## Dual Enhancement Mode MOSFET (N- and P-Channel)

## Features

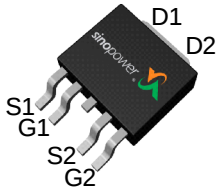
- N-Channel
  60V/20A,
  $R_{DS(ON)}$ =48mΩ(max.) @ $V_{GS}$ = 10V
  $R_{DS(ON)}$ =59mΩ(max.) @ $V_{GS}$ = 4.5V
- P-Channel
  -60V/-15A,
  $R_{DS(ON)}$ =95mΩ(max.) @ $V_{GS}$ =-10V
  $R_{DS(ON)}$ =130mΩ(max.) @ $V_{GS}$ =-4.5V
- Reliable and Rugged
- Lead Free and Green Devices Available (RoHS Compliant)
- ESD protection

**Note :** The diode connected between the gate and source serves only as protection against ESD. No gate overvoltage rating is implied.

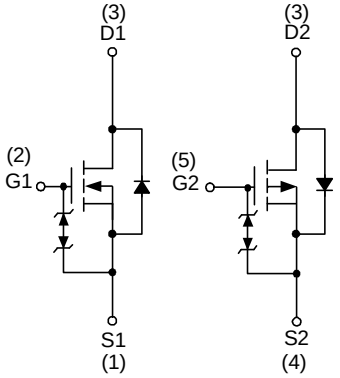
## Applications

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

## Pin Description




Top View of TO-252-4




N-Channel MOSFET P-Channel MOSFET

## Ordering and Marking Information

SM6042CS □□□-□□ □

- Assembly Material
- Handling Code
- Temperature Range
- Package Code

Package Code
U4 : TO-252-4
Operating Junction Temperature Range
C : -55 to 150 °C
Handling Code
TR : Tape & Reel (2500ea/reel)
Assembly Material
G : Halogen and Lead Free Device

SM6042CS U4 : SM6042CS XXXXX

XXXXX - Lot Code

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 lead-free 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).

**SINOPOWER 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 ($T_A$ = 25°C unless otherwise noted)

| Symbol | Parameter | | N Channel | P Channel | Unit |
|---|---|---|---|---|---|
| **Common Ratings** | | | | | |
| $V_{DSS}$ | Drain-Source Voltage | | 60 | -60 | V |
| $V_{GSS}$ | Gate-Source Voltage | | ±20 | ±20 | |
| $T_J$ | Maximum Junction Temperature | | 150 | | °C |
| $T_{STG}$ | Storage Temperature Range | | -55 to 150 | | |
| $I_S$ | Diode Continuous Forward Current | $T_C$=25°C | 10 | -7.5 | A |
| $I_D$ | Continuous Drain Current | $T_C$=25°C | 20 | -15 | |
| | | $T_C$=100°C | 12.8 | -9.7 | |
| $P_D$ | Maximum Power Dissipation | $T_C$=25°C | 35.7 | 44.6 | W |
| | | $T_C$=100°C | 14.2 | 17.8 | |
| $R_{\theta JC}$ | Thermal Resistance-Junction to Case | | 3.5 | 2.8 | °C/W |
| $I_D$ | Continuous Drain Current | $T_A$=25°C | 8.5 | -5.7 | A |
| | | $T_A$=70°C | 6.8 | -4.6 | |
| $I_{DM}$ [a] | Pulsed Drain Current | $T_C$=25°C | 80 * | -60 * | |
| $P_D$ [b] | Power Dissipation | $T_A$=25°C | 6.25 | 6.25 | W |
| | | $T_A$=70°C | 4 | 4 | |
| $R_{\theta JA}$ [c] | Thermal Resistance-Junction to Ambient | t ≤ 10s | 20 | 20 | °C/W |
| | | Steady State | 60 | 60 | |
| $I_{AS}$ [d] | Avalanche Current, Single pulse | L=0.5mH | 8 | -10 | A |
| $E_{AS}$ [d] | Avalanche Energy, Single pulse | L=0.5mH | 16 | 25 | mJ |

Note * : Limited by package.
Note a : Pulse width limited by max. junction temperature.
Note b : t < 10s.
Note c : $R_{\theta JA}$ steady state t=100s. $R_{\theta JA}$ is measured with the device mounted on 1in$^2$ , FR-4 board with 2oz. Copper.
Note d : UIS tested and pulse width limited by maximum junction temperature 150°C (initial temperature Tj=25°C).

## Electrical Characteristics ($T_A$ = 25°C unless otherwise noted)

| Symbol | Parameter | Test Conditions | N Channel | | | Unit |
|---|---|---|---|---|---|---|
| | | | Min. | Typ. | Max. | |
| **Static Characteristics** | | | | | | |
| $BV_{DSS}$ | Drain-Source Breakdown Voltage | $V_{GS}$=0V, $I_{DS}$=250μA | 60 | - | - | V |
| $I_{DSS}$ | Zero Gate Voltage Drain Current | $V_{DS}$=48V, $V_{GS}$=0V | - | - | 1 | μA |
| | | $T_J$=85°C | - | - | 30 | |
| $V_{GS(th)}$ | Gate Threshold Voltage | $V_{DS}$=$V_{GS}$, $I_{DS}$=250μA | 1 | 2 | 3 | V |
| $I_{GSS}$ | Gate Leakage Current | $V_{GS}$=±20V, $V_{DS}$=0V | - | - | ±10 | μA |
| $R_{DS(ON)}$ | Drain-Source On-state Resistance | $V_{GS}$=10V, $I_{DS}$=10A | - | 40 | 48 | mΩ |
| | | $V_{GS}$=4.5V, $I_{DS}$=8A | - | 45 | 59 | |
| **Diode Characteristics** | | | | | | |
| $V_{SD}$ | Diode Forward Voltage | $I_{SD}$=5A, $V_{GS}$=0V | - | 0.8 | 1.3 | V |
| $t_{rr}$ | Reverse Recovery Time | $I_{DS}$=12A, $dI_{SD}/dt$=100A/μs | - | 20 | - | ns |
| $Q_{rr}$ | Reverse Recovery Charge | | - | 20 | - | nC |
| **Dynamic Characteristics** [e] | | | | | | |
| $R_G$ | Gate Resistance | $V_{GS}$=0V,$V_{DS}$=0V,F=1MHz | - | 2.8 | 5.6 | Ω |
| $C_{iss}$ | Input Capacitance | $V_{GS}$=0V, $V_{DS}$=30V, Frequency=1.0MHz | - | 540 | 700 | pF |
| $C_{oss}$ | Output Capacitance | | - | 56 | - | |
| $C_{rss}$ | Reverse Transfer Capacitance | | - | 26 | - | |
| $t_{d(ON)}$ | Turn-on Delay Time | $V_{DD}$=30V, $R_L$=30Ω, $I_{DS}$=1A, $V_{GEN}$=10V, $R_G$=6Ω | - | 10 | 18 | ns |
| $t_r$ | Turn-on Rise Time | | - | 6 | 11 | |
| $t_{d(OFF)}$ | Turn-off Delay Time | | - | 21 | 38 | |
| $t_f$ | Turn-off Fall Time | | - | 5 | 9 | |
| **Gate Charge Characteristics** [e] | | | | | | |
| $Q_g$ | Total Gate Charge | $V_{DS}$=30V, $V_{GS}$=4.5V, $I_{DS}$=12A | - | 5.5 | - | nC |
| $Q_g$ | Total Gate Charge | $V_{DS}$=30V, $V_{GS}$=10V, $I_{DS}$=12A | - | 11.5 | 16 | |
| $Q_{gs}$ | Gate-Source Charge | | - | 2.3 | - | |
| $Q_{gd}$ | Gate-Drain Charge | | - | 2.2 | - | |
| $Q_{gth}$ | Threshold Gate Charge | | - | 1.9 | - | |

