

Self-Protected Low Side Driver with Temperature and Current Limit

65 V, 7.0 A, Single N-Channel



ON Semiconductor®

www.onsemi.com

NCV8406A, NCV8406B

NCV8406A/B is a three terminal protected Low-Side Smart Discrete device. The protection features include overcurrent, overtemperature, ESD and integrated Drain-to-Gate clamping for overvoltage protection. This device offers protection and is suitable for harsh automotive environments.

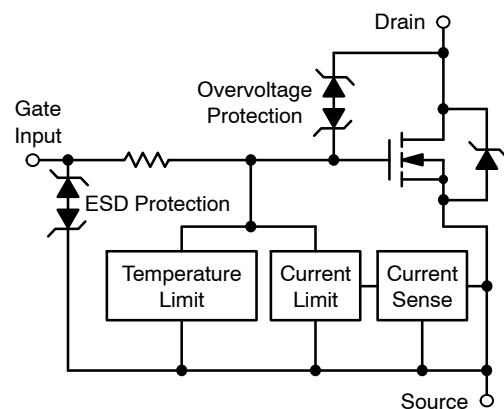
Features

- Short Circuit Protection
- Thermal Shutdown with Automatic Restart
- Over Voltage Protection
- Integrated Clamp for Inductive Switching
- ESD Protection
- dV/dt Robustness
- Analog Drive Capability (Logic Level Input)
- These Devices are Faster than the Rest of the NCV Devices
- NCV Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC-Q101 Qualified and PPAP Capable
- These Devices are Pb-Free, Halogen Free/BFR Free and are RoHS Compliant

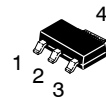
Typical Applications

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

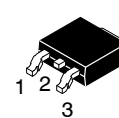
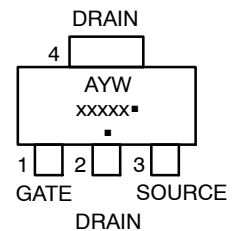
| V _{DSS} (Clamped) | R _{DS(on)} TYP | I _D TYP (Limited) |
|----------------------------|-------------------------|------------------------------|
| 65 V | 210 mΩ | 7.0 A |



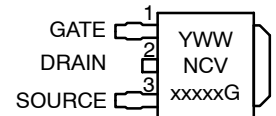
MARKING DIAGRAM



SOT-223
CASE 318E
STYLE 3



DPAK
CASE 369C



A = Assembly Location
Y = Year
W, WW = Work Week
xxxxx = 8406A or 8406B
G or ▪ = 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 10 of this data sheet.

NCV8406A, NCV8406B

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

| Rating | Symbol | Value | Unit |
|--|---|--------------------|--------------------|
| Drain-to-Source Voltage Internally Clamped | V_{DSS} | 60 | Vdc |
| Gate-to-Source Voltage | V_{GS} | ± 14 | Vdc |
| Drain Current | I_D | Internally Limited | |
| Total Power Dissipation – SOT-223 Version @ $T_A = 25^\circ\text{C}$ (Note 1) @ $T_A = 25^\circ\text{C}$ (Note 2) | P_D | 1.25 1.81 | W |
| Total Power Dissipation – DPAK Version @ $T_A = 25^\circ\text{C}$ (Note 1) @ $T_A = 25^\circ\text{C}$ (Note 2) | P_D | 1.31 2.31 | W |
| Thermal Resistance – SOT-223 Version Junction-to-Soldering Point Junction-to-Ambient (Note 1) Junction-to-Ambient (Note 2) | $R_{\theta JS}$ $R_{\theta JA}$ $R_{\theta JA}$ | 7.0 100 69 | $^\circ\text{C/W}$ |
| Thermal Resistance – DPAK Version Junction-to-Soldering Point Junction-to-Ambient (Note 1) Junction-to-Ambient (Note 2) | $R_{\theta JS}$ $R_{\theta JA}$ $R_{\theta JA}$ | 1.0 95 54 | $^\circ\text{C/W}$ |
| Single Pulse Inductive Load Switching Energy (Starting $T_J = 25^\circ\text{C}$, $V_{DD} = 50$ Vdc, $V_{GS} = 5.0$ Vdc, $I_L = 2.1$ Apk, $L = 50$ mH, $R_G = 25$ Ω) | E_{AS} | 110 | mJ |
| Load Dump Voltage ($V_{GS} = 0$ and 10 V, $R_I = 2$ Ω , $R_L = 7$ Ω , $t_d = 400$ ms) | V_{LD} | 75 | V |
| Operating Junction Temperature Range | T_J | -40 to 150 | $^\circ\text{C}$ |
| Storage Temperature Range | T_{stg} | -55 to 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. Surface mounted onto minimum pad size (100 sq/mm) FR4 PCB, 1 oz cu.
2. Mounted onto 1" square pad size (700 sq/mm) FR4 PCB, 1 oz cu.

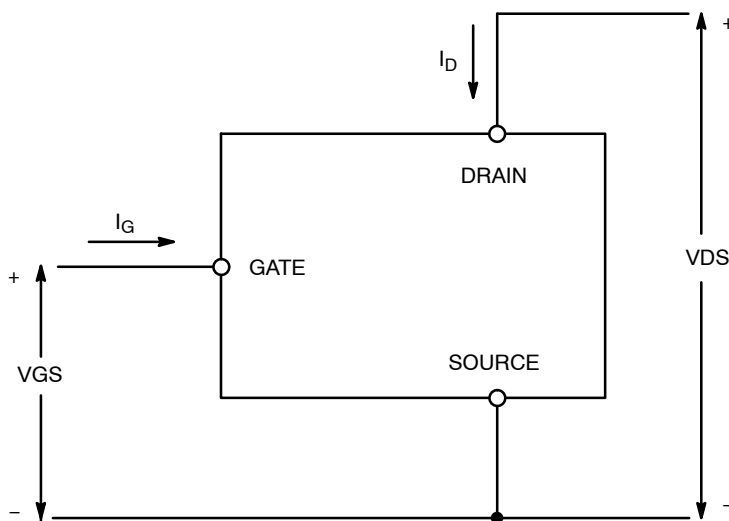


Figure 1. Voltage and Current Convention

NCV8406A, NCV8406B

MOSFET ELECTRICAL CHARACTERISTICS (T_J = 25°C unless otherwise noted)

