

## N-Channel Enhancement Mode MOSFET

### Features

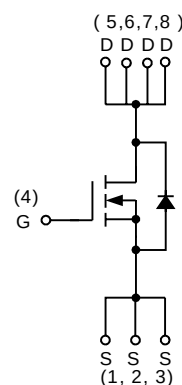
- 25V/16A,  
 $R_{DS(ON)} = 7.5m\Omega (typ.) @ V_{GS} = 10V$   
 $R_{DS(ON)} = 10m\Omega (typ.) @ V_{GS} = 4.5V$
- Super High Dense Cell Design
- Avalanche Rated
- Reliable and Rugged
- Thermal Pad Exposed with Standard SOP-8 Outline
- Lead Free Available (RoHS Compliant)

### Pin Description



SOP – 8 Exposed

 = Thermal Pad  
(connected to Drain plane for better heat dissipation)

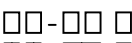
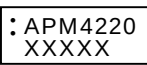


N-Channel MOSFET

### Applications

- Power Management in Notebook Computer, Portable Equipment and Battery Powered Systems

### Ordering and Marking Information

|                                                                                                                                                                                      |                                                                                                                                                                                                                                |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>APM4220 </p> <p>Lead Free Code</p> <p>Handling Code</p> <p>Temp. Range</p> <p>Package Code</p> | <p>Package Code<br/>KA : SOP-8-P</p> <p>Operating Junction Temp. Range<br/>C : -55 to 150°C</p> <p>Handling Code<br/>TU : Tube TR : Tape &amp; Reel</p> <p>Lead Free Code<br/>L : Lead Free Device Blank : Original Device</p> |
| <p>APM4220 KA : </p>                                                                              | <p>XXXXXX - Date Code</p>                                                                                                                                                                                                      |

Note: ANPEC lead-free products contain molding compounds/die attach materials and 100% matte in plate termination finish; which are fully compliant with RoHS and compatible with both SnPb and lead-free soldering operations. ANPEC lead-free products meet or exceed the lead-free requirements of IPC/JEDEC J STD-020C for MSL classification at lead-free peak reflow temperature.

ANPEC reserves the right to make changes to improve reliability or manufacturability without notice, and advise customers to obtain the latest version of relevant information to verify before placing orders.

## Absolute Maximum Ratings

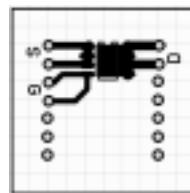
| Symbol                                                       | Parameter                                        |                       | Rating     | Unit |
|--------------------------------------------------------------|--------------------------------------------------|-----------------------|------------|------|
| Common Ratings (T <sub>A</sub> =25°C Unless Otherwise Noted) |                                                  |                       |            |      |
| V <sub>DSS</sub>                                             | Drain-Source Voltage                             |                       | 25         | V    |
| V <sub>GSS</sub>                                             | Gate-Source Voltage                              |                       | ±20        |      |
| T <sub>J</sub>                                               | Maximum Junction Temperature                     |                       | 150        | °C   |
| T <sub>STG</sub>                                             | Storage Temperature Range                        |                       | -55 to 150 | °C   |
| Mounted on Large Heat Sink                                   |                                                  |                       |            |      |
| P <sub>D</sub>                                               | Maximum Power Dissipation                        | T <sub>C</sub> =25°C  | 50         | W    |
|                                                              |                                                  | T <sub>C</sub> =100°C | 20         |      |
| R <sub>θJC</sub>                                             | Thermal Resistance-Junction to Case              |                       | 2.5        | °C/W |
| Mounted on PCB of 1in <sup>2</sup> Pad Area <sup>①</sup>     |                                                  |                       |            |      |
| I <sub>DP</sub>                                              | 300μs Pulse Drain Current Tested                 | T <sub>A</sub> =25°C  | 50         | A    |
|                                                              |                                                  | T <sub>A</sub> =100°C | 25         |      |
| I <sub>D</sub>                                               | Continuous Drain Current                         | T <sub>A</sub> =25°C  | 16         | A    |
|                                                              |                                                  | T <sub>A</sub> =100°C | 8          |      |
| P <sub>D</sub>                                               | Maximum Power Dissipation                        | T <sub>A</sub> =25°C  | 3          | W    |
|                                                              |                                                  | T <sub>A</sub> =100°C | 1.2        |      |
| R <sub>θJA</sub>                                             | Thermal Resistance-Junction to Ambient           |                       | 40         | °C/W |
| Mounted on PCB of Minimum Footprint <sup>②</sup>             |                                                  |                       |            |      |
| I <sub>DP</sub>                                              | 300μs Pulse Drain Current Tested                 | T <sub>A</sub> =25°C  | 50         | A    |
|                                                              |                                                  | T <sub>A</sub> =100°C | 25         |      |
| I <sub>D</sub>                                               | Continuous Drain Current                         | T <sub>A</sub> =25°C  | 13         | A    |
|                                                              |                                                  | T <sub>A</sub> =100°C | 6          |      |
| P <sub>D</sub>                                               | Maximum Power Dissipation                        | T <sub>A</sub> =25°C  | 2.5        | W    |
|                                                              |                                                  | T <sub>A</sub> =100°C | 1          |      |
| R <sub>θJA</sub>                                             | Thermal Resistance-Junction to Minimum Footprint |                       | 50         | °C/W |

Notes:

①. The value of  $R_{\theta\text{JA}}$  is when the device mounted on 1in<sup>2</sup> pad with 2oz. Copper,  $t \leq 10\text{s}$ .



