Half Bridge Gate Driver (Isolated High & Non-Isolated Low)

NCD57200

The NCD57200 is a high voltage gate driver with one non−isolated low side gate driver and one galvanically isolated high or low side gate driver. It can directly drive two IGBTs in a half bridge configuration. Isolated high side driver can be powered with an isolated power supply or with Bootstrap technique from the low side power supply.

The galvanic isolation for the high side gate driver guarantees reliable switching in high power applications for IGBTs that operate up to 800 V, at high dv/dt. The optimized output stages provide a mean of reducing IGBT losses. Its features include two independent inputs with deadtime and interlock, accurate asymmetric UVLOs, and short and matched propagation delays. The NCD57200 operates with its V_{DD}/V_{BS} up to 20 V.

Features

- High Peak Output Current (+1.9 A/−2.3 A)
- Low Output Voltage Drop for Enhanced IGBT Conduction
- Floating Channel for Bootstrap Operation up to +800 V
- CMTI up to 100 kV/μs
- Reliable Operation for V_S Negative Swing to −800 V
- V_{DD} & V_{BS} Supply Range up to 20 V
- 3.3 V, 5 V, and 15 V Logic Input
- Asymmetric Under Voltage Lockout Thresholds for High Side and Low Side
- Matched Propagation Delay 90 ns
- Built−in 20 ns Minimum Pulse Width Filter (or Input Noise Filter)
- Built−in 340 ns Dead−Time and High and Low Inputs Interlock
- Non−Inverting Output Signal
- This Device is Pb−Free, Halogen Free/BFR Free and is RoHS Compliant

Typical Applications

- Fans, Pumps
- Home Appliances
- Consumer Electronics
- General Purpose Half Bridge Applications

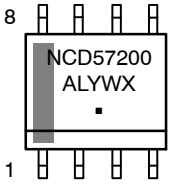
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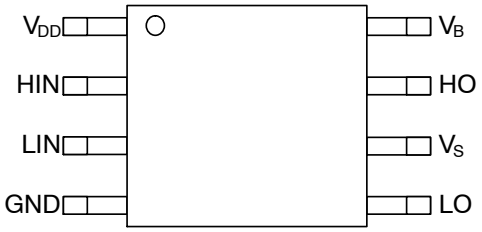
SOIC−8 NB
CASE 751−07

MARKING DIAGRAM



NCD57200	= Specific Device Code
A	= Assembly Location
L	= Wafer Lot
Y	= Year
W	= Work Week
▪	= Pb−Free Package

PIN CONNECTIONS



ORDERING INFORMATION

See detailed ordering and shipping information on page 15 of this data sheet.

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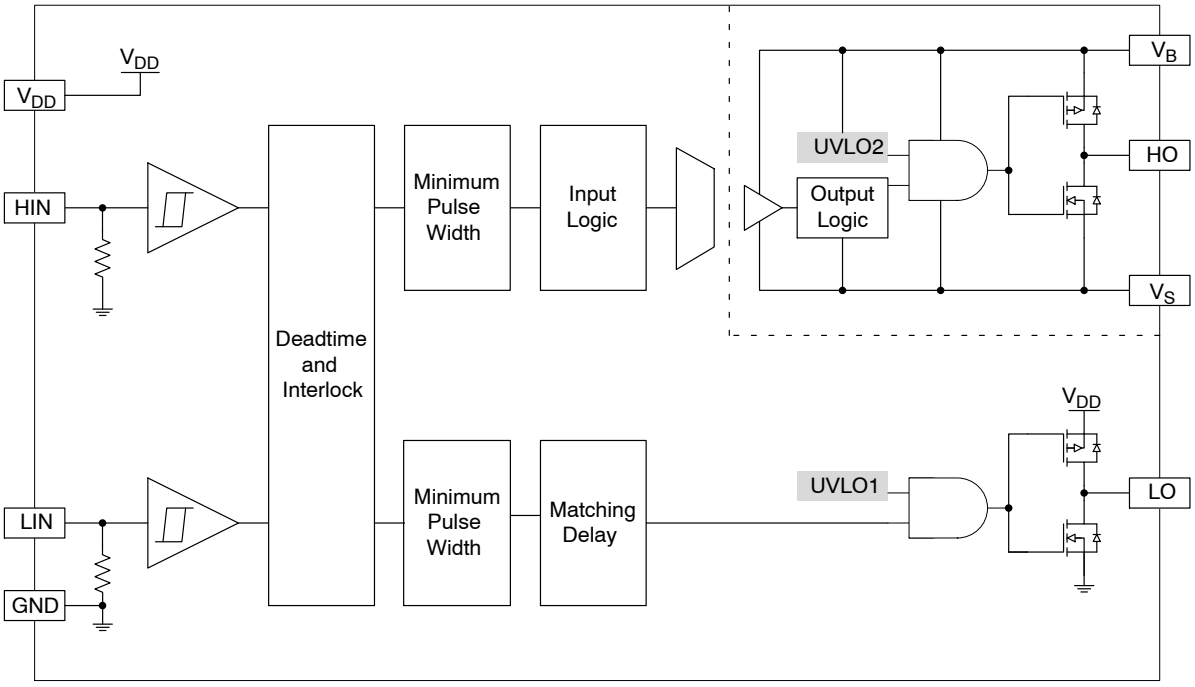


Figure 1. Simplified Block Diagram

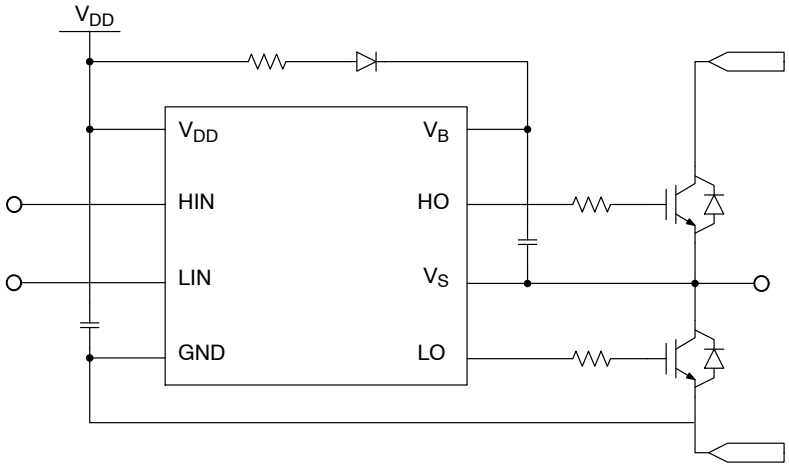


Figure 2. Simplified Application Schematics

Table 1. FUNCTION DESCRIPTION

Pin Name	No.	I/O	Description
V_{DD}	1	Power	Low side and main power supply. A good quality bypassing capacitor is required from this pin to GND and should be placed close to the pins for best results. The under voltage lockout (UVLO) circuit enables the device to operate at power on when a typical supply voltage higher than $V_{UVLO1-OUT-ON}$ is present. Please see Figure 5 for more details. A filter time t_{UVF1} helps to suppress noise on V_{DD} pin.
HIN	2	I	High side non-inverting gate driver input. It has an equivalent pull−down resistor of 125 kΩ to ensure that output is low in the absence of an input signal. A minimum positive or negative going pulse width is required at HIN before HO reacts. It adopts 3.3 V logic signal thresholds for input voltage up to V_{DD}. There is deadtime and interlocking logic between HIN and LIN.
LIN	3	I	Low side non-inverting gate driver input. It has an equivalent pull−down resistor of 125 kΩ to ensure that output is low in the absence of an input signal. A minimum positive or negative going pulse width is required at LIN before LO reacts. It adopts 3.3 V logic signal thresholds for input voltage up to V_{DD}. There is deadtime and interlocking logic between HIN and LIN.
GND	4	Power	Logic ground and low side driver return.
LO	5	O	Low side driver output that provides the appropriate drive voltage and source/sink current to the IGBT gate. LO is actively pulled low during startup and under UVLO1 condition. There is deadtime and interlocking logic to prevent unintended HO and LO cross conduction.
V_S	6	Power	Bootstrap return or high side floating supply offset.
HO	7	O	Galvanically isolated high side driver output that provides the appropriate drive voltage and source/sink current to the IGBT gate. HO is actively pulled low during startup and under UVLOx condition. There is deadtime and interlocking logic to prevent unintended HO and LO cross conduction.
V_B	8	Power	Bootstrap or high side floating power supply. A good quality bypassing capacitor is required from this pin to V_S and should be placed close to the pins for best results. The under voltage lockout (UVLO) circuit enables the device to operate at power on when a typical supply voltage higher than $V_{UVLO2-OUT-ON}$ is present. Please see Figure 5 for more details. A filter time t_{UVF2} helps to suppress noise on V_B pin.

