Supply Voltage ( $V_{CC} = V_{BOOT}$ )

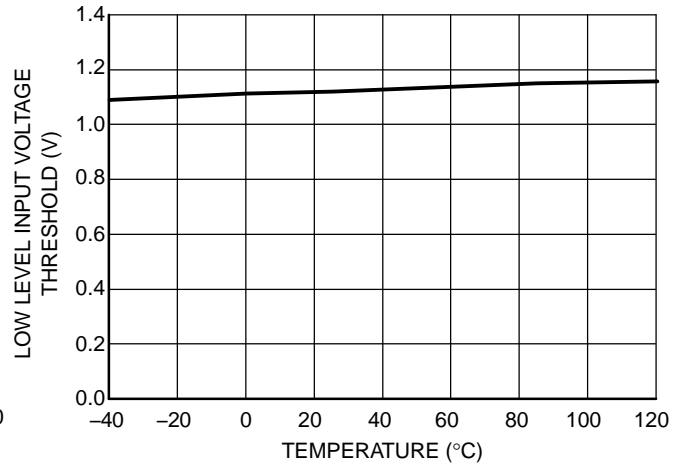


Figure 20. Low Level Input Voltage Threshold vs. Temperature

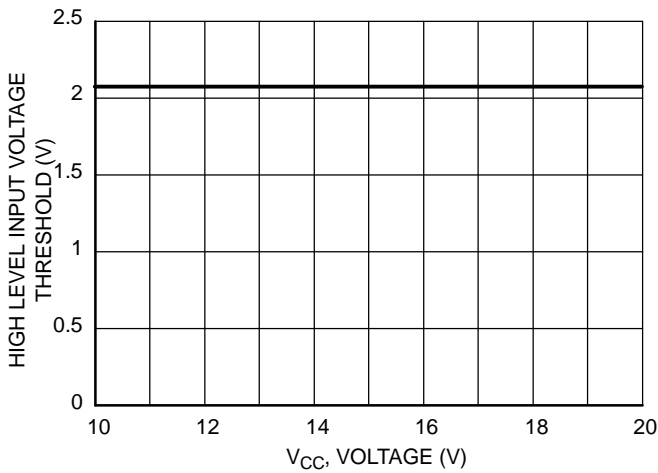


Figure 21. High Level Input Voltage Threshold vs. Supply Voltage ( $V_{CC} = V_{BOOT}$ )

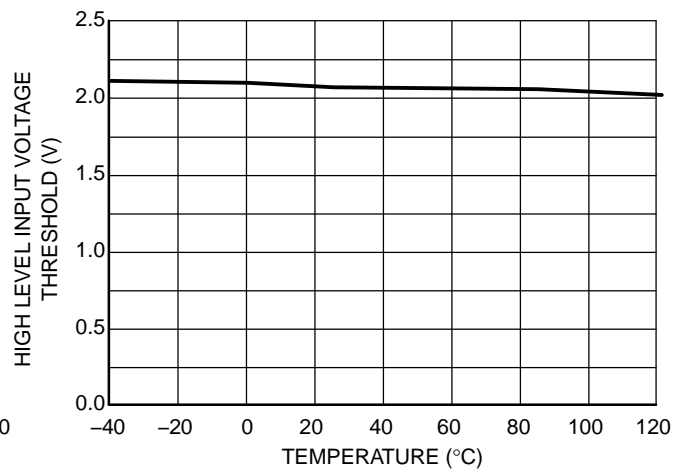


Figure 22. High Level Input Voltage Threshold vs. Temperature

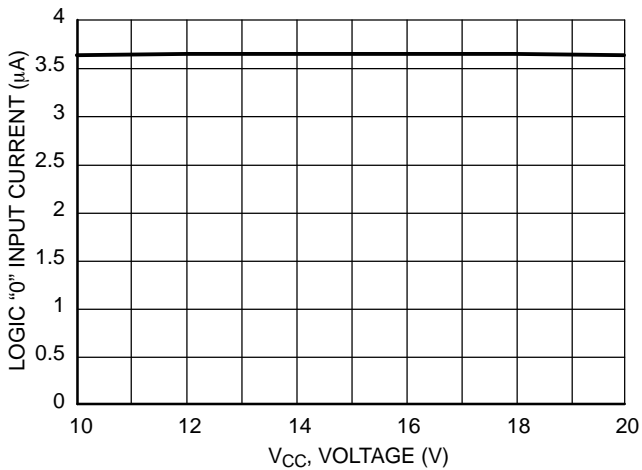


Figure 23. Logic "0" Input Current vs. Supply Voltage ( $V_{CC} = V_{BOOT}$ )

