

## N-Channel Enhancement Mode MOSFET

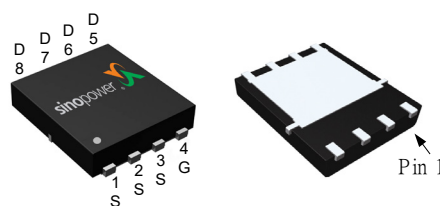
## Features

- 40V/88A  
 $R_{DS(ON)} = 5\text{m}\Omega(\text{max.}) @ V_{GS} = 10\text{V}$   
 $R_{DS(ON)} = 7.3\text{m}\Omega(\text{max.}) @ V_{GS} = 4.5\text{V}$
- 100% UIS +  $R_g$  Tested
- Reliable and Rugged
- Lead Free and Green Devices Available  
(RoHS Compliant)
- Moisture Sensitivity Level MSL1  
(per JEDEC J-STD-020D)

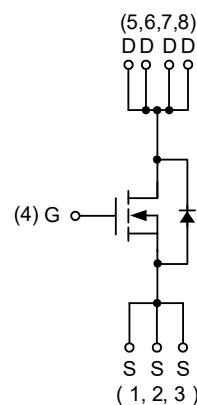
## Applications

- Power Management in Desktop Computer or DC/DC Converters.

## Pin Description



DFN5x6A-8\_EP



N-Channel MOSFET

## Ordering and Marking Information

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                         |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>SM4038NH <span style="border: 1px solid black; padding: 2px;">  </span><span style="border: 1px solid black; padding: 2px;">  </span><span style="border: 1px solid black; padding: 2px;">  </span>-<span style="border: 1px solid black; padding: 2px;">  </span><span style="border: 1px solid black; padding: 2px;">  </span><span style="border: 1px solid black; padding: 2px;">  </span></p> <div style="display: flex; align-items: center; justify-content: center;"> <div style="border-left: 1px solid black; border-right: 1px solid black; height: 40px; margin: 0 5px;"></div> <div style="border-left: 1px solid black; border-right: 1px solid black; height: 40px; margin: 0 5px;"></div> <div style="border-left: 1px solid black; border-right: 1px solid black; height: 40px; margin: 0 5px;"></div> <div style="border-left: 1px solid black; border-right: 1px solid black; height: 40px; margin: 0 5px;"></div> <div style="border-left: 1px solid black; border-right: 1px solid black; height: 40px; margin: 0 5px;"></div> </div> <div style="display: flex; justify-content: center; margin-top: 10px;"> <div style="width: 20px; height: 20px; border: 1px solid black; margin-right: 5px;"></div> <div> <p>Assembly Material</p> <p>Handling Code</p> <p>Temperature Range</p> <p>Package Code</p> </div> </div> | <p>Package Code<br/>KP : DFN5x6A-8_EP</p> <p>Operating Junction Temperature Range<br/>C : -55 to 175 °C</p> <p>Handling Code<br/>TR : Tape &amp; Reel</p> <p>Assembly Material<br/>G : Halogen and Lead Free Device</p> |
| <p>SM4038NH KP :</p> <div style="border: 1px solid black; padding: 5px; display: inline-block; text-align: center;"> <br/> <b>4038NH</b><br/>         XXXXX       </div>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <p>XXXXXX - Lot Code</p>                                                                                                                                                                                                |

Note : SINOPOWER lead-free products contain molding compounds/die attach materials and 100% matte tin plate termination finish; which are fully compliant with RoHS. SINOPOWER lead-free products meet or exceed the leadfree requirements of IPC/JEDEC J-STD-020D for MSL classification at lead-free peak reflow temperature. SINOPOWER defines "Green" to mean lead-free (RoHS compliant) and halogen free (Br or Cl does not exceed 900ppm by weight in homogeneous material and total of Br and Cl does not exceed 1500ppm by weight).

