NCP5304

High Voltage, High and Low Side Driver

The NCP5304 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. The driver works with 2 independent inputs with cross conduction protection.

Features

- High Voltage Range: up to 600 V
- dV/dt Immunity ±50 V/nsec
- Negative Current Injection Characterized Over the Temperature Range
- 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
- Outputs in Phase with the Inputs
- Cross Conduction Protection with 100 ns Internal Fixed Dead Time
- 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
- Full−bridge Converters

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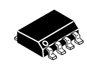
MARKING DIAGRAMS



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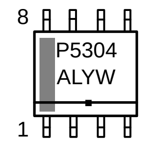
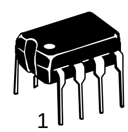
SOIC−8
D SUFFIX
CASE 751





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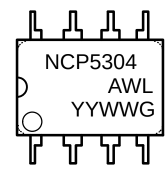
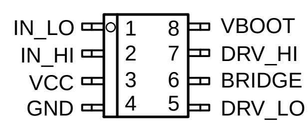
PDIP−8
P SUFFIX
CASE 626



NCP5304	= 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†
NCP5304PG	PDIP−8 (Pb−Free)	50 Units / Rail
NCP5304DR2G	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.

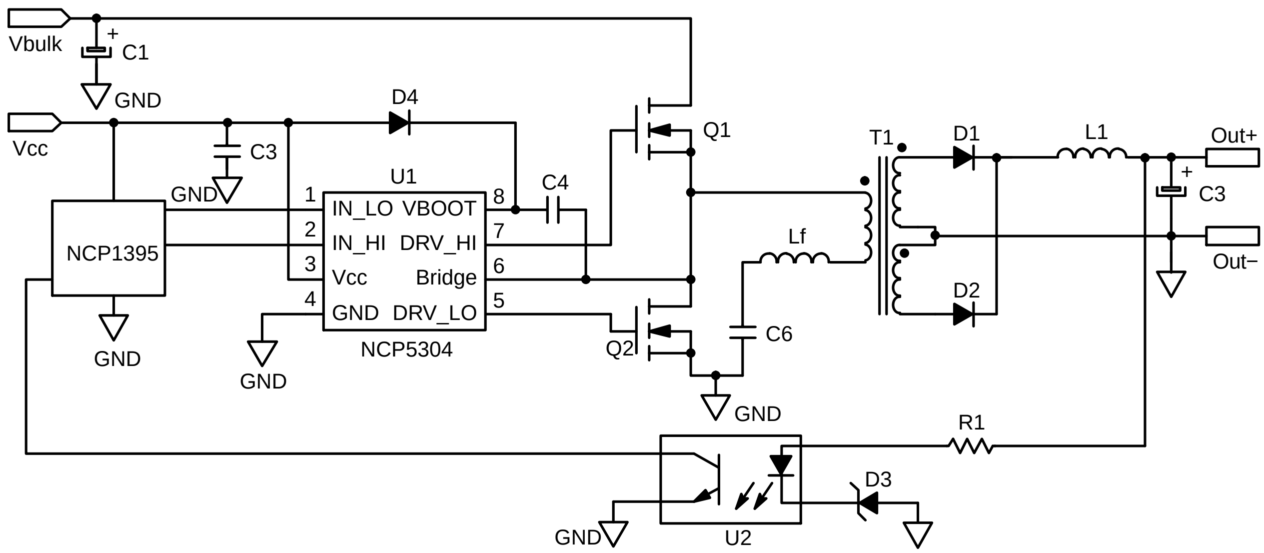


Figure 1. Typical Application Resonant Converter (LLC type)

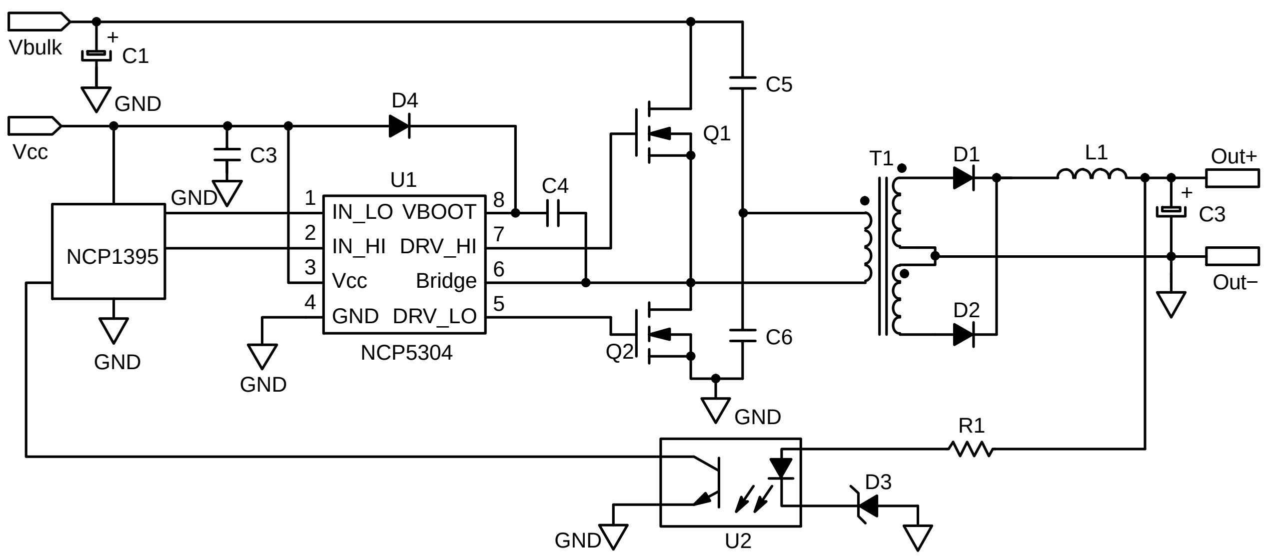


Figure 2. Typical Application Half Bridge Converter

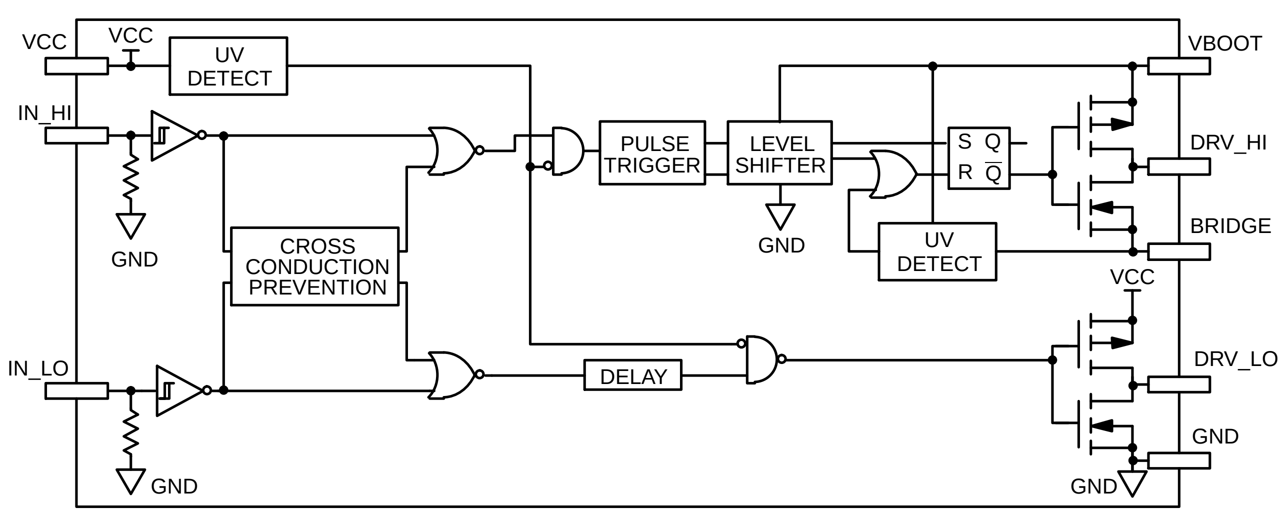


Figure 3. Detailed Block Diagram

PIN DESCRIPTIONS

Pin No.	Pin Name	Pin Function
1	IN_LO	Logic Input for Low side driver output in phase
2	IN_HI	Logic Input for High side driver output in phase
3	VCC	Low side and main power supply
4	GND	Ground
5	DRV_LO	Low side gate drive output
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: IV_{CC_max} = 5 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 (see characterization curves for detailed results)	−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_XX}	Inputs IN_HI, IN_LO	−1.0 to V_{CC} + 0.3	V
	ESD Capability: − HBM model (all pins except pins 6−7−8 in 8 pins package or 11−12−13 in 14 pins package) − Machine model (all pins except pins 6−7−8 in 8 pins package or 11−12−13 in 14 pins package)	 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_{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.

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 $V_{DRV} = V_{CC}$, 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)	t_{ON}	–	100	170	ns
Turn−off propagation delay (Vbridge = 0 V or 50 V) (Note 2)	t_{OFF}	–	100	170	ns
Output voltage rise time (from 10% to 90% @ V_{CC} = 15 V) with 1 nF load	tr	–	85	160	ns
Output voltage fall time (from 90% to 10% @V_{CC} = 15 V) with 1 nF load	tf	–	35	75	ns
Propagation delay matching between the High side and the Low side @ 25°C (Note 3)	Δt	–	20	35	ns
Internal fixed dead time (Note 4)	DT	65	100	190	ns
Minimum input width that changes the output	t_{PW1}	–	–	50	ns
Maximum input width that does not change the output	t_{PW2}	20	–	–	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_XX} = 5 V @ 25°C	I_{IN+}	–	5	25	μA
Logic “0” input bias current @ V_{IN_XX} = 0 V @ 25°C	$I_{IN−}$	–	–	2.0	μA
SUPPLY SECTION					
V_{CC} UV Start−up voltage threshold	VCC_stup	8.0	8.9	9.9	V
V_{CC} UV Shut−down voltage threshold	VCC_shtdwn	7.3	8.2	9.1	V
Hysteresis on V_{CC}	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	9.9	V
Vboot UV Shut−down voltage threshold	Vboot_shtdwn	7.3	8.2	9.1	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 (V_{CC} = Vboot, fsw = 100 kHz and 1 nF load on both driver outputs)	ICC1	–	4	5	mA
Consumption in inhibition mode (V_{CC} = Vboot)	ICC2	–	250	400	μA
V_{CC} current consumption in inhibition mode	ICC3	–	200	–	μA
Vboot current consumption in inhibition mode	ICC4	–	50	–	μA

1. Parameter guaranteed by design
2. Turn−off propagation delay @ Vbridge = 600 V is guaranteed by design
3. See characterization curve for Δt parameters variation on the full range temperature.
4. Timing diagram definition see Figure 7.
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.

