NCP5104

High Voltage, Half Bridge Driver

The NCP5104 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 insure a proper drive of the High−side power switch.

Features

- High Voltage Range: up to 600 V
- dV/dt Immunity ±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
- 1 Input with Internal Fixed Dead Time (520 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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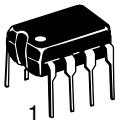
SOIC−8
D SUFFIX
CASE 751



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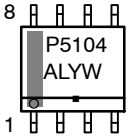
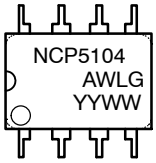
PDIP−8
P SUFFIX
CASE 626

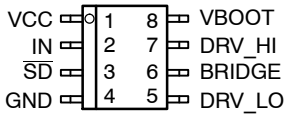
MARKING DIAGRAMS





NCP5104 = 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

PINOUT INFORMATION



8 Pin Package

ORDERING INFORMATION

Device	Package	Shipping†
NCP5104PG	PDIP−8 (Pb−Free)	50 Units / Rail
NCP5104DR2G	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.

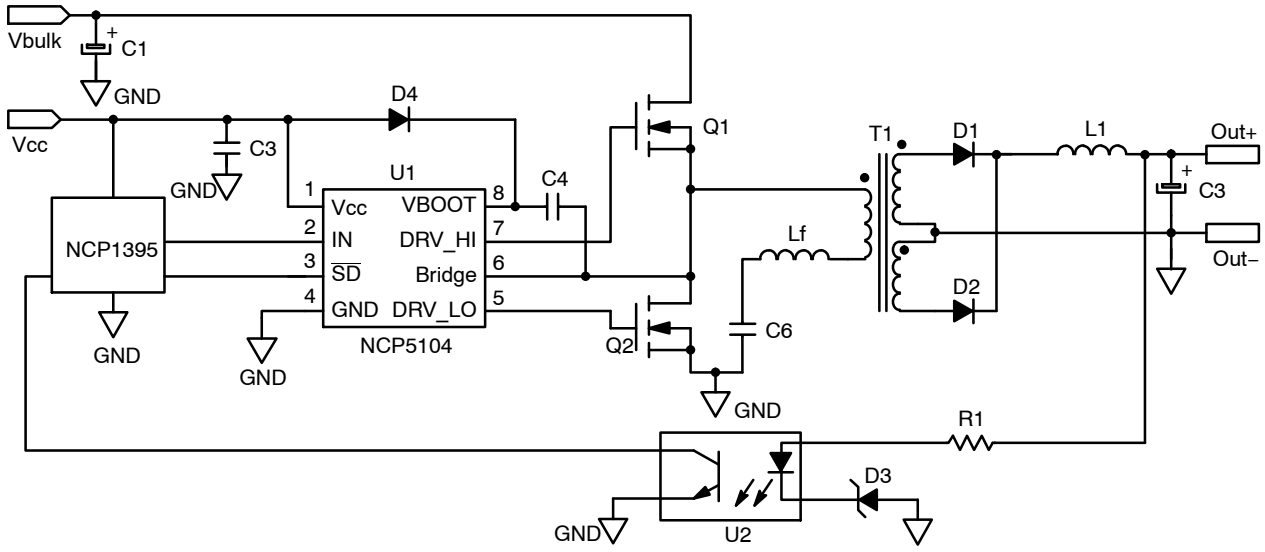


Figure 1. Typical Application Resonant Converter (LLC type)

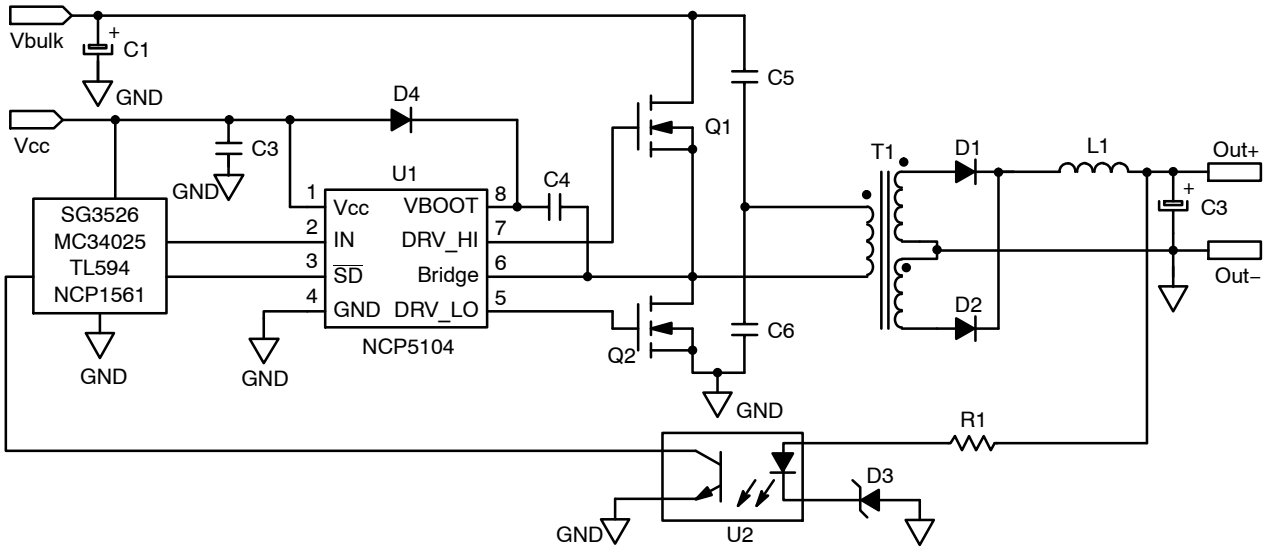


Figure 2. Typical Application Half Bridge Converter

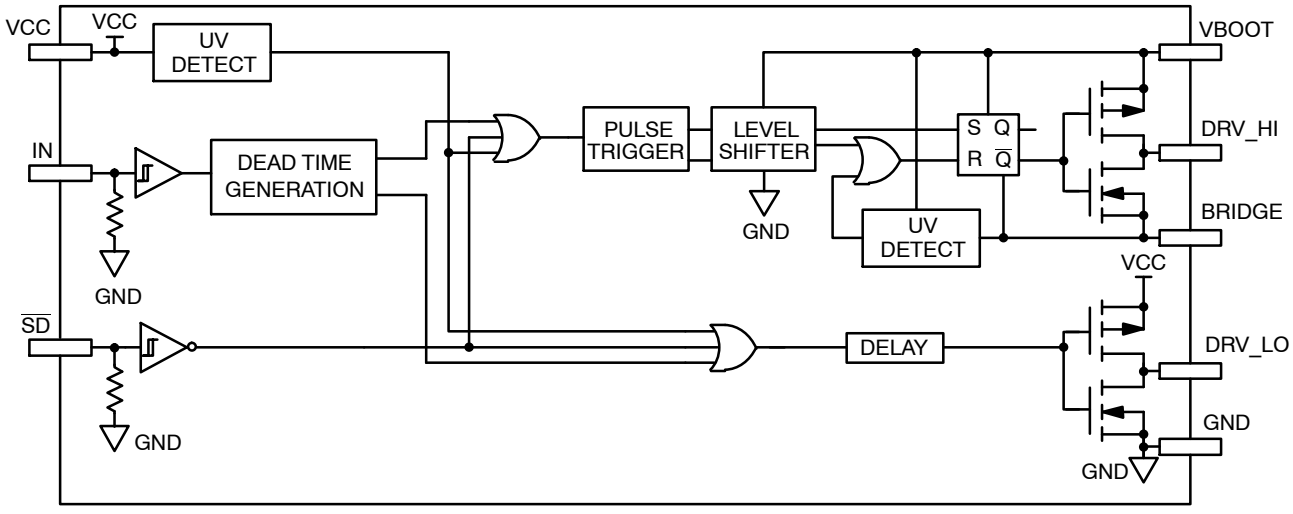


Figure 3. Detailed Block Diagram

PIN DESCRIPTION

Pin Name	Description
V_{CC}	Low Side and Main Power Supply
IN	Logic Input
$\overline{SD}$	Logic Input for Shutdown
GND	Ground
DRV_LO	Low Side Gate Drive Output
V_{BOOT}	Bootstrap Power Supply
DRV_HI	High Side Gate Drive Output
BRIDGE	Bootstrap Return or High Side Floating Supply Return