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

OFF CHARACTERISTICS

| | | | | | |
|---|----------------------|----|----|-----|----|
| Drain-to-Source Clamped Breakdown Voltage (V _{GS} = 0 V, I _D = 2 mA) | V _{(BR)DSS} | 60 | 65 | 70 | V |
| Zero Gate Voltage Drain Current (V _{DS} = 52 V, V _{GS} = 0 V) | I _{DSS} | - | 22 | 100 | μA |
| Gate Input Current (V _{GS} = 5.0 V, V _{DS} = 0 V) | I _{GSS} | - | 30 | 100 | μA |

ON CHARACTERISTICS

| | | | | | |
|--|---------------------|----------|-------------|------------|-------------|
| Gate Threshold Voltage (V _{DS} = V _{GS} , I _D = 150 μA) Threshold Temperature Coefficient | V _{GS(th)} | 1.2 - | 1.66 4.0 | 2.0 - | V -mV/°C |
| Static Drain-to-Source On-Resistance (Note 3) (V _{GS} = 10 V, I _D = 2.0 A, T _J @ 25°C) | R _{DS(on)} | - | 185 | 210 | mΩ |
| Static Drain-to-Source On-Resistance (Note 3) (V _{GS} = 5.0 V, I _D = 2.0 A, T _J @ 25°C) (V _{GS} = 5.0 V, I _D = 2.0 A, T _J @ 150°C) | R _{DS(on)} | - | 210 445 | 240 520 | mΩ |
| Source-Drain Forward On Voltage (I _S = 7.0 A, V _{GS} = 0 V) | V _{SD} | - | 0.9 | 1.1 | V |

SWITCHING CHARACTERISTICS (Note 6)

| | | | | | | |
|---------------------|---|-------------------------------------|---|------|---|------|
| Turn-on Delay Time | R _L = 6.6 Ω, V _{in} = 0 to 10 V, V _{DD} = 13.8 V, I _D = 2.0 A, 10% V _{in} to 10% I _D | t _{d(on)} | - | 127 | - | ns |
| Turn-on Rise Time | R _L = 6.6 Ω, V _{in} = 0 to 10 V, V _{DD} = 13.8 V, I _D = 2.0 A, 10% I _D to 90% I _D | t _{rise} | - | 486 | - | ns |
| Turn-off Delay Time | R _L = 6.6 Ω, V _{in} = 0 to 10 V, V _{DD} = 13.8 V, I _D = 2.0 A, 90% V _{in} to 90% I _D | t _{d(off)} | - | 1600 | - | ns |
| Turn-off Fall Time | R _L = 6.6 Ω, V _{in} = 0 to 10 V, V _{DD} = 13.8 V, I _D = 2.0 A, 90% I _D to 10% I _D | t _{fall} | - | 692 | - | ns |
| Slew Rate ON | R _L = 6.6 Ω, V _{in} = 0 to 10 V, V _{DD} = 13.8 V, I _D = 2.0 A, 70% to 50% V _{DD} | dV _{DS} /dT _{on} | - | 79 | - | V/μs |
| Slew Rate OFF | R _L = 6.6 Ω, V _{in} = 0 to 10 V, V _{DD} = 13.8 V, I _D = 2.0 A, 50% to 70% V _{DD} | dV _{DS} /dT _{off} | - | 27 | - | V/μs |

SELF PROTECTION CHARACTERISTICS (Note 4)

| | | | | | | |
|------------------------------------|--|-----------------------|-------------------|-------------------|--------------------|----|
| Current Limit | V _{DS} = 10 V, V _{GS} = 5.0 V, T _J = 25°C (Note 5) V _{DS} = 10 V, V _{GS} = 5.0 V, T _J = 150°C (Notes 5, 6) V _{DS} = 10 V, V _{GS} = 10 V, T _J = 25°C (Notes 5) | I _{LIM} | 5.0 3.5 6.5 | 7.0 4.5 8.5 | 9.5 6.0 10.5 | A |
| Temperature Limit (Turn-off) | V _{GS} = 5.0 V (Note 6) | T _{LIM(off)} | 150 | 180 | 200 | °C |
| Thermal Hysteresis | V _{GS} = 5.0 V | ΔT _{LIM(on)} | - | 10 | - | °C |
| Temperature Limit (Turn-off) | V _{GS} = 10 V (Note 6) | T _{LIM(off)} | 150 | 180 | 200 | °C |
| Thermal Hysteresis | V _{GS} = 10 V | ΔT _{LIM(on)} | - | 20 | - | °C |
| Input Current during Thermal Fault | V _{DS} = 0 V, V _{GS} = 5.0 V, T _J = T _J > T _(fault) (Note 6) V _{DS} = 0 V, V _{GS} = 10 V, T _J = T _J > T _(fault) (Note 6) | I _{g(fault)} | - | 5.9 12.3 | - | mA |

ESD ELECTRICAL CHARACTERISTICS

| | | | | | | |
|---|-----|-------------|---|---|---|---|
| Electro-Static Discharge Capability Human Body Model (HBM) Machine Model (MM) | ESD | 6000 500 | - | - | - | V |
|---|-----|-------------|---|---|---|---|

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.

3. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2%.
4. Fault conditions are viewed as beyond the normal operating range of the part.
5. Current limit measured at 380 μs after gate pulse.
6. Not subject to production test.