**Absolute Maximum Ratings** ( $T_A=25^{\circ}\text{C}$  Unless Otherwise Noted)

| Symbol                        | Parameter                              |                       | Rating     | Unit |
|-------------------------------|----------------------------------------|-----------------------|------------|------|
| Common Ratings                |                                        |                       |            |      |
| V <sub>DSS</sub>              | Drain-Source Voltage                   |                       | 40         | V    |
| V <sub>GSS</sub>              | Gate-Source Voltage                    |                       | ±20        |      |
| T <sub>J</sub>                | Maximum Junction Temperature           |                       | 175        | °C   |
| T <sub>STG</sub>              | Storage Temperature Range              |                       | -55 to 175 | °C   |
| I <sub>S</sub>                | Diode Continuous Forward Current       | T <sub>C</sub> =25°C  | 40         | A    |
| I <sub>D</sub>                | Continuous Drain Current               | T <sub>C</sub> =25°C  | 88         | A    |
|                               |                                        | T <sub>C</sub> =100°C | 62         |      |
| I <sub>DM</sub> <sup>a</sup>  | Pulse Drain Current                    | T <sub>C</sub> =25°C  | 353        | A    |
| P <sub>D</sub>                | Maximum Power Dissipation              | T <sub>C</sub> =25°C  | 68         | W    |
|                               |                                        | T <sub>C</sub> =100°C | 34         |      |
| R <sub>θJC</sub>              | Thermal Resistance-Junction to Case    | Steady State          | 2.2        | °C/W |
| I <sub>D</sub>                | Continuous Drain Current               | T <sub>A</sub> =25°C  | 16.4       | A    |
|                               |                                        | T <sub>A</sub> =70°C  | 13.7       |      |
| I <sub>DM</sub> <sup>a</sup>  | Pulse Drain Current                    | T <sub>A</sub> =25°C  | 65         | A    |
| P <sub>D</sub> <sup>b</sup>   | Maximum Power Dissipation              | T <sub>A</sub> =25°C  | 2.3        | W    |
|                               |                                        | T <sub>A</sub> =70°C  | 1.6        |      |
| R <sub>θJA</sub> <sup>b</sup> | Thermal Resistance-Junction to Ambient | t ≤ 10s               | 25         | °C/W |
|                               |                                        | Steady State          | 64         |      |
| I <sub>AS</sub> <sup>c</sup>  | Avalanche Current, Single pulse        | L=0.1mH               | 27         | A    |
| E <sub>AS</sub> <sup>c</sup>  | Avalanche Energy, Single pulse         | L=0.1mH               | 36         | mJ   |

Note a : Pulse width is limited by max. junction temperature.

Note b : Surface mounted on  $1\text{in}^2$  pad area, steady state  $t = 999\text{s}$ .

Note c : UIS tested and pulse width limited by maximum junction temperature (initial temperature  $T_J=25^{\circ}\text{C}$ ).

**Electrical Characteristics** ( $T_A = 25^\circ\text{C}$  unless otherwise noted)

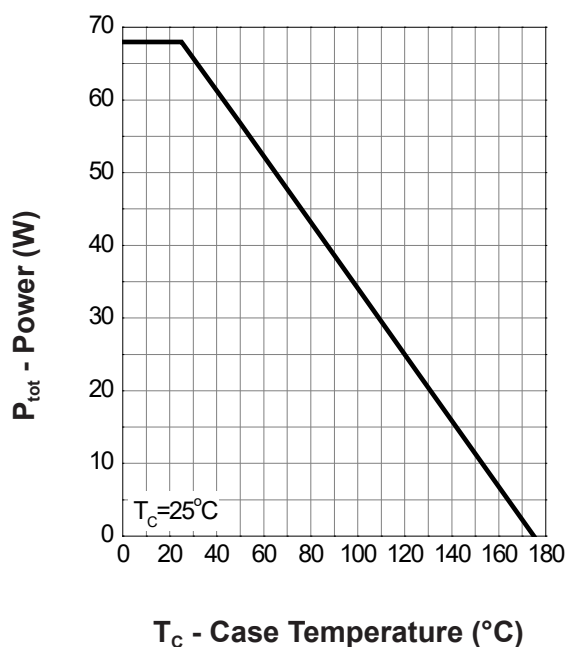
| Symbol                           | Parameter                        | Test Conditions                                                                                                 | Min. | Typ.       | Max.    | Unit |
|----------------------------------|----------------------------------|-----------------------------------------------------------------------------------------------------------------|------|------------|---------|------|
| Static Characteristics           |                                  |                                                                                                                 |      |            |         |      |
| BV <sub>DSS</sub>                | Drain-Source Breakdown Voltage   | V <sub>GS</sub> =0V, I <sub>DS</sub> =250μA                                                                     | 40   | -          | -       | V    |
| I <sub>DSS</sub>                 | Zero Gate Voltage Drain Current  | V <sub>DS</sub> =32V, V <sub>GS</sub> =0V<br>T <sub>J</sub> =85°C                                               | -    | -          | 1<br>30 | μA   |
| V <sub>GS(th)</sub>              | Gate Threshold Voltage           | V <sub>DS</sub> =V <sub>GS</sub> , I <sub>DS</sub> =250μA                                                       | 1.4  | 1.8        | 2.5     | V    |
| I <sub>GSS</sub>                 | Gate Leakage Current             | V <sub>GS</sub> =±20V, V <sub>DS</sub> =0V                                                                      | -    | -          | ±100    | nA   |
| R <sub>DS(ON)</sub> <sup>d</sup> | Drain-Source On-state Resistance | V <sub>GS</sub> =10V, I <sub>DS</sub> =20A<br>T <sub>J</sub> =125°C                                             | -    | 4.2<br>6.3 | 5<br>-  | mΩ   |
|                                  |                                  | V <sub>GS</sub> =4.5V, I <sub>DS</sub> =15A                                                                     | -    | 5.6        | 7.3     |      |
| Gfs                              | Forward Transconductance         | V <sub>DS</sub> =5V, I <sub>DS</sub> =15A                                                                       | -    | 25         | -       | S    |
| Diode Characteristics            |                                  |                                                                                                                 |      |            |         |      |
| V <sub>SD</sub> <sup>d</sup>     | Diode Forward Voltage            | I <sub>SD</sub> =20A, V <sub>GS</sub> =0V                                                                       | -    | 0.85       | 1.1     | V    |
| t <sub>rr</sub>                  | Reverse Recovery Time            | I <sub>DS</sub> =20A, dI <sub>SD</sub> /dt=100A/μs                                                              | -    | 25         | -       | ns   |
| t <sub>a</sub>                   | Charge Time                      |                                                                                                                 | -    | 15         | -       |      |
| t <sub>b</sub>                   | Discharge Time                   |                                                                                                                 | -    | 10         | -       |      |
| Q <sub>rr</sub>                  | Reverse Recovery Charge          |                                                                                                                 | -    | 15         | -       | nC   |
| Dynamic Characteristics °        |                                  |                                                                                                                 |      |            |         |      |
| R <sub>G</sub>                   | Gate Resistance                  | V <sub>GS</sub> =0V,V <sub>DS</sub> =0V,F=1MHz                                                                  | -    | 1          | 2       | Ω    |
| C <sub>iss</sub>                 | Input Capacitance                | V <sub>GS</sub> =0V,<br>V <sub>DS</sub> =20V,<br>Frequency=1.0MHz                                               | -    | 1370       | 1781    | pF   |
| C <sub>oss</sub>                 | Output Capacitance               |                                                                                                                 | -    | 317        | -       |      |
| C <sub>rss</sub>                 | Reverse Transfer Capacitance     |                                                                                                                 | -    | 46         | -       |      |
| t <sub>d(ON)</sub>               | Turn-on Delay Time               | V <sub>DD</sub> =20V, R <sub>L</sub> =20Ω,<br>I <sub>DS</sub> =1A, V <sub>GEN</sub> =10V,<br>R <sub>G</sub> =6Ω | -    | 13.3       | 24      | ns   |
| t <sub>r</sub>                   | Turn-on Rise Time                |                                                                                                                 | -    | 7.9        | 15      |      |
| t <sub>d(OFF)</sub>              | Turn-off Delay Time              |                                                                                                                 | -    | 29.1       | 53      |      |
| t <sub>f</sub>                   | Turn-off Fall Time               |                                                                                                                 | -    | 21         | 38      |      |
| Gate Charge Characteristics °    |                                  |                                                                                                                 |      |            |         |      |
| Q <sub>g</sub>                   | Total Gate Charge                | V <sub>DS</sub> =20V, V <sub>GS</sub> =10V,<br>I <sub>DS</sub> =20A                                             | -    | 22         | 30.8    | nC   |
| Q <sub>gth</sub>                 | Threshold Gate Charge            |                                                                                                                 | -    | 2.3        | -       |      |
| Q <sub>gs</sub>                  | Gate-Source Charge               |                                                                                                                 | -    | 4.2        | -       |      |
| Q <sub>gd</sub>                  | Gate-Drain Charge                |                                                                                                                 | -    | 3          | -       |      |