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: IV_{CC_max} = 5 mA during 10 ms	23	V
V_{BOOT}	VHV: High Voltage BOOT Pin	−1 to 620	V
V_{BRIDGE}	VHV: High Voltage BRIDGE pin	−1 to 600	V
V_{BRIDGE}	Allowable Negative Bridge Pin Voltage for IN 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}, V_{SD}	Inputs IN & SD	−1.0 to V_{CC} + 0.3	V
	ESD Capability: − HBM model (all pins except pins 6−7−8 in 8) − Machine model (all pins except pins 6−7−8)	 2 200	 kV V
	Latch up 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_{ST}	Storage Temperature Range	−55 to +150	°C
T_{J_max}	Maximum Operating Junction Temperature	+150	°C

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

ELECTRICAL CHARACTERISTIC (V_{CC} = V_{boot} = 15 V, V_{GND} = V_{bridge}, −40°C < T_J < 125°C, Outputs loaded with 1 nF)

Rating	Symbol	T_J −40°C to 125°C			Units
		Min	Typ	Max	
OUTPUT SECTION					
Output high short circuit pulsed current V_{DRV} = 0 V, PW ≤ 10 μs (Note 1)	$I_{DRVsource}$	–	250	–	mA
Output low short circuit pulsed current V_{DRV} = Vcc, PW ≤ 10 μs (Note 1)	$I_{DRVsink}$	–	500	–	mA
Output resistor (Typical value @ 25°C) Source	R_{OH}	–	30	60	Ω
Output resistor (Typical value @ 25°C) Sink	R_{OL}	–	10	20	Ω
High level output voltage, V_{BIAS}−V_{DRV_XX} @ I_{DRV_XX} = 20 mA	V_{DRV_H}	–	0.7	1.6	V
Low level output voltage V_{DRV_XX} @ I_{DRV_XX} = 20 mA	V_{DRV_L}	–	0.2	0.6	V
DYNAMIC OUTPUT SECTION					
Turn−on propagation delay (Vbridge = 0 V) (Note 2)	t_{ON}	–	620	800	ns
Turn−off propagation delay (Vbridge = 0 V or 50 V) (Note 3)	t_{OFF}	–	100	170	ns
Shutdown propagation delay, when Shutdown is enabled	t_{sd_en}	–	100	170	ns
Shutdown propagation delay, when Shutdown is disabled	t_{sd_dis}	–	620	800	ns
Output voltage rise time (from 10% to 90% @ V_{CC} = 15 V) with 1 nF load	t_r	–	85	160	ns
Output voltage fall time (from 90% to 10% @ V_{CC} = 15 V) with 1 nF load	t_f	–	35	75	ns
Propagation delay matching between the High side and the Low side @ 25°C (Note 4)	Δt	–	10	45	ns
Internal fixed dead time (Note 5)	DT	400	520	650	ns
INPUT SECTION					
Low level input voltage threshold	V_{IN}	–	–	0.8	V
Input pull−down resistor (V_{IN} < 0.5 V)	R_{IN}	–	200	–	kΩ
High level input voltage threshold	V_{IN}	2.3	–	–	V
Logic “1” input bias current @ V_{IN} = 5 V @ 25°C	I_{IN+}	–	5	25	μA
Logic “0” input bias current @ V_{IN} = 0 V @ 25°C	I_{IN-}	–	–	2.0	μA
SUPPLY SECTION					
Vcc UV Start−up voltage threshold	Vcc_stup	8.0	8.9	9.8	V
Vcc UV Shut−down voltage threshold	Vcc_shtdwn	7.3	8.2	9.0	V
Hysteresis on Vcc	Vcc_hyst	0.3	0.7	–	V
Vboot Start−up voltage threshold reference to bridge pin (Vboot_stup = Vboot − Vbridge)	Vboot_stup	8.0	8.9	9.8	V
Vboot UV Shut−down voltage threshold	Vboot_shtdwn	7.3	8.2	9.0	V
Hysteresis on Vboot	Vboot_shtdwn	0.3	0.7	–	V
Leakage current on high voltage pins to GND (V_{BOOT} = V_{BRIDGE} = DRV_HI = 600 V)	I_{HV_LEAK}	–	5	40	μA
Consumption in active mode (Vcc = Vboot, fsw = 100 kHz and 1 nF load on both driver outputs)	ICC1	–	4	5	mA
Consumption in inhibition mode (Vcc = Vboot)	ICC2	–	250	400	μA
Vcc current consumption in inhibition mode	ICC3	–	200	–	μA
Vboot current consumption in inhibition mode	ICC4	–	50	–	μA

1. Parameter guaranteed by design.
2. T_{ON} = T_{OFF} + DT
3. Turn−off propagation delay @ Vbridge = 600 V is guaranteed by design.
4. See characterization curve for Δt parameters variation on the full range temperature.
5. Timing diagram definition see: Figure 4, Figure 5 and Figure 6.

