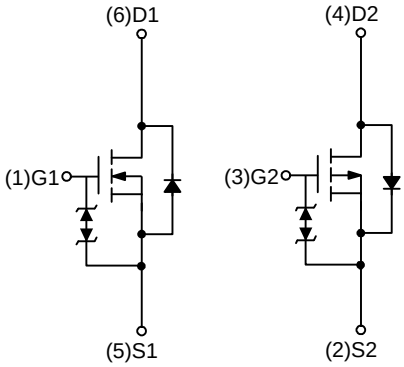
Dual Enhancement Mode MOSFET (N- and P-Channel)

## Features

- N-Channel
  20V/3A,
  $R_{DS(ON)}$=50mΩ(typ.) @ $V_{GS}$=4.5V
  $R_{DS(ON)}$=65mΩ(typ.) @ $V_{GS}$=2.5V
- P-Channel
  -20V/-2A,
  $R_{DS(ON)}$=90mΩ(typ.) @ $V_{GS}$=-4.5V
  $R_{DS(ON)}$=130mΩ(typ.) @ $V_{GS}$=-2.5V
- Reliable and Rugged
- Lead Free and Green Devices Available (RoHS Compliant)

## Pin Description


Top View of SOT-23-6




N-Channel MOSFET P-Channel MOSFET

## Applications

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

## Ordering and Marking Information

| | |
|---|---|
| APM2701A □□-□□ □<br>Assembly Material<br>Handling Code<br>Temperature Range<br>Package Code | Package Code<br>C : SOT-23-6<br>Operating Junction Temperature Range<br>C : -55 to 150 °C<br>Handling Code<br>TR : Tape & Reel<br>Assembly Material<br>G : Halogen and Lead Free Device |
| APM2701A C : A71X | X - Date Code |

Note: ANPEC lead-free products contain molding compounds/die attach materials and 100% matte tin plate termination finish; which are fully compliant with RoHS. 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 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°C unless otherwise noted)

| Symbol | Parameter | | Rating | | Unit |
|---|---|---|---|---|---|
| | | | N-Channel | P-Channel | |
| $V_{DSS}$ | Drain-Source Voltage | | 20 | -20 | V |
| $V_{GSS}$ | Gate-Source Voltage | | ±12 | ±12 | |
| $I_D$* | Continuous Drain Current | $V_{GS}$=±4.5V | 3 | -2 | A |
| $I_{DM}$* | 300µs Pulsed Drain Current | | 12 | -8 | |
| $I_S$* | Diode Continuous Forward Current | | 1 | -1 | A |
| $T_J$ | Maximum Junction Temperature | | 150 | | °C |
| $T_{STG}$ | Storage Temperature Range | | -55 to 150 | | |
| $P_D$* | Power Dissipation | $T_A$=25°C | 0.83 | | W |
| | | $T_A$=100°C | 0.3 | | |
| $R_{\theta JA}$* | Thermal Resistance-Junction to Ambient | | 150 | | °C/W |

Note : *Surface Mounted on 1in² pad area, t ≤ 10sec.

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

| Symbol | Parameter | Test Conditions | | APM2701AC | | | Unit |
|---|---|---|---|---|---|---|---|
| | | | | Min. | Typ. | Max. | |
| **Static Characteristics** | | | | | | | |
| $BV_{DSS}$ | Drain-Source Breakdown Voltage | $V_{GS}$=0V, $I_{DS}$=250µA | N-Ch | 20 | - | - | V |
| | | $V_{GS}$=0V, $I_{DS}$=-250µA | P-Ch | -20 | - | - | |
| $I_{DSS}$ | Zero Gate Voltage Drain Current | $V_{DS}$=16V, $V_{GS}$=0V | N-Ch | - | - | 1 | µA |
| | | $T_J$=85°C | | - | - | 30 | |
| | | $V_{DS}$=-16V, $V_{GS}$=0V | P-Ch | - | - | -1 | |
| | | $T_J$=85°C | | - | - | -30 | |
| $V_{GS(th)}$ | Gate Threshold Voltage | $V_{DS}$=$V_{GS}$, $I_{DS}$=250µA | N-Ch | 0.5 | 0.7 | 1 | V |
| | | $V_{DS}$=$V_{GS}$, $I_{DS}$=-250µA | P-Ch | -0.5 | -0.7 | -1 | |
| $I_{GSS}$ | Gate Leakage Current | $V_{GS}$=±10V, $V_{DS}$=0V | N-Ch | - | - | ±10 | µA |
| | | | P-Ch | - | - | ±10 | |
| $R_{DS(ON)}$ [a] | Drain-Source On-State Resistance | $V_{GS}$=4.5V, $I_{DS}$=3A | N-Ch | - | 50 | 65 | mΩ |
| | | $V_{GS}$=-4.5V, $I_{DS}$=-2A | P-Ch | - | 90 | 120 | |
| | | $V_{GS}$=2.5V, $I_{DS}$=1.7A | N-Ch | - | 65 | 90 | |
| | | $V_{GS}$=-2.5V, $I_{DS}$=-1A | P-Ch | - | 130 | 180 | |