Table 2. ABSOLUTE MAXIMUM RATINGS (Note 1) Over operating free−air temperature range unless otherwise noted

Parameter	Symbol	Minimum	Maximum	Unit
High−Side Offset Voltage (see Figure 2)	V_S	−900	900	V
High−Side Supply Voltage (see Figure 2)	V_B	−900	900	V
Low−Side Supply Voltage	V_{DD}	−0.3	25	V
High−Side Floating Supply Voltage	V_{BS}	−0.3	25	V
High−Side Output Voltage (HO) (see Figure 2)	V_{HO}	V_S−0.3	V_{BS}+0.3	V
Low−Side Output Voltage (LO)	V_{LO}	−0.3	V_{DD}+0.3	V
Logic Input Voltage (HIN, LIN)	V_{IN}	−0.3	V_{DD}+0.3	V
Allowable Offset Voltage Slew Rate (see Figure 32)	dV_S/dt		±100	V/ns
Maximum Junction Temperature	TJ(max)	−40	150	°C
Storage Temperature Range	TSTG	−65	150	°C
ESD Capability, Human Body Model (Note 2)	ESDHBM		±4	kV
ESD Capability, Charged Device Model (Note 2)	ESDCDM		±2	kV
Moisture Sensitivity Level	MSL		1	−
Lead Temperature Soldering Reflow (SMD Styles Only), Pb−Free Versions (Note 3)	TSLD		260	°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.

1. Refer to ELECTRICAL CHARACTERISTICS and APPLICATION INFORMATION for Safe Operating Area.
2. This device series incorporates ESD protection and is tested by the following methods:
   ESD Human Body Model tested per AEC−Q100−002 (EIA/JESD22−A114).
   ESD Charged Device Model tested per AEC−Q100−011 (EIA/JESD22−C101).
   Latchup Current Maximum Rating: ≤ 100 mA per JEDEC standard: JESD78, 125°C.
3. For information, please refer to our Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

Table 3. THERMAL CHARACTERISTICS

Parameter	Symbol	Value	Unit
Thermal Characteristics, SOIC−8 (Note 4) Thermal Resistance, Junction−to−Air (Note 5)	$R_{\theta JA}$	167	°C/W

4. Refer to ELECTRICAL CHARACTERISTICS and APPLICATION INFORMATION for Safe Operating Area.
5. Values based on copper area of 100 mm² (or 0.16 in²) of 1 oz copper thickness and FR4 PCB substrate.

Table 4. RECOMMENDED OPERATING RANGES (Note 6)

Parameter	Symbol	Min	Max	Unit
High−Side Floating Supply Voltage	V_{BS}	V_S+UVLO2	V_S+20	V
High−Side Offset Voltage (see Figure 2)	V_S	−800	800	V
High−Side Output Voltage (HO) (see Figure 2)	V_{HO}	V_S	V_{BS}	V
Low−Side Output Voltage (LO)	V_{LO}	GND	V_{DD}	V
Logic Input Voltage (HIN, LIN)	V_{IN}	GND	V_{DD}	V
Low−Side Supply Voltage	V_{DD}	UVLO1	20	V
Ambient Temperature	T_A	−40	+125	°C

Functional operation above the stresses listed in the Recommended Operating Ranges is not implied. Extended exposure to stresses beyond the Recommended Operating Ranges limits may affect device reliability.

6. Refer to ELECTRICAL CHARACTERISTICS and APPLICATION INFORMATION for Safe Operating Area.

Table 5. ELECTRICAL CHARACTERISTICS V_{DD} = V_{BS} = 15 V.
For typical values T_A = 25°C, for min/max values, T_A is the operating ambient temperature range that applies, unless otherwise noted.

Parameter	Test Conditions	Symbol	Min	Typ	Max	Unit
VOLTAGE SUPPLY						
V_{BS} Supply Under Voltage Output Enabled		$V_{UVLO2-OUT-ON}$	11	11.5	12	V
V_{BS} Supply Under Voltage Output Disabled		$V_{UVLO2-OUT-OFF}$	10	10.5	11	V
V_{BS} Supply Voltage Output Enabled/Disabled Hysteresis		$V_{UVLO2-HYST}$	0.5	1.0	1.2	V
V_{DD} Supply Under Voltage Output Enabled		$V_{UVLO1-OUT-ON}$	12	12.5	13	V
V_{DD} Supply Under Voltage Output Disabled		$V_{UVLO1-OUT-OFF}$	11	11.5	12	V
V_{DD} Supply Voltage Output Enabled/Disabled Hysteresis		$V_{UVLO1-HYST}$	0.5	1.0	1.2	V
Leakage Current Between V_S and GND	V_S = ± 800 V, T_A = 25°C V_S = ± 800 V, T_A = −40°C to 125°C	I_{HV_LEAK1} I_{HV_LEAK2}		20	200 600	nA
Quiescent Current V_{BS} Supply (V_B Only)	HO = Low	I_{QBS1}		260	325	μA
Quiescent Current V_{BS} Supply (V_B Only)	HO = High	I_{QBS2}		330	440	μA
Quiescent Current V_{DD} Supply (V_{DD} Only)	V_{LIN} = Float, V_{HIN} = 0 V,	I_{QDD1}		380	440	μA
Quiescent Current V_{DD} Supply (V_{DD} Only)	V_{LIN} = 3.3 V, V_{HIN} = 0 V,	I_{QDD2}		440	500	μA
Quiescent Current V_{DD} Supply (V_{DD} Only)	V_{LIN} = 0 V, V_{HIN} = 3.3 V,	I_{QDD3}		2.4	3	mA
LOGIC INPUT						
Low Level Input Voltage		V_{IL}			0.9	V
High Level Input Voltage		V_{IH}	2.4			V
Logic “1” Input Bias Current	V_{LIN} = 3.3 V, V_{HIN} = 3.3 V	I_{LIN1+}, I_{HIN1+}		25	50	μA
Logic “1” Input Bias Current	V_{LIN} = 20 V, V_{HIN} = 20 V, V_{DD} = V_{BS} = 20 V	I_{LIN2+}, I_{HIN2+}		100	150	μA
Logic “0” Input Bias Current	V_{LIN} = 0 V, V_{HIN} = 0 V	I_{LIN-}, I_{HIN-}		40	100	nA
DRIVER OUTPUT						
Output Low State	I_{SINK} = 200 mA, T_A = 25°C	V_{OL1}		0.2	0.3	V
	I_{SINK} = 200 mA, T_A = −40°C to 125°C	V_{OL2}			0.5	
Output High State	I_{SOURCE} = 200 mA, T_A = 25°C	V_{OH1}	14.4	14.5		V
	I_{SOURCE} = 200 mA, T_A = −40°C to 125°C	V_{OH2}	14			
Peak Driver Current, Sink (Note 7)	V_{HO} = V_{LO} = 15 V	$I_{PK-SNK1}$		2.3		A
	V_{HO} = V_{LO} = 9 V (near Miller Plateau)	$I_{PK-SNK2}$		2.1		
Peak Driver Current, Source (Note 7)	V_{HO} = V_{LO} = 0 V	$I_{PK-SRC1}$		1.9		A
	V_{HO} = V_{LO} = 9 V (near Miller Plateau)	$I_{PK-SRC2}$		1.5		

Table 5. ELECTRICAL CHARACTERISTICS V_{DD} = V_{BS} = 15 V.
For typical values T_A = 25°C, for min/max values, T_A is the operating ambient temperature range that applies, unless otherwise noted.