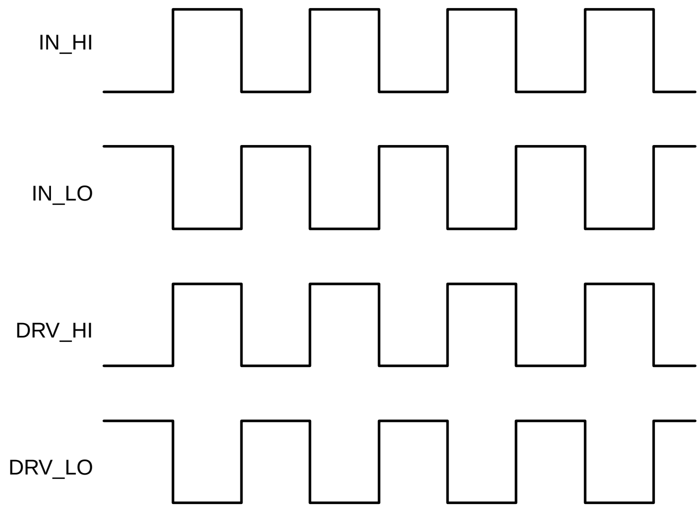


Figure 4. Input/Output Timing Diagram

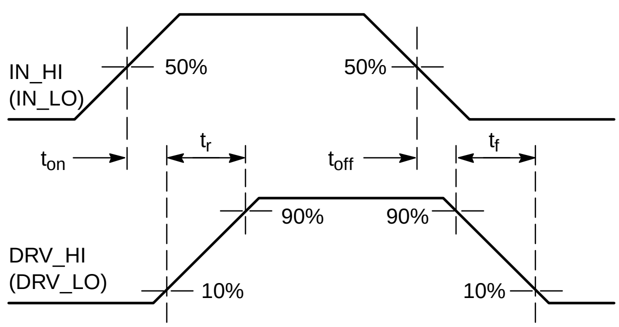


Figure 5. Propagation Delay and Rise / Fall Time Definition

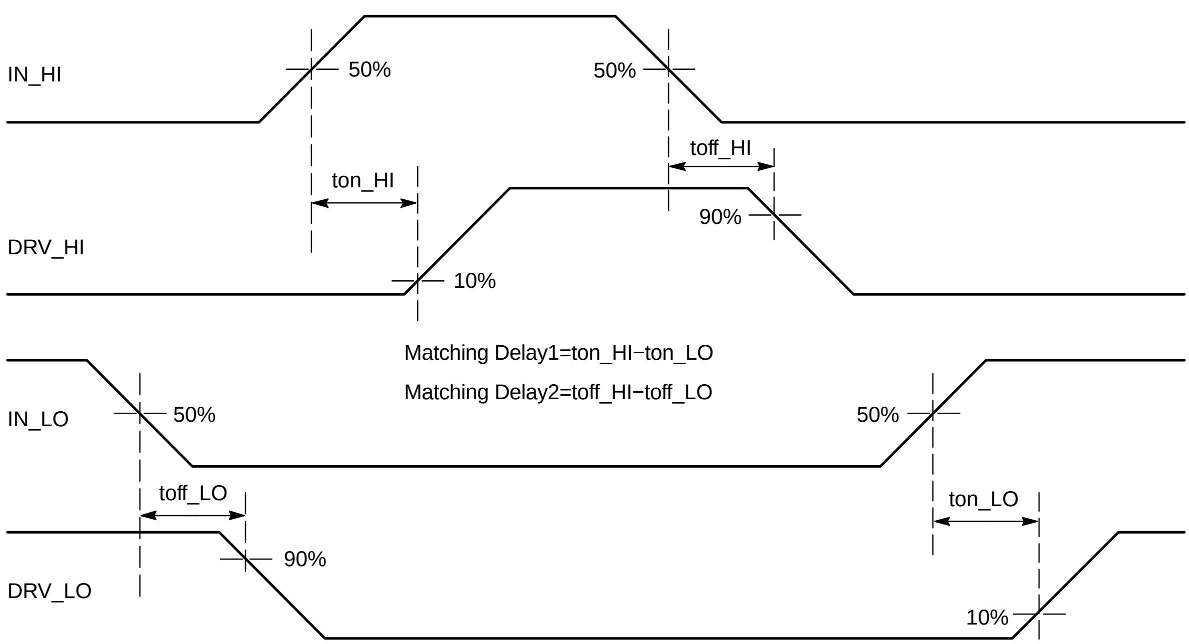


Figure 6. Matching Propagation Delay

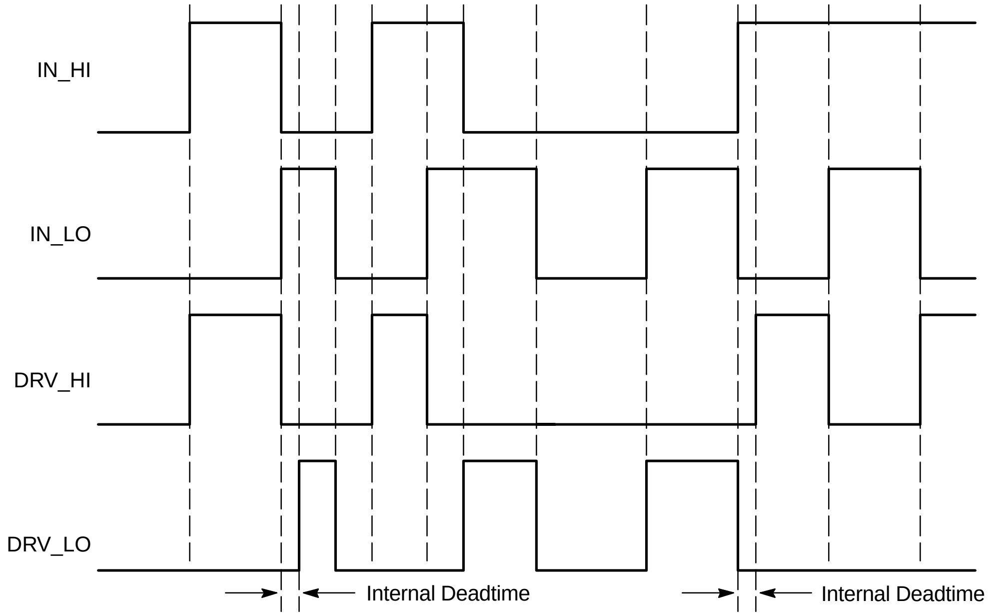


Figure 7. Input/Output Cross Conduction Output Protection Timing Diagram

CHARACTERIZATION CURVES

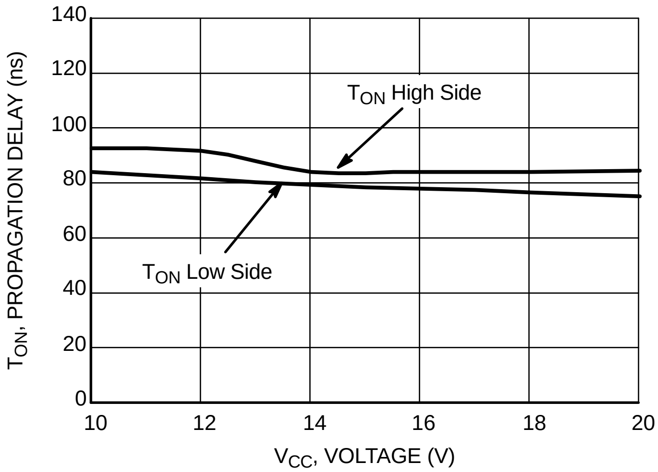


Figure 8. Turn ON Propagation Delay vs. Supply Voltage (V_{CC} = V_{BOOT})

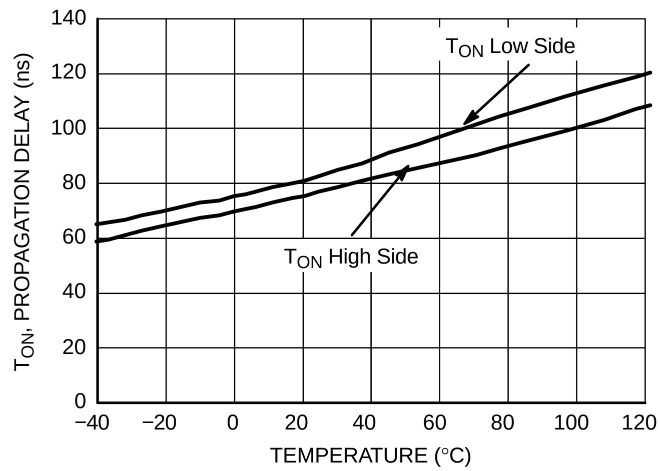


Figure 9. Turn ON Propagation Delay vs. Temperature

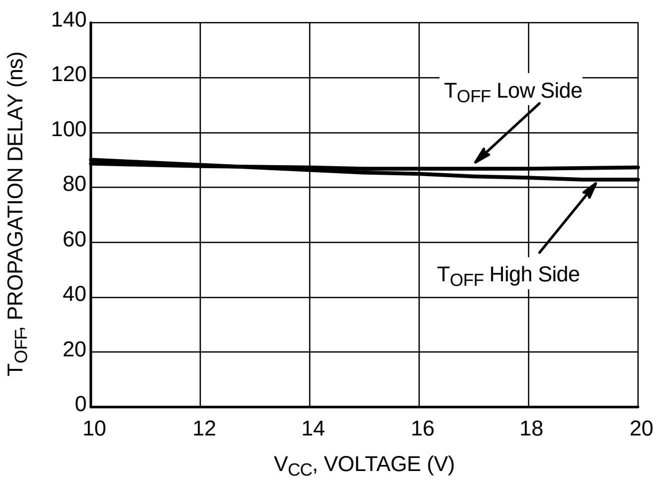


Figure 10. Turn OFF Propagation Delay vs. Supply Voltage (V_{CC} = V_{BOOT})