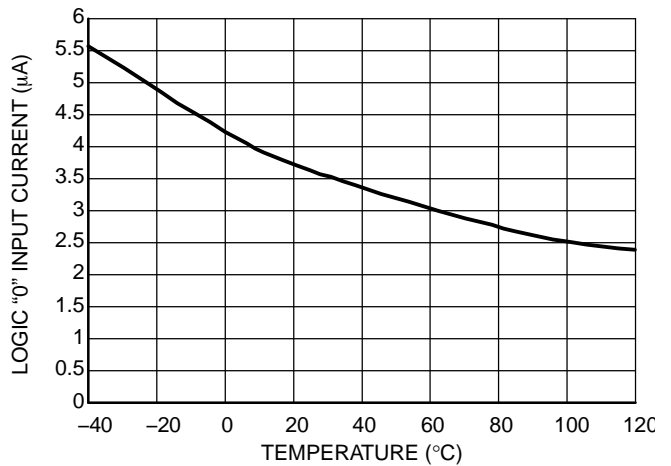


Figure 24. Logic "0" Input Current vs. Temperature



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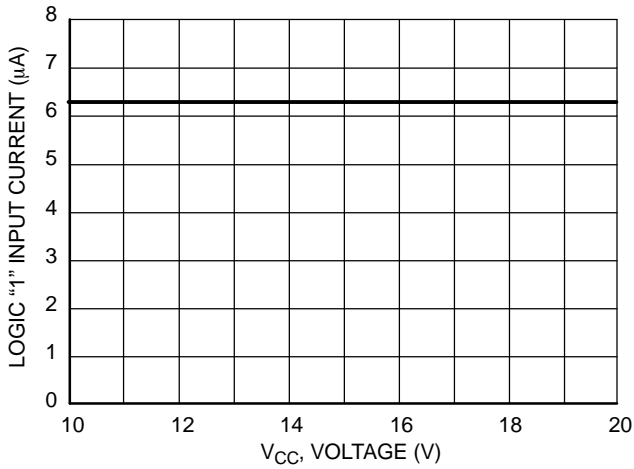


Figure 25. Logic "1" Input Current vs. Supply Voltage ( $V_{CC} = V_{BOOT}$ )

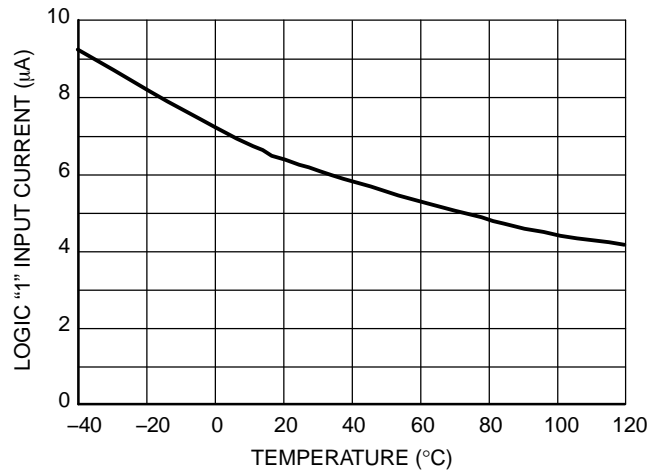


Figure 26. Logic "1" Input Current vs. Temperature

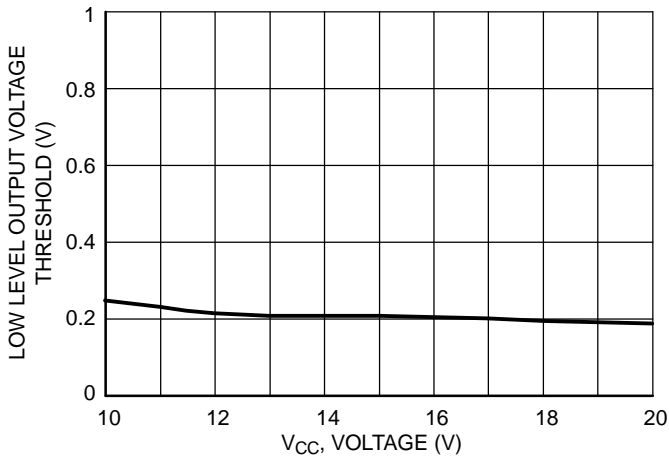


Figure 27. Low Level Output Voltage vs. Supply Voltage ( $V_{CC} = V_{BOOT}$ )