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

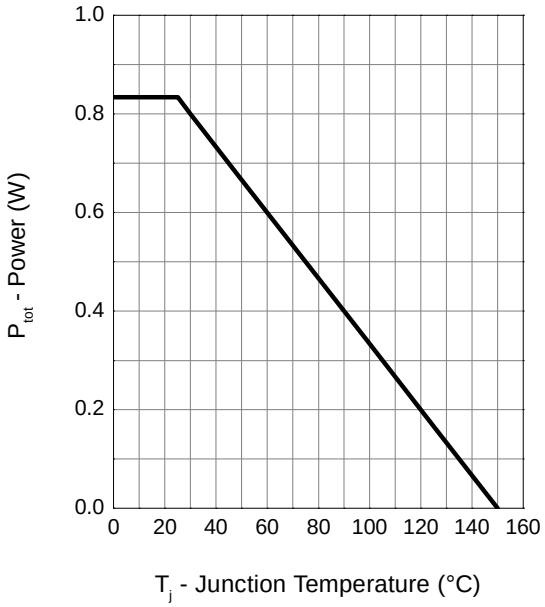
| Symbol | Parameter | Test Conditions | | APM2701AC | | | Unit |
|---|---|---|---|---|---|---|---|
| | | | | Min. | Typ. | Max. | |
| **Diode Characteristics** | | | | | | | |
| $V_{SD}$ [a] | Diode Forward Voltage | $I_{SD}$=0.5A, $V_{GS}$=0V | N-Ch | - | 0.7 | 1.3 | V |
| | | $I_{SD}$=-0.5A, $V_{GS}$=0V | P-Ch | - | -0.7 | -1.3 | |
| $t_{rr}$ | Reverse Recovery Time | N-Channel $I_{SD}$=3A, $dI_{SD}/dt$=100A/µs | N-Ch | - | 11 | - | ns |
| | | | P-Ch | - | 12 | - | |
| $Q_{rr}$ | Reverse Recovery Charge | P-Channel $I_{SD}$=-2A, $dI_{SD}/dt$=100A/µs | N-Ch | - | 4 | - | nC |
| | | | P-Ch | - | 4 | - | |
| **Dynamic Characteristics** [b] | | | | | | | |
| $C_{iss}$ | Input Capacitance | N-Channel $V_{GS}$=0V, $V_{DS}$=10V, Frequency=1.0MHz | N-Ch | - | 300 | - | pF |
| | | | P-Ch | - | 375 | - | |
| $C_{oss}$ | Output Capacitance | | N-Ch | - | 70 | - | |
| | | P-Channel $V_{GS}$=0V, $V_{DS}$=-10V, Frequency=1.0MHz | P-Ch | - | 70 | - | |
| $C_{rss}$ | Reverse Transfer Capacitance | | N-Ch | - | 50 | - | |
| | | | P-Ch | - | 50 | - | |
| $t_{d(ON)}$ | Turn-on Delay Time | N-Channel $V_{DD}$=10V, $R_L$=10Ω, $I_{DS}$=1A, $V_{GEN}$=4.5V, $R_G$=6Ω | N-Ch | - | 4 | 8 | ns |
| | | | P-Ch | - | 6 | 12 | |
| $T_r$ | Turn-on Rise Time | | N-Ch | - | 14 | 26 | |
| | | | P-Ch | - | 14 | 26 | |
| $t_{d(OFF)}$ | Turn-off Delay Time | P-Channel $V_{DD}$=-10V, $R_L$=10Ω, $I_{DS}$=-1A, $V_{GEN}$=-4.5V, $R_G$=6Ω | N-Ch | - | 21 | 39 | |
| | | | P-Ch | - | 27 | 50 | |
| $T_f$ | Turn-off Fall Time | | N-Ch | - | 5 | 10 | |
| | | | P-Ch | - | 5 | 10 | |
| **Gate Charge Characteristics** [b] | | | | | | | |
| $Q_g$ | Total Gate Charge | N-Channel $V_{DS}$=10V, $V_{GS}$=4.5V, $I_{DS}$=3A | N-Ch | - | 4.1 | 6 | nC |
| | | | P-Ch | - | 4.2 | 6 | |
| $Q_{gs}$ | Gate-Source Charge | | N-Ch | - | 0.4 | - | |
| | | P-Channel $V_{DS}$=-10V, $V_{GS}$=-4.5V, $I_{DS}$=-2A | P-Ch | - | 0.6 | - | |
| $Q_{gd}$ | Gate-Drain Charge | | N-Ch | - | 1.7 | - | |
| | | | P-Ch | - | 1.3 | - | |

Note a : Pulse test ; pulse width ≤300µs, duty cycle ≤ 2%.
Note b : Guaranteed by design, not subject to production testing.