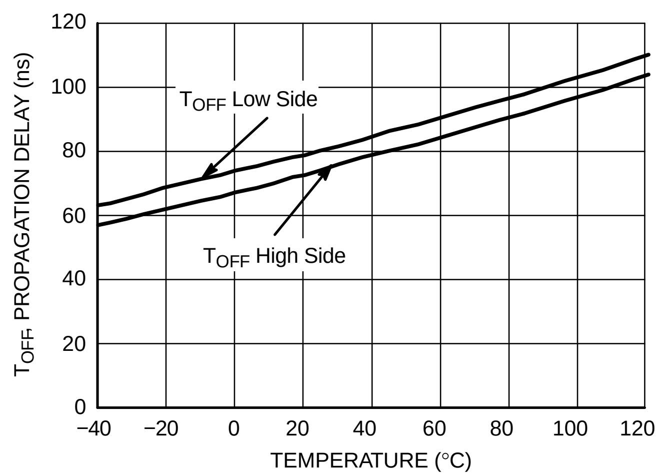


Figure 11. Turn OFF Propagation Delay vs. Temperature

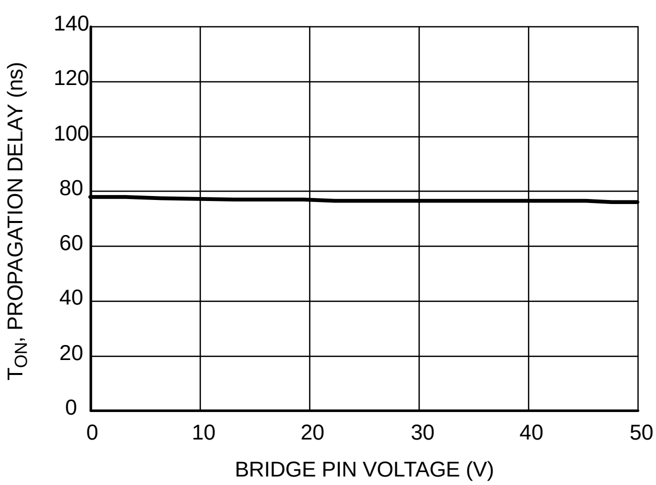


Figure 12. High Side Turn ON Propagation Delay vs. VBRIDGE Voltage

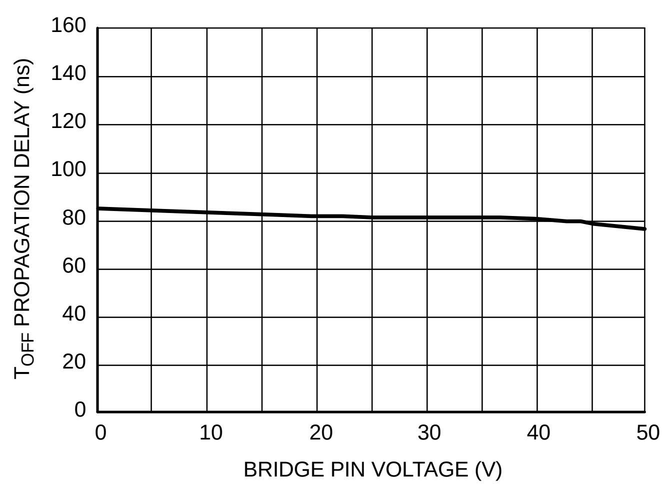


Figure 13. High Side Turn OFF Propagation Delay vs. VBRIDGE Voltage

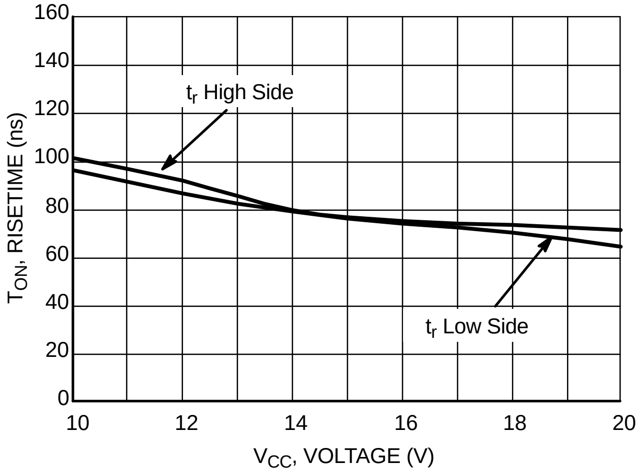


Figure 14. Turn ON Risetime vs. Supply Voltage ($V_{CC} = V_{BOOT}$)

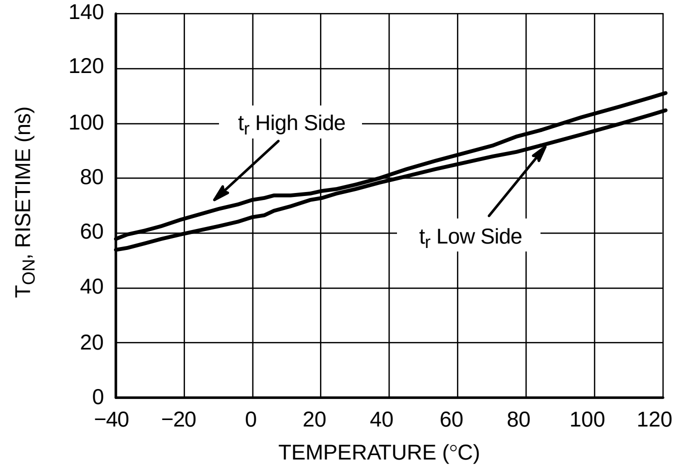


Figure 15. Turn ON Risetime vs. Temperature

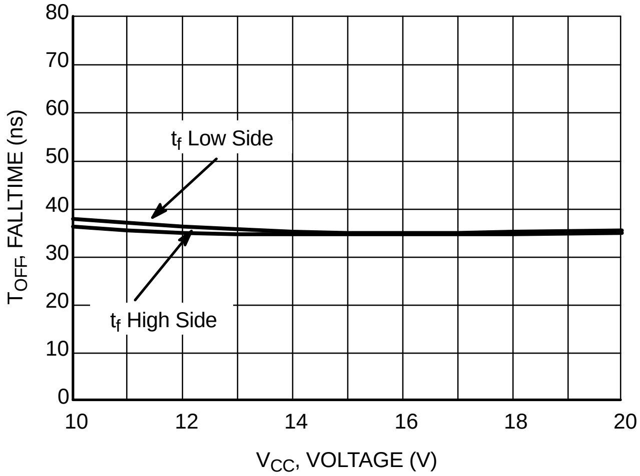


Figure 16. Turn OFF Falltime vs. Supply Voltage ($V_{CC} = V_{BOOT}$)

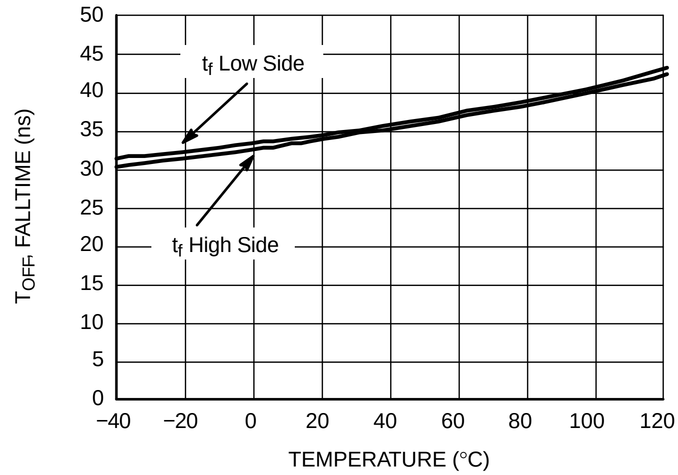


Figure 17. Turn OFF Falltime vs. Temperature

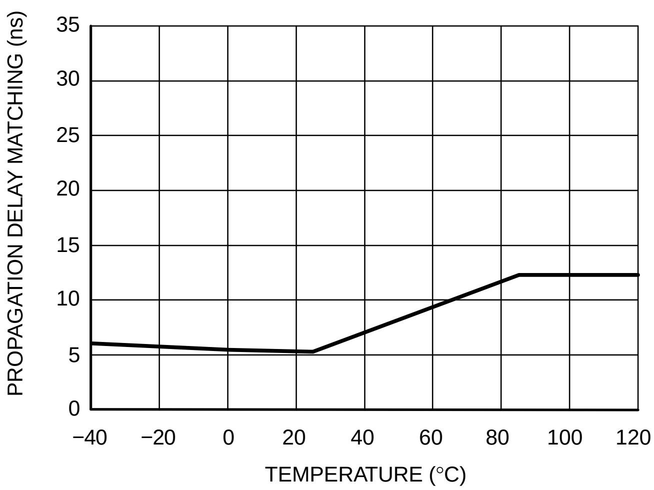


Figure 18. Propagation Delay Matching Between High Side and Low Side Driver vs. Temperature