Note d : Pulse test ; pulse width $\leq 300\mu s$ , duty cycle $\leq 2\%$ .

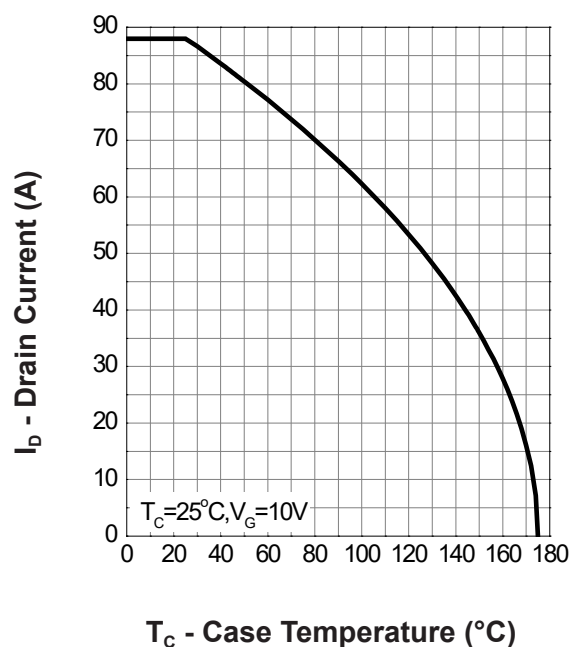
Note e : Guaranteed by design, not subject to production testing.