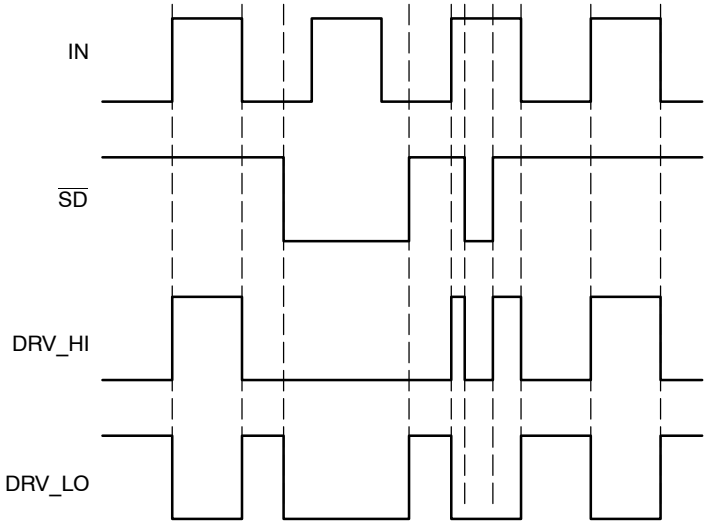


Figure 4. Input/Output Timing Diagram

Note: DRV_HI output is in phase with the input

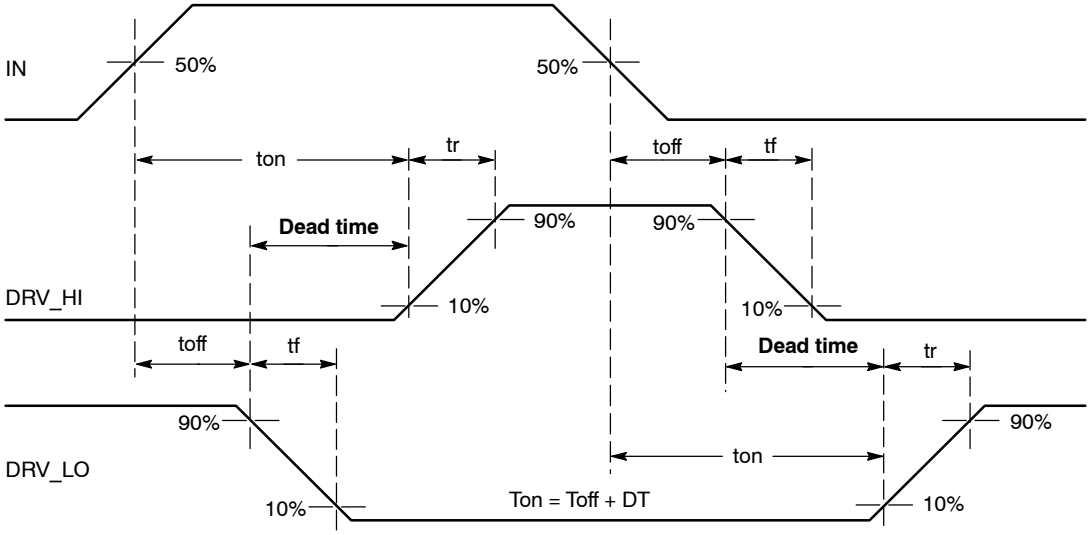


Figure 5. Timing Definitions

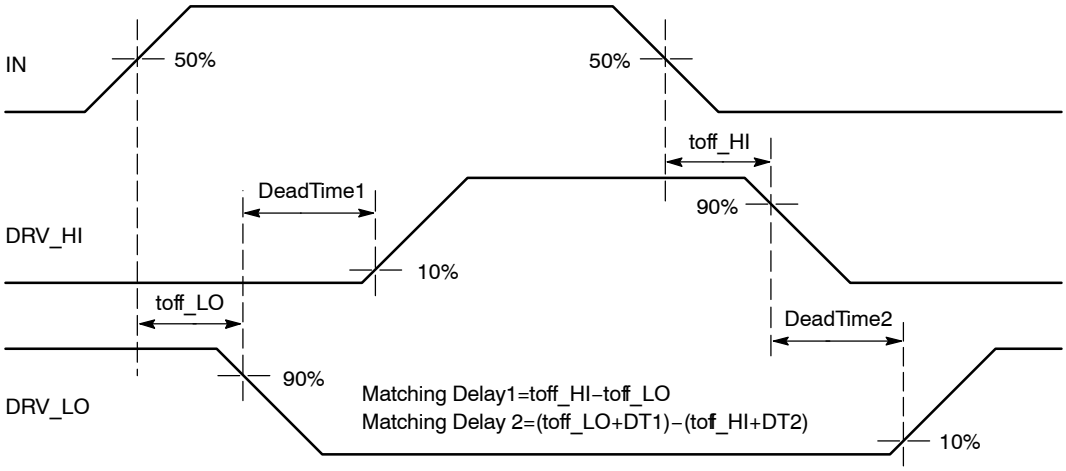


Figure 6. Matching Propagation Delay Definition

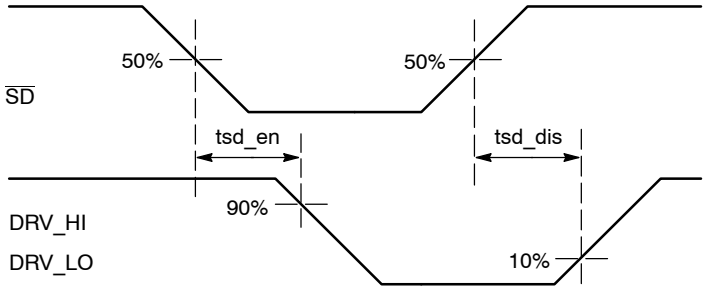


Figure 7. Shutdown Waveform Definition

CHARACTERIZATION CURVES

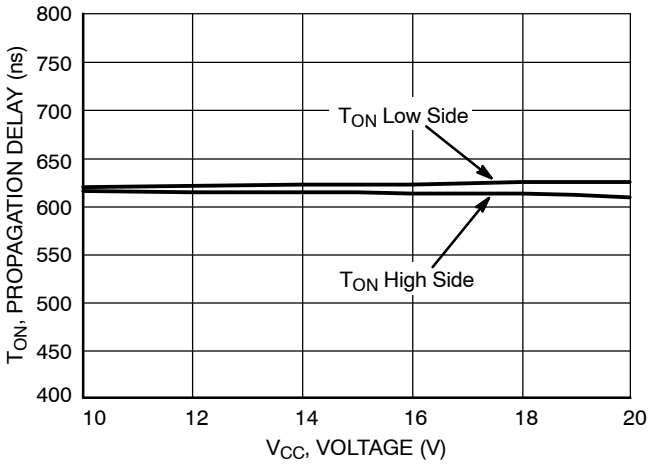


Figure 8. Turn ON Propagation Delay vs. Supply Voltage (V_{CC} = V_{BOOT})

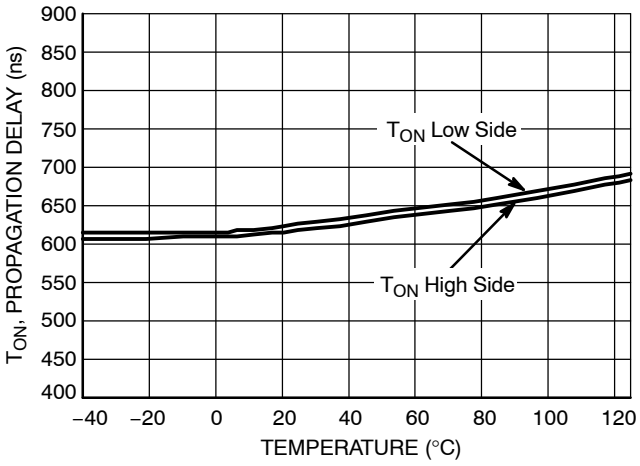


Figure 9. Turn ON Propagation Delay vs. Temperature

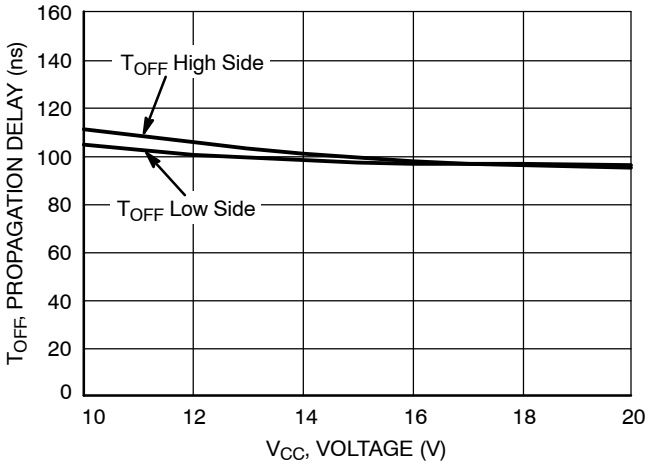


Figure 10. Turn OFF Propagation Delay vs. Supply Voltage (V_{CC} = V_{BOOT})

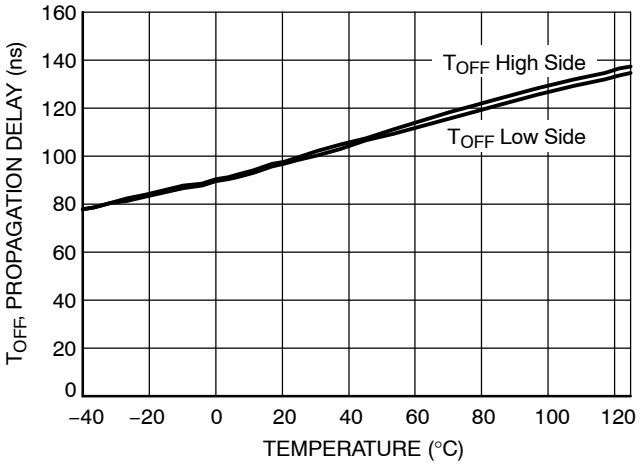


Figure 11. Turn OFF Propagation Delay vs. Temperature

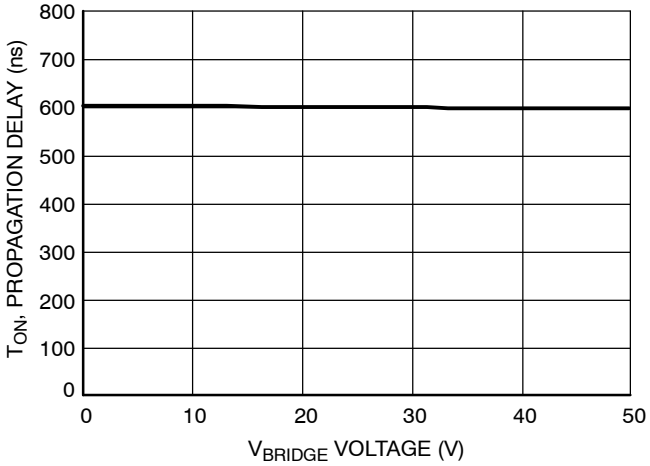


Figure 12. High Side Turn ON Propagation Delay vs. V_{BRIDGE} Voltage (V_{CC} = V_{BOOT})

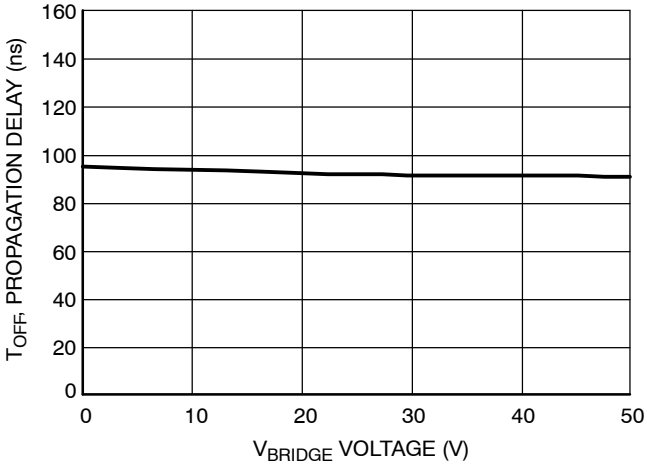


Figure 13. High Side Turn OFF Propagation Delay vs. V_{BRIDGE} Voltage (V_{CC} = V_{BOOT})