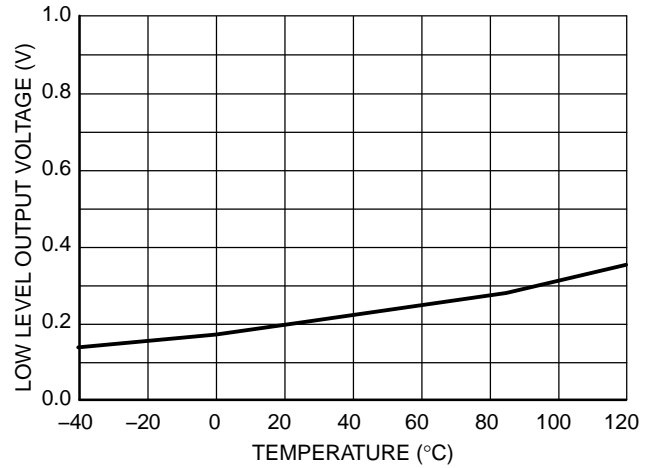


Figure 28. Low Level Output Voltage vs. Temperature

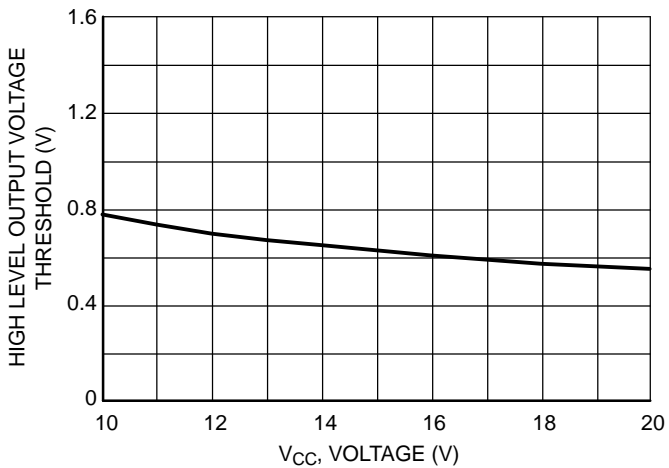


Figure 29. High Level Output Voltage vs. Supply Voltage ( $V_{CC} = V_{BOOT}$ )

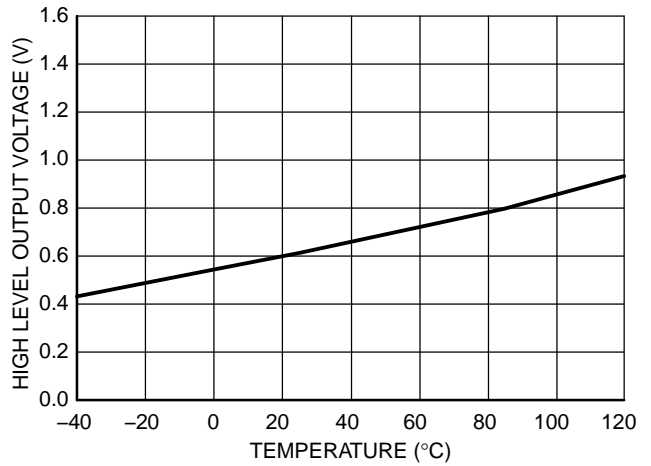


Figure 30. High Level Output Voltage vs. Temperature

CHARACTERIZATION CURVES

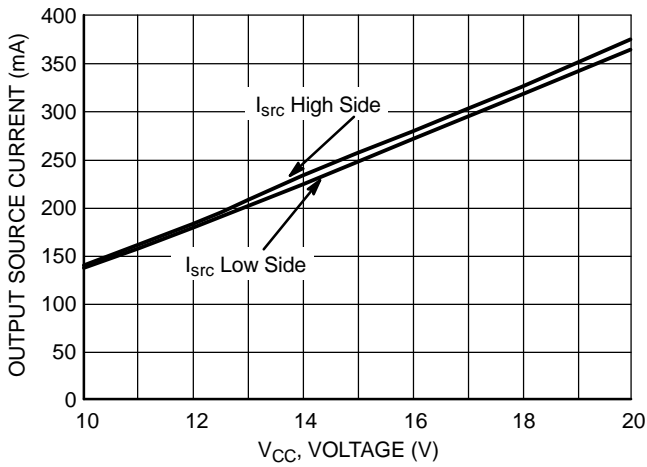


Figure 31. Output Source Current vs. Supply Voltage ( $V_{CC} = V_{BOOT}$ )

