5 kV_{RMS}, 4.5-A/9-A Isolated Single Channel Gate Driver

NCV51153

The NCV51153 is a family of isolated single-channel gate driver with 4.5−A/9−A source and sink peak current respectively. They are designed for fast switching to drive power MOSFETs, IGBTs and SiC MOSFET power switches. The NCV51153 offers short and matched propagation delays. The NCV51153xA provides a split output that controls the rise and fall times individually. The NCV51153xB has its V_{CC} UVLO referenced to GND2.

The NCV51153 is available in a wide body SOIC−8 package and can support isolation voltage up to 5 kV_{RMS}.

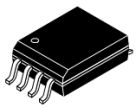
The NCV51153 offers other important protection function such as independent under-voltage lockout for primary and secondary side of the driver.

Features

- Feature Options
  - Separated Outputs (NCV51153xA)
  - Wide Bias Voltage Range Including Negative V_{EE} and V_{CC} UVLO Referenced to GND2 (NCV51153xB)
- 3−V to 20−V Input Supply Voltage
- Output Supply Voltage from 6.5 V to 30 V with 6−V and 9−V for MOSFET, 12−V and 17−V for SiC UVLO Threshold
- 4.5−A Peak Source, 9−A Peak Sink Output Current Capability
- 200 V/ns dV/dt Immunity
- Negative 5−V Handling Capability on Input Pins
- Propagation Delay Typical 36 ns with
  - 5 ns Max Delay Matching
- Gate Clamping During Short Circuit (NCV51153xA)
- AEC-Q100 Qualified for Automotive Application Requirements
- Isolation & Safety
  - 5 kV_{RMS} Isolation for 1 Minute (per UL1577 Requirements) (Planned)
  - 4242 V_{PK} Reinforced Isolation Voltage (per VDE0884-11 Requirements) (Planned)
  - CQC Certification per GB4943.1-2011 (Planned)
  - SGS FIMO Certification per IEC 62386-1 (Planned)

Typical Applications

- On-board Chargers
- xEV DC-DC Converters
- Traction Inverters
- Charging Stations

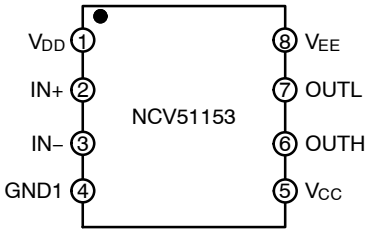


SOIC-8 WB
CASE 751EW

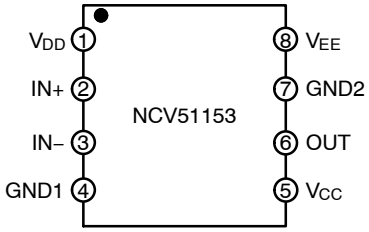
MARKING DIAGRAM

NCV51153	= Specific Device Code
X	= A or B or C or D for UVLO Option
Y	= A: Split Output, or B: VEE_GND2 for True UVLO
A	= Assembly Location
WL	= Wafer Lot
YY	= Year
WW	= Work Week

PIN CONNECTIONS



NCV51153xA

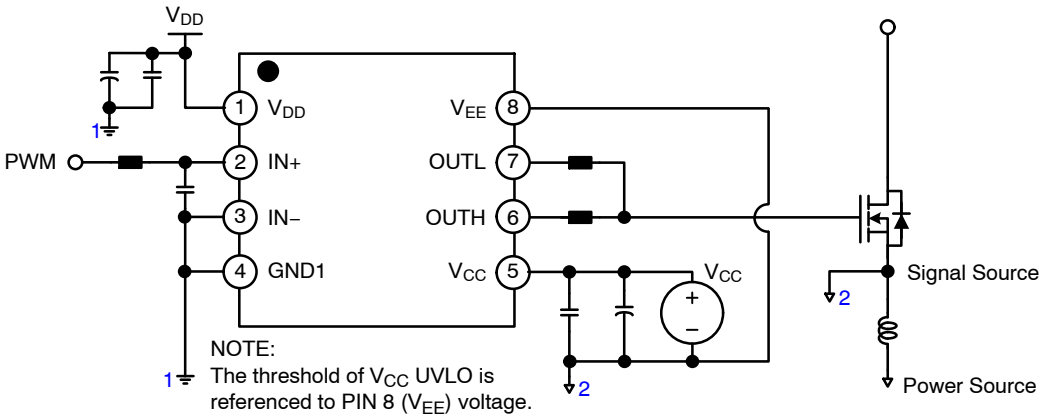


NCV51153xB

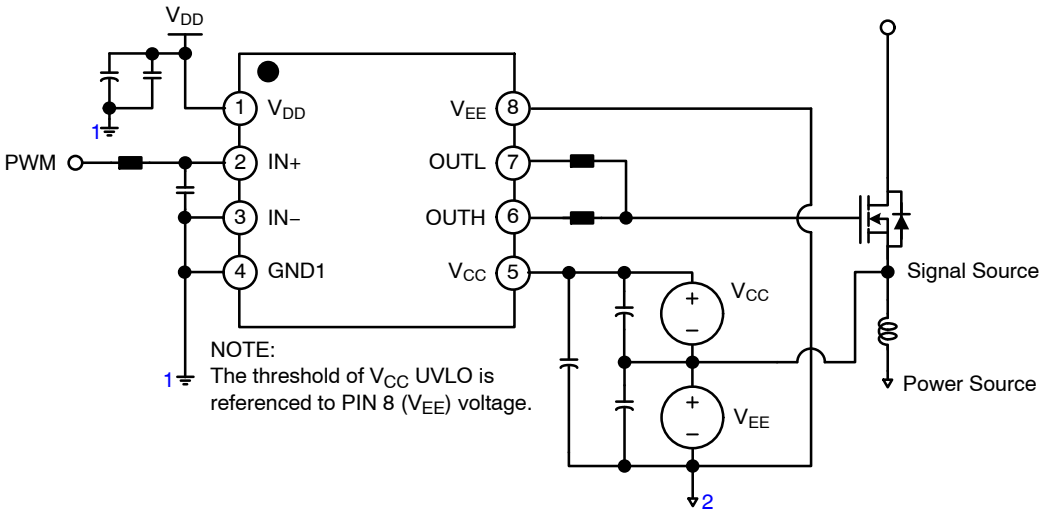
ORDERING INFORMATION

See detailed ordering and shipping information on page 22 of this data sheet.

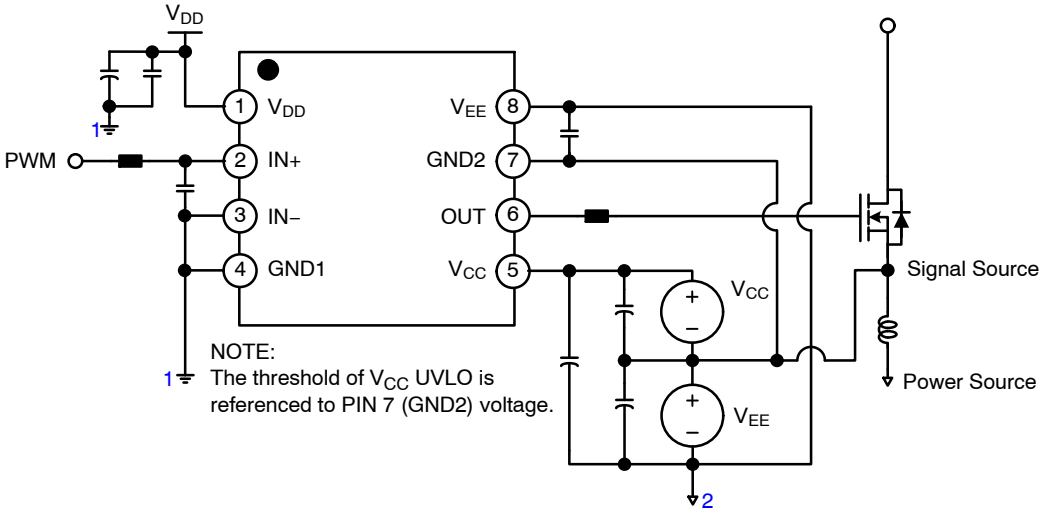
TYPICAL APPLICATION CIRCUIT



(a) Split Output for variant A



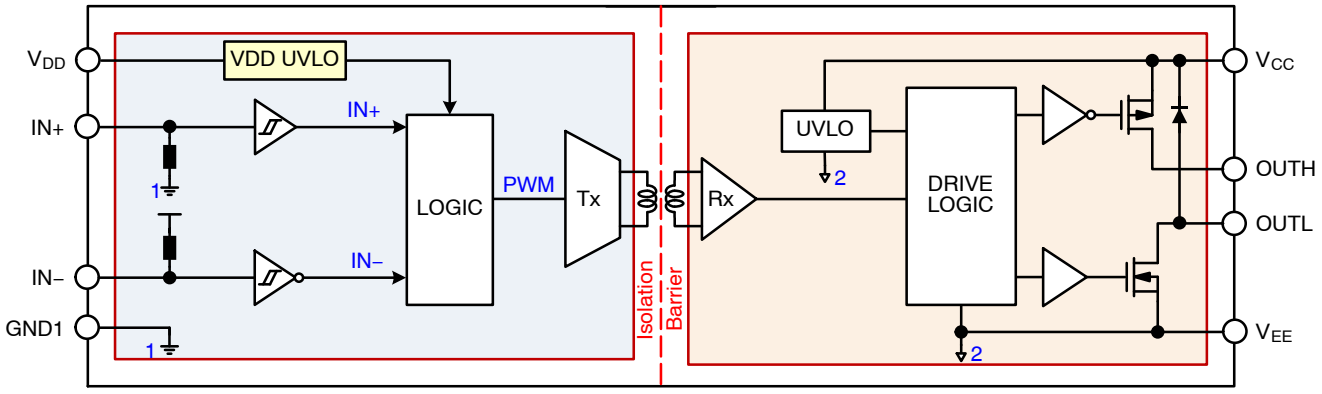
(b) Split Output and external negative bias for variant A



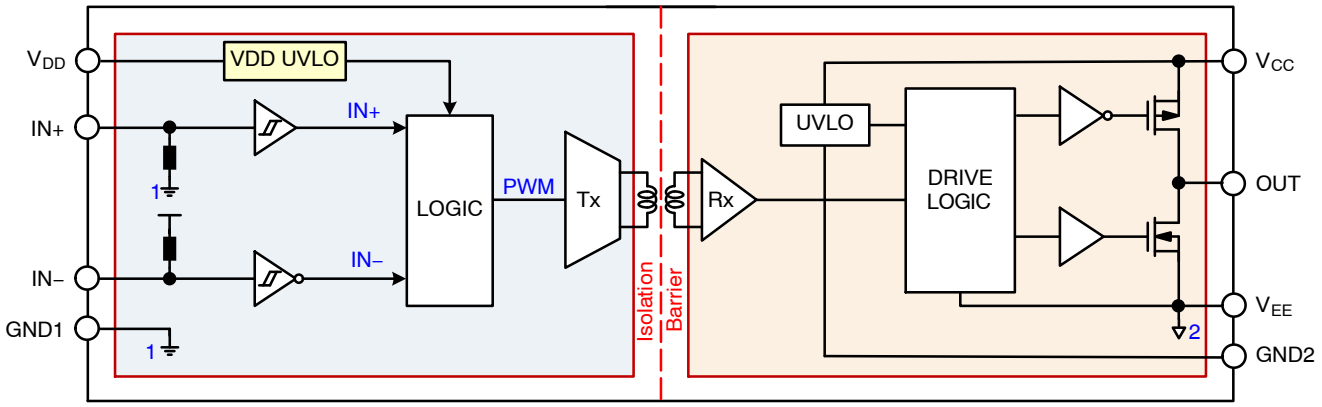
(c) External negative bias for variant B

Figure 1. Typical Application Schematic

FUNCTIONAL BLOCK DIAGRAM



(a) Separated Output (Variant A)



(b) V_{CC} UVLO Referenced to GND2 and external negative bias (Variant B)

