# LMNP2093EX7F N & P Pair Enhancement Mode MOSFET

## Features

- N-Channel
- 20V/0.5A, $R_{DS(ON)}$=450mΩ@$V_{GS}$=4.5V
- 20V/0.4A, $R_{DS(ON)}$=600mΩ@$V_{GS}$=2.5V
- 20V/0.2A, $R_{DS(ON)}$=750mΩ@$V_{GS}$=1.8V
- P-Channel
- -20V/-0.5A, $R_{DS(ON)}$=800mΩ@$V_{GS}$=-4.5V
- -20V/-0.2A, $R_{DS(ON)}$=1050mΩ@$V_{GS}$=-2.5V
- -20V/-0.1A, $R_{DS(ON)}$=1500mΩ@$V_{GS}$=-1.8V
- Low-Voltage Operation
- High-Speed Circuits
- Low Battery Voltage Operation
- SOT-563 package design

## Product Description

LMNP2093E is the N and P Pair enhancement mode MOSFET, uses Advanced Trench Technology to provide excellent $R_{DS(ON)}$, low gate charge.

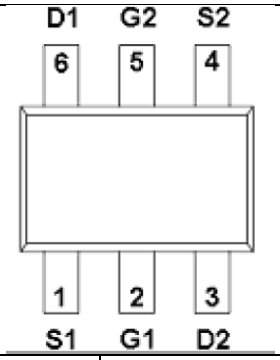
These devices are particularly suited for low voltage power management, such as smart phone and notebook computer and other battery powered circuits, and low in-line power loss are needed in commercial industrial surface mount applications.

## Applications

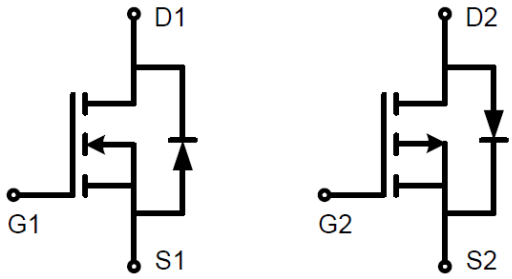
- Load Switch for Portable Devices, Smart Phones, Pagers.

## Pin Configuration

LMNP2093EX7F (SOT-563)




| Pin | Description |
|---|---|
| 1 | Source 1 |
| 2 | Gate 1 |
| 3 | Drain 2 |
| 4 | Source 2 |
| 5 | Gate 2 |
| 6 | Drain 1 |





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## Ordering Information

| Ordering Information | | | | |
|---|---|---|---|---|
| Part Number | P/N | PKG code | Pb Free code | Package |
| LMNP2093EX6F | LMNP2093E | X7 | F | SOT-563 |

## Marking Information

| Marking Information | |
|---|---|
| Part Number | LFC code |
| 9 | XM |

## Absolute Maximum Ratings

($T_C$=25ºC Unless otherwise noted)

| Symbol | Parameter | | Typical | | Unit |
|---|---|---|---|---|---|
| | | | N-Channel | P-Channel | |
| $V_{DSS}$ | Drain-Source Voltage | | 20 | -20 | V |
| $V_{GSS}$ | Gate-Source Voltage | | ±10 | ±8 | V |
| $I_D$ | Continuous Drain Current ($T_J$=150℃)[1] | $T_A$=25℃[1] | 0.59 | -0.45 | A |
| | | $T_A$=70℃ | 0.48 | -0.36 | |
| $I_{DM}$ | Pulsed Drain Current | | 1.7 | -1.3 | A |
| $P_D$ | Power Dissipation | $T_A$=25℃ | 0.28 | | W |
| | | $T_A$=70℃ | 0.18 | | W/℃ |
| $T_J$ | Operating Junction Temperature | | -55/150 | | ℃ |
| $T_{STG}$ | Storage Temperature Range | | -55/150 | | ℃ |
| $R_{\theta JA}$ | Thermal Resistance-Junction to Case | | 450 | | ℃/W |

Note:

1. Device mounted on FR-4 substrate PC board.





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## Electrical Characteristics(N-Channel)