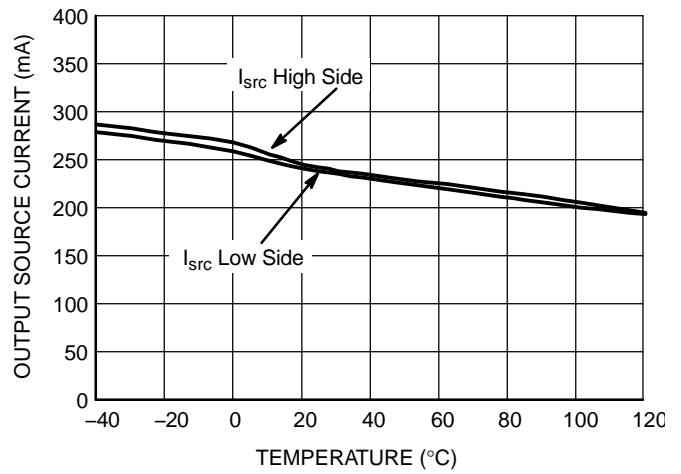


Figure 32. Output Source Current vs. Temperature

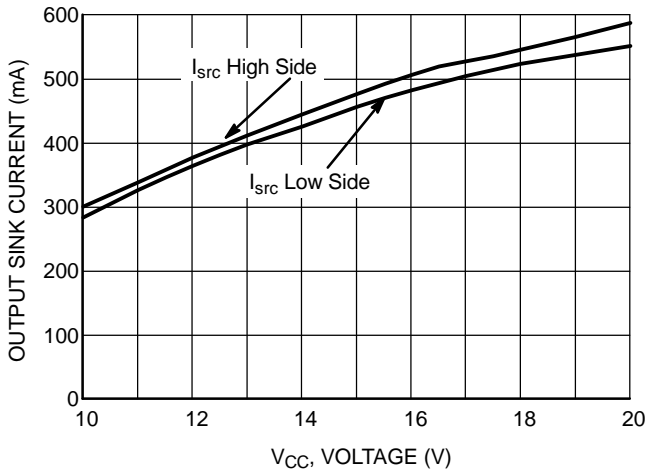


Figure 33. Output Sink Current vs. Supply Voltage ( $V_{CC} = V_{BOOT}$ )

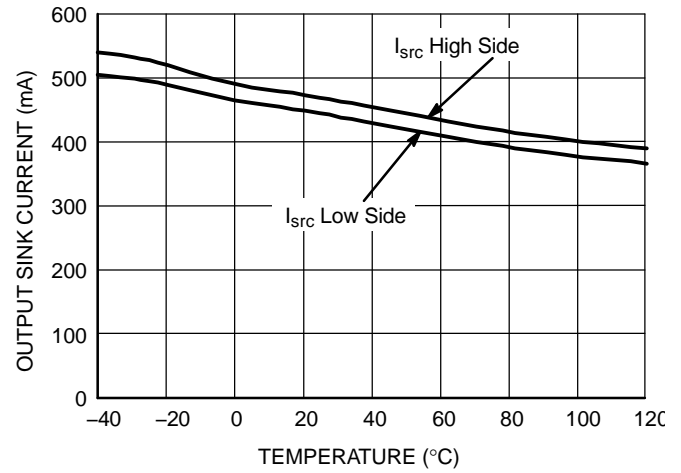


Figure 34. Output Sink Current vs. Temperature

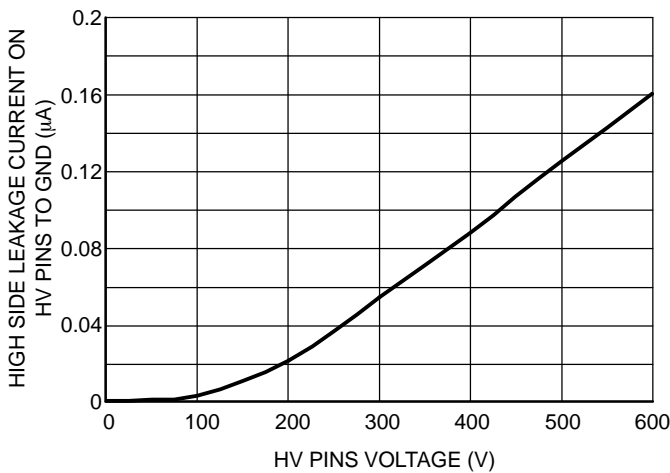


Figure 35. Leakage Current on High Voltage Pins (600 V) to Ground vs.  $V_{BRIDGE}$  Voltage ( $V_{BRIDGE} = V_{BOOT} = V_{DRV\_HI}$ )