Figure 2. Simplified Block Diagram

PIN CONNECTIONS

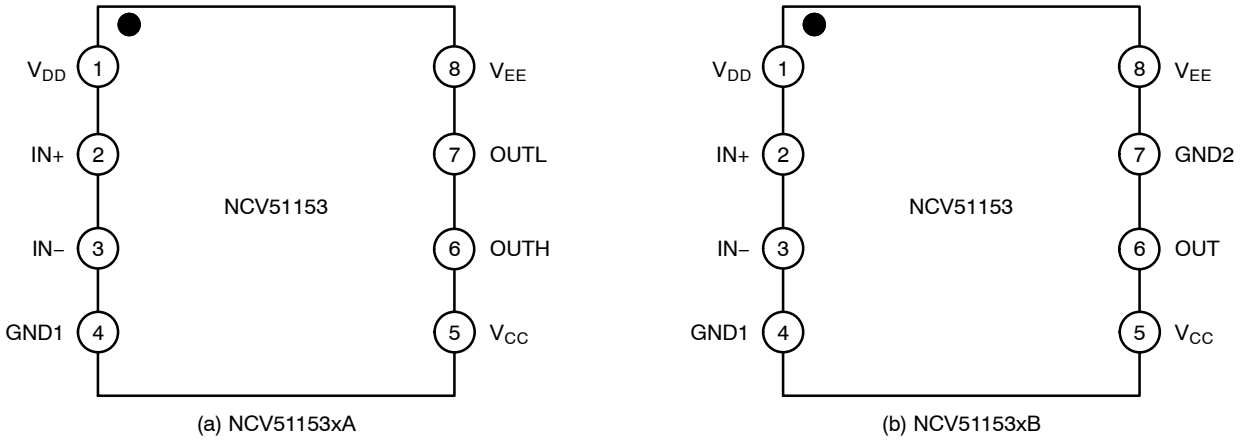


Figure 3. Pin Connections – SOIC-8 WB (Top View)

PIN FUNCTION DESCRIPTION

Pin Name	Pin No.		I/O	Description
	NCV51153xA	NCV51153xB		
V_{DD}	1	1	Power	Input-side Supply Voltage. It is recommended to place a bypass capacitor from V_{DD} to GND1.
IN+	2	2	Input	Non-inverting Logic Input with internal pull-down resistor to GND1.
IN–	3	3	Input	Inverting Logic Input with internal pull-up resistor to V_{DD}.
GND1	4	4	Power	Ground Input-side (all signals on input-side are referenced to this ground).
V_{CC}	5	5	Power	Positive Output Supply Rail.
OUTH	6	6	Output	Gate Drive Pull-up Output.
OUTL	7	–	Output	Gate Drive Pull-down Output.
GND2	–	7	Power	Gate-drive common pin. Connect this pin to the MOSFET source. V_{CC} UVLO with respect to GND2 for variant B.
V_{EE}	8	8	Power	Negative output supply rail for variant B and ground for variant A.

INSULATION RATINGS

Symbol	Parameter		Value	Unit
	Installation Classifications per DIN VDE 0110/1.89 Table 1 Rated Mains Voltage	<150 V_{RMS}	I–IV	
		<300 V_{RMS}	I–IV	
		<450 V_{RMS}	I–IV	
		<600 V_{RMS}	I–IV	
		<1000 V_{RMS}	I–III	
CTI	Comparative Tracking Index (DIN IEC 112/VDE 0303 Part 1)		600	
	Climatic Classification		40/125/21	
	Pollution Degree (DIN VDE 0110/1.89)		2	
V_{PR}	Input-to-Output Test Voltage, Method b, V_{IORM} x 1.875 = V_{PR}, 100% Production Test with t_m = 1 s, Partial Discharge < 5 pC		2250	V_{PK}
V_{IORM}	Maximum Repetitive Peak Isolation Voltage		1200	V_{PK}
V_{IOWM}	Maximum Working Voltage		870	V_{RMS}
V_{IOTM}	Maximum Transient Isolation Voltage		8400	V_{PK}
E_{CR}	External Creepage		8.0	mm
E_{CL}	External Clearance		8.0	mm
DTI	Insulation Thickness		17.3	μm
R_{IO}	Insulation Resistance at T_S, V_{IO} = 500 V		10^9	Ω

SAFETY LIMITING VALUE

Symbol	Parameter	Test Condition	Side	Value	Unit
P_S	Safety Supply Power	$R_{\theta JA}$ = 100 °C/W, T_A = 25 °C, T_J = 150 °C	INPUT	0.21	W
			OUTPUT	1.04	W
			TOTAL	1.25	W
T_S	Safety Temperature			150	°C

MAXIMUM RATINGS

Symbol		Parameter	Min	Max	Unit
V_{DD} to GND1		Power Supply Voltage – Input Side (Note 2)	–0.3	25	V
V_{CC} – GND2		Positive Supply Voltage – Driver Side	–0.3	33	V
VEE – GND2		Negative Supply Voltage for Only B Version (Note 3)	–18	0.3	V
V_{CC} – VEE		Differential Supply Voltage – Driver Side (Note 3)	–0.3	33	V
OUT to VEE		Driver Output Voltage (Note 3)	V_{EE} – 0.3	V_{CC} + 0.3	V
OUT to VEE, Transient for 200 ns (Note 4)			V_{EE} – 2	V_{CC} + 0.3	V
IN+, and IN–		Input Signal Voltages (Note 2)	–5	V_{DD} + 0.3	V
T_J		Junction Temperature	–40	+150	°C
T_S		Storage Temperature	–65	+150	°C
Electrostatic Discharge Capability	HBM (Note 5)	Human Body Model	–	2	kV
	CDM (Note 5)	Charged Device Model	–	1	kV

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, RECOMMENDED OPERATING RANGES and/or APPLICATION INFORMATION for Safe Operating parameters.
2. All voltage values are given with respect to GND1 pin.
3. All voltage values are given with respect to VEE pin.
4. This parameter verified by design and bench test, not tested in production.
5. 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)
   Latch up Current Maximum Rating: ≤100 mA per JEDEC standard: JESD78F.

THERMAL CHARACTERISTICS

Symbol	Parameter	PCB	Value	Unit
θ_{JA}	Secondary Thermal Resistance of Junction-Air (Note 6)	Type-A (Note 6)	100	°C/W
		Type-B (Note 7)	115	
Ψ_{JT}	Thermal Characterization Parameter Junction-Case Top	Type-A (Note 6)	13	
		Type-B (Note 7)	13	
P_D	Secondary Power Dissipation (Note 6)	Type-A (Note 6)	1.25	W
		Type-B (Note 7)	1.08	

6. Refer to ELECTRICAL CHARACTERISTICS, RECOMMENDED OPERATING RANGES and/or APPLICATION INFORMATION for Safe Operating parameters.
7. As specified for a reference layout shown in Figure 4. The DUT is mounted on a 65 x 40 x 1.6 mm FR4 substrate with an additional heat spreading copper of 240 mm^2/300 mm^2 (Primary/Secondary). The copper thickness is 1 oz and test conditions is under natural convection or zero air flow.

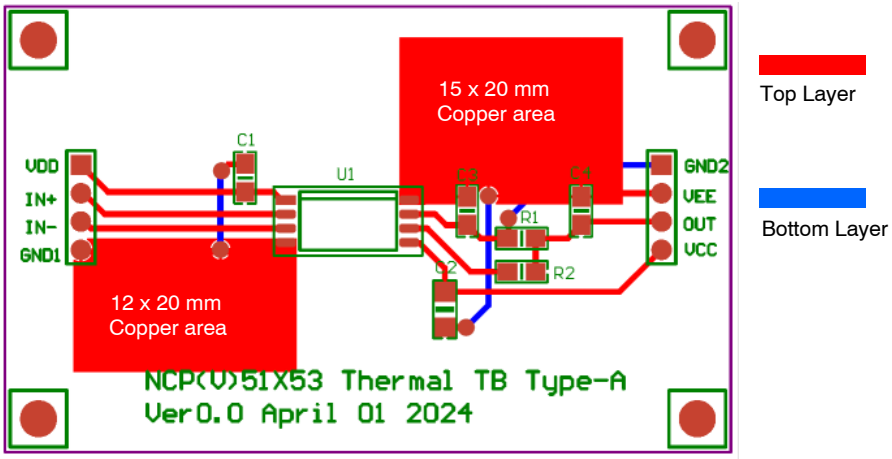


Figure 4. Reference Layout for the Type-A

8. As specified for a reference layout shown in Figure 5. The DUT is mounted on a 65 x 40 x 1.6 mm FR4 substrate with an additional heat spreading copper of 240 mm^2/300 mm^2 (Primary/Secondary). The copper thickness is 1oz and test conditions is under natural convection or zero air flow.

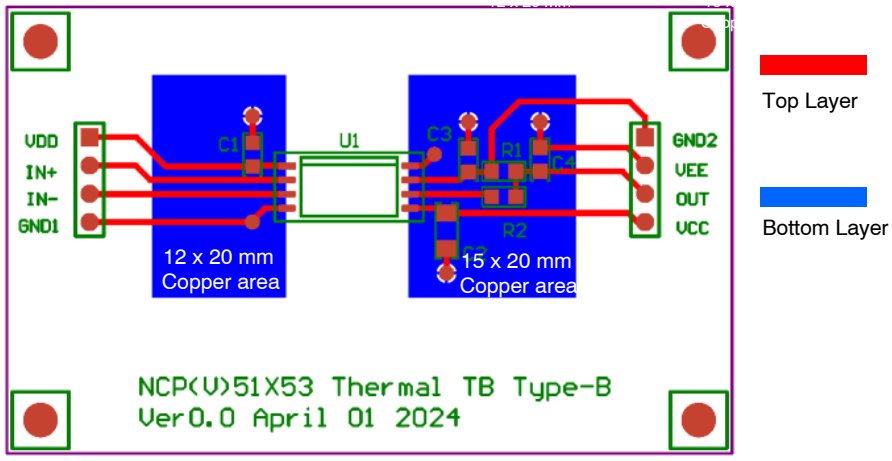


Figure 5. Reference Layout for the Type-B

RECOMMENDED OPERATING CONDITIONS

Symbol	Rating		Min	Max	Unit
V_{DD}	Power Supply Voltage – Input Side		3.0	20	V
V_{CC}	Power Supply Voltage – Driver Side (Note 9)	6–V UVLO Version	6.5	30	V
		9–V UVLO Version	9.5	30	V
		12–V UVLO Version	13.5	30	V
		17–V UVLO Version	18.5	30	V
VEE – GND2	Negative Supply Voltage for only Variant B (NCV51153xB)		–15	0	V
V_{IN}	Logic Input Voltage at Pins IN+, and IN–		0	V_{DD}	V
T_A	Ambient Temperature		–40	+125	°C
T_J	Junction Temperature		–40	+125	°C
CMTI	Common Mode Transient Immunity		200	–	kV/μs

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.

9. All V_{CC} UVLO threshold voltages of the variant A and B are given with respect to V_{EE} and GND2 pins respectively.

ISOLATION CHARACTERISTICS

Symbol	Parameter	Condition	Value	Unit
$V_{ISO,INPUT\ TO\ OUTPUT}$	Input to Output Isolation Voltage	T_A = 25 °C, Relative Humidity < 50%, t = 1.0 minute, I_{I-O} < 30 μA, 50 Hz (Note 10,11,12)	5000	V_{RMS}
R_{ISO}	Isolation Resistance	V_{I_O} = 500 V (Note 10)	10^{11}	Ω

10. Device is considered a two-terminal device: pins 1 to 4 are shorted together and pins 5 to 8 are shorted together.
11. 5,000 V_{RMS} for 1–minute duration is equivalent to 6,000 V_{RMS} for 1–second duration for input to output isolation test, and Impulse Test > 10 ms; sample tested for between channel isolation test.
12. The input-output isolation voltage is a dielectric voltage rating per UL1577. It should not be regarded as an input-output continuous voltage rating. For the continuous working voltage rating, refer to equipment-level safety specification or DIN VDE V 0884-11 Safety and Insulation Ratings Table.

