

# NCV8450, NCV8450A

## Self-Protected High Side Driver with Temperature and Current Limit

The NCV8450/A is a fully protected High-Side Smart Discrete device with a typical  $R_{DS(on)}$  of  $1.0\ \Omega$  and an internal current limit of  $0.8\text{ A}$  typical. The device can switch a wide variety of resistive, inductive, and capacitive loads.

### Features

- Short Circuit Protection
- Thermal Shutdown with Automatic Restart
- Overvoltage Protection
- Integrated Clamp for Inductive Switching
- Loss of Ground Protection
- ESD Protection
- Slew Rate Control for Low EMI
- Very Low Standby Current
- NCV Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC-Q100 Qualified and PPAP Capable
- These Devices are Pb-Free, Halogen Free/BFR Free and are RoHS Compliant

### Typical Applications

- Automotive
- Industrial

### PRODUCT SUMMARY

| Symbol       | Characteristics        | Value    | Unit     |
|--------------|------------------------|----------|----------|
| $V_{IN\_CL}$ | Overvoltage Protection | 54       | V        |
| $V_{D(on)}$  | Operation Voltage      | 4.5 – 45 | V        |
| $R_{on}$     | On-State Resistance    | 1.0      | $\Omega$ |



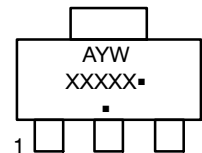
ON Semiconductor®

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### MARKING DIAGRAM



SOT-223  
(TO-261)  
CASE 318E



XXXXX = V8450 or 8450A  
A = Assembly Location  
Y = Year  
W = Work Week  
▪ = Pb-Free Package

(Note: Microdot may be in either location)

### ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 8 of this data sheet.

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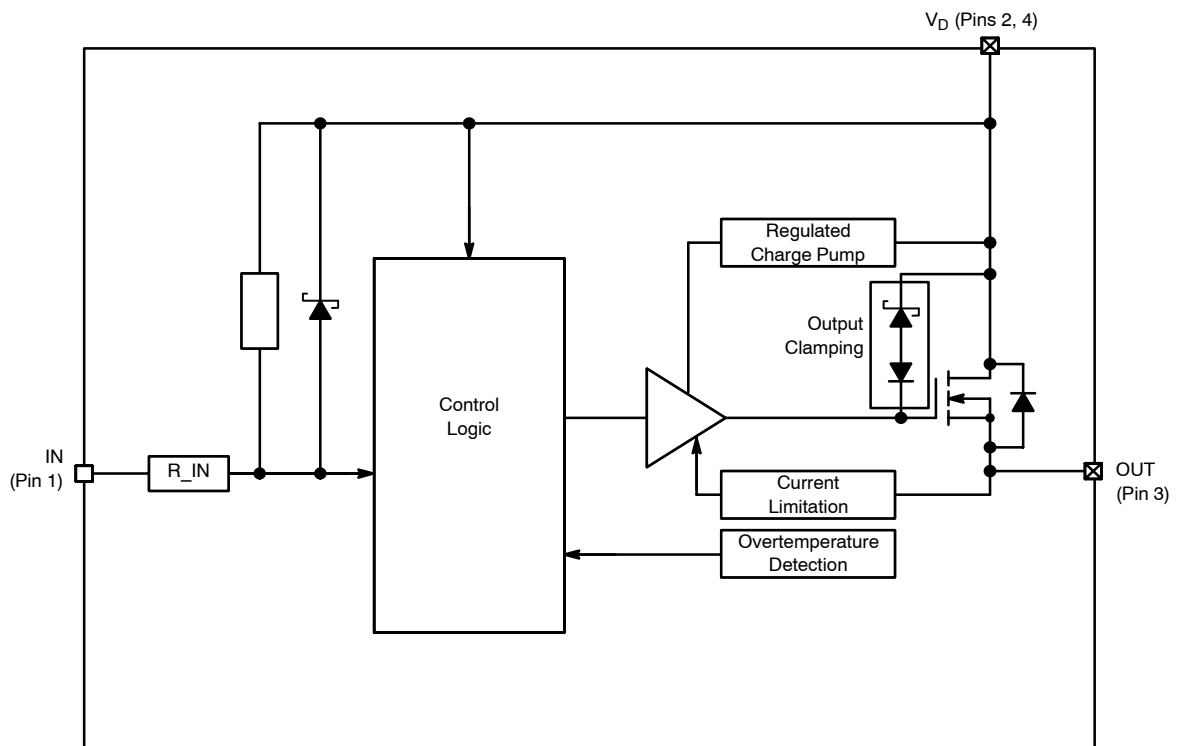