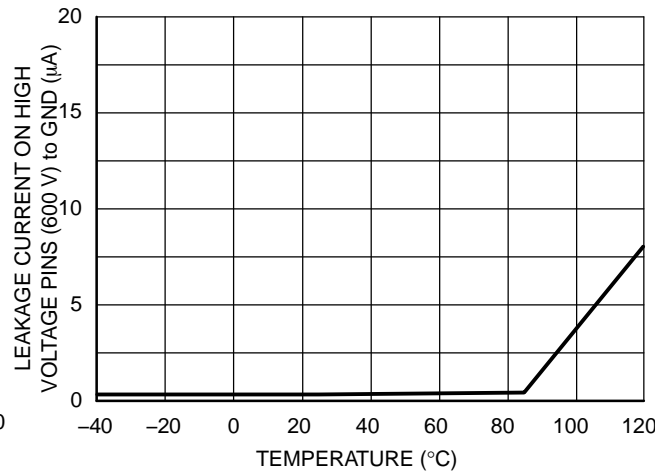


Figure 36. Leakage Current on High Voltage Pins (600 V) to Ground vs. Temperature ( $V_{BRIDGE} = V_{BOOT} = V_{DRV\_HI} = 600\text{ V}$ )

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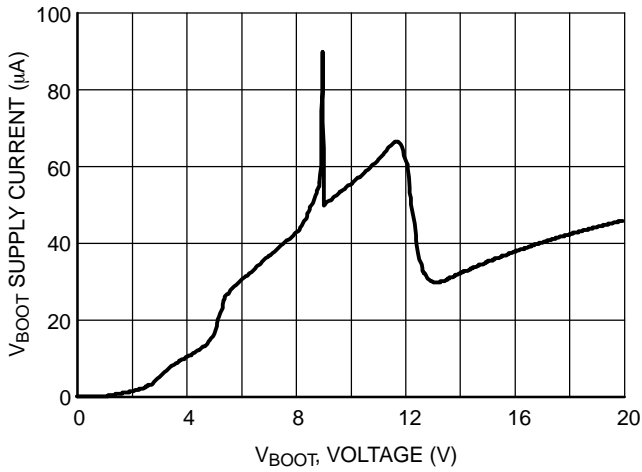