ELECTRICAL CHARACTERISTICS

V_{DD} = 5 V, V_{CC} = 15 V, or 20 V (V_{EE} = 0 V for NCV51153xB) (Note 14) for typical values T_J = T_A = 25 °C, for min/max values T_J = −40 °C to +125 °C, unless otherwise specified. (Note 14))

Symbol	Parameter	Condition	Min	Typ	Max	Unit
PRIMARY POWER SUPPLY SECTION (VDD)						
I_{QVDD}	V_{DD} Quiescent Current	V_{IN+}= V_{IN-} = 0 V, V_{DD} = 5 V	500	715	1000	μA
		V_{IN+}= V_{IN-} = 0 V, V_{DD} = 15 V	600	870	1100	μA
		V_{IN+} = V_{IN-} = V_{DD}, V_{DD} = 5 V	500	720	1000	μA
		V_{IN+} = V_{IN-} = V_{DD}, V_{DD} = 15 V	600	870	1100	μA
I_{VDD}	V_{DD} Operating Current	V_{IN+} = V_{DD}, V_{IN-} = 0 V, V_{DD} = 5 V	4.5	6.4	8.0	mA
		V_{IN+} = V_{DD}, V_{IN-} = 0 V, V_{DD} = 15 V	5.0	6.6	8.4	mA
		f_{IN+} = 500 kHz, C_{OUT} = 200 pF, V_{DD} = 5 V	2.9	3.9	5.0	mA
		f_{IN+} = 500 kHz, C_{OUT} = 200 pF, V_{DD} = 15 V	3.0	4.1	5.2	mA
V_{DDUV+}	V_{DD} Supply Under-Voltage Positive-Going Threshold	V_{DD} = Sweep	2.7	2.8	2.9	V
V_{DDUV-}	V_{DD} Supply Under-Voltage Negative-Going Threshold	V_{DD} = Sweep	2.6	2.7	2.8	V
V_{DDHYS}	V_{DD} Supply Under-Voltage Lockout Hysteresis	V_{DD} = Sweep	–	0.1	–	V
t_{VDDUV}	Debounce Time (Note 15)		–	–	10	μs
SECONDARY POWER SUPPLY SECTION						
I_{QVCC}	V_{CC} Quiescent Current	V_{IN+} = V_{IN-} = 0 V or 5 V, No Load	200	385	700	μA
		V_{IN+} = 5 V, V_{IN-} = 0 V, No Load	200	507	800	μA
I_{VCC}	V_{CC} Operating Current	f_{IN+} = 500 kHz, C_{OUT} = 200 pF, V_{CC} = 15 V	3.0	4.2	5.0	mA
		f_{IN+} = 500 kHz, C_{OUT} = 200 pF, V_{CC} = 20 V	3.7	5.2	6.2	mA
VCC UVLO THRESHOLD (6−V UVLO VERSION)						
V_{CCUV+}	V_{CC} Supply Under-Voltage Positive-Going Threshold (Note 9)		5.7	6.0	6.4	V
V_{CCUV-}	V_{CC} Supply Under-Voltage Negative-Going Threshold		5.3	5.7	6.0	V
V_{CCHYS}	Under-Voltage Lockout Hysteresis		–	0.3	–	V
t_{VCCUV}	UVLO Filter Debounce Time (Note 15)		–	–	10	μs
VCC UVLO THRESHOLD (9−V UVLO VERSION)						
V_{CCUV+}	V_{CC} Supply Under-Voltage Positive-Going Threshold (Note 9)		8.2	8.7	9.2	V
V_{CCUV-}	V_{CC} Supply Under-Voltage Negative-Going Threshold		7.7	8.2	8.7	V
V_{CCHYS}	Under-Voltage Lockout Hysteresis		–	0.5	–	V
t_{VCCUV}	UVLO Filter Debounce Time (Note 15)		–	–	10	μs
VCC UVLO THRESHOLD (12−V UVLO VERSION)						
V_{CCUV+}	V_{CC} Supply Under-Voltage Positive-Going Threshold (Note 9)		11	12	13	V
V_{CCUV-}	V_{CC} Supply Under-Voltage Negative-Going Threshold		10	11	12	V
V_{CCHYS}	Under-Voltage Lockout Hysteresis		–	1.0	–	V
t_{VCCUV}	UVLO Filter Debounce Time (Note 15)		–	–	10	μs

ELECTRICAL CHARACTERISTICS

V_{DD} = 5 V, V_{CC} = 15 V, or 20 V (V_{EE} = 0 V for NCV51153xB) (Note 14) for typical values T_J = T_A = 25 °C, for min/max values T_J = −40 °C to +125 °C, unless otherwise specified. (Note 14)) (continued)

Symbol	Parameter	Condition	Min	Typ	Max	Unit
VCC UVLO THRESHOLD (17−V UVLO VERSION)						
V_{CCUV+}	V_{CC} Supply Under-Voltage Positive-Going Threshold (Note 9)		16	17	18	V
V_{CCUV-}	V_{CC} Supply Under-Voltage Negative-Going Threshold		15	16	17	V
V_{CCHYS}	Under-Voltage Lockout Hysteresis		–	1.0	–	V
t_{VCCUV}	UVLO Filter Debounce Time (Note 15)		–	–	10	μs
LOGIC INPUT SECTION (IN+, AND IN−)						
V_{INH}	High Level Input Voltage		1.4	1.63	2.0	V
V_{INL}	Low Level Input Voltage		0.8	1.08	1.4	V
V_{INHYS}	Input Logic Hysteresis		–	0.55	–	V
I_{IN+H}	High Level Logic Input Bias Current at IN+	V_{IN+} = 5 V	33	40	52	μA
I_{IN+L}	Low Level Logic Input Bias Current at IN−	V_{IN+} = GND1	–	–	1.0	μA
I_{IN-H}	High Level Logic Input Bias Current at IN+	V_{IN-} = 5 V	−1.0	–	–	μA
I_{IN-L}	Low Level Logic Input Bias Current at IN−	V_{IN-} = GND1	−52	−40	−33	μA
R_{IN}	Logic Input Pull-Up/Down Resistance		95	125	155	kΩ
SHORT CIRCUIT SECTION						
$V_{CLP-OUT}$	Clamping Voltage, Sourcing (V_{OUTH} −V_{CC} or V_{OUT} − V_{CC})	IN+ = High, IN− = Low, t_{CLAMP} = 10 μs I_{OUTH} or I_{OUT} = 500 mA	–	0.7	1.75	V
	Clamping Voltage, Sinking (V_{EE} − V_{OUTL} or V_{EE} − V_{OUT})	IN+ = Low, IN− = High, t_{CLAMP} = 10 μs I_{OUTH} or I_{OUT} = −500 mA	–	0.24	0.5	V
GATE DRIVE SECTION						
I_{OUT+}	Source Peak Current (Note 15)	V_{IN+} = 5 V, PW ≤ 5 μs	2.6	4.5	–	A
I_{OUT-}	Sink Peak Current (Note 15)	V_{IN+} = 0 V, PW ≤ 5 μs	7.0	9.0	–	A
R_{OH}	Output Resistance at High State	I_{OUTH} = 100 mA	–	1.4	2.8	Ω
R_{OL}	Output Resistance at Low State	I_{OUTL} = 100 mA	–	0.5	1.0	Ω
V_{OH}	High Level Output Voltage (V_{CC} − V_{OUT})	I_{OUTH} = 100 mA	–	140	280	mV
V_{OL}	Low Level Output Voltage (V_{OUT} − V_{EE})	I_{OUTL} = 100 mA	–	50	100	mV

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.

13. Performance guaranteed over the indicated operating temperature range by design and/or characterization tested at T_J = T_A = 25 °C.
14. V_{CC} = 15 V is used for the test condition of 5−V, and 8−V UVLO, V_{CC} = 20 V is used for 12−V and 17−V UVLO.
15. These parameters verified by bench test only and not tested in production

DYNAMIC ELECTRICAL CHARACTERISTICS

Symbol	Parameter	Condition	Min	Typ	Max	Unit
t_{PDON}	Turn-On Propagation Delay from IN to OUT	C_{LOAD} = 0 nF	20	36	55	ns
t_{PDOFF}	Turn-Off Propagation Delay from IN to OUT		20	36	55	ns
t_{PWD}	Pulse Width Distortion (t_{PDON} − t_{PDOFF})		−5	–	5	ns
$t_{SK(PP)}$	Propagation Part-to-part Skew (Note 16)		−20	–	20	ns
$t_{VPOR\ to\ OUT}$	Power-up Delay from the V_{POR} to Output (Note 16)	See the Figure 47	–	18	–	μs
t_R	Turn-On Rise Time	C_{LOAD} = 1.8 nF	–	12	22	ns
t_F	Turn-Off Fall Time	C_{LOAD} = 1.8 nF	–	8.3	22	ns
t_{PW}	Minimum Input Pulse Width that Change Output State	C_{LOAD} = 0 nF	–	15	35	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.

16. These parameters verified by bench test only and not tested in production

INSULATION CHARACTERISTICS CURVES

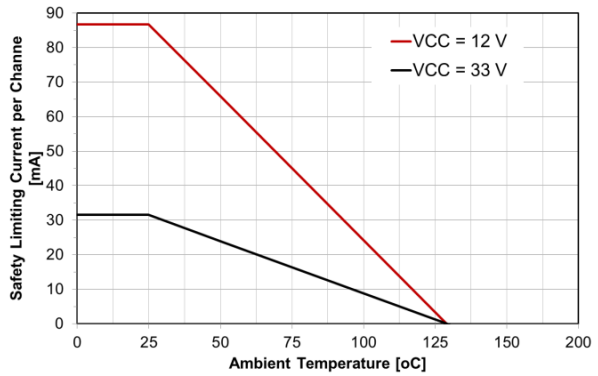


Figure 6. Thermal Derating Curve for Safety-related Limiting Current (θ_{JA} = 100 °C/W) (Note 7)

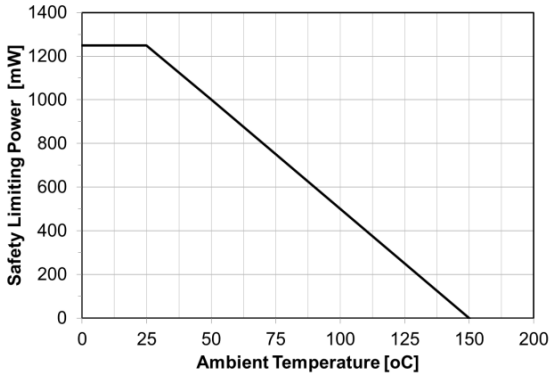


Figure 7. Thermal Derating Curve for Safety-related Limiting Power (θ_{JA} = 100 °C/W) (Note 7)

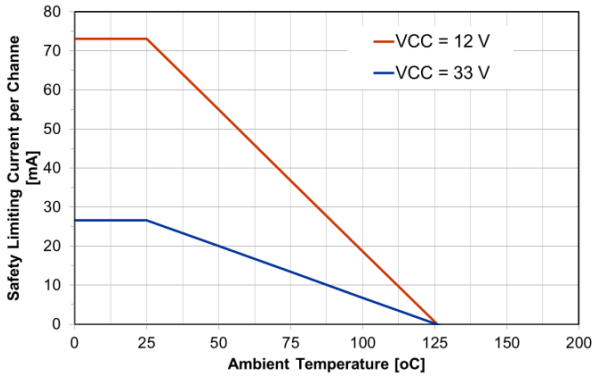


Figure 8. Thermal Derating Curve for Safety-related Limiting Current (θ_{JA} = 115 °C/W) (Note 8)

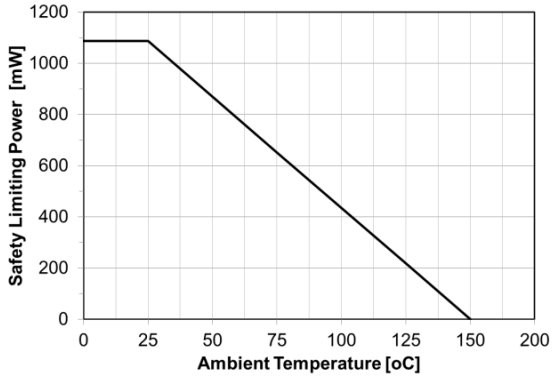


Figure 9. Thermal Derating Curve for Safety-related Limiting Power (θ_{JA} = 115 °C/W) (Note 8)