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

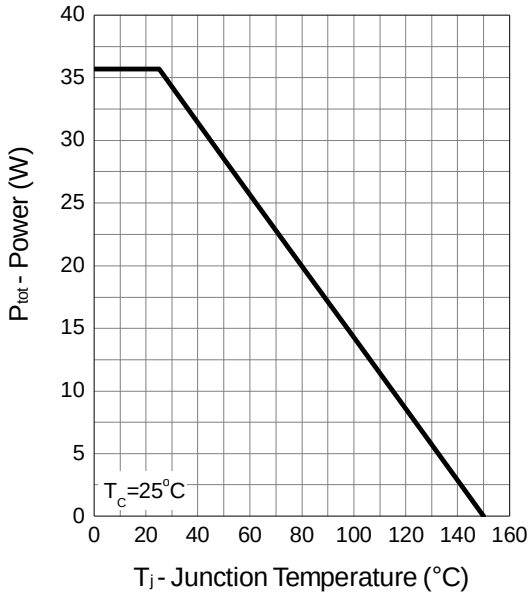
## Electrical Characteristics (Cont.) ($T_A$ = 25°C unless otherwise noted)

| Symbol | Parameter | Test Conditions | P Channel | | | Unit |
|---|---|---|---|---|---|---|
| | | | Min. | Typ. | Max. | |
| **Static Characteristics** | | | | | | |
| $BV_{DSS}$ | Drain-Source Breakdown Voltage | $V_{GS}$=0V, $I_{DS}$=-250μA | -60 | - | - | V |
| $I_{DSS}$ | Zero Gate Voltage Drain Current | $V_{DS}$=-48V, $V_{GS}$=0V | - | - | -1 | μA |
| | | $T_J$=85°C | - | - | -30 | |
| $V_{GS(th)}$ | Gate Threshold Voltage | $V_{DS}$=$V_{GS}$ , $I_{DS}$=-250μA | -1 | -2 | -3 | V |
| $I_{GSS}$ | Gate Leakage Current | $V_{GS}$=±20V, $V_{DS}$=0V | - | - | ±10 | μA |
| $R_{DS(ON)}$ | Drain-Source On-state Resistance | $V_{GS}$=-10V, $I_{DS}$=-7.5A | - | 75 | 95 | mΩ |
| | | $V_{GS}$=-4.5V, $I_{DS}$=-6.5A | - | 95 | 130 | |
| **Diode Characteristics** | | | | | | |
| $V_{SD}$ | Diode Forward Voltage | $I_{SD}$=-1A, $V_{GS}$=0V | - | -0.7 | -1 | V |
| $t_{rr}$ | Reverse Recovery Time | $I_{DS}$=-7.5A, $dI_{SD}/dt$=100A/μs | - | 18 | - | ns |
| $Q_{rr}$ | Reverse Recovery Charge | | - | 13 | - | nC |
| **Dynamic Characteristics** [e] | | | | | | |
| $R_G$ | Gate Resistance | $V_{GS}$=0V,$V_{DS}$=0V,F=1MHz | - | 10 | 20 | Ω |
| $C_{iss}$ | Input Capacitance | $V_{GS}$=0V, $V_{DS}$=-30V, Frequency=1.0MHz | - | 530 | 690 | pF |
| $C_{oss}$ | Output Capacitance | | - | 66 | - | |
| $C_{rss}$ | Reverse Transfer Capacitance | | - | 36 | - | |
| $t_{d(ON)}$ | Turn-on Delay Time | $V_{DD}$=-30V, $R_L$=30Ω, $I_{DS}$=-1A, $V_{GEN}$=-10V, $R_G$=6Ω | - | 8 | 15 | ns |
| $t_r$ | Turn-on Rise Time | | - | 4.5 | 8 | |
| $t_{d(OFF)}$ | Turn-off Delay Time | | - | 40 | 72 | |
| $t_f$ | Turn-off Fall Time | | - | 27 | 49 | |
| **Gate Charge Characteristics** [e] | | | | | | |
| $Q_g$ | Total Gate Charge | $V_{DS}$=-30V, $V_{GS}$=-4.5V, $I_{DS}$=-7.5A | - | 6 | - | nC |
| $Q_g$ | Total Gate Charge | $V_{DS}$=-30V, $V_{GS}$=-10V, $I_{DS}$=-7.5A | - | 12 | 17 | |
| $Q_{gs}$ | Gate-Source Charge | | - | 1.2 | - | |
| $Q_{gd}$ | Gate-Drain Charge | | - | 3.6 | - | |
| $Q_{gth}$ | Threshold Gate Charge | | - | 1 | - | |

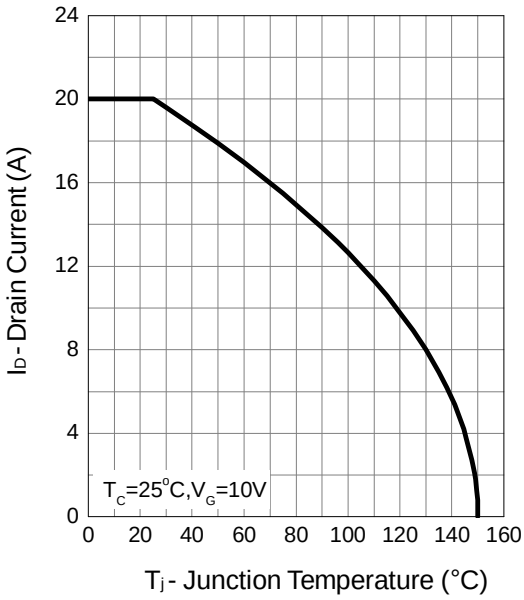
Note e：Guaranteed by design, not subject to production testing.