②. The value of  $R_{\theta\text{JA}}$  is when the device mounted on minimum pad with 2oz. Copper,  $t \leq 10\text{s}$ .



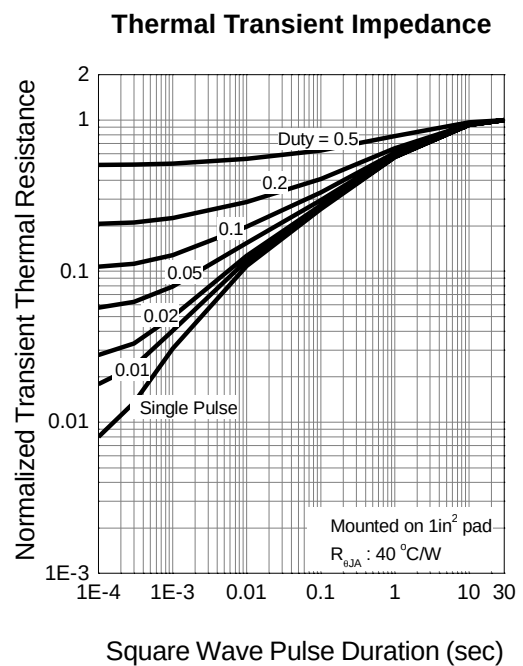
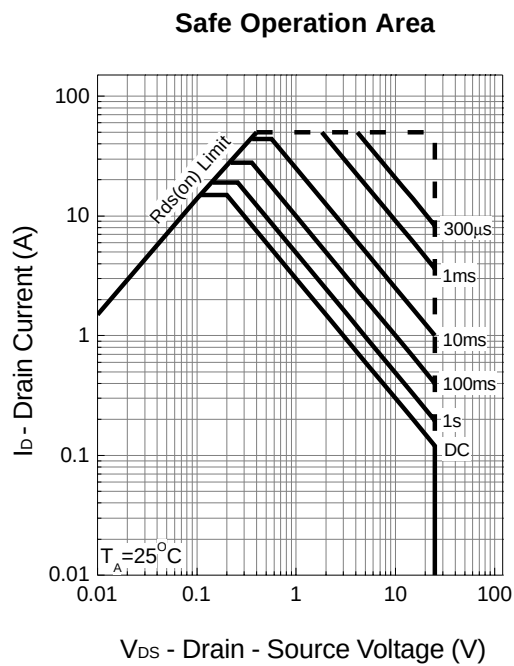
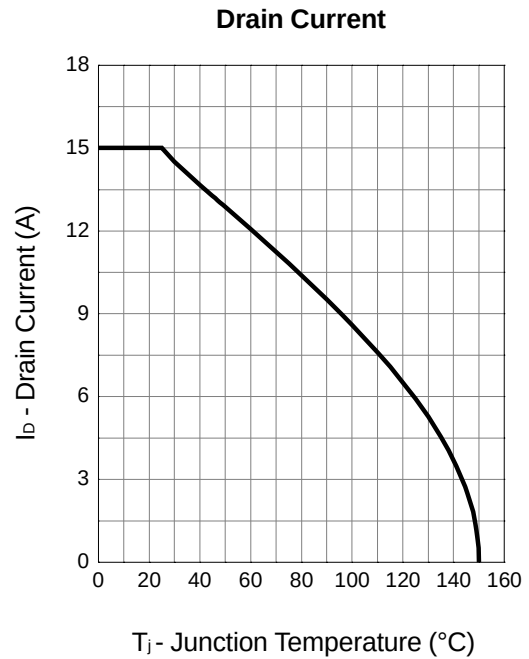
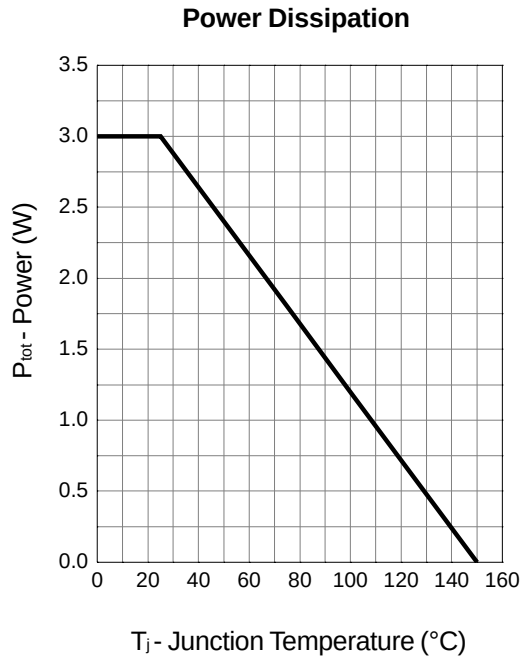
## Electrical Characteristics ( $T_A = 25^\circ\text{C}$ unless otherwise noted)