## Typical Operating Characteristics

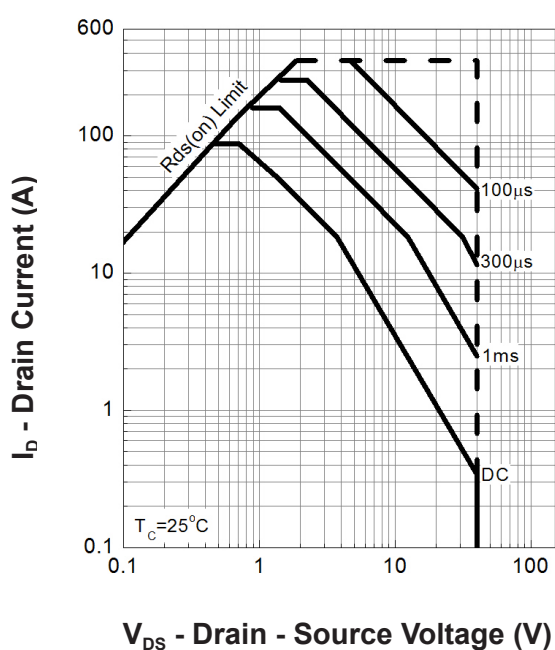
Power Dissipation



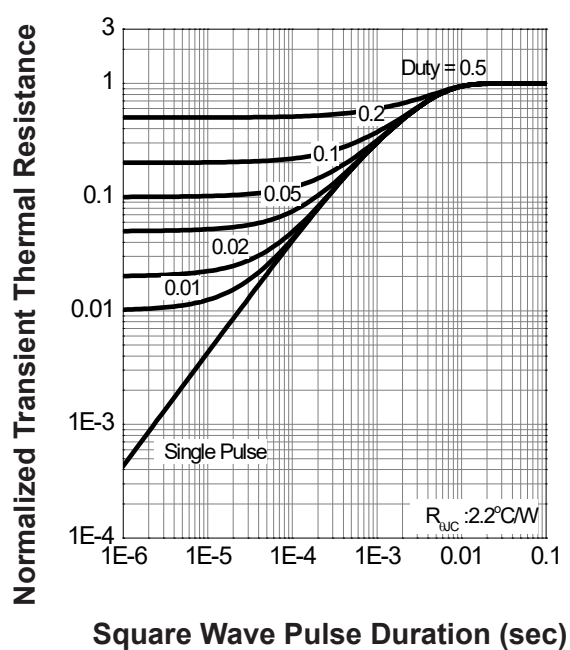
Drain Current



Safe Operation Area

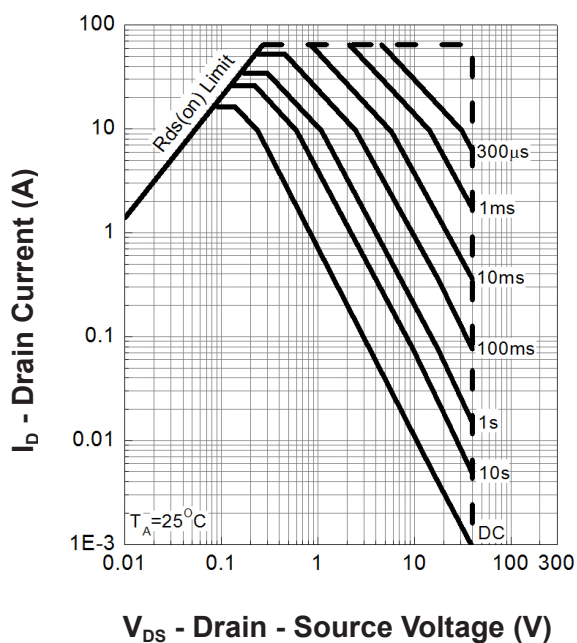


Thermal Transient Impedance

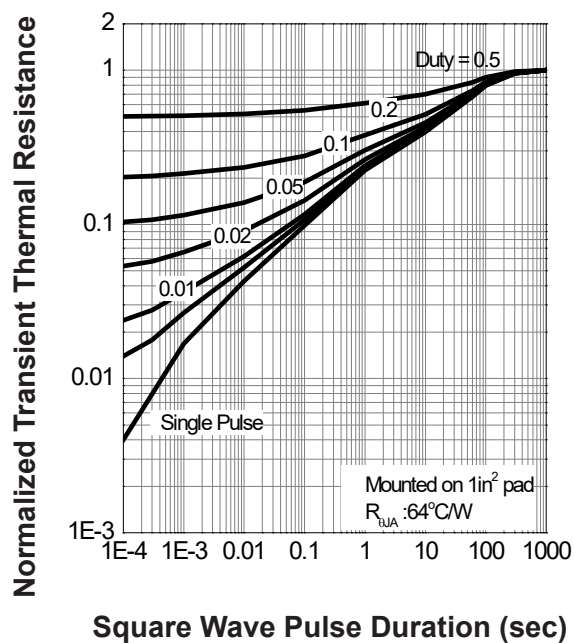


## Typical Operating Characteristics(Cont.)

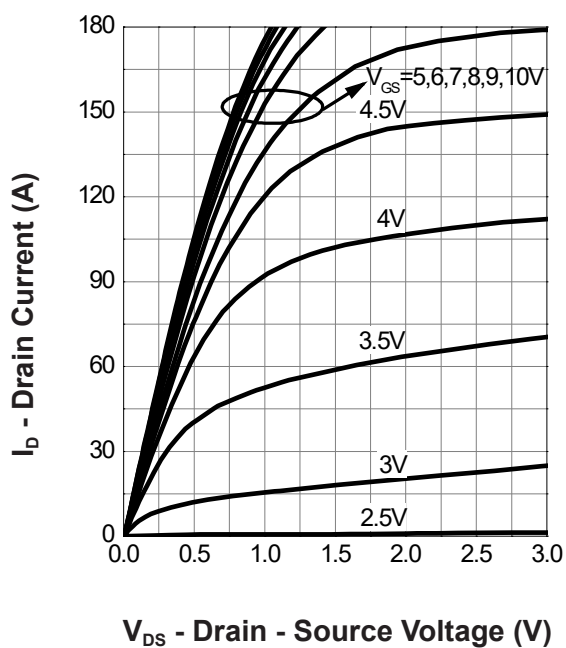
