NCV8460A

Self Protected High Side Driver with Temperature Shutdown and Current Limit

The NCV8460A is a fully protected High−Side driver that can be used to switch a wide variety of loads, such as bulbs, solenoids and other acuators. The device is internally protected from an overload condition by an active current limit and thermal shutdown.

A diagnostic output reports ON and OFF state open load conditions as well as thermal shutdown.

Features

- Short Circuit Protection
- Thermal Shutdown with Automatic Restart
- CMOS (3.3 V / 5 V) compatible control input
- Open Load Detection in On and Off State
- Diagnostic Output
- Undervoltage and Overvoltage Shutdown
- Loss of Ground Protection
- ESD protection
- Slew Rate Control for Low EMI Switching
- Very Low Standby Current
- NCV Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC Qualified and PPAP Capable
- These Devices are Pb−Free and are RoHS Compliant

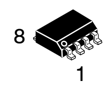
Typical Applications

- Switch a Variety of Resistive, Inductive and Capacitive Loads
- Can Replace Electromechanical Relays and Discrete Circuits
- Automotive / Industrial

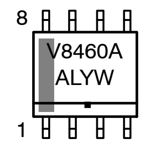
ON Semiconductor®

http://onsemi.com

MARKING DIAGRAM

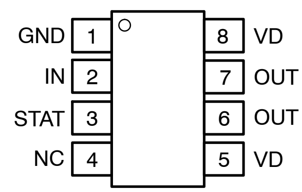


SO−8
D SUFFIX
CASE 751



V8460A = Specific Device Code
A = Assembly Location
L = Wafer Lot
Y = Year
W = Work Week
▪ = Pb−Free Package

PIN CONNECTIONS



(Top View)

ORDERING INFORMATION

Device	Package	Shipping†
NCV8460ADR2G	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.

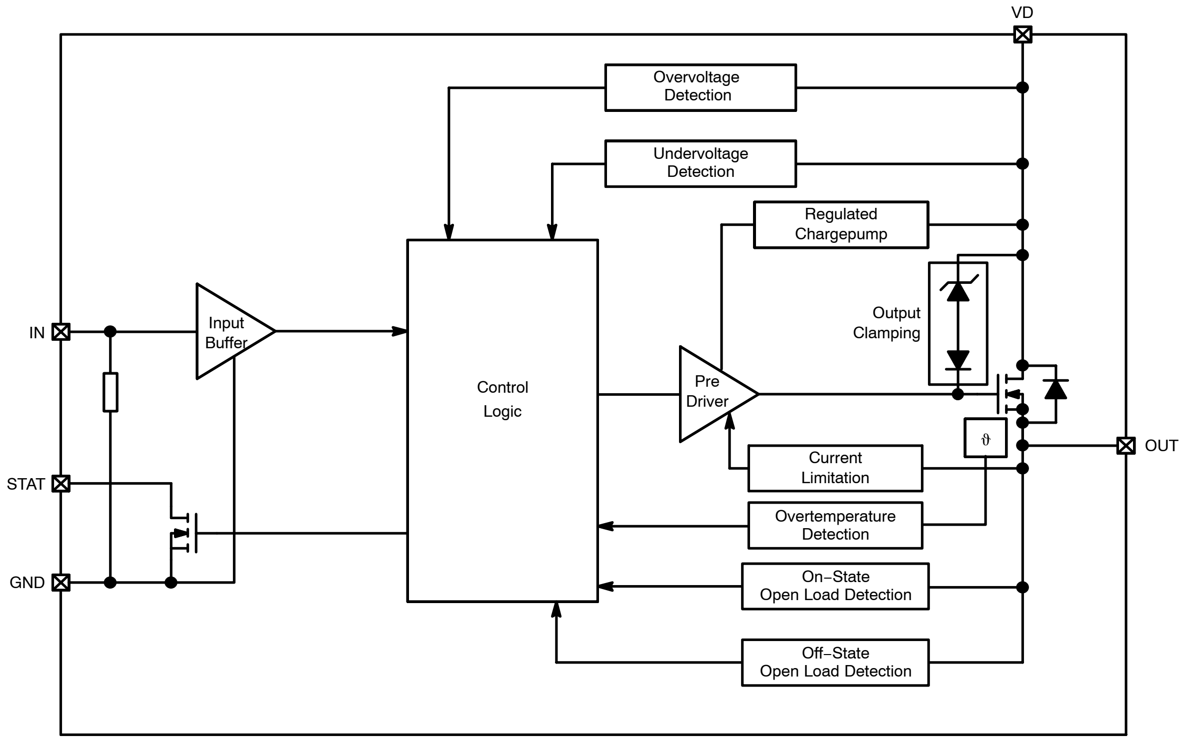


Figure 1. Block Diagram

PIN DESCRIPTION

Pin #	Symbol	Description
1	GND	Ground
2	IN	Logic Level Input
3	STAT	Status Output
4	N/C	No Connection
5	V_D	Supply Voltage
6	OUT	Output
7	OUT	Output
8	V_D	Supply Voltage

MAXIMUM RATINGS

Rating	Symbol	Value		Unit
		Min	Max	
DC Supply Voltage	V_D	−16	42	V
Peak Transient Input Voltage (Load Dump 42.5 V, V_D = 13.5 V, R_{LOAD} = 6.5 Ω, ISO7637−2 pulse 5)	V_{peak}		56	V
Input Voltage	V_{in}	−8	8	V
Input Current	I_{in}	−5	5	mA
Output Current (Note 1)	I_{out}	−6	Internally Limited	A
Negative Ground Current	$-I_{gnd}$	−200	−	mA
Status Current	I_{status}	−5	5	mA
Power Dissipation, Tc = 25°C	P_{tot}	1.183		W
Electrostatic Discharge (HBM Model 100 pF / 1500 Ω) Input Status Output V_D		 4 3.5 5 5		DC kV kV kV kV
Single Pulse Inductive Load Switching Energy (Note 2) (L = 1.8 mH, V_{bat} = 13.5 V; I_L = 9 A, T_{Jstart} = 150°C)	E_{AS}	100		mJ
Operating Junction Temperature	T_J	−40	+150	°C
Storage Temperature	$T_{storage}$	−55	+150	°C

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

1. Reverse Output current has to be limited by the load to stay within absolute maximum ratings and thermal performance.
2. Not subjected to production testing.

THERMAL RESISTANCE RATINGS

Parameter	Symbol	Max Value	Unit
Thermal Resistance Junction−to−Lead Junction−to−Ambient (min. Pad) Junction−to−Ambient (1” square pad size, FR−4, 1 oz Cu)	 $R_{\theta JL}$ $R_{\theta JA}$ $R_{\theta JA}$	 72 110.8 105.6	 °C/W °C/W °C/W

ELECTRICAL CHARACTERISTICS ($8 \le V_D \le 36$ V; −40°C < T_J < 150°C unless otherwise specified)