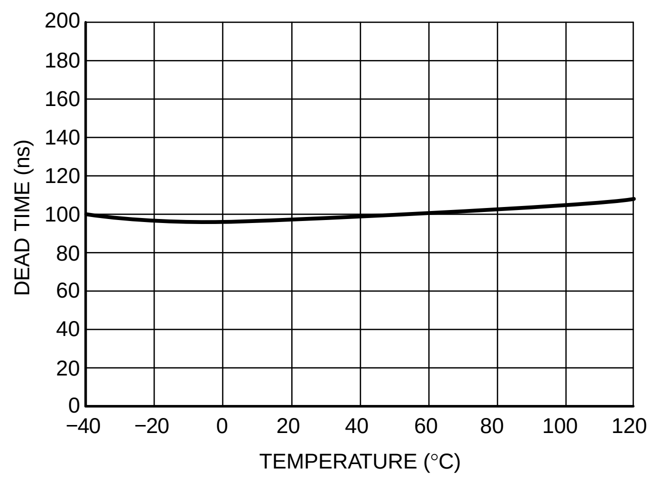


Figure 19. Dead Time vs. Temperature

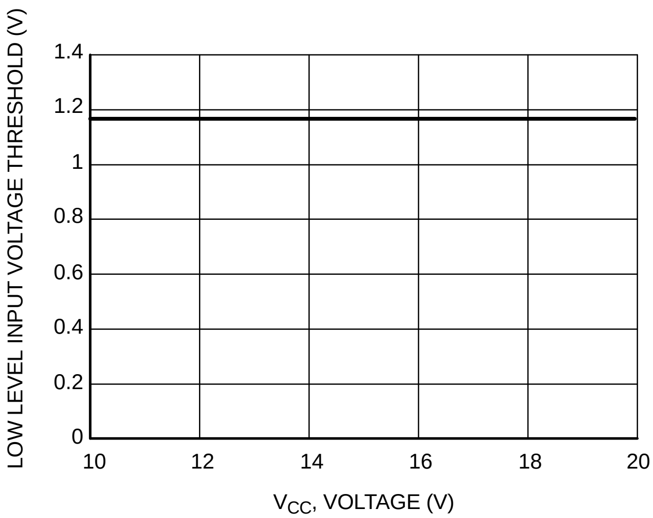


Figure 20. Low Level Input Voltage Threshold vs. Supply Voltage ($V_{CC} = V_{BOOT}$)

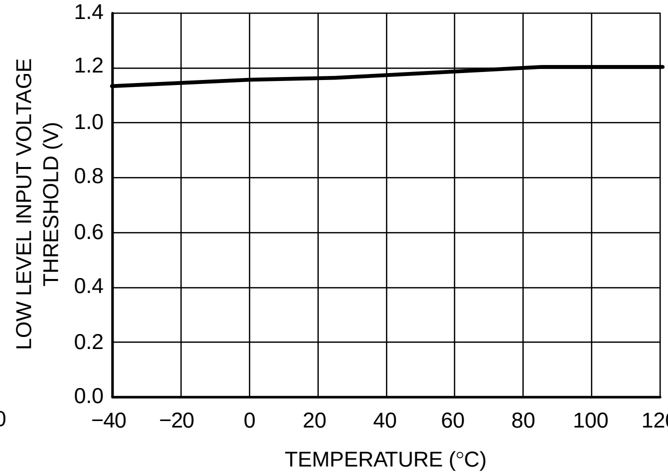


Figure 21. Low Level Input Voltage Threshold vs. Temperature

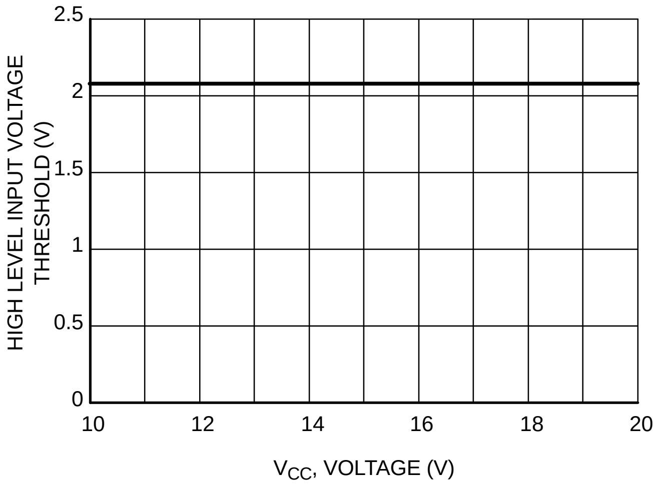


Figure 22. High Level Input Voltage Threshold vs. Supply Voltage ($V_{CC} = V_{BOOT}$)

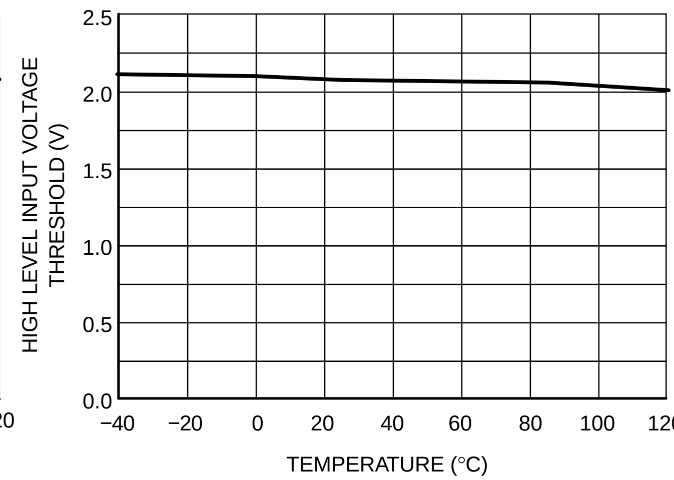


Figure 23. High Level Input Voltage Threshold vs. Temperature

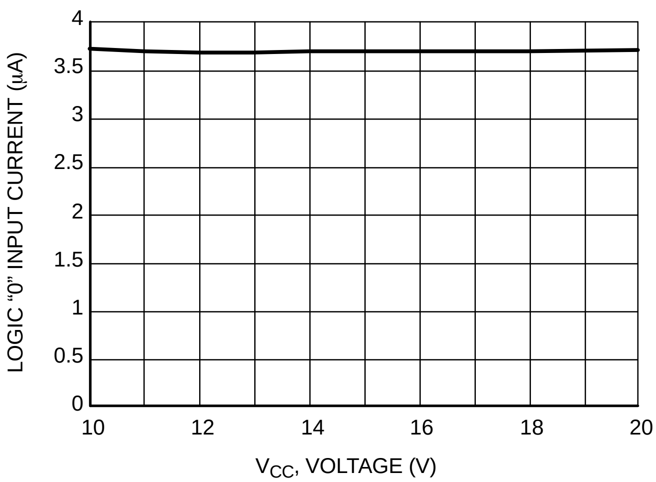


Figure 24. Logic "0" Input Current vs. Supply Voltage ($V_{CC} = V_{BOOT}$)

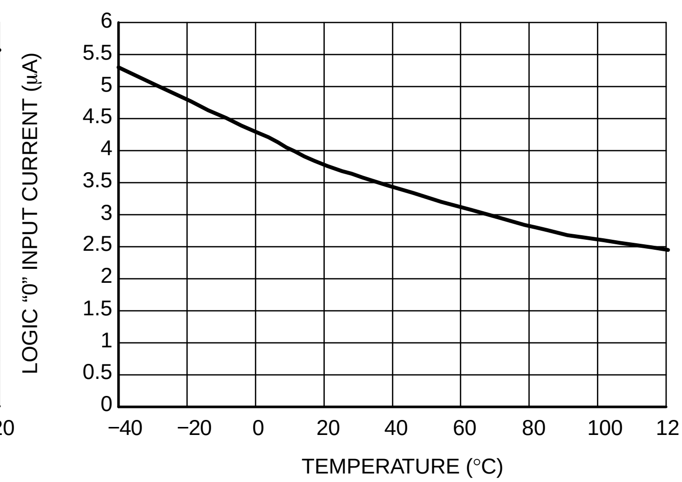


Figure 25. Logic "0" Input Current vs. Temperature

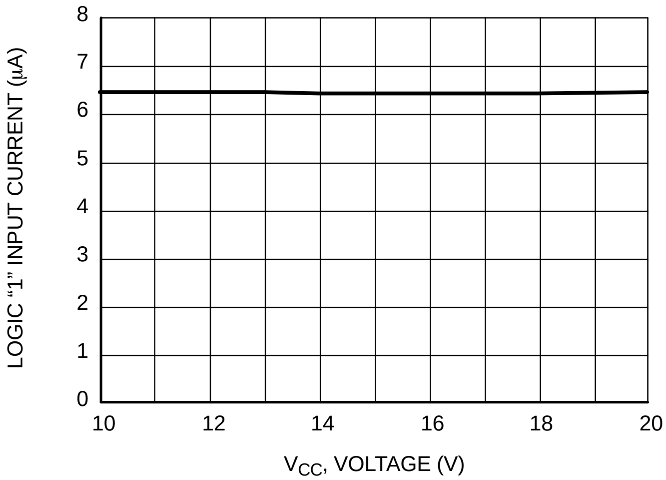


Figure 26. Logic "1" Input Current vs. Supply Voltage ($V_{CC} = V_{BOOT}$)

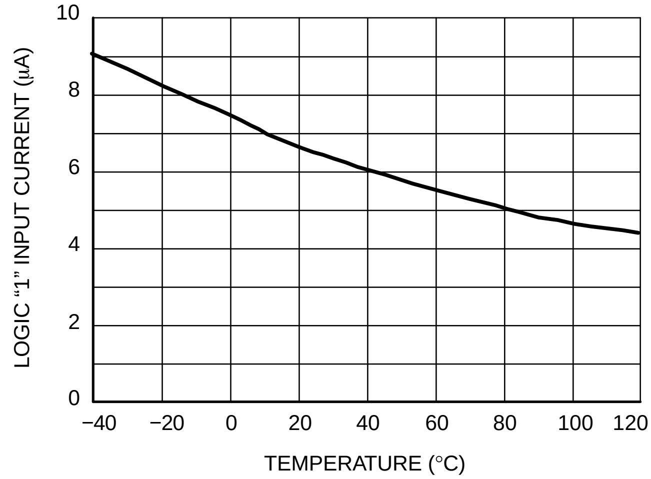


Figure 27. Logic "1" Input Current vs. Temperature

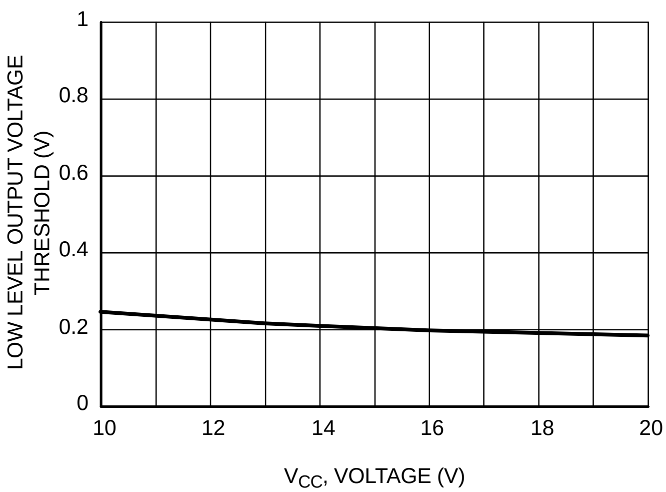


Figure 28. Low Level Output Voltage vs. Supply Voltage ($V_{CC} = V_{BOOT}$)