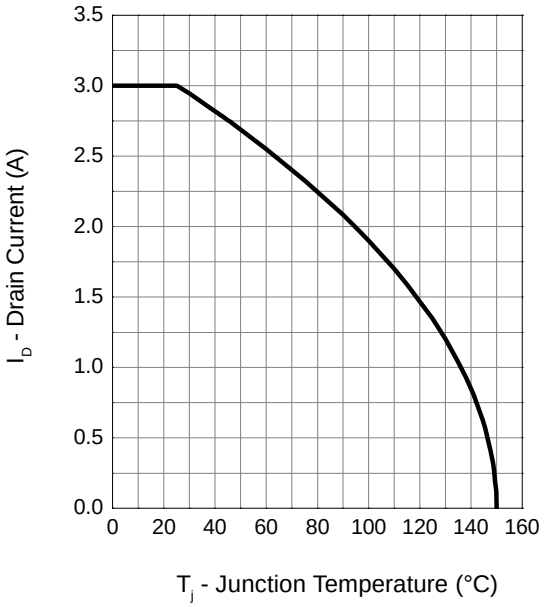
## Typical Operating Characteristics

**N-Channel**

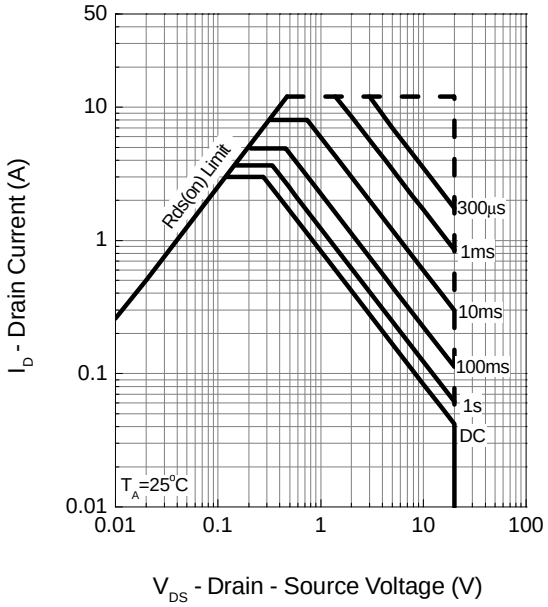
**Power Dissipation**



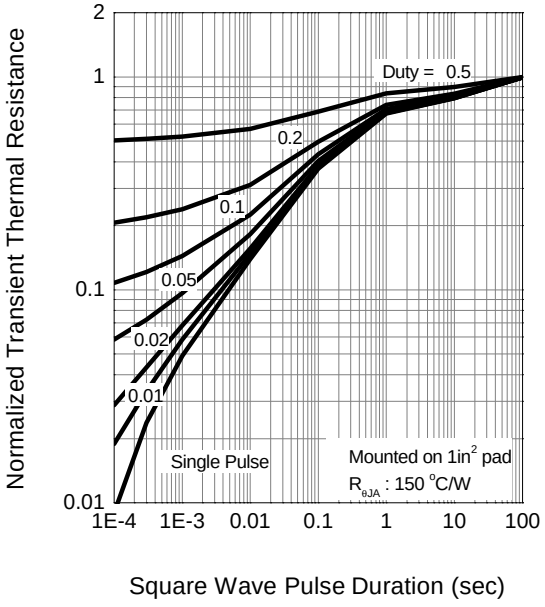

**Drain Current**




**Safe Operation Area**



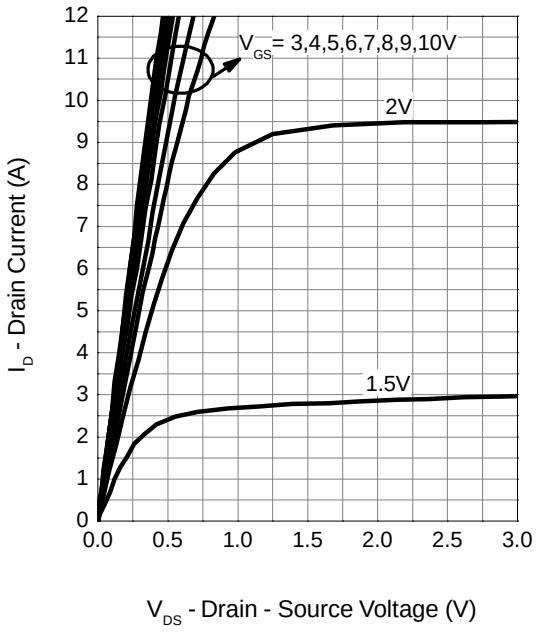

**Thermal Transient Impedance**



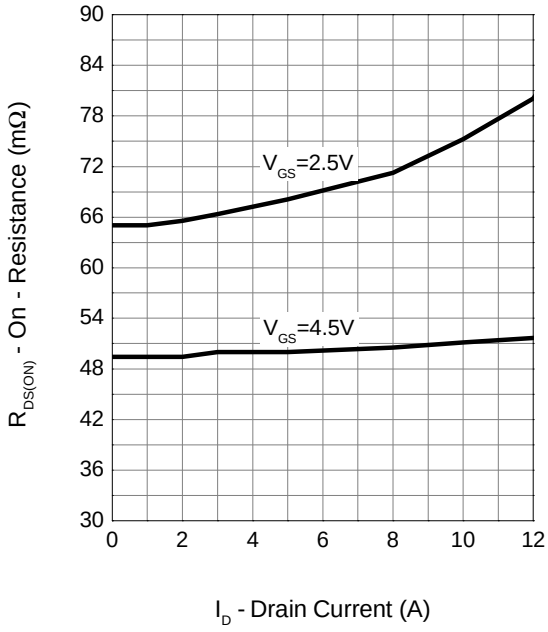
## Typical Operating Characteristics (Cont.)