Figure 1. Block Diagram

## PACKAGE PIN DESCRIPTION

| Pin # | Symbol | Description               |
|-------|--------|---------------------------|
| 1     | IN     | Control Input, Active Low |
| 2     | $V_D$  | Supply Voltage            |
| 3     | OUT    | Output                    |
| 4     | $V_D$  | Supply Voltage            |

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## MAXIMUM RATINGS

| Rating                                                                                                                                                               | Symbol         | Value |                    | Unit             |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|-------|--------------------|------------------|
|                                                                                                                                                                      |                | Min   | Max                |                  |
| DC Supply Voltage (Note 1)                                                                                                                                           | $V_D$          | -16   | 45                 | V                |
| Load Dump Protection<br>( $R_I = 2\ \Omega$ , $t_d = 400\text{ ms}$ , $V_{IN} = 0, 10\text{ V}$ , $I_L = 150\text{ mA}$ , $V_{bb} = 13.5\text{ V}$ )                 | $V_{LoadDump}$ |       | 85                 | V                |
| Input Current                                                                                                                                                        | $I_{in}$       | -15   | 15                 | mA               |
| Output Current (Note 1)                                                                                                                                              | $I_{out}$      |       | Internally Limited | A                |
| Total Power Dissipation<br>@ $T_A = 25^\circ\text{C}$ (Note 2)<br>@ $T_A = 25^\circ\text{C}$ (Note 3)                                                                | $P_D$          |       | 1.13<br>1.60       | W                |
| Electrostatic Discharge (Note 4)<br>(Human Body Model (HBM) 100 pF/1500 $\Omega$ )<br>Input<br>All other                                                             |                |       | 1<br>5             | kV               |
| Single Pulse Inductive Load Switching Energy (Note 4)<br>( $V_{DD} = 13.5\text{ V}$ , $I = 465\text{ mA}$ , $L = 200\text{ mH}$ , $T_{JStart} = 150^\circ\text{C}$ ) | $E_{AS}$       |       | 29                 | mJ               |
| Operating Junction Temperature                                                                                                                                       | $T_J$          | -40   | +150               | $^\circ\text{C}$ |
| Storage Temperature                                                                                                                                                  | $T_{storage}$  | -55   | +150               | $^\circ\text{C}$ |

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. Reverse Output current has to be limited by the load to stay within absolute maximum ratings and thermal performance.
2. Minimum Pad.
3. 1 in square pad size, FR-4, 1 oz Cu.
4. Not subjected to production testing.

## THERMAL RESISTANCE RATINGS

| Parameter                                                                                   | Symbol                             | Max Value   | Unit |
|---------------------------------------------------------------------------------------------|------------------------------------|-------------|------|
| Thermal Resistance (Note 5)<br>Junction-to-Ambient (Note 2)<br>Junction-to-Ambient (Note 3) | $R_{\theta JA}$<br>$R_{\theta JA}$ | 110<br>78.3 | K/W  |

5. Not subjected to production testing.

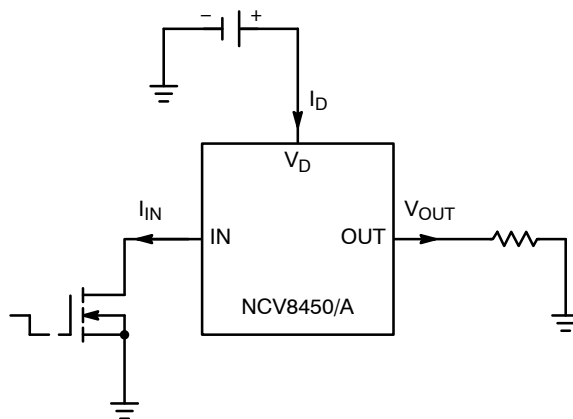


Figure 2. Applications Test Circuit

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## ELECTRICAL CHARACTERISTICS (6 ≤ V<sub>D</sub> ≤ 45 V; -40°C < T<sub>J</sub> < 150°C unless otherwise specified)

| Rating | Symbol | Conditions | Value |     |     | Unit |
|--------|--------|------------|-------|-----|-----|------|
|        |        |            | Min   | Typ | Max |      |

### OUTPUT CHARACTERISTICS

|                                           |                     |                                                                                                                                                                                                                                                       |     |                   |               |    |
|-------------------------------------------|---------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-------------------|---------------|----|
| Operating Supply Voltage                  | V <sub>SUPPLY</sub> |                                                                                                                                                                                                                                                       | 4.5 | –                 | 45            | V  |
| On Resistance<br>(Pin 1 Connected to GND) | R <sub>ON</sub>     | T <sub>J</sub> = 25°C, I <sub>OUT</sub> = 150 mA, V <sub>D</sub> = 7 V – 45 V<br>T <sub>J</sub> = 150°C, I <sub>OUT</sub> = 150 mA, V <sub>D</sub> = 7 V – 45 V<br>(Note 6)<br>T <sub>J</sub> = 25°C, I <sub>OUT</sub> = 150 mA, V <sub>D</sub> = 6 V |     | 1.0<br>1.4<br>1.1 | 2<br>3<br>2.1 | Ω  |
| Standby Current (Pin 1 Open)              | I <sub>D</sub>      | V <sub>D</sub> ≤ 20 V<br>V <sub>D</sub> > 20 V                                                                                                                                                                                                        |     | 0.6               | 10<br>100     | μA |