**Safe Operation Area**



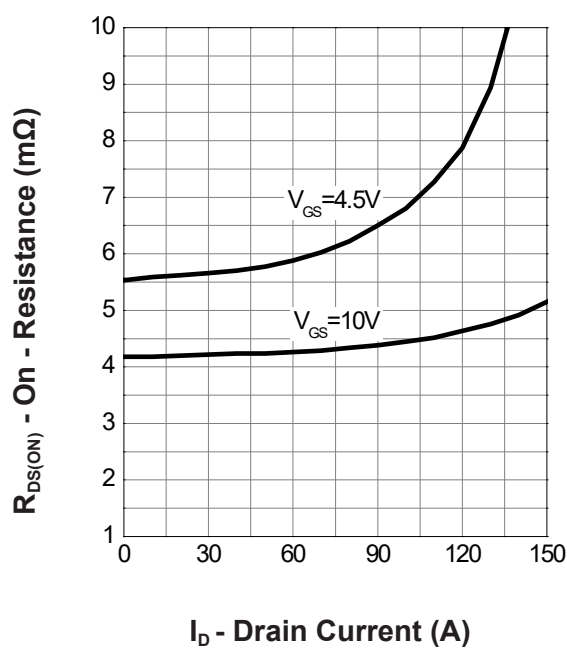
**Thermal Transient Impedance**



**Output Characteristics**

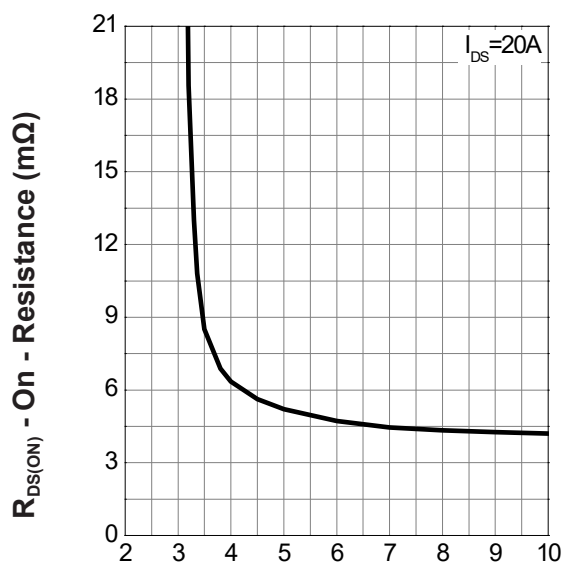


**Drain-Source On Resistance**

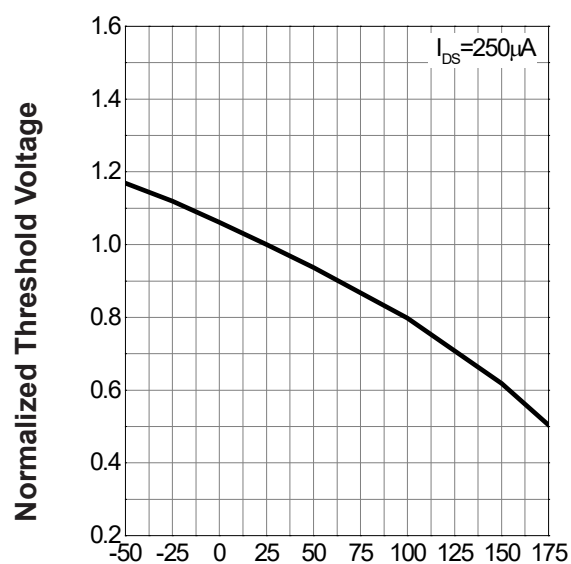


## Typical Operating Characteristics(Cont.)

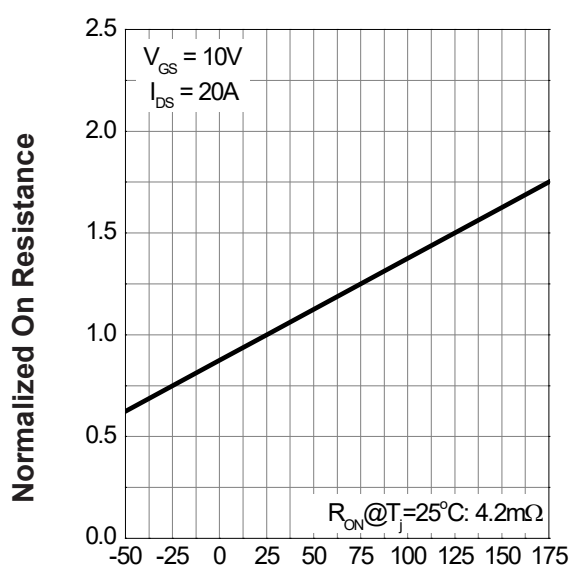
Gate-Source On Resistance

 $V_{GS}$  - Gate - Source Voltage (V)

