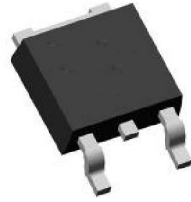


## Main Product Characteristics

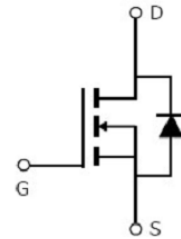
|              |             |
|--------------|-------------|
| $V_{DSS}$    | 40V         |
| $R_{DS(on)}$ | 3.2mΩ(typ.) |
| $I_D$        | 145A        |



TO-252 (DPAK)



Marking and Pin Assignment



Schematic Diagram

## Features and Benefits

- Advanced MOSFET process technology
- Ideal for PWM, load switching and general purpose applications
- Ultra low on-resistance with low gate charge
- Fast switching and reverse body recovery
- 175°C operating temperature



## Description

The SSFD4004 utilizes the latest processing techniques to achieve high cell density, low on-resistance and high repetitive avalanche rating. These features make this device extremely efficient and reliable device for use in power switching applications and a wide variety of other applications.

## Absolute Max Ratings

| Symbol                          | Parameter  | Max.         | Units |
|---------------------------------|--|--------------|-------|
| $I_D @ T_C = 25^\circ\text{C}$  | Continuous Drain Current, $V_{GS} @ 10\text{V}$  | 145①         | A     |
| $I_D @ T_C = 100^\circ\text{C}$ | Continuous Drain Current, $V_{GS} @ 10\text{V}$  | 100①         |       |
| $I_{DM}$                        | Pulsed Drain Current ②                           | 580          |       |
| $P_D @ T_C = 25^\circ\text{C}$  | Power Dissipation ③                              | 153          | W     |
|                                 | Linear Derating Factor                           | 1.02         | W/°C  |
| $V_{DS}$                        | Drain-Source Voltage                             | 40           | V     |
| $V_{GS}$                        | Gate-to-Source Voltage                           | ± 20         | V     |
| $E_{AS}$                        | Single Pulse Avalanche Energy @ L=0.1mH          | 281.3        | mJ    |
| $I_{AS}$                        | Avalanche Current @ L=0.1mH                      | 75           | A     |
| $T_J, T_{STG}$                  | Operating Junction and Storage Temperature Range | -55 to + 175 | °C    |

## Thermal Resistance

| Symbol          | Characteristics                                   | Typ. | Max. | Units |
|-----------------|---|------|------|-------|
| $R_{\theta JC}$ | Junction-to-Case ③                                | —    | 0.98 | °C/W  |
| $R_{\theta JA}$ | Junction-to-Ambient ( $t \leq 10s$ ) ④            | —    | 62   | °C/W  |
|                 | Junction-to-Ambient (PCB mounted, steady-state) ④ | —    | 40   | °C/W  |

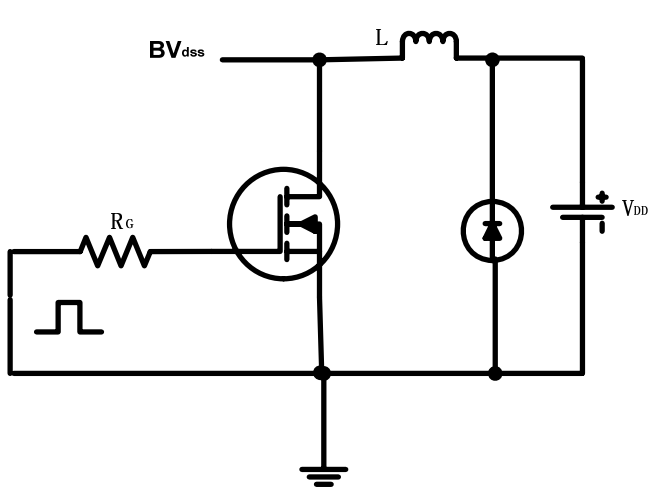
## Electrical Characteristics ( $T_A=25^\circ\text{C}$ unless otherwise specified)