### INPUT CHARACTERISTICS

|                                              |                     |                                                                                                                                                              |            |     |   |    |
|----------------------------------------------|---------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|-----|---|----|
| Input Current – Off State                    | I <sub>IN_OFF</sub> | V <sub>OUT</sub> ≤ 0.1 V, R <sub>L</sub> = 270 Ω, T <sub>J</sub> = 25°C<br>V <sub>OUT</sub> ≤ 0.1 V, R <sub>L</sub> = 270 Ω, T <sub>J</sub> = 150°C (Note 6) | -50<br>-40 |     |   | μA |
| Input Current – On State<br>(Pin 1 Grounded) | I <sub>IN_ON</sub>  |                                                                                                                                                              |            | 1.5 | 3 | mA |
| Input Resistance (Note 6)                    | R <sub>IN</sub>     |                                                                                                                                                              |            | 1   |   | kΩ |

### SWITCHING CHARACTERISTICS

|                                                                                                  |                      |                                                                                                           |  |     |            |      |
|--------------------------------------------------------------------------------------------------|----------------------|-----------------------------------------------------------------------------------------------------------|--|-----|------------|------|
| Turn-On Time (Note 7)<br>(V <sub>IN</sub> = V <sub>D</sub> to 0 V) to 90% V <sub>OUT</sub>       | t <sub>ON</sub>      | R <sub>L</sub> = 270 Ω (Note 6)<br>V <sub>D</sub> = 13.5 V, R <sub>L</sub> = 270 Ω, T <sub>J</sub> = 25°C |  | 30  | 125<br>100 | μs   |
| Turn-Off Time (Note 7)<br>(V <sub>IN</sub> = 0 V to V <sub>D</sub> ) to 10% V <sub>OUT</sub>     | t <sub>OFF</sub>     | R <sub>L</sub> = 270 Ω (Note 6)<br>V <sub>D</sub> = 13.5 V, R <sub>L</sub> = 270 Ω, T <sub>J</sub> = 25°C |  | 60  | 175<br>150 | μs   |
| Slew Rate On (Note 7)<br>(V <sub>IN</sub> = V <sub>D</sub> to 0V) 10% to 30% V <sub>OUT</sub>    | dV/dt <sub>ON</sub>  | R <sub>L</sub> = 270 Ω (Note 6)<br>V <sub>D</sub> = 13.5 V, R <sub>L</sub> = 270 Ω, T <sub>J</sub> = 25°C |  | 0.7 | 4<br>4     | V/μs |
| Slew Rate Off (Note 7)<br>(V <sub>IN</sub> = 0 V to V <sub>D</sub> ) 70% to 40% V <sub>OUT</sub> | dV/dt <sub>OFF</sub> | R <sub>L</sub> = 270 Ω (Note 6)<br>V <sub>D</sub> = 13.5 V, R <sub>L</sub> = 270 Ω, T <sub>J</sub> = 25°C |  | 0.9 | 4<br>4     | V/μs |

### OUTPUT DIODE CHARACTERISTICS (Note 6)

|                                  |                |                           |  |     |     |   |
|----------------------------------|----------------|---------------------------|--|-----|-----|---|
| Drain-Source Diode Voltage       | V <sub>F</sub> | I <sub>OUT</sub> = -0.2 A |  | 0.6 |     | V |
| Continuous Reverse Drain Current | I <sub>S</sub> | T <sub>J</sub> = 25°C     |  |     | 0.2 | A |

### PROTECTION FUNCTIONS (Note 8)

|                                                                                                                  |                      |                                                                                                                                                                                                                                                   |     |     |     |    |
|------------------------------------------------------------------------------------------------------------------|----------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-----|-----|----|
| Temperature Shutdown (Note 6)                                                                                    | T <sub>SD</sub>      |                                                                                                                                                                                                                                                   | 150 | 175 | –   | °C |
| Temperature Shutdown Hysteresis (Note 6)                                                                         | T <sub>SD_HYST</sub> |                                                                                                                                                                                                                                                   |     | 5   |     | °C |
| Output Current Limit                                                                                             | I <sub>LIM</sub>     | T <sub>J</sub> = -40°C, V <sub>D</sub> = 13.5 V, t <sub>m</sub> = 100 μs (Note 6)<br>T <sub>J</sub> = 25°C, V <sub>D</sub> = 13.5 V, t <sub>m</sub> = 100 μs<br>T <sub>J</sub> = 150°C, V <sub>D</sub> = 13.5 V, t <sub>m</sub> = 100 μs (Note 6) | 0.5 | 0.8 | 1.5 | A  |
| Output Clamp Voltage<br>(Inductive Load Switch Off)<br>At V <sub>OUT</sub> = V <sub>D</sub> – V <sub>CLAMP</sub> | V <sub>CLAMP</sub>   | I <sub>OUT</sub> = 4 mA                                                                                                                                                                                                                           | 45  | 52  |     | V  |
| Overvoltage Protection                                                                                           | V <sub>IN_CL</sub>   | I <sub>CLAMP</sub> = 4 mA                                                                                                                                                                                                                         | 50  | 54  |     | V  |