## N Channel Typical Operating Characteristics

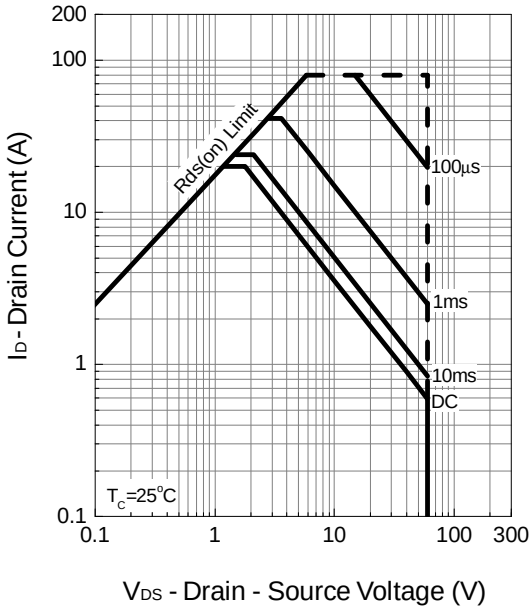
### Power Dissipation



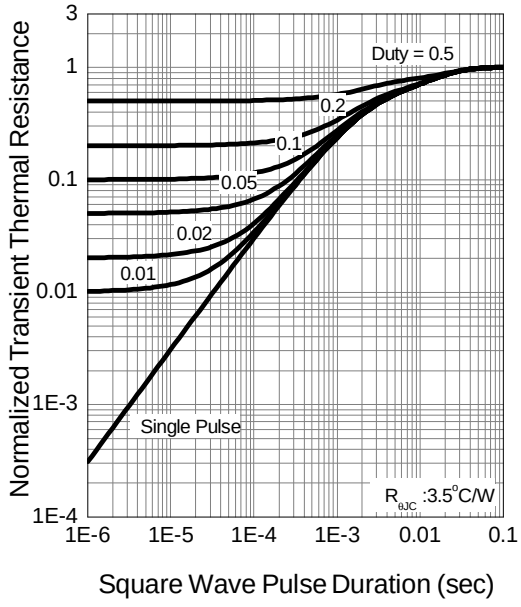

### Drain Current




### Safe Operation Area

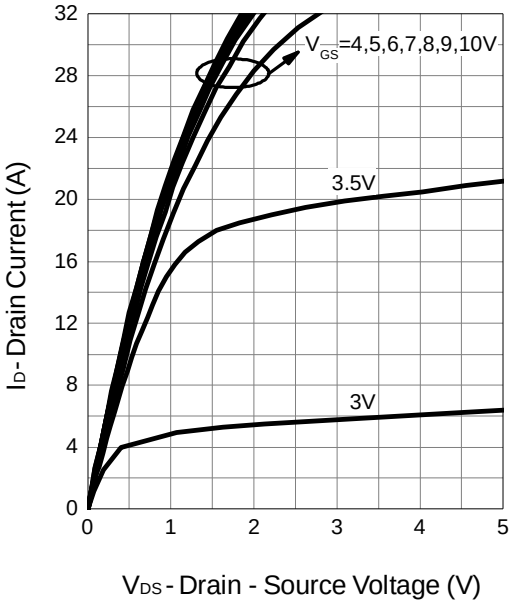



### Thermal Transient Impedance

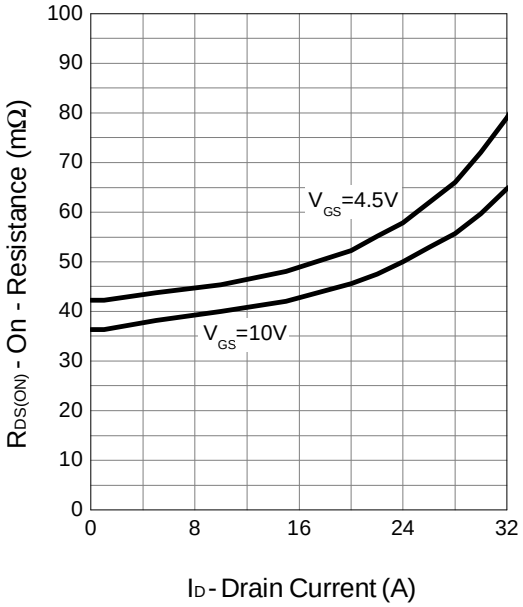


## N Channel Typical Operating Characteristics (Cont.)

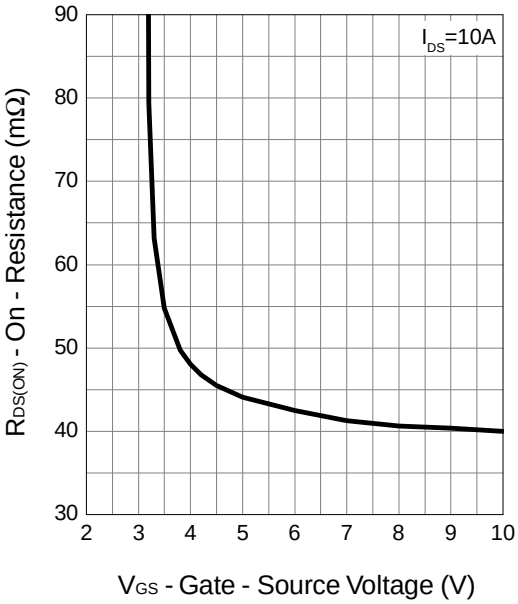
**Output Characteristics**



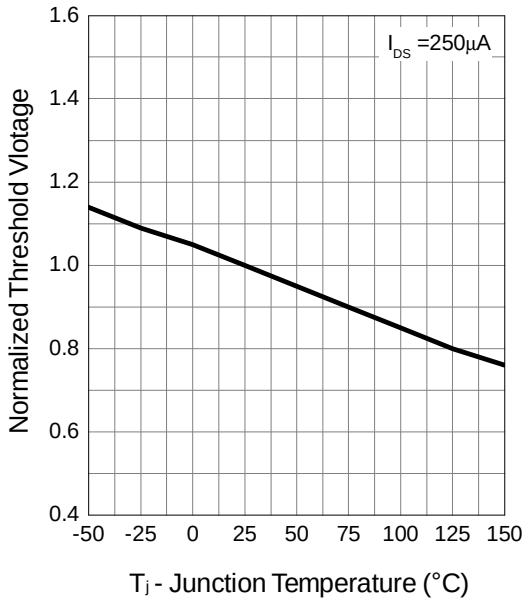

**Drain-Source On Resistance**




**Gate-Source On Resistance**

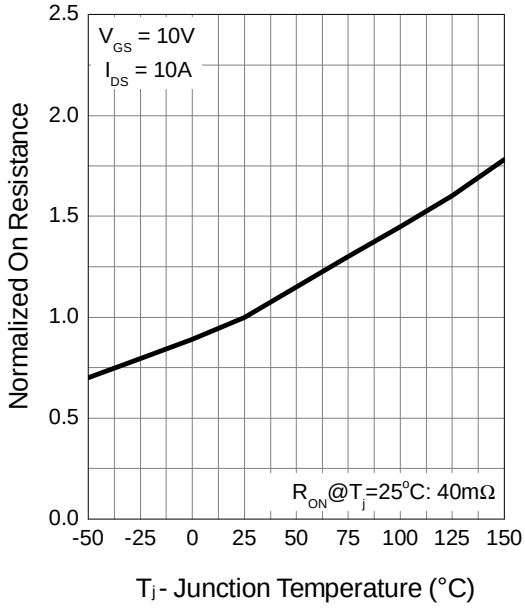