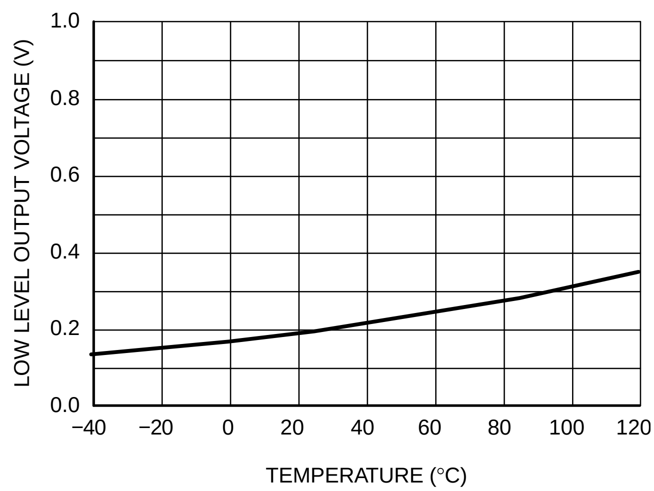


Figure 29. Low Level Output Voltage vs. Temperature

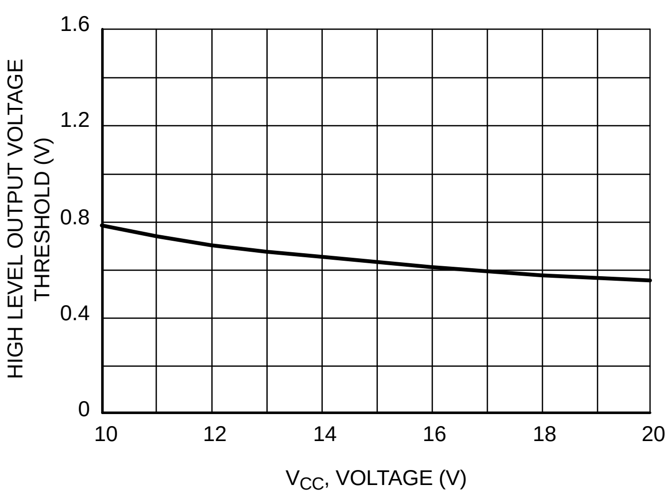


Figure 30. High Level Output Voltage vs. Supply Voltage ($V_{CC} = V_{BOOT}$)

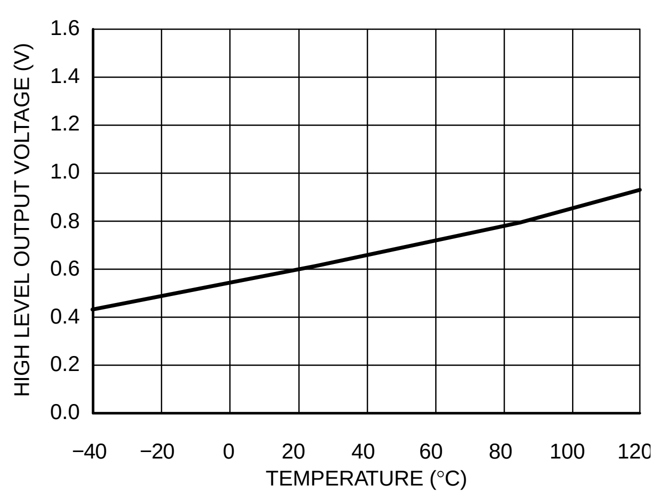


Figure 31. High Level Output Voltage vs. Temperature

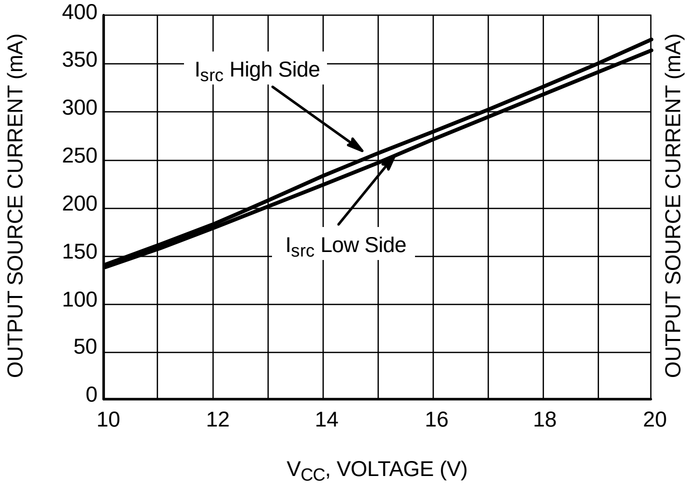


Figure 32. Output Source Current vs. Supply Voltage ($V_{CC} = V_{BOOT}$)

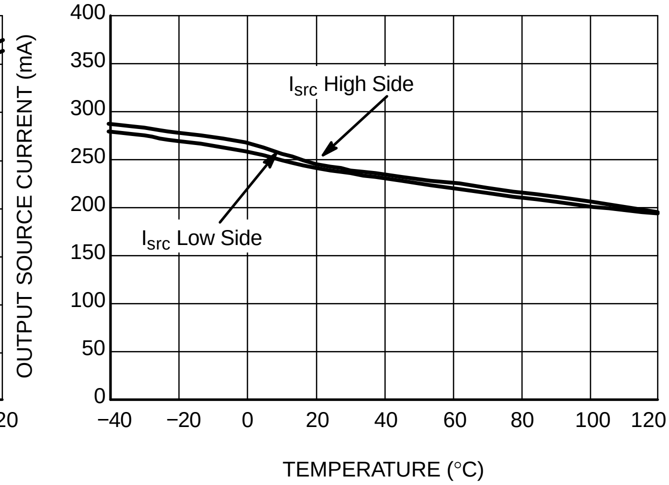


Figure 33. Output Source Current vs. Temperature

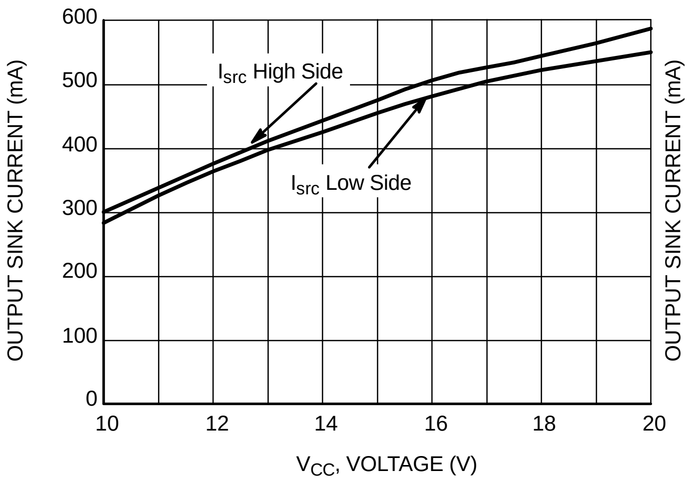


Figure 34. Output Sink Current vs. Supply Voltage ($V_{CC} = V_{BOOT}$)

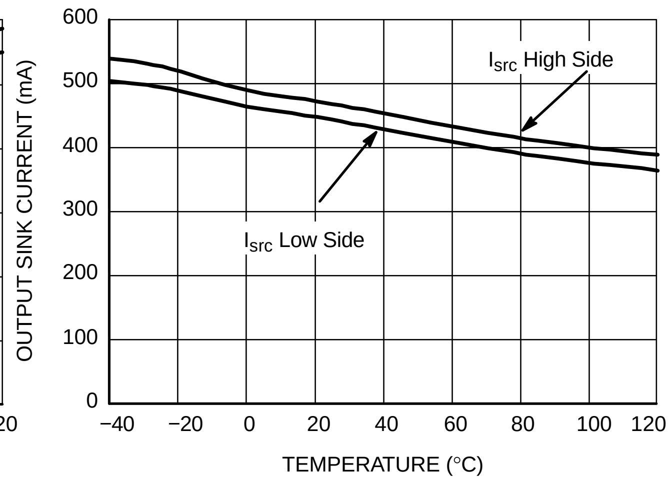


Figure 35. Output Sink Current vs. Temperature

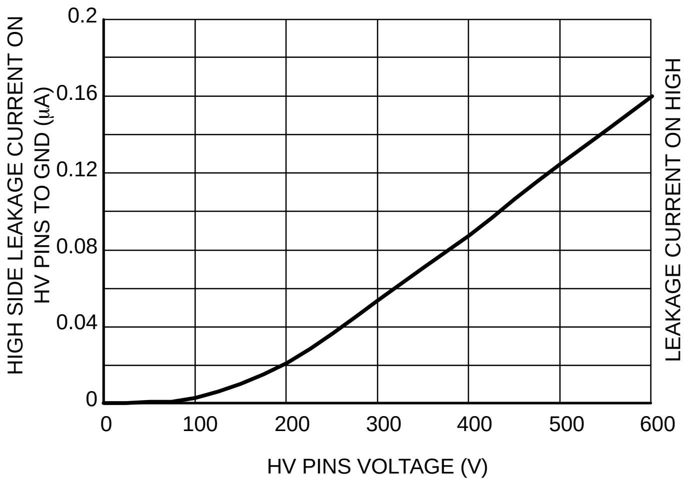


Figure 36. Leakage Current on High Voltage Pins (600 V) to Ground vs. V_{BRIDGE} Voltage ($V_{BRIGDE} = V_{BOOT}$ = VDRV_HI)