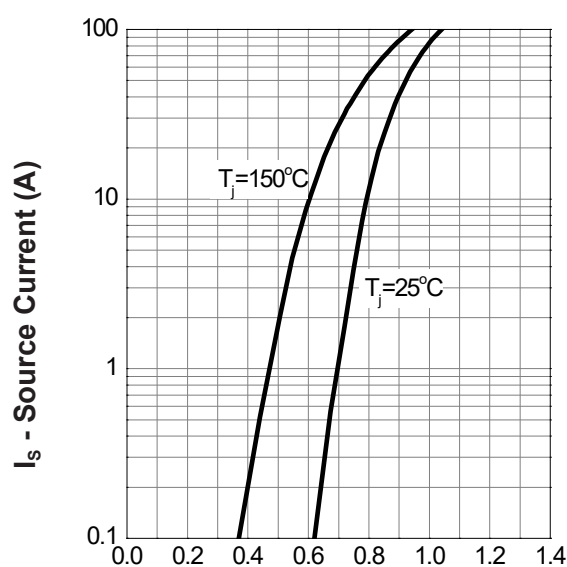
Gate Threshold Voltage

 $T_j$  - Junction Temperature (°C)

Drain-Source On Resistance

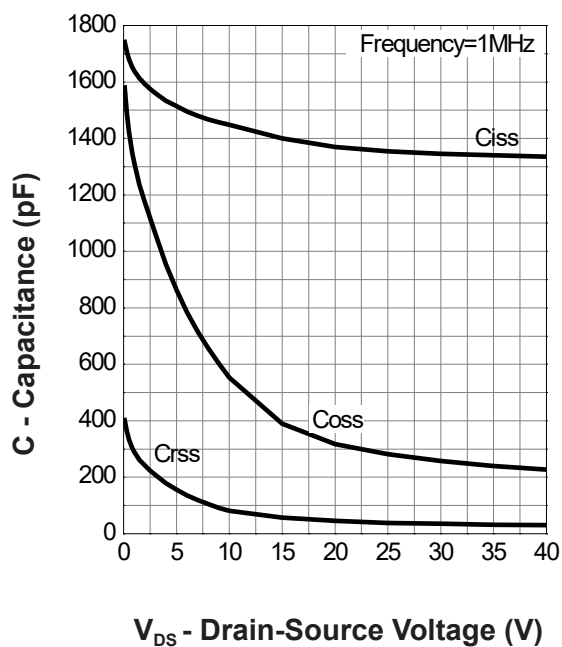
 $T_j$  - Junction Temperature (°C)

Source-Drain Diode Forward

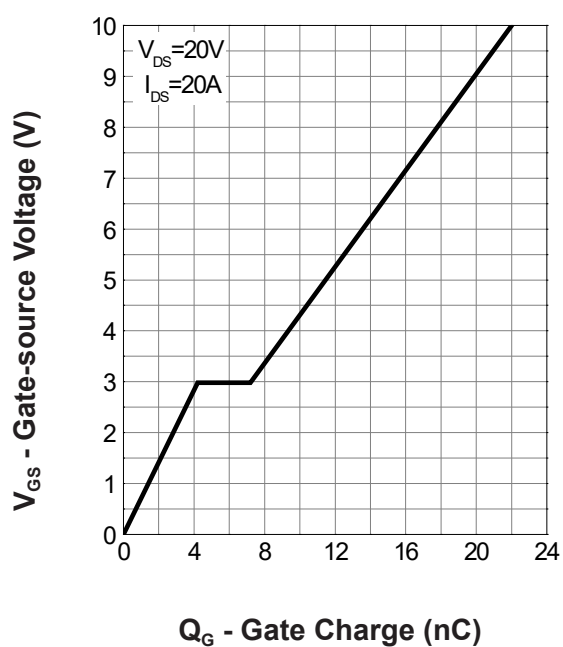
 $V_{SD}$  - Source - Drain Voltage (V)