CHARACTERIZATION CURVES

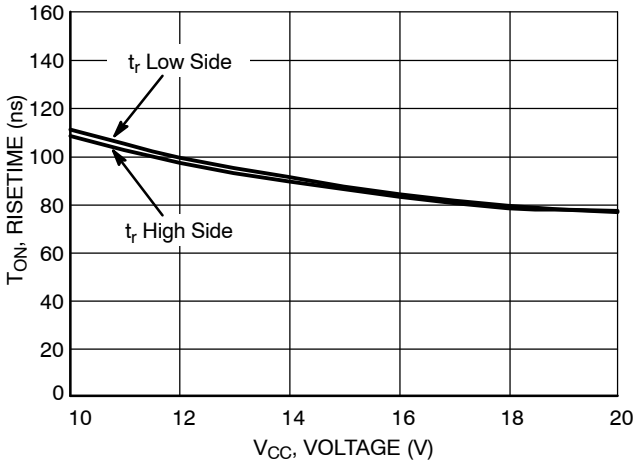


Figure 14. Turn ON Risetime vs. Supply Voltage (V_{CC} = V_{BOOT})

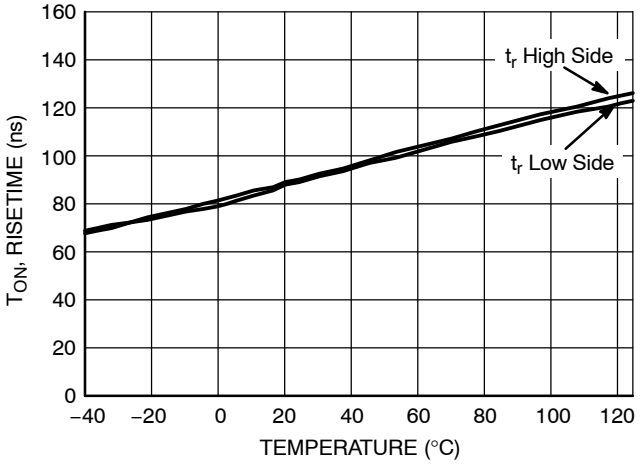


Figure 15. Turn ON Risetime vs. Temperature

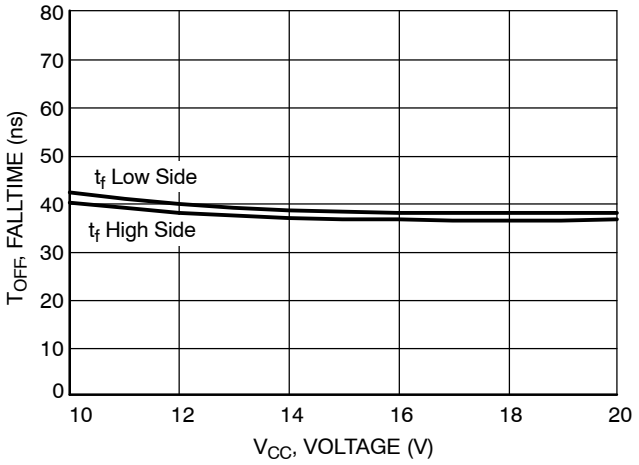


Figure 16. Turn OFF Falltime vs. Supply Voltage (V_{CC} = V_{BOOT})

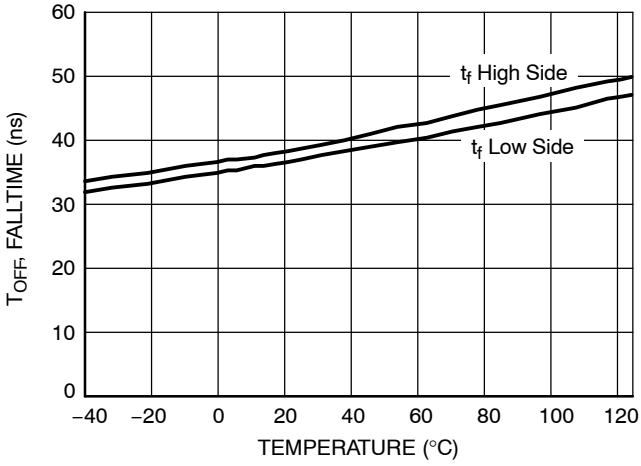


Figure 17. Turn OFF Falltime vs. Temperature

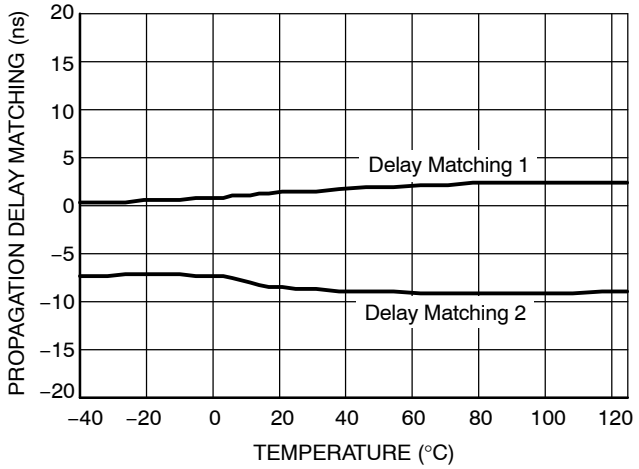


Figure 18. Propagation Delay Matching Between High Side and Low Side Driver vs. Temperature

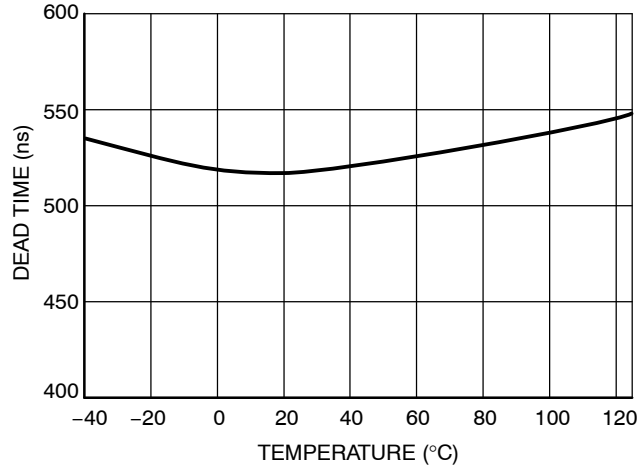


Figure 19. Dead Time vs. Temperature

CHARACTERIZATION CURVES

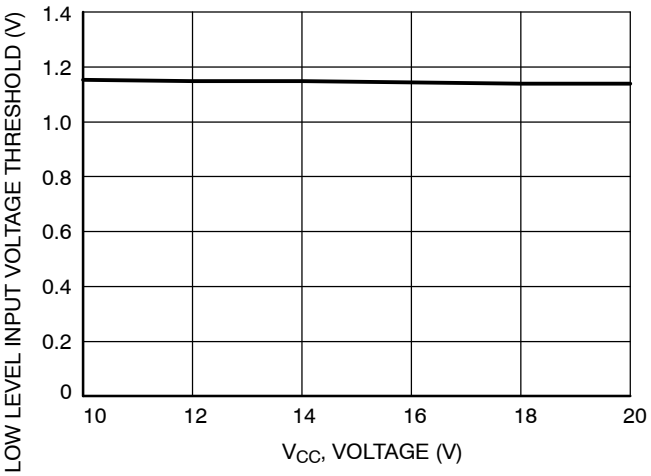


Figure 20. Low Level Input Voltage Threshold vs. Supply Voltage (V_{CC} = V_{BOOT})