| Symbol        | Parameter                            | Min. | Typ. | Max. | Units | Conditions   |
|---------------|--------------------------------------|------|------|------|-------|--|
| $V_{(BR)DSS}$ | Drain-to-Source Breakdown Voltage    | 40   | —    | —    | V     | $V_{GS} = 0V, I_D = 250\mu A$  |
| $R_{DS(on)}$  | Static Drain-to-Source On-resistance | —    | 3.2  | 4    | mΩ    | $V_{GS}=10V, I_D = 30A$  |
|               |                                      | —    | 6.17 | —    |       | $T_J = 125^\circ\text{C}$  |
| $V_{GS(th)}$  | Gate Threshold Voltage               | 1    | —    | 3    | V     | $V_{DS} = V_{GS}, I_D = 250\mu A$  |
|               |                                      | —    | 1.11 | —    |       | $T_J = 125^\circ\text{C}$  |
| $I_{DSS}$     | Drain-to-Source Leakage Current      | —    | —    | 1    | μA    | $V_{DS} = 40V, V_{GS} = 0V$  |
|               |                                      | —    | —    | 50   |       | $T_J = 125^\circ\text{C}$  |
| $I_{GSS}$     | Gate-to-Source Forward Leakage       | —    | —    | 100  | nA    | $V_{GS} = 20V$   |
|               |                                      | —    | —    | -100 |       | $V_{GS} = -20V$  |
| $Q_g$         | Total Gate Charge                    | —    | 52.3 | —    | nC    | $I_D = 20A,$<br>$V_{DS}=15V,$<br>$V_{GS} = 4.5V$                                     |
| $Q_{gs}$      | Gate-to-Source Charge                | —    | 20.3 | —    |       |  |
| $Q_{gd}$      | Gate-to-Drain("Miller") Charge       | —    | 23.1 | —    |       |  |
| $t_{d(on)}$   | Turn-on Delay Time                   | —    | 15.9 | —    | nS    | $V_{GS}=10V, V_{DS} = 15V,$<br>$R_L=0.75\Omega,$<br>$R_{GEN}=3\Omega$<br>$I_D = 20A$ |
| $t_r$         | Rise Time                            | —    | 49.0 | —    |       |  |
| $t_{d(off)}$  | Turn-Off Delay Time                  | —    | 61.6 | —    |       |  |
| $t_f$         | Fall Time                            | —    | 25.6 | —    |       |  |
| $C_{iss}$     | Input Capacitance                    | —    | 6653 | —    | pF    | $V_{GS} = 0V$  |
| $C_{oss}$     | Output Capacitance                   | —    | 632  | —    |       | $V_{DS} = 15V$   |
| $C_{rss}$     | Reverse Transfer Capacitance         | —    | 603  | —    |       | $f = 1\text{MHz}$  |

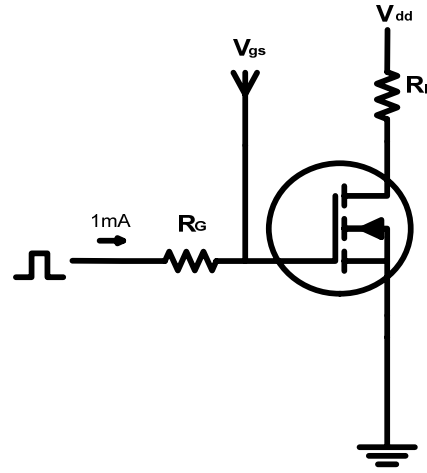
## Source-Drain Ratings and Characteristics

| Symbol   | Parameter                                 | Min. | Typ. | Max. | Units | Conditions  |
|----------|---|------|------|------|-------|---|
| $I_S$    | Continuous Source Current<br>(Body Diode) | —    | —    | 145① | A     | MOSFET symbol<br>showing the<br>integral reverse<br>p-n junction diode. |
| $I_{SM}$ | Pulsed Source Current<br>(Body Diode)     | —    | —    | 580  | A     |   |
| $V_{SD}$ | Diode Forward Voltage                     | —    | 0.72 | 1.2  | V     | $I_S=2.1A, V_{GS}=0V$   |
| $t_{rr}$ | Reverse Recovery Time                     | —    | 30.8 | —    | nS    | $T_J = 25^\circ\text{C}, I_F = 20A, di/dt =$                            |
| $Q_{rr}$ | Reverse Recovery Charge                   | —    | 31.1 | —    | nC    | 100A/μs   |