**N-Channel**

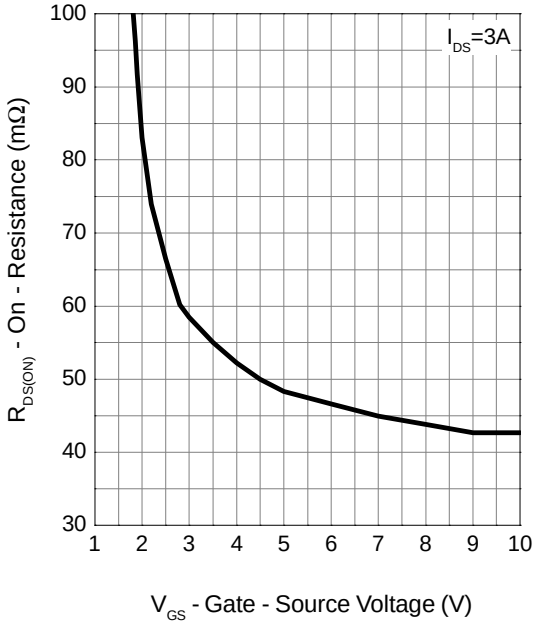
**Output Characteristics**



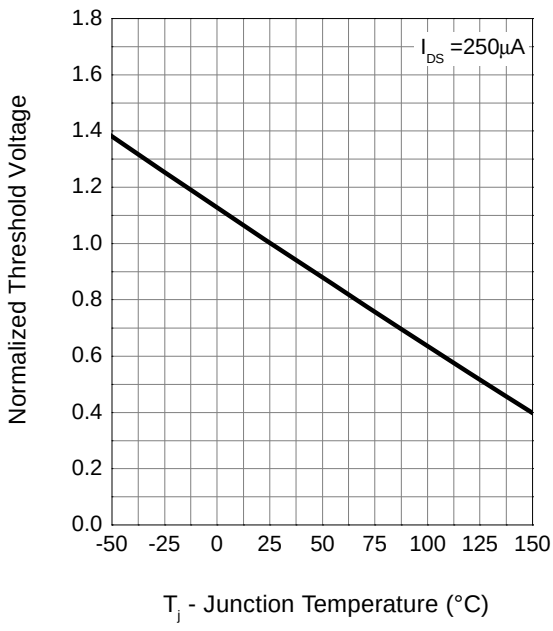

**Drain-Source On Resistance**




**Transfer Characteristics**



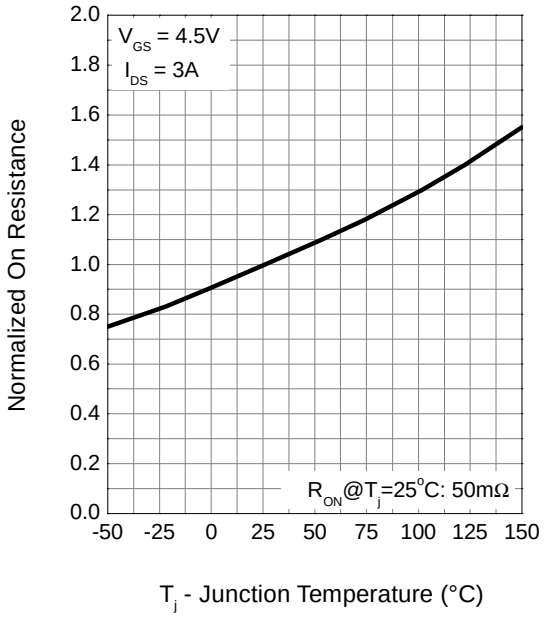

**Gate Threshold Voltage**



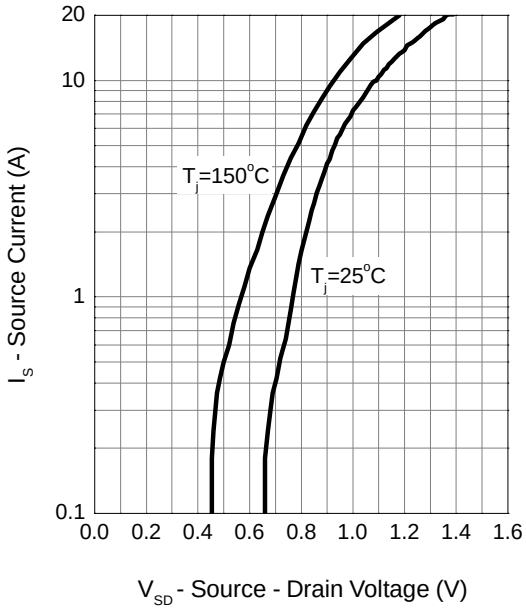
## Typical Operating Characteristics (Cont.)