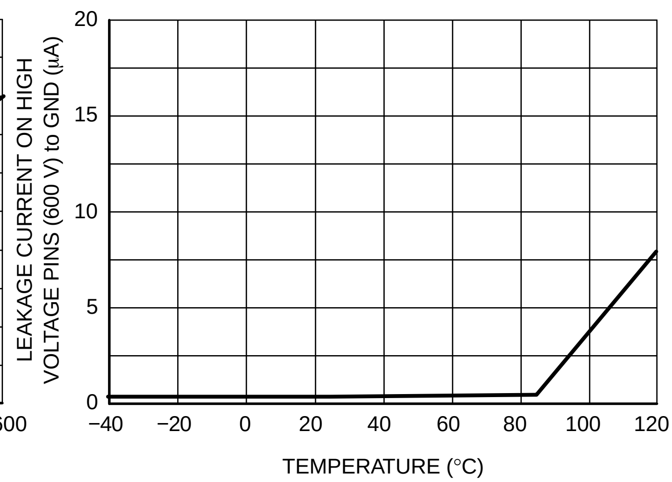


Figure 37. Leakage Current on High Voltage Pins (600 V) to Ground vs. Temperature (VBRIDGE = V_{BOOT} = VDRV_HI = 600 V)

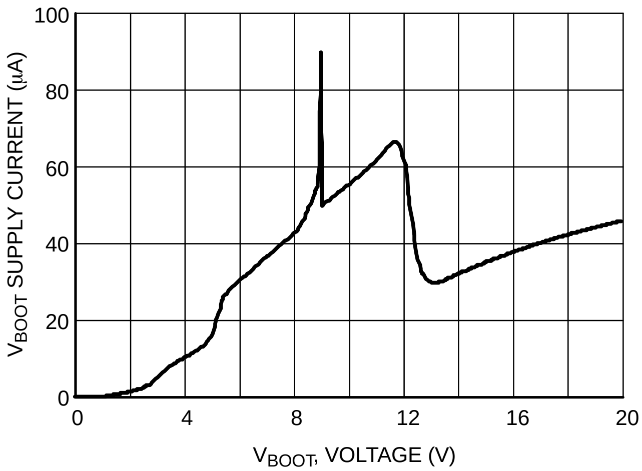


Figure 38. V_{BOOT} Supply Current vs. Bootstrap Supply Voltage

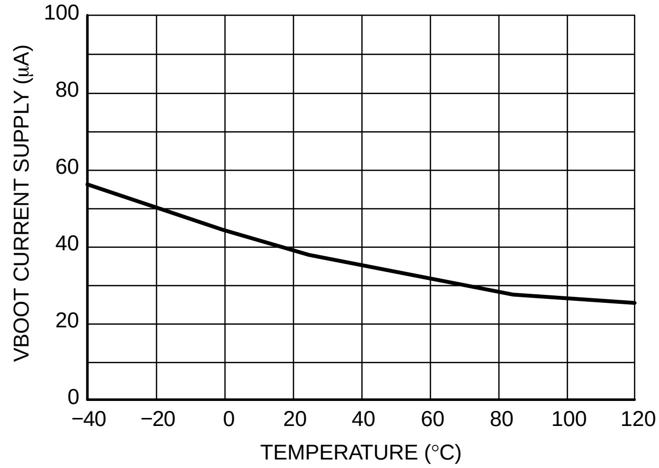


Figure 39. V_{BOOT} Supply Current vs. Temperature

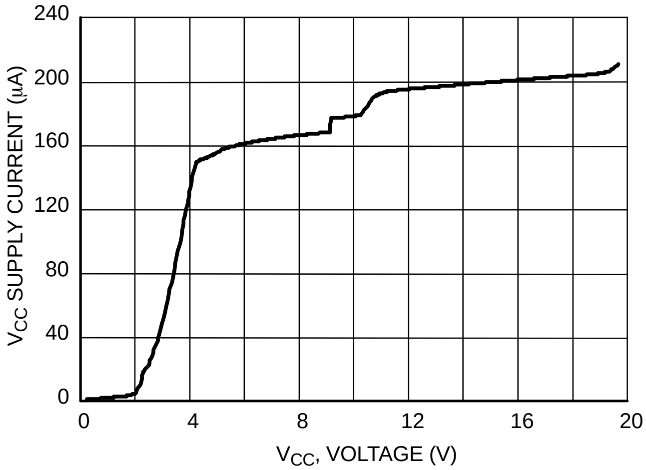


Figure 40. V_{CC} Supply Current vs. V_{CC} Supply Voltage

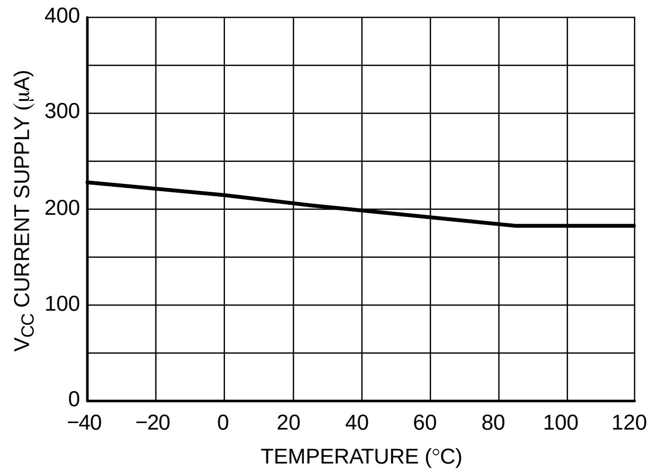


Figure 41. V_{CC} Supply Current vs. Temperature

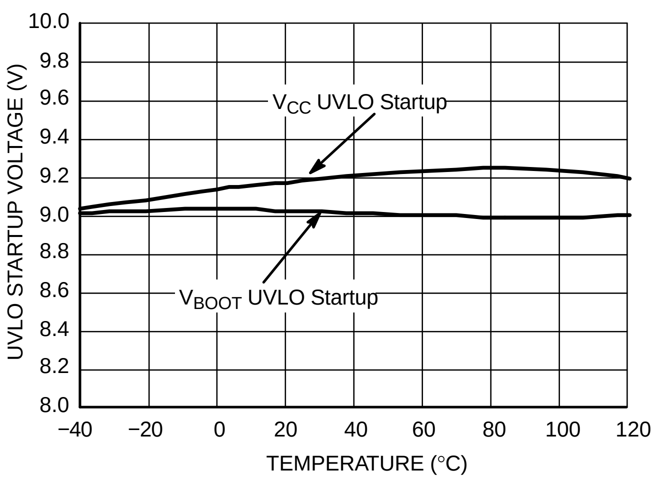


Figure 42. UVLO Startup Voltage vs. Temperature

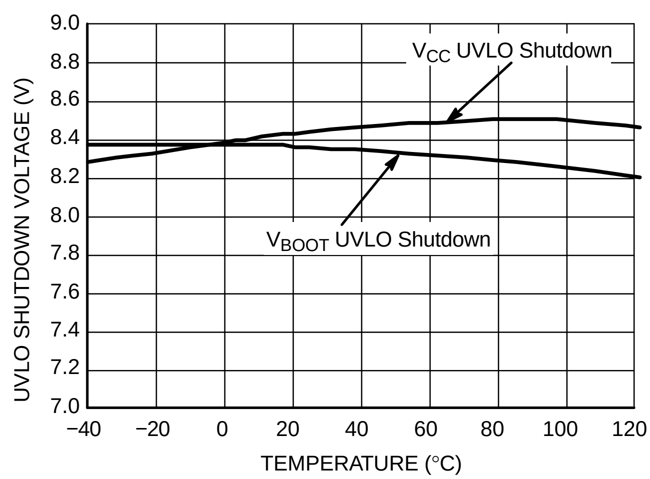


Figure 43. UVLO Shutdown Voltage vs. Temperature

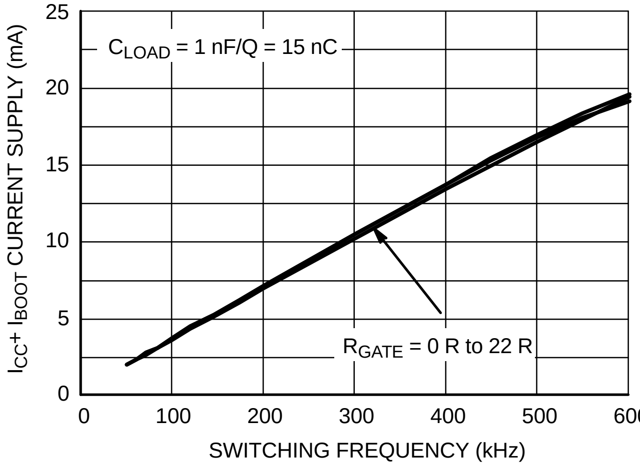


Figure 44. I_{CC1} Consumption vs. Switching Frequency with 15 nC Load on Each Driver @ V_{CC} = 15 V

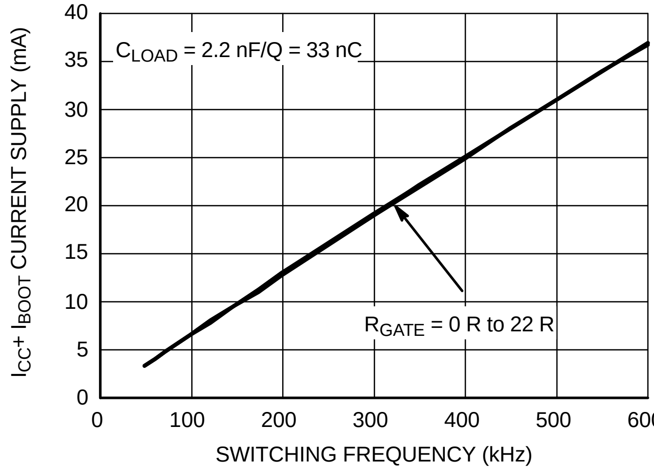


Figure 45. I_{CC1} Consumption vs. Switching Frequency with 33 nC Load on Each Driver @ V_{CC} = 15 V

