

# NCV8408

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

42 V, 10 A, Single N-Channel, DPAK

NCV8408 is a single channel protected Low-Side Smart Discrete device. The protection features include overcurrent, overtemperature, ESD and integrated Drain-to-Gate clamping for overvoltage protection. Thermal protection includes a latch which can be reset by toggling the input. This device is suitable for harsh automotive environments.

### Features

- Short Circuit Protection
- Thermal Shutdown with Latched Reset
- Gate Input Current Flag During Latched Fault Condition
- Overvoltage Protection
- Integrated Clamp for Inductive Switching
- ESD Protection
- dV/dt Robustness
- Analog Drive Capability (Logic Level Input)
- 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 and are RoHS Compliant

### Typical Applications

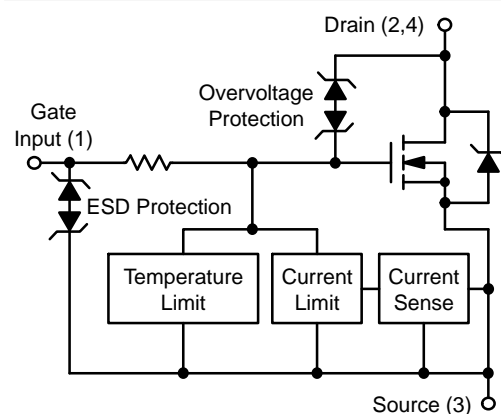
- Switch a Variety of Resistive, Inductive and Capacitive Loads
- Can Replace Electromechanical Relays and Discrete Circuits
- Automotive / Industrial



ON Semiconductor®

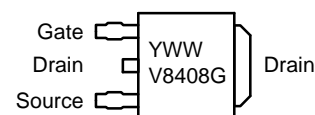
<http://onsemi.com>

| V <sub>DSS</sub> (Clamped) | R <sub>DS(on)</sub> TYP | I <sub>D</sub> MAX (Limited) |
|----------------------------|-------------------------|------------------------------|
| 42 V                       | 55 mΩ @ 5 V             | 10 A                         |



DPAK  
CASE 369C  
STYLE 2

### MARKING DIAGRAM



Y = Year  
WW = Work Week  
V8408 = Specific Device Code  
G = Pb-Free Package

### ORDERING INFORMATION

| Device       | Package        | Shipping†        |
|--------------|----------------|------------------|
| NCV8408DTRKG | DPAK (Pb-Free) | 2500/Tape & Reel |

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

# NCV8408

## MAXIMUM RATINGS ( $T_J = 25^\circ\text{C}$ unless otherwise noted)

| Rating  | Symbol  | Value              | Unit               |
|---|---|--------------------|--------------------|
| Drain-to-Source Voltage Internally Clamped  | $V_{DSS}$   | 42                 | Vdc                |
| Drain-to-Gate Voltage Internally Clamped ( $R_{GS} = 1.0\text{ M}\Omega$ )  | $V_{DGR}$   | 42                 | V                  |
| Gate-to-Source Voltage  | $V_{GS}$  | $\pm 14$           | Vdc                |
| Continuous Drain Current  | $I_D$   | Internally Limited |                    |
| Gate Input Current ( $V_{GS} = \pm 14\text{ V}_{DC}$ )  | $I_{GS}$  | $\pm 10$           | mA                 |
| Source to Drain Current   | $I_{SD}$  | 4.0                | A                  |
| Total Power Dissipation<br>@ $T_A = 25^\circ\text{C}$ (Note 1)<br>@ $T_A = 25^\circ\text{C}$ (Note 2)   | $P_D$   | 1.8<br>2.3         | W                  |
| Thermal Resistance<br>Junction-to-Ambient Steady State (Note 1)<br>Junction-to-Ambient Steady State (Note 2)<br>Junction-to-Tab Steady State (Note 3)         | $R_{\theta JA}$<br>$R_{\theta JA}$<br>$R_{\theta JT}$ | 70<br>55<br>2.1    | $^\circ\text{C/W}$ |
| Single Pulse Inductive Load Switching Energy<br>( $V_{DD} = 20\text{ Vdc}$ , $V_{GS} = 5.0\text{ V}$ , $I_L = 8.0\text{ A}$ )                                 | $E_{AS}$  | 185                | mJ                 |
| Repetitive Pulse Inductive Load Switching Energy<br>( $V_{DD} = 20\text{ Vdc}$ , $V_{GS} = 5.0\text{ V}$ , $I_L = 8.0\text{ A}$ , $T_J = 25^\circ\text{C}$ )  | $E_{AR}$  | 128                |                    |
| Repetitive Pulse Inductive Load Switching Energy<br>( $V_{DD} = 20\text{ Vdc}$ , $V_{GS} = 5.0\text{ V}$ , $I_L = 6.8\text{ A}$ , $T_J = 105^\circ\text{C}$ ) | $E_{AR}$  | 92                 |                    |
| Load Dump Voltage ( $V_{GS} = 0$ and $10\text{ V}$ , $R_I = 2.0\ \Omega$ , $R_L = 4.5\ \Omega$ , $t_d = 400\text{ ms}$ , $T_J = 25^\circ\text{C}$ )           | $V_{LD}$  | 63                 | V                  |
| Operating Junction Temperature  | $T_J$   | -40 to 150         | $^\circ\text{C}$   |
| Storage Temperature   | $T_{stg}$   | -55 to 150         | $^\circ\text{C}$   |

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. Surface-mounted onto minimum pad FR4 PCB (1 oz Cu, 0.06" thick).
2. Surface-mounted onto 2" square FR4 PCB, (1" square, 1 oz Cu, 0.06" thick).
3. Surface-mounted onto minimum pad FR4 PCB (2 oz Cu, 0.06" thick).