## Typical Operating Characteristics(Cont.)

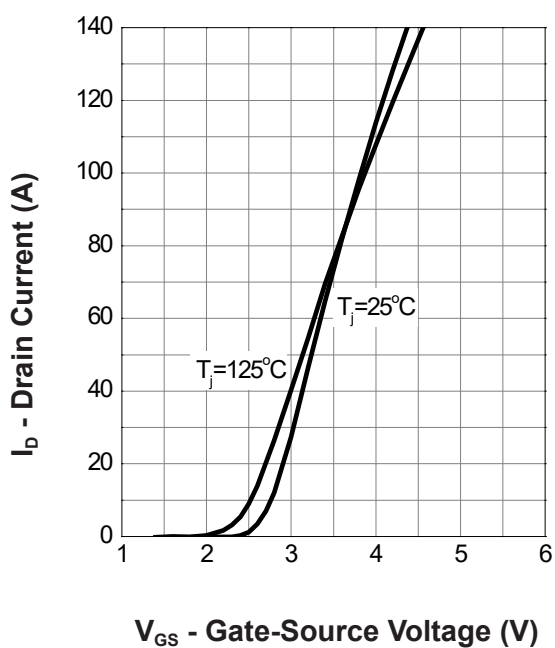
Capacitance



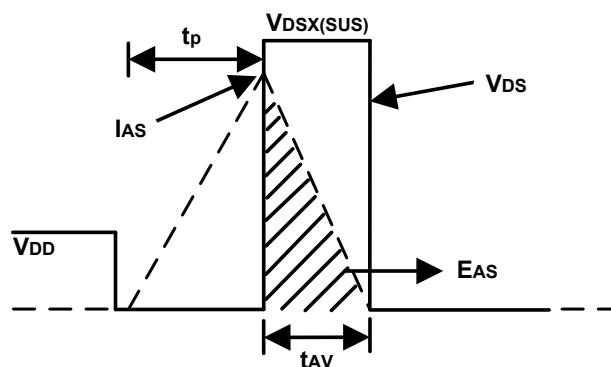
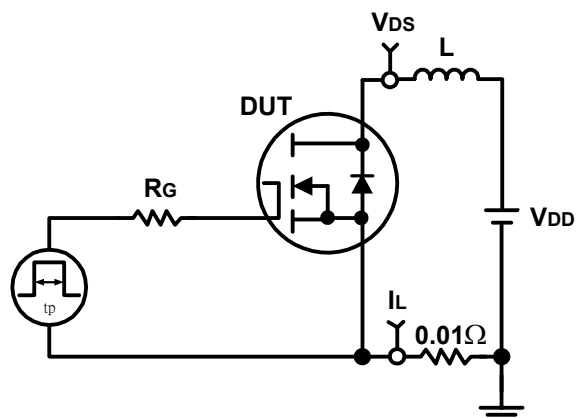
Gate Charge



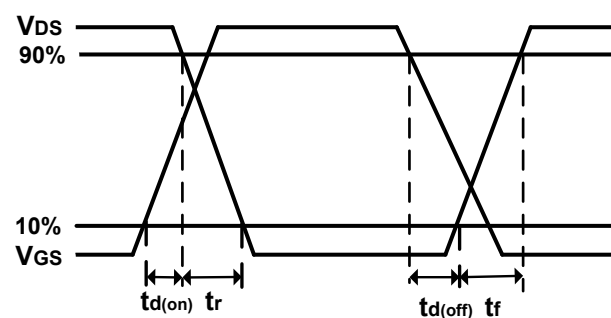
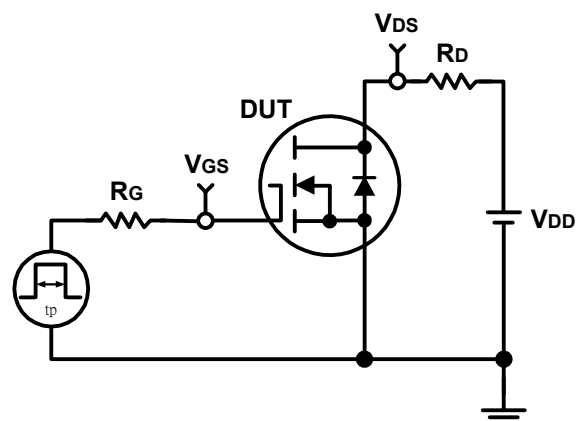
Transfer Characteristics



## Avalanche Test Circuit and Waveforms



## Switching Time Test Circuit and Waveforms



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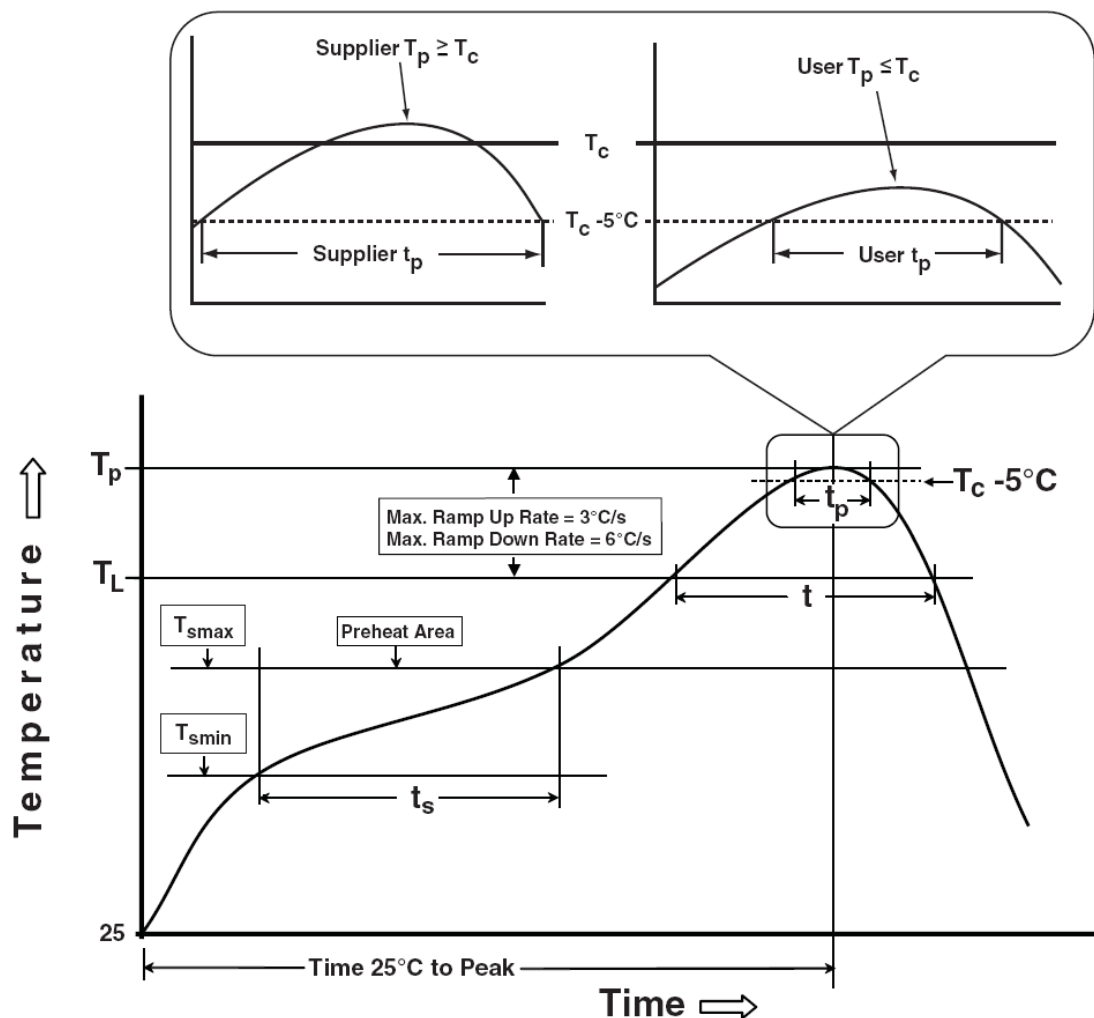
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## Classification Profile