**N-Channel**

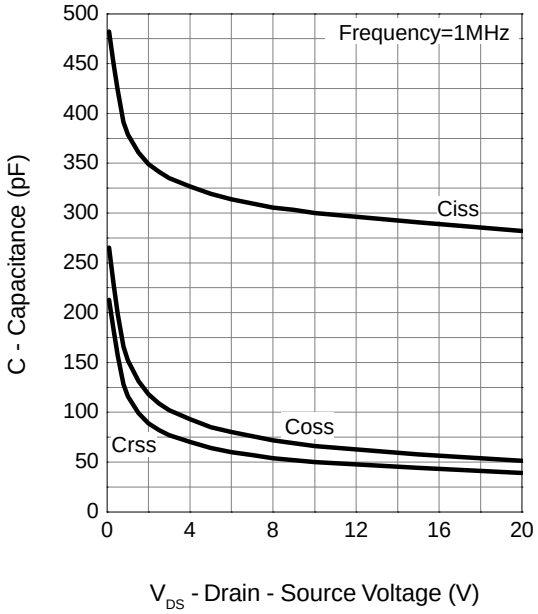
**Drain-Source On Resistance**



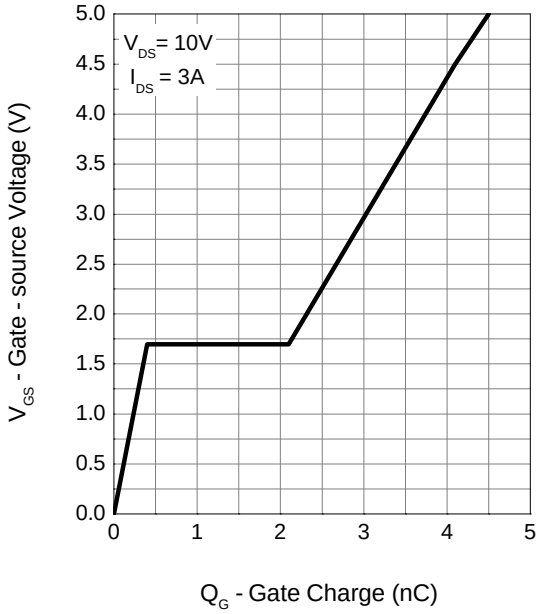

**Source-Drain Diode Forward**




**Capacitance**



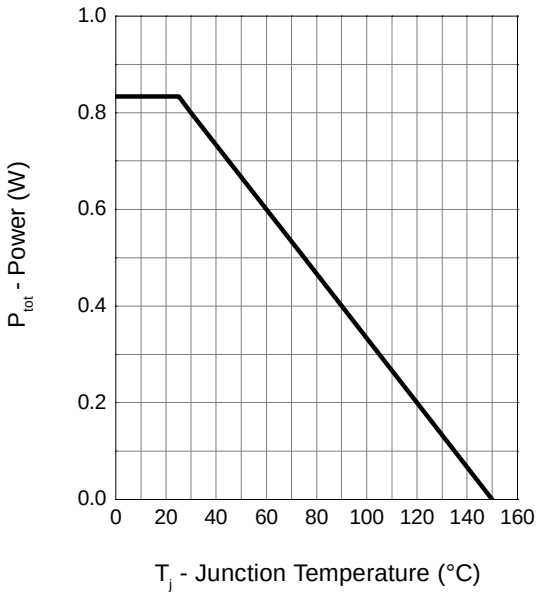

**Gate Charge**



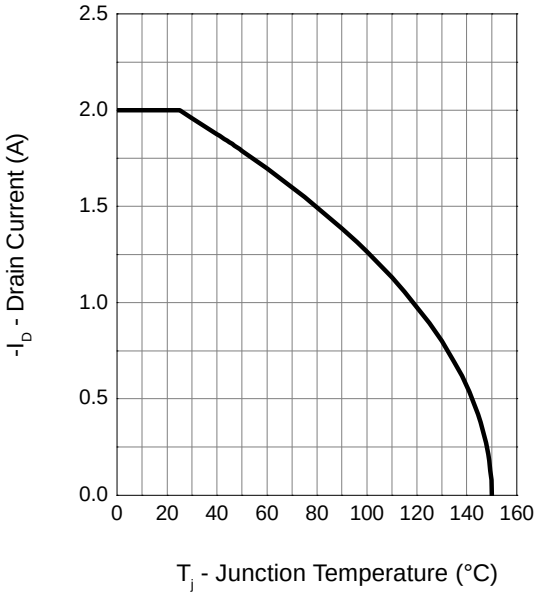
## Typical Operating Characteristics (Cont.)

**P-Channel**

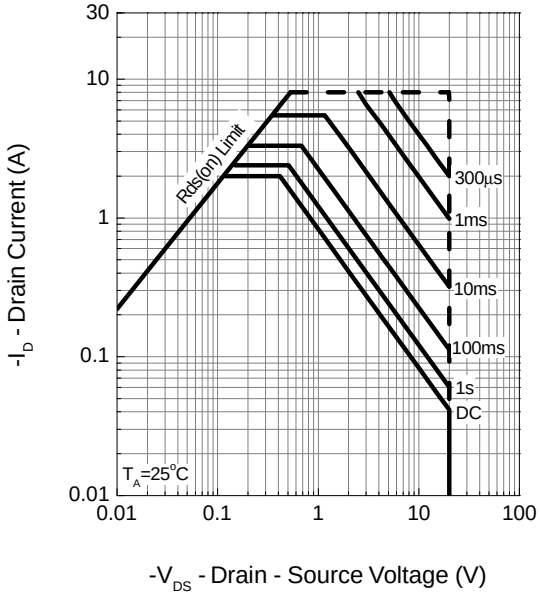
**Power Dissipation**



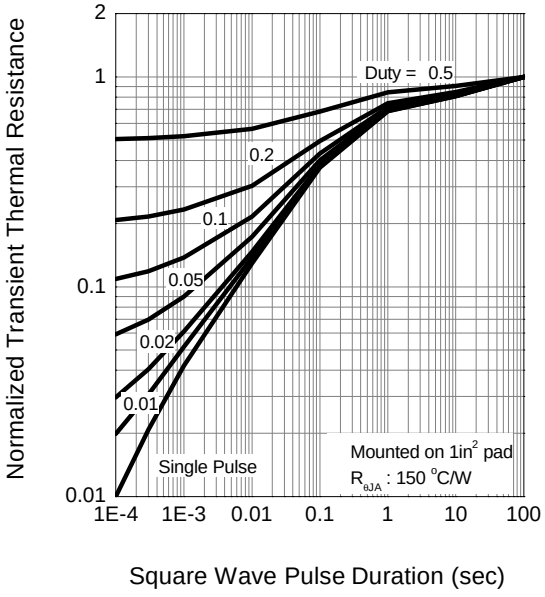

**Drain Current**




**Safe Operation Area**



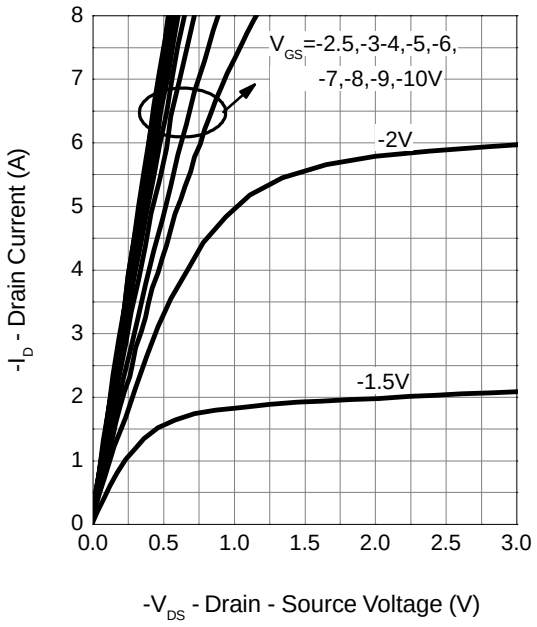

**Thermal Transient Impedance**



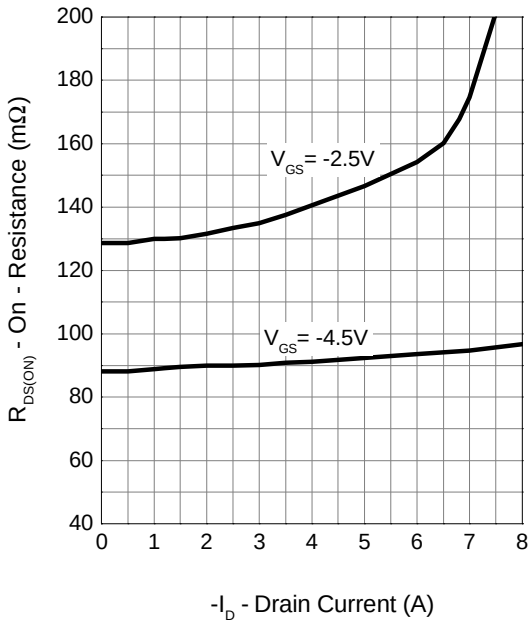
## Typical Operating Characteristics (Cont.)

