

AFP2309S23RG-VB Datasheet P-Channel 60-V (D-S) MOSFET

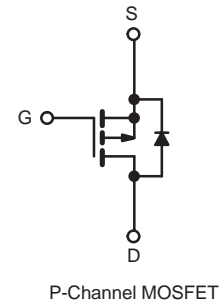
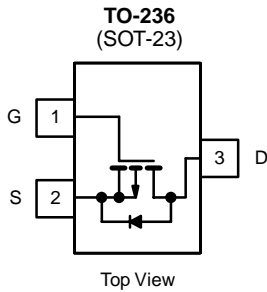
| PRODUCT SUMMARY | | |
|---------------------------|------------------|------|
| V_{DS} (V) | - 60 | |
| $R_{DS(on)}$ (Ω) | $V_{GS} = -10$ V | 0.05 |
| Q_g (Max.) (nC) | 12 | |
| Q_{gs} (nC) | 3.8 | |
| Q_{gd} (nC) | 5.1 | |
| Configuration | Single | |

FEATURES

- Isolated Package
- High Voltage Isolation = 2.5 kV_{RMS} (t = 60 s; f = 60 Hz)
- Sink to Lead Creepage Distance = 4.8 mm
- P-Channel
- 175 °C Operating Temperature
- Dynamic dV/dt Rating
- Low Thermal Resistance
- Lead (Pb)-free Available



Available
RoHS*
COMPLIANT


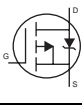


| ABSOLUTE MAXIMUM RATINGS $T_C = 25$ °C, unless otherwise noted | | | | |
|--|--------------------|----------------|------------------|----------|
| PARAMETER | SYMBOL | LIMIT | UNIT | |
| Drain-Source Voltage | V_{DS} | - 60 | V | |
| Gate-Source Voltage | V_{GS} | ± 20 | | |
| Continuous Drain Current | V_{GS} at - 10 V | $T_C = 25$ °C | - 5.2 | A |
| | | $T_C = 100$ °C | - 3.8 | |
| Pulsed Drain Current ^a | I_{DM} | - 21 | | |
| Linear Derating Factor | | 0.18 | W/°C | |
| Single Pulse Avalanche Energy ^b | E_{AS} | 120 | mJ | |
| Repetitive Avalanche Current ^a | I_{AR} | - 5.2 | A | |
| Repetitive Avalanche Energy ^a | E_{AR} | 2.7 | mJ | |
| Maximum Power Dissipation | $T_C = 25$ °C | P_D | 27 | W |
| Peak Diode Recovery dV/dt ^c | | dV/dt | - 4.5 | V/ns |
| Operating Junction and Storage Temperature Range | | T_J, T_{stg} | - 55 to + 175 | °C |
| Soldering Recommendations (Peak Temperature) | for 10 s | | 300 ^d | |
| Mounting Torque | 6-32 or M3 screw | | 10 | lbf · in |
| | | | 1.1 | N · m |

Notes

- Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11).
- $V_{DD} = -25$ V, starting $T_J = 25$ °C, L = 5.0 mH, $R_G = 25$ Ω , $I_{AS} = -5.3$ A (see fig. 12).
- $I_{SD} \leq -6.7$ A, $dI/dt \leq 90$ A/ μ s, $V_{DD} \leq V_{DS}$, $T_J \leq 175$ °C.
- 1.6 mm from case.

| THERMAL RESISTANCE RATINGS | | | | |
|----------------------------------|------------|------|------|------|
| PARAMETER | SYMBOL | TYP. | MAX. | UNIT |
| Maximum Junction-to-Ambient | R_{thJA} | - | 65 | °C/W |
| Maximum Junction-to-Case (Drain) | R_{thJC} | - | 5.5 | |