6. Not subjected to production testing

7. Only valid with high input slew rates

8. Protection functions are not designed for continuous repetitive operation and are considered outside normal operating range

TYPICAL CHARACTERISTIC CURVES

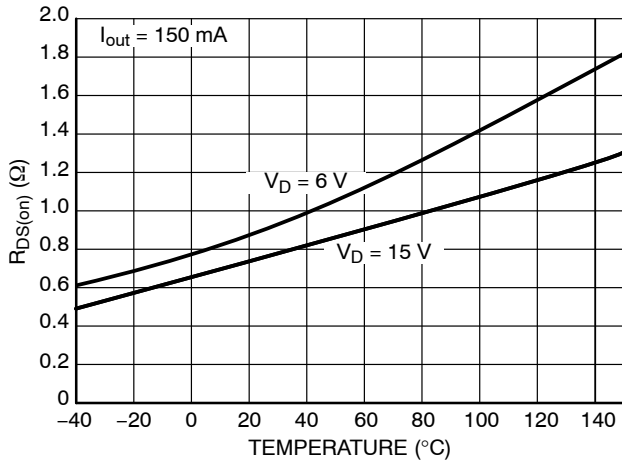


Figure 3.  $R_{DS(on)}$  vs. Temperature

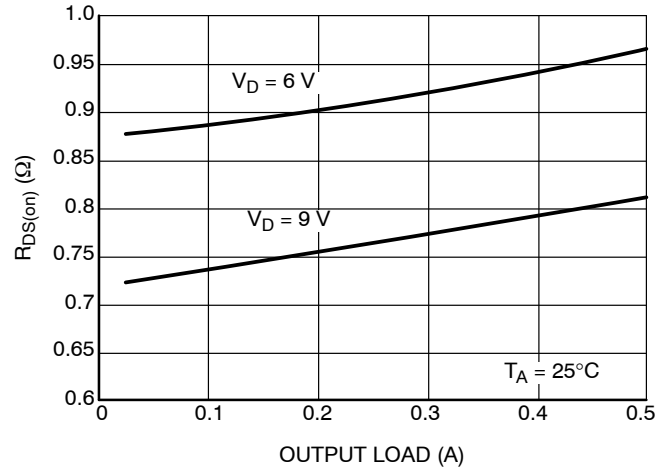


Figure 4.  $R_{DS(on)}$  vs. Output Load

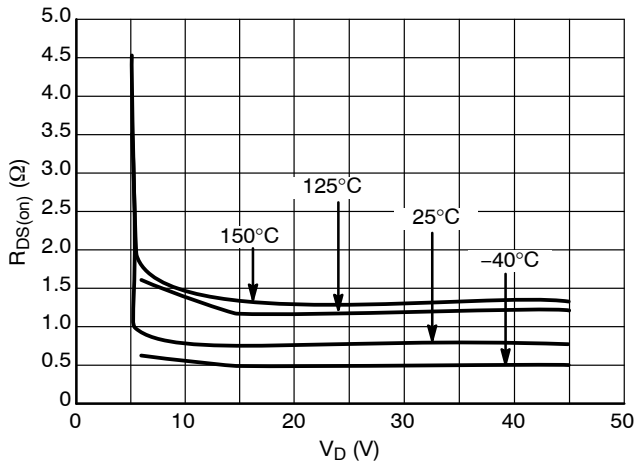


Figure 5.  $R_{DS(on)}$  vs.  $V_D$

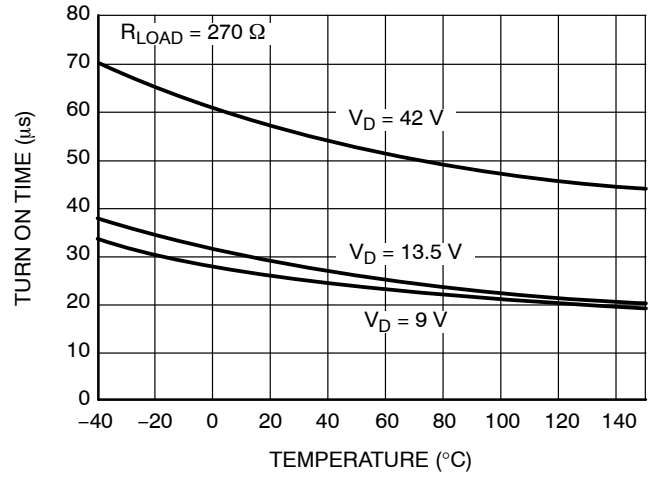


Figure 6. Turn On Time vs. Temperature

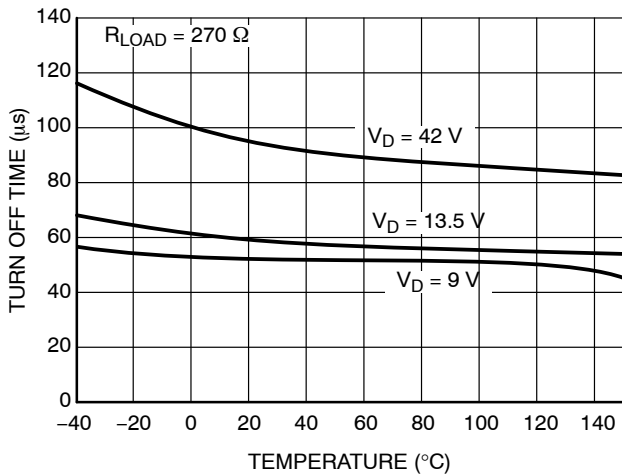