($T_C$=25ºC Unless otherwise noted)

| Symbol | Parameter | Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| **Static characteristics** | | | | | | | |
| $V_{(BR)DSS}$ | Drain-Source Breakdown Voltage | $V_{GS}$=0V, $I_D$=250uA | N-Ch | 20 | | | V |
| | | $V_{GS}$=0V, $I_D$=-250uA | P-Ch | -20 | | | |
| $V_{GS\ (th)}$ | Gate Threshold Voltage | $V_{DS}$=$V_{GS}$, $I_D$=250uA | N-Ch | 0.3 | | 1.0 | |
| | | $V_{DS}$=$V_{GS}$, $I_D$=-250uA | P-Ch | -0.3 | | -1.0 | |
| $I_{GSS}$ | Gate Leakage Current | $V_{DS}$=0V, $V_{GS}$=±10V | N-Ch | | | ±10 | uA |
| | | $V_{DS}$=0V, $V_{GS}$=±8V | P-Ch | | | ±10 | |
| $I_{DSS}$ | Zero Gate Voltage Drain Current | $V_{DS}$=16V, $V_{GS}$=0V | N-Ch | | | 1 | uA |
| | | $V_{DS}$=-16V, $V_{GS}$=0V | P-Ch | | | -1 | |
| $V_{SD}$ | Diode Forward Voltage | $V_{GS}$=0V, $I_S$=0.15A | N-Ch | | | 1.3 | V |
| | | $V_{GS}$=0V, $I_S$=-0.15A | P-Ch | | | -1.3 | |
| $R_{DS(on)}$ | Drain-Source On-Resistance | $V_{GS}$=4.5V, $I_D$=0.5A | N-Ch | | 230 | 450 | mΩ |
| | | $V_{GS}$=-4.5V, $I_D$=-0.5A | P-Ch | | 615 | 800 | |
| | | $V_{GS}$=2.5V, $I_D$=0.4A | N-Ch | | 300 | 600 | |
| | | $V_{GS}$=-2.5V, $I_D$=-0.2A | P-Ch | | 815 | 1050 | |
| | | $V_{GS}$=1.8V, $I_D$=0.2A | N-Ch | | 400 | 750 | |
| | | $V_{GS}$=-1.8V, $I_D$=-0.1A | P-Ch | | 1050 | 1500 | |
| $g_{FS}$ | Forward Transconductance | $V_{DS}$=10V, $I_D$=0.4A | N-Ch | | 0.9 | | S |
| | | $V_{DS}$=-10V, $I_D$=-0.4A | P-Ch | | 1.1 | | |
| **Dynamic characteristics** | | | | | | | |
| $Q_g$ | Total Gate Charge[1,2] | N-Channel $V_{DS}$=10V, $V_{GS}$=4.5V, $I_D$=0.25A P-Channel $V_{DS}$=-10V, $V_{GS}$=-4.5V, $I_D$=-0.25A | N-Ch | | 0.74 | | nC |
| | | | P-Ch | | 0.63 | | |
| $Q_{gs}$ | Gate-Source Charge[1,2] | | N-Ch | | 0.1 | | |
| | | | P-Ch | | 0.11 | | |
| $Q_{gd}$ | Gate-Drain Charge[1,2] | | N-Ch | | 0.12 | | |
| | | | P-Ch | | 0.13 | | |
| $C_{iss}$ | Input Capacitance | $V_{DS}$=10V, $V_{GS}$=0V, f=1.0MHz | N-Ch | | 60.7 | | pF |
| | | $V_{DS}$=-16V, $V_{GS}$=0V, f=1.0MHz | P-Ch | | 59.8 | | |
| $C_{oss}$ | Output Capacitance | $V_{DS}$=10V, $V_{GS}$=0V, f=1.0MHz | N-Ch | | 10 | | |
| | | $V_{DS}$=-16V, $V_{GS}$=0V, f=1.0MHz | P-Ch | | 12.1 | | |
| $C_{rss}$ | Reverse Transfer Capacitance | $V_{DS}$=10V, $V_{GS}$=0V, f=1.0MHz | N-Ch | | 5.37 | | |
| | | $V_{DS}$=-16V, $V_{GS}$=0V, f=1.0MHz | P-Ch | | 6.4 | | |
| $t_{d(on)}$ | Turn-On Time | N-Channel VDD=10V, RL=47Ω, ID=0.2A VGEN=4.5V, RG=10Ω P-Channel VDD=-10V, RL=47Ω, ID=-0.2A VGEN=-4.5V, RG=10Ω | N-Ch | | 5.1 | | ns |
| | | | P-Ch | | 5.1 | | |
| $t_r$ | | | N-Ch | | 7.4 | | |
| | | | P-Ch | | 8.1 | | |
| $t_{d(off)}$ | Turn-Off Time | | N-Ch | | 27 | | |
| | | | P-Ch | | 29 | | |
| $t_f$ | | | N-Ch | | 13 | | |
| | | | P-Ch | | 21 | | |