TYPICAL CHARACTERISTICS

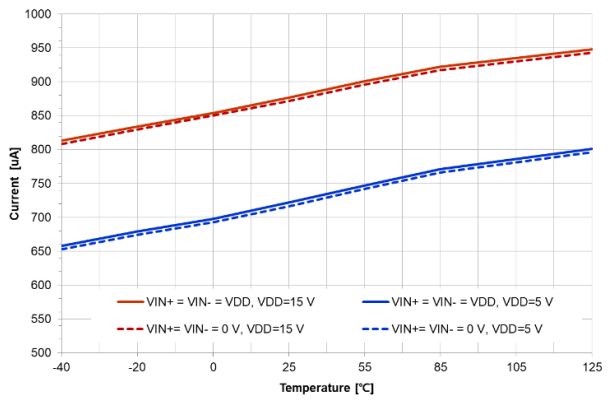


Figure 10. V_{DD} Quiescent Current vs. Temperature

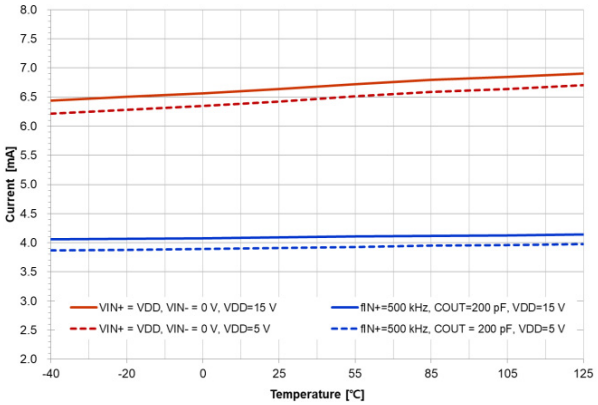


Figure 11. V_{DD} Quiescent Current vs. Temperature

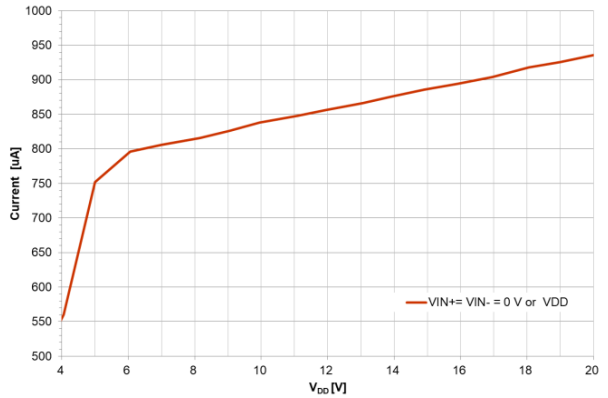


Figure 12. V_{DD} Quiescent Current vs. V_{DD}

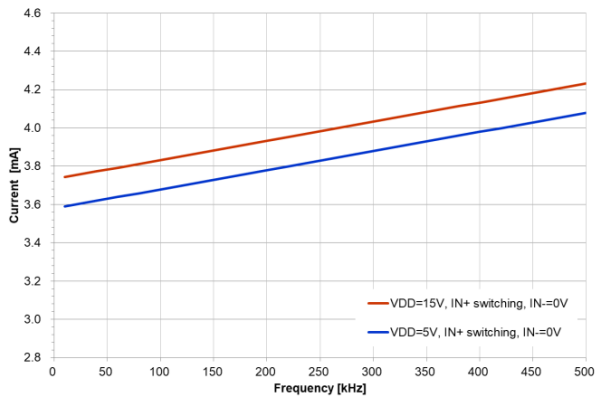


Figure 13. V_{DD} Operating Current vs. Switching Frequency

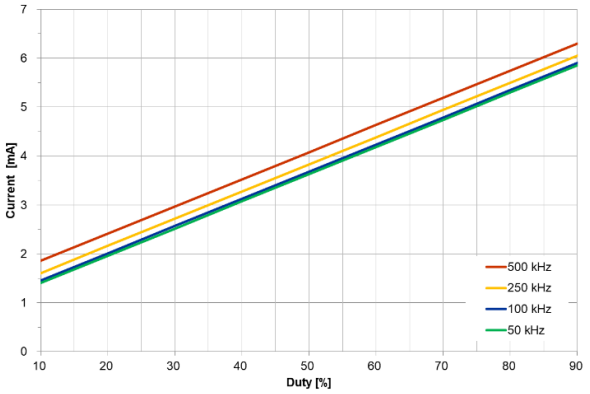


Figure 14. V_{DD} Operating Current vs. Duty (V_{DD} = 5 V, IN+ Switching with Different Frequency, IN− = 0 V)

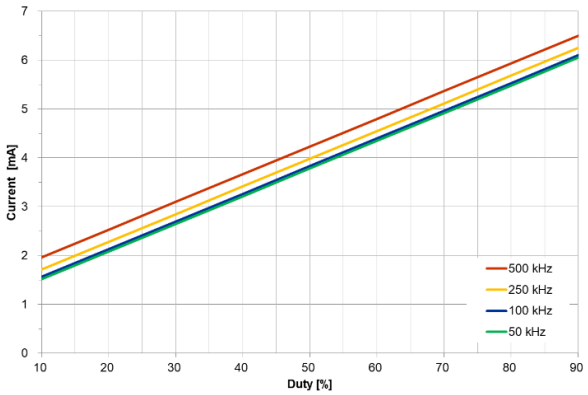


Figure 15. V_{DD} Operating Current vs. Duty (V_{DD} = 15 V, IN+ Switching with Different Frequency, IN− = 0 V)

TYPICAL CHARACTERISTICS (continued)

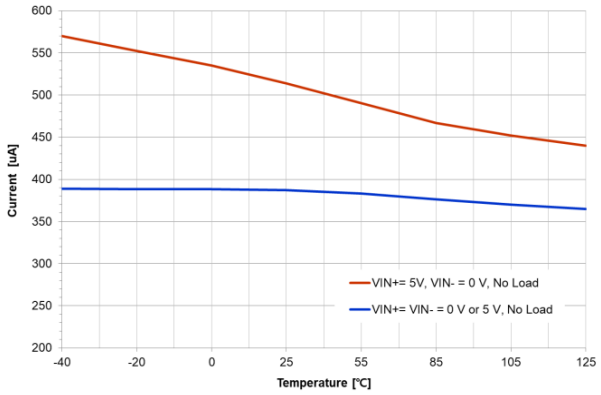


Figure 16. Quiescent V_{CC} Supply Current vs. Temperature

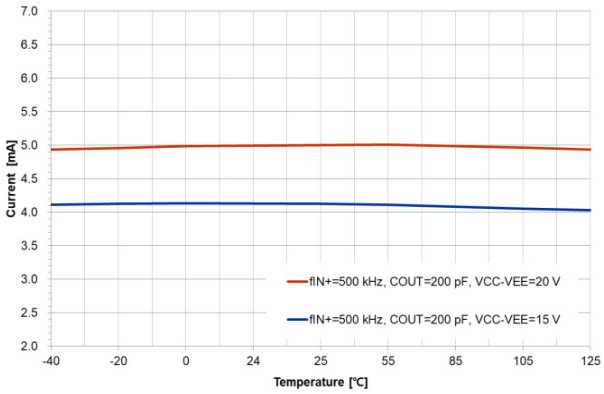


Figure 17. V_{CC} Operating Current vs. Temperature

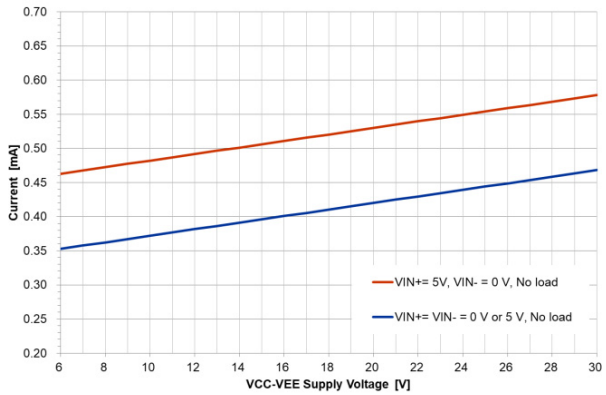


Figure 18. Quiescent V_{CC} Supply Current vs. V_{CC} Supply Voltage

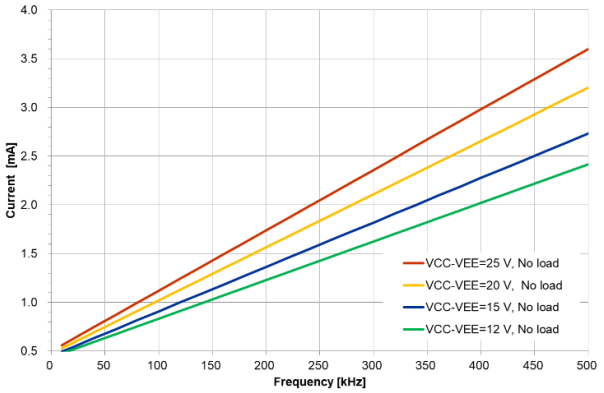


Figure 19. V_{CC} Operating Current vs. Switching Frequency (V_{CC} – V_{EE} = 12/15/20/25 V and No Load)

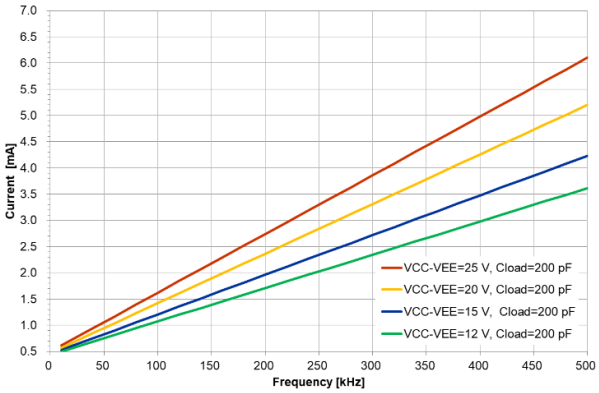


Figure 20. V_{CC} Operating Current vs. Switching Frequency (V_{CC} – V_{EE} = 12/15/20/25 V and C_{LOAD} = 200 pF)

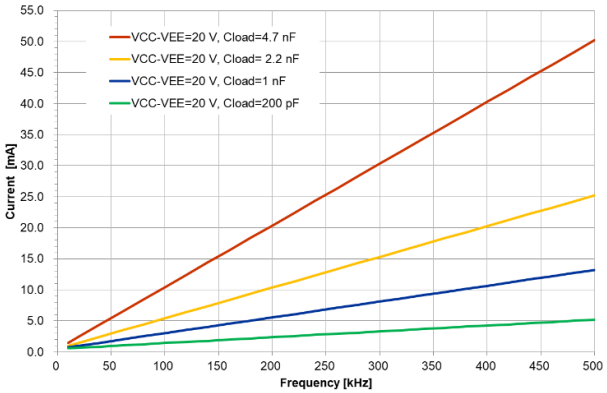


Figure 21. V_{CC} Operating Current vs. Switching Frequency (V_{CC} – V_{EE} = 20 V and Different C_{LOAD})

TYPICAL CHARACTERISTICS (continued)