Figure 7. Turn Off Time vs. Temperature

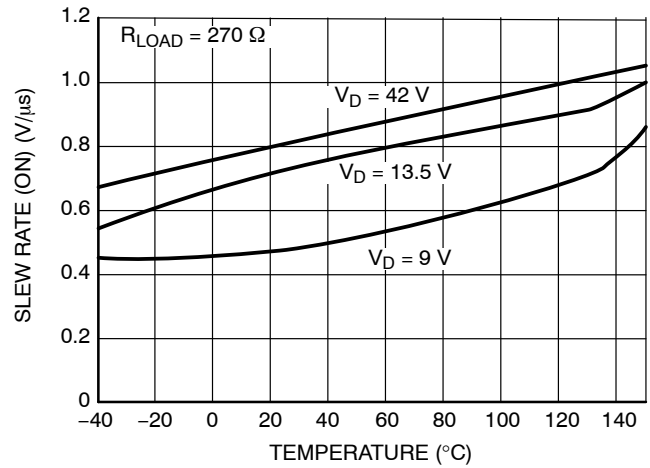


Figure 8. Slew Rate (ON) vs. Temperature

TYPICAL CHARACTERISTIC CURVES

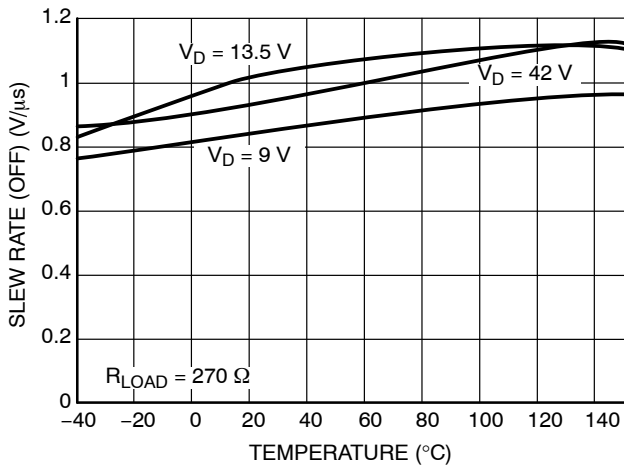


Figure 9. Slew Rate (OFF) vs. Temperature

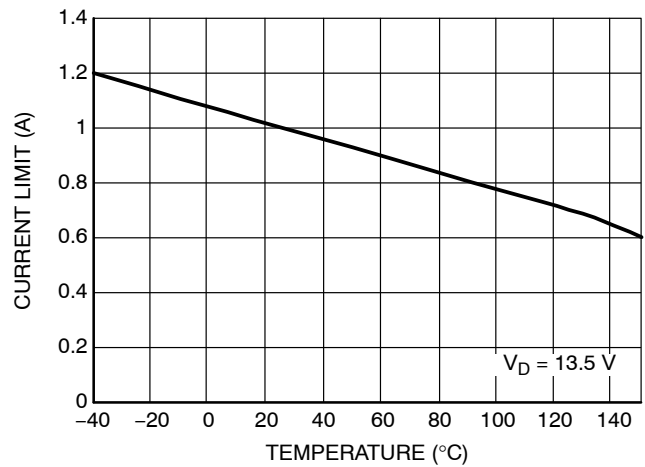


Figure 10. Current Limit vs. Temperature

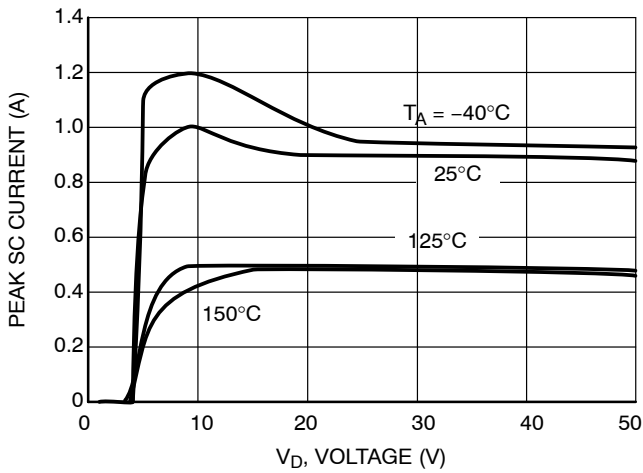


Figure 11. Peak Short Circuit Current vs.  $V_D$  Voltage

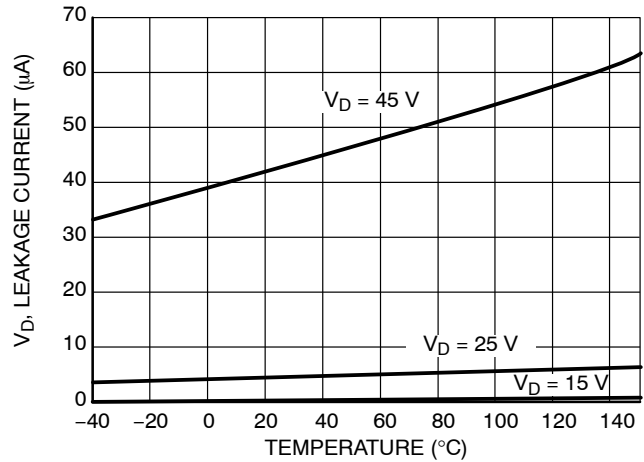


Figure 12.  $V_D$  Leakage Current vs. Temperature Off-State

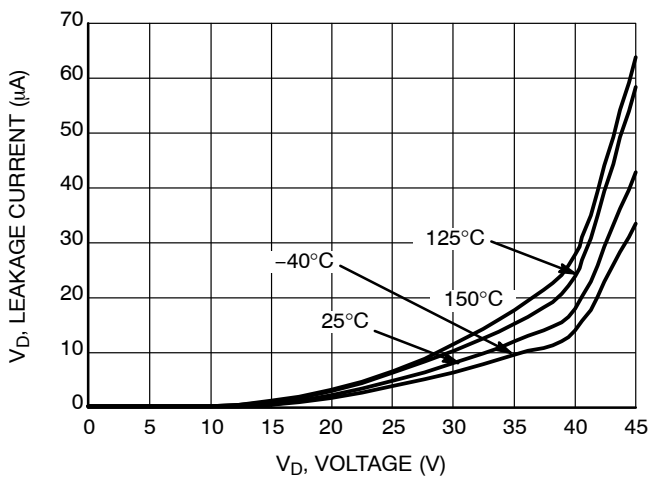


Figure 13.  $V_D$  Leakage Current vs.  $V_D$  Voltage Off-State