Rating	Symbol	Conditions	Value Min	Value Typ	Value Max	Unit
Operating Supply Voltage	V_D		6	–	36	V
Undervoltage Shutdown	V_{UV}		3	5	6	V
Undervoltage	V_{UV_Rst}				6.5	V
Overvoltage Shutdown	V_{OV}		36			V
On Resistance	R_{ON}	I_{out} = 2 A; T_J = 25°C, V_D > 8 V I_{out} = 2 A, V_D > 8 V			60 120	mΩ
Standby Current	I_D	Off State, V_{in} = V_{out} = 0 V, V_D = 13.5 V On State; V_{in} = 5 V, V_D = 13.5 V, I_{out} = 0 A		10 1.5	20 3.5	μA mA
Output Leakage Current	I_L	V_{in} = V_{out} = 0 V V_{in} = 0 V, V_{out} = 3.5 V V_{in} = V_{out} = 0 V, V_D = 13.5 V	−20		50 10 3	μA
INPUT CHARACTERISTICS						
Input Voltage – Low	V_{in_low}				1.25	V
Input Current – Low	I_{in_low}	V_{in} = 1.25 V	1			μA
Input Voltage – High	V_{in_high}		3.25			V
Input Current – High	I_{in_high}	V_{in} = 3.25 V			10	μA
Input Hysteresis Voltage	V_{hyst}		0.25			V
Input Clamp Voltage	V_{in_cl}	I_{in} = 1 mA I_{in} = −1 mA	11 −13	12 −12	13 −11	V
SWITCHING CHARACTERISTICS						
Turn−On Delay Time	t_{d_on}	to 10% V_{out}, V_D = 13.5 V, R_L = 6.5 Ω		40		μs
Turn−Off Delay Time	t_{d_off}	to 90% V_{out}, V_D = 13.5 V, R_L = 6.5 Ω		30		μs
Slew Rate On	dV_{out} / dt_{on}	10% to 80% V_{out}, V_D = 13.5 V, R_L = 6.5 Ω		0.9		V / μs
Slew Rate Off	dV_{out} / dt_{off}	90% to 10% V_{out}, V_D = 13.5 V, R_L = 6.5 Ω		0.7		V / μs
OUTPUT DIODE CHARACTERISTICS (Note 3)						
Forward Voltage	V_F	I_{out} = −1.3 A, T_J = 150°C			0.6	V
STATUS PIN CHARACTERISTICS						
Status Output Voltage Low	V_{stat_low}	I_{stat} = 1.6 mA		0.2	0.5	V
Status Leakage Current	$I_{stat\_leakage}$	V_{stat} = 5 V		1	10	μA
Status Pin Input Capacitance	C_{stat}	V_{stat} = 5 V (Note 3)			100	pF
Status Clamp Voltage	V_{stat_cl}	I_{stat} =1 mA I_{stat} = −1 mA	10 −2.2	11 −1.2	12 −0.6	V
PROTECTION FUNCTIONS (Note 4)						
Temperature Shutdown (Note 3)	T_{SD}		150	175	200	°C
Temperature Shutdown Hysteresis (Note 3)	T_{SD_hyst}		7	15		°C
Output Current Limit	I_{lim}	8 V < V_D < 36 V	6	9	15	A
		6 V < V_D < 36 V			15	A
Status Delay in Overload	t_{d_stat}				20	μs
Switch Off Output Clamp Voltage	V_{clamp}	I_{out} = 2 A, V_{in} = 0 V, L = 6 mH	V_D − 41	V_D − 45	V_D − 55	V

3. Not subjected to production testing
4. To ensure long term reliability under heavy overload or short circuit conditions, protection and related diagnostic signals must be used together with a proper hardware/software strategy. If the devices operates under abnormal conditions this hardware/software solutions must limit the duration and number of activation cycles.

ELECTRICAL CHARACTERISTICS ($8 \le V_D \le 36$ V; −40°C < T_J < 150°C unless otherwise specified)

Rating	Symbol	Conditions	Value Min	Value Typ	Value Max	Unit
DIAGNOSTICS CHARACTERISTICS						
Openload On State Detection Threshold	I_{OL1}	V_{in} = 5 V, T_J > 25°C	30		300	mA
Openload On State Detection Threshold	I_{OL2}	V_{in} = 5 V, T_J < 25°C	30		350	mA
Openload On State Detection Delay	$t_{d\_OL\_on}$	I_{out} = 0 A			220	μs
Openload Off State Detection Threshold	V_{OL}	V_{in} = 0 V	1.5	–	3.5	V
Openload Detection Delay at Turn Off	$t_{d\_OL\_off}$				1000	μs

3. Not subjected to production testing
4. To ensure long term reliability under heavy overload or short circuit conditions, protection and related diagnostic signals must be used together with a proper hardware/software strategy. If the devices operates under abnormal conditions this hardware/software solutions must limit the duration and number of activation cycles.

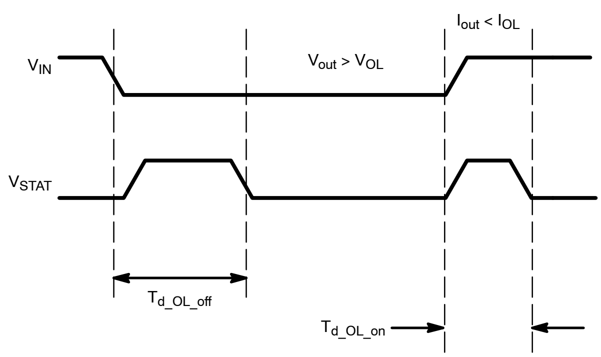


Figure 2. Open Load Status Timing (with external pull−up)

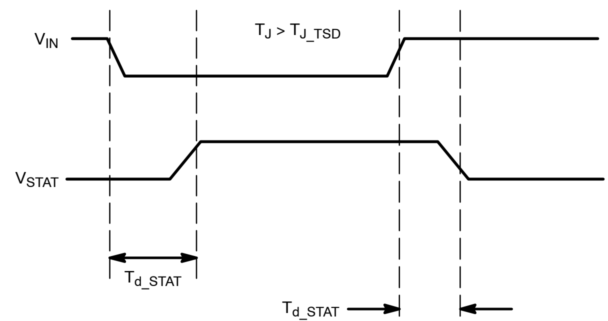


Figure 3. Overtemperature Status Timing

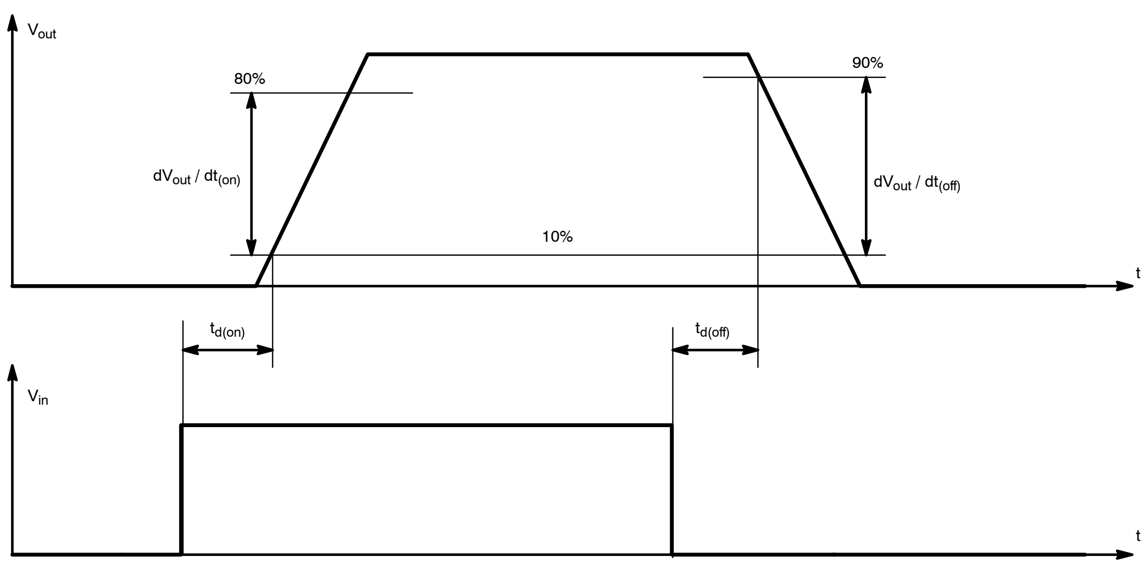


Figure 4. Switching Timing Diagram

STATUS PIN TRUTH TABLE

Conditions	Input	Output	Status
Normal Operation	L H	L H	H H
Undervoltage	L H	L L	X X
Overvoltage	L H	L L	H H
Current Limitation	L H H	L X X	H (T_J < T_{SD}) H (T_J > T_{SD}) L
Overtemperature	L H	L L	H L
Output Voltage > V_{OL}	L H	H H	L H
Output Current < I_{OL}	L H	L H	H L