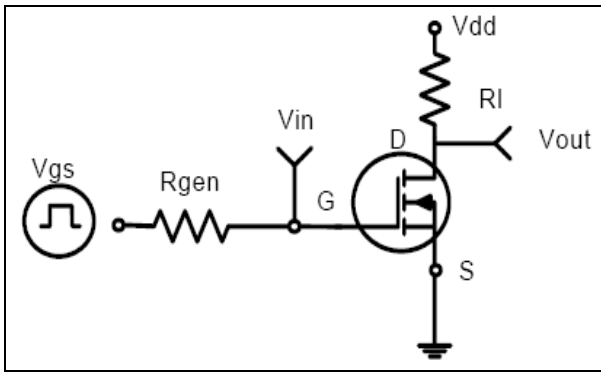
**Test Circuits and Waveforms**



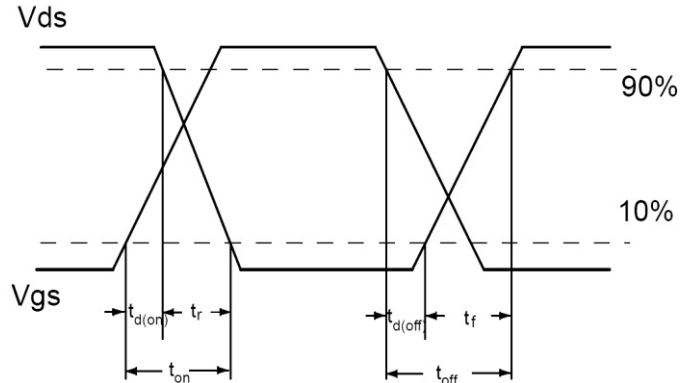
**E<sub>AS</sub> Test Circuit**



**Gate Charge Test Circuit**



**Switching Time Test Circuit**

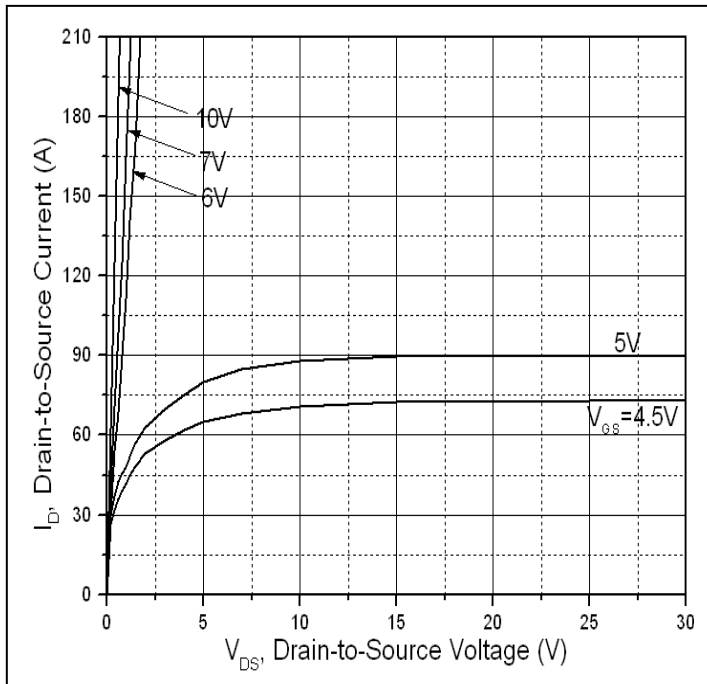


**Switching Waveforms**

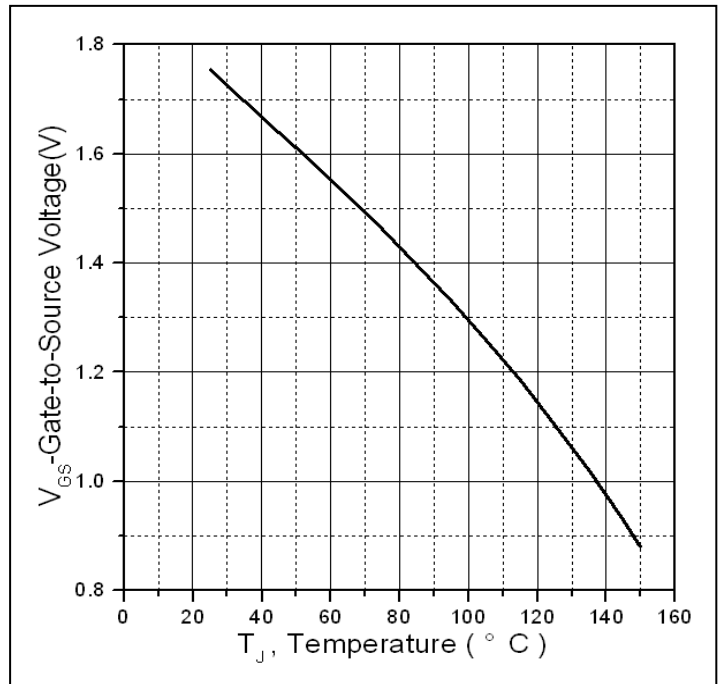
**Notes:**

- ① Calculated continuous current based on maximum allowable junction temperature. Package limitation current is 75A.
- ② Repetitive rating; pulse width limited by max. junction temperature.