| Symbol                                   | Parameter                        | Test Condition                                                                                                  | APM4220KA |      |      | Unit |
|------------------------------------------|----------------------------------|-----------------------------------------------------------------------------------------------------------------|-----------|------|------|------|
|                                          |                                  |                                                                                                                 | Min.      | Typ. | Max. |      |
| Drain-Source Avalanche Ratings           |                                  |                                                                                                                 |           |      |      |      |
| E <sub>AS</sub>                          | Avalanche Energy, Single Pulsed  | I <sub>D</sub> =15A, V <sub>DD</sub> =15V                                                                       |           |      | 50   | mJ   |
| Static Characteristics                   |                                  |                                                                                                                 |           |      |      |      |
| BV <sub>DSS</sub>                        | Drain-Source Breakdown Voltage   | V <sub>GS</sub> =0V, I <sub>DS</sub> =250μA                                                                     | 25        |      |      | V    |
| I <sub>DSS</sub>                         | Zero Gate Voltage Drain Current  | V <sub>DS</sub> =20V, V <sub>GS</sub> =0V                                                                       |           |      | 1    | μA   |
|                                          |                                  | V <sub>DS</sub> =20V, V <sub>GS</sub> =0V<br>T <sub>A</sub> =25°C                                               |           |      | 30   |      |
| V <sub>GS(th)</sub>                      | Gate Threshold Voltage           | V <sub>DS</sub> =V <sub>GS</sub> , I <sub>DS</sub> =250μA                                                       | 1.3       | 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>a</sup>         | Drain-Source On-state Resistance | V <sub>GS</sub> =10V, I <sub>DS</sub> =16A                                                                      |           | 7.5  | 9    | mΩ   |
|                                          |                                  | V <sub>GS</sub> =4.5V, I <sub>DS</sub> =14A                                                                     |           | 10   | 12   |      |
| V <sub>SD</sub> <sup>a</sup>             | Diode Forward Voltage            | I <sub>SD</sub> =3A, V <sub>GS</sub> =0V                                                                        |           | 0.8  | 1.3  | V    |
| Gate Charge Characteristics <sup>b</sup> |                                  |                                                                                                                 |           |      |      |      |
| Q <sub>g</sub>                           | Total Gate Charge                | V <sub>DS</sub> =10V, V <sub>GS</sub> =4.5V,<br>I <sub>DS</sub> =12A                                            |           | 20   | 26   | nC   |
| Q <sub>gs</sub>                          | Gate-Source Charge               |                                                                                                                 |           | 4.8  |      |      |
| Q <sub>gd</sub>                          | Gate-Drain Charge                |                                                                                                                 |           | 8.4  |      |      |
| Dynamic Characteristics <sup>b</sup>     |                                  |                                                                                                                 |           |      |      |      |
| R <sub>G</sub>                           | Gate Resistance                  | V <sub>GS</sub> =0V, V <sub>DS</sub> =0V, f=1MHz                                                                |           | 2    |      | Ω    |
| C <sub>iss</sub>                         | Input Capacitance                | V <sub>GS</sub> =0V,<br>V <sub>DS</sub> =15V,<br>Frequency=1.0MHz                                               |           | 1785 |      | pF   |
| C <sub>oss</sub>                         | Output Capacitance               |                                                                                                                 |           | 500  |      |      |
| C <sub>rss</sub>                         | Reverse Transfer Capacitance     |                                                                                                                 |           | 300  |      |      |
| t <sub>d(ON)</sub>                       | Turn-on Delay Time               | V <sub>DD</sub> =15V, R <sub>L</sub> =15Ω,<br>I <sub>DS</sub> =1A, V <sub>GEN</sub> =10V,<br>R <sub>G</sub> =6Ω |           | 10   | 19   | ns   |
| T <sub>r</sub>                           | Turn-on Rise Time                |                                                                                                                 |           | 7    | 13   |      |
| t <sub>d(OFF)</sub>                      | Turn-off Delay Time              |                                                                                                                 |           | 69   | 95   |      |
| T <sub>f</sub>                           | Turn-off Fall Time               |                                                                                                                 |           | 32   | 46   |      |

Notes:

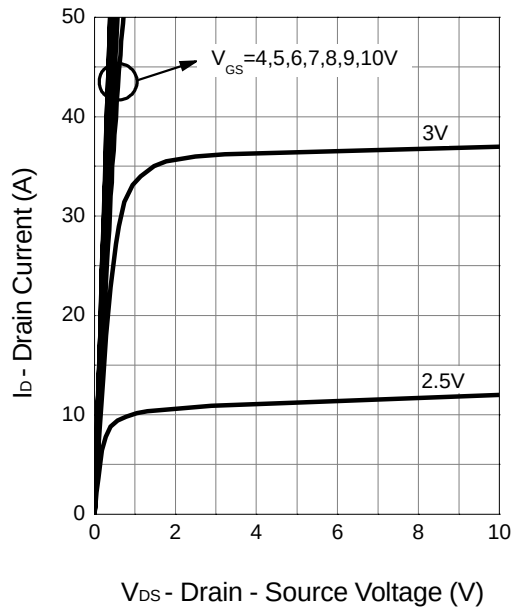
- a: Pulse test ; pulse width  $\leq 300\mu\text{s}$ , duty cycle  $\leq 2\%$ .
- b: Guaranteed by design, not subject to production testing.

## Typical Characteristics

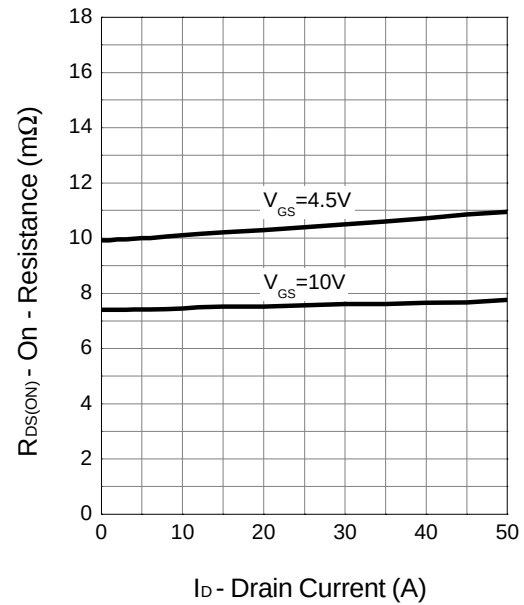


## Typical Characteristics (Cont.)

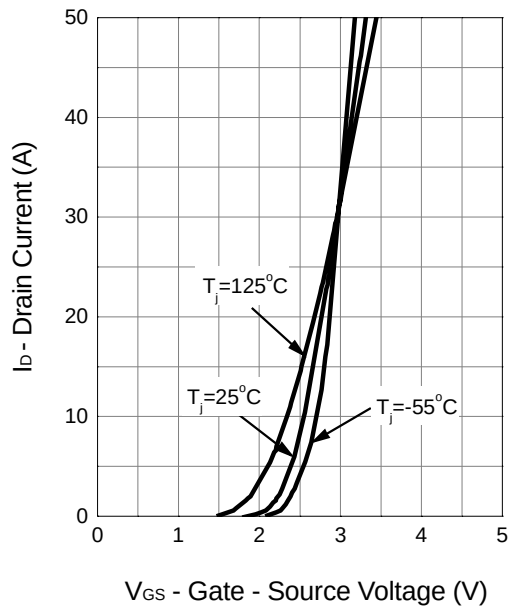
Output Characteristics



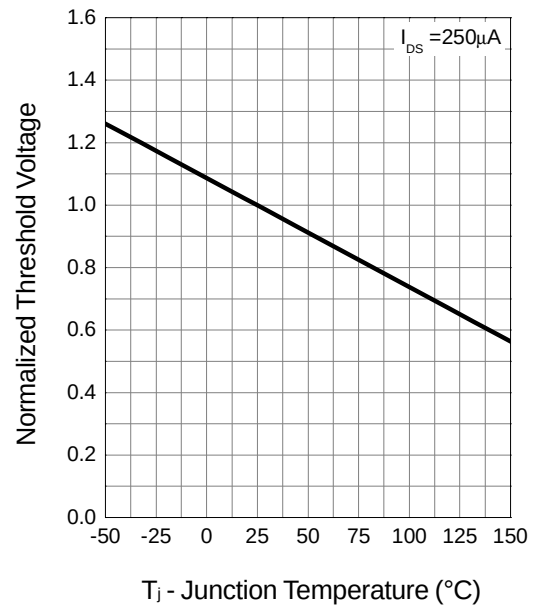
Drain-Source On Resistance