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## Typical Performance Characteristics(N-Channel)

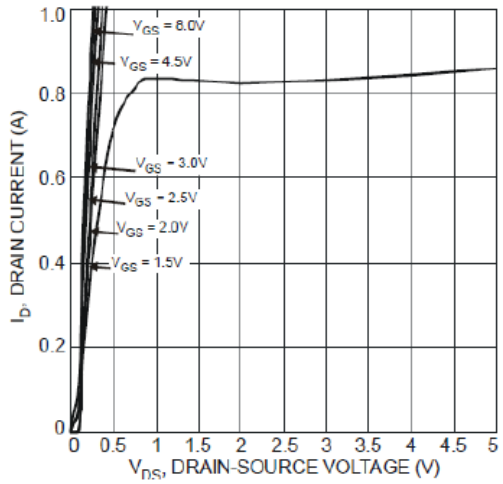


Fig. 1 Typical Output Characteristics

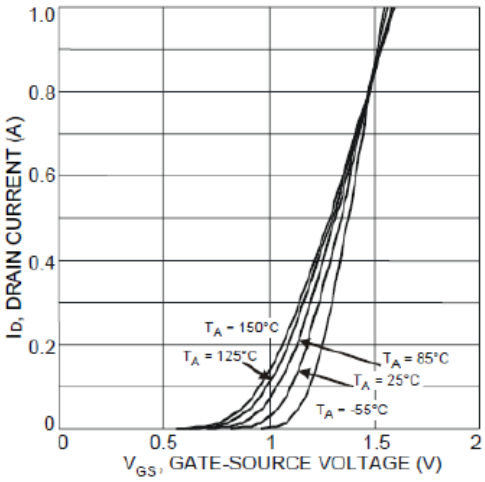


Fig. 2 Typical Transfer Characteristics

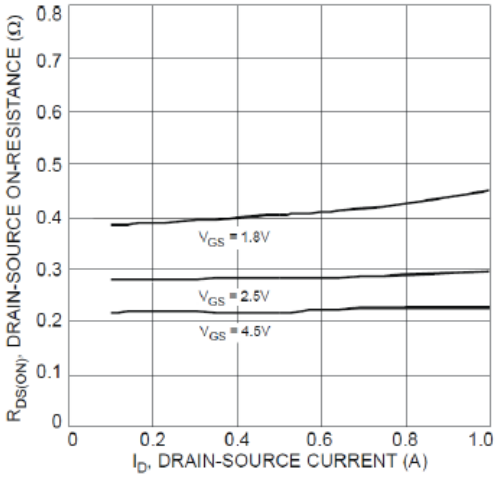


Fig. 3 Typical On-Resistance vs. $I_D$ and $V_{GS}$

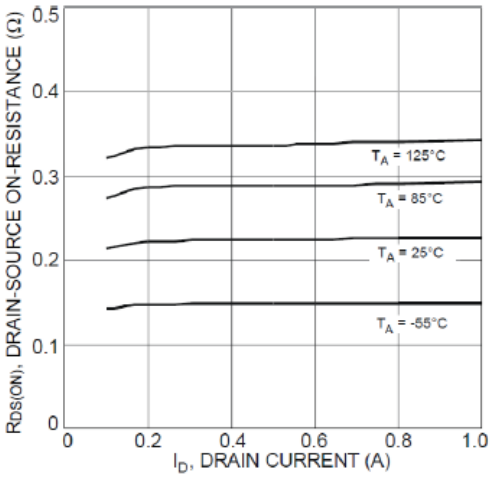


Fig. 4 Typical Drain-Source On-Resistance vs. $I_D$ and $T_J$





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## Typical Performance Characteristics (N-Channel Continue)