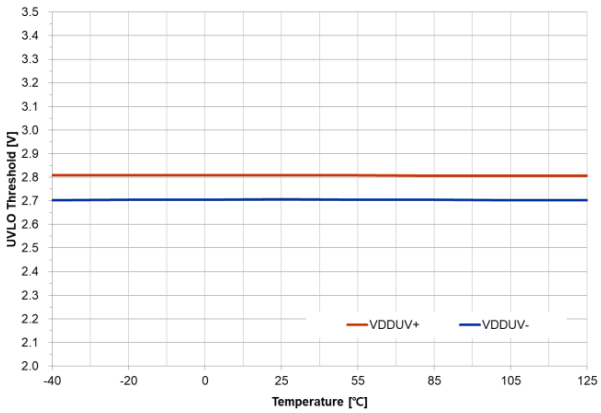


Figure 22. V_{DD} UVLO vs. Temperature

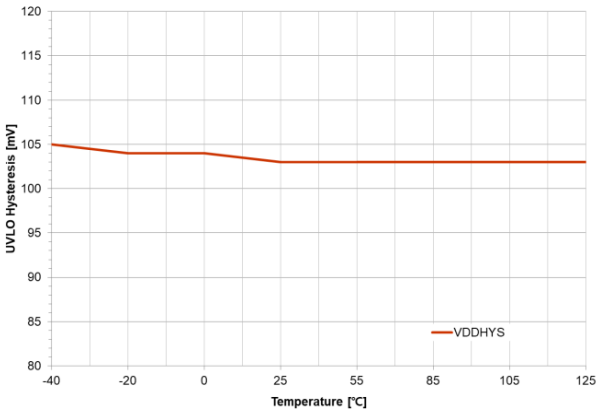


Figure 23. V_{DD} UVLO Hysteresis vs. Temperature

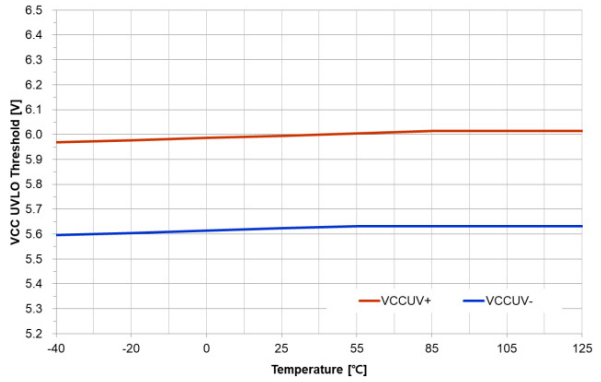


Figure 24. V_{CC} 6−V UVLO Threshold vs. Temperature

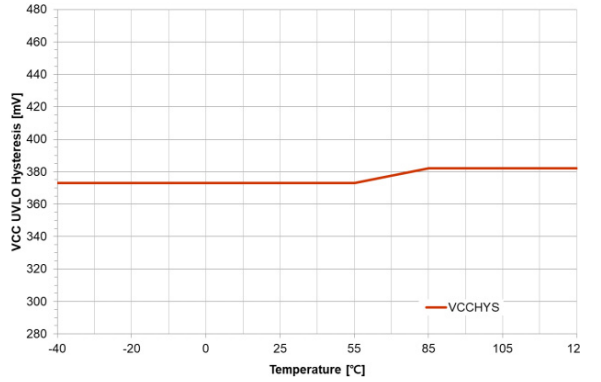


Figure 25. V_{CC} 6−V UVLO Hysteresis vs. Temperature

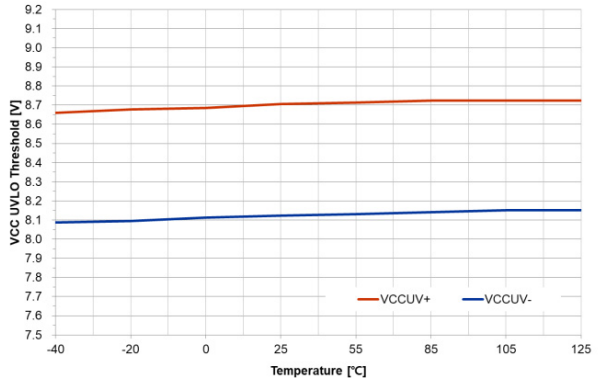


Figure 26. V_{CC} 9−V UVLO Threshold vs. Temperature

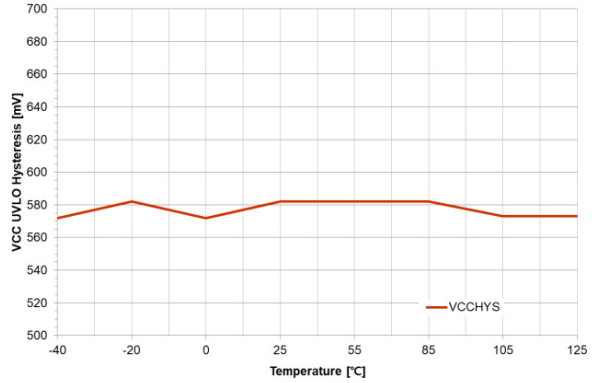


Figure 27. V_{CC} 9−V UVLO Hysteresis vs. Temperature

TYPICAL CHARACTERISTICS (continued)

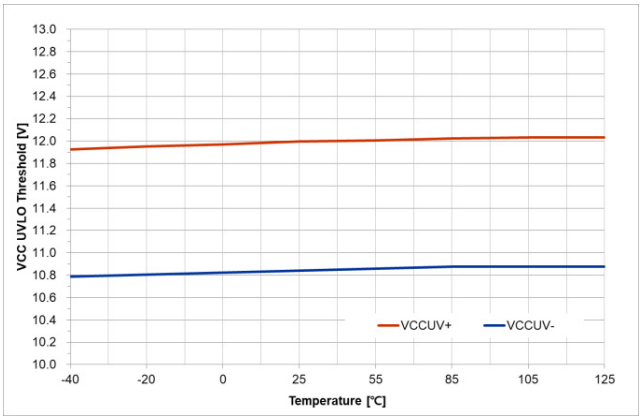


Figure 28. V_{CC} 12−V UVLO Threshold vs. Temperature

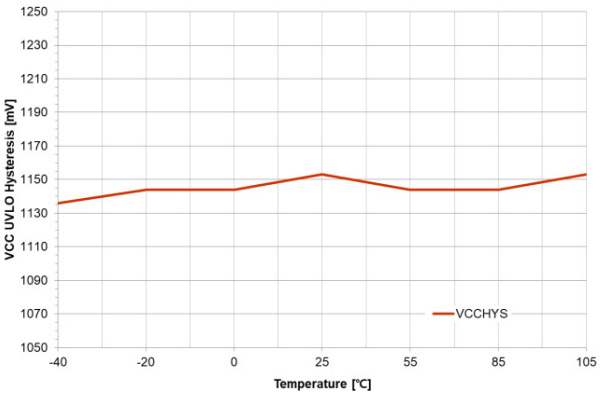


Figure 29. V_{CC} 12−V UVLO Hysteresis vs. Temperature

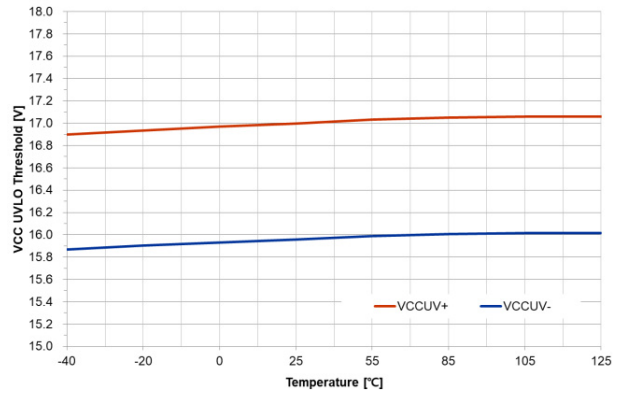


Figure 30. V_{CC} 17−V UVLO Threshold vs. Temperature

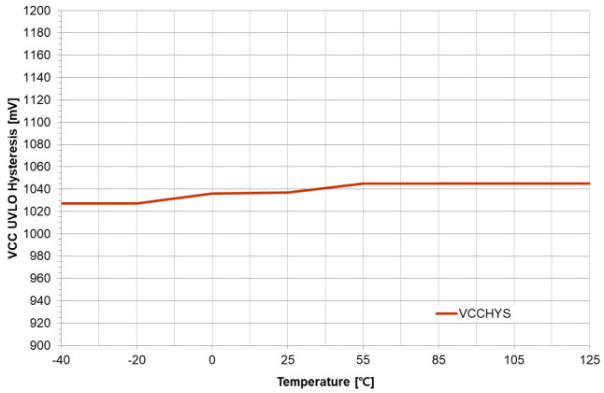


Figure 31. V_{CC} 17−V UVLO Hysteresis vs. Temperature

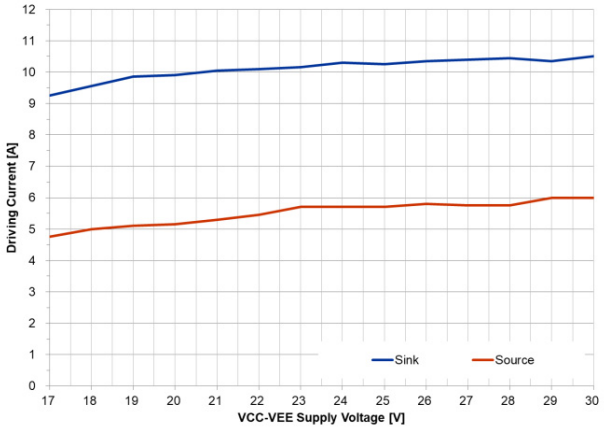


Figure 32. Output Current vs. V_{CC} Supply Voltage

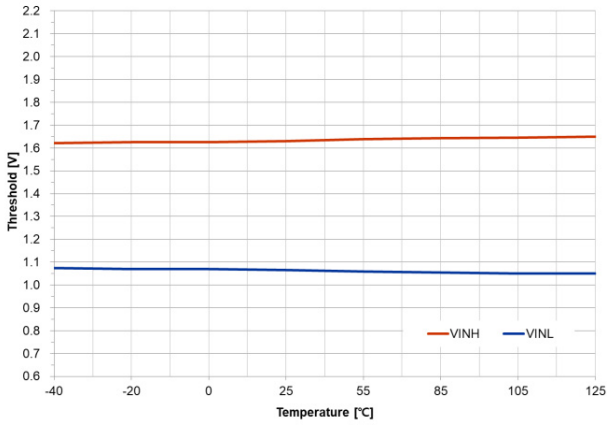


Figure 33. Input Logic Threshold vs. Temperature

TYPICAL CHARACTERISTICS (continued)