Transfer Characteristics

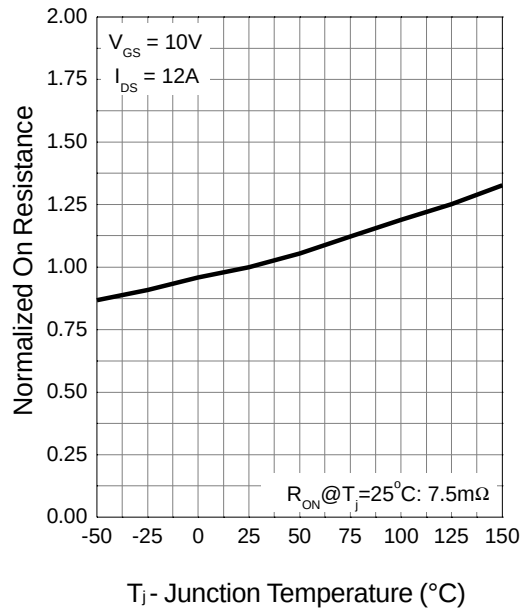


Gate Threshold Voltage

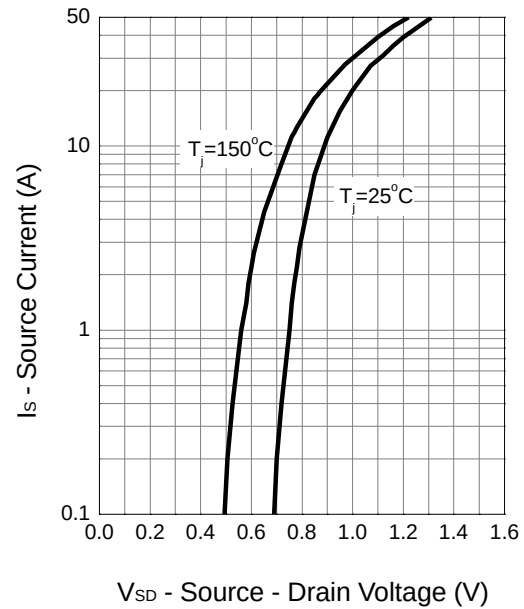


## Typical Characteristics (Cont.)

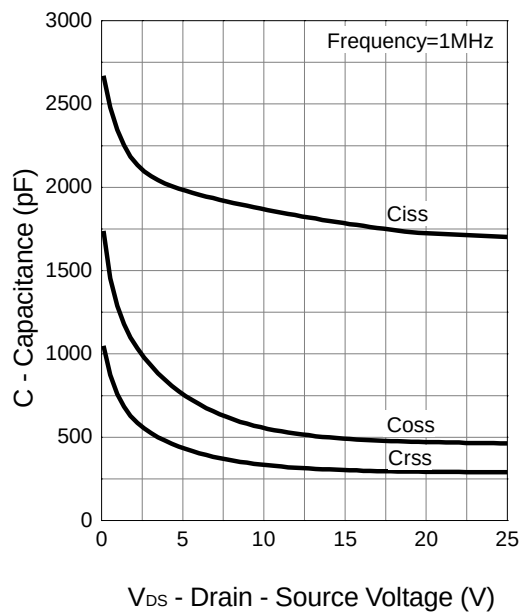
Drain-Source On Resistance



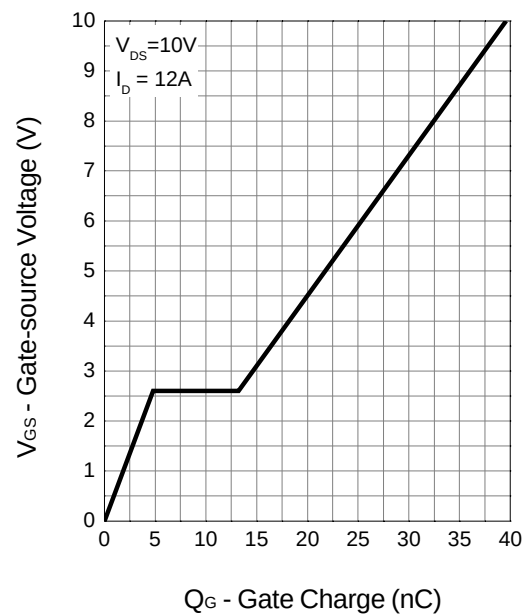
Source-Drain Diode Forward



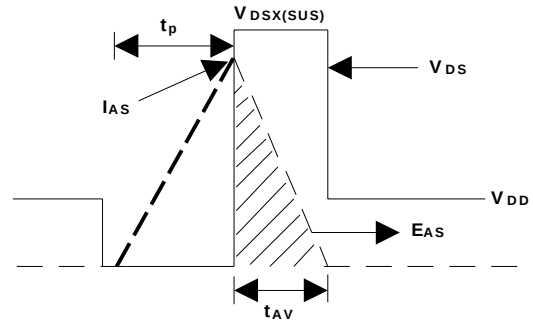
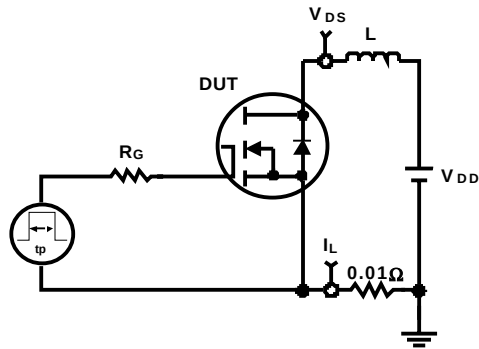
Capacitance