Parameter	Test Conditions	Symbol	Min	Typ	Max	Unit
IGBT SHORT CIRCUIT CLAMPING						
Clamping Voltage (V_{HO} − V_B) / (V_{LO} − V_{DD})	I_{HO} = 100 mA, I_{LO} = 100 mA (pulse test, t_{CLPmax} = 10 μs)	$V_{CLAMP-OUT}$		0.8	1.3	V
DYNAMIC CHARACTERISTIC						
HO High Propagation Delay	C_{LOAD} = 1 nF, V_{IH} to 10% of Output Change for PW > 150 ns	$t_{PD-ON-H}$	50	90	110	ns
HO Low Propagation Delay	C_{LOAD} = 1 nF, V_{IL} to 90% of Output Change for PW > 150 ns	$t_{PD-OFF-H}$	50	90	110	ns
Propagation Delay Distortion(HS) (= $t_{PD-ON-H}$ − $t_{PD-OFF-H}$)	PW >150 ns	$t_{DISTORT-H}$	−25	0	25	ns
LO High Propagation Delay	C_{LOAD} = 1 nF, V_{IH} to 10% of Output Change for PW > 150 ns	$t_{PD-ON-L}$	50	90	110	ns
LO Low Propagation Delay	C_{LOAD} = 1 nF, V_{IL} to 90% of Output Change for PW > 150 ns	$t_{PD-OFF-L}$	50	90	110	ns
Propagation Delay Distortion(LS) (= $t_{PD-ON-L}$ − $t_{PD-OFF-L}$)	PW >150 ns	$t_{DISTORT-L}$	−25	0	25	ns
High Propagation Delay Distortion between High and Low Sides	PW > 150 ns	$t_{DISTORT-HL-H}$	−25	0	25	ns
Low Propagation Delay Distortion between High and Low Sides	PW > 150 ns	$t_{DISTORT-HL-L}$	−25	0	25	ns
Rise Time (HO) (see Figure 3)	C_{LOAD} = 1 nF, 10% to 90% of Output Change	t_{RISE-H}		13		ns
Fall Time (HO) (see Figure 3)	C_{LOAD} = 1 nF, 90% to 10% of Output Change	t_{FALL-H}		8		ns
Rise Time (LO) (see Figure 3)	C_{LOAD} = 1 nF, 10% to 90% of Output Change	t_{RISE-L}		13		ns
Fall Time (LO) (see Figure 3)	C_{LOAD} = 1 nF, 90% to 10% of Output Change	t_{FALL-L}		8		ns
Deadtime, HO Delays (see Figure 6)	$V_{LIN/HIN}$ = 0 V and 3.3 V	t_{DT1}		340		ns
Deadtime, LO Delays (see Figure 6)	$V_{LIN/HIN}$ = 0 V and 3.3 V	t_{DT2}		350		ns
Deadtime Matching		t_{MDT}		10		ns
Minimum Pulse Width Filtering Time (see Figure 3)	T_A = 25°C	t_{MIN1}, t_{MIN2}	10		40	ns
UVLO Fall Delay (HO and LO)		t_{UVF1}, t_{UVF2}		1300		ns
UVLO Rise Delay (HO and LO)		t_{UVR1}, t_{UVR2}		1100		ns

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.
7. Values based on design and/or characterization.