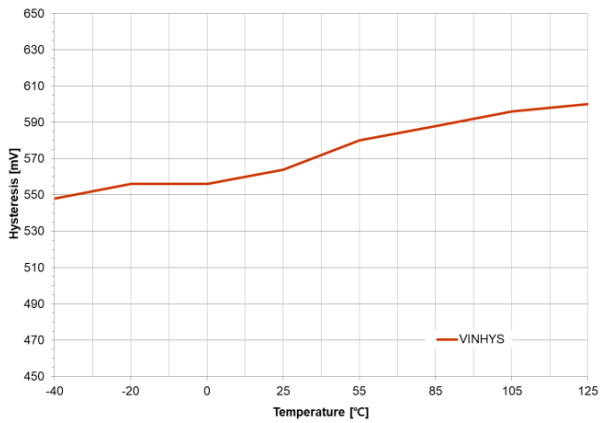


Figure 34. Input Logic Hysteresis vs. Temperature

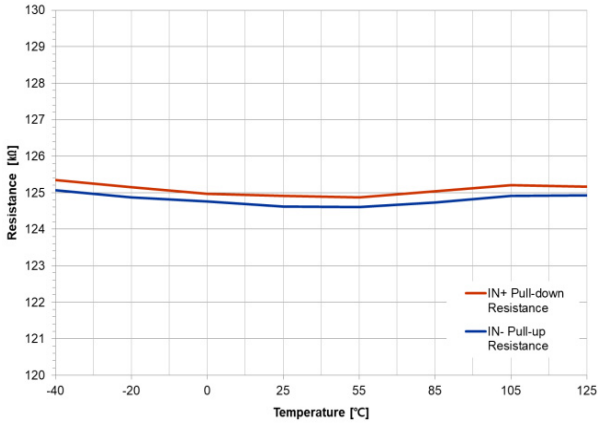


Figure 35. Logic Input Pull-Up/Down Resistance vs. Temperature

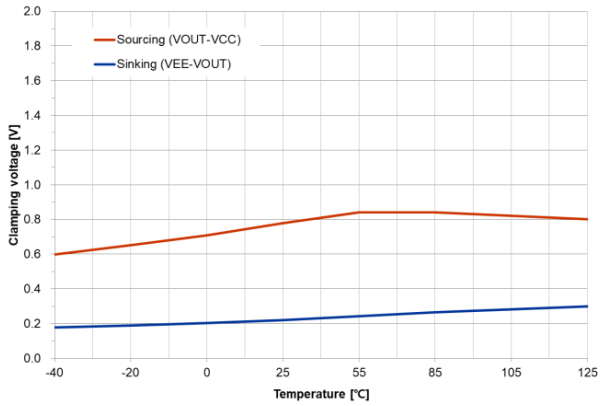


Figure 36. Clamping Voltage vs. Temperature

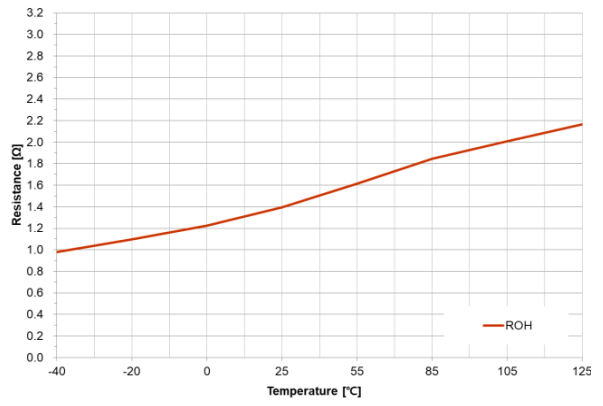


Figure 37. Output Resistance at High State vs. Temperature

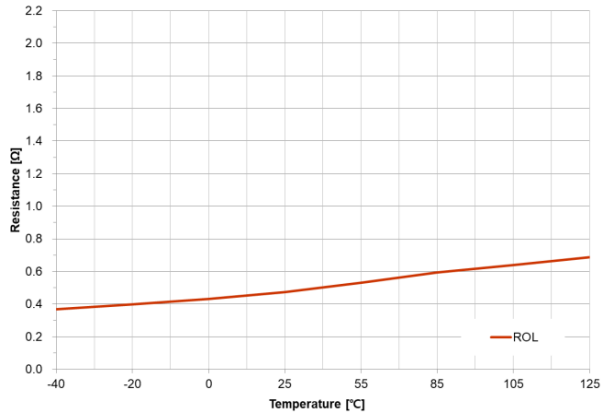


Figure 38. Output Resistance at Low State vs. Temperature

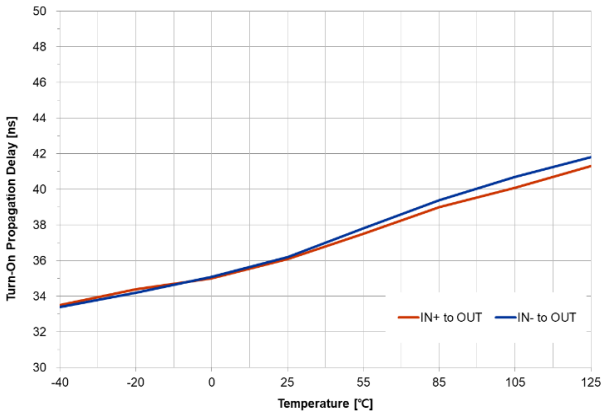


Figure 39. Turn-on Propagation Delay vs. Temperature (C_{LOAD} = 0 nF)

TYPICAL CHARACTERISTICS (continued)

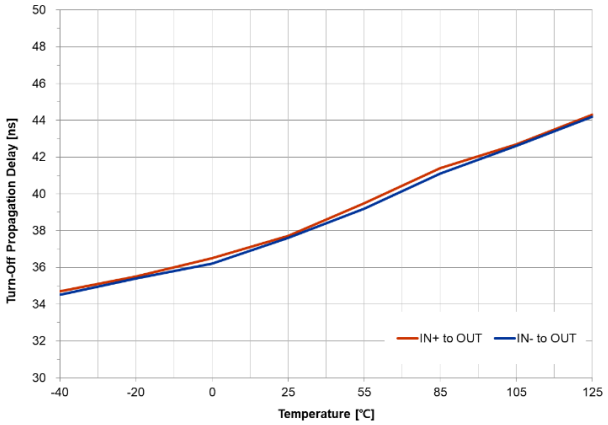


Figure 40. Turn-off Propagation Delay vs. Temperature (C_{LOAD} = 0 nF)

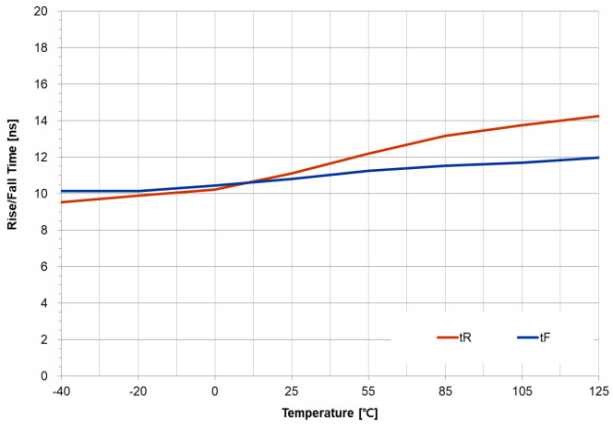


Figure 41. Rise/Fall Time vs. Temperature (C_{LOAD} = 1.8 nF)

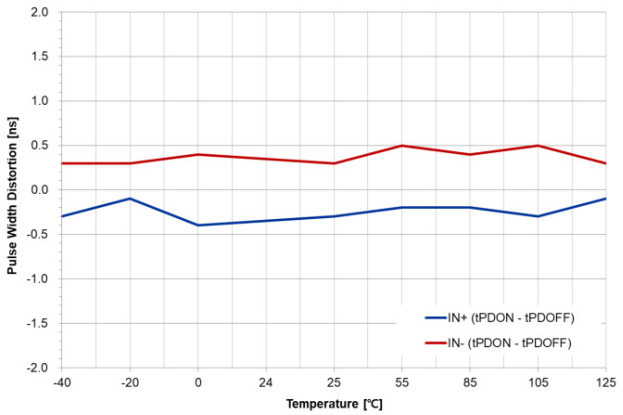


Figure 42. Pulse Width Distortion vs. Temperature (CLOAD = 0 nF)

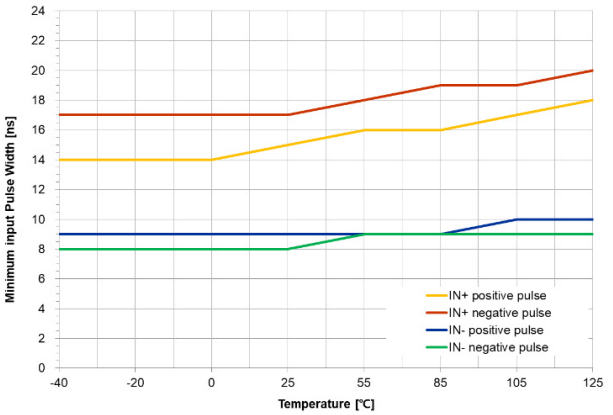


Figure 43. Minimum Input Pulse Width vs. Temperature

PARAMETER MEASUREMENT DEFINITION

Switching Time Definitions

Figure 44 shows the switching time waveforms definitions of the turn-on (t_{PDON}) and turn-off (t_{PDOFF}) propagation delay times among the driver's input signal IN+ and output signal OUT. The typical values of the propagation delay (t_{PDON}, t_{PDOFF}), pulse width distortion (t_{PWD}) and delay matching between channel times are specified in the electrical characteristics table.

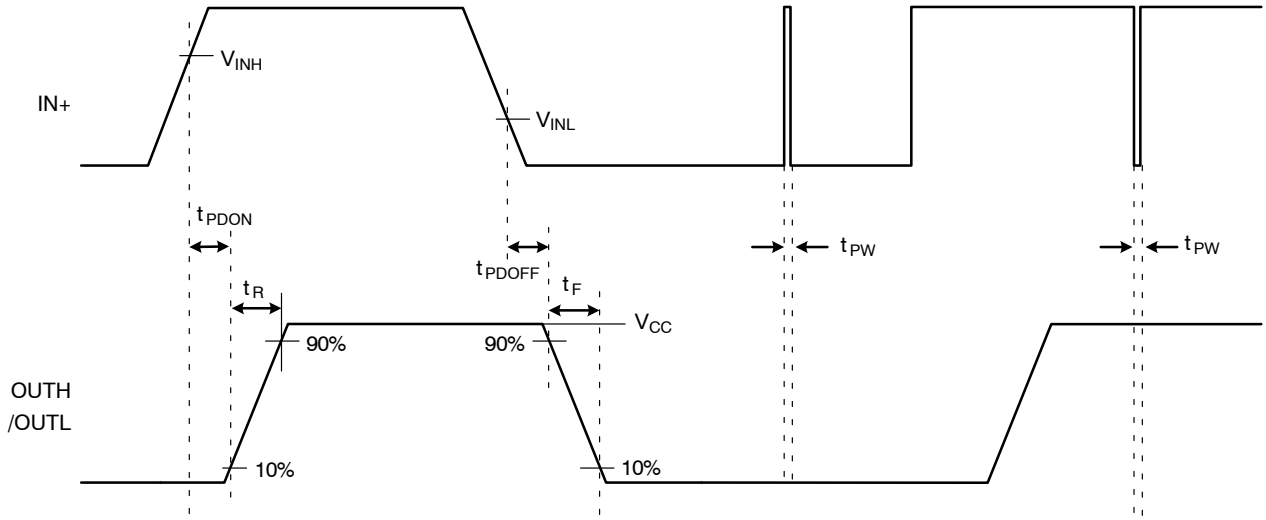


Figure 44. Switching Time Definition

Input to Output Operation Definitions

The NCV51153 provides important protection functions such as independent under-voltage lockout for gate driver. Figure 45 shows an overall input to output timing diagram. Under-Voltage Lockout protection on the primary and secondary−side power supplies events in the *CASE-A, B and C* and the gate driver output (OUT) is immediately turned off when two input signal (IN+ and IN−) are HIGH at same time in the *CASE-D*.

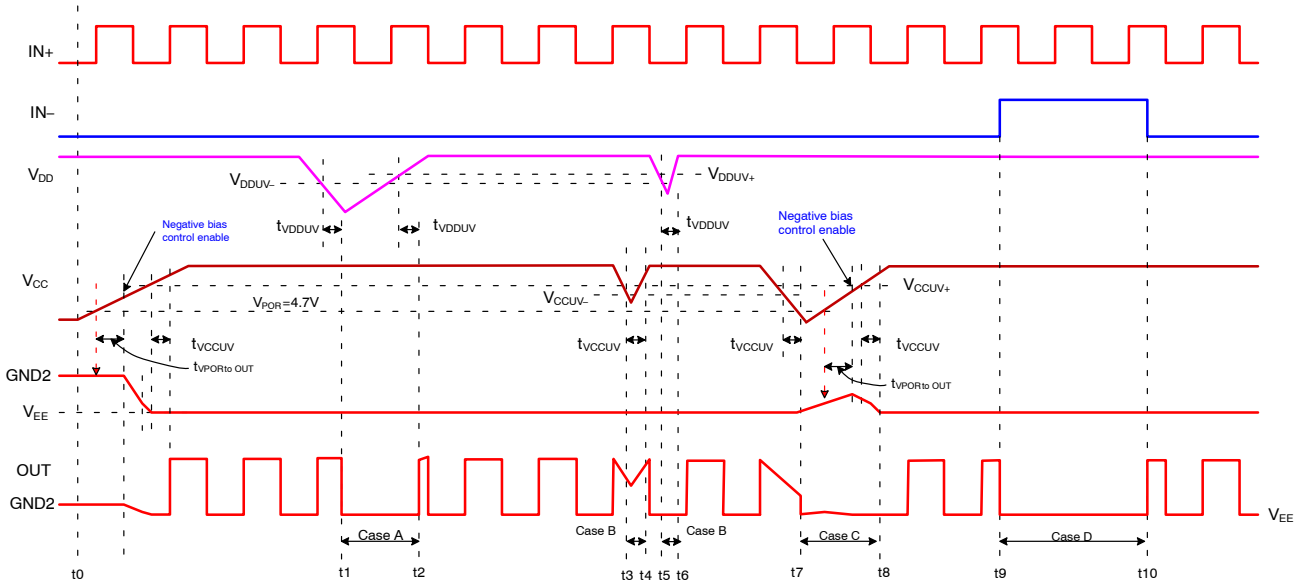


Figure 45. Overall Operating Waveforms Definitions

PROTECTION FUNCTION

The NCV51153 provides the protection features including Under-Voltage Lockout (UVLO) of power supplies on primary-side (V_{DD}) and secondary-side (V_{CC}).