**Gate Threshold Voltage**

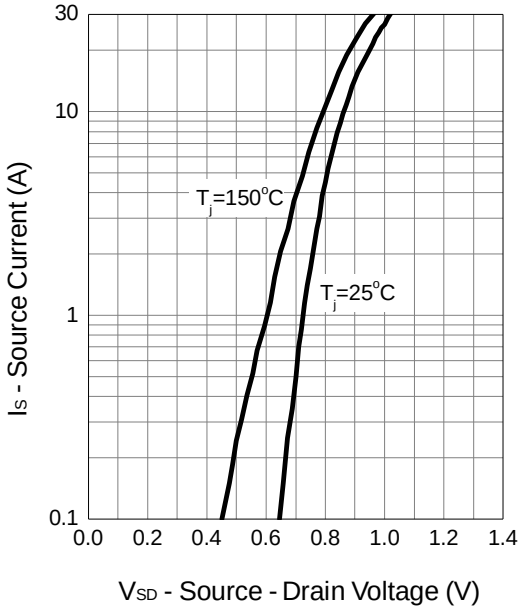


## N Channel Typical Operating Characteristics (Cont.)

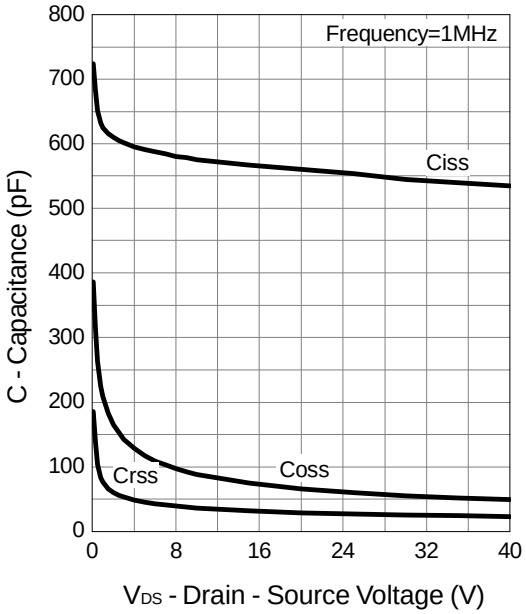
**Drain-Source On Resistance**



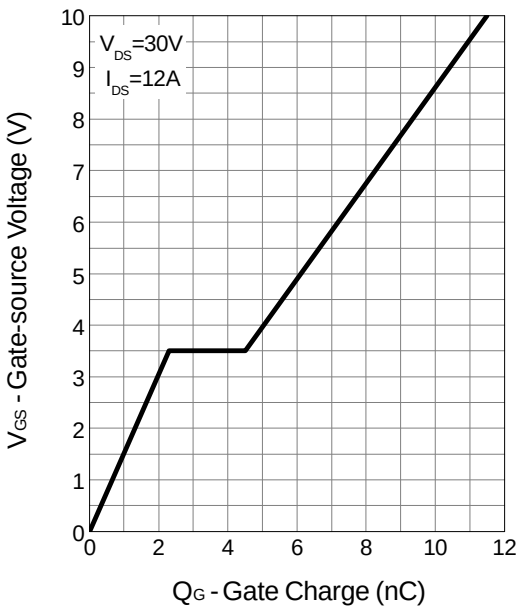

**Source-Drain Diode Forward**




**Capacitance**

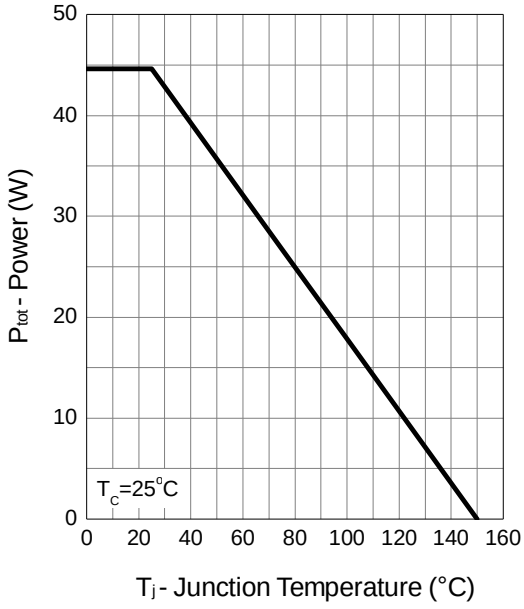



**Gate Charge**

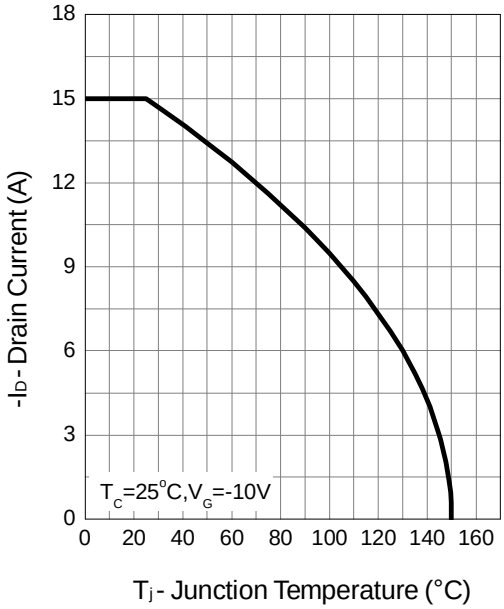


## P Channel Typical Operating Characteristics (Cont.)

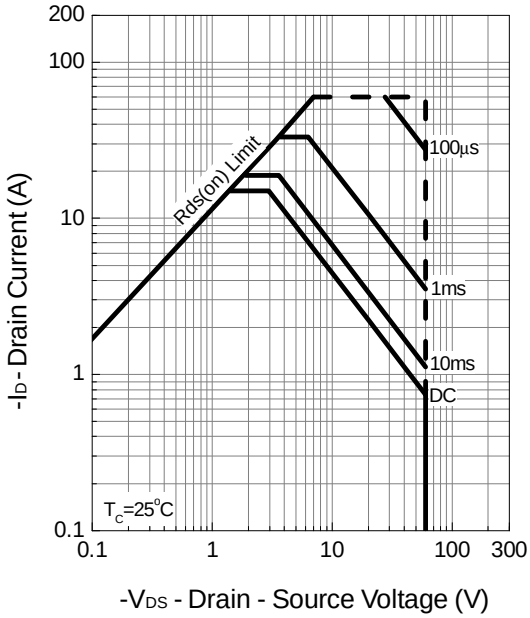
**Power Dissipation**



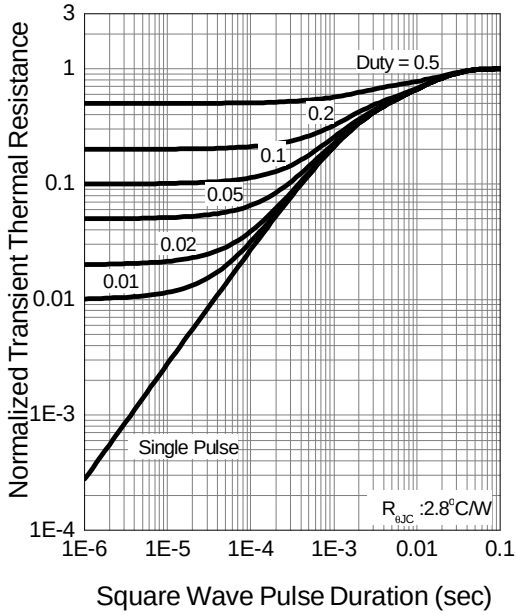

**Drain Current**




**Safe Operation Area**

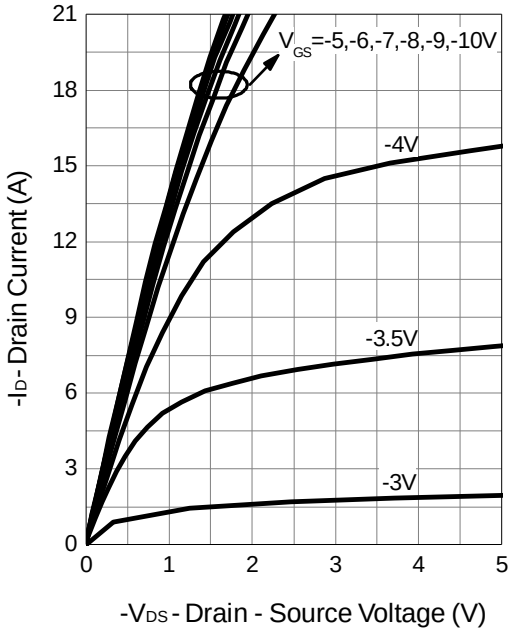