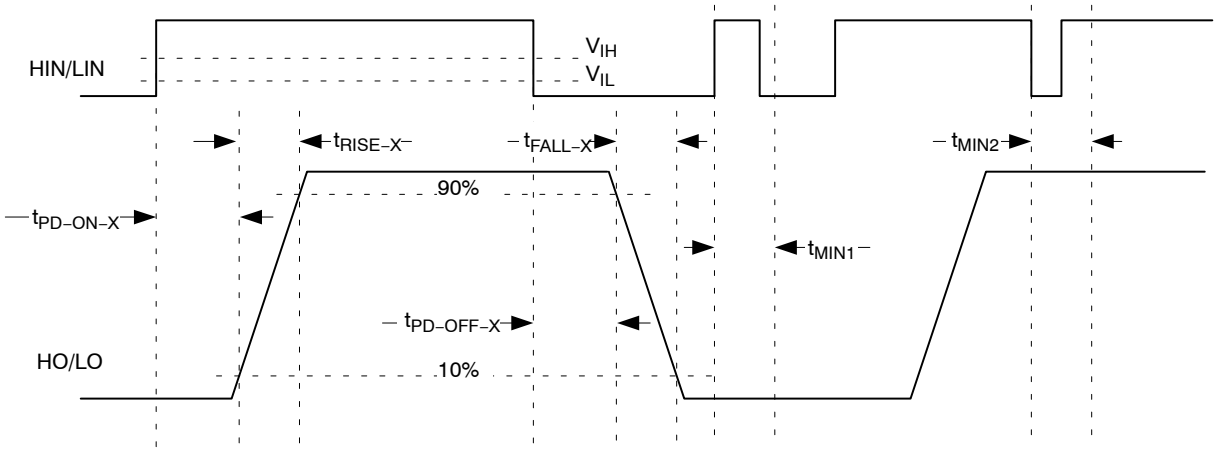


Figure 3. Propagation Delay, Rise and Fall Time

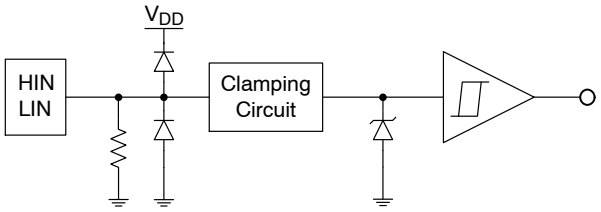


Figure 4. Input Pin Structure

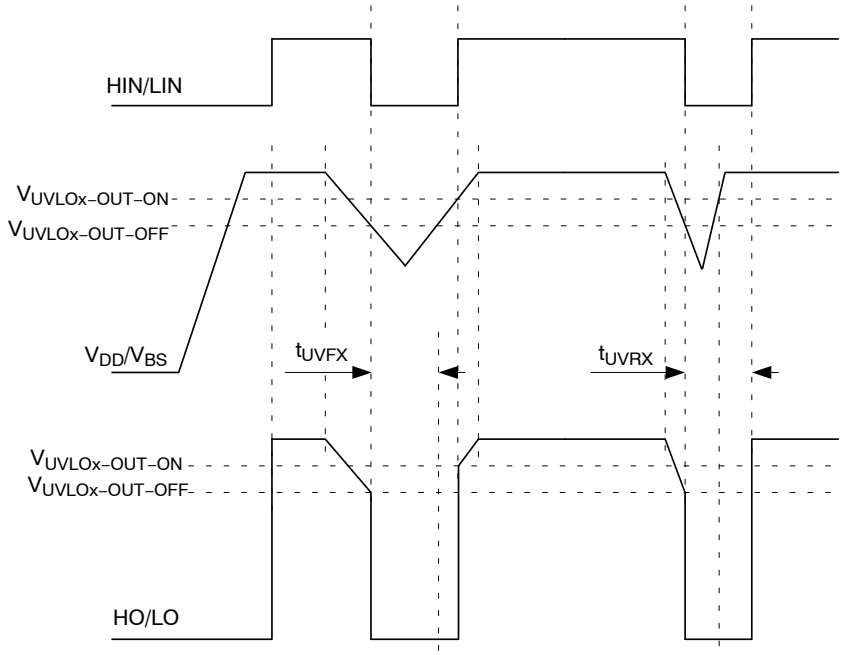


Figure 5. UVLO

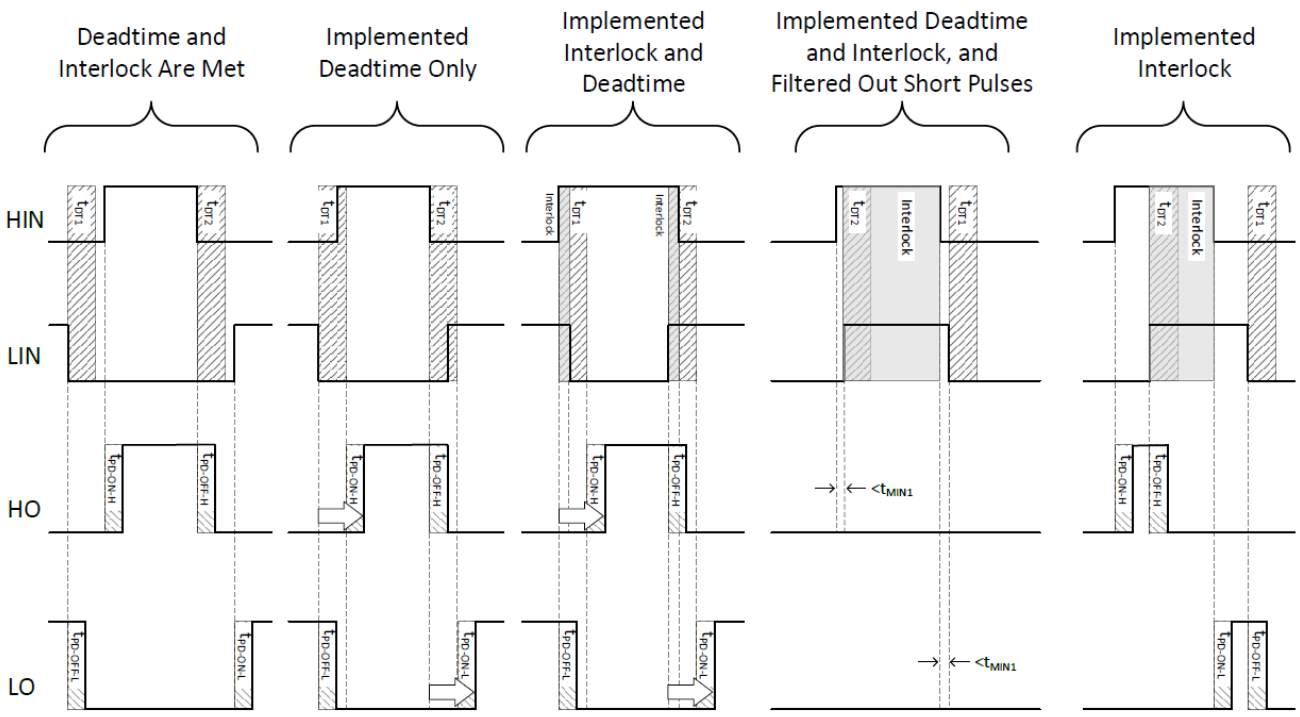


Figure 6. Deadtime, Interlock and Output Minimum Pulse Width

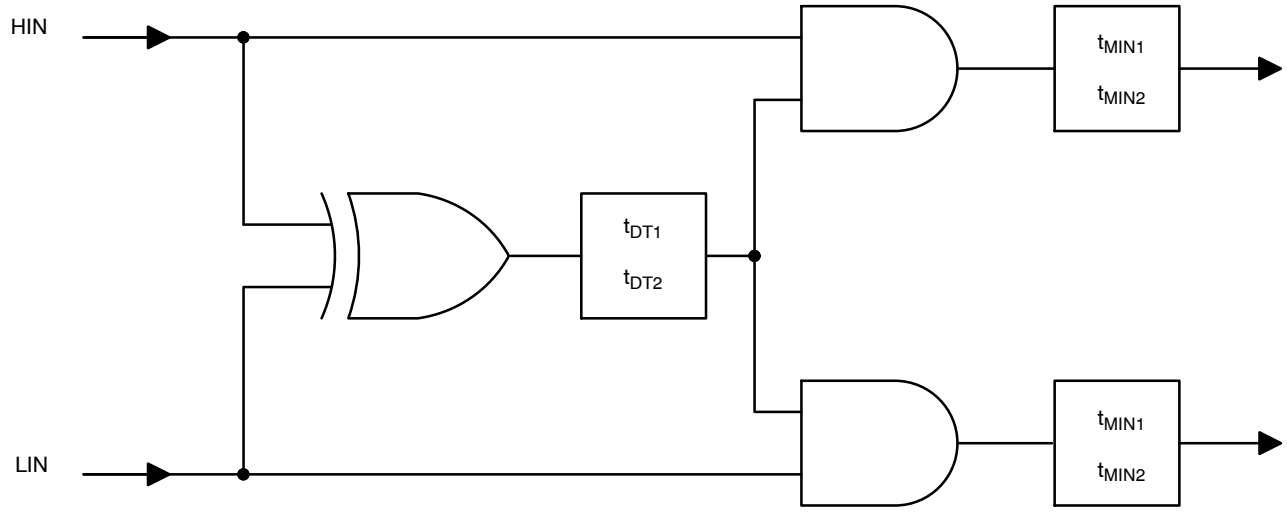


Figure 7. Input Circuit

TYPICAL CHARACTERISTICS

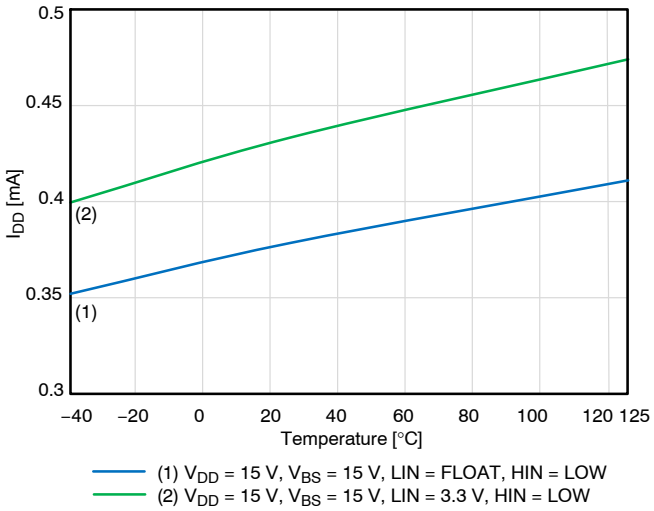


Figure 8. I_{DD} Supply Current V_{DD} = 15 V

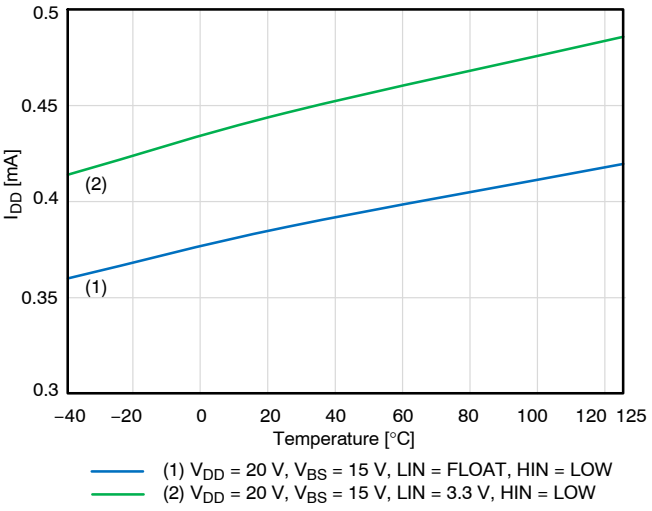


Figure 9. I_{DD} Supply Current V_{DD} = 20 V

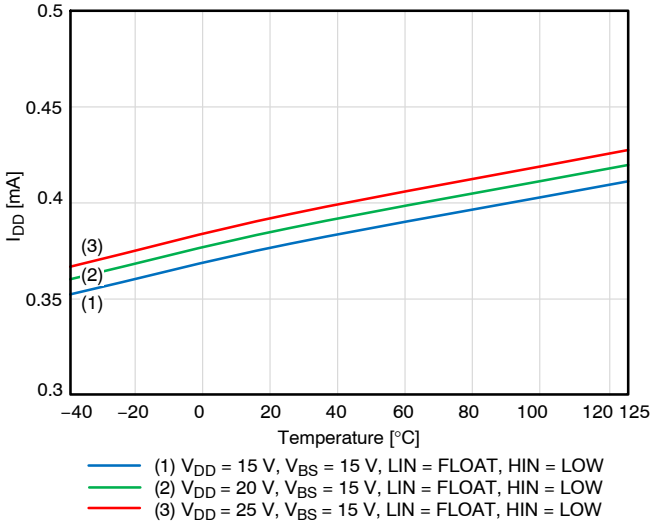


Figure 10. I_{DD} Supply Current V_{DD} = 15–25 V, Input Float

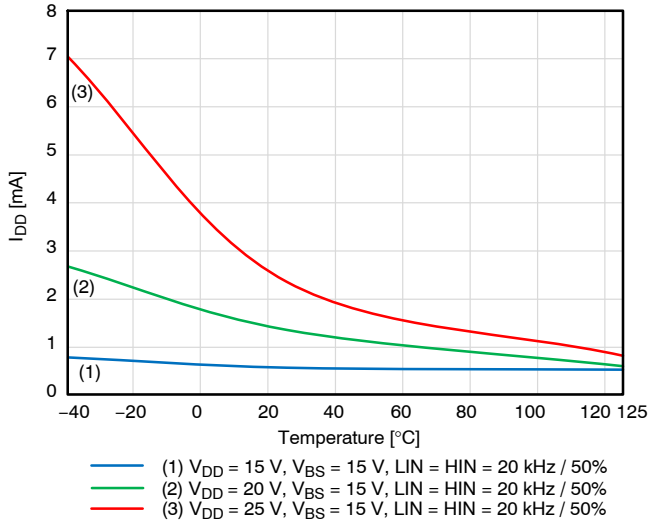


Figure 11. I_{DD} Supply Current V_{DD} = 15–25 V, LIN = HIN = 20 kHz / 50%