TYPICAL PERFORMANCE CURVES

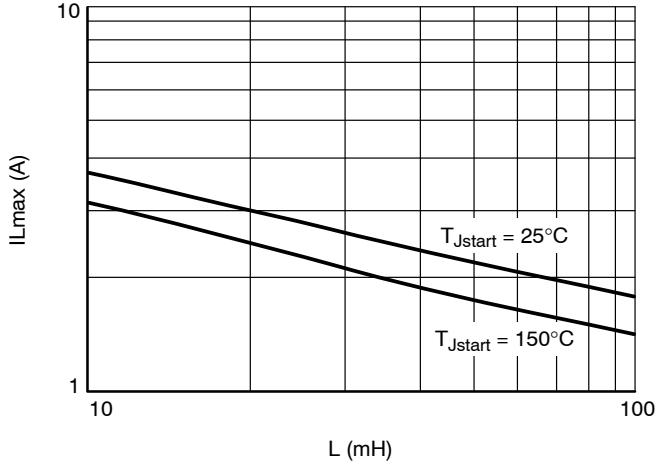


Figure 2. Single Pulse Maximum Switch-off Current vs. Load Inductance

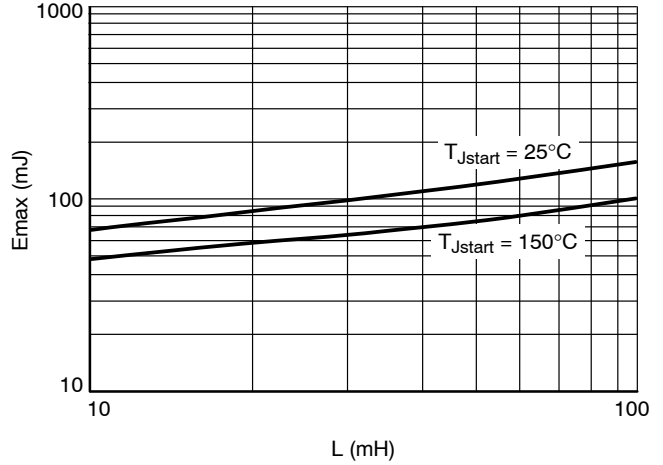


Figure 3. Single-Pulse Maximum Switching Energy vs. Load Inductance

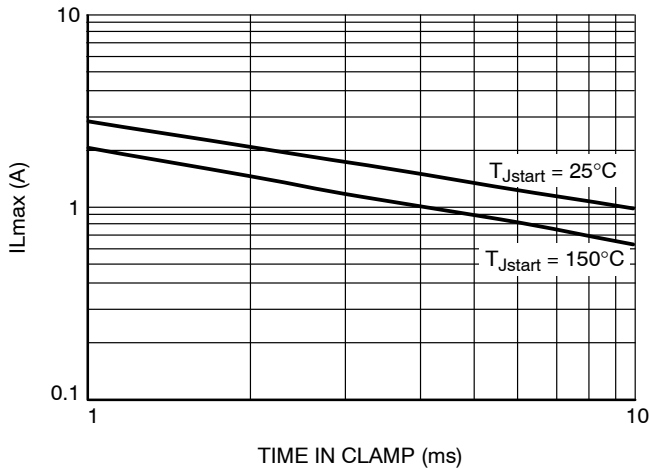


Figure 4. Single Pulse Maximum Inductive Switch-off Current vs. Time in Clamp

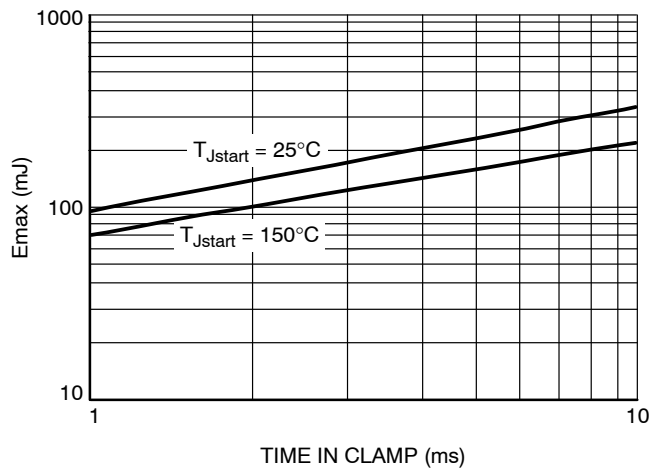


Figure 5. Single-Pulse Maximum Inductive Switching Energy vs. Time in Clamp

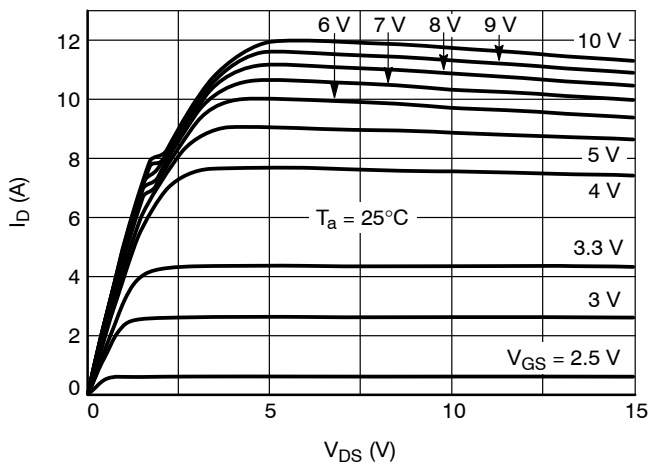


Figure 6. On-state Output Characteristics