| SPECIFICATIONS $T_J = 25\text{ }^\circ\text{C}$, unless otherwise noted | | | | | | |
|--|---------------------|--|----------------------|--------|-----------|---------------|
| PARAMETER | SYMBOL | TEST CONDITIONS | MIN. | TYP. | MAX. | UNIT |
| Static | | | | | | |
| Drain-Source Breakdown Voltage | V_{DS} | $V_{GS} = 0\text{ V}, I_D = -250\text{ }\mu\text{A}$ | -60 | - | - | V |
| V_{DS} Temperature Coefficient | $\Delta V_{DS}/T_J$ | Reference to $25\text{ }^\circ\text{C}$, $I_D = -1\text{ mA}$ | - | -0.060 | - | V/°C |
| Gate-Source Threshold Voltage | $V_{GS(th)}$ | $V_{DS} = V_{GS}, I_D = -250\text{ }\mu\text{A}$ | -1.0 | - | -2.5 | V |
| Gate-Source Leakage | I_{GSS} | $V_{GS} = \pm 20\text{ V}$ | - | - | ± 100 | nA |
| Zero Gate Voltage Drain Current | I_{DSS} | $V_{DS} = -60\text{ V}, V_{GS} = 0\text{ V}$ | - | - | -100 | μA |
| | | $V_{DS} = -48\text{ V}, V_{GS} = 0\text{ V}, T_J = 150\text{ }^\circ\text{C}$ | - | - | -500 | |
| Drain-Source On-State Resistance | $R_{DS(on)}$ | $V_{GS} = -10\text{ V}, I_D = -3.2\text{ A}^b$ | - | 0.05 | - | Ω |
| Forward Transconductance | g_{fs} | $V_{DS} = -25\text{ V}, I_D = -3.2\text{ A}^b$ | 1.6 | - | - | S |
| Dynamic | | | | | | |
| Input Capacitance | C_{iss} | $V_{GS} = 0\text{ V}, V_{DS} = -25\text{ V}, f = 1.0\text{ MHz}$, see fig. 5 | - | 270 | - | pF |
| Output Capacitance | C_{oss} | | - | 170 | - | |
| Reverse Transfer Capacitance | C_{rss} | | - | 31 | - | |
| Drain to Sink Capacitance | C | | $f = 1.0\text{ MHz}$ | - | 12 | |
| Total Gate Charge | Q_g | $V_{GS} = -10\text{ V}, I_D = -4.7\text{ A}, V_{DS} = -48\text{ V}$, see fig. 6 and 13 ^b | - | - | 12 | nC |
| Gate-Source Charge | Q_{gs} | | - | - | 3.8 | |
| Gate-Drain Charge | Q_{gd} | | - | - | 5.1 | |
| Turn-On Delay Time | $t_{d(on)}$ | $V_{DD} = -30\text{ V}, I_D = -4.7\text{ A}, R_G = 24\text{ }\Omega, R_D = 4.0\text{ }\Omega$, see fig. 10 ^b | - | 11 | - | ns |
| Rise Time | t_r | | - | 63 | - | |
| Turn-Off Delay Time | $t_{d(off)}$ | | - | 9.6 | - | |
| Fall Time | t_f | | - | 31 | - | |
| Internal Drain Inductance | L_D | Between lead, 6 mm (0.25") from package and center of die contact  | - | 4.5 | - | nH |
| Internal Source Inductance | L_S | | - | 7.5 | - | |
| Drain-Source Body Diode Characteristics | | | | | | |
| Continuous Source-Drain Diode Current | I_S | MOSFET symbol showing the integral reverse p-n junction diode  | - | - | -5.2 | A |
| Pulsed Diode Forward Current ^a | I_{SM} | | - | - | -21 | |
| Body Diode Voltage | V_{SD} | $T_J = 25\text{ }^\circ\text{C}, I_S = -5.2\text{ A}, V_{GS} = 0\text{ V}^b$ | - | - | -5.5 | V |
| Body Diode Reverse Recovery Time | t_{rr} | $T_J = 25\text{ }^\circ\text{C}, I_F = -4.7\text{ A}, dI/dt = 100\text{ A}/\mu\text{s}^b$ | - | 80 | 160 | ns |
| Body Diode Reverse Recovery Charge | Q_{rr} | | - | 0.096 | 0.19 | μC |
| Forward Turn-On Time | t_{on} | Intrinsic turn-on time is negligible (turn-on is dominated by L_S and L_D) | | | | |

Notes

- a. Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11).
 b. Pulse width $\leq 300\text{ }\mu\text{s}$; duty cycle $\leq 2\%$.