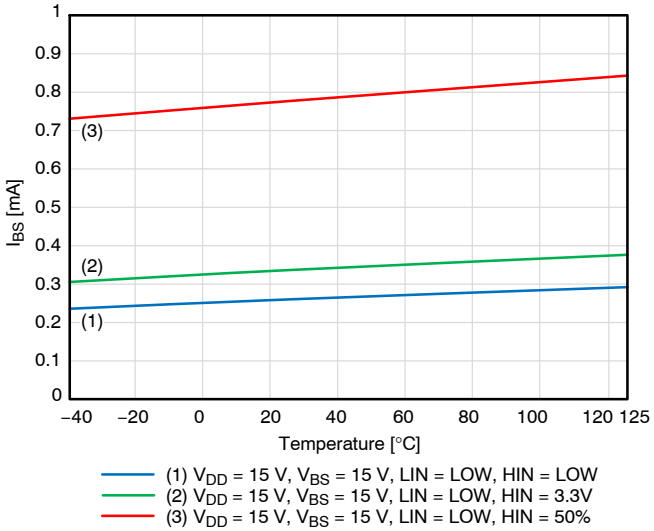


Figure 12. I_{BS} Supply Current V_{BS} = 15 V

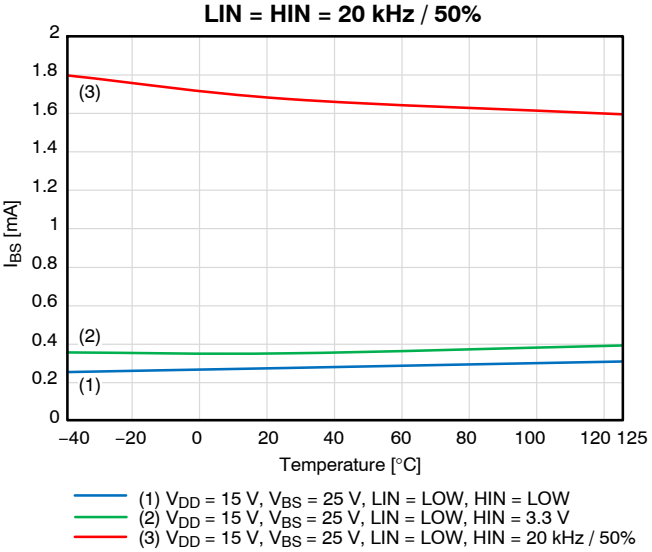


Figure 13. I_{BS} Supply Current V_{BS} = 25 V

TYPICAL CHARACTERISTICS (continued)

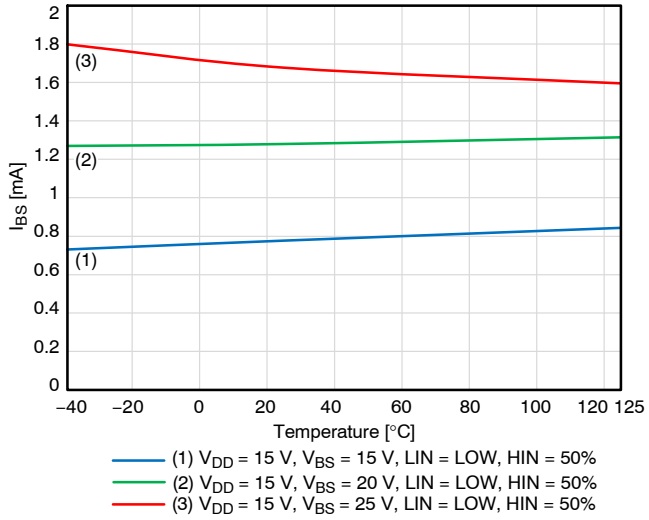


Figure 14. I_{BS} Supply Current V_{BS} = 15–25 V, HIN = 20 kHz / 50%

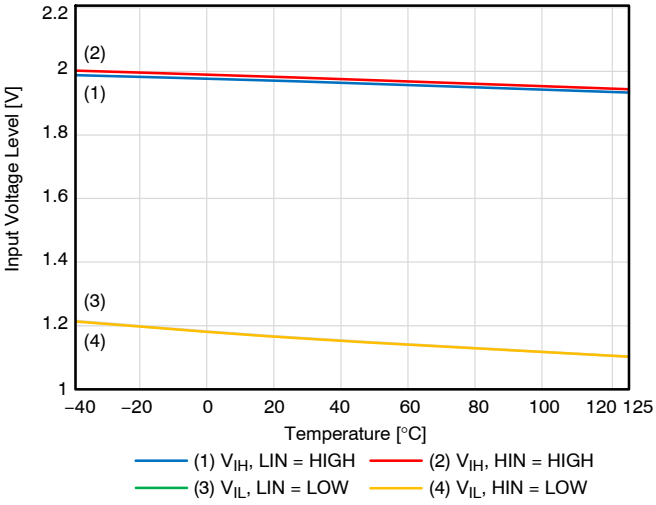


Figure 15. Input Voltage Level

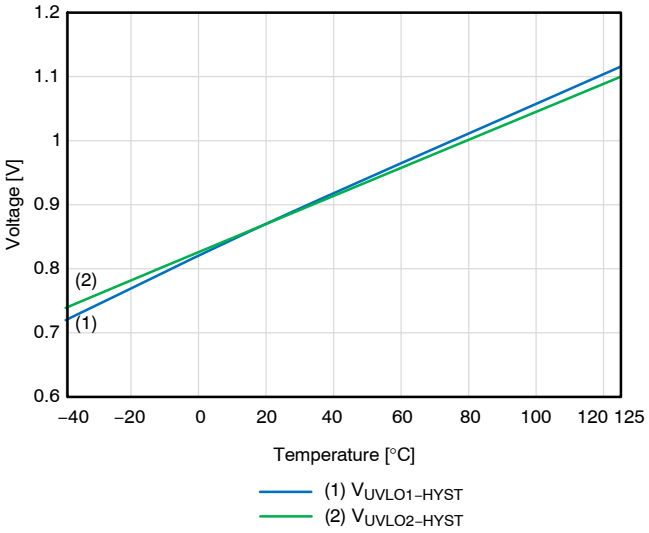


Figure 16. UVLO Hysteresis

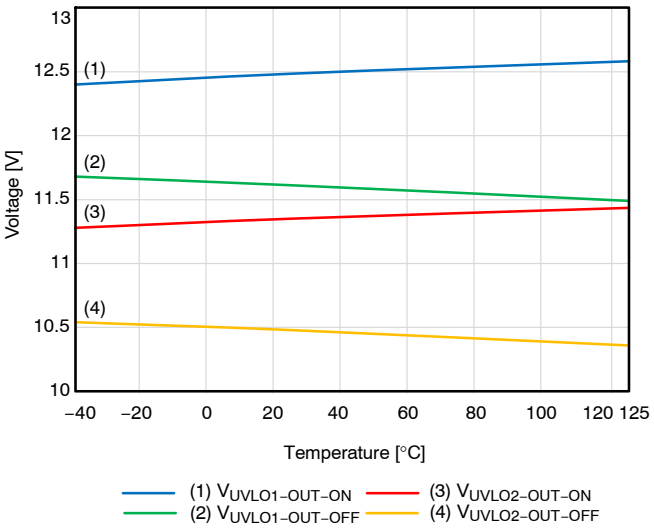


Figure 17. UVLO Threshold Voltage

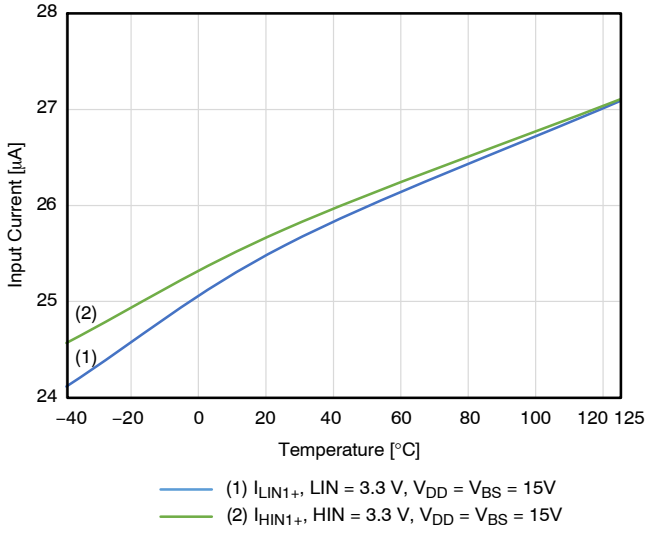


Figure 18. Input Current V_{DD} = V_{BS} = 15 V

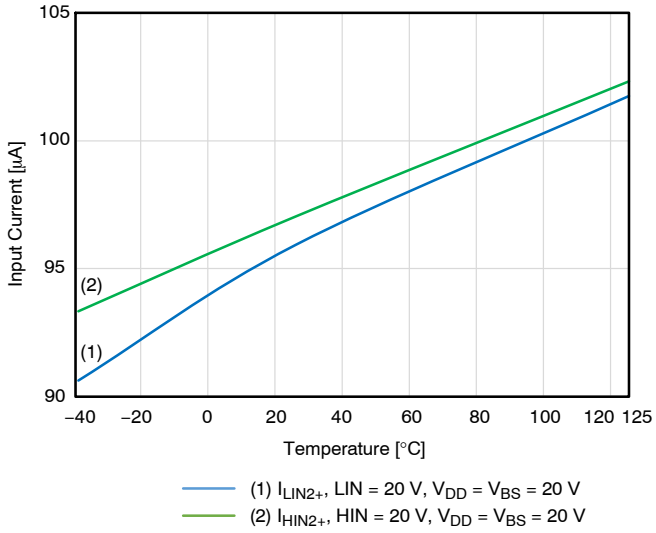


Figure 19. Input Current V_{DD} = V_{BS} = 20 V

TYPICAL CHARACTERISTICS (continued)