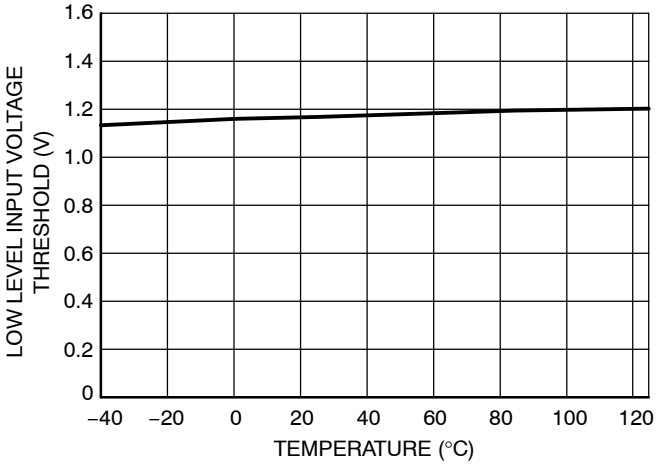


Figure 21. Low Level Input Voltage Threshold vs. Temperature

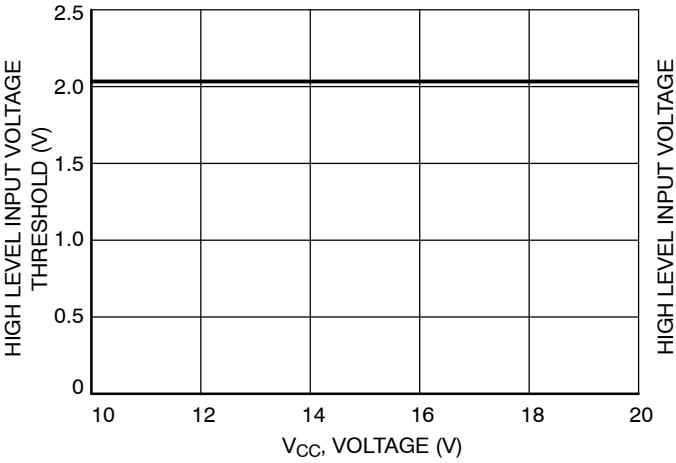


Figure 22. High Level Input Voltage Threshold vs. Supply Voltage (V_{CC} = V_{BOOT})

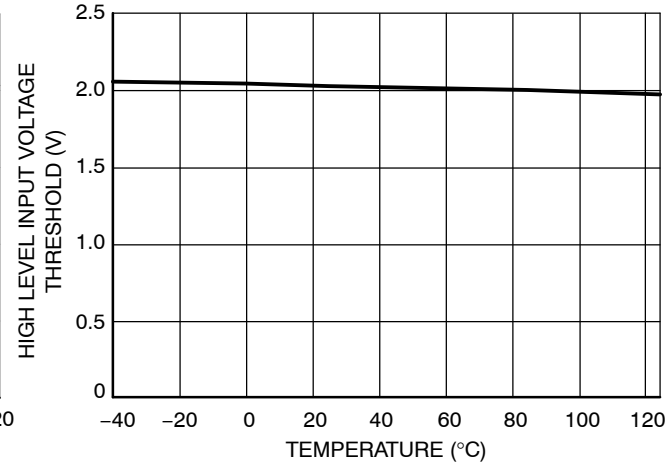


Figure 23. High Level Input Voltage Threshold vs. Temperature

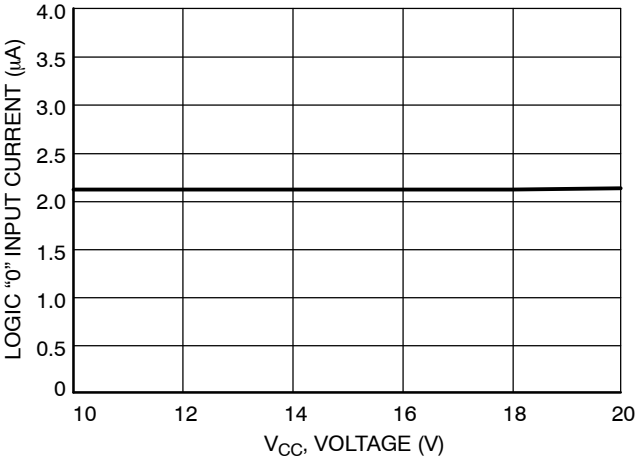


Figure 24. Logic "0" Input Current vs. Supply Voltage (V_{CC} = V_{BOOT})

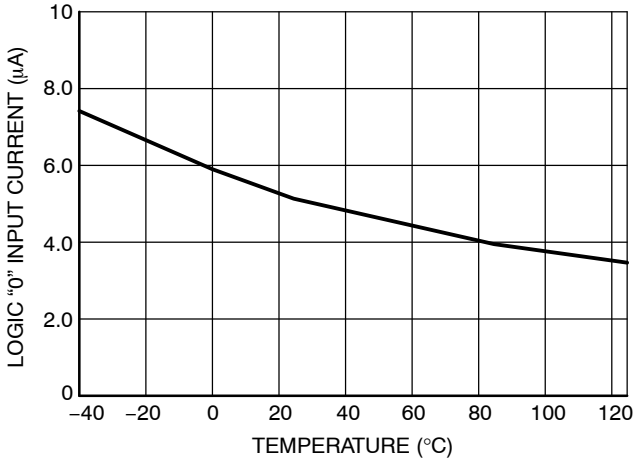


Figure 25. Logic "0" Input Current vs. Temperature

CHARACTERIZATION CURVES

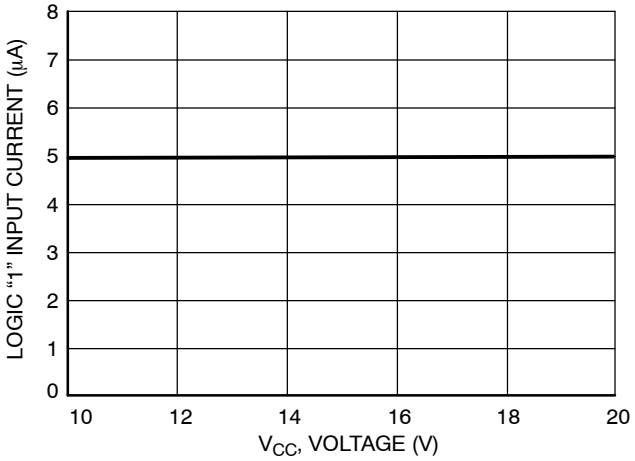


Figure 26. Logic "1" Input Current vs. Supply Voltage (V_{CC} = V_{BOOT})

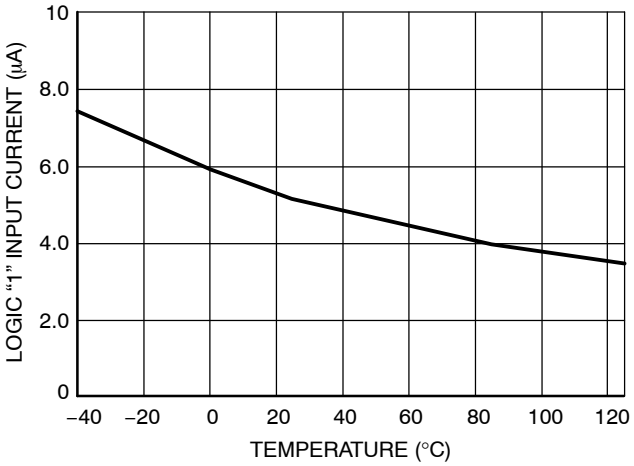


Figure 27. Logic "1" Input Current vs. Temperature

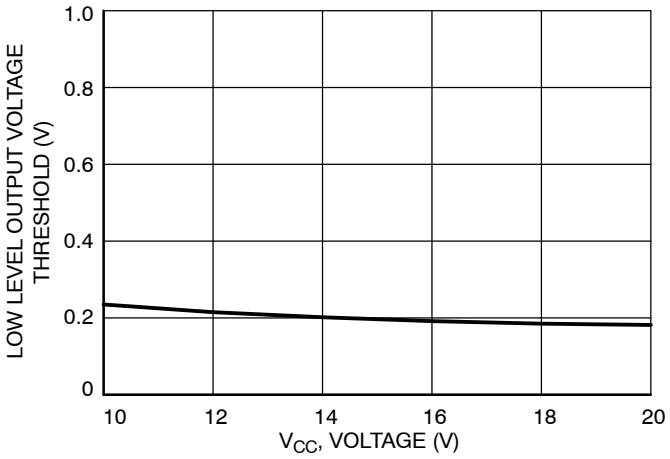


Figure 28. Low Level Output Voltage vs. Supply Voltage (V_{CC} = V_{BOOT})