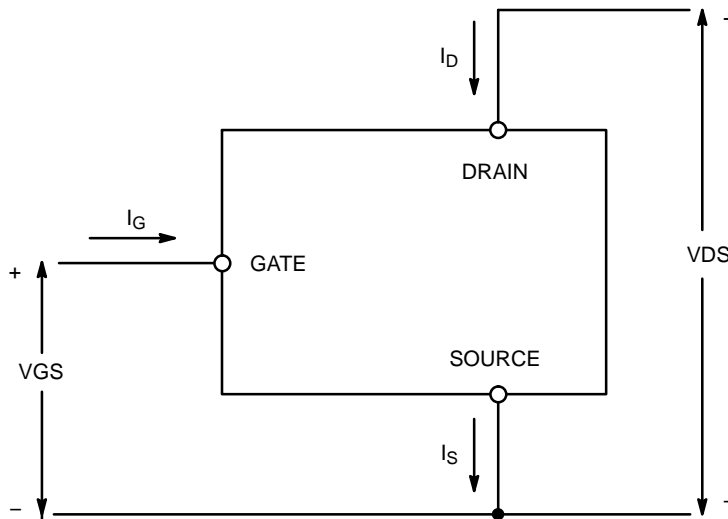


Figure 1. Voltage and Current Convention

# NCV8408

## ELECTRICAL CHARACTERISTICS (T<sub>J</sub> = 25°C unless otherwise noted)

| Characteristic | Test Conditions | Symbol | Min | Typ | Max | Unit |
|----------------|-----------------|--------|-----|-----|-----|------|
|----------------|-----------------|--------|-----|-----|-----|------|

### OFF CHARACTERISTICS

|  |  |                      |                |                |                |    |
|--|--|----------------------|----------------|----------------|----------------|----|
| Drain-to-Source Clamped Breakdown Voltage (Note 4)<br>(V <sub>GS</sub> = 0 V, I <sub>D</sub> = 10 mA, T <sub>J</sub> = 25°C)<br>(V <sub>GS</sub> = 0 V, I <sub>D</sub> = 10 mA, T <sub>J</sub> = 150°C) (Note 6)<br>(V <sub>GS</sub> = 0 V, I <sub>D</sub> = 10 mA, T <sub>J</sub> = -40°C) (Note 6) |  | V <sub>(BR)DSS</sub> | 42<br>40<br>43 | 46<br>45<br>47 | 51<br>51<br>51 | V  |
| Zero Gate Voltage Drain Current<br>(V <sub>GS</sub> = 0 V, V <sub>DS</sub> = 32 V, T <sub>J</sub> = 25°C)<br>(V <sub>GS</sub> = 0 V, V <sub>DS</sub> = 32 V, T <sub>J</sub> = 150°C) (Note 6)  |  | I <sub>DSS</sub>     | -<br>-         | 0.6<br>2.5     | 5.0<br>10      | μA |

### INPUT CHARACTERISTICS (Note 4)

|   |   |                                     |     |      |     |        |
|---|---|-------------------------------------|-----|------|-----|--------|
| Gate Input Current – Normal Operation   | (V <sub>GS</sub> = 5.0 V)                                   | I <sub>GSSF</sub>                   | -   | 25   | 50  | μA     |
| Gate Input Current – Protection Latched | (V <sub>GS</sub> = 5.0 V) (Note 6)                          | I <sub>GSSL</sub>                   | -   | 440  | -   | μA     |
| Gate Threshold Voltage                  | (V <sub>GS</sub> = V <sub>DS</sub> , I <sub>D</sub> = 1 mA) | V <sub>GS(th)</sub>                 | 1.0 | 1.7  | 2.2 | V      |
| Gate Threshold Temperature Coefficient  |   | V <sub>GS(th)</sub> /T <sub>J</sub> | -   | 5.0  | -   | -mV/°C |
| Latched Reset Voltage                   | (Note 6)  | V <sub>LR</sub>                     | 0.8 | 1.4  | 1.9 | V      |
| Latched Reset Time                      | (V <sub>GS</sub> = 5.0 V to V <sub>GS</sub> < 1 V) (Note 6) | t <sub>LR</sub>                     | 10  | 40   | 100 | μs     |
| Internal Gate Input Resistance          |   |                                     | -   | 25.5 | -   | kΩ     |

### ON CHARACTERISTICS (Note 4)

|  |   |                     |        |           |           |    |
|--|---|---------------------|--------|-----------|-----------|----|
| Static Drain-to-Source On-Resistance<br>(V <sub>GS</sub> = 5.0 V, I <sub>D</sub> = 3.0 A, T <sub>J</sub> @ 25°C)<br>(V <sub>GS</sub> = 5.0 V, I <sub>D</sub> = 3.0 A, T <sub>J</sub> @ 150°C) (Note 6) |   | R <sub>DS(on)</sub> | -<br>- | 55<br>100 | 60<br>120 | mΩ |
| Source-Drain Forward On Voltage  | (V <sub>GS</sub> = 0 V, I <sub>S</sub> = 7.0 A) | V <sub>SD</sub>     | -      | 0.95      | -         | V  |