- ③ The power dissipation  $P_D$  is based on max. junction temperature, using junction-to-case thermal resistance.
- ④ The value of  $R_{\theta JA}$  is measured with the device mounted on 1 in<sup>2</sup> FR-4 board with 2oz. Copper, in a still air environment with  $T_A = 25^\circ\text{C}$ .

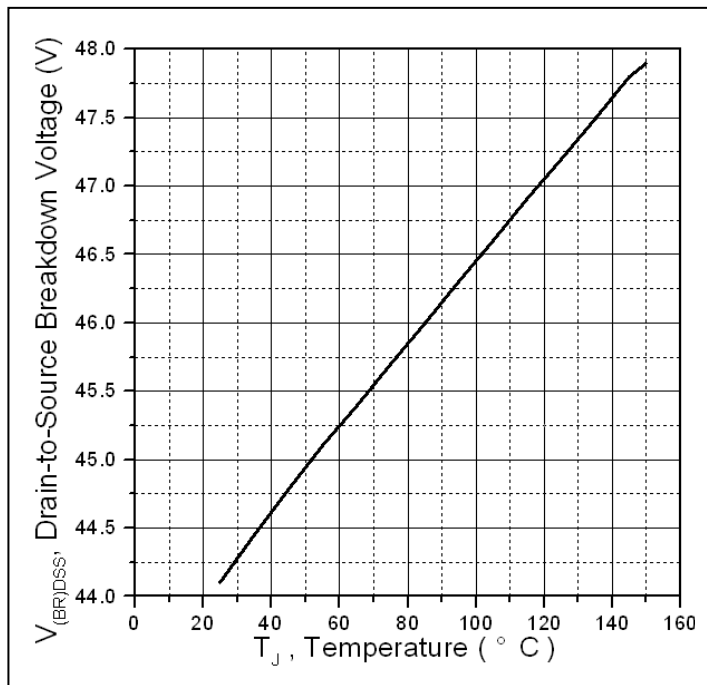
**Typical Electrical and Thermal Characteristics**



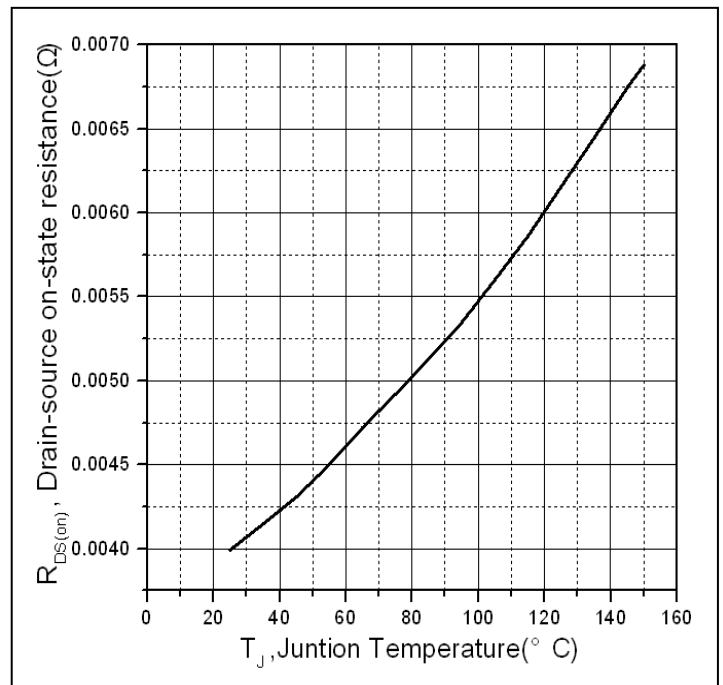
**Figure 1. Typical Output Characteristics**