Under-Voltage Lockout Protection V_{DD} and V_{CC}

The NCV51153 provides the Under-Voltage Lockout (UVLO) protection function for V_{DD} in primary-side and gate drive output for VCC in secondary-side as shown in Figure 46. The gate driver is running when the VDD supply voltage is greater than the specified under-voltage lockout threshold voltage (e.g. typically 2.8 V).

In addition, gate output driver has an under-voltage lockout protection (UVLO) function in secondary-side (e.g. VCC).

The variant A and B need to be greater than specified UVLO threshold level with respect to V_{EE} and GND2 respectively to let the output operate per input signal. The typical V_{CC} UVLO threshold voltage levels for each option respectively as are per Table 1.

Table 1. V_{CC} UVLO OPTION TABLE

Option	V_{CC} UVLO Threshold	V_{CC} UVLO Referenced		Unit
		Variant A	Variant B	
6–V	6.0	V_{EE}	GND2	V
9–V	8.7	V_{EE}	GND2	V
12–V	12	V_{EE}	GND2	V
17–V	17	V_{EE}	GND2	V

UVLO protection has the hysteresis to provide immunity to short V_{CC} drops that can occur.

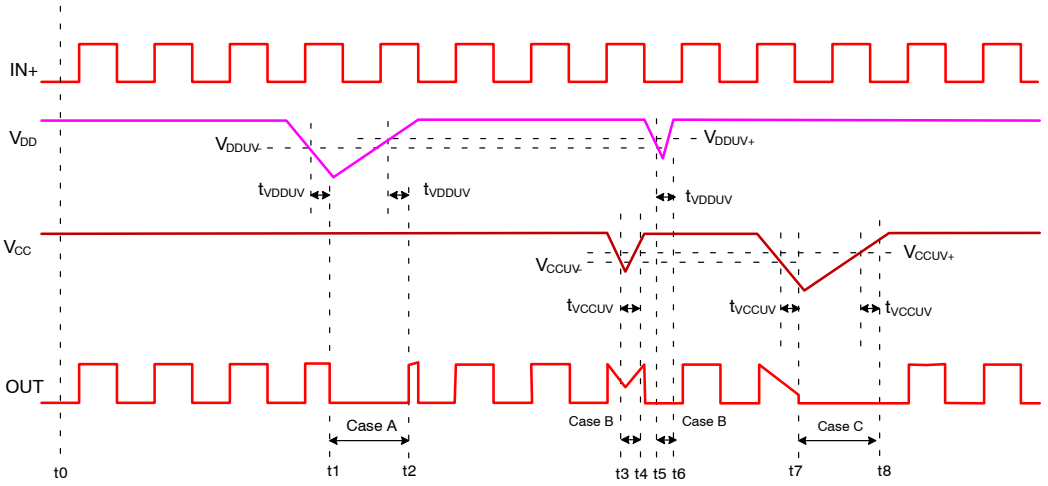


Figure 46. Timing Chart Under-Voltage Lockout Protection

Power-up V_{CC} UVLO Delay to OUTPUT

To provide a variety of Under-Voltage Lockout (UVLO) thresholds NCV51153 has a power-up delay time during initial V_{CC} start-up or after POR event.

Before the gate driver is ready to deliver a proper output state, there is a power-up delay time from the V_{CC} power-on reset (POR) threshold to output and it is defined as $t_{VPOR\ to\ OUT}$ (e.g. typically18 μs). Figure 47 shows the V_{CC} power-up UVLO delay time diagram.

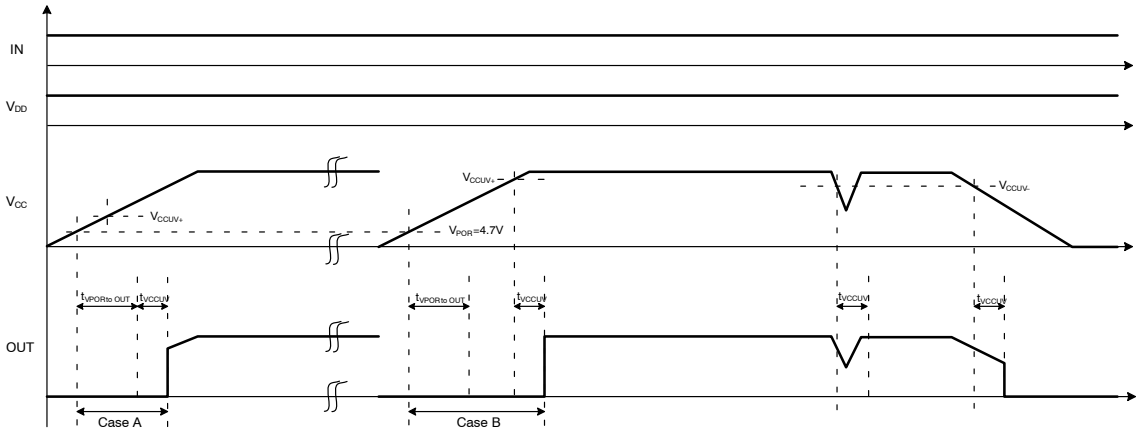


Figure 47. V_{CC} Power-up UVLO Delay Time

FUNCTIONAL MODES TABLE

Table 2 and Table 3 shows the functional modes for the NCV51153 variant A and B assuming V_{DD} and V_{CC} are in the recommended range.

Table 2. FUNCTIONAL MODES FOR THE VARIANT A

Input		Gate Drive Output	
IN+	IN−	OUTH	OUTL
LOW	X (Note 17)	Hi−Z	LOW
X (Note 17)	HIGH	Hi−Z	LOW
HIGH	LOW	HIGH	Hi−Z

Table 3. FUNCTIONAL MODES FOR THE VARIANT B

Input		Gate Drive Output
IN+	IN−	OUT
LOW	X (Note 17)	LOW
X (Note 17)	HIGH	LOW
HIGH	LOW	HIGH

17.X: Don't care

APPLICATION INFORMATION

This section provides application guidelines when using the NCV51153.

Power Supply Recommendations

The NCV51153 variant A and B are designed to support unipolar or bipolar power supply respectively.

The VDD input power supply supports a wide voltage range from 3 V to 20 V and the VCC output supply supports a voltage range from 6.5 V to 30 V. The V_{CC} local bypass capacitor should be placed between the V_{CC} and V_{EE} pins with a value of at least ten times the gate capacitance, and an additional capacitor 100−nF in parallel for device biasing and both capacitors located as close to the device as possible. A low ESR, ceramic surface mount capacitors are recommended. Additionally, for the negative bias supply capacitor should be placed between GND2 and V_{EE} pins with a value of at least few hundred nanofarads (variant B).

Similarly, the V_{DD} bypass capacitor should also be placed between the V_{DD} and GND1 pins for input logic power supply. We recommend using 2 capacitors; at least 100 nF ceramic surface-mount capacitor with few microfarads added in parallel and both capacitors also located as close to the pins of the device as shown in Figure 48.

- In Unipolar power supply the driver is typically supplied with a positive voltage at V_{CC}. For operation with unipolar supply, the V_{CC} supply is connected to 15 V with respect to V_{EE} pin for IGBTs and MOSFET and 20 V for SiC MOSFETs (variant A).
- In bipolar power supply the driver is typically supplied of the V_{CC} and VEE power supplies. Typical supply values for bipolar operation are 15 V and –8 V with respect to GND2 for IGBTs and 20 V and –5 V for SiC MOSFETs. Negative power supply prevents the power device from unintentionally turning on because of current induced from the Miller effect (variant B).

Input Stage

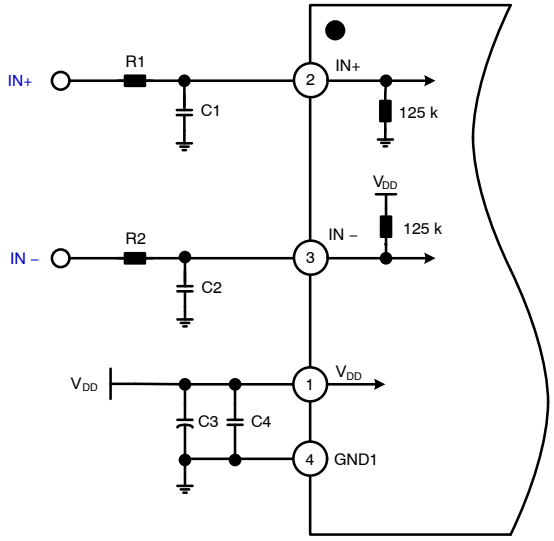


Figure 48. Schematic of Input Stage

The input signal pins (IN+, and IN−) of the NCV51153 are based on the TTL compatible input-threshold logic that is independent of the VDD supply voltage.

The logic level compatible input provides a typically HIGH and LOW threshold of 1.6 V and 1.1 V respectively.

The input signal pins impedance is 125 kΩ typically and the IN+ pin is pulled to GND1 pin and IN− pin is pulled to V_{DD} pin as shown in Figure 48. For non-inverting input logic input signal is applied to IN+ while the IN− input can be used as an enable function. If IN− is pulled HIGH, the driver output remains LOW state regardless of the state of IN+. To enable the driver output, IN− should be tied to GND1 through a few tens of kΩ resistor (e.g.10 kΩ) or can be used as an active LOW enable pull down.

- Non-inverting input IN+ controls the driver output while inverting input IN− is set to LOW
- Inverting input IN− controls the driver output while non-inverting input IN+ is set to HIGH

An RC filter is recommended to be added on the input signal pins to reduce the impact of system noise and ground bounce as shown in Figure 48. Such a filter should use an R_{IN} in the range of 0 Ω to 100 Ω and a C_{IN} between 10 pF and 100 pF.

Output Stage

The NCV51153 have different output stages of the variant A and B as shown in Figure 49.

For the variant A is designed to support separate source (OUTH) and sink (OUTL) outputs. This scheme allows a single resistor between each pin and the MOSFET gate to independently control gate ringing as well as fine tuning dV_{DS}/dT turn-on and turn-off transitions present on the MOSFET drain-source voltage.

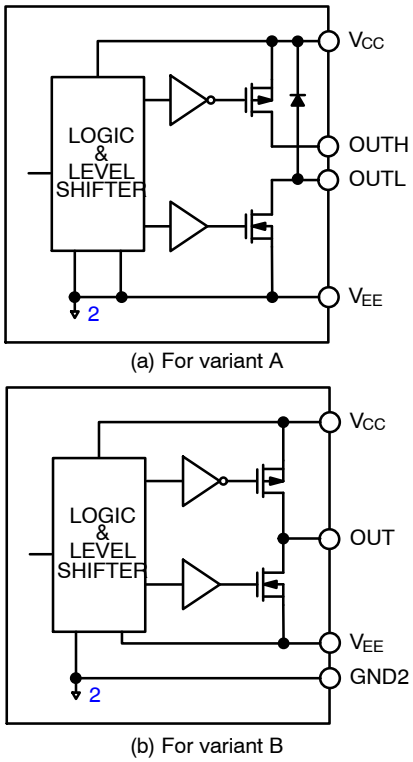


Figure 49. Schematic of Output Stage

The output impedance of the pull up and pull down switches shall be able to provide about +4.5 A and −9 A peak currents typical at 25 °C and the minimum sink and source peak currents are −7 A sink and +2.6 A source at 125 °C.