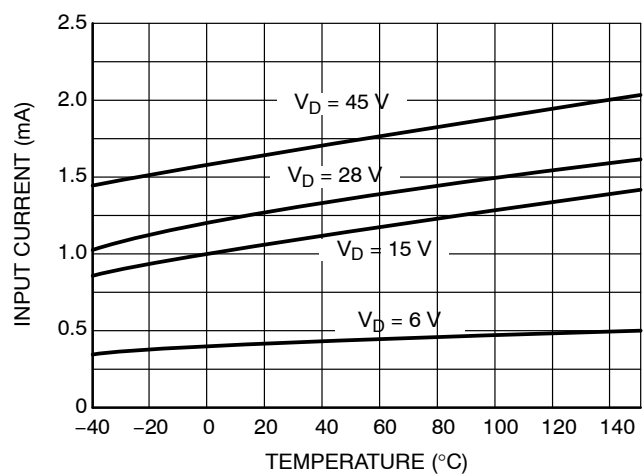


Figure 14. On-State Input Current vs. Temperature

# NCV8450, NCV8450A

## TYPICAL CHARACTERISTIC CURVES

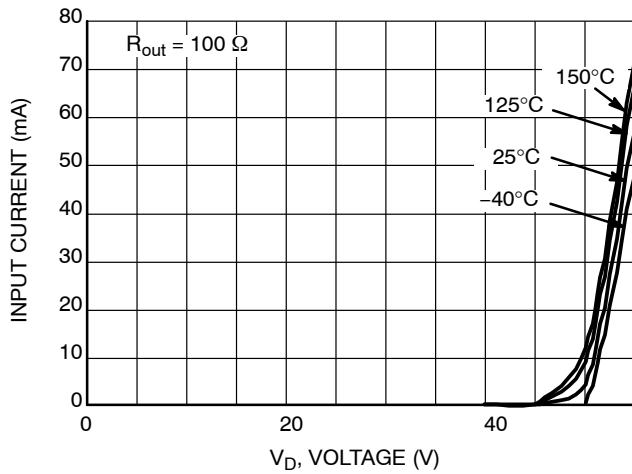


Figure 18. Input Current vs.  $V_D$  Voltage Off-State

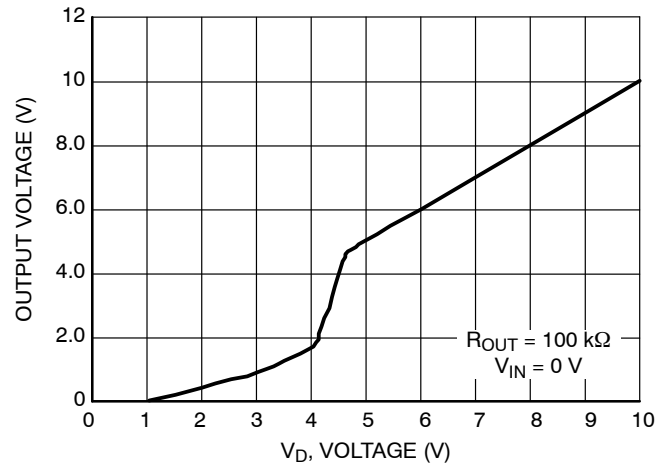


Figure 15. Output Voltage vs.  $V_D$  Voltage

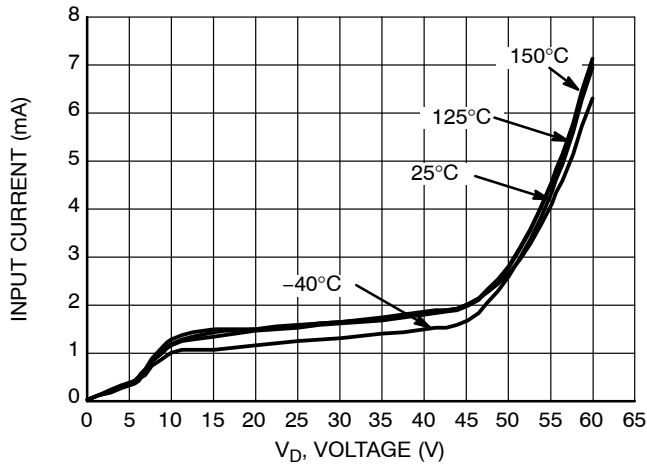


Figure 16. Input Current vs.  $V_D$  Voltage On-State

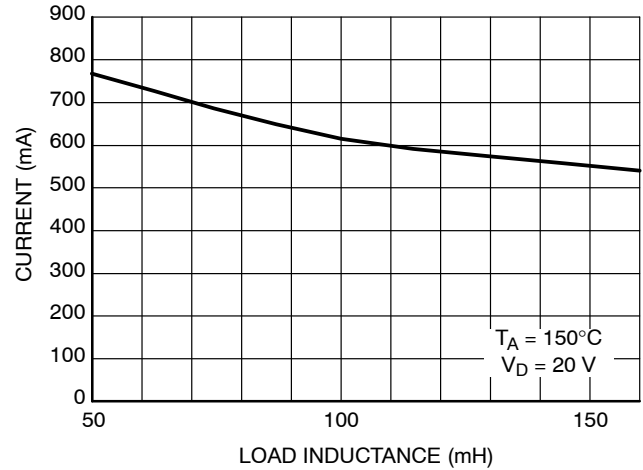


Figure 17. Single Pulse Maximum Switch-off Current vs. Load Inductance

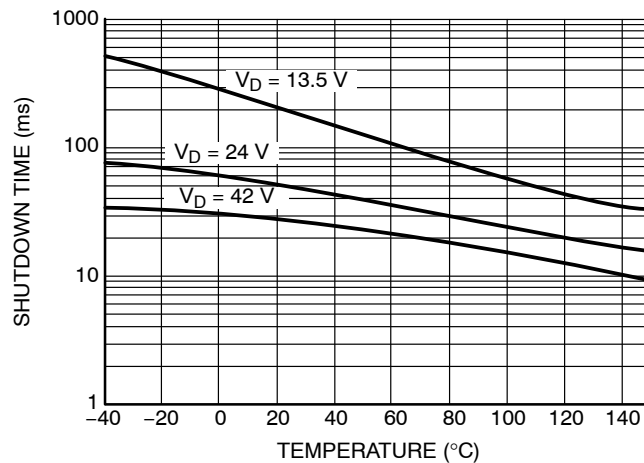


Figure 19. Initial Short-Circuit Shutdown Time vs. Temperature