**Figure 2. Gate to Source Cut-off Voltage**



**Figure 3. Drain-to-Source Breakdown Voltage vs. Temperature**



**Figure 4. Normalized On-Resistance Vs. Case Temperature**

Typical Electrical and Thermal Characteristics

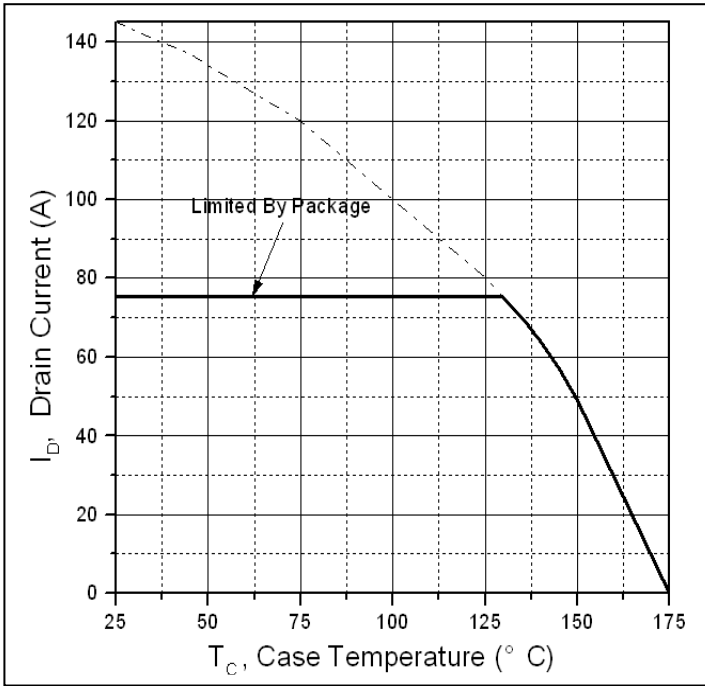