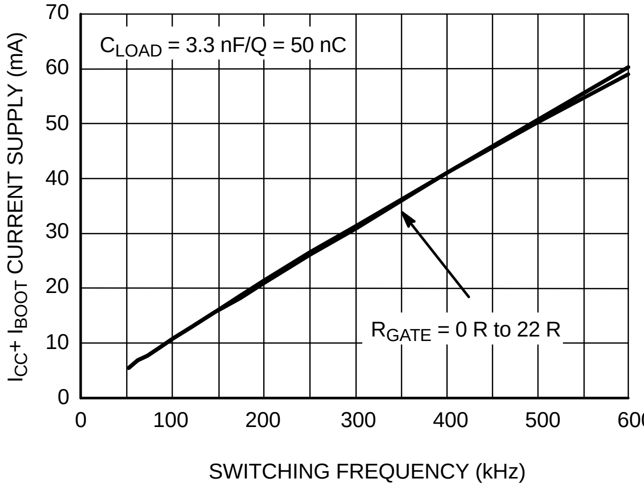


Figure 46. I_{CC1} Consumption vs. Switching Frequency with 50 nC Load on Each Driver @ V_{CC} = 15 V

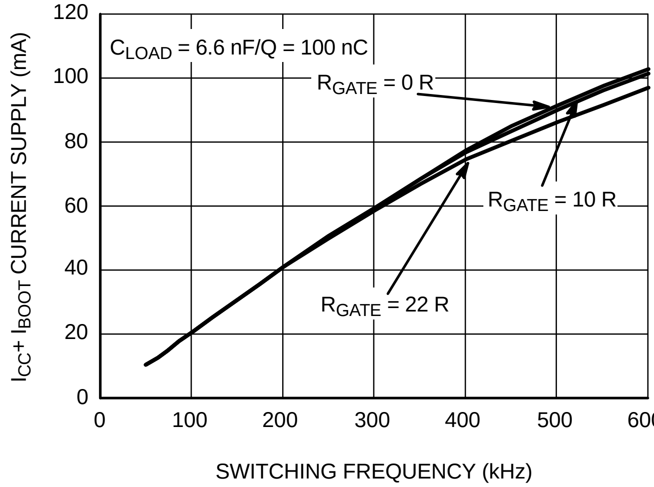


Figure 47. I_{CC1} Consumption vs. Switching Frequency with 100 nC Load on Each Driver @ V_{CC} = 15 V

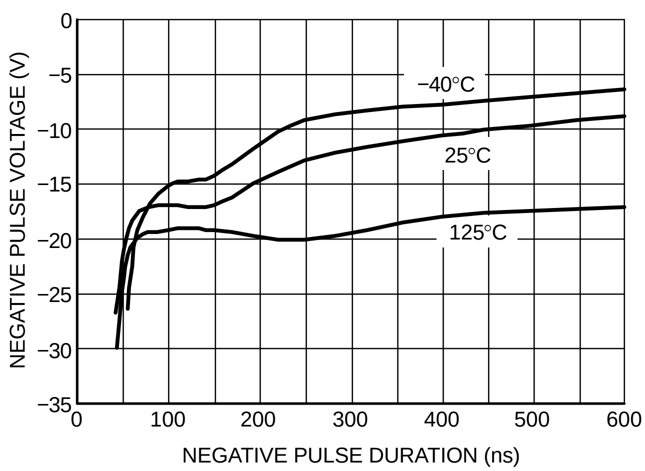


Figure 48. NCP5304, Negative Voltage Safe Operating Area on the Bridge Pin

APPLICATION INFORMATION

Negative Voltage Safe Operating Area

When the driver is used in a half bridge configuration, it is possible to see negative voltage appearing on the bridge pin (pin 6) during the power MOSFETs transitions. When the high−side MOSFET is switched off, the body diode of the low−side MOSFET starts to conduct. The negative voltage applied to the bridge pin thus corresponds to the forward voltage of the body diode. However, as pcb copper tracks and wire bonding introduce stray elements (inductance and capacitor), the maximum negative voltage of the bridge pin will combine the forward voltage and the oscillations created by the parasitic elements. As any CMOS device, the deep negative voltage of a selected pin can inject carriers into the substrate, leading to an erratic behavior of the concerned component. ON Semiconductor provides characterization data of its half−bridge driver to show the maximum negative voltage the driver can safely operate with. To prevent the negative injection, it is the designer duty to verify that the amount of negative voltage pertinent to his/her application does not exceed the characterization curve we provide, including some safety margin.

In order to estimate the maximum negative voltage accepted by the driver, this parameter has been characterized over full the temperature range of the component. A test fixture has been developed in which we purposely negatively bias the bridge pin during the freewheel period of a buck converter. When the upper gate voltage shows signs of an erratic behavior, we consider the limit has been reached.

Figure 48, illustrates the negative voltage safe operating area. Its interpretation is as follows: assume a negative 10 V pulse featuring a 100 ns width is applied on the bridge pin, the driver will work correctly over the whole die temperature range. Should the pulse swing to −20 V, keeping the same width of 100 ns, the driver will not work properly or will be damaged for temperatures below 125°C.

Summary:

- If the negative pulse characteristic (negative voltage level & pulse width) is above the curves the driver runs in safe operating area.
- If the negative pulse characteristic (negative voltage level and pulse width) is below one or all curves the driver will NOT run in safe operating area.

Note, each curve of the Figure 48 represents the negative voltage and width level where the driver starts to fail at the corresponding die temperature.

If in the application the bridge pin is too close of the safe operating limit, it is possible to limit the negative voltage to the bridge pin by inserting one resistor and one diode as follows:

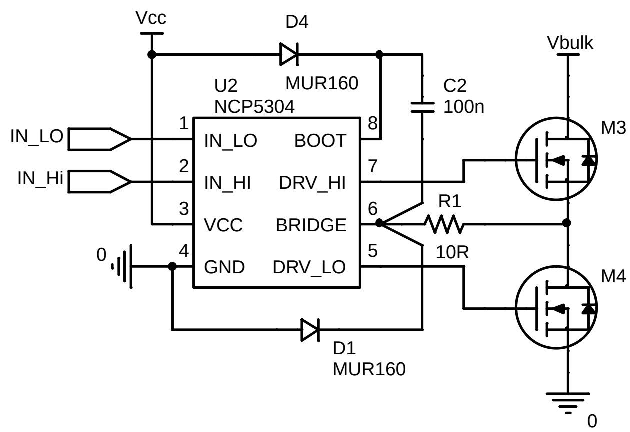
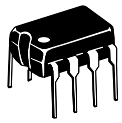


Figure 49. R1 and D1 Improves the Robustness of the Driver

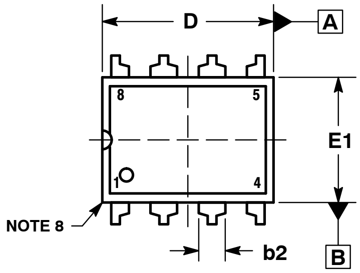
R1 and D1 should be placed as close as possible of the driver. D1 should be connected directly between the bridge pin (pin 6) and the ground pin (pin 4). By this way the negative voltage applied to the bridge pin will be limited by D1 and R1 and will prevent any wrong behavior.



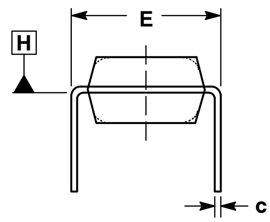
SCALE 1:1

PDIP−8
CASE 626−05
ISSUE P

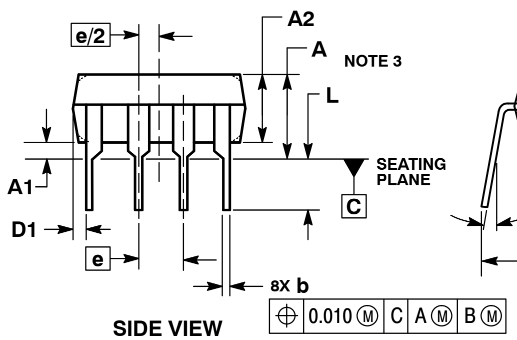
DATE 22 APR 2015



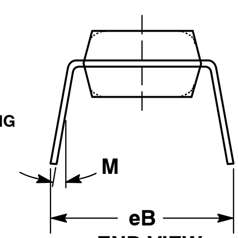
TOP VIEW



END VIEW
WITH LEADS CONSTRAINED
NOTE 5



SIDE VIEW



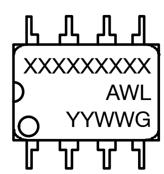
END VIEW
NOTE 6

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 eB 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).

	INCHES		MILLIMETERS	
DIM	**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°

STYLE 1:
PIN 1. AC IN
2. DC + IN
3. DC − IN
4. AC IN
5. GROUND
6. OUTPUT
7. AUXILIARY
8. V_{CC}

GENERIC MARKING DIAGRAM*



XXXX = Specific Device Code
A = Assembly Location
WL = Wafer Lot
YY = Year
WW = Work Week
G = Pb−Free Package

*This information is generic. Please refer to device data sheet for actual part marking. Pb−Free indicator, “G” or microdot “ ▪”, may or may not be present.