Figure 37.  $V_{BOOT}$  Supply Current vs. Bootstrap Supply Voltage

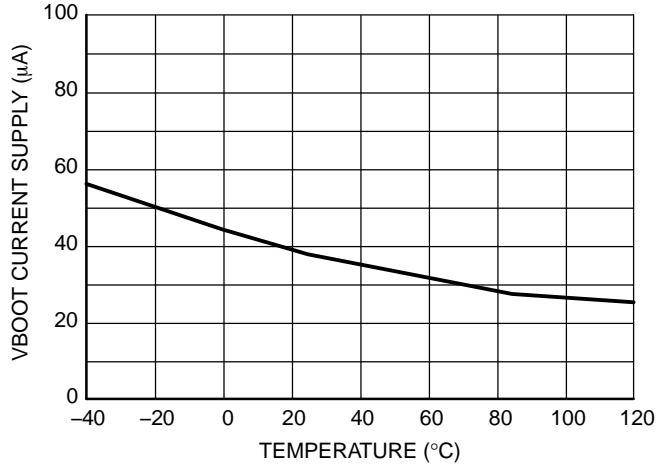


Figure 38.  $V_{BOOT}$  Supply Current vs. Temperature

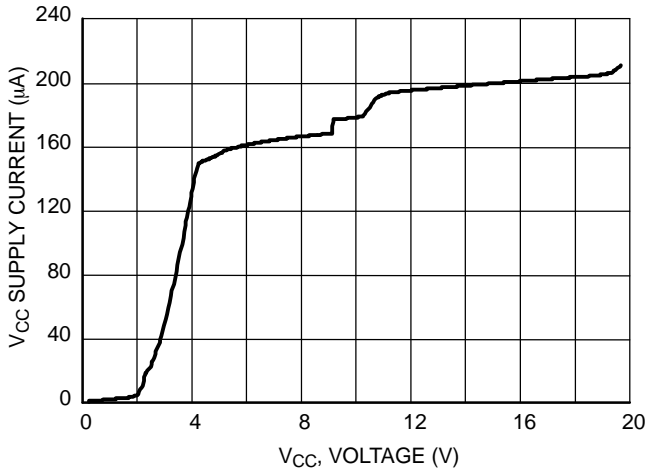


Figure 39.  $V_{CC}$  Supply Current vs.  $V_{CC}$  Supply Voltage

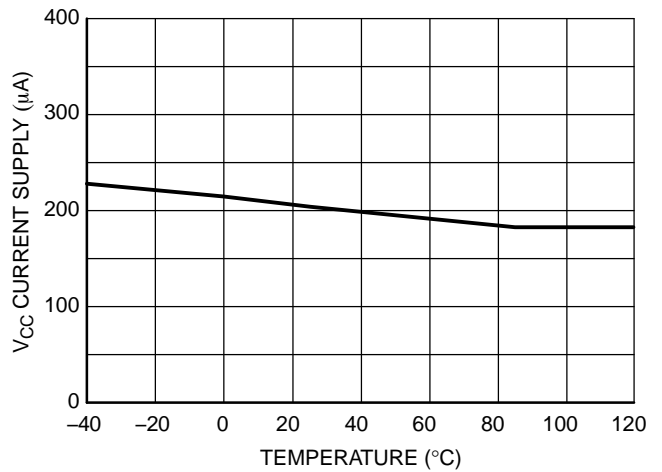


Figure 40.  $V_{CC}$  Supply Current vs. Temperature

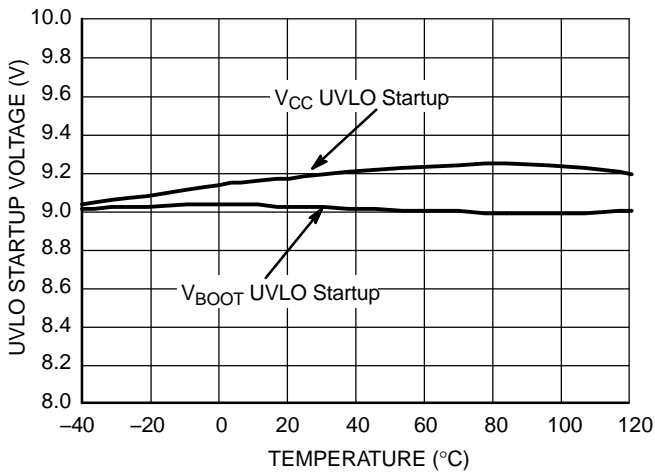


Figure 41. UVLO Startup Voltage vs. Temperature

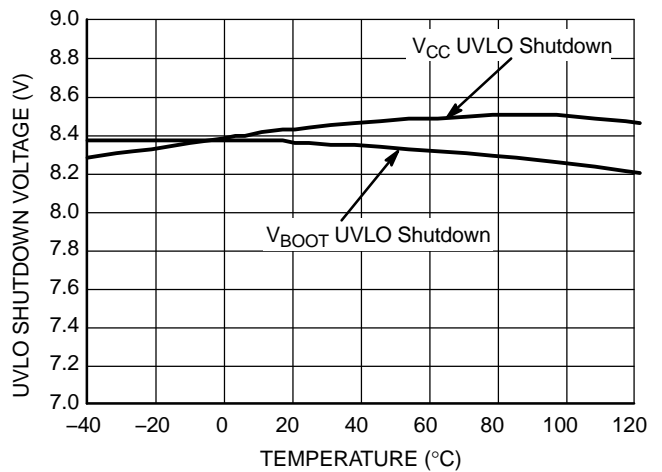


Figure 42. UVLO Shutdown Voltage vs. Temperature

CHARACTERIZATION CURVES

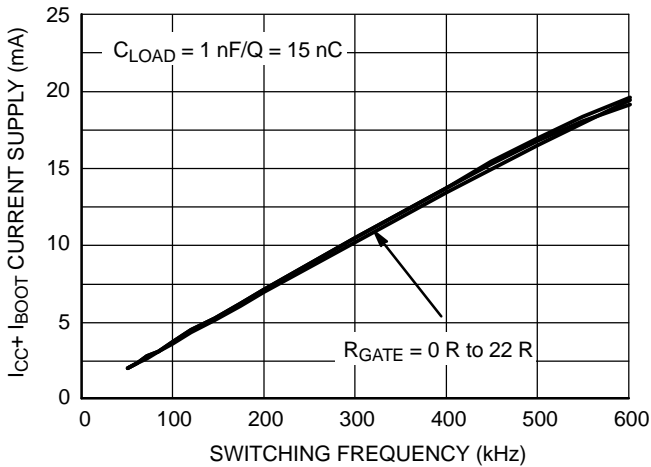


Figure 43.  $I_{CC1}$  Consumption vs. Switching Frequency with 15 nC Load on Each Driver @  $V_{CC} = 15 V$

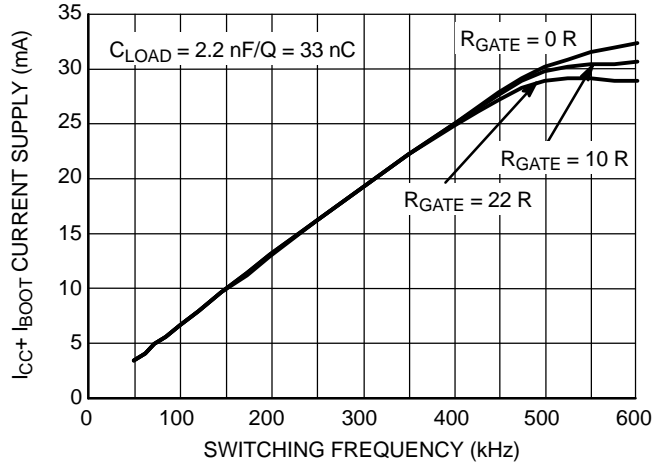


Figure 44.  $I_{CC1}$  Consumption vs. Switching Frequency with 33 nC Load on Each Driver @  $V_{CC} = 15 V$