### SWITCHING CHARACTERISTICS (Note 6)

|   |   |                                     |                         |                  |                     |      |
|---|---|-------------------------------------|-------------------------|------------------|---------------------|------|
| Turn-OFF/ON Slew Rate Matching                            | V <sub>GS</sub> = 5.0 V, V <sub>DS</sub> = 13 V, R <sub>L</sub> = 4 Ω;<br>T <sub>J</sub> = -40°C<br>T <sub>J</sub> = 150°C<br>T <sub>J</sub> = 25°C<br>-40°C < T <sub>J</sub> < 150°C | T <sub>Match</sub>                  | -15<br>-15<br>-5<br>-20 | -<br>-<br>-<br>- | 15<br>15<br>5<br>20 | %    |
| Turn-ON Delay Time  | V <sub>GS</sub> = 5 V, V <sub>DS</sub> = 13 V<br>R <sub>L</sub> = 4 Ω, -40°C < T <sub>J</sub> < 150°C   | t <sub>d(ON)</sub>                  |                         | 10               | 20                  | μs   |
| Rise Time (10% I <sub>D</sub> to 90% I <sub>D</sub> )     |   | t <sub>r</sub>                      |                         | 20               | 40                  |      |
| Turn-OFF Delay Time                                       |   | t <sub>d(OFF)</sub>                 |                         | 30               | 60                  |      |
| Fall Time (90% I <sub>D</sub> to 10% I <sub>D</sub> )     |   | t <sub>f</sub>                      |                         | 20               | 40                  |      |
| Slew-Rate ON (90% V <sub>D</sub> to 10% V <sub>D</sub> )  |   | -dV <sub>DS</sub> /dt <sub>ON</sub> |                         | 0.5              |                     | V/μs |
| Slew-Rate OFF (10% V <sub>D</sub> to 90% V <sub>D</sub> ) |   | dV <sub>DS</sub> /dt <sub>OFF</sub> |                         | 0.5              |                     |      |

### SELF PROTECTION CHARACTERISTICS (T<sub>J</sub> = 25°C unless otherwise noted) (Note 5)

|   |   |                       |               |              |                |    |
|---|---|-----------------------|---------------|--------------|----------------|----|
| Current Limit<br>V <sub>GS</sub> = 5.0 V, V <sub>DS</sub> = 10 V, T <sub>J</sub> @ 25°C<br>V <sub>GS</sub> = 5.0 V, V <sub>DS</sub> = 10 V, T <sub>J</sub> = 150°C (Note 6)<br>V <sub>GS</sub> = 5.0 V, V <sub>DS</sub> = 10 V, T <sub>J</sub> = -40°C (Note 6) |   | I <sub>LIM</sub>      | 10<br>10<br>9 | 13<br>-<br>- | 16<br>18<br>16 | A  |
| Temperature Limit (Turn-off)  | V <sub>GS</sub> = 5.0 V<br>V <sub>GS</sub> = 10 V | T <sub>LIM(off)</sub> | 150<br>150    | 175<br>165   | 200<br>185     | °C |

### ESD ELECTRICAL CHARACTERISTICS (T<sub>J</sub> = 25°C unless otherwise noted)

|                                     |                        |     |      |   |   |   |
|-------------------------------------|------------------------|-----|------|---|---|---|
| Electro-Static Discharge Capability | Human Body Model (HBM) | ESD | 4000 | - | - | V |
| Electro-Static Discharge Capability | Machine Model (MM)     | ESD | 400  | - | - | V |

- Pulse Test: Pulse Width = 300 μs, Duty Cycle = 2%.
- Fault conditions are viewed as beyond the normal operating range of the part.
- Not subject to production testing.