# NCV8450, NCV8450A

## TYPICAL CHARACTERISTIC CURVES

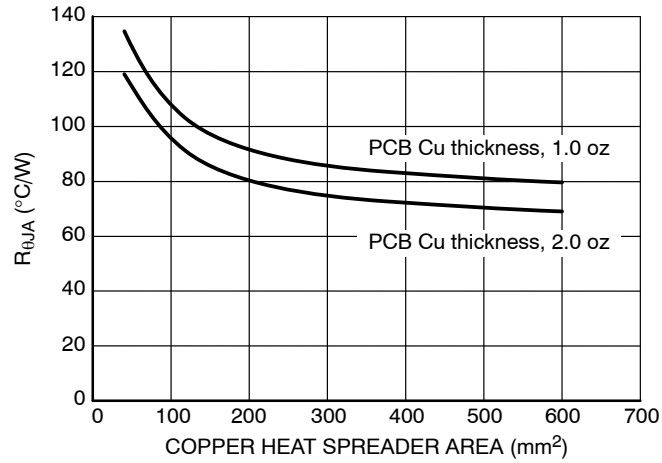


Figure 20.  $R_{\theta JA}$  vs. Copper Area

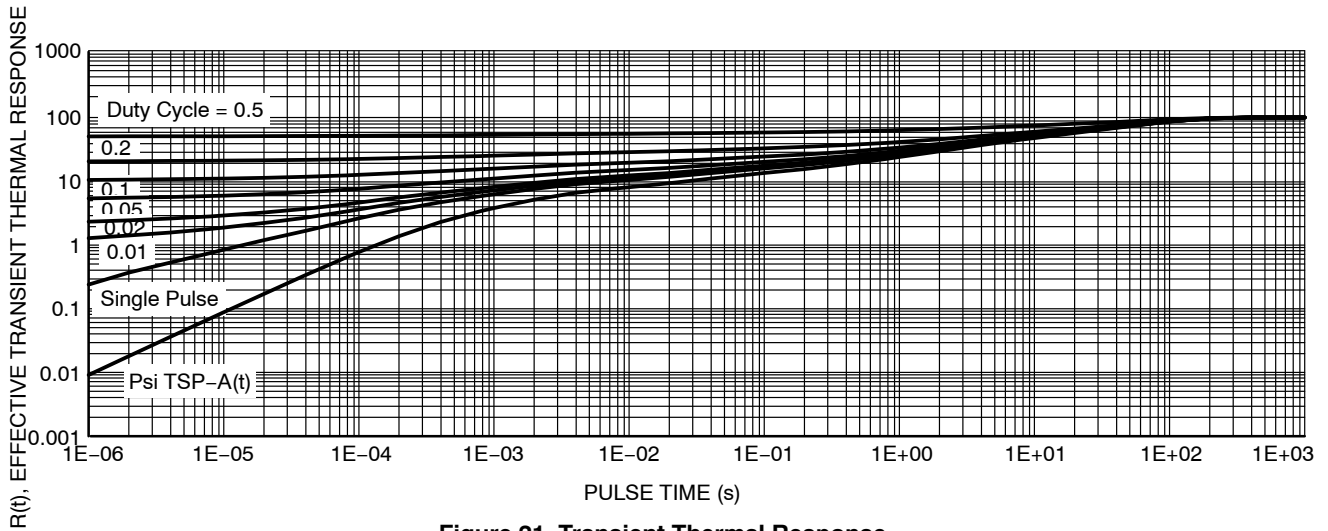


Figure 21. Transient Thermal Response

### ISO PULSE TEST RESULTS

| Test Pulse | Test Level | Test Results | Pulse Cycle Time and Generator Impedance |
|------------|------------|--------------|------------------------------------------|
| 1          | 200 V      | C            | 500 ms, 10 $\Omega$                      |
| 2          | 150 V      | C            | 500 ms, 10 $\Omega$                      |
| 3a         | 200 V      | C            | 100 ms, 50 $\Omega$                      |
| 3b         | 200 V      | C            | 100 ms, 50 $\Omega$                      |
| 5          | 175 V      | E(100 V)     | 400 ms, 2 $\Omega$                       |

### ORDERING INFORMATION

| Device        | Package              | Shipping <sup>†</sup> |
|---------------|----------------------|-----------------------|
| NCV8450STT3G  | SOT-223<br>(Pb-Free) | 4000 / Tape & Reel    |
| NCV8450ASTT3G | SOT-223<br>(Pb-Free) | 4000 / Tape & Reel    |

<sup>†</sup>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.

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