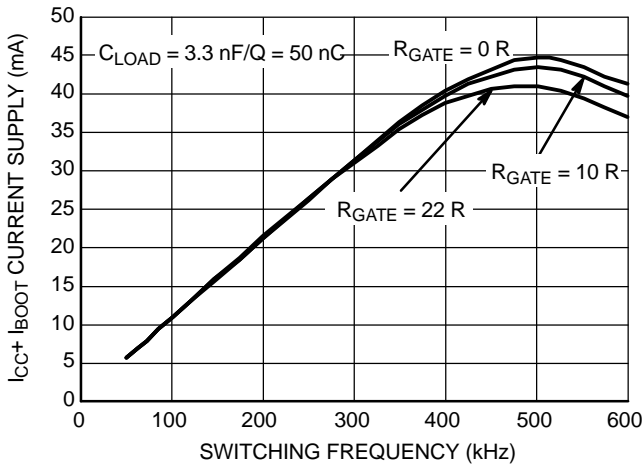


Figure 45.  $I_{CC1}$  Consumption vs. Switching Frequency with 50 nC Load on Each Driver @  $V_{CC} = 15 V$

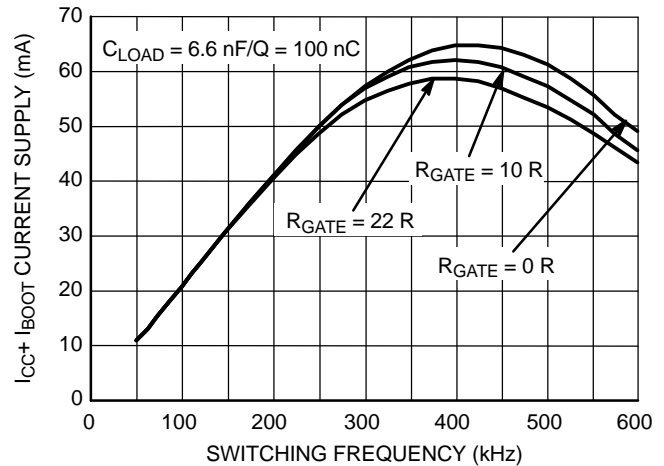
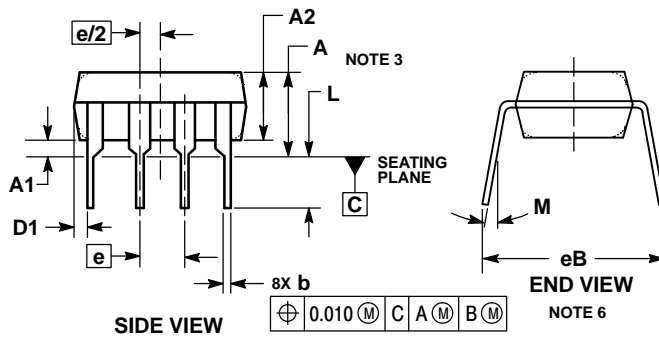
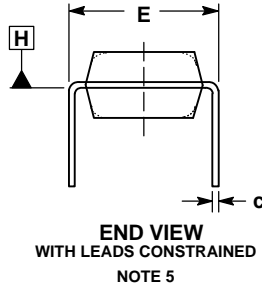
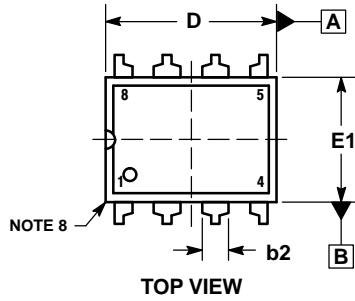


Figure 46.  $I_{CC1}$  Consumption vs. Switching Frequency with 100 nC Load on Each Driver @  $V_{CC} = 15 V$