**P-Channel**

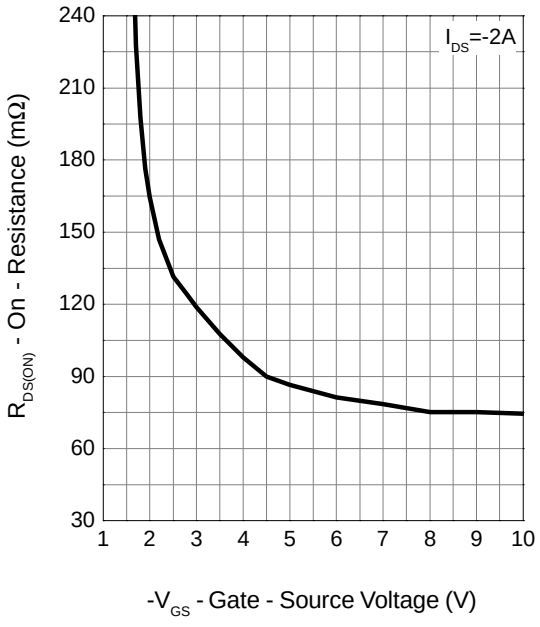
**Output Characteristics**



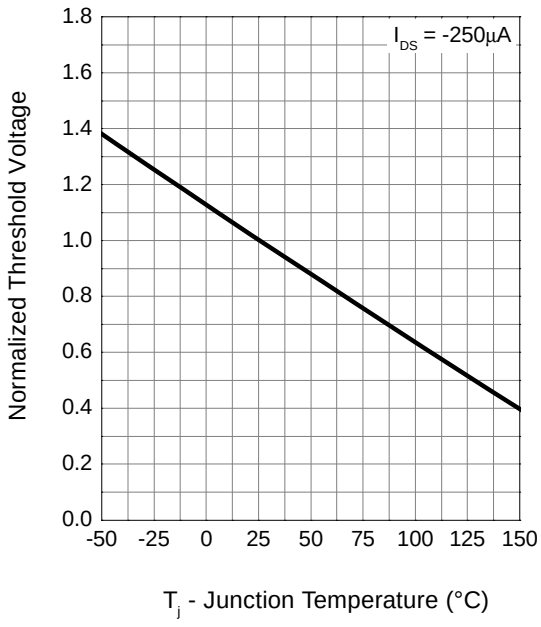

**Drain-Source On Resistance**




**Transfer Characteristics**



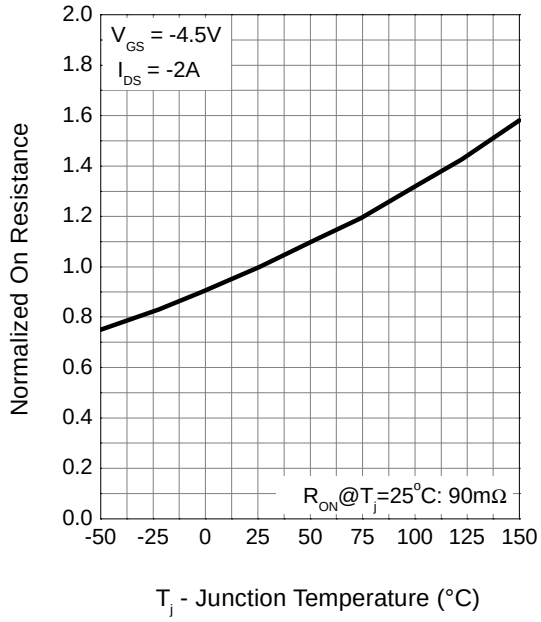

**Gate Threshold Voltage**



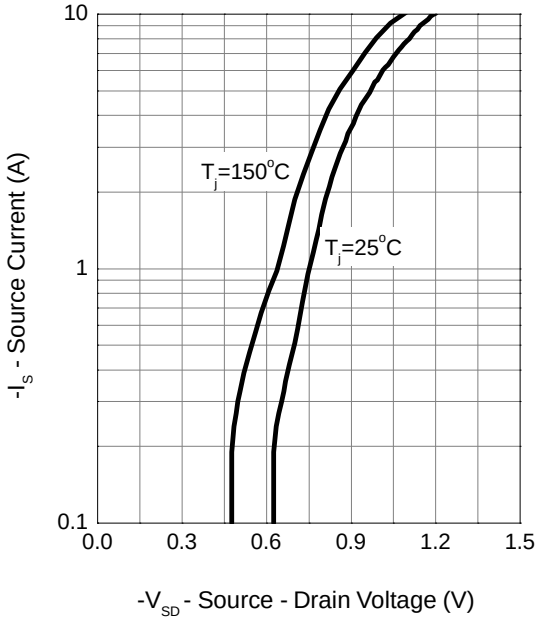
## Typical Operating Characteristics (Cont.)