Figure 5. Maximum Drain Current Vs. Case Temperature

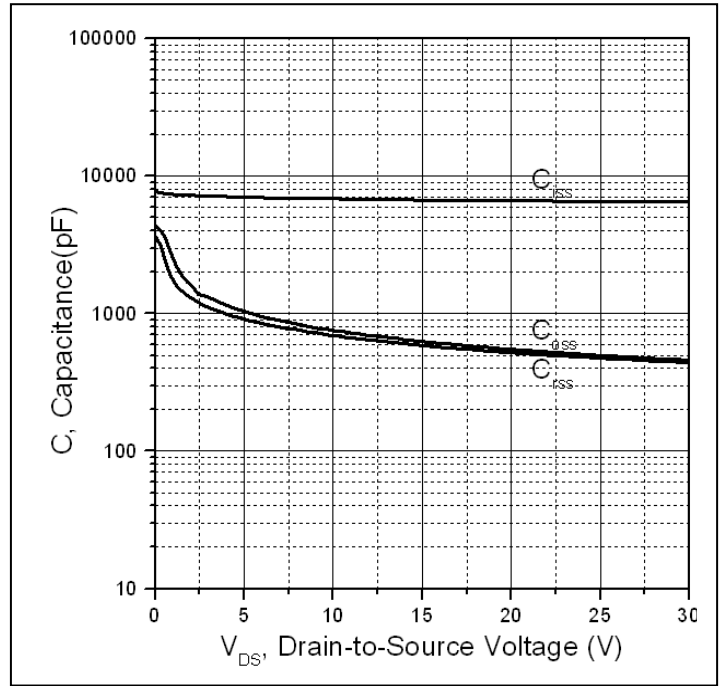


Figure 6. Typical Capacitance Vs. Drain-to-Source Voltage

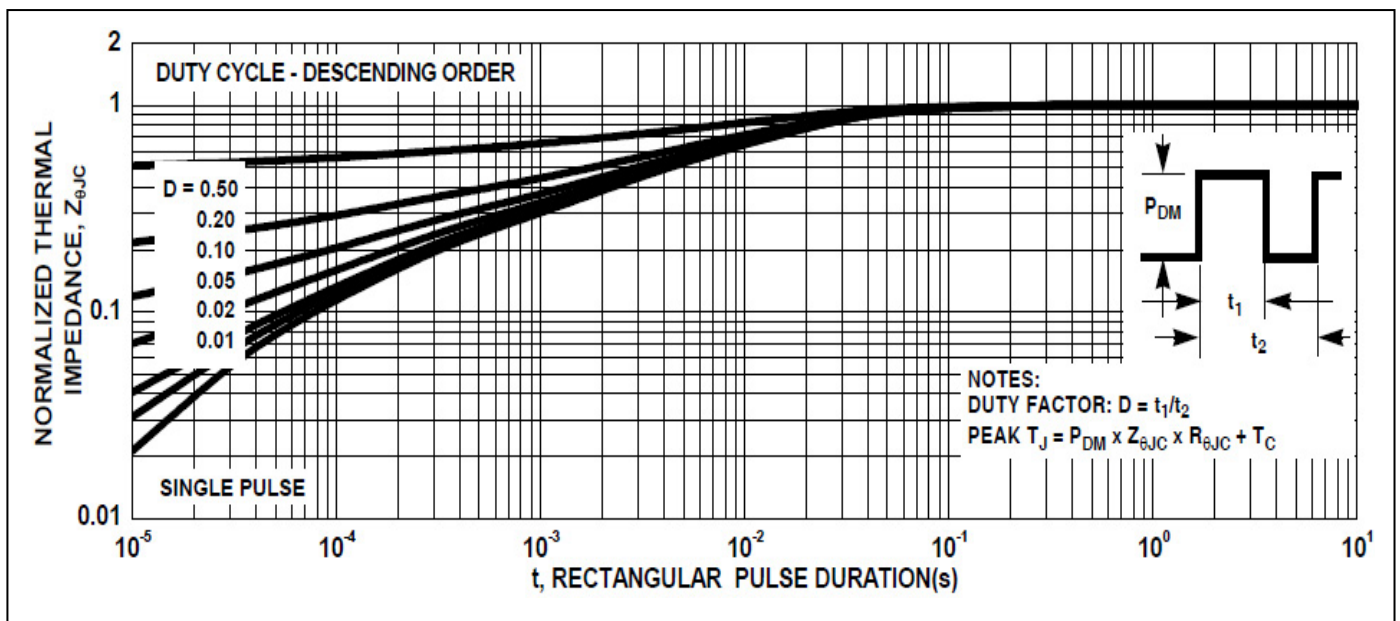
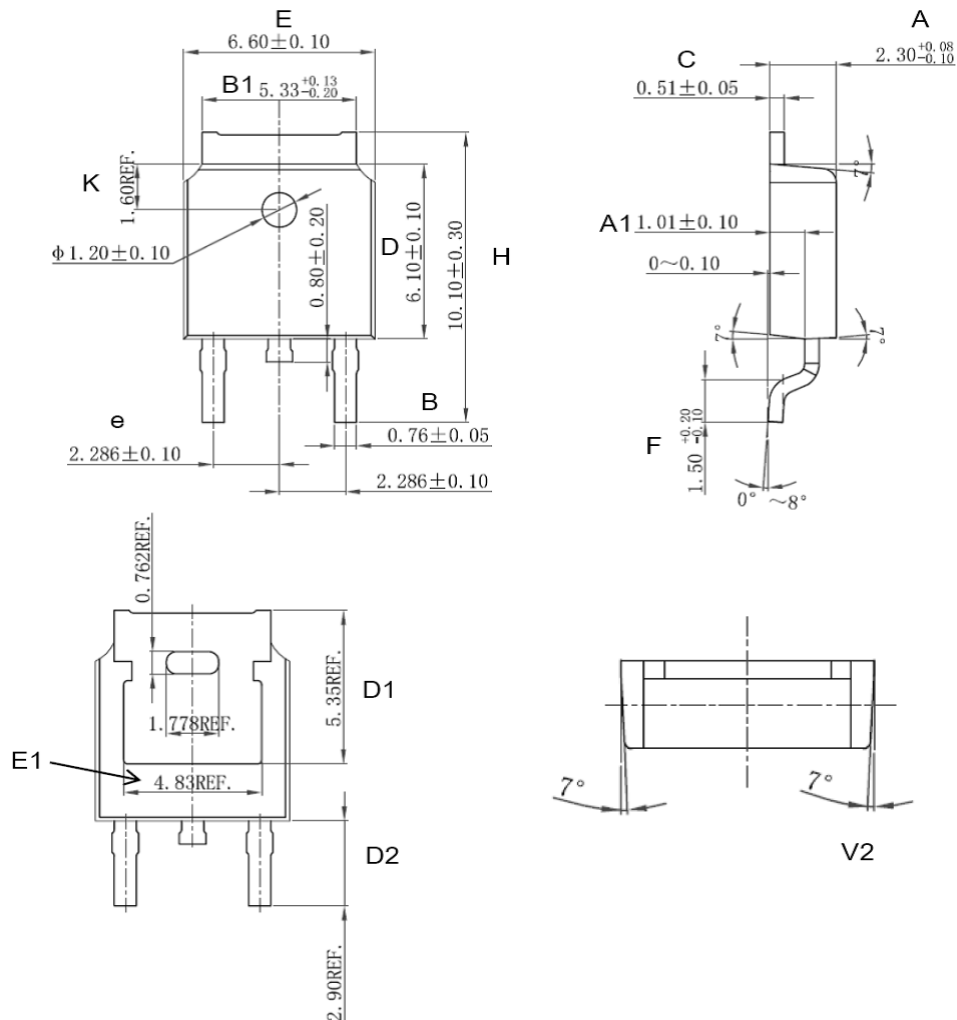