**Thermal Transient Impedance**

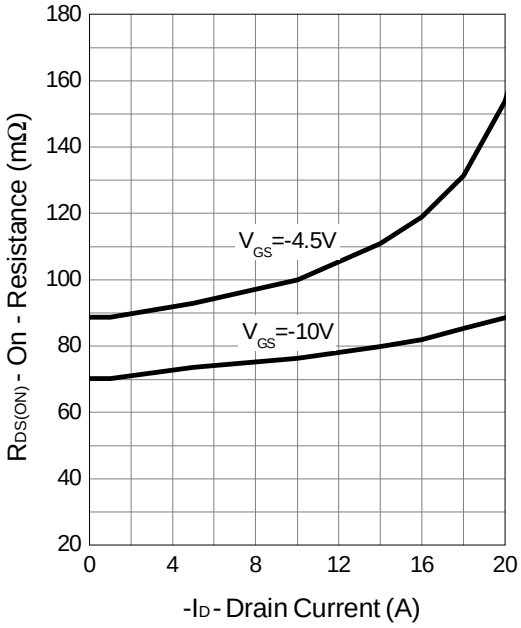


## P Channel Typical Operating Characteristics (Cont.)

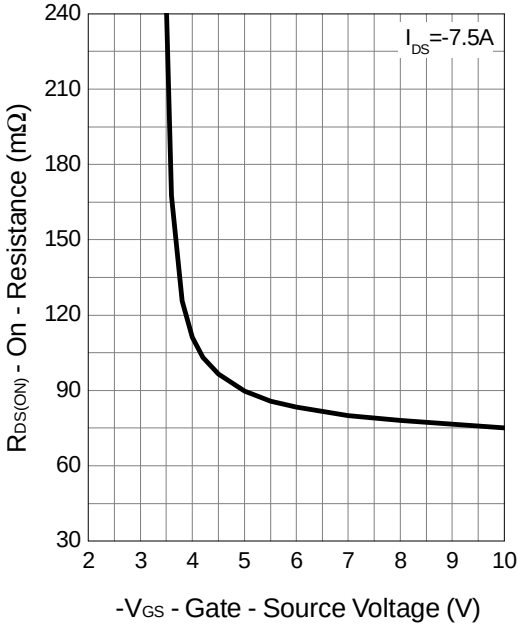
**Output Characteristics**



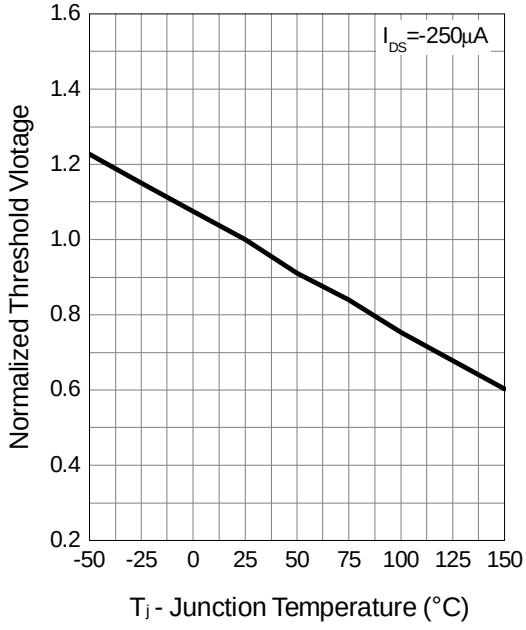

**Drain-Source On Resistance**



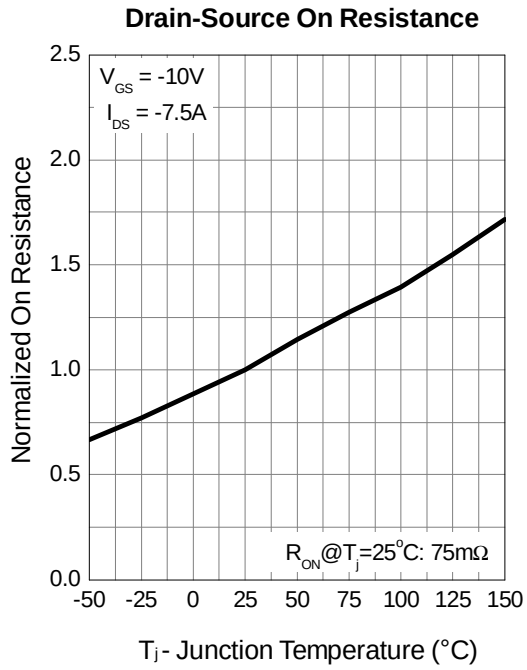

**Gate-Source On Resistance**

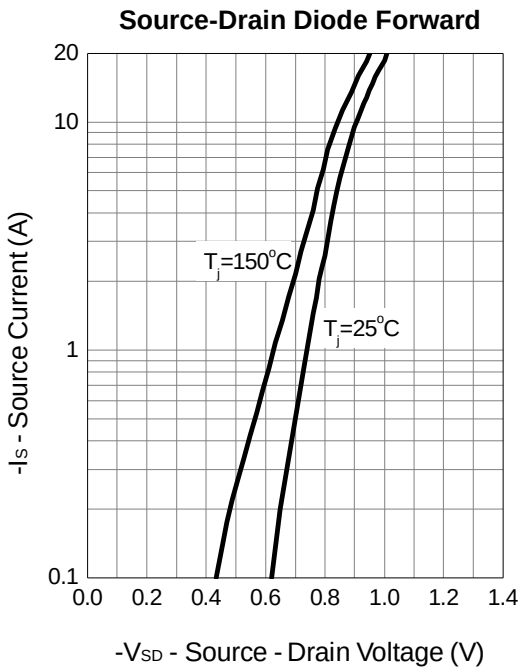


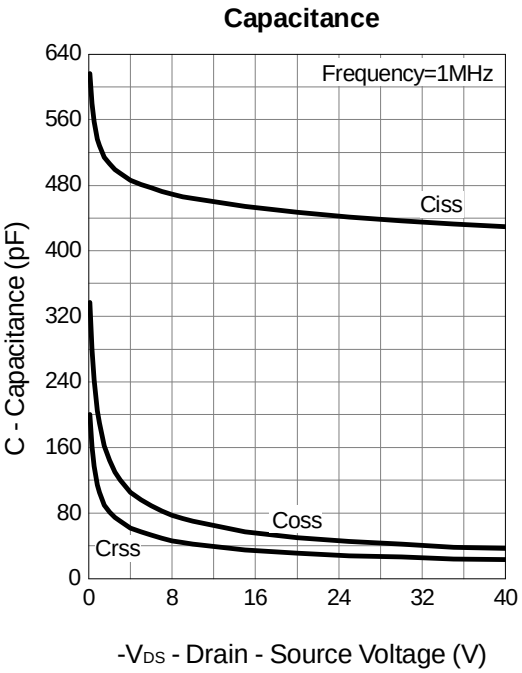

**Gate Threshold Voltage**

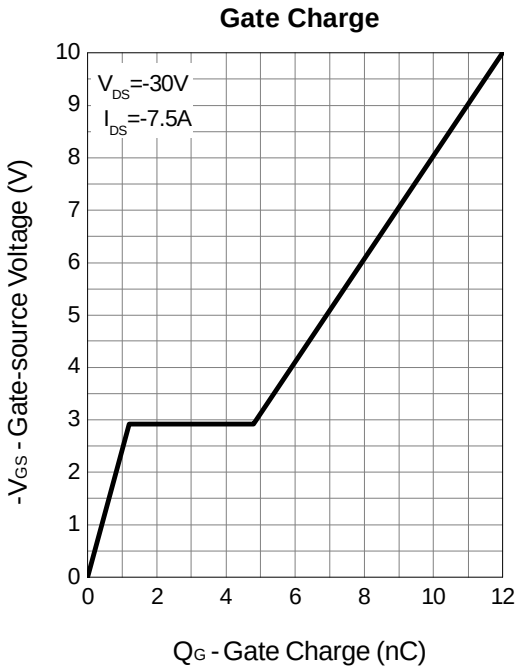


## P Channel Typical Operating Characteristics (Cont.)



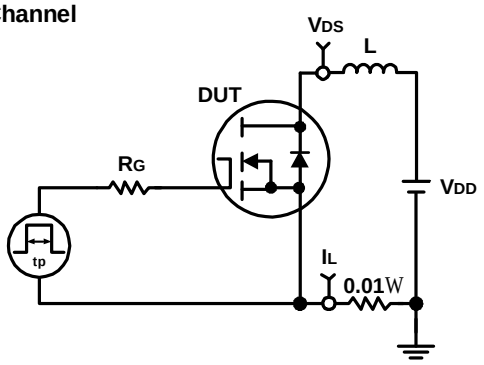