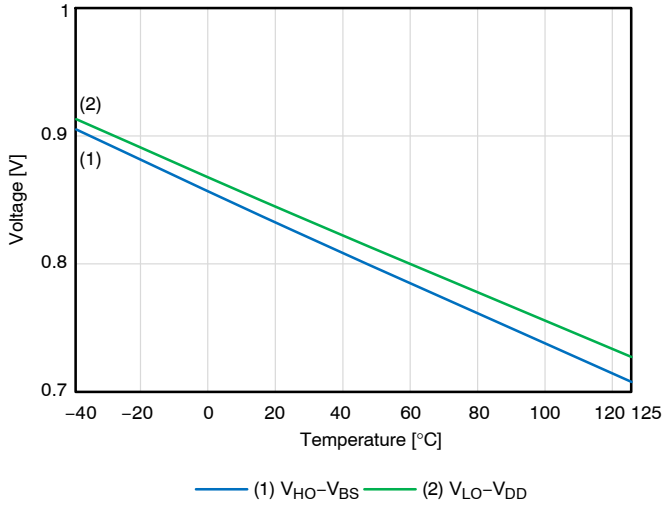


Figure 20. IGBT Short Circuit CLAMP Voltage Drop

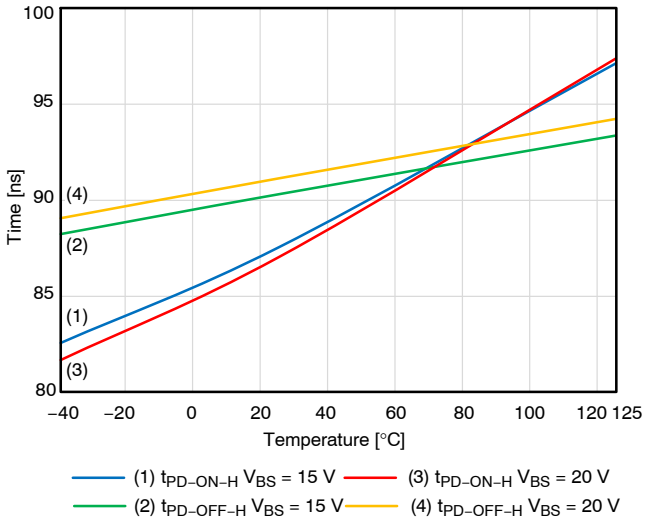


Figure 21. HO Propagation Delay

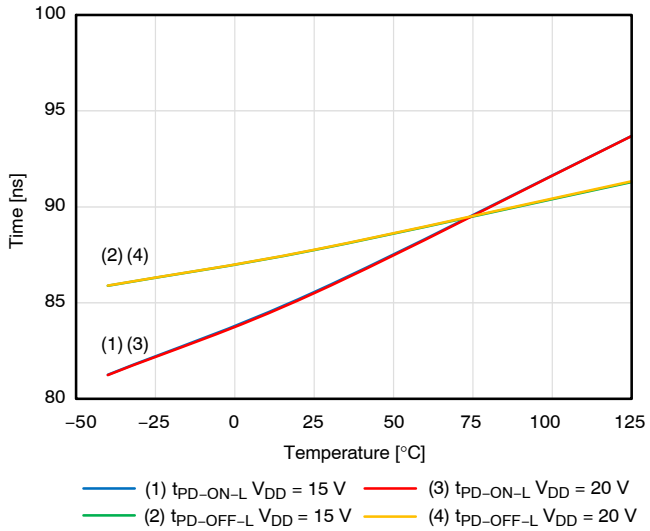


Figure 22. LO Propagation Delay

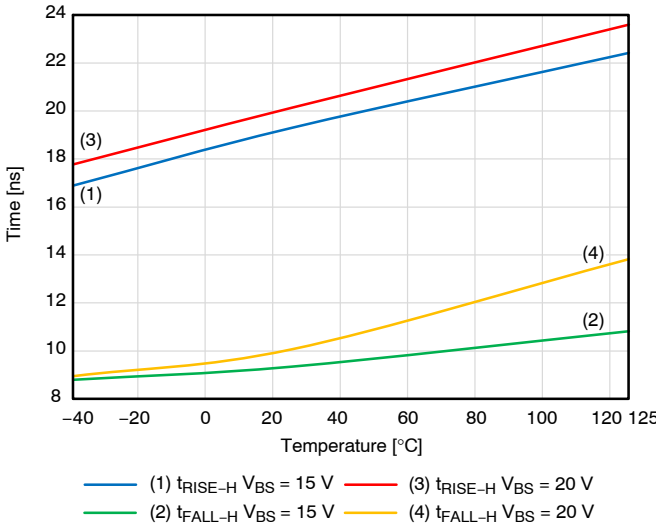


Figure 23. HO Rise – Fall Time

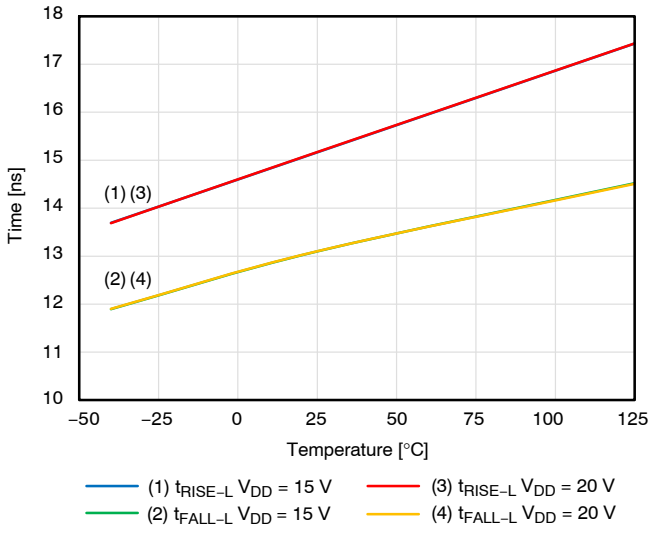


Figure 24. LO Rise – Fall Time

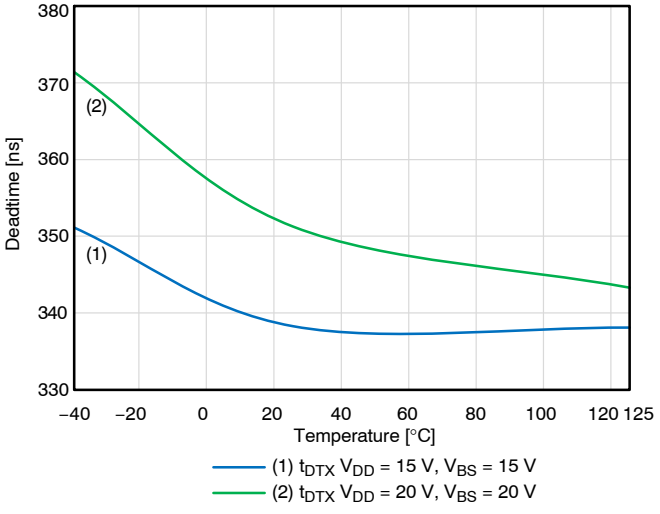


Figure 25. Deadtime

TYPICAL CHARACTERISTICS (continued)