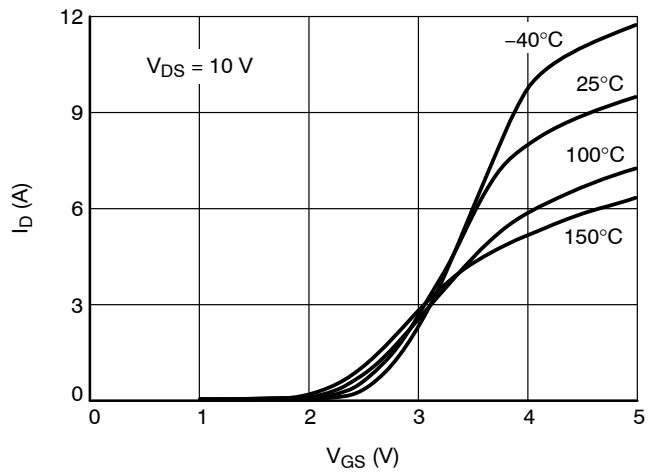


Figure 7. Transfer Characteristics

TYPICAL PERFORMANCE CURVES

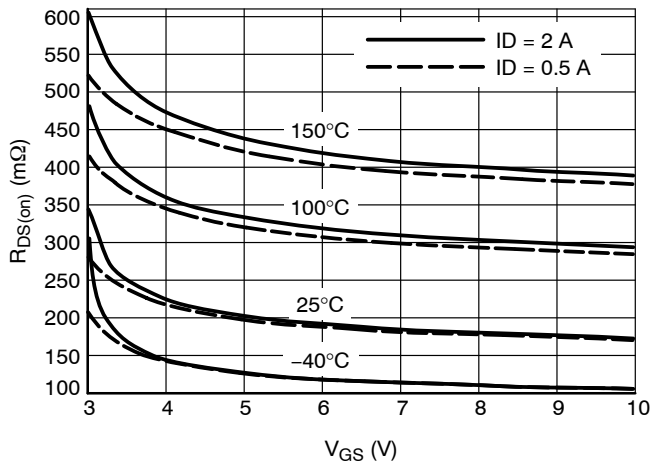


Figure 8. $R_{DS(on)}$ vs. Gate-Source Voltage

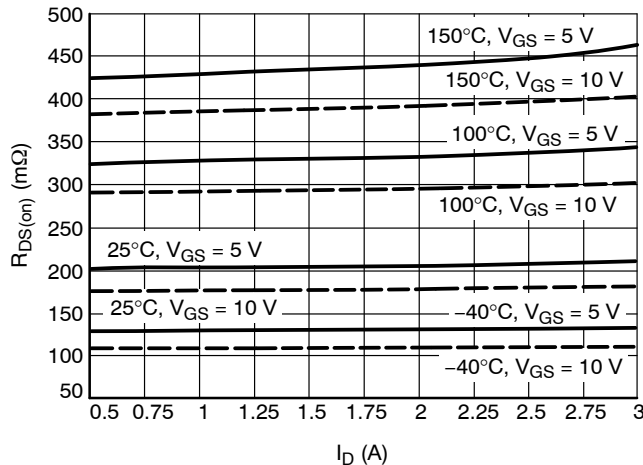


Figure 9. $R_{DS(on)}$ vs. Drain Current

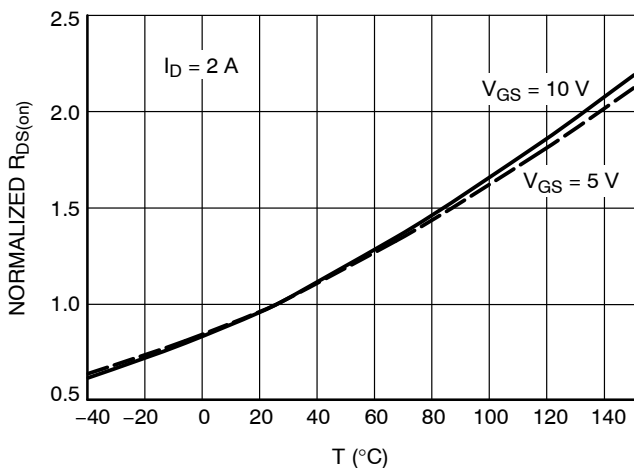


Figure 10. Normalized $R_{DS(on)}$ vs. Temperature

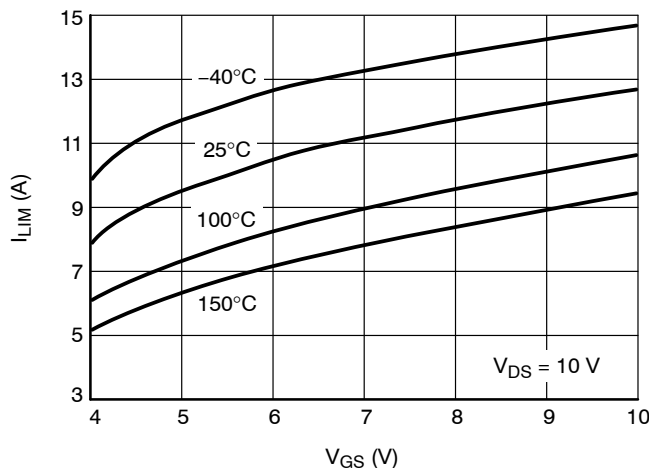


Figure 11. Current Limit vs. Gate-Source Voltage

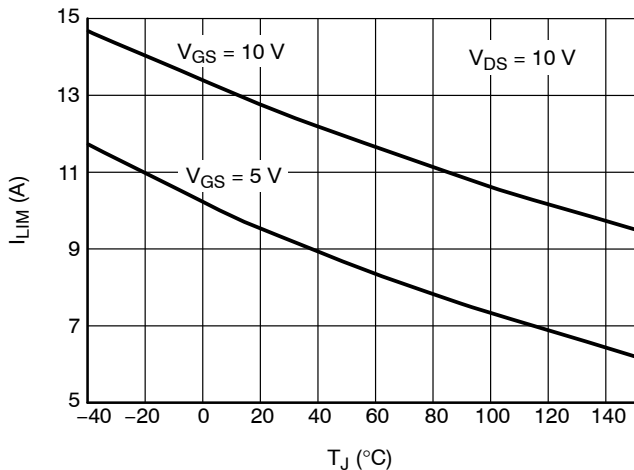


Figure 12. Current Limit vs. Junction Temperature

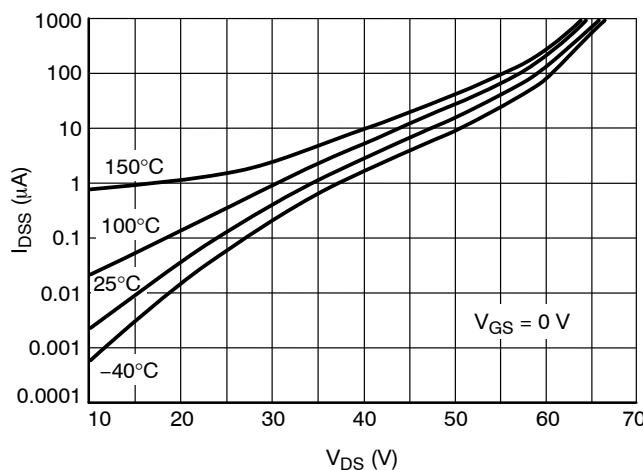