# NCP5111

## PACKAGE DIMENSIONS

### 8 LEAD PDIP CASE 626-05 ISSUE N



**NOTES:**

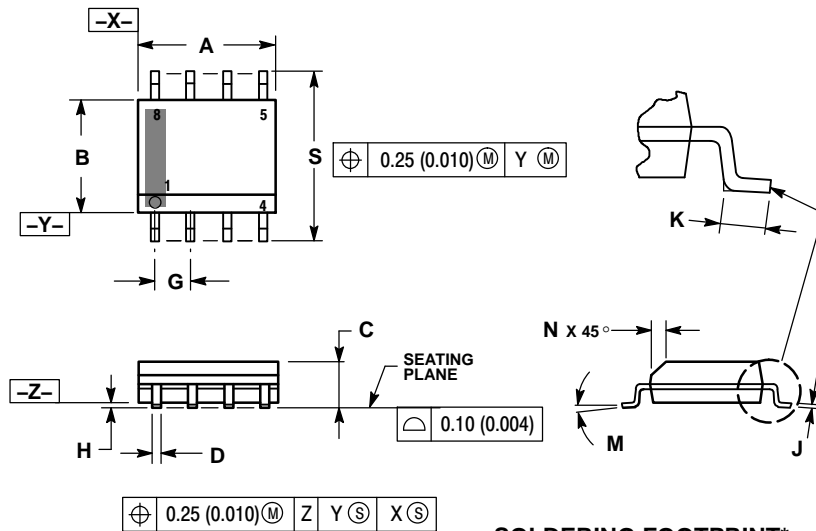
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: INCHES.
3. DIMENSIONS A, A1 AND L ARE MEASURED WITH THE PACKAGE SEATED IN JEDEC SEATING PLANE GAUGE GS-3.
4. DIMENSIONS D, D1 AND E1 DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS. MOLD FLASH OR PROTRUSIONS ARE NOT TO EXCEED 0.10 INCH.
5. DIMENSION E IS MEASURED AT A POINT 0.015 BELOW DATUM PLANE H WITH THE LEADS CONSTRAINED PERPENDICULAR TO DATUM C.
6. DIMENSION E3 IS MEASURED AT THE LEAD TIPS WITH THE LEADS UNCONSTRAINED.
7. DATUM PLANE H IS COINCIDENT WITH THE BOTTOM OF THE LEADS, WHERE THE LEADS EXIT THE BODY.
8. PACKAGE CONTOUR IS OPTIONAL (ROUNDED OR SQUARE CORNERS).

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	---	0.210	---	5.33
A1	0.015	---	0.38	---
A2	0.115	0.195	2.92	4.95
b	0.014	0.022	0.35	0.56
b2	0.060 TYP		1.52 TYP	
C	0.008	0.014	0.20	0.36
D	0.355	0.400	9.02	10.16
D1	0.005	---	0.13	---
E	0.300	0.325	7.62	8.26
E1	0.240	0.280	6.10	7.11
e	0.100 BSC		2.54 BSC	
eB	---	0.430	---	10.92
L	0.115	0.150	2.92	3.81
M	---	10°	---	10°

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## PACKAGE DIMENSIONS

SOIC-8 NB  
CASE 751-07  
ISSUE AK

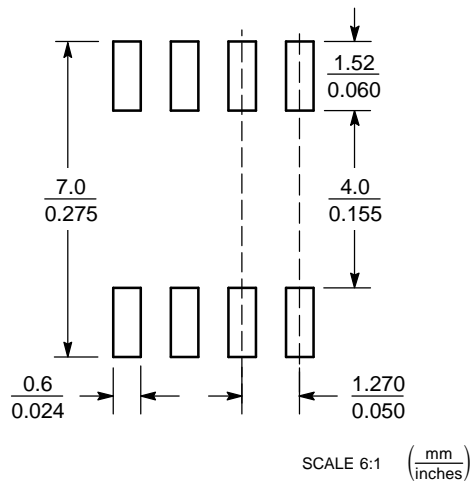


**NOTES:**

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSION A AND B DO NOT INCLUDE MOLD PROTRUSION.
4. MAXIMUM MOLD PROTRUSION 0.15 (0.006) PER SIDE.
5. DIMENSION D DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.127 (0.005) TOTAL IN EXCESS OF THE D DIMENSION AT MAXIMUM MATERIAL CONDITION.
6. 751-01 THRU 751-06 ARE OBSOLETE. NEW STANDARD IS 751-07.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.80	5.00	0.189	0.197
B	3.80	4.00	0.150	0.157
C	1.35	1.75	0.053	0.069
D	0.33	0.51	0.013	0.020
G	1.27 BSC		0.050 BSC	
H	0.10	0.25	0.004	0.010
J	0.19	0.25	0.007	0.010
K	0.40	1.27	0.016	0.050
M	0°	8°	0°	8°
N	0.25	0.50	0.010	0.020
S	5.80	6.20	0.228	0.244

### SOLDERING FOOTPRINT\*



\*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

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