# NCV8408

## TEST CIRCUITS AND WAVEFORMS

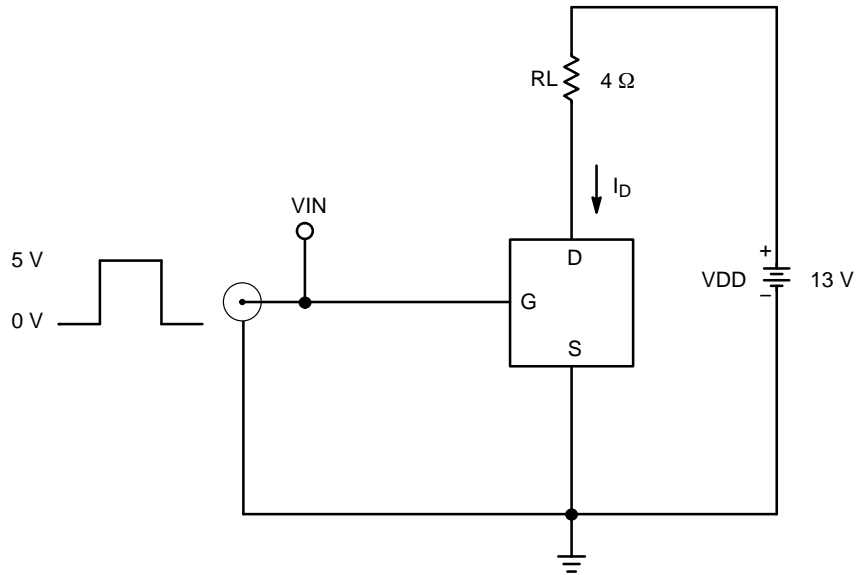


Figure 2. Resistive Load Switching Test Circuit

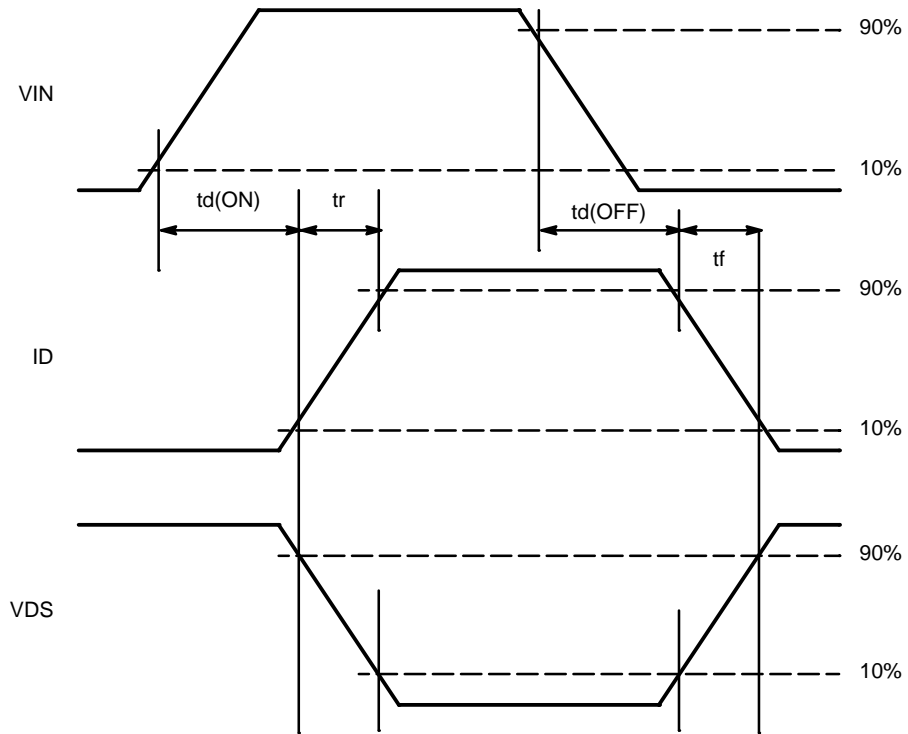


Figure 3. Resistive Load Switching Waveforms

TEST CIRCUITS AND WAVEFORMS

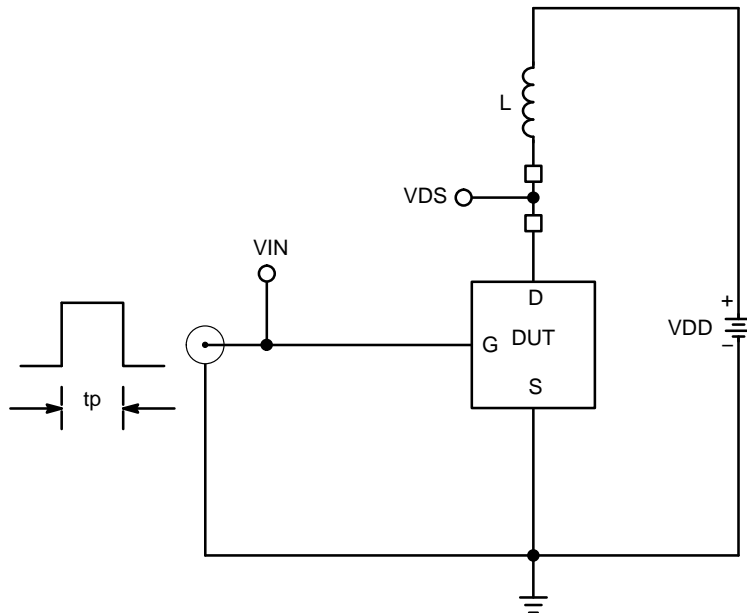


Figure 4. Inductive Load Switching Test Circuit

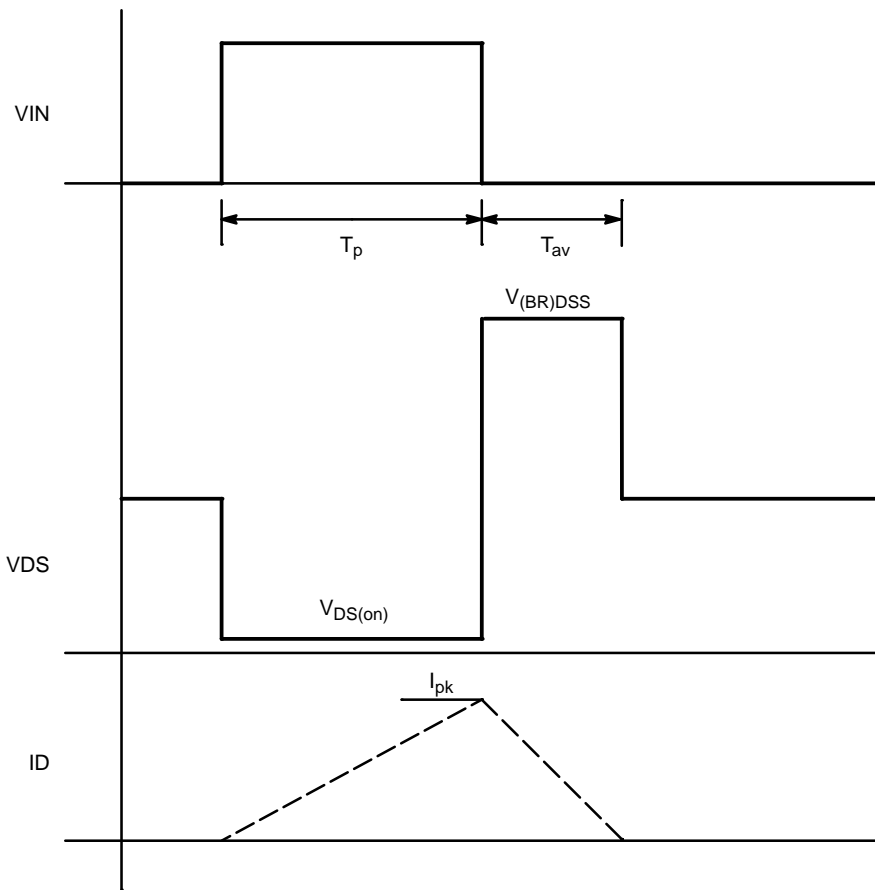


Figure 5. Inductive Load Switching Waveforms

# NCV8408

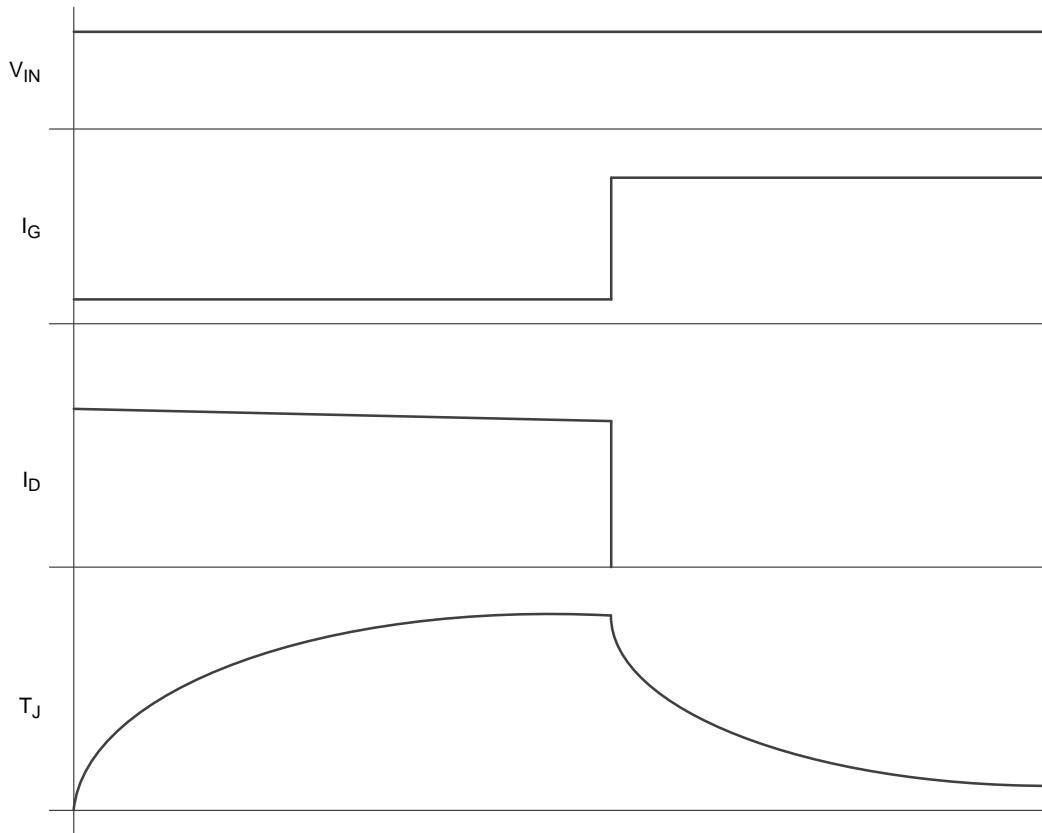


Figure 6. Short-Circuit Protection Behavior

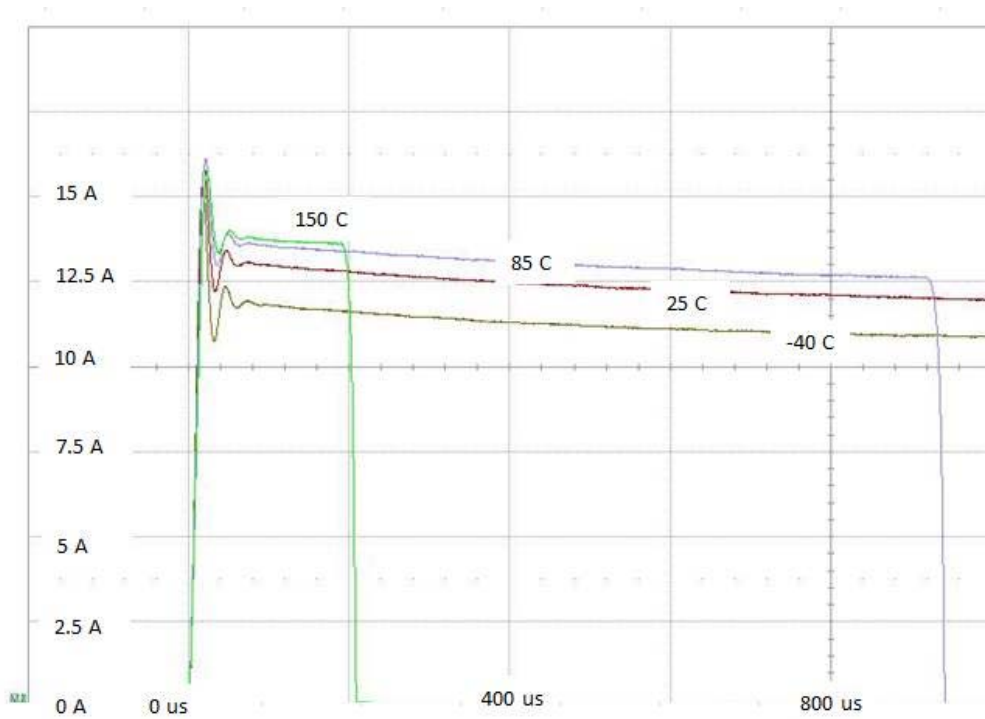


Figure 7. Turn on into Short Circuit Device Response