TYPICAL CHARACTERISTICS CURVES

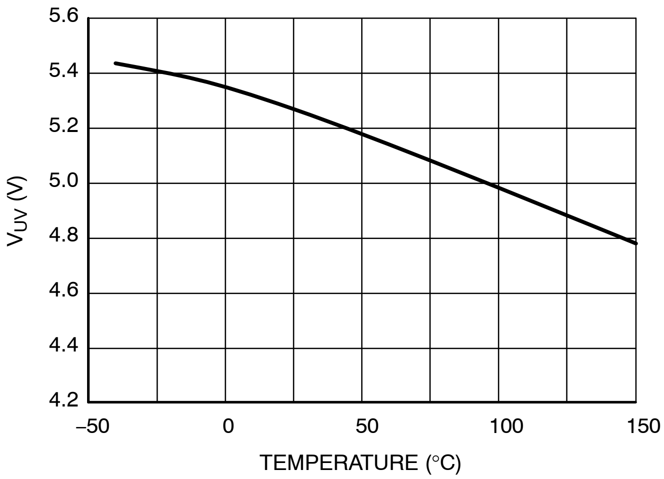


Figure 5. Undervoltage Shutdown vs. Temperature

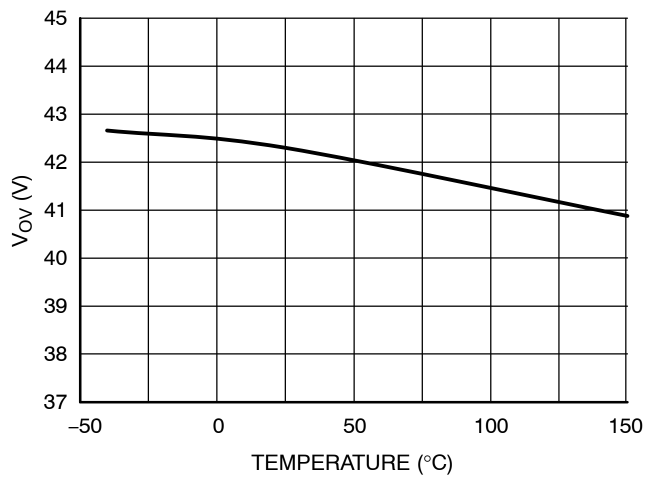


Figure 6. Overvoltage Shutdown vs. Temperature

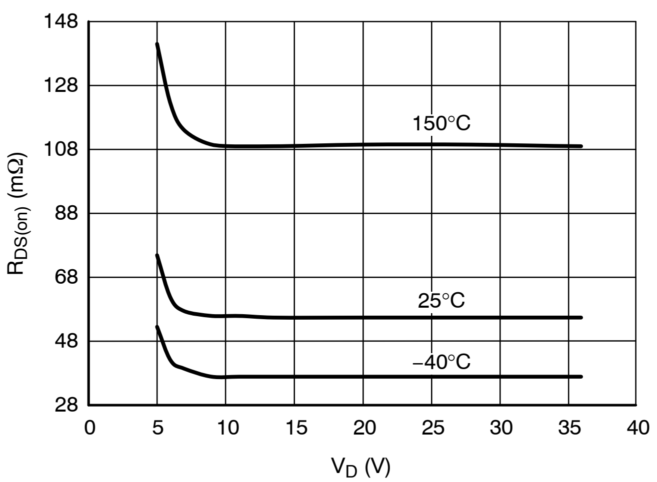


Figure 7. $R_{DS(on)}$ vs. V_D

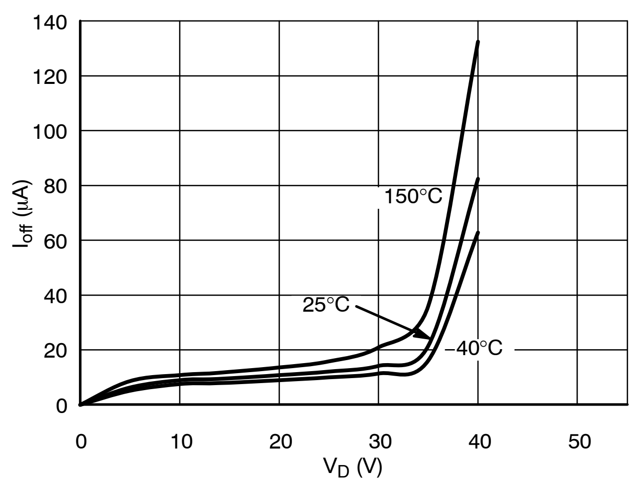


Figure 8. OFF State Standby Current vs. V_D

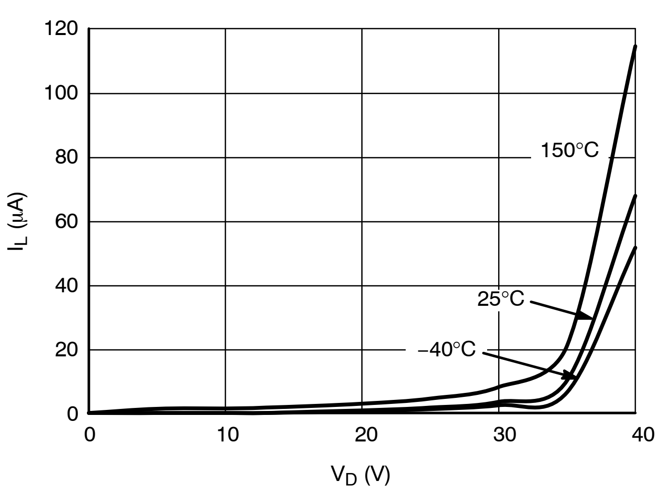


Figure 9. Output Leakage vs. V_D
V_{out} = 0 V

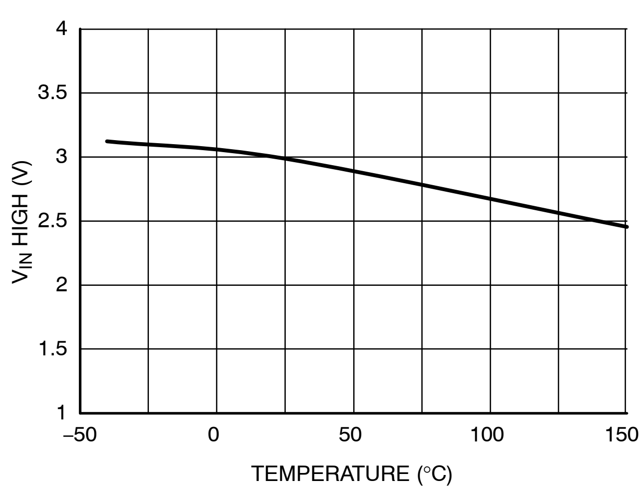


Figure 10. V_{in} Threshold High vs. Temperature

TYPICAL CHARACTERISTICS CURVES

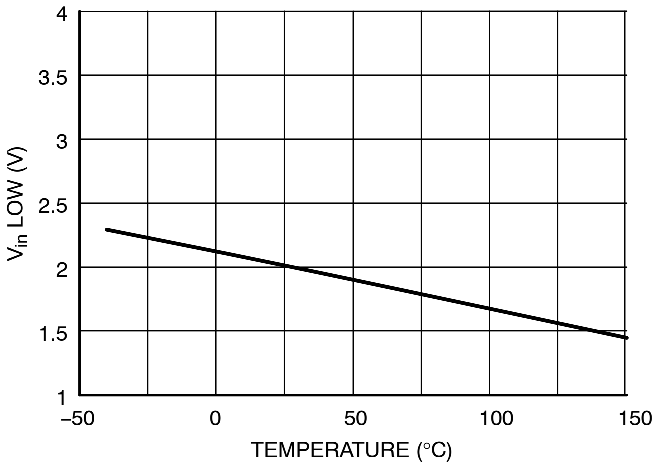


Figure 11. V_{in} Threshold Low vs. Temperature

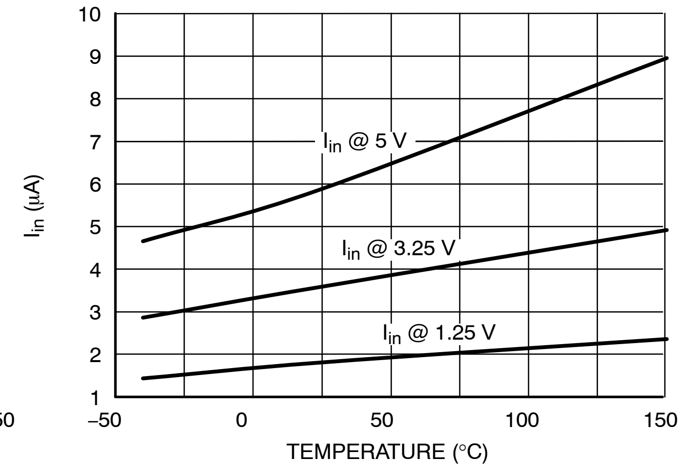


Figure 12. Input Current vs. Temperature

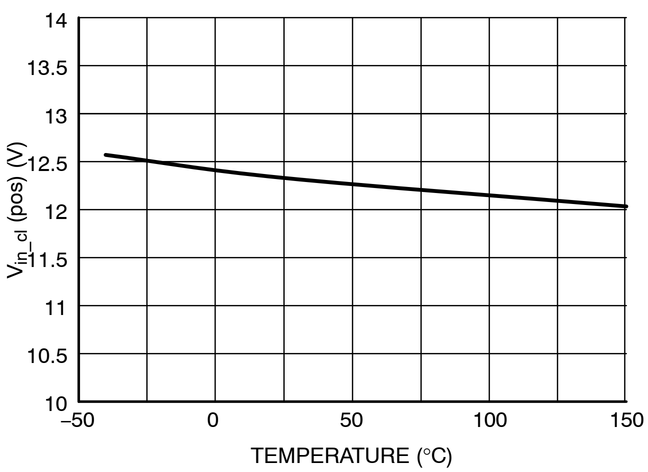


Figure 13. Input Clamp Voltage (Positive) vs. Temperature

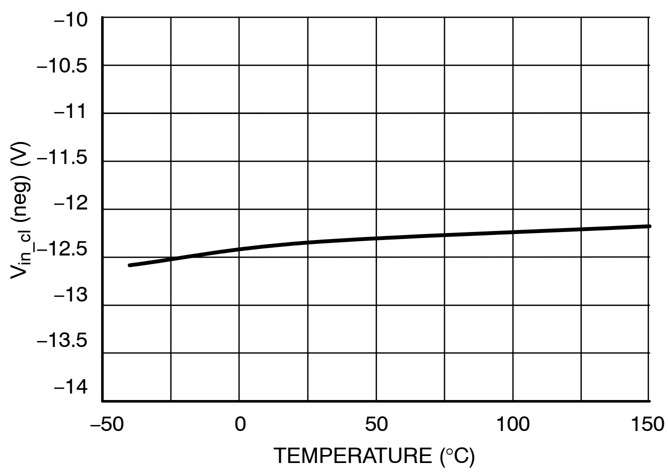


Figure 14. Input Clamp Voltage (Negative) vs. Temperature