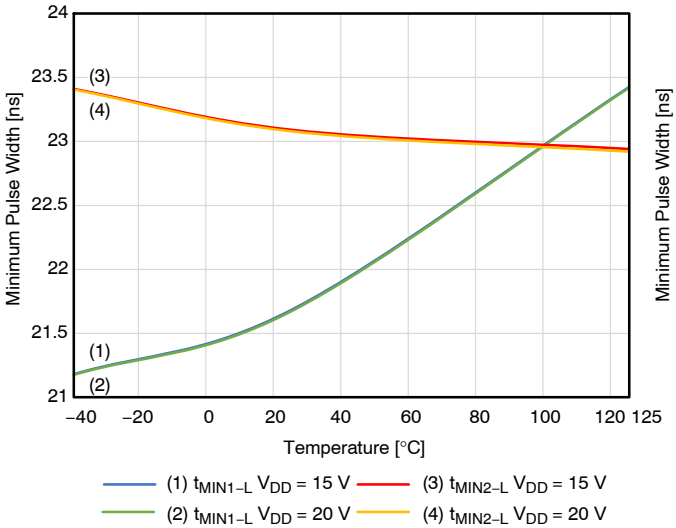


Figure 26. Minimum Pulse Width Filtering Time (LO)

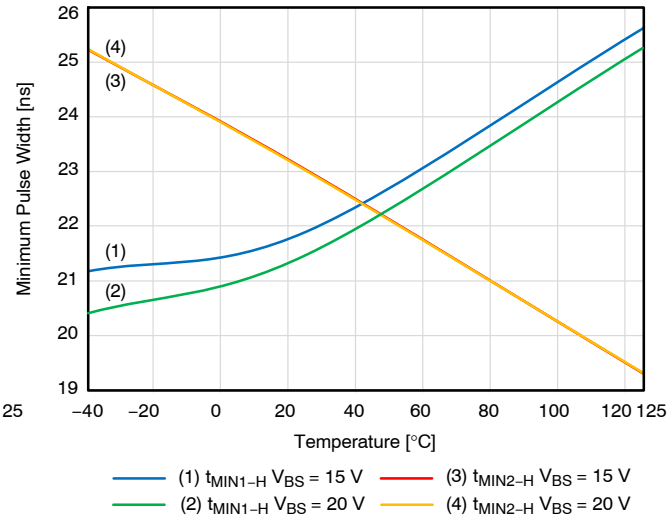


Figure 27. Minimum Pulse Width Filtering Time (HO)

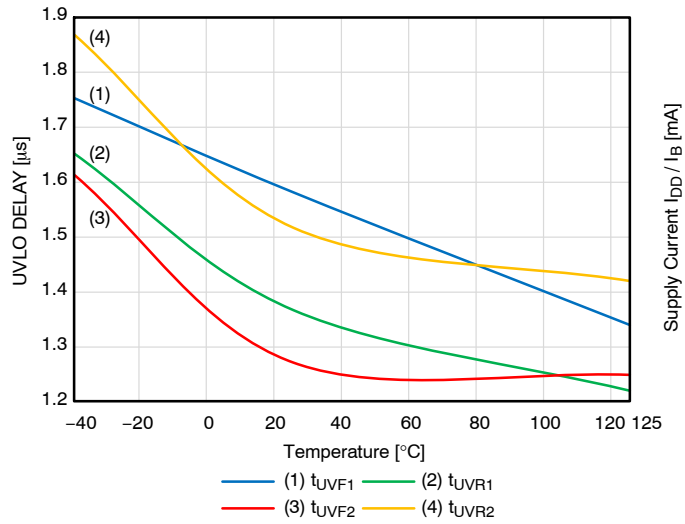


Figure 28. UVLO Delay

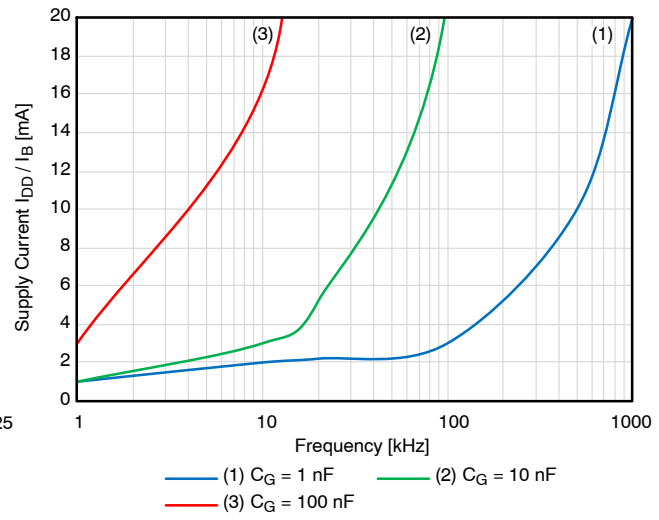


Figure 29. Power Supply Current vs. Switching Frequency (Duty Cycle 50%)

Under Voltage Lockout (UVLO)

UVLO ensures correct switching of IGBT connected to the driver output.

- The IGBT is turned−off, if the supply V_{DD} drops below $V_{UVLO1−OUT−OFF}$ or V_{BS} drops below $V_{UVLO2−OUT−OFF}$
- The driver output does not start to react to the input signal on HIN or LIN until the V_{DD} or V_{BS} rises above the $V_{UVLOX−OUT−ON}$

Power Supply (V_{DD}, V_{BS})

NCD57200 is designed to support unipolar power supply on both individual channels.

For reliable high output current suitable external power capacitors are required. Parallel combination of 100 nF + 4.7 μF ceramic capacitors is optimal for a wide range of applications using IGBT. For reliable driving of IGBT modules (containing several parallel IGBTs) a higher capacitance is required (typically 100 nF + 10 μF). Capacitors should be as close as possible to the driver's power pins.

Power supply of isolated (HO) channel can be provided by an external DC power supply or Bootstrap circuit.

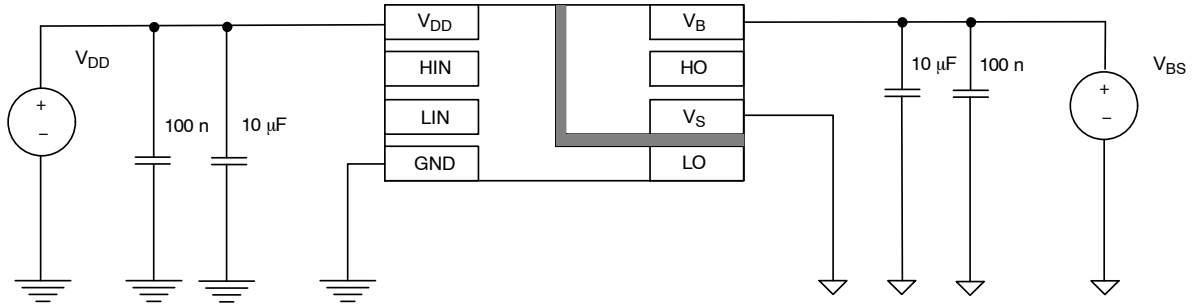


Figure 30. Unipolar Power Supply

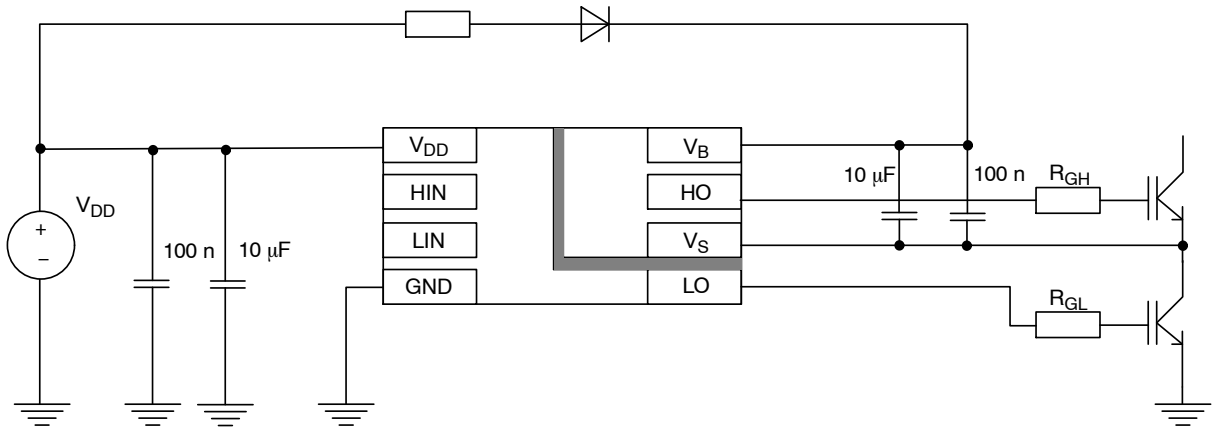


Figure 31. Bootstrap Power Supply

Signal Inputs (HIN, LIN)

Inputs of NCD57200 are active high. Outputs are in phase with inputs signals respecting internal logic (see Figure 5, 6, 7).