Figure 13. Drain-to-Source Leakage Current

TYPICAL PERFORMANCE CURVES

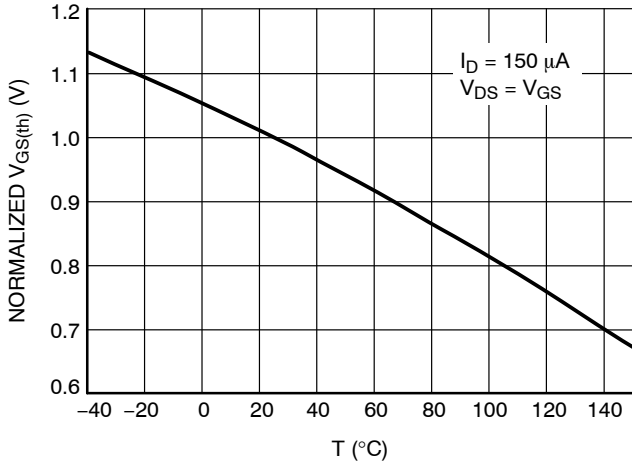


Figure 14. Normalized Threshold Voltage vs. Temperature

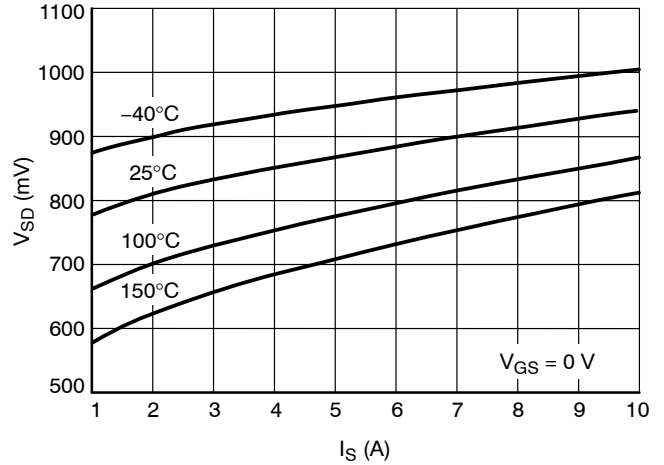


Figure 15. Source-Drain Diode Forward Characteristics

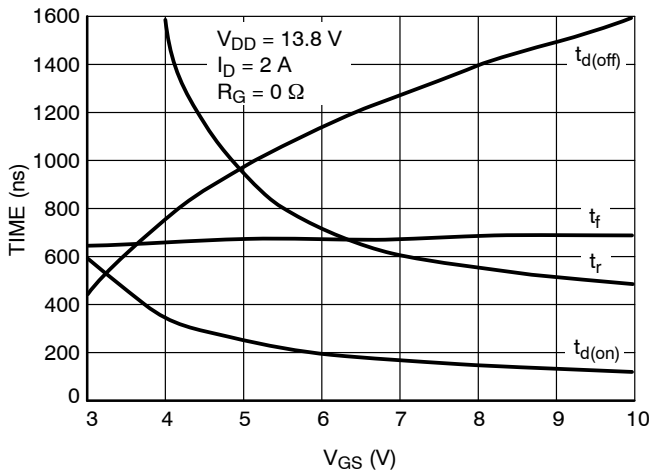


Figure 16. Resistive Load Switching Time vs. Gate-Source Voltage

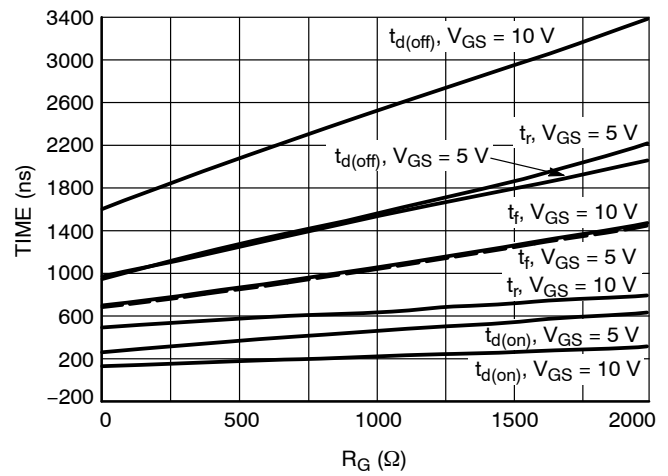


Figure 17. Resistive Load Switching Time vs. Gate Resistance

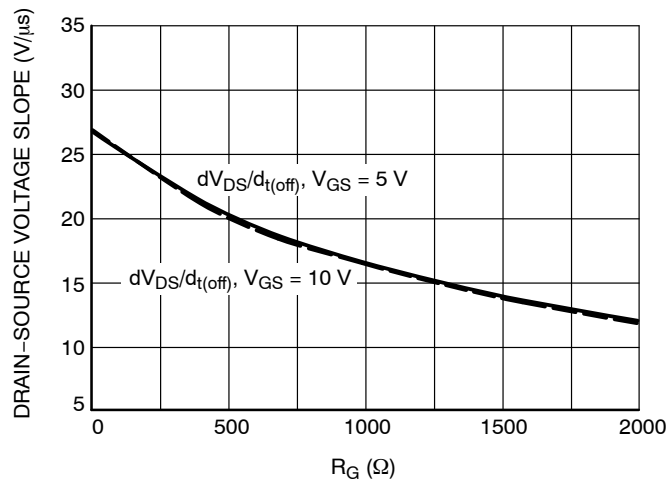


Figure 18. Drain-Source Voltage Slope during Turn On and Turn Off vs. Gate Resistance