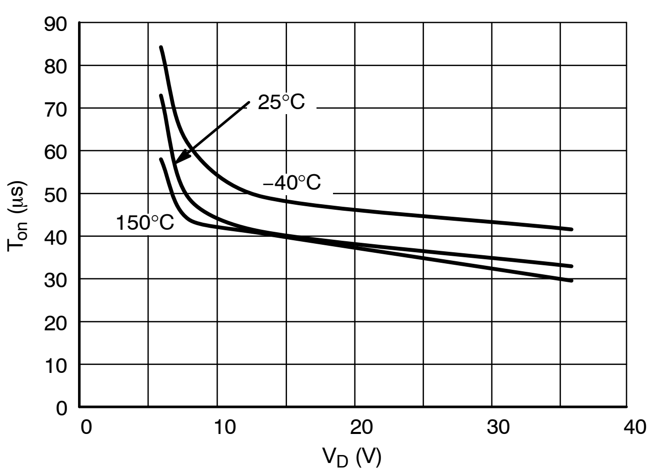


Figure 15. Turn On Time vs. V_D

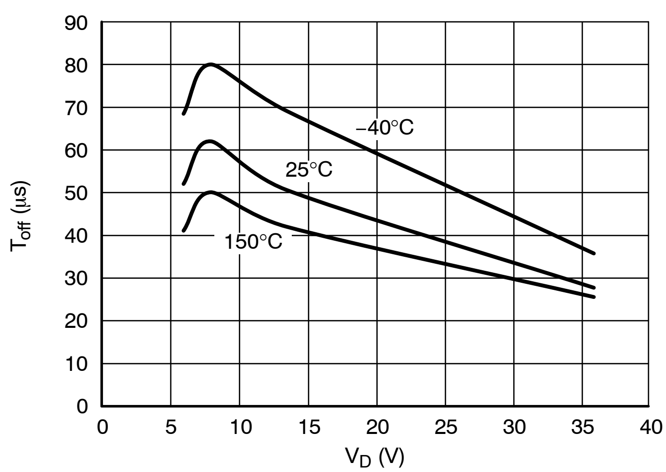


Figure 16. Turn Off Time vs. V_D

TYPICAL CHARACTERISTICS CURVES

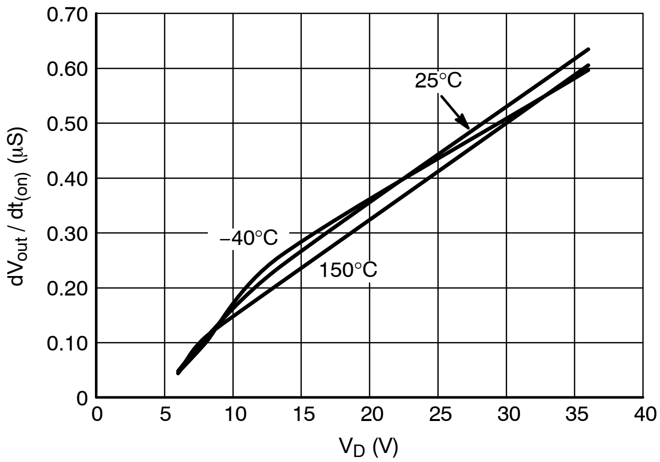


Figure 17. Slew Rate ON vs. V_D

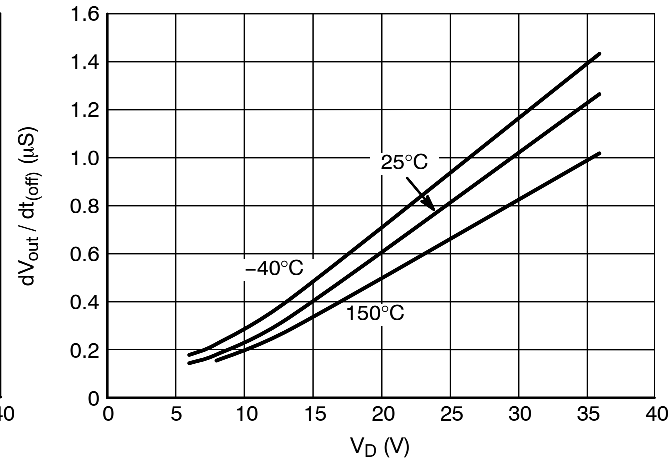


Figure 18. Slew Rate OFF vs. V_D

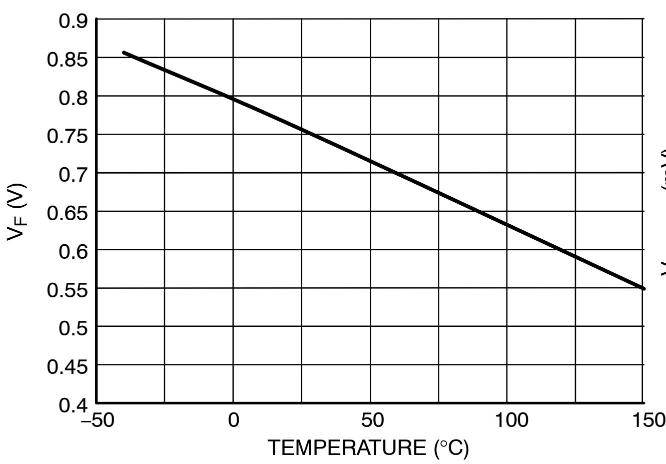


Figure 19. Forward Voltage (@ −1.3 A) vs. Temperature

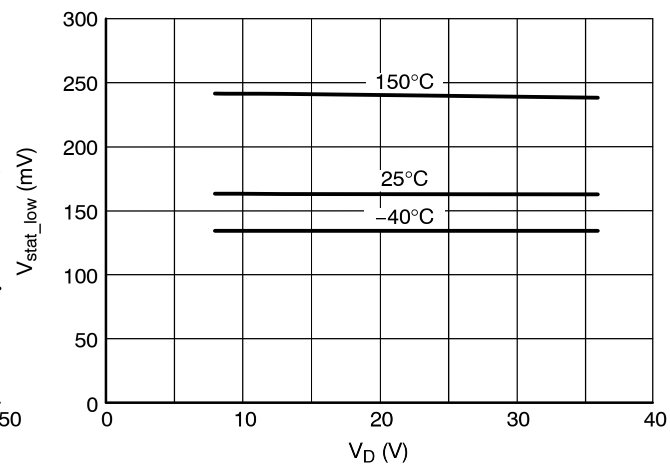


Figure 20. STAT Low Voltage vs. V_D

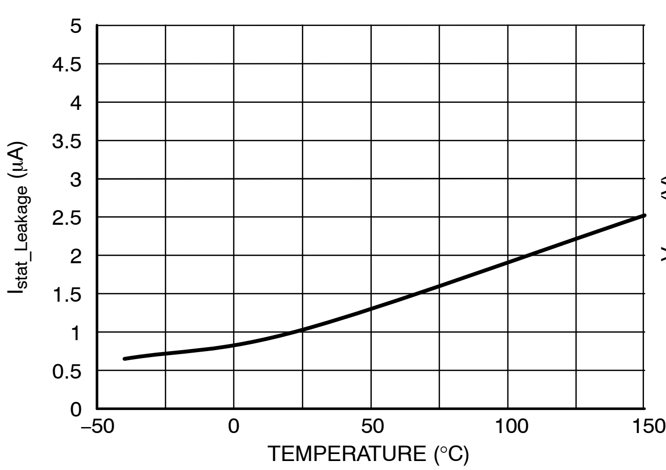


Figure 21. Status Leakage Current vs. Temperature

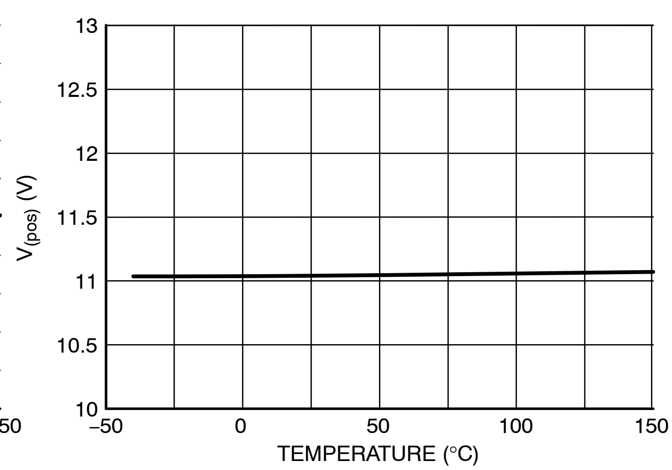


Figure 22. Status Clamp Voltage (Positive) vs. Temperature

TYPICAL CHARACTERISTICS CURVES

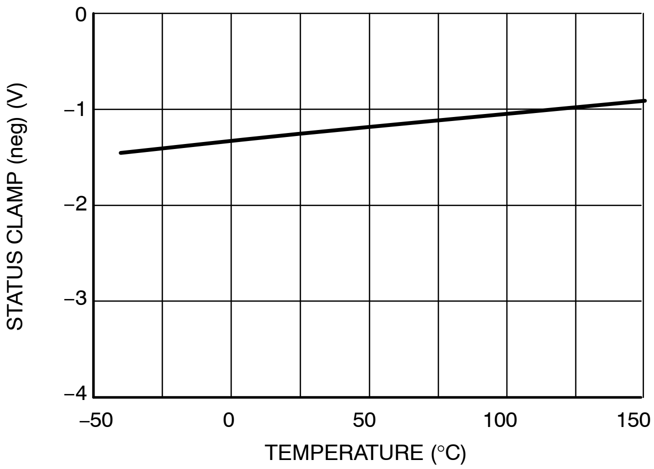


Figure 23. Status Clamp Voltage (Negative) vs. Temperature

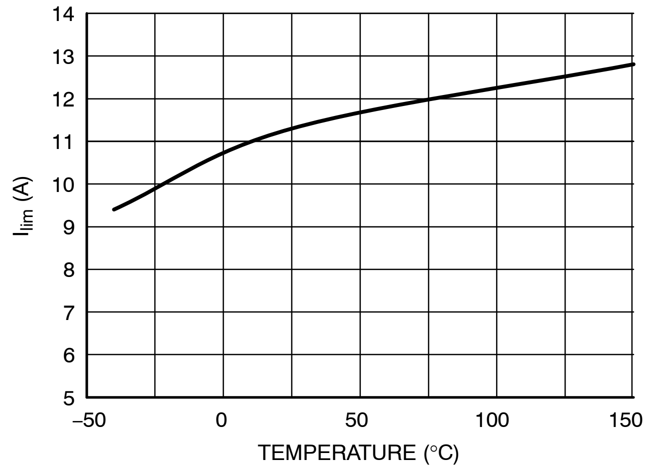


Figure 24. Current Limit vs. Temperature V_D = 13.5 V

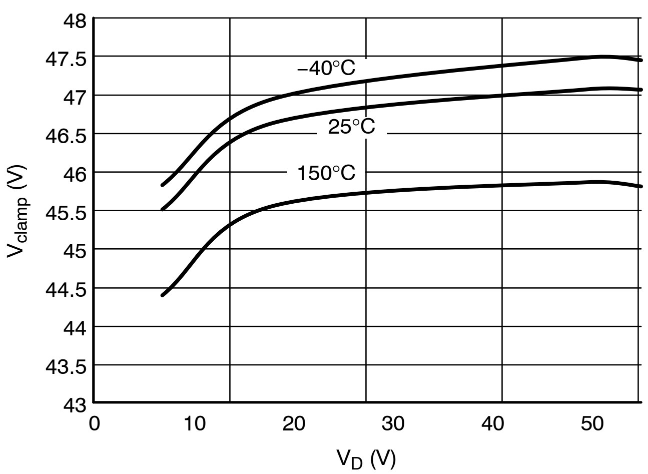