WARNING: When the application uses an independent or separate power supply for the control unit on the input side of the driver, all inputs should be protected by a serial resistor (In case of a power failure of the driver, the driver may be damaged due to overloading of the input protection circuits).

Common Mode Transient Immunity (CMTI)

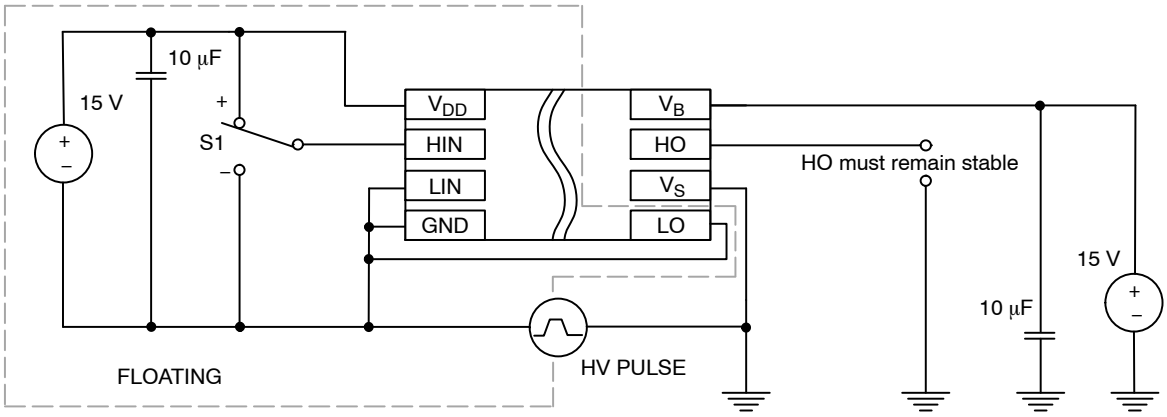
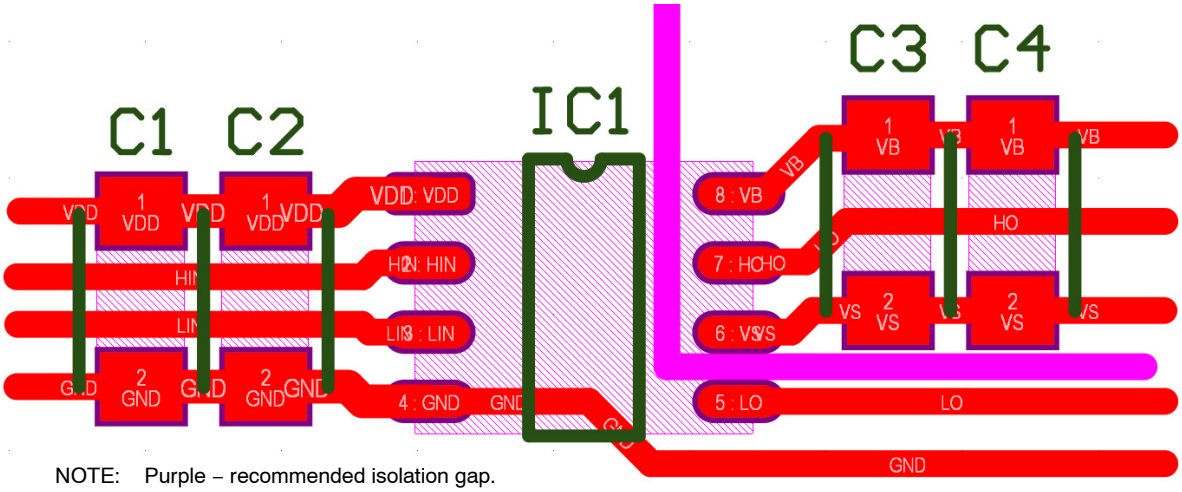


Figure 32. CMTI Test Setup
(Test Conditions: HV PULSE = ±900 V, dV/dt = 1−100 V/ns, V_{DD} = 15 V, V_B = 15 V)



NOTE: Purple − recommended isolation gap.

Figure 33. Recommended Layout

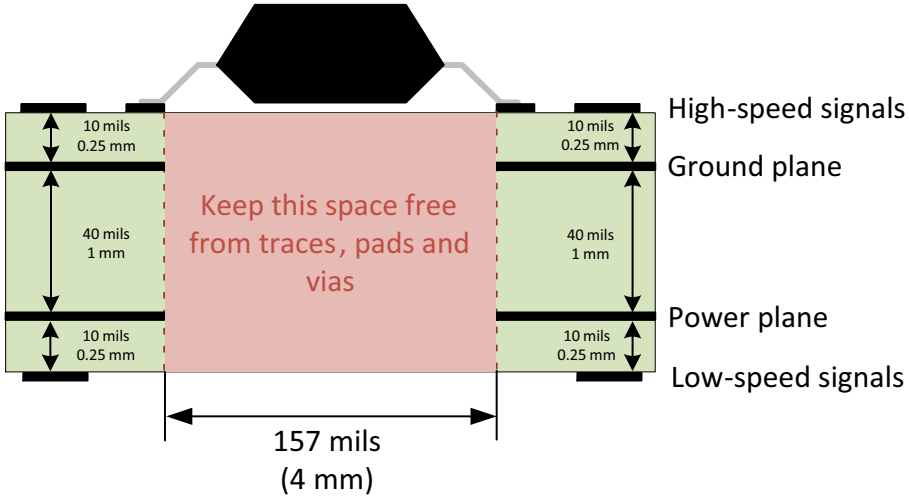


Figure 34. Recommended Layer Stack

ORDERING INFORMATION

Device	Package	Shipping†
NCD57200DR2G	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 Specifications Brochure, BRD8011/D.

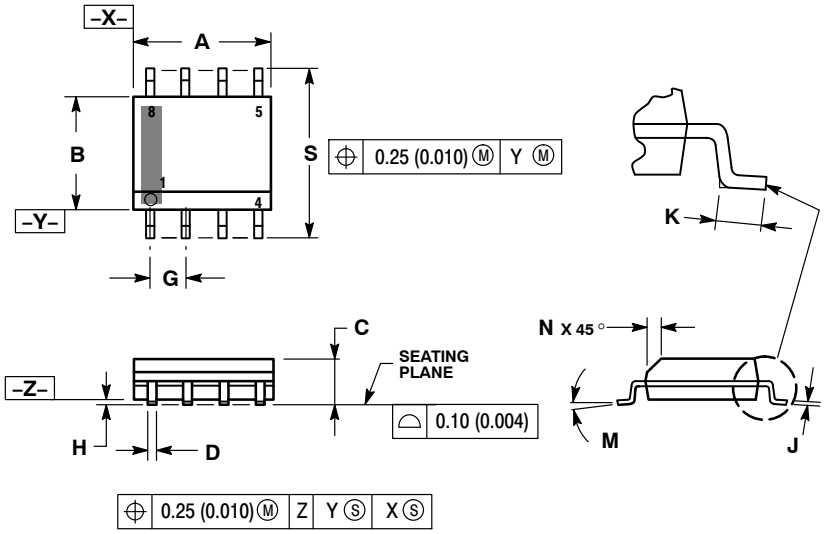
MECHANICAL CASE OUTLINE
PACKAGE DIMENSIONS



SCALE 1:1

SOIC−8 NB
CASE 751−07
ISSUE AK

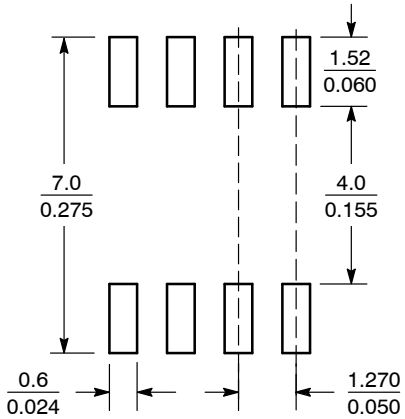
DATE 16 FEB 2011



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

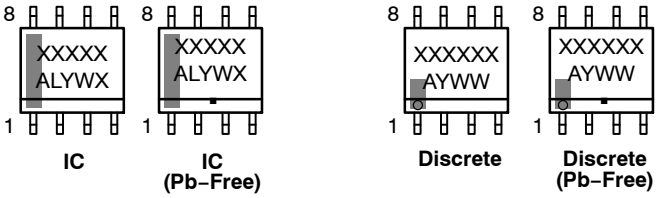
SOLDERING FOOTPRINT*



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.

GENERIC MARKING DIAGRAM*



IC | IC (Pb−Free) | Discrete | Discrete (Pb−Free)

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

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SOIC−8 NB
CASE 751−07
ISSUE AK

DATE 16 FEB 2011

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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