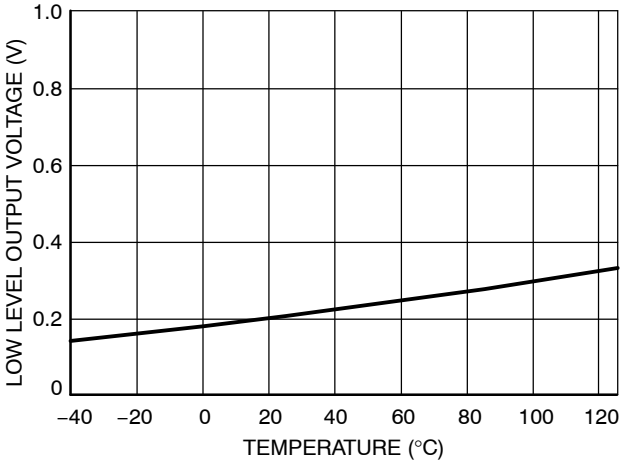


Figure 29. Low Level Output Voltage vs. Temperature

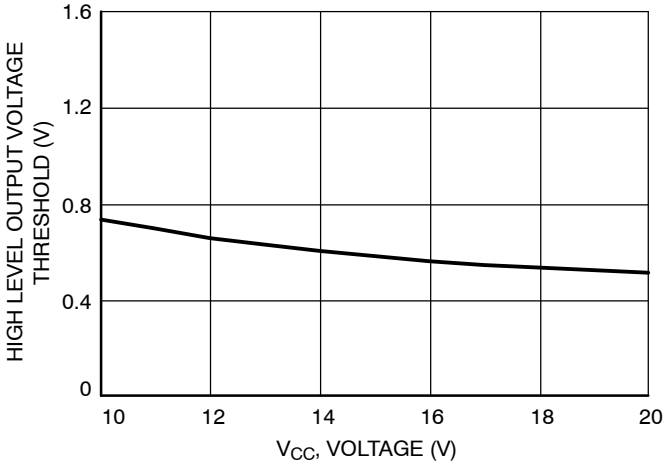


Figure 30. High Level Output Voltage vs. Supply Voltage (V_{CC} = V_{BOOT})

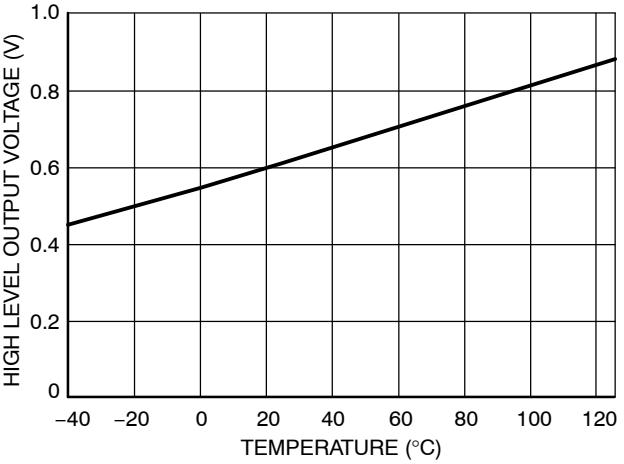


Figure 31. High Level Output Voltage vs. Temperature

CHARACTERIZATION CURVES

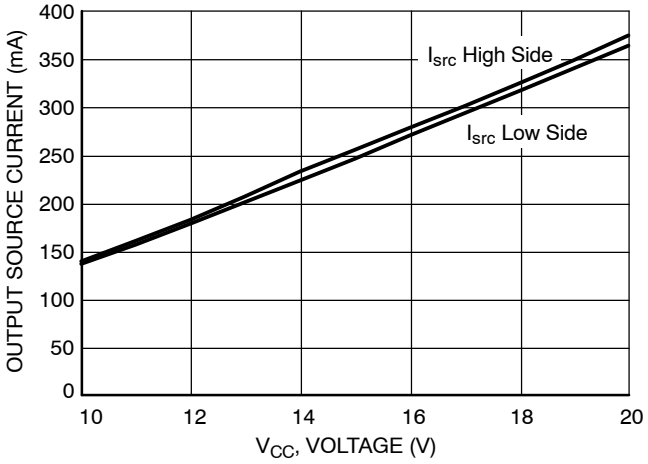


Figure 32. Output Source Current vs. Supply Voltage (V_{CC} = V_{BOOT})

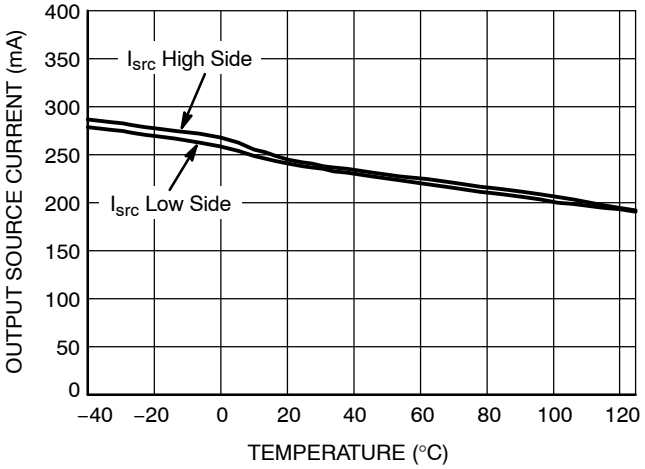


Figure 33. Output Source Current vs. Temperature

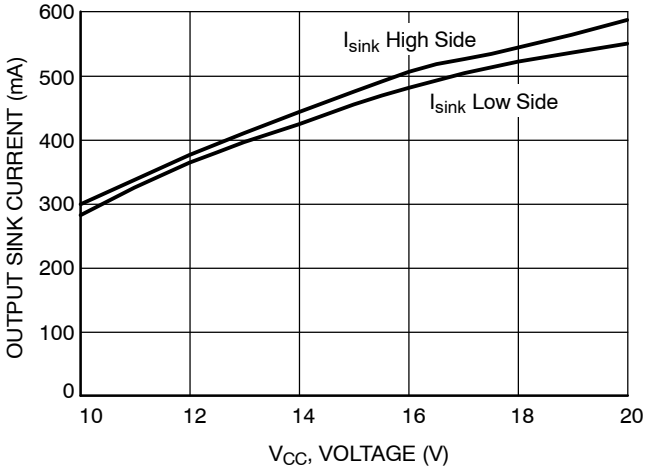


Figure 34. Output Sink Current vs. Supply Voltage (V_{CC} = V_{BOOT})

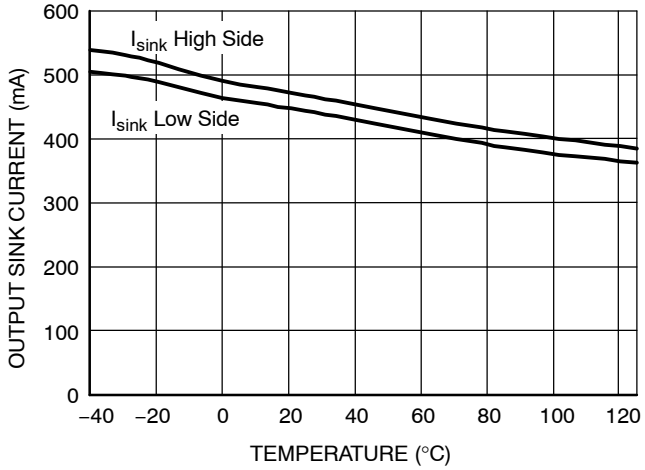


Figure 35. Output Sink Current vs. Temperature

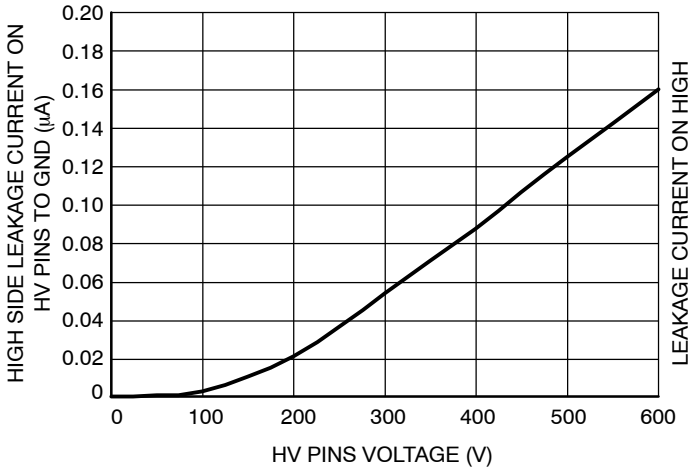


Figure 36. Leakage Current on High Voltage Pins (600 V) to Ground vs. V_{BRIDGE} Voltage (V_{BRIDGE} = V_{BOOT} = V_{DRV_HI})