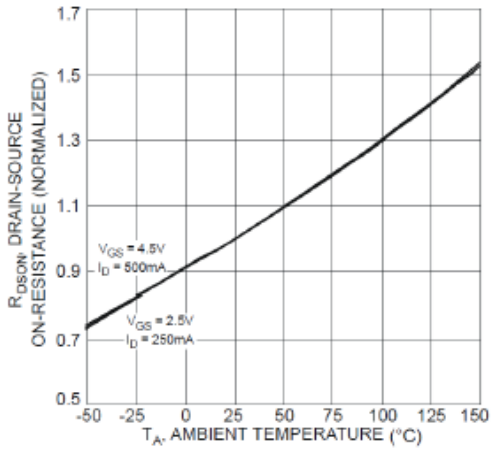


Fig. 5 On-Resistance Variation with $T_A$

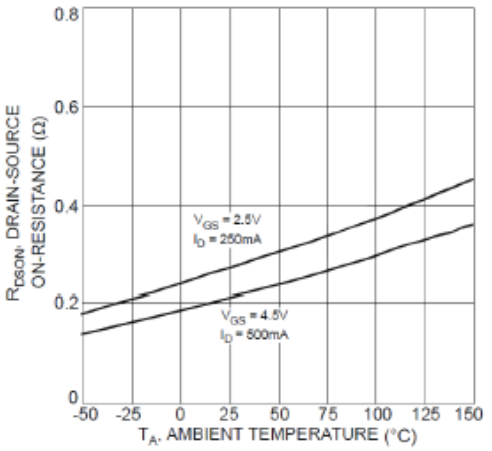


Fig. 6 On-Resistance Variation with $T_A$

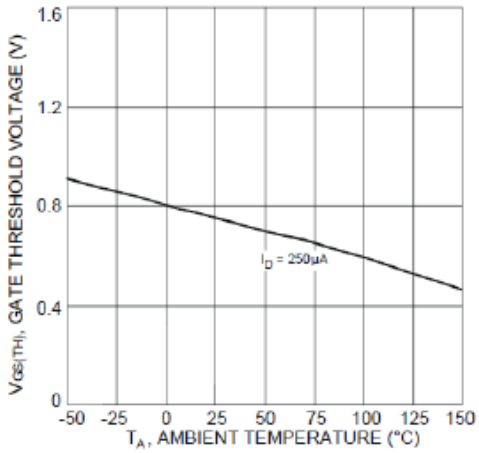


Fig. 7 Gate Threshold Variation vs. $T_A$

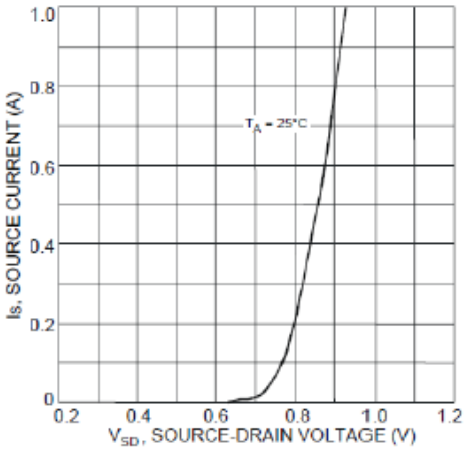


Fig. 8 Diode Forward Voltage vs. Current

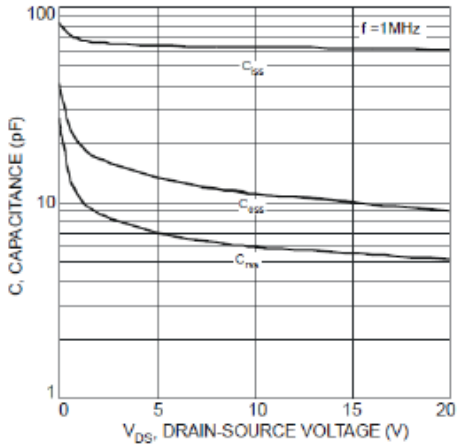


Fig. 9 Typical Capacitance



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## Typical Performance Characteristics (N-Channel Continue)