Figure 25. Turn Off Output Clamp Voltage vs. V_D and Temperature

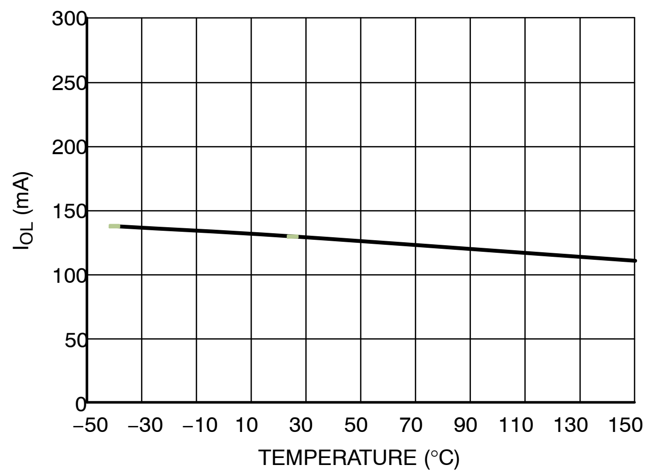


Figure 26. ON State Open Load Detection vs. Temperature V_D = 13.5 V

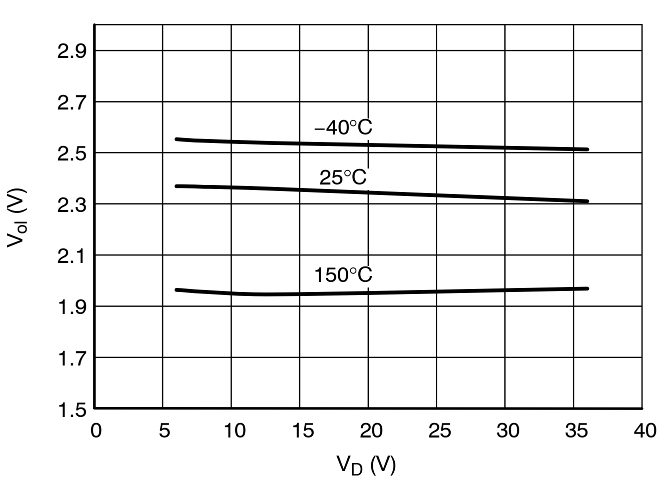


Figure 27. Off State OL Detection Threshold vs. V_D and Temperature

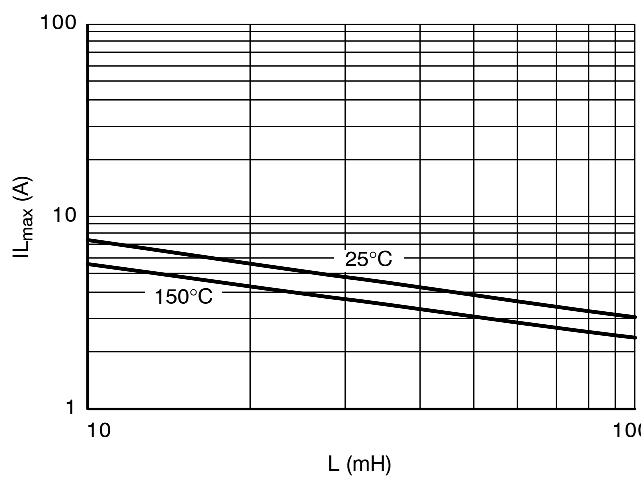


Figure 28. Single−Pulse Maximum Switch−off Current vs. Load Inductance

TYPICAL CHARACTERISTICS CURVES

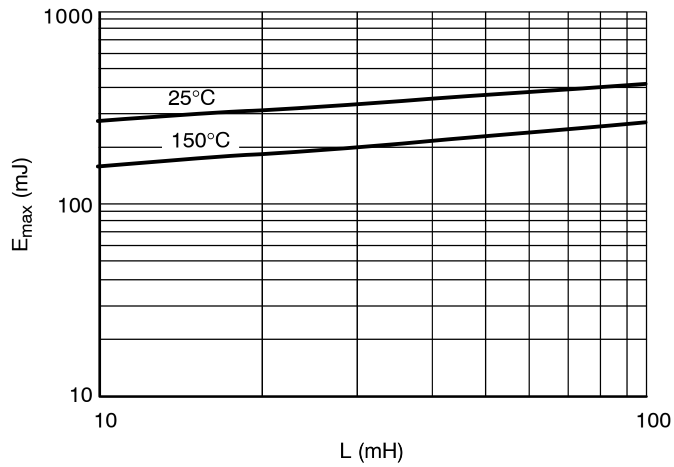


Figure 29. Single−Pulse Maximum Switch−off Current vs. Load Inductance

ISO 7637−2: 2004(E) PULSE TEST RESULTS

ISO 7637−2:2004(E)	Test Levels				Delays and
Test Pulse	**I**	**II**	**III**	**IV**	**Impedance**
1	−25 V	−50 V	−75 V	−100 V	2 ms, 10 Ω
2a	+25 V	+50 V	+37 V	+50 V	0.05 ms, 10 Ω
3a	−25 V	−50 V	−112 V	−150 V	0.1 μs, 50 Ω
3b	+25 V	+50 V	+75 V	+100 V	0.1 μs, 50 Ω
4	−4 V	−5 V	−6 V	−7 V	5 s, .01 Ω
5 (Load Dump)	+26.5 V	+46.5 V	+66.5 V	+86.5 V	400 ms, 2 Ω

ISO 7637−2:2004(E)	Test Results			
Test Pulse	**I**	**II**	**III**	**IV**
1	C	C	C	C
2a	C	C	C	C
3a	C	C	C	C
3b	C	C	C	C
4	C	C	C	C
5 (Load Dump)	C	E	E	E

Class	Functional Status
A	All functions of a device perform as designed during and after exposure to disturbance.
B	All functions of a device perform as designed during exposure. However,one or more of
	them can go beyond specified tolerance. All functions return automatically to within normal
	limits after exposure is removed. Memory functions shall remain class A.
C	One or more functions of a device do not perform as designed during exposure but return
	automatically to normal operation after exposure is removed.
D	One or more functions of a device do not perform as designed during exposure and do not return to normal operation until exposure is removed and the device is reset by simple
E	One or more functions of a device do not perform as designed during and after exposure and cannot be returned to proper operation without replacing the device.