## Classification Reflow Profiles

| Profile Feature                                                                                                  | Sn-Pb Eutectic Assembly            | Pb-Free Assembly                   |
|------------------------------------------------------------------------------------------------------------------|------------------------------------|------------------------------------|
| <b>Preheat &amp; Soak</b>                                                                                        |                                    |                                    |
| Temperature min ( $T_{smin}$ )                                                                                   | 100 °C                             | 150 °C                             |
| Temperature max ( $T_{smax}$ )                                                                                   | 150 °C                             | 200 °C                             |
| Time ( $T_{smin}$ to $T_{smax}$ ) ( $t_s$ )                                                                      | 60-120 seconds                     | 60-120 seconds                     |
| Average ramp-up rate ( $T_{smax}$ to $T_p$ )                                                                     | 3 °C/second max.                   | 3°C/second max.                    |
| Liquidous temperature ( $T_L$ )                                                                                  | 183 °C                             | 217 °C                             |
| Time at liquidous ( $t_L$ )                                                                                      | 60-150 seconds                     | 60-150 seconds                     |
| Peak package body Temperature ( $T_p$ )*                                                                         | See Classification Temp in table 1 | See Classification Temp in table 2 |
| Time ( $t_p$ )** within 5°C of the specified classification temperature ( $T_c$ )                                | 20** seconds                       | 30** seconds                       |
| Average ramp-down rate ( $T_p$ to $T_{smax}$ )                                                                   | 6 °C/second max.                   | 6 °C/second max.                   |
| Time 25°C to peak temperature                                                                                    | 6 minutes max.                     | 8 minutes max.                     |
| * Tolerance for peak profile Temperature ( $T_p$ ) is defined as a supplier minimum and a user maximum.          |                                    |                                    |
| ** Tolerance for time at peak profile temperature ( $t_p$ ) is defined as a supplier minimum and a user maximum. |                                    |                                    |

Table 1. SnPb Eutectic Process – Classification Temperatures ( $T_c$ )

| Package Thickness | Volume mm <sup>3</sup><br><350 | Volume mm <sup>3</sup><br>≥350 |
|-------------------|--------------------------------|--------------------------------|
| <2.5 mm           | 235 °C                         | 220 °C                         |
| ≥2.5 mm           | 220 °C                         | 220 °C                         |

Table 2. Pb-free Process – Classification Temperatures ( $T_c$ )

| Package Thickness | Volume mm <sup>3</sup><br><350 | Volume mm <sup>3</sup><br>350-2000 | Volume mm <sup>3</sup><br>>2000 |
|-------------------|--------------------------------|------------------------------------|---------------------------------|
| <1.6 mm           | 260 °C                         | 260 °C                             | 260 °C                          |
| 1.6 mm – 2.5 mm   | 260 °C                         | 250 °C                             | 245 °C                          |
| ≥2.5 mm           | 250 °C                         | 245 °C                             | 245 °C                          |

## Reliability Test Program

| Test item     | Method        | Description                            |
|---------------|---------------|----------------------------------------|
| SOLDERABILITY | JESD-22, B102 | 5 Sec, 245°C                           |
| HTRB          | JESD-22, A108 | 1000 Hrs, 80% of VDS max @ $T_{jmax}$  |
| HTGB          | JESD-22, A108 | 1000 Hrs, 100% of VGS max @ $T_{jmax}$ |
| PCT           | JESD-22, A102 | 168 Hrs, 100%RH, 2atm, 121°C           |
| TCT           | JESD-22, A104 | 500 Cycles, -65°C~150°C                |

## Customer Service

### Sinopower Semiconductor Inc.

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