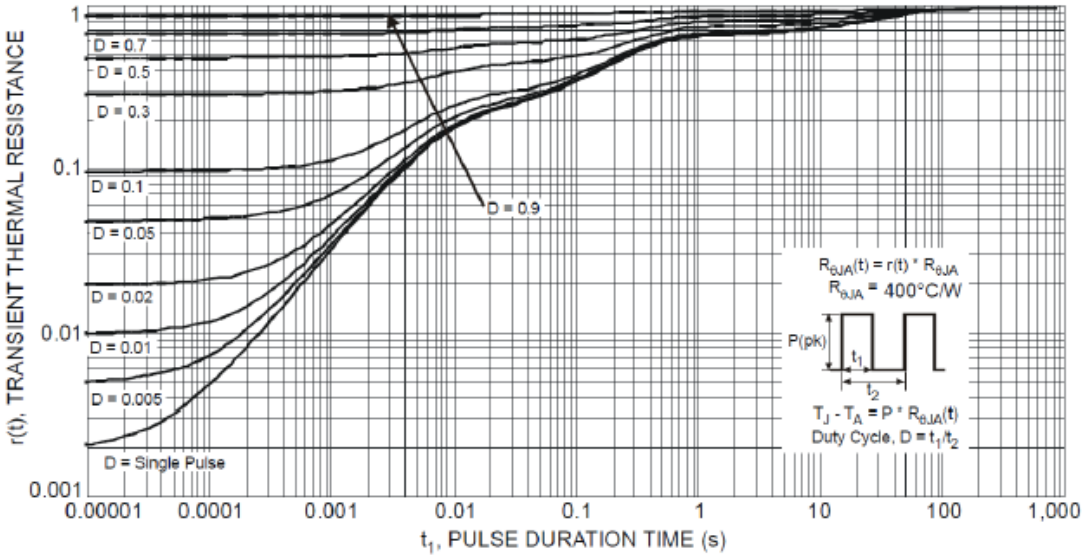


Fig. 10 Transient Thermal Response



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## Typical Performance Characteristics(P-Channel)