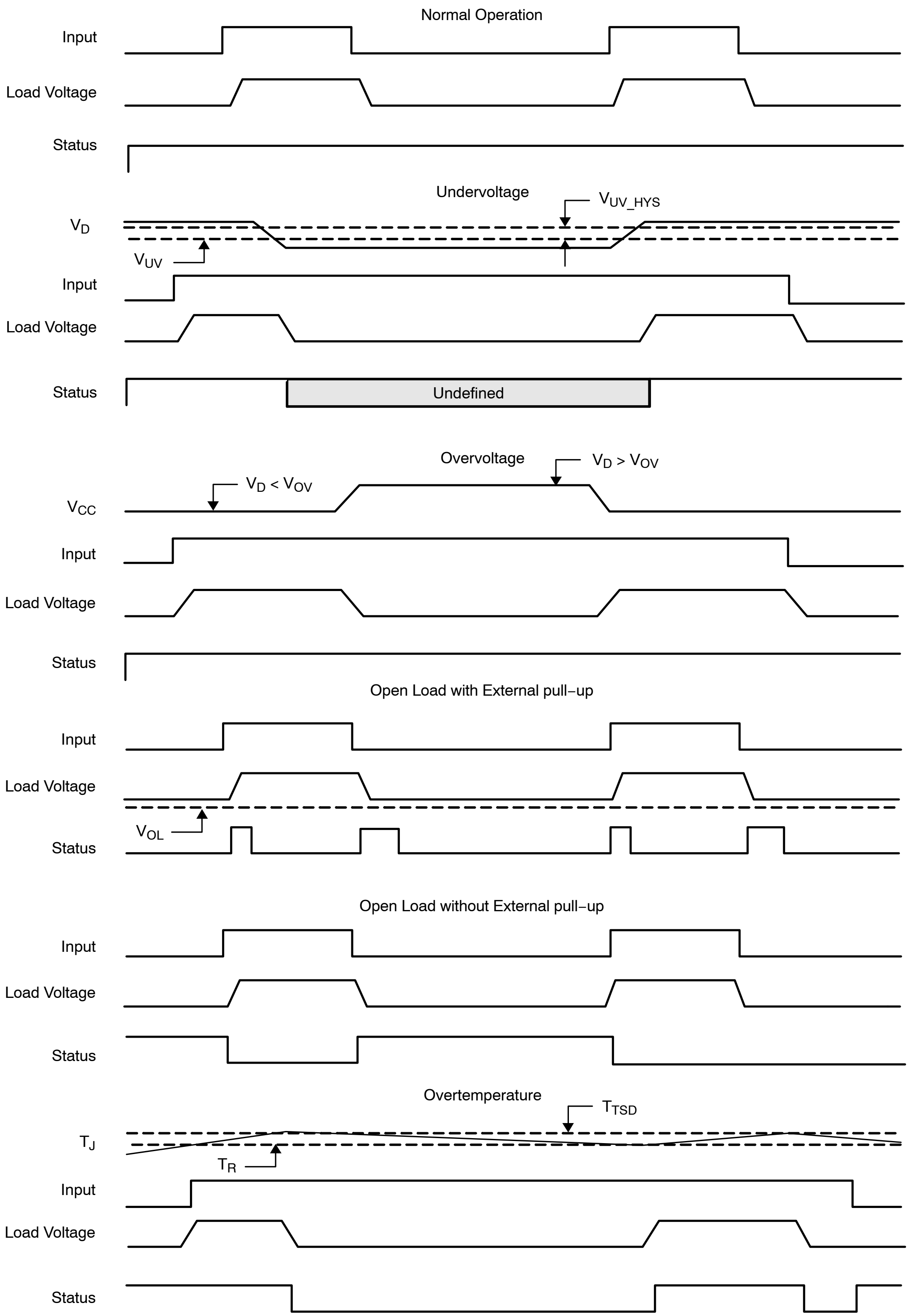


Figure 30. Waveforms

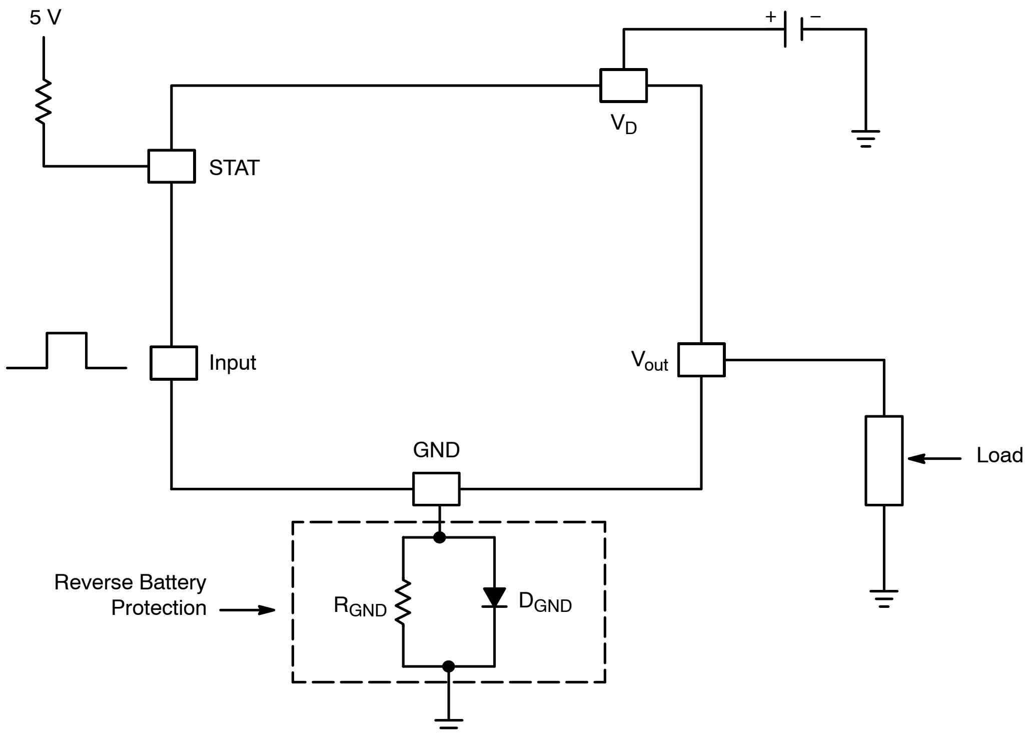


Figure 31. Application Diagram

Reverse Battery Protection

An external resistor R_{GND} is required to adequately protect the device from a Reverse Battery event. The resistor value can be calculated using the following two formulas.

1. $R_{GND} \geq 600\ mV / (I_d\ (on)\ max)$
2. $R_{GND} \geq (-V_D) / (-I_{gnd})$

Maximum ($-I_{gnd}$) current, which is the reverse GND pin current, can be found in the Maximum Ratings section. Several High Side Devices can share same the reverse battery protection resistor. Please note that the sum of (I_d (on) max) of all devices should be used to calculate R_{GND} value. If the microprocessor ground is not common with the device ground, R_{GND} will produce a voltage offset ((I_d (on) max) x R_{GND}) with respect to the IN and STAT pins.

This offset will be increased when more than one device shares the resistor.

Power Dissipation during a reverse battery event is equal to:

$$P_D = (-V_D)^2 / R_{GND}$$

In the case of high power dissipation due to several devices sharing R_{GND}, it is recommended to place a diode D_{GND} in the ground path as an alternate reverse battery protection method. When driving an inductive load, a 1 kΩ resistor should be placed in parallel with the D_{GND} diode. This method will also produce a voltage offset of ~600 mV with respect to the IN and STAT pins. This diode can also be shared amongst several High Side Devices. This voltage offset will vary if D_{GND} is shared by multiple devices.

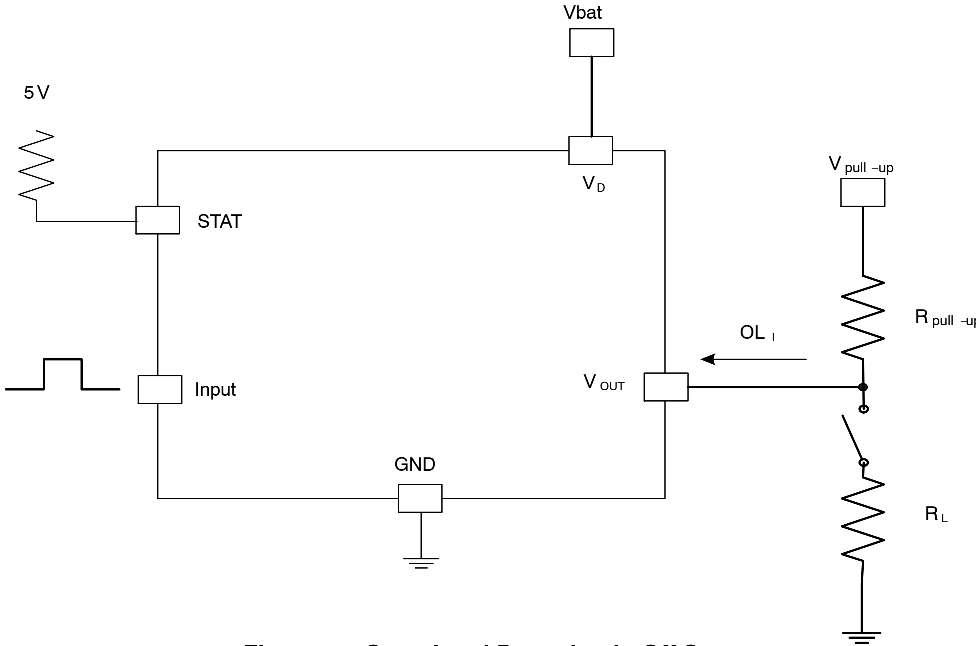


Figure 32. Open Load Detection In Off State

OFF State Open Load Detection

Off State Open Load Detection requires an external pull-up resistor ($R_{pull-up}$) connected between V_{OUT} pin and a positive supply voltage ($V_{pull-up}$).