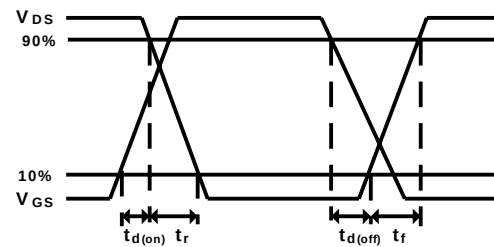
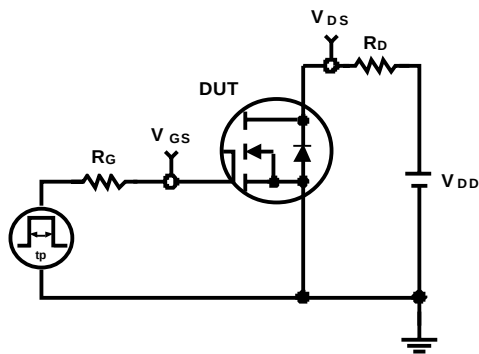
Gate Charge



## Avalanche Test Circuit and Waveforms

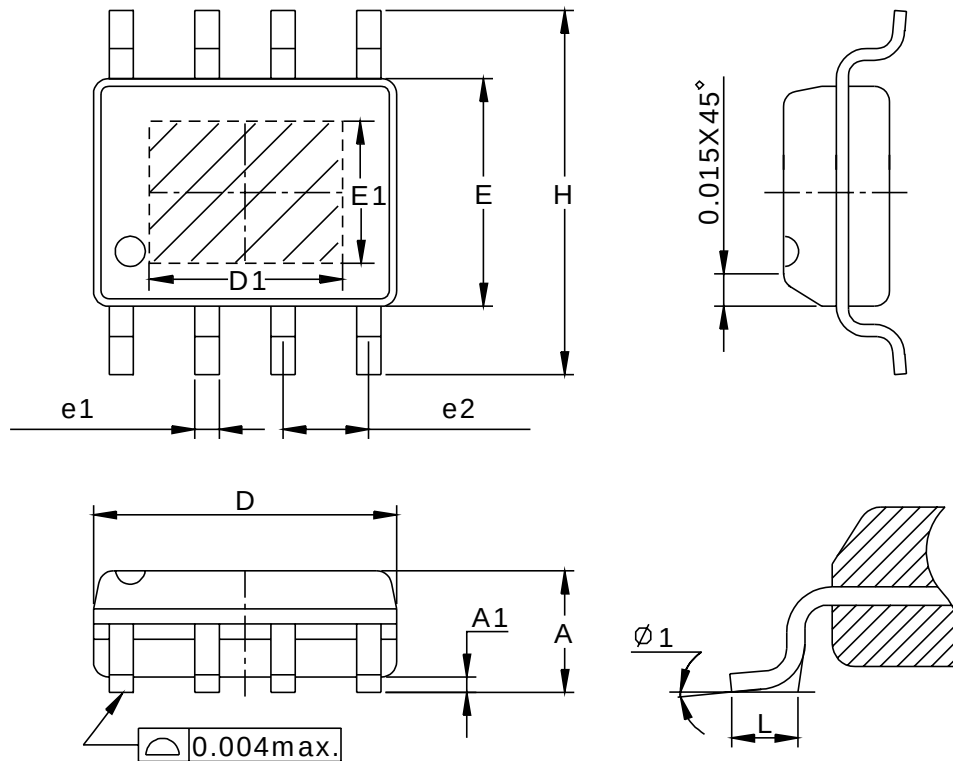


## Switching Time Test Circuit and Waveforms



## Packaging Information

SOP-8-P pin ( Reference JEDEC Registration MS-012)



| Dim | Millimeters |      | Inches  |       |
|-----|-------------|------|---------|-------|
|     | Min.        | Max. | Min.    | Max.  |
| A   | 1.35        | 1.75 | 0.053   | 0.069 |
| A1  | 0.10        | 0.25 | 0.004   | 0.010 |
| D   | 4.80        | 5.00 | 0.189   | 0.197 |
| D1* | 3.34        | 3.84 | 0.132   | 0.151 |
| E   | 3.80        | 4.00 | 0.150   | 0.157 |
| E1* | 2.23        | 2.68 | 0.088   | 0.106 |
| H   | 5.80        | 6.20 | 0.228   | 0.244 |
| L   | 0.40        | 1.27 | 0.016   | 0.050 |
| e1  | 0.33        | 0.51 | 0.013   | 0.020 |
| e2  | 1.27BSC     |      | 0.50BSC |       |
| Ø 1 | 8°          |      | 8°      |       |