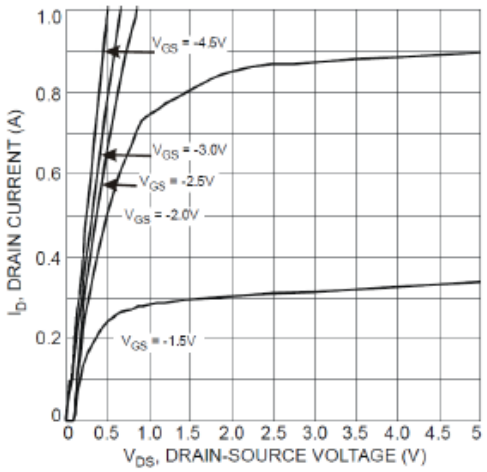


Fig. 1 Typical Output Characteristics

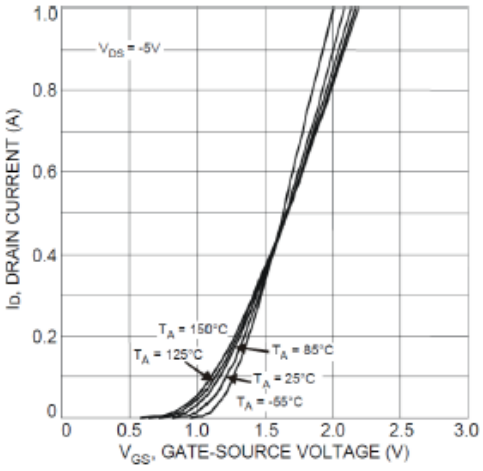


Fig. 2 Typical Transfer Characteristics

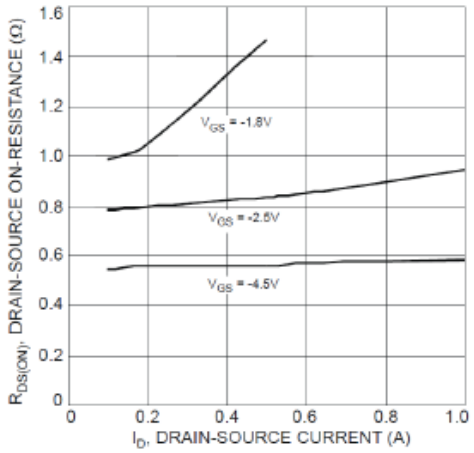


Fig. 3 Typical On-Resistance vs. $I_D$ and $V_{GS}$

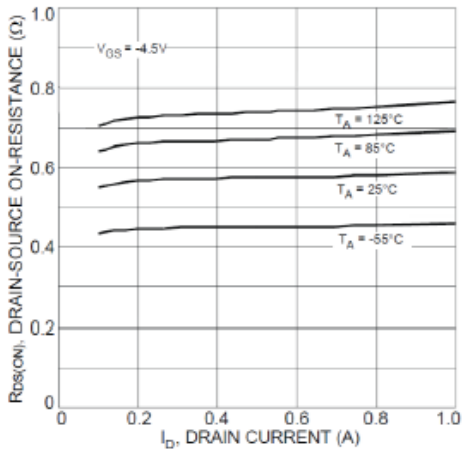


Fig. 4 Typical Drain-Source On-Resistance vs. $I_D$ and $T_A$

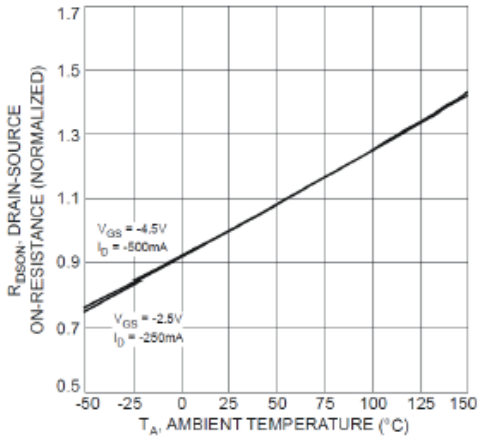


Fig. 5 On-Resistance Variation with $T_J$

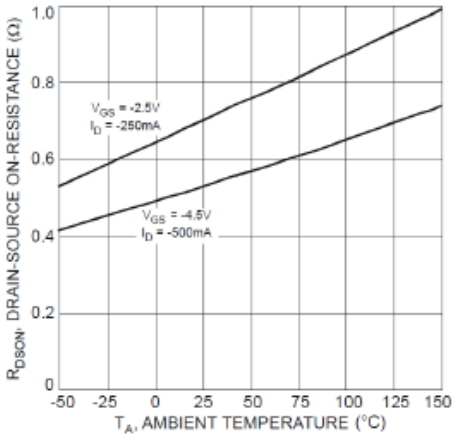


Fig. 6 On-Resistance Variation with $T_J$





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## Typical Performance Characteristics (P-Channel Continue)