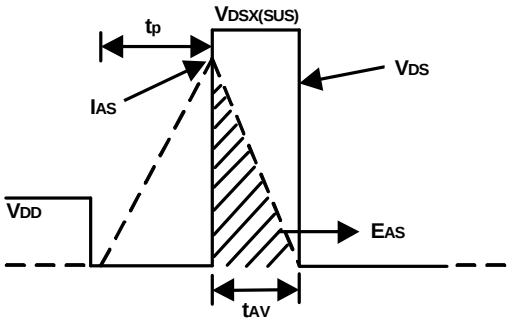



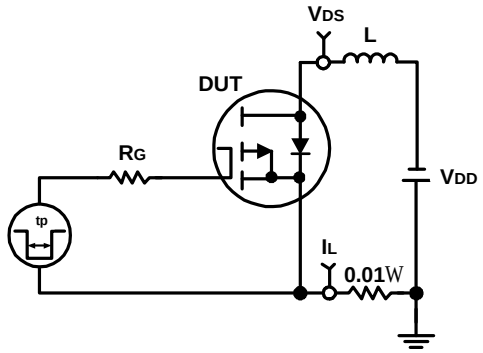
## Avalanche Test Circuit and Waveforms

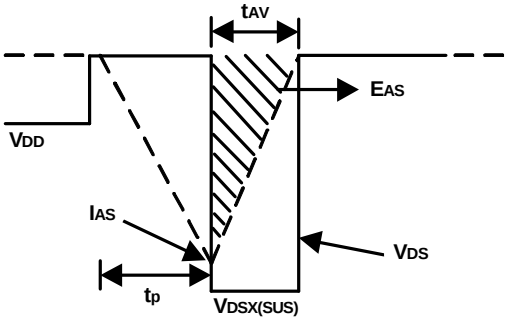
N Channel



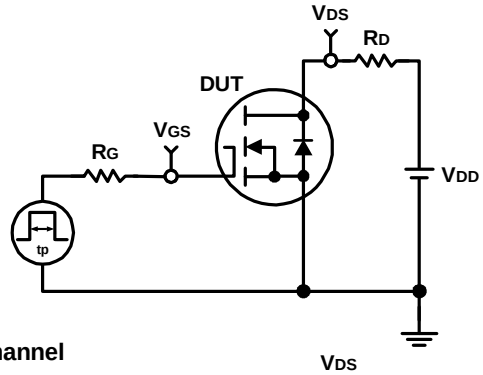

P Channel

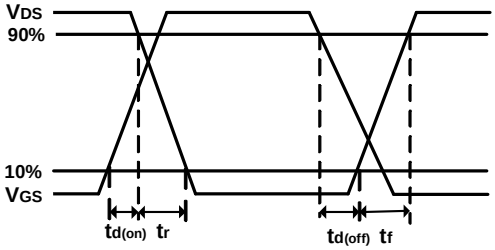


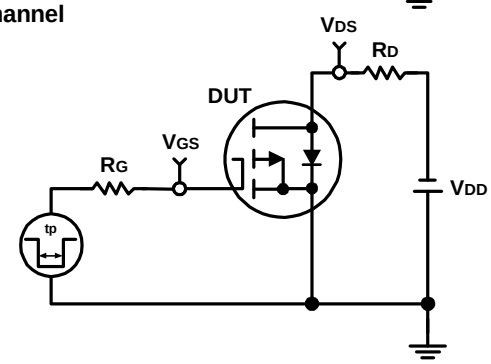

## Switching Time Test Circuit and Waveforms

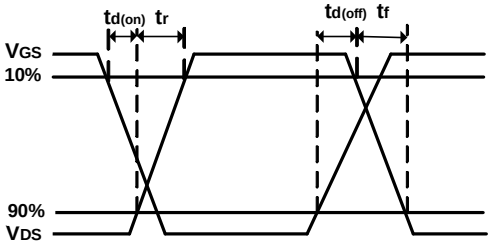
N Channel



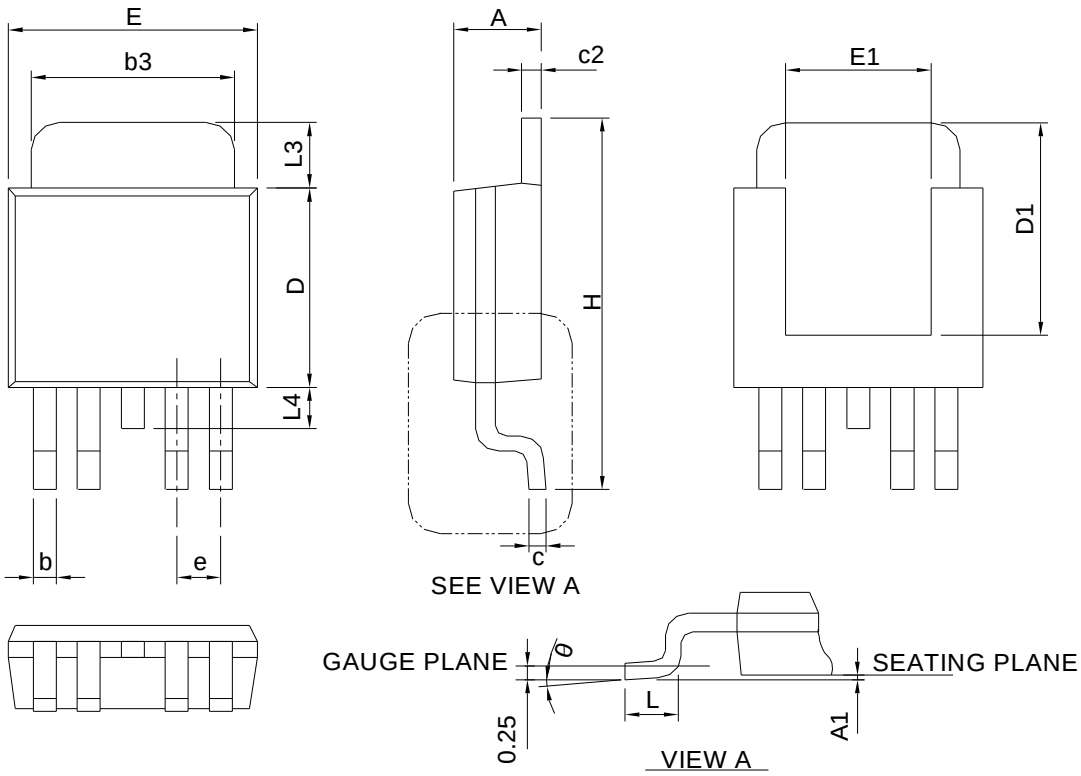

P Channel



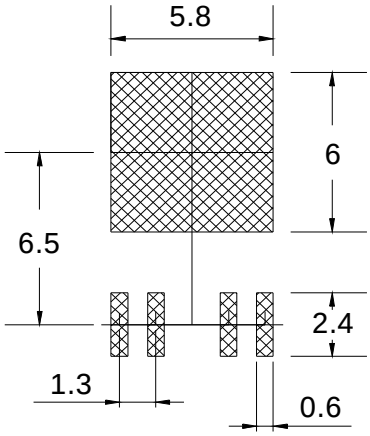
## Package Information

**TO-252-4**



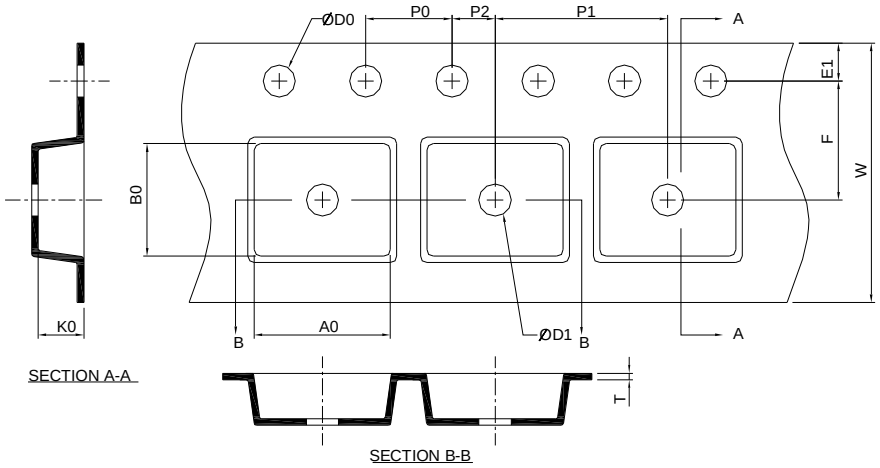

| SYMBOL | TO-252-4 | | | |
|---|---|---|---|---|
| | MILLIMETERS | | INCHES | |
| | MIN. | MAX. | MIN. | MAX. |
| A | 2.18 | 2.39 | 0.086 | 0.094 |
| A1 | - | 0.2 | - | 0.008 |
| b | 0.50 | 0.71 | 0.020 | 0.028 |
| b3 | 4.32 | 5.46 | 0.170 | 0.215 |
| c | 0.46 | 0.61 | 0.018 | 0.024 |
| c2 | 0.46 | 0.89 | 0.018 | 0.035 |
| D | 5.33 | 6.22 | 0.210 | 0.245 |
| D1 | 4.57 | 6.00 | 0.180 | 0.236 |
| E | 6.35 | 6.73 | 0.250 | 0.265 |
| E1 | 3.81 | 6.00 | 0.150 | 0.236 |
| e | 1.30 BSC | | 0.051 BSC | |
| H | 9.40 | 10.41 | 0.370 | 0.410 |
| L | 1.40 | 1.78 | 0.055 | 0.070 |
| L3 | 0.89 | 2.03 | 0.035 | 0.080 |
| L4 | - | 1.02 | - | 0.040 |
| θ | 0° | 8° | 0° | 8° |