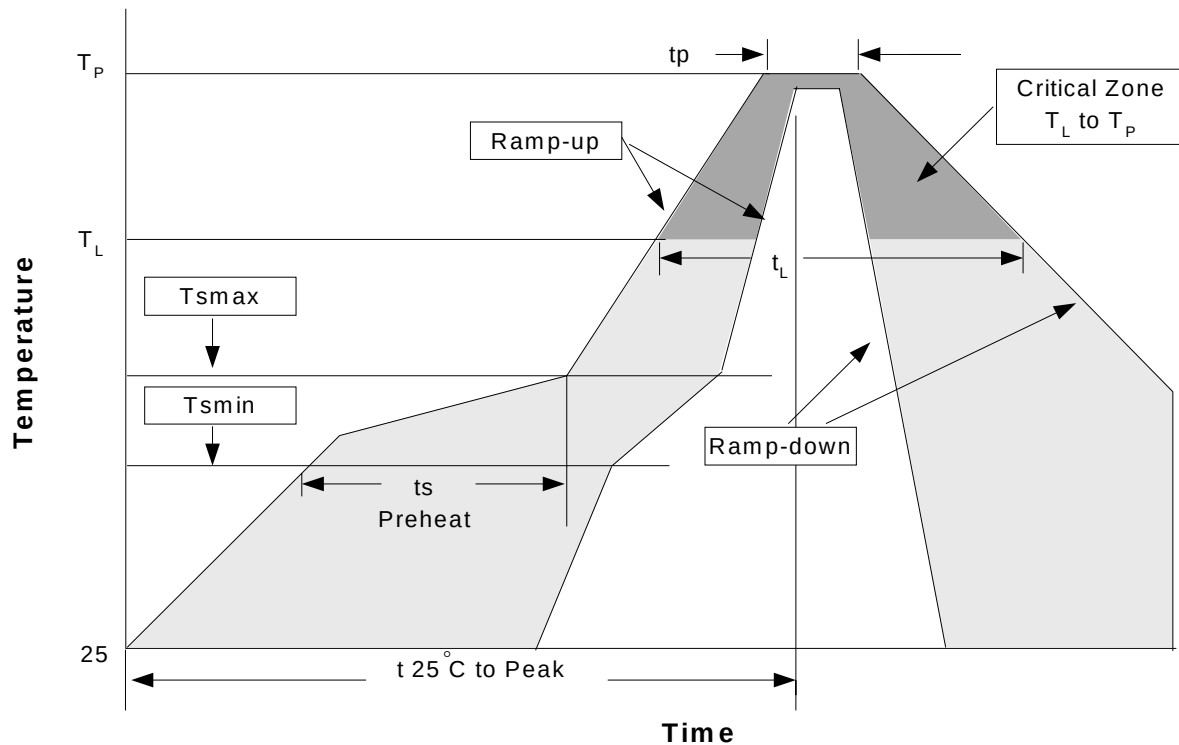
\* Thermal pad dimension



## Physical Specifications

|                    |                                                                      |
|--------------------|----------------------------------------------------------------------|
| Terminal Material  | Solder-Plated Copper (Solder Material : 90/10 or 63/37 SnPb), 100%Sn |
| Lead Solderability | Meets EIA Specification RSI86-91, ANSI/J-STD-002 Category 3.         |

## Reflow Condition (IR/Convection or VPR Reflow)



## Classification Reflow Profiles

| Profile Feature                                                                                                                                                                | Sn-Pb Eutectic Assembly          | Pb-Free Assembly                 |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------|----------------------------------|
| Average ramp-up rate (T <sub>L</sub> to T <sub>p</sub> )                                                                                                                       | 3°C/second max.                  | 3°C/second max.                  |
| Preheat <ul style="list-style-type: none"> <li>- Temperature Min (T<sub>smin</sub>)</li> <li>- Temperature Max (T<sub>smax</sub>)</li> <li>- Time (min to max) (ts)</li> </ul> | 100°C<br>150°C<br>60-120 seconds | 150°C<br>200°C<br>60-180 seconds |
| Time maintained above: <ul style="list-style-type: none"> <li>- Temperature (T<sub>L</sub>)</li> <li>- Time (t<sub>L</sub>)</li> </ul>                                         | 183°C<br>60-150 seconds          | 217°C<br>60-150 seconds          |
| Peak/Classification Temperature (T <sub>p</sub> )                                                                                                                              | See table 1                      | See table 2                      |
| Time within 5°C of actual Peak Temperature (tp)                                                                                                                                | 10-30 seconds                    | 20-40 seconds                    |
| Ramp-down Rate                                                                                                                                                                 | 6°C/second max.                  | 6°C/second max.                  |
| Time 25°C to Peak Temperature                                                                                                                                                  | 6 minutes max.                   | 8 minutes max.                   |

Notes: All temperatures refer to topside of the package .Measured on the body surface.