Common Mode Transient Immunity Testing

Figure 50 shows a simplified diagram of the Common Mode Transient Immunity (CMTI) testing configuration for each the variant A and B. CMTI is the maximum sustainable common-mode voltage slew rate while maintaining the correct output. CMTI applies to both rising and falling common-mode voltage edges. CMTI is tested with the transient generator connected between GND1 and V_{EE} (V_{CM}= 1500 V).

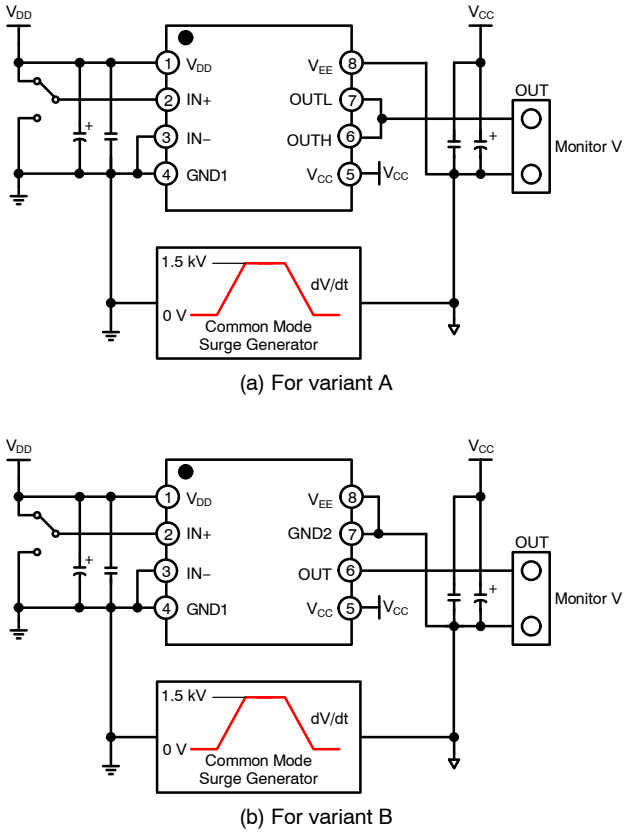


Figure 50. Common Mode Transient Immunity Test Circuit

PCB Layout Guideline

To improve the switching characteristics and efficiency of the design, the following should be considered before beginning a PCB layout.

Component Placement

- Keep the input/output traces as short as possible. Minimize influence of the parasitic inductance and capacitance on the layout. (To maintain low signal-path inductance, avoid using via).
- Placement and routing for supply bypass capacitors for V_{DD}, V_{CC}, V_{EE} and gate resistors need to be located as close as possible to the gate driver.
- The gate driver should be located to the switching device as close as possible to decrease the trace inductance and avoid output ringing.

Grounding Consideration

- Have a solid ground plane underneath the high-speed signal layer.

High-Voltage (VISO) Consideration

- To ensure isolation performance between the primary and secondary side, any PCB traces or copper should not be placed under the driver device as shown in Figure 51. A PCB cutout is recommended to avoid contamination that may impair the isolation performance of NCV51153.

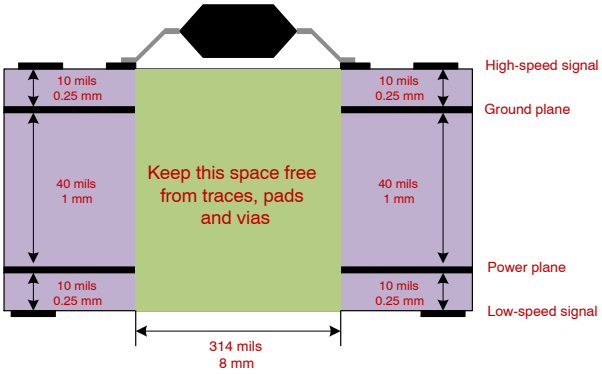


Figure 51. Recommended Layer Stack

Figure 52 shows the 3D layout of the top view of an evaluation board. The component's location of the PCB cutout between primary and secondary side ensures isolation performance.

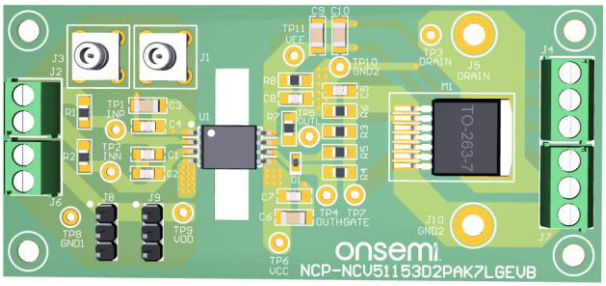
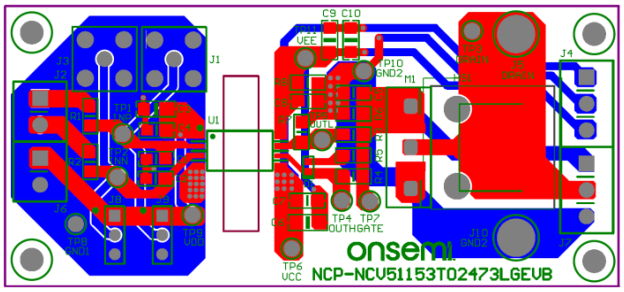
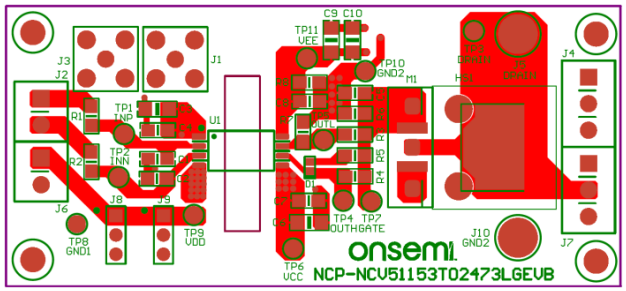


Figure 52. 3-D PCB View

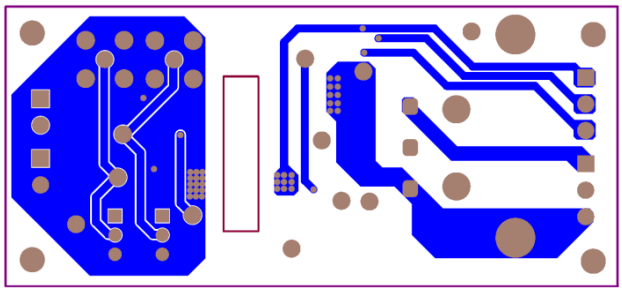
Figure 53 shows the top and bottom layer traces and copper of printed circuit board layout.



(A) Top & Bottom View



(B) Top View



(C) Bottom View

Figure 53. Printed Circuit Board

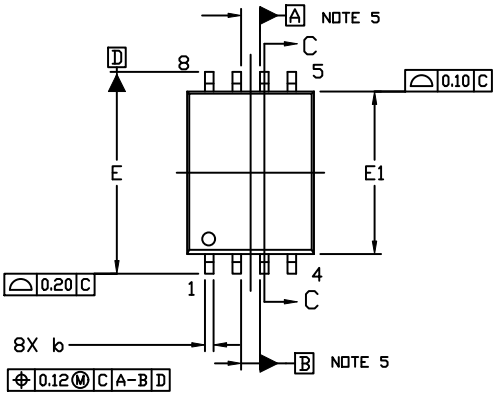
ORDERING INFORMATION

Device	Description	Package	UVLO	OUTPUT/UVLO/NEG	Shipping†
NCV51153AADWR2G*	High current single isolated MOS driver	SOIC-8 WB (Pb – Free)	6 V	Split OUTPUT	1000 / Tape & Reel
NCV51153BADWR2G		SOIC-8 WB (Pb – Free)	9 V		1000 / Tape & Reel
NCV51153CADWR2G		SOIC-8 WB (Pb – Free)	12 V		1000 / Tape & Reel
NCV51153DADWR2G*		SOIC-8 WB (Pb – Free)	17 V		1000 / Tape & Reel
NCV51153ABDWR2G*	High current single isolated MOS driver with true VCC UVLO	SOIC-8 WB (Pb – Free)	6 V	TRUE VCC UVLO	1000 / Tape & Reel
NCV51153BBDWR2G*		SOIC-8 WB (Pb – Free)	9 V		1000 / Tape & Reel
NCV51153CBDWR2G*		SOIC-8 WB (Pb – Free)	12 V		1000 / Tape & Reel
NCV51153DBDWR2G*		SOIC-8 WB (Pb – Free)	17 V		1000 / Tape & Reel

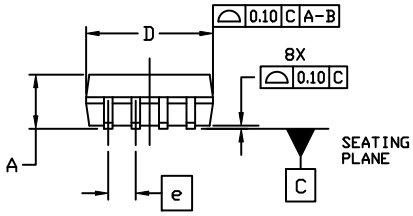
†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.
*Option on demand

SOIC8 WB
CASE 751EW
ISSUE A

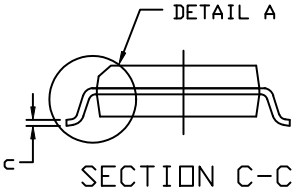
DATE 31 MAY 2019



TOP VIEW



SIDE VIEW

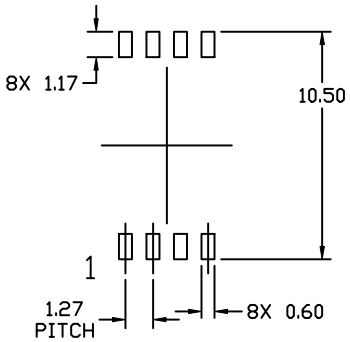


SECTION C-C

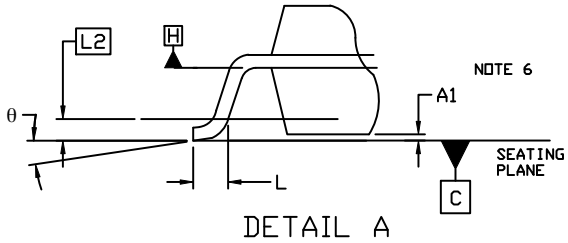
NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS
3. DIMENSION b DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE PROTRUSION SHALL BE 0.10 mm IN EXCESS OF MAXIMUM MATERIAL CONDITION.
4. DIMENSIONS D AND E DO NOT INCLUDE MOLD FLASH, PROTRUSIONS, OR GATE BURRS. MOLD FLASH, PROTRUSIONS, OR GATE BURRS SHALL NOT EXCEED 0.15 mm PER SIDE. DIMENSIONS D AND E ARE DETERMINED AT DATUM H.
5. DATUMS A AND B ARE TO BE DETERMINED AT DATUM H.
6. A1 IS DEFINED AS THE VERTICAL DISTANCE FROM THE SEATING PLANE TO THE LOWEST POINT ON THE PACKAGE BODY.
7. NO JEDEC STANDARD AT TIME OF SETUP.

DIM	MILLIMETERS		
	MIN.	NOM.	MAX.
A	2.35	2.50	2.65
A1	0.10	0.20	0.30
b	0.31	0.41	0.51
c	0.20	0.27	0.33
D	5.65	5.85	6.05
E	10.11	10.31	10.51
E1	7.40	7.50	7.60
e	1.27 BSC		
L	0.40	0.58	0.75
L2	0.25 BSC		
θ	0°	---	8°

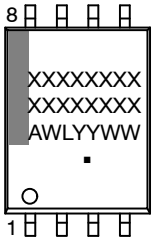


RECOMMENDED
MOUNTING FOOTPRINT



DETAIL A

GENERIC
MARKING DIAGRAM*



XXXXX = Specific Device Code
A = Assembly Location
WL = Wafer Lot
YY = 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.

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