TYPICAL PERFORMANCE CURVES

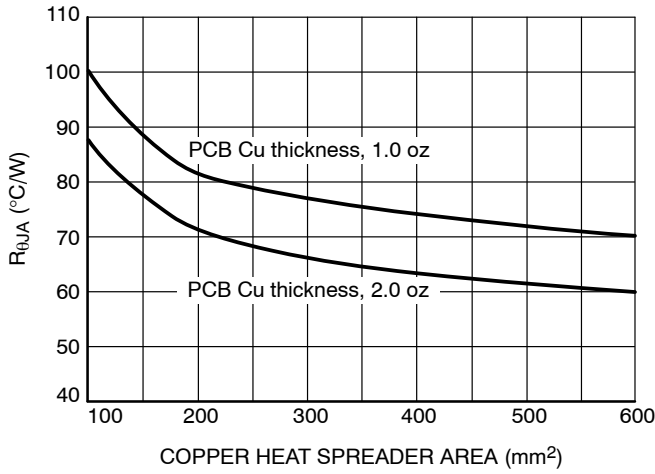


Figure 19. $R_{\theta JA}$ vs. Copper Area – SOT-223

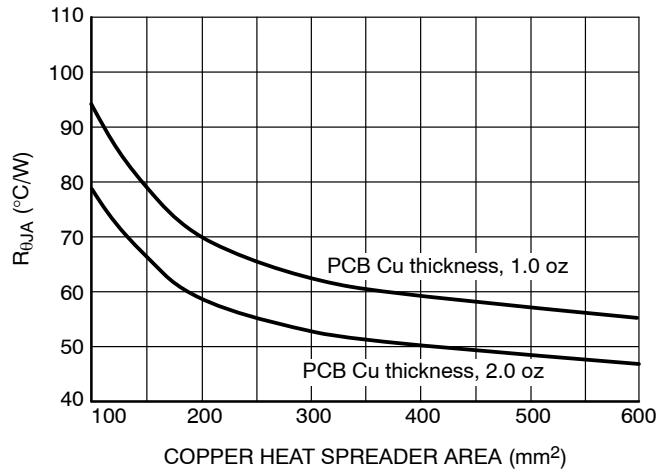


Figure 20. $R_{\theta JA}$ vs. Copper Area – DPAK

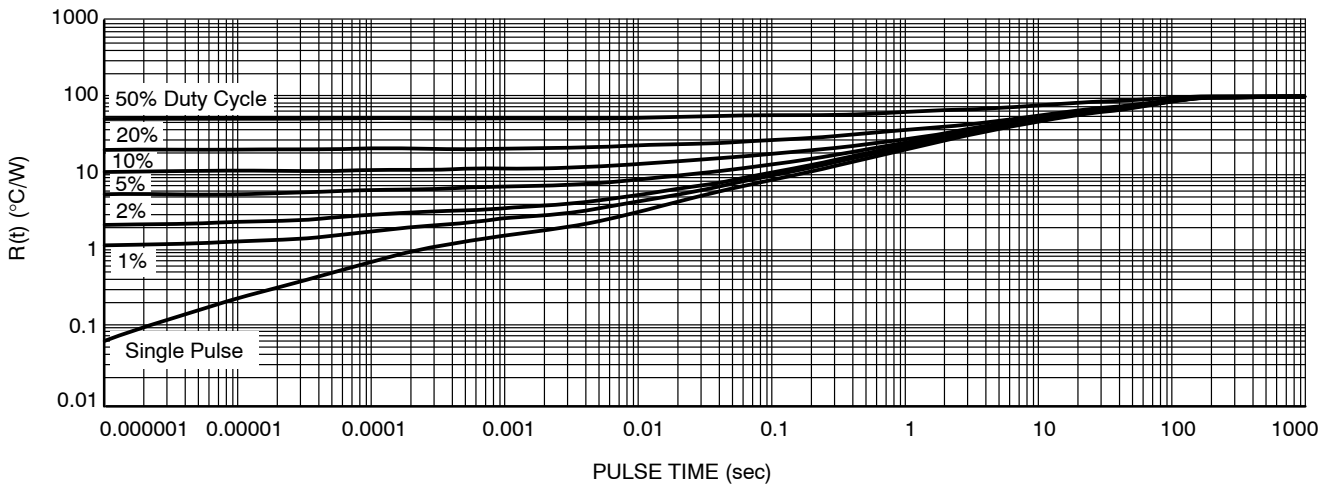


Figure 21. Transient Thermal Resistance – SOT-223 Version

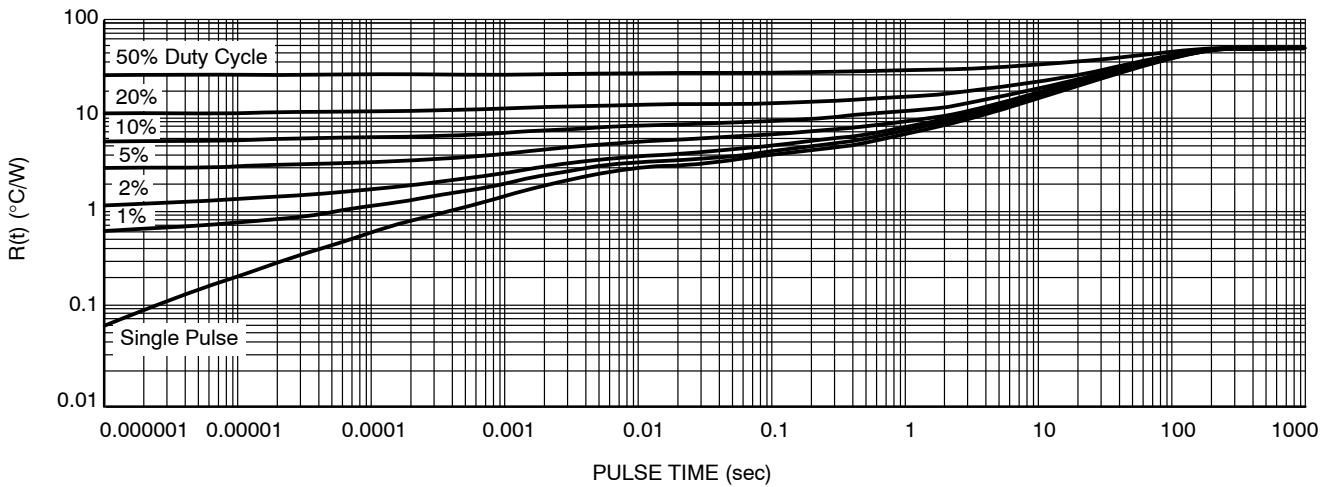


Figure 22. Transient Thermal Resistance – DPAK Version

NCV8406A, NCV8406B

TEST CIRCUITS AND WAVEFORMS

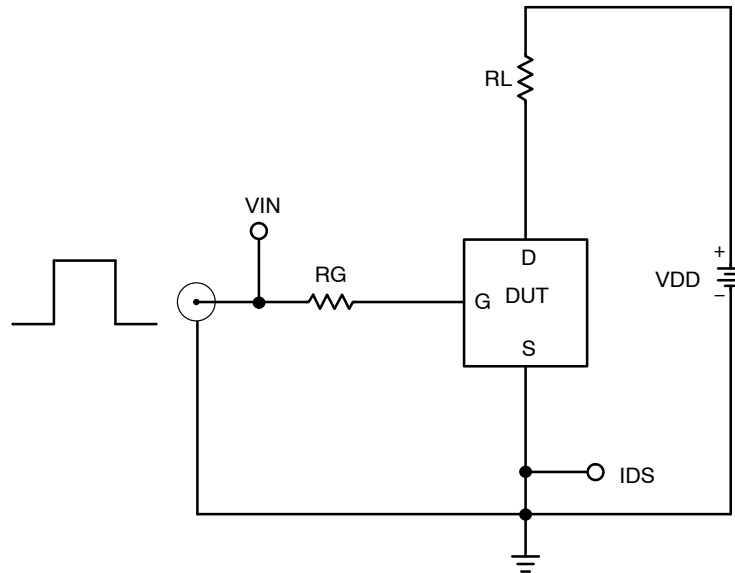


Figure 23. Resistive Load Switching Test Circuit

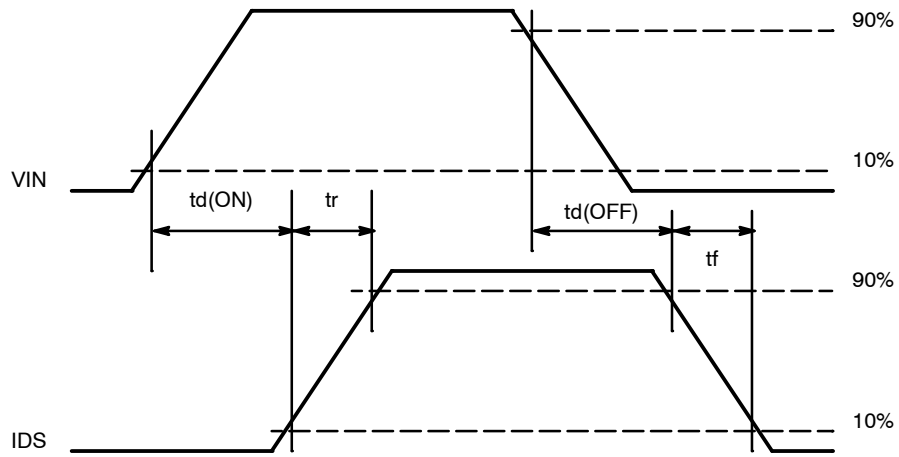


Figure 24. Resistive Load Switching Waveforms

NCV8406A, NCV8406B

TEST CIRCUITS AND WAVEFORMS

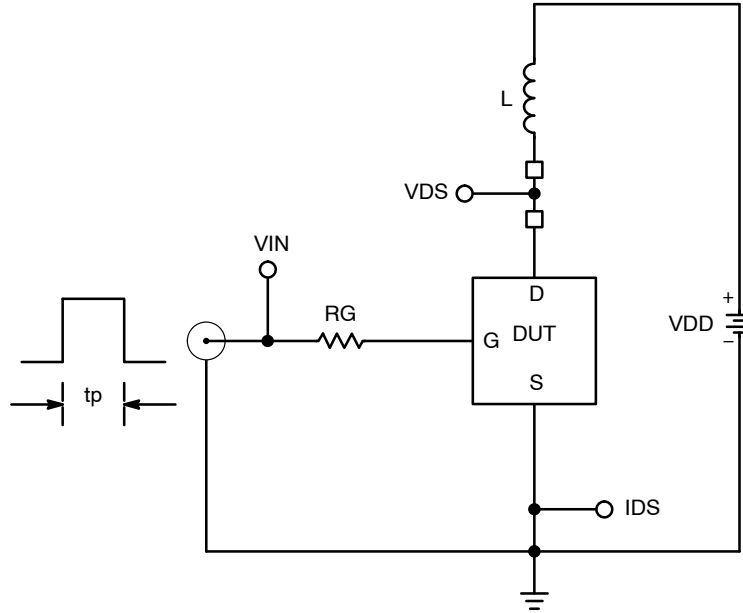


Figure 25. Inductive Load Switching Test Circuit

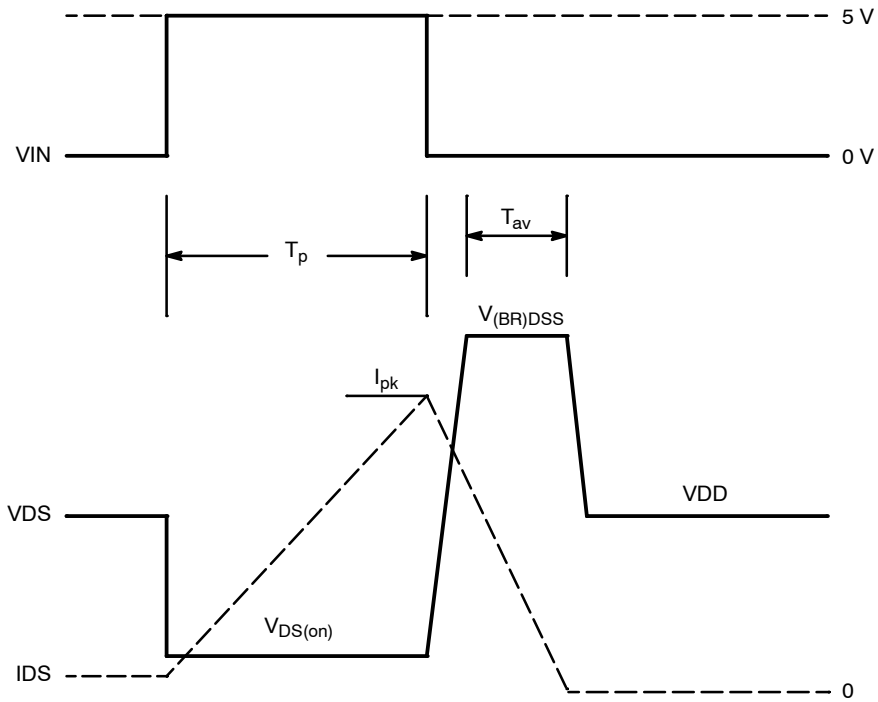


Figure 26. Inductive Load Switching Waveforms

NCV8406A, NCV8406B

ORDERING INFORMATION

| Device | Package | Shipping† |
|---------------|----------------------|--------------------|
| NCV8406ASTT1G | SOT-223 (Pb-Free) | 1000 / Tape & Reel |
| NCV8406ASTT3G | SOT-223 (Pb-Free) | 4000 / Tape & Reel |
| NCV8406ADTRKG | DPAK (Pb-Free) | 2500 / Tape & Reel |