## Classification Reflow Profiles(Cont.)

Table 1. SnPb Eutectic Process – Package Peak Reflow Temperatures

| Package Thickness | Volume mm <sup>3</sup><br><350 | Volume mm <sup>3</sup><br>≥350 |
|-------------------|--------------------------------|--------------------------------|
| <2.5 mm           | 240 +0/-5°C                    | 225 +0/-5°C                    |
| ≥2.5 mm           | 225 +0/-5°C                    | 225 +0/-5°C                    |

Table 2. Pb-free Process – Package Classification Reflow Temperatures

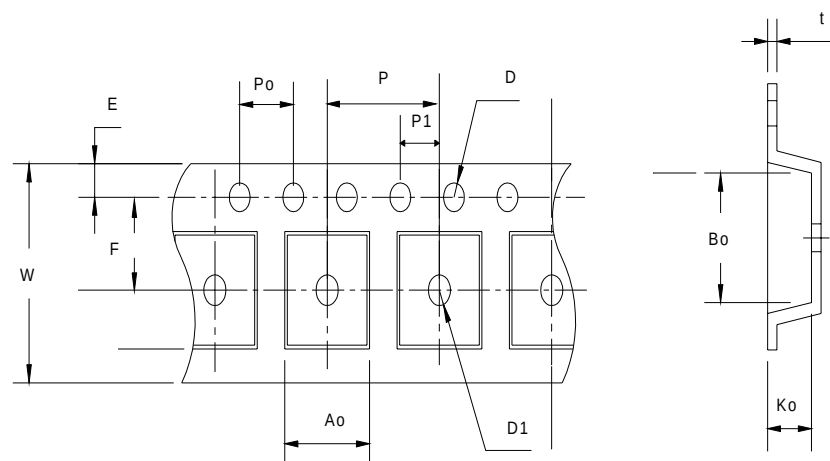
| Package Thickness | Volume mm <sup>3</sup><br><350 | Volume mm <sup>3</sup><br>350-2000 | Volume mm <sup>3</sup><br>>2000 |
|-------------------|--------------------------------|------------------------------------|---------------------------------|
| <1.6 mm           | 260 +0°C*                      | 260 +0°C*                          | 260 +0°C*                       |
| 1.6 mm – 2.5 mm   | 260 +0°C*                      | 250 +0°C*                          | 245 +0°C*                       |
| ≥2.5 mm           | 250 +0°C*                      | 245 +0°C*                          | 245 +0°C*                       |

\*Tolerance: The device manufacturer/supplier **shall** assure process compatibility up to and including the stated classification temperature (this means Peak reflow temperature +0°C. For example 260°C+0°C) at the rated MSL level.

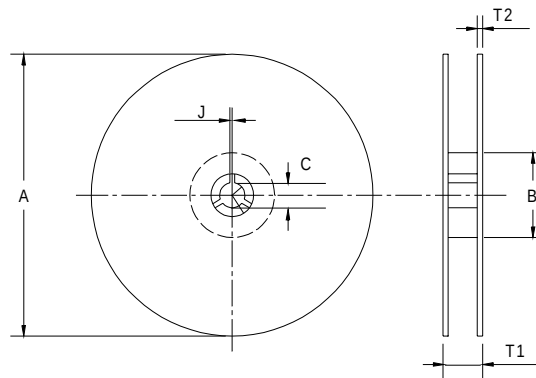
## Reliability Test Program

| Test item     | Method              | Description               |
|---------------|---------------------|---------------------------|
| SOLDERABILITY | MIL-STD-883D-2003   | 245°C, 5 SEC              |
| HOLT          | MIL-STD 883D-1005.7 | 1000 Hrs Bias @ 125°C     |
| PCT           | JESD-22-B, A102     | 168 Hrs, 100% RH, 121°C   |
| TST           | MIL-STD 883D-1011.9 | -65°C ~ 150°C, 200 Cycles |

## Carrier Tape



## Carrier Tape(Cont.)



| Application | A           | B           | C             | J             | T1             | T2            | W             | P             | E              |
|-------------|-------------|-------------|---------------|---------------|----------------|---------------|---------------|---------------|----------------|
| SOP- 8-P    | $330 \pm 1$ | $62 +1.5$   | $12.75+0.15$  | $2 \pm 0.5$   | $12.4 \pm 0.2$ | $2 \pm 0.2$   | $12 \pm 0.3$  | $8 \pm 0.1$   | $1.75 \pm 0.1$ |
|             | F           | D           | D1            | Po            | P1             | Ao            | Bo            | Ko            | t              |
|             | $5.5 \pm 1$ | $1.55 +0.1$ | $1.55 + 0.25$ | $4.0 \pm 0.1$ | $2.0 \pm 0.1$  | $6.4 \pm 0.1$ | $5.2 \pm 0.1$ | $2.1 \pm 0.1$ | $.3 \pm 0.013$ |

(mm)

## Cover Tape Dimensions

| Application | Carrier Width | Cover Tape Width | Devices Per Reel |
|-------------|---------------|------------------|------------------|
| SOP- 8-P    | 12            | 9.3              | 2500             |

## Customer Service

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