Figure 7. Maximum Effective Transient Thermal Impedance, Junction-to-Case

**Mechanical Data**

**TO252/DPAK PACKAGE OUTLINE DIMENSIONS**



| Symbol | Dimensions In Millimeters |        |        | Dimensions In Inches |       |       |
|--------|---------------------------|--------|--------|----------------------|-------|-------|
|        | Min                       | Nom    | Max    | Min                  | Nom   | Max   |
| A      | 2.200                     | 2.300  | 2.380  | 0.087                | 0.091 | 0.094 |
| A1     | 0.910                     | 1.010  | 1.110  | 0.036                | 0.040 | 0.044 |
| B      | 0.710                     | 0.760  | 0.810  | 0.028                | 0.030 | 0.032 |
| B1     | 5.130                     | 5.330  | 5.460  | 0.202                | 0.210 | 0.215 |
| C      | 0.460                     | 0.510  | 0.560  | 0.018                | 0.020 | 0.022 |
| D      | 6.000                     | 6.100  | 6.200  | 0.236                | 0.240 | 0.244 |
| D1     | 5.350 (REF)               |        |        | 0.211 (REF)          |       |       |
| D2     | 2.900 (REF)               |        |        | 0.114 (REF)          |       |       |
| E      | 6.500                     | 6.600  | 6.700  | 0.256                | 0.260 | 0.264 |
| E1     | 4.83 (REF)                |        |        | 0.190 (REF)          |       |       |
| e      | 2.186                     | 2.286  | 2.386  | 0.086                | 0.090 | 0.094 |
| H      | 9.800                     | 10.100 | 10.400 | 0.386                | 0.398 | 0.409 |
| F      | 1.400                     | 1.500  | 1.700  | 0.055                | 0.059 | 0.067 |
| K      | 1.600 (REF)               |        |        | 0.063 (REF)          |       |       |
| V2     | 8° (REF)                  |        |        | 8° (REF)             |       |       |

## Ordering and Marking Information

### Device Marking: SSFD4004

Package (Available)  
 DPAK/TO-252  
 Operating Temperature Range  
 C : -55 to 175 °C

## Devices per Unit

### Option1

| Package Type | Units/Tape | Tapes/Inner Box | Units/Inner Box | Inner Boxes/ Carton Box | Units/ Carton Box |
|--------------|------------|-----------------|-----------------|-------------------------|-------------------|
| TO-252       | 2500       | 2               | 5000            | 7                       | 35000             |

### Option2

| Package Type | Units/Tape | Tapes/Inner Box | Units/Inner Box | Inner Boxes/ Carton Box | Units/ Carton Box |
|--------------|------------|-----------------|-----------------|-------------------------|-------------------|
| TO-252       | 2500       | 1               | 2500            | 10                      | 25000             |

## Reliability Test Program

| Test Item                           | Conditions  | Duration                             | Sample Size         |
|-------------------------------------|---|--------------------------------------|---------------------|
| High Temperature Reverse Bias(HTRB) | $T_j=125^{\circ}\text{C}$ to $175^{\circ}\text{C}$<br>@ 80% of Max<br>$V_{DSS}/V_{CES}/V_R$ | 168 hours<br>500 hours<br>1000 hours | 3 lots x 77 devices |
| High Temperature Gate Bias(HTGB)    | $T_j=150^{\circ}\text{C}$ or $175^{\circ}\text{C}$<br>@ 100% of Max $V_{GSS}$               | 168 hours<br>500 hours<br>1000 hours | 3 lots x 77 devices |