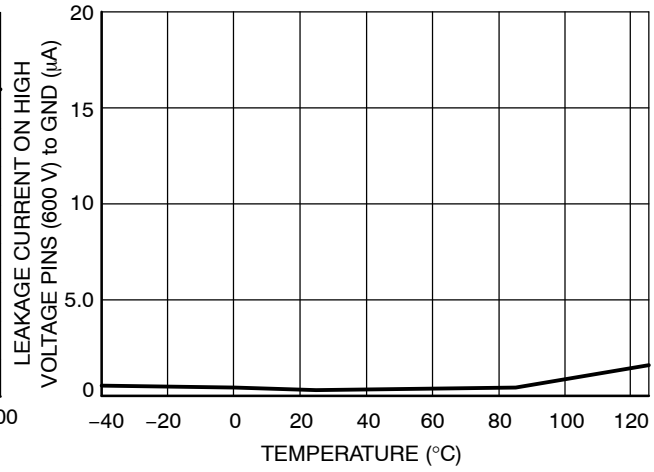


Figure 37. Leakage Current on High Voltage Pins (600 V) to Ground vs. Temperature (V_{BRIDGE} = V_{BOOT} = V_{DRv_HI} = 600 V)

CHARACTERIZATION CURVES

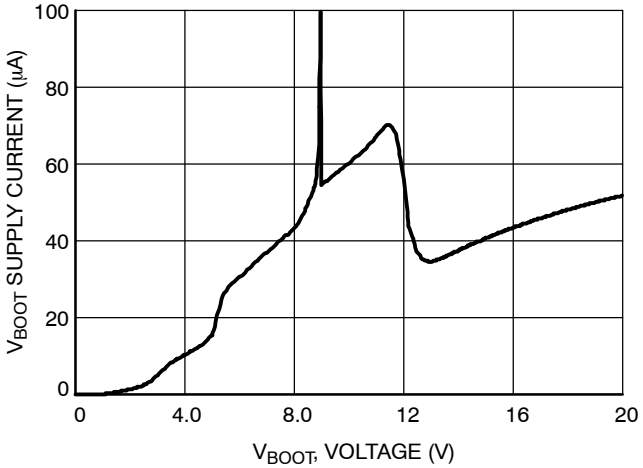


Figure 38. V_{BOOT} Supply Current vs. Bootstrap Supply Voltage (V_{CC} = V_{BOOT})

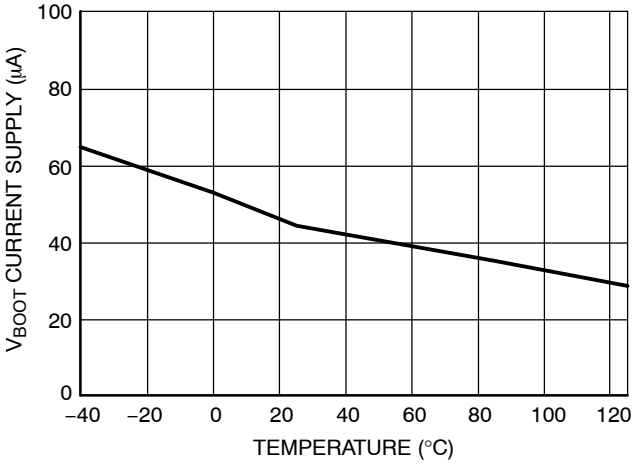


Figure 39. V_{BOOT} Supply Current vs. Temperature

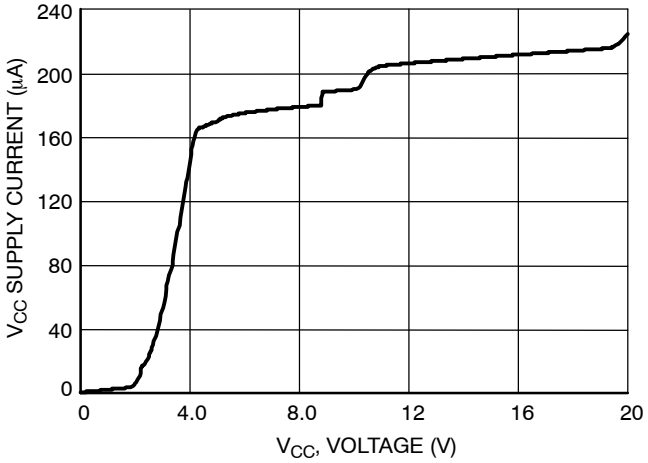


Figure 40. V_{CC} Supply Current vs. V_{CC} Supply Voltage (V_{CC} = V_{BOOT})

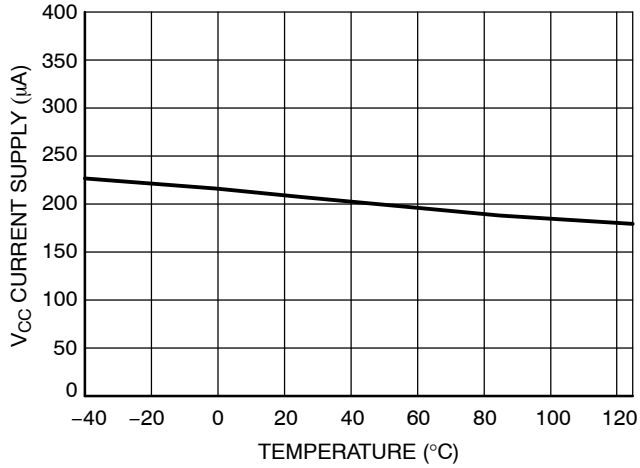


Figure 41. V_{CC} Supply Current vs. Temperature

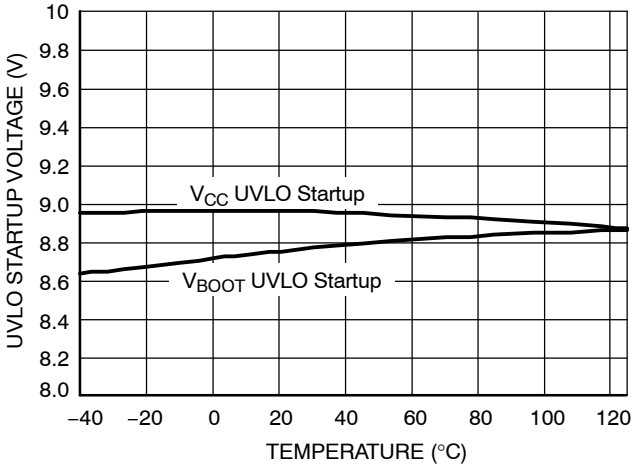


Figure 42. UVLO Startup Voltage vs. Temperature

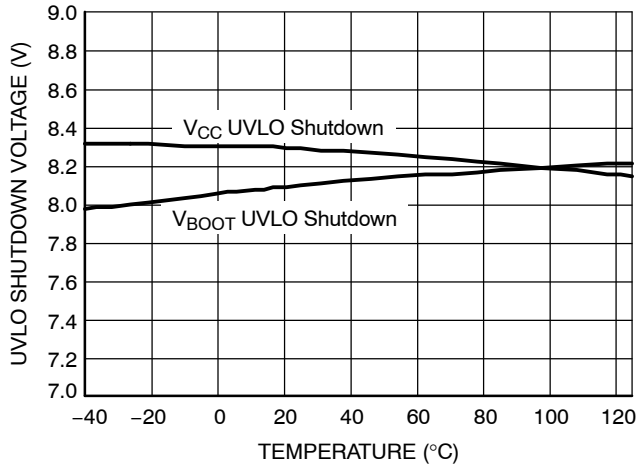


Figure 43. UVLO Shutdown Voltage vs. Temperature

CHARACTERIZATION CURVES

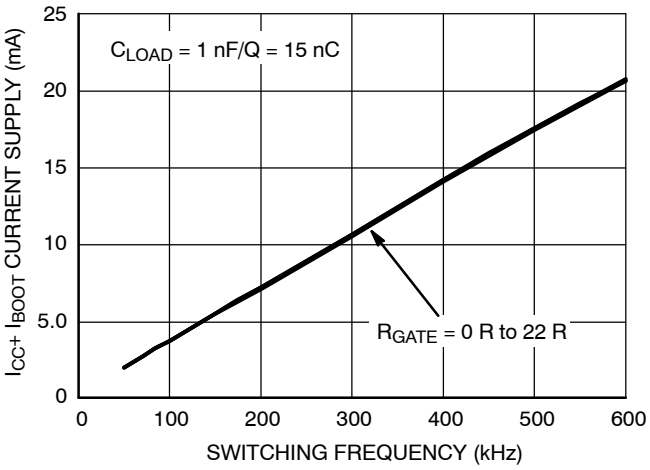


Figure 44. I_{CC1} Consumption vs. Switching Frequency with 15 nC Load on Each Driver @ V_{CC} = 15 V