**P-Channel**

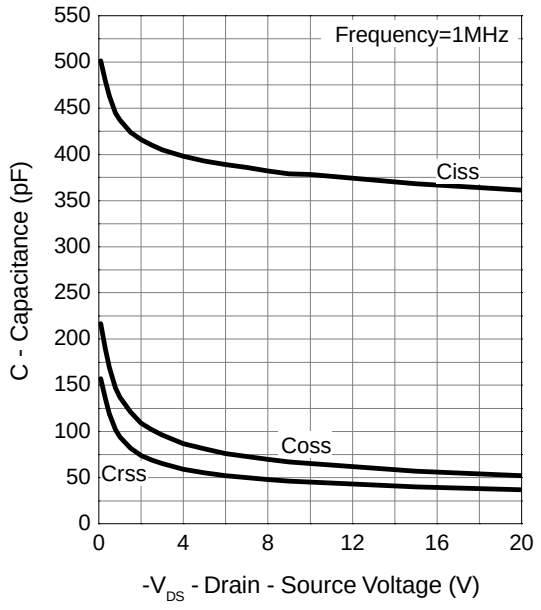
**Drain-Source On Resistance**



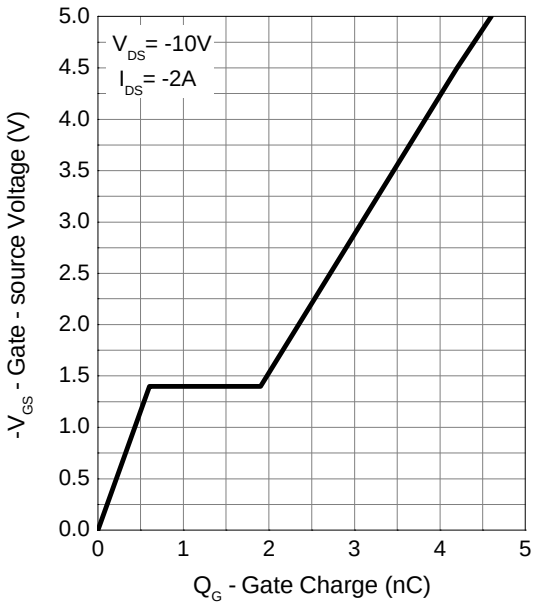

**Source-Drain Diode Forward**




**Capacitance**

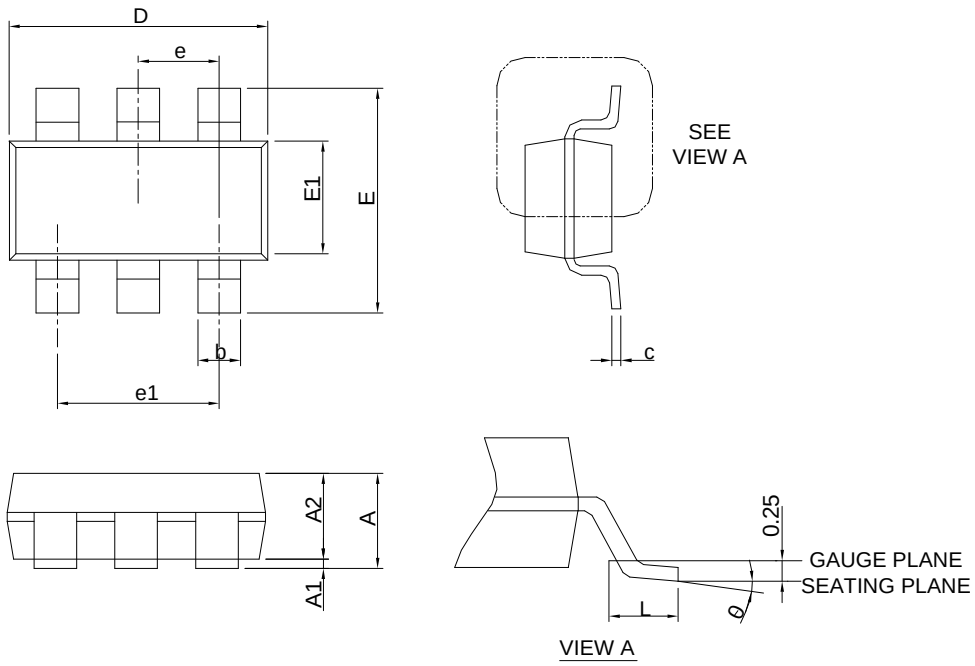



**Gate Charge**



## Package Information

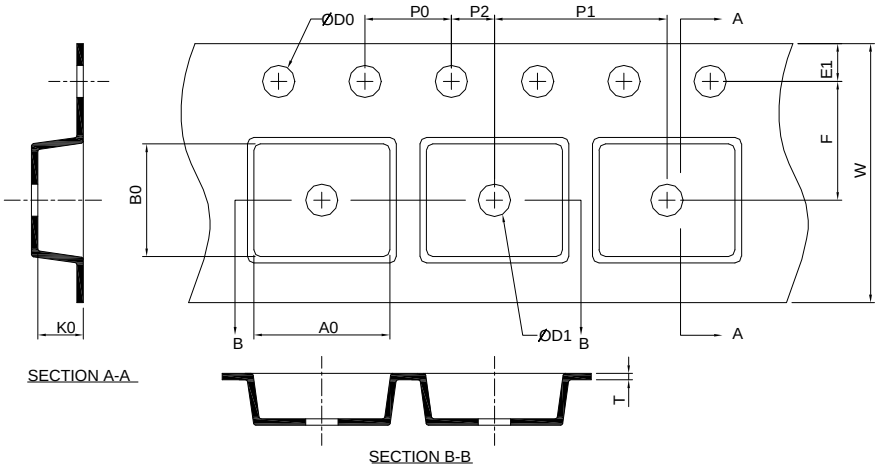
**SOT-23-6**

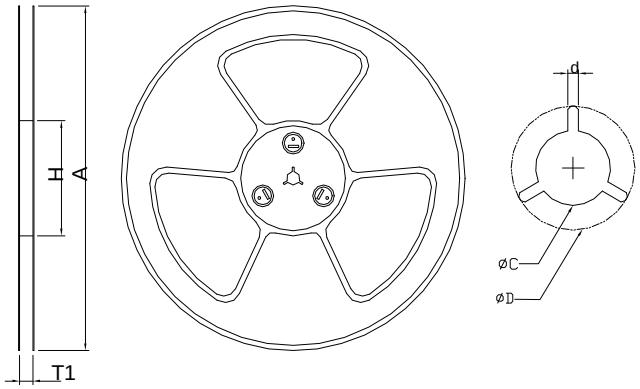



| SYMBOL | SOT-23-6 | | | |
|---|---|---|---|---|
| | MILLIMETERS | | INCHES | |
| | MIN. | MAX. | MIN. | MAX. |
| A | | 1.45 | | 0.057 |
| A1 | 0.00 | 0.15 | 0.000 | 0.006 |
| A2 | 0.90 | 1.30 | 0.035 | 0.051 |
| b | 0.30 | 0.50 | 0.012 | 0.020 |
| c | 0.08 | 0.22 | 0.003 | 0.009 |
| D | 2.70 | 3.10 | 0.106 | 0.122 |
| E | 2.60 | 3.00 | 0.102 | 0.118 |
| E1 | 1.40 | 1.80 | 0.055 | 0.071 |
| e | 0.95 BSC | | 0.037 BSC | |
| e1 | 1.90 BSC | | 0.075 BSC | |
| L | 0.30 | 0.60 | 0.012 | 0.024 |
| θ | 0° | 8° | 0° | 8° |

Note : 1. Follow JEDEC TO-178 AB.
2. Dimension D and E1 do not include mold flash, protrusions or gate burrs. Mold flash, protrusion or gate burrs shall not exceed 10 mil per side.