TYPICAL CHARACTERISTICS 25 °C, unless otherwise noted

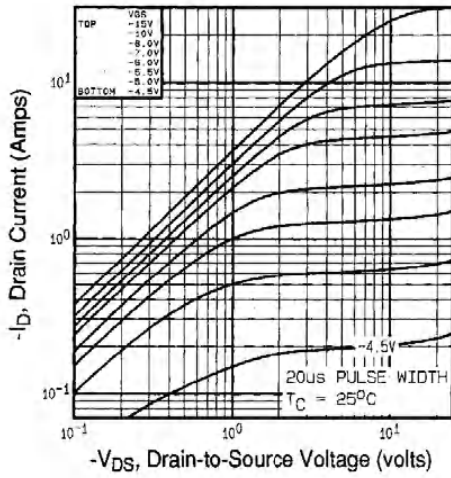


Fig. 1 - Typical Output Characteristics, $T_C = 25\text{ }^\circ\text{C}$

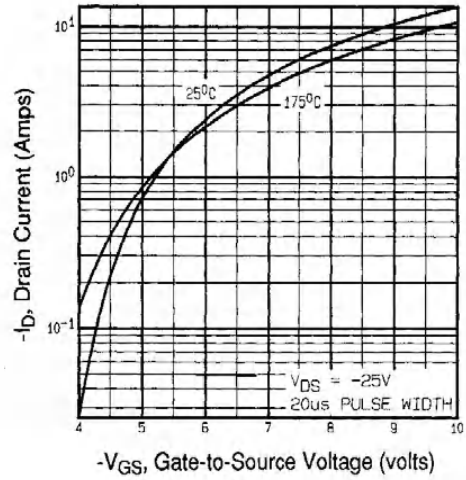


Fig. 3 - Typical Transfer Characteristics

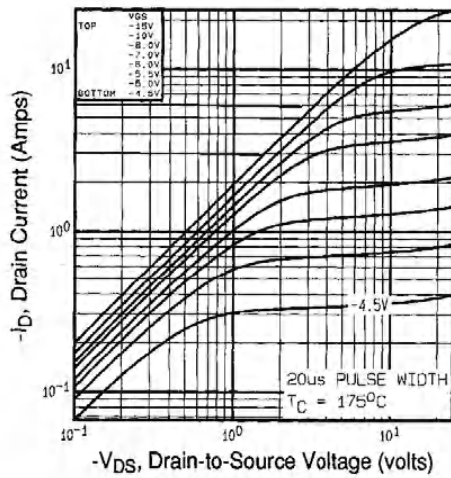


Fig. 2 - Typical Output Characteristics, $T_C = 175\text{ }^\circ\text{C}$

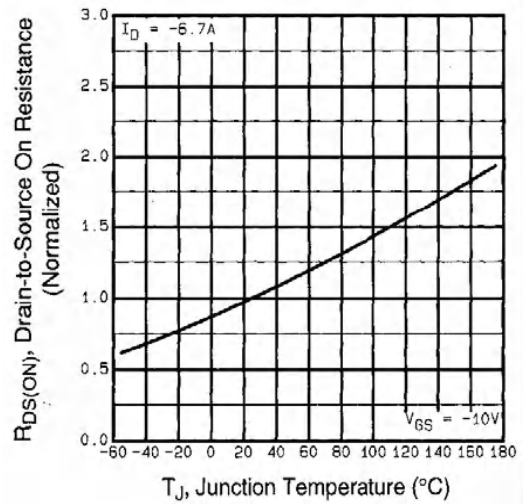


Fig. 4 - Normalized On-Resistance vs. Temperature



Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage

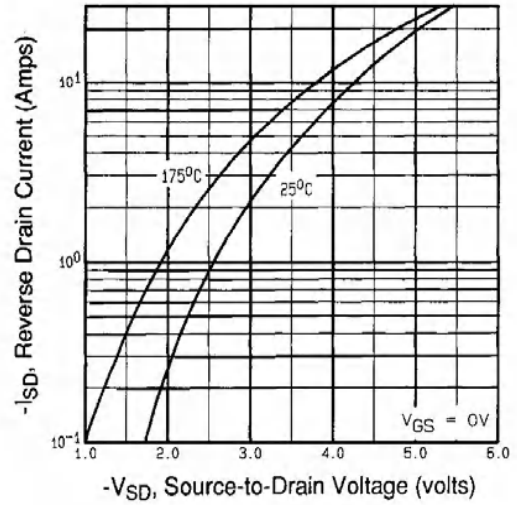


Fig. 7 - Typical Source-Drain Diode Forward Voltage



Fig. 6 - Typical Gate Charge vs. Gate-to-Source Voltage

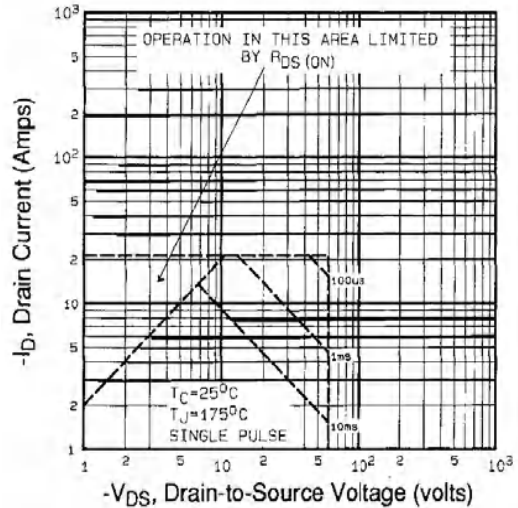


Fig. 8 - Maximum Safe Operating Area

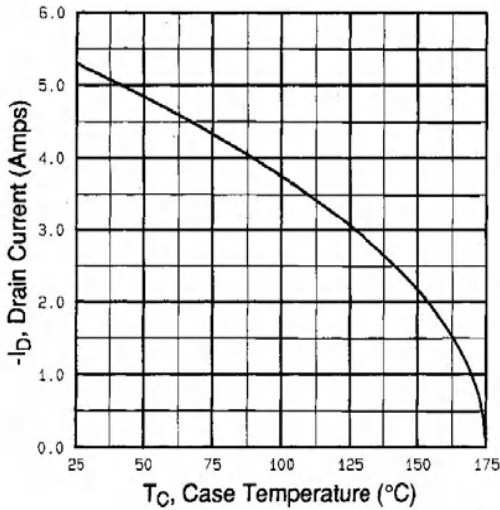


Fig. 9 - Maximum Drain Current vs. Case Temperature

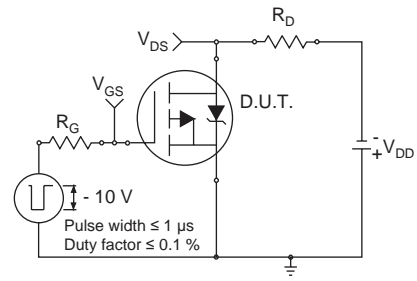


Fig. 10a - Switching Time Test Circuit

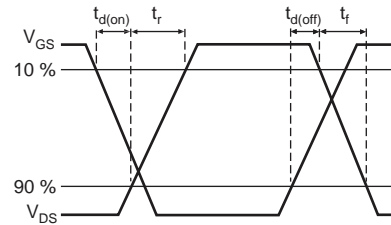


Fig. 10b - Switching Time Waveforms



Fig. 11 - Maximum Effective Transient Thermal Impedance, Junction-to-Case