The external $R_{pull-up}$ resistor value should be selected to ensure that a false OFF State OL condition is not detected when the load (R_L) is connected. A V_{OUT} voltage above the V_{OL_min} (Openload Off State Detection Threshold) minimum value with the load (R_L) connected needs to be avoided. The following formula shows this relationship:

$$V_{OUT} = \left(V_{pull-up} / \left(R_L + R_{pull-up}\right)\right) R_L < V_{OL\_min}$$

In addition to ensuring the selected $R_{pull-up}$ resistor value does not cause a false OFF State OL detection condition when the load is connected, the $R_{pull-up}$ must also not cause the OFF State OL to miss detecting an OL condition when the load is disconnected. A V_{OUT} voltage below the V_{OL_max} (Openload Off State Detection Threshold) maximum value with the load (R_L) disconnected needs to be avoided. The following formula shows this relationship:

$$R_{pull-up} < \left(V_{pull-up} - V_{OL\_max}\right) / OL_1$$

$$OL_1 = I_L\left(\text{Output Leakage with } V_{OUT} = 3.5\ \text{V}\right)$$

Because I_d (OFF) may significantly increase if V_{OUT} is pulled high (up to several mA), $R_{pull-up}$ resistor should be connected to a supply that is switched OFF when the module is in standby.

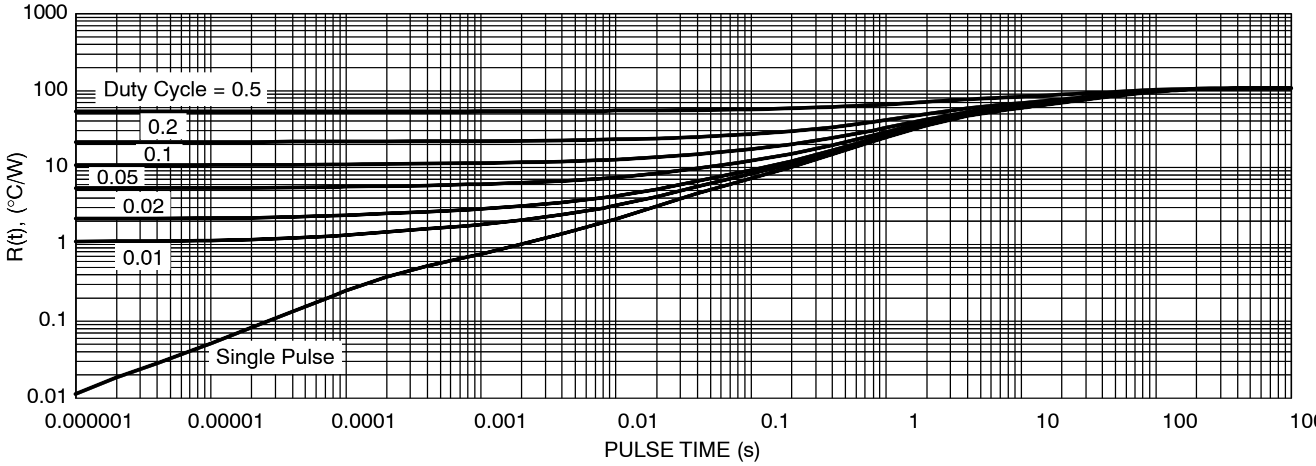


Figure 33. Transient Thermal Impedance

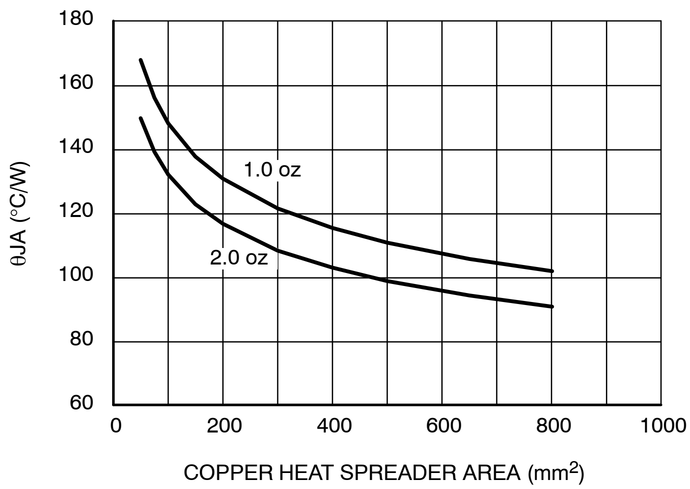
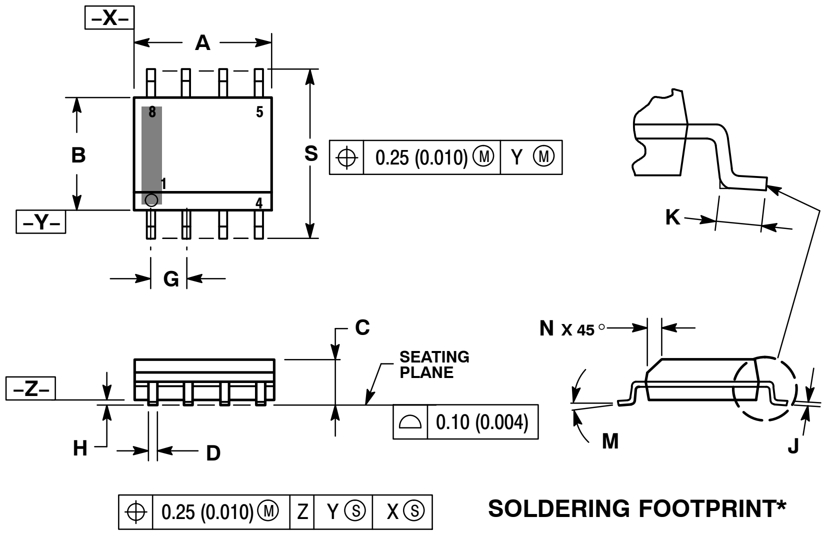


Figure 34. $R_{\theta JA}$ vs Copper Area

PACKAGE DIMENSIONS

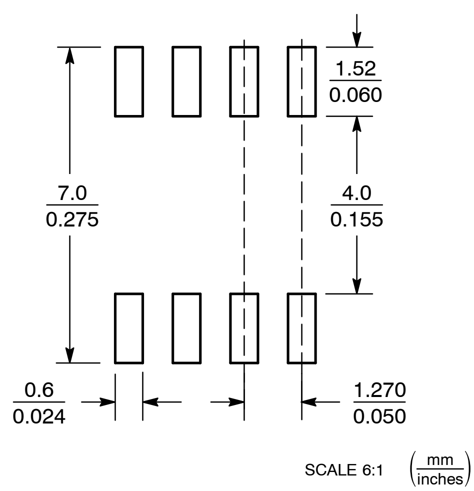
SOIC−8 NB
CASE 751−07
ISSUE AK



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

	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.

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