# NCV8408

## TYPICAL CHARACTERISTICS

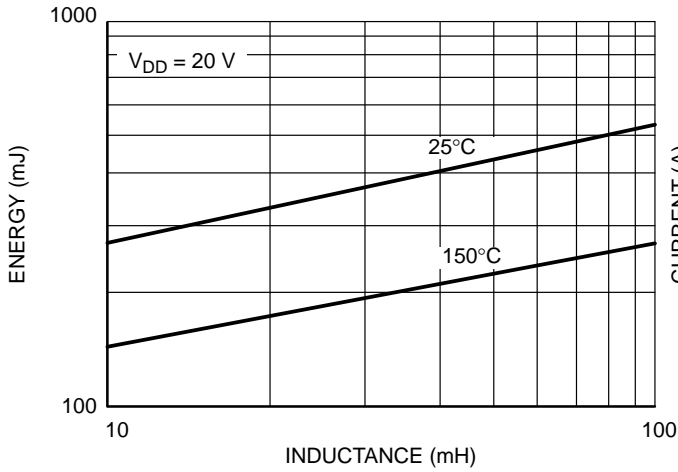


Figure 8. NCV8408 Maximum Switch Off Energy vs Inductance

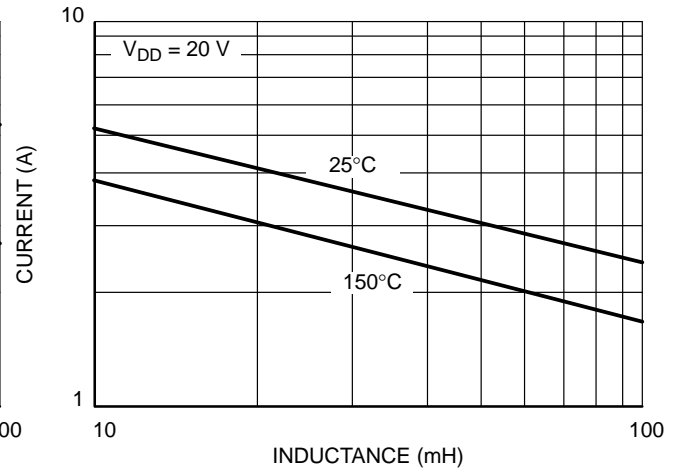


Figure 9. NCV8408 Maximum Switch Off Current vs Inductance

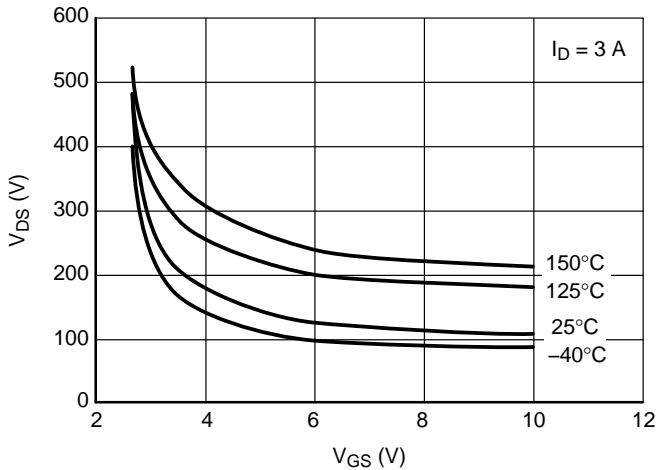


Figure 10.  $V_{GS}$  vs  $V_{DS}$

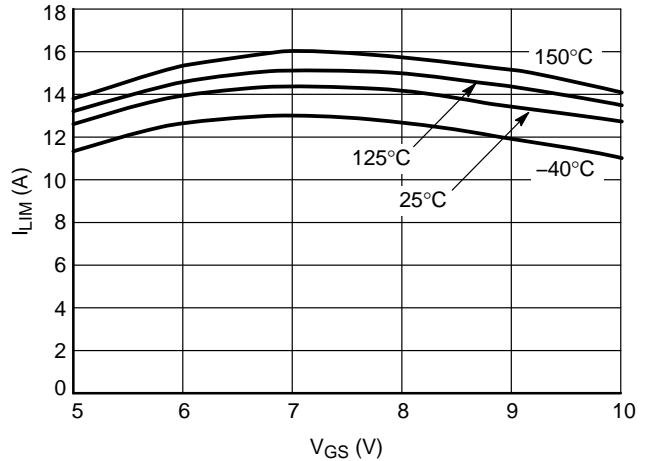


Figure 11. Current Limit vs. Gate Voltage

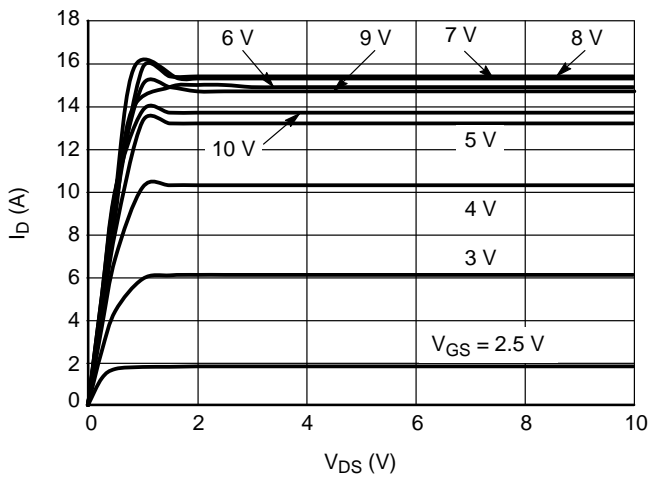


Figure 12. Drain Current vs. Drain Voltage

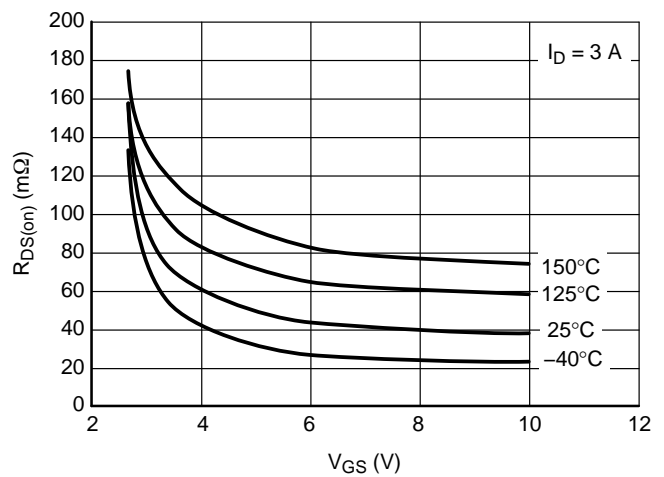


Figure 13.  $R_{DS(on)}$  vs. Gate Voltage

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## TYPICAL CHARACTERISTICS

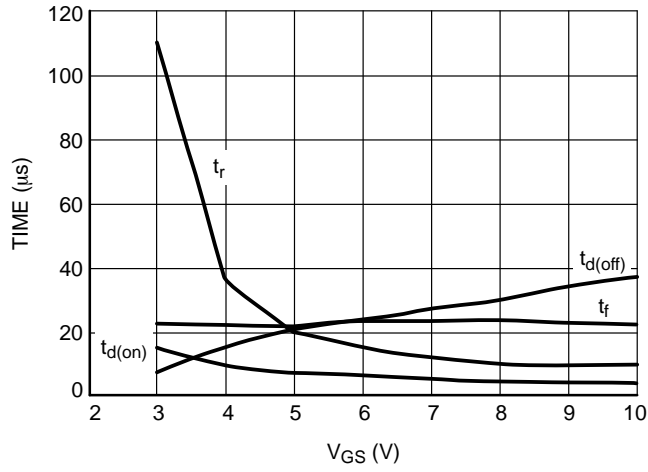