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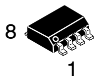
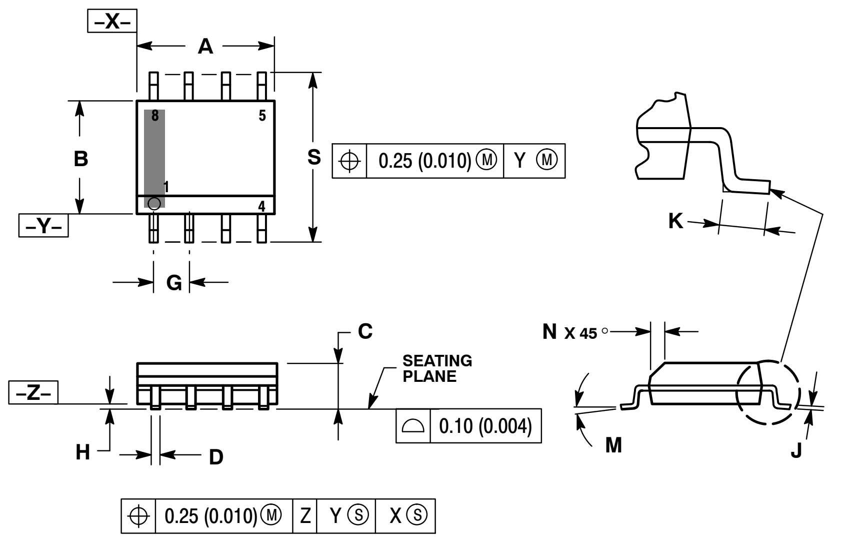
DESCRIPTION:	**PDIP−8**	**PAGE 1 OF 1**



SCALE 1:1

SOIC−8 NB
CASE 751−07
ISSUE AK

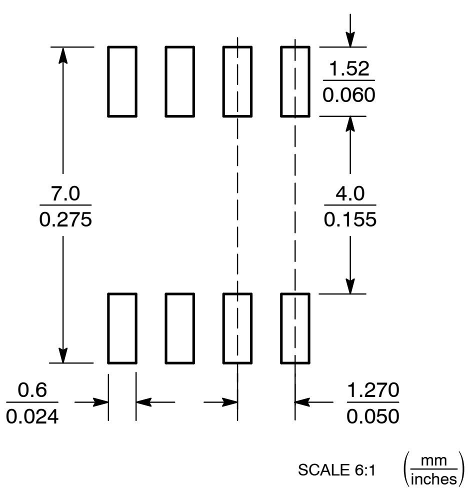
DATE 16 FEB 2011



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.

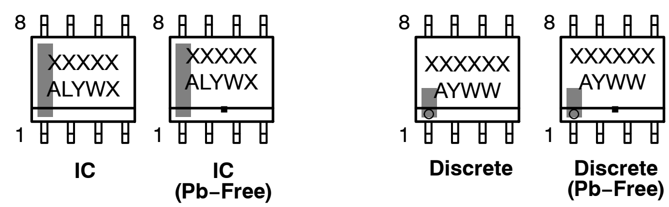
	MILLIMETERS		INCHES	
DIM	MIN	MAX	MIN	MAX
A	4.80	5.00	0.189	0.197
B	3.80	4.00	0.150	0.157
C	1.35	1.75	0.053	0.069
D	0.33	0.51	0.013	0.020
G	1.27 BSC		0.050 BSC	
H	0.10	0.25	0.004	0.010
J	0.19	0.25	0.007	0.010
K	0.40	1.27	0.016	0.050
M	0 °	8 °	0 °	8 °
N	0.25	0.50	0.010	0.020
S	5.80	6.20	0.228	0.244

SOLDERING FOOTPRINT*



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

GENERIC MARKING DIAGRAM*



XXXXX = Specific Device Code
A = Assembly Location
L = Wafer Lot
Y = Year
W = Work Week
▪ = Pb−Free Package

XXXXXX = Specific Device Code
A = Assembly Location
Y = Year
WW = Work Week
▪ = Pb−Free Package

*This information is generic. Please refer to device data sheet for actual part marking. Pb−Free indicator, “G” or microdot “▪”, may or may not be present. Some products may not follow the Generic Marking.

STYLES ON PAGE 2

DOCUMENT NUMBER:	98ASB42564B	Electronic versions are uncontrolled except when accessed directly from the Document Repository. Printed versions are uncontrolled except when stamped “CONTROLLED COPY” in red.
DESCRIPTION:	SOIC−8 NB	PAGE 1 OF 2

STYLE 1:
PIN 1. EMITTER
2. COLLECTOR
3. COLLECTOR
4. EMITTER
5. EMITTER
6. BASE
7. BASE
8. EMITTER

STYLE 2:
PIN 1. COLLECTOR, DIE, #1
2. COLLECTOR, #1
3. COLLECTOR, #2
4. COLLECTOR, #2
5. BASE, #2
6. EMITTER, #2
7. BASE, #1
8. EMITTER, #1

STYLE 3:
PIN 1. DRAIN, DIE #1
2. DRAIN, #1
3. DRAIN, #2
4. DRAIN, #2
5. GATE, #2
6. SOURCE, #2
7. GATE, #1
8. SOURCE, #1

STYLE 4:
PIN 1. ANODE
2. ANODE
3. ANODE
4. ANODE
5. ANODE
6. ANODE
7. ANODE
8. COMMON CATHODE

STYLE 5:
PIN 1. DRAIN
2. DRAIN
3. DRAIN
4. DRAIN
5. GATE
6. GATE
7. SOURCE
8. SOURCE

STYLE 6:
PIN 1. SOURCE
2. DRAIN
3. DRAIN
4. SOURCE
5. SOURCE
6. GATE
7. GATE
8. SOURCE

STYLE 7:
PIN 1. INPUT
2. EXTERNAL BYPASS
3. THIRD STAGE SOURCE
4. GROUND
5. DRAIN
6. GATE 3
7. SECOND STAGE Vd
8. FIRST STAGE Vd

STYLE 8:
PIN 1. COLLECTOR, DIE #1
2. BASE, #1
3. BASE, #2
4. COLLECTOR, #2
5. COLLECTOR, #2
6. EMITTER, #2
7. EMITTER, #1
8. COLLECTOR, #1

STYLE 9:
PIN 1. EMITTER, COMMON
2. COLLECTOR, DIE #1
3. COLLECTOR, DIE #2
4. EMITTER, COMMON
5. EMITTER, COMMON
6. BASE, DIE #2
7. BASE, DIE #1
8. EMITTER, COMMON

STYLE 10:
PIN 1. GROUND
2. BIAS 1
3. OUTPUT
4. GROUND
5. GROUND
6. BIAS 2
7. INPUT
8. GROUND

STYLE 11:
PIN 1. SOURCE 1
2. GATE 1
3. SOURCE 2
4. GATE 2
5. DRAIN 2
6. DRAIN 2
7. DRAIN 1
8. DRAIN 1

STYLE 12:
PIN 1. SOURCE
2. SOURCE
3. SOURCE
4. GATE
5. DRAIN
6. DRAIN
7. DRAIN
8. DRAIN

STYLE 13:
PIN 1. N.C.
2. SOURCE
3. SOURCE
4. GATE
5. DRAIN
6. DRAIN
7. DRAIN
8. DRAIN

STYLE 14:
PIN 1. N−SOURCE
2. N−GATE
3. P−SOURCE
4. P−GATE
5. P−DRAIN
6. P−DRAIN
7. N−DRAIN
8. N−DRAIN

STYLE 15:
PIN 1. ANODE 1
2. ANODE 1
3. ANODE 1
4. ANODE 1
5. CATHODE, COMMON
6. CATHODE, COMMON
7. CATHODE, COMMON
8. CATHODE, COMMON

STYLE 16:
PIN 1. EMITTER, DIE #1
2. BASE, DIE #1
3. EMITTER, DIE #2
4. BASE, DIE #2
5. COLLECTOR, DIE #2
6. COLLECTOR, DIE #2
7. COLLECTOR, DIE #1
8. COLLECTOR, DIE #1

STYLE 17:
PIN 1. VCC
2. V2OUT
3. V1OUT
4. TXE
5. RXE
6. VEE
7. GND
8. ACC

STYLE 18:
PIN 1. ANODE
2. ANODE
3. SOURCE
4. GATE
5. DRAIN
6. DRAIN
7. CATHODE
8. CATHODE

STYLE 19:
PIN 1. SOURCE 1
2. GATE 1
3. SOURCE 2
4. GATE 2
5. DRAIN 2
6. MIRROR 2
7. DRAIN 1
8. MIRROR 1

STYLE 20:
PIN 1. SOURCE (N)
2. GATE (N)
3. SOURCE (P)
4. GATE (P)
5. DRAIN
6. DRAIN
7. DRAIN
8. DRAIN

STYLE 21:
PIN 1. CATHODE 1
2. CATHODE 2
3. CATHODE 3
4. CATHODE 4
5. CATHODE 5
6. COMMON ANODE
7. COMMON ANODE
8. CATHODE 6

STYLE 22:
PIN 1. I/O LINE 1
2. COMMON CATHODE/VCC
3. COMMON CATHODE/VCC
4. I/O LINE 3
5. COMMON ANODE/GND
6. I/O LINE 4
7. I/O LINE 5
8. COMMON ANODE/GND

STYLE 23:
PIN 1. LINE 1 IN
2. COMMON ANODE/GND
3. COMMON ANODE/GND
4. LINE 2 IN
5. LINE 2 OUT
6. COMMON ANODE/GND
7. COMMON ANODE/GND
8. LINE 1 OUT

STYLE 24:
PIN 1. BASE
2. EMITTER
3. COLLECTOR/ANODE
4. COLLECTOR/ANODE
5. CATHODE
6. CATHODE
7. COLLECTOR/ANODE
8. COLLECTOR/ANODE

STYLE 25:
PIN 1. VIN
2. N/C
3. REXT
4. GND
5. IOUT
6. IOUT
7. IOUT
8. IOUT

STYLE 26:
PIN 1. GND
2. dv/dt
3. ENABLE
4. ILIMIT
5. SOURCE
6. SOURCE
7. SOURCE
8. VCC

STYLE 27:
PIN 1. ILIMIT
2. OVLO
3. UVLO
4. INPUT+
5. SOURCE
6. SOURCE
7. SOURCE
8. DRAIN

STYLE 28:
PIN 1. SW_TO_GND
2. DASIC_OFF
3. DASIC_SW_DET
4. GND
5. V_MON
6. VBULK
7. VBULK
8. VIN

STYLE 29:
PIN 1. BASE, DIE #1
2. EMITTER, #1
3. BASE, #2
4. EMITTER, #2
5. COLLECTOR, #2
6. COLLECTOR, #2
7. COLLECTOR, #1
8. COLLECTOR, #1

STYLE 30:
PIN 1. DRAIN 1
2. DRAIN 1
3. GATE 2
4. SOURCE 2
5. SOURCE 1/DRAIN 2
6. SOURCE 1/DRAIN 2
7. SOURCE 1/DRAIN 2
8. GATE 1

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