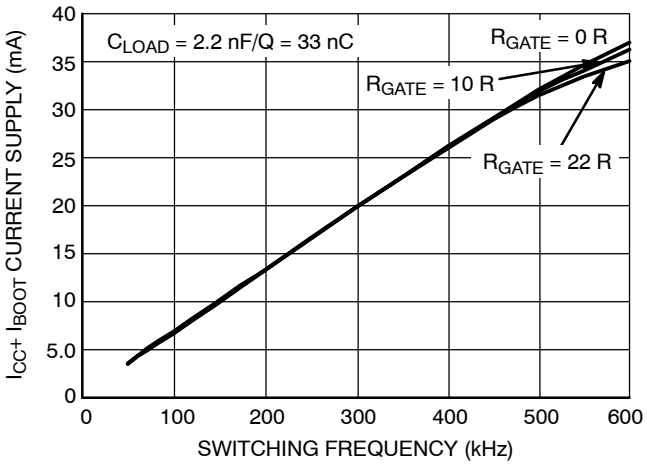


Figure 45. I_{CC1} Consumption vs. Switching Frequency with 33 nC Load on Each Driver @ V_{CC} = 15 V

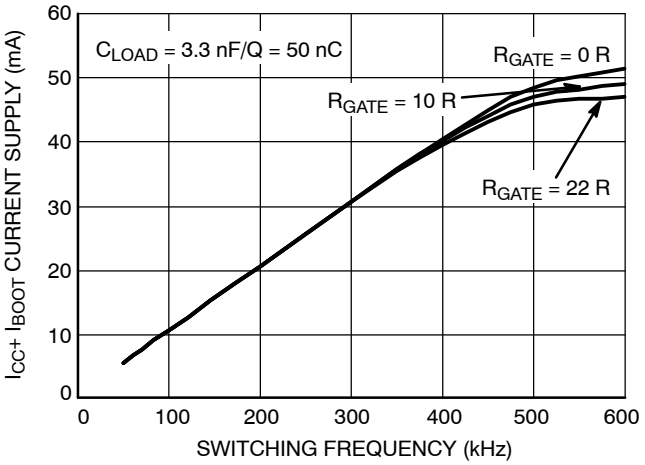


Figure 46. I_{CC1} Consumption vs. Switching Frequency with 50 nC Load on Each Driver @ V_{CC} = 15 V

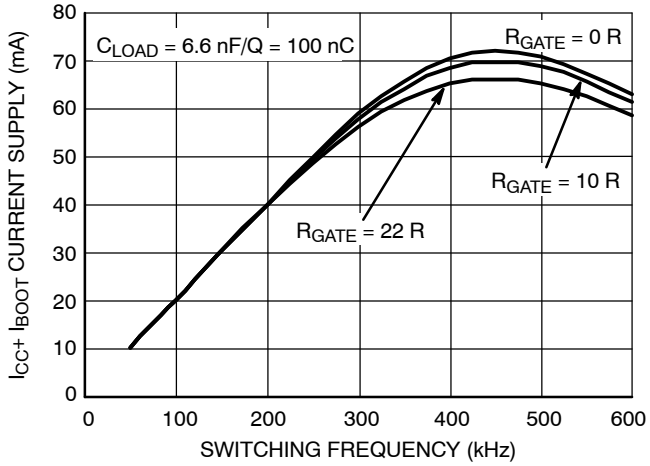
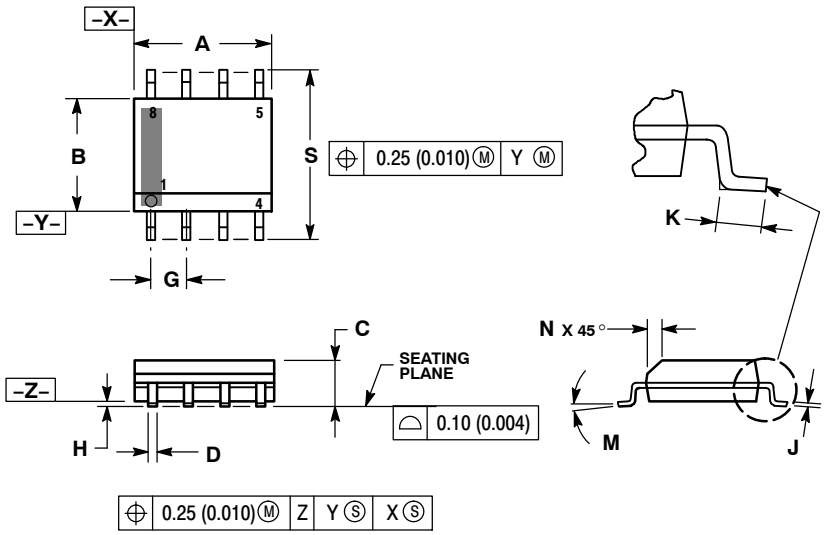


Figure 47. I_{CC1} Consumption vs. Switching Frequency with 100 nC Load on Each Driver @ V_{CC} = 15 V

PACKAGE DIMENSIONS

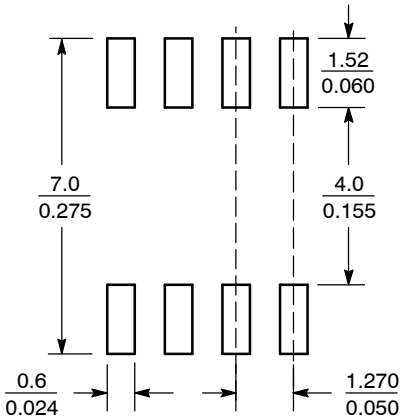
SOIC−8 NB
CASE 751−07
ISSUE AJ



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.

	MILLIMETERS		INCHES	
DIM	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*

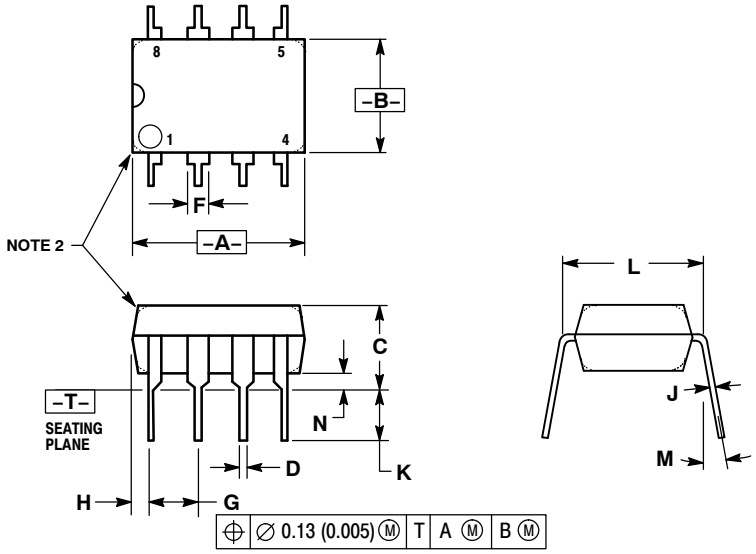


SCALE 6:1 (mm / inches)

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

PACKAGE DIMENSIONS

8 LEAD PDIP
CASE 626−05
ISSUE L



NOTES:
1. DIMENSION L TO CENTER OF LEAD WHEN FORMED PARALLEL.
2. PACKAGE CONTOUR OPTIONAL (ROUND OR SQUARE CORNERS).
3. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.

	MILLIMETERS		INCHES	
DIM	MIN	MAX	MIN	MAX
A	9.40	10.16	0.370	0.400
B	6.10	6.60	0.240	0.260
C	3.94	4.45	0.155	0.175
D	0.38	0.51	0.015	0.020
F	1.02	1.78	0.040	0.070
G	2.54 BSC		0.100 BSC	
H	0.76	1.27	0.030	0.050
J	0.20	0.30	0.008	0.012
K	2.92	3.43	0.115	0.135
L	7.62 BSC		0.300 BSC	
M	---	10°	---	10°
N	0.76	1.01	0.030	0.040

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