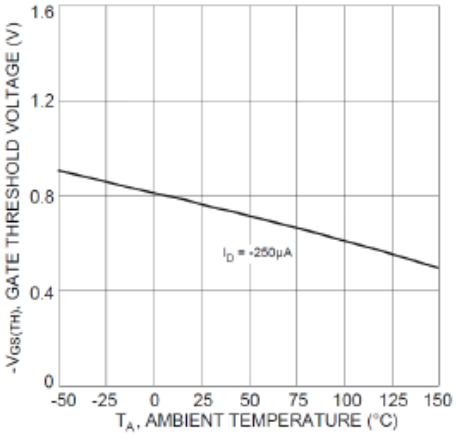


Fig. 7 Gate Threshold Variation vs. $T_A$

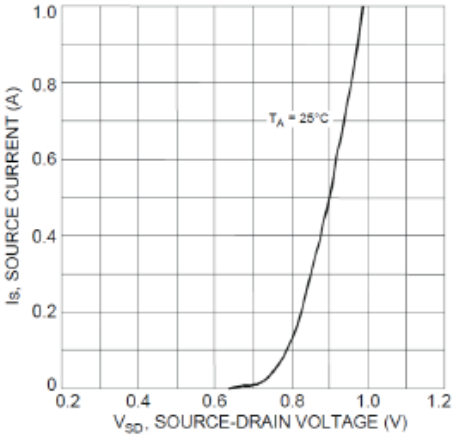


Fig. 8 Diode Forward Voltage vs. Current

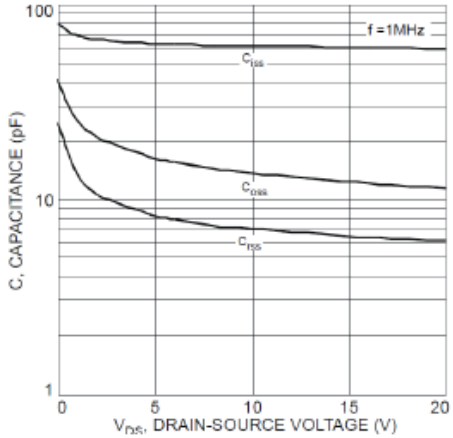


Fig. 9 Typical Capacitance

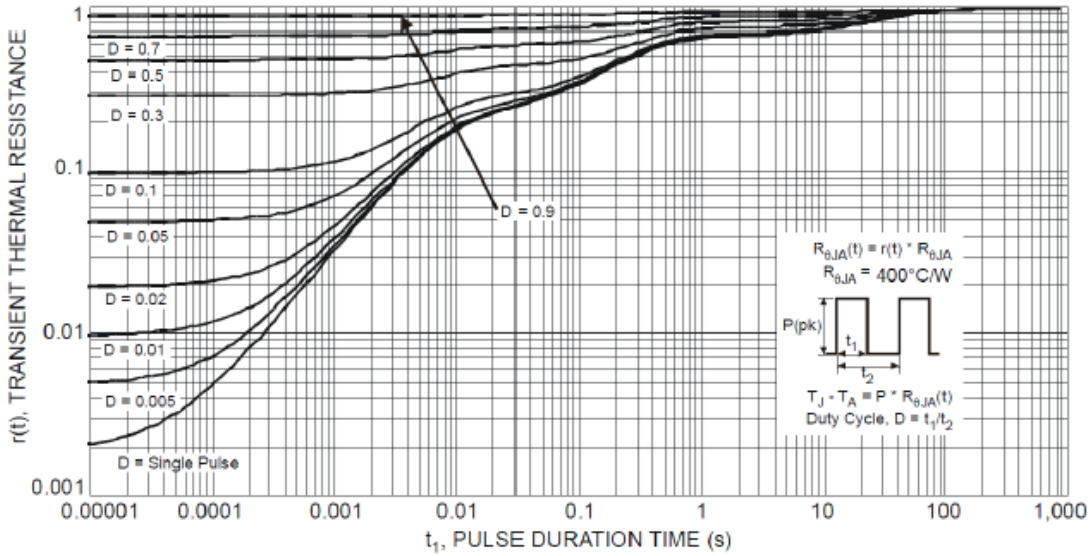


Fig. 10 Transient Thermal Response





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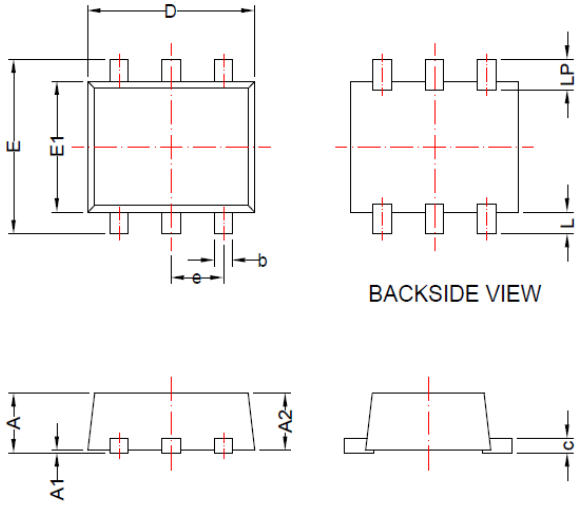
## Package Dimension:

### SOT-563




DIMENSION D AND E1 DO NOT INCLUDE MOLD FLASH,TIE BAR BURRS，GATE BURRS，AND INTERLEAD FLASH,NOT INCLUDING ANY MISMATCH BETWEEN THE TOP AND BOTTOM OF THE PLASTIC BODY

| Dimensions | | | | |
|---|---|---|---|---|
| Symbol | Millimeters | | Inches | |
| | Min | Max | Min | Max |
| **A** | 0.45 | 0.65 | 0.018 | 0.026 |
| **A1** | 0.00 | 0.10 | 0.000 | 0.004 |
| **A2** | 0.45 | 0.60 | 0.018 | 0.024 |
| **b** | 0.15 | 0.30 | 0.006 | 0.012 |
| **c** | 0.07 | 0.20 | 0.003 | 0.008 |
| **D** | 1.50 | 1.70 | 0.059 | 0.067 |
| **E** | 1.50 | 1.70 | 0.059 | 0.067 |
| **E1** | 1.10 | 1.30 | 0.043 | 0.051 |
| **e** | 0.50 BSC | | 0.020 BSC | |
| **L** | 0.10 | 0.30 | 0.004 | 0.012 |
| **LP** | 0.16 | 0.4 | 0.006 | 0.016 |



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