| NCV8406BDTRKG | 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 Specifications Brochure, BRD8011/D.

onsemi, **Onsemi**, and other names, marks, and brands are registered and/or common law trademarks of Semiconductor Components Industries, LLC dba "**onsemi**" or its affiliates and/or subsidiaries in the United States and/or other countries. **onsemi** owns the rights to a number of patents, trademarks, copyrights, trade secrets, and other intellectual property. A listing of **onsemi**'s product/patent coverage may be accessed at www.onsemi.com/site/pdf/Patent-Marking.pdf. **onsemi** reserves the right to make changes at any time to any products or information herein, without notice. The information herein is provided "as-is" and **onsemi** makes no warranty, representation or guarantee regarding the accuracy of the information, product features, availability, functionality, or suitability of its products for any particular purpose, nor does **onsemi** assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. Buyer is responsible for its products and applications using **onsemi** products, including compliance with all laws, regulations and safety requirements or standards, regardless of any support or applications information provided by **onsemi**. "Typical" parameters which may be provided in **onsemi** data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. **onsemi** does not convey any license under any of its intellectual property rights nor the rights of others. **onsemi** products are not designed, intended, or authorized for use as a critical component in life support systems or any FDA Class 3 medical devices or medical devices with a same or similar classification in a foreign jurisdiction or any devices intended for implantation in the human body. Should Buyer purchase or use **onsemi** products for any such unintended or unauthorized application, Buyer shall indemnify and hold **onsemi** and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that **onsemi** was negligent regarding the design or manufacture of the part. **onsemi** is an Equal Opportunity/Affirmative Action Employer. This literature is subject to all applicable copyright laws and is not for resale in any manner.

ADDITIONAL INFORMATION

TECHNICAL PUBLICATIONS:

Technical Library: www.onsemi.com/design/resources/technical-documentation
onsemi Website: www.onsemi.com

ONLINE SUPPORT: www.onsemi.com/support

For additional information, please contact your local Sales Representative at www.onsemi.com/support/sales