## Carrier Tape & Reel Dimensions




| Application | A | H | T1 | C | d | D | W | E1 | F |
|---|---|---|---|---|---|---|---|---|---|
| SOT-23-6 | 178.0±2.00 | 50 MIN. | 8.4+2.00 -0.00 | 13.0+0.50 -0.20 | 1.5 MIN. | 20.2 MIN. | 8.0±0.30 | 1.75±0.10 | 3.5±0.05 |
| | **P0** | **P1** | **P2** | **D0** | **D1** | **T** | **A0** | **B0** | **K0** |
| | 4.0±0.10 | 4.0±0.10 | 2.0±0.05 | 1.5+0.10 -0.00 | 1.0 MIN. | 0.6+0.00 -0.40 | 3.20±0.20 | 3.10±0.20 | 1.50±0.20 |

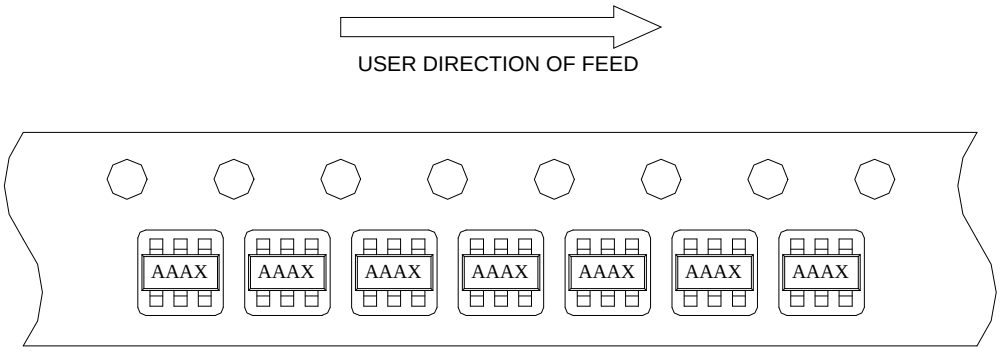
(mm)

## Devices Per Unit

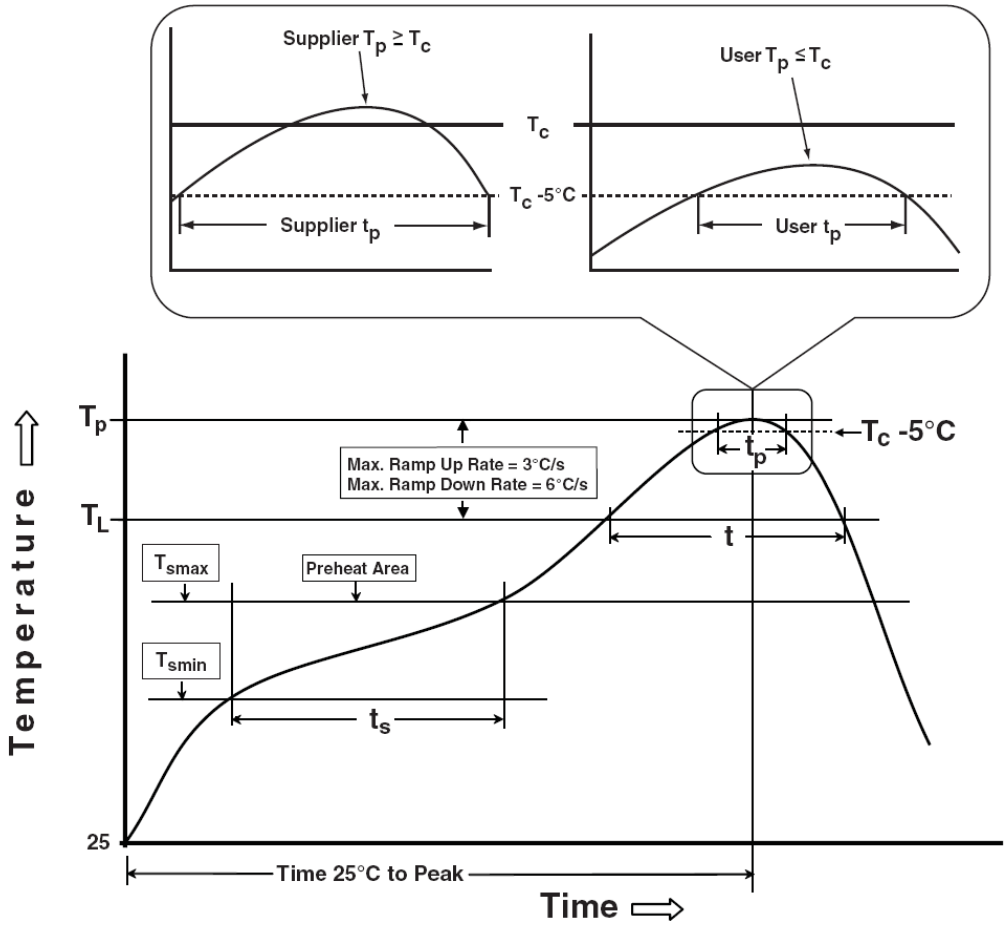
| Package Type | Unit | Quantity |
|---|---|---|
| **SOT-23-6** | Tape & Reel | 3000 |

## Taping Direction Information

**SOT-23-6**




## Classification Profile



## 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 |
| HOLT | JESD-22, A108 | 1000 Hrs, Bias @ 125°C |
| 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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