Figure 14. Resistive Switching

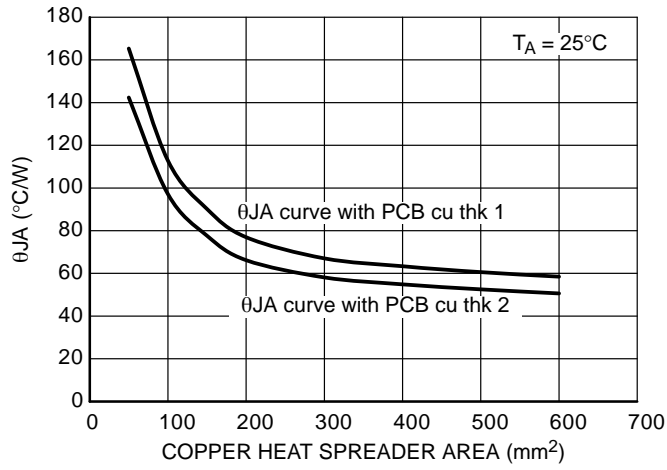


Figure 15.  $R_{\theta JA}$  vs. Copper Area

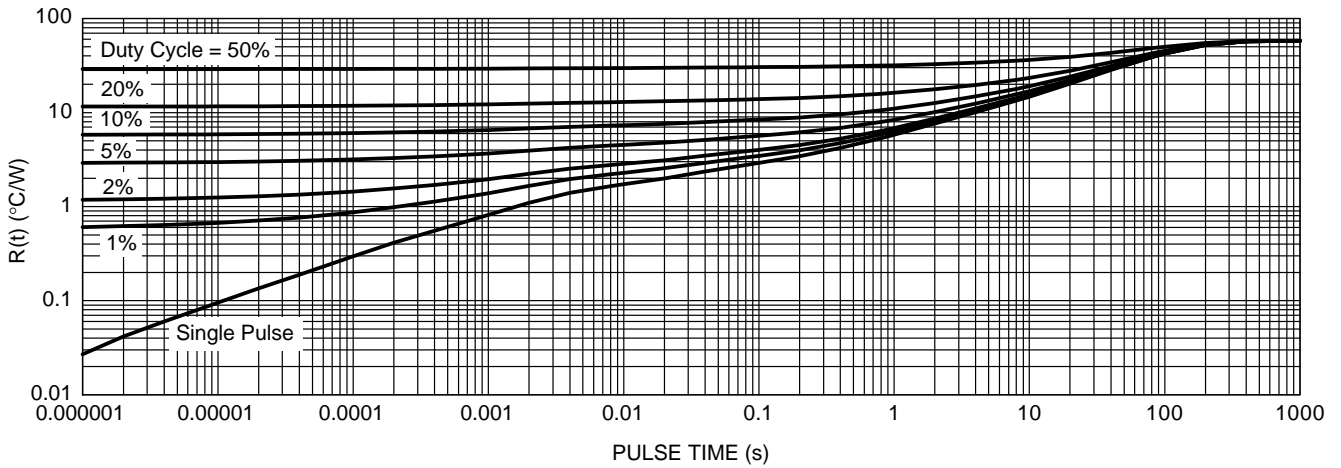


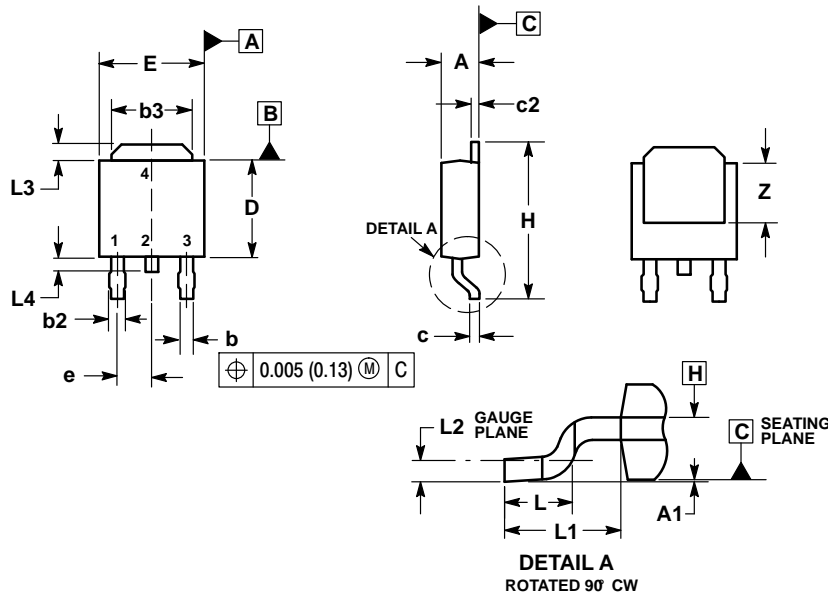
Figure 16. Transient Thermal Resistance



# NCV8408

## PACKAGE DIMENSIONS

### DKPAK (SINGLE GAUGE) CASE 369C ISSUE D



**NOTES:**

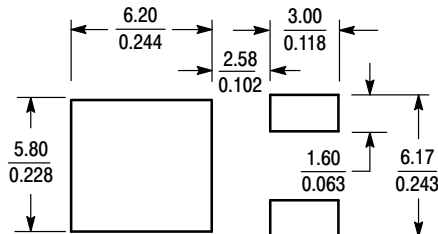
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: INCHES.
3. THERMAL PAD CONTOUR OPTIONAL WITHIN DIMENSIONS b3, L3 and Z.
4. DIMENSIONS D AND E DO NOT INCLUDE MOLD FLASH, PROTRUSIONS, OR BURRS. MOLD FLASH, PROTRUSIONS, OR GATE BURRS SHALL NOT EXCEED 0.006 INCHES PER SIDE.