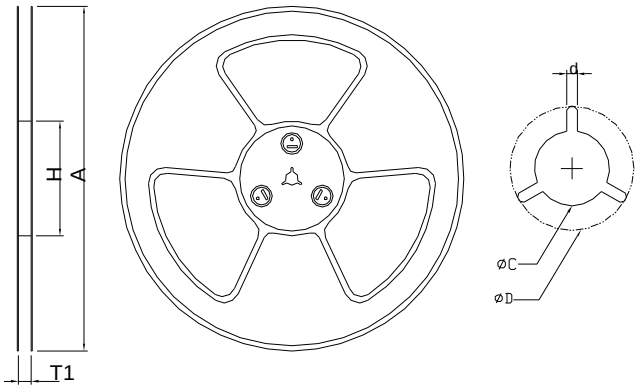
RECOMMENDED LAND PATTERN




UNIT: mm

## Carrier Tape & Reel Dimensions



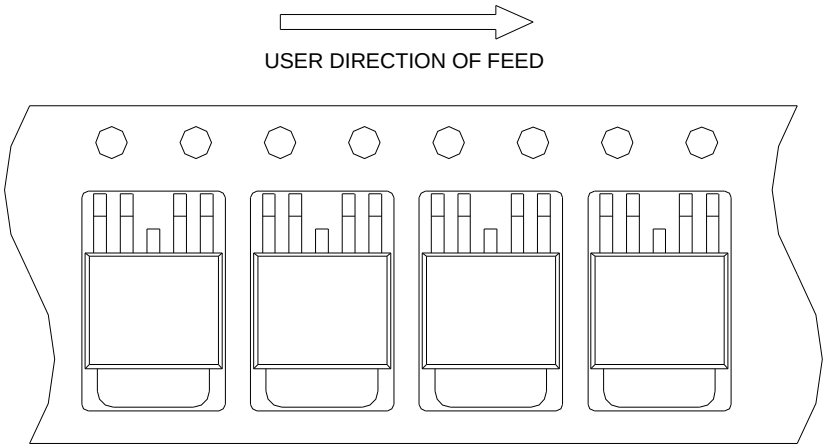




| Application | A | H | T1 | C | d | D | W | E1 | F |
|---|---|---|---|---|---|---|---|---|---|
| TO-252-4 | 330.0±2.00 | 50 MIN. | 16.4+2.00 -0.00 | 13.0+0.50 -0.20 | 1.5 MIN. | 20.2 MIN. | 16.0±0.30 | 1.75±0.10 | 7.50±0.05 |
| | **P0** | **P1** | **P2** | **D0** | **D1** | **T** | **A0** | **B0** | **K0** |
| | 4.0±0.10 | 8.0±0.10 | 2.0±0.05 | 1.5+0.10 -0.00 | 1.5 MIN. | 0.6+0.00 -0.40 | 6.80±0.20 | 10.40±0.20 | 2.50±0.20 |

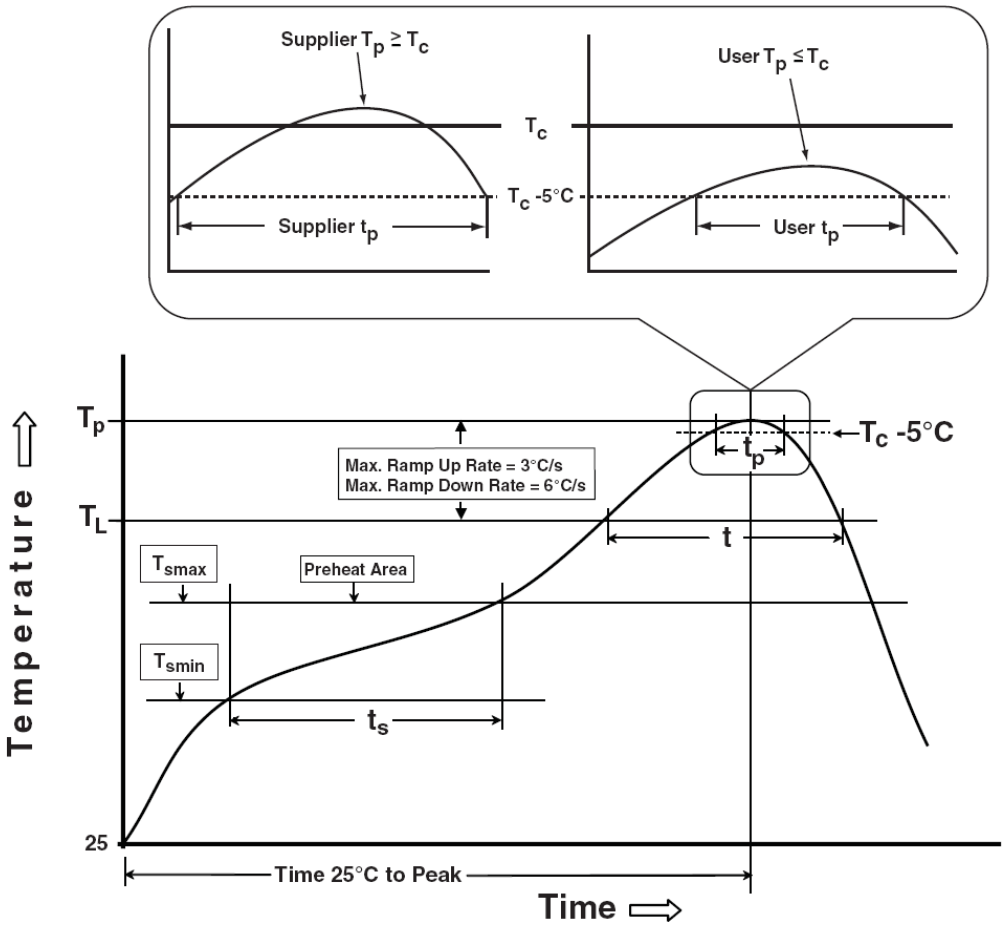
(mm)

## Taping Direction Information

**TO-252-4**




## Classification Profile



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## Classification Reflow Profiles

| Profile Feature | Sn-Pb Eutectic Assembly | Pb-Free Assembly |
|---|---|---|
| **Preheat & Soak**<br>Temperature min ($T_{smin}$)<br>Temperature max ($T_{smax}$)<br>Time ($T_{smin}$ to $T_{smax}$) ($t_s$) | 100 °C<br>150 °C<br>60-120 seconds | 150 °C<br>200 °C<br>60-120 seconds |
| Average ramp-up rate ($T_{smax}$ to $T_P$) | 3 °C/second max. | 3°C/second max. |
| Liquidous temperature ($T_L$)<br>Time at liquidous ($t_L$) | 183 °C<br>60-150 seconds | 217 °C<br>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.<br>** 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 (Tc)

| Package Thickness | Volume $mm^3$ <350 | Volume $mm^3$ 3350 |
|---|---|---|
| <2.5 mm | 235 °C | 220 °C |
| ≥2.5 mm | 220 °C | 220 °C |

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

| Package Thickness | Volume $mm^3$ <350 | Volume $mm^3$ 350-2000 | Volume $mm^3$ >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 @ Tjmax |
| HTGB | JESD-22, A108 | 1000 Hrs, 100% of VGS max @ Tjmax |
| PCT | JESD-22, A102 | 168 Hrs, 100%RH, 2atm, 121°C |
| TCT | JESD-22, A104 | 500 Cycles, -65°C~150°C |

## Customer Service

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