5. DIMENSIONS D AND E ARE DETERMINED AT THE OUTERMOST EXTREMES OF THE PLASTIC BODY.
6. DATUMS A AND B ARE DETERMINED AT DATUM PLANE H.

| DIM | INCHES    |       | MILLIMETERS |       |
|-----|-----------|-------|-------------|-------|
|     | MIN       | MAX   | MIN         | MAX   |
| A   | 0.086     | 0.094 | 2.18        | 2.38  |
| A1  | 0.000     | 0.005 | 0.00        | 0.13  |
| b   | 0.025     | 0.035 | 0.63        | 0.89  |
| b2  | 0.030     | 0.045 | 0.76        | 1.14  |
| b3  | 0.180     | 0.215 | 4.57        | 5.46  |
| c   | 0.018     | 0.024 | 0.46        | 0.61  |
| c2  | 0.018     | 0.024 | 0.46        | 0.61  |
| D   | 0.235     | 0.245 | 5.97        | 6.22  |
| E   | 0.250     | 0.265 | 6.35        | 6.73  |
| e   | 0.090 BSC |       | 2.29 BSC    |       |
| H   | 0.370     | 0.410 | 9.40        | 10.41 |
| L   | 0.055     | 0.070 | 1.40        | 1.78  |
| L1  | 0.108 REF |       | 2.74 REF    |       |
| L2  | 0.020 BSC |       | 0.51 BSC    |       |
| L3  | 0.035     | 0.050 | 0.89        | 1.27  |
| L4  | ---       | 0.040 | ---         | 1.01  |
| Z   | 0.155     | ---   | 3.93        | ---   |

**STYLE 2:**

- PIN 1. GATE
- DRAIN
- SOURCE
- DRAIN

### SOLDERING FOOTPRINT\*



SCALE 3:1 (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.

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