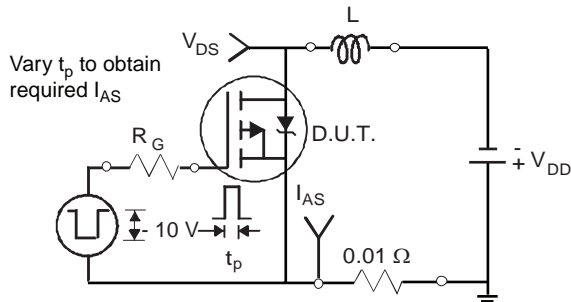


Fig. 12a - Unclamped Inductive Test Circuit

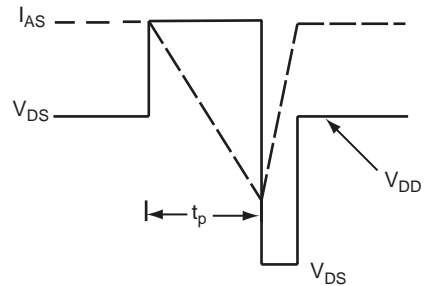


Fig. 12b - Unclamped Inductive Waveforms

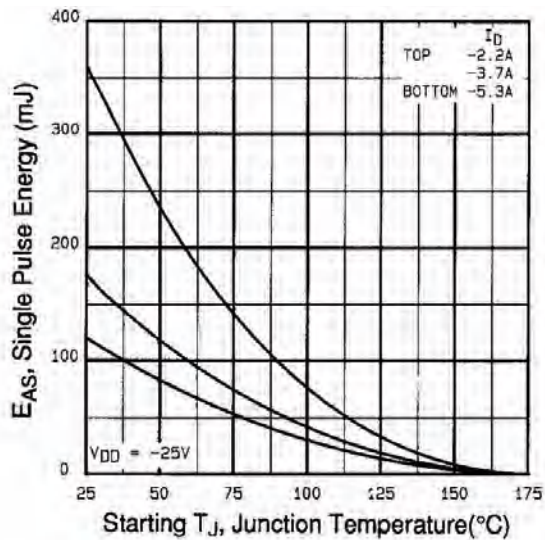


Fig. 12c - Maximum Avalanche Energy vs. Drain Current

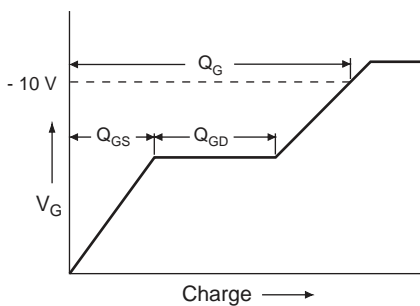


Fig. 13a - Basic Gate Charge Waveform

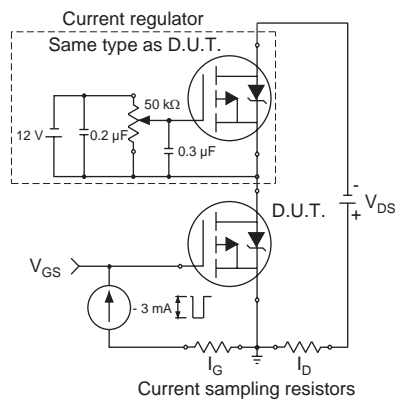
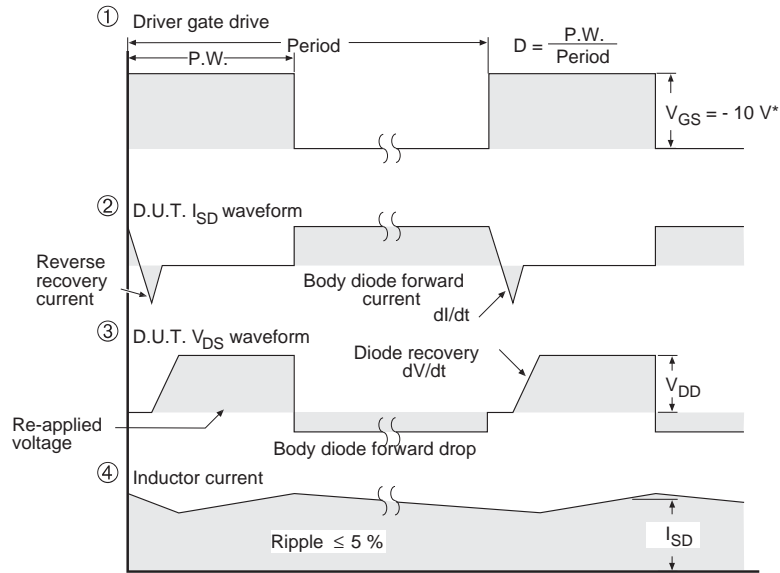
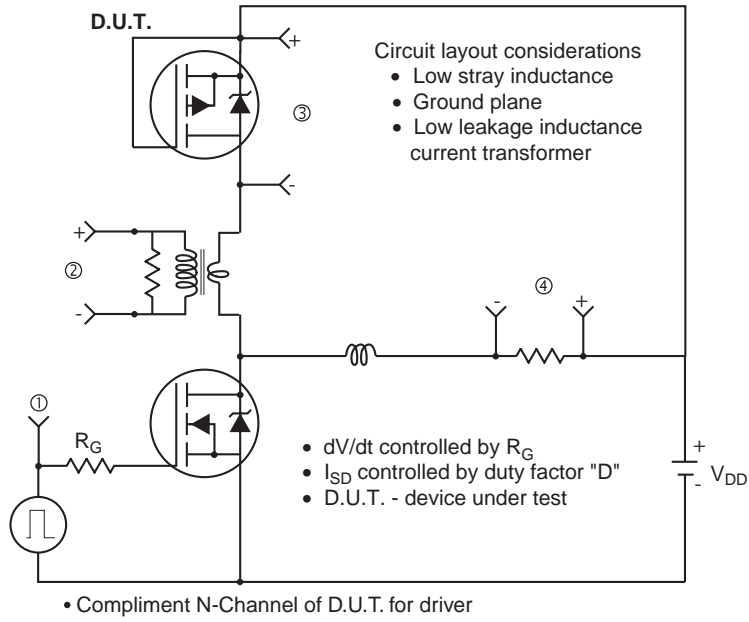


Fig. 13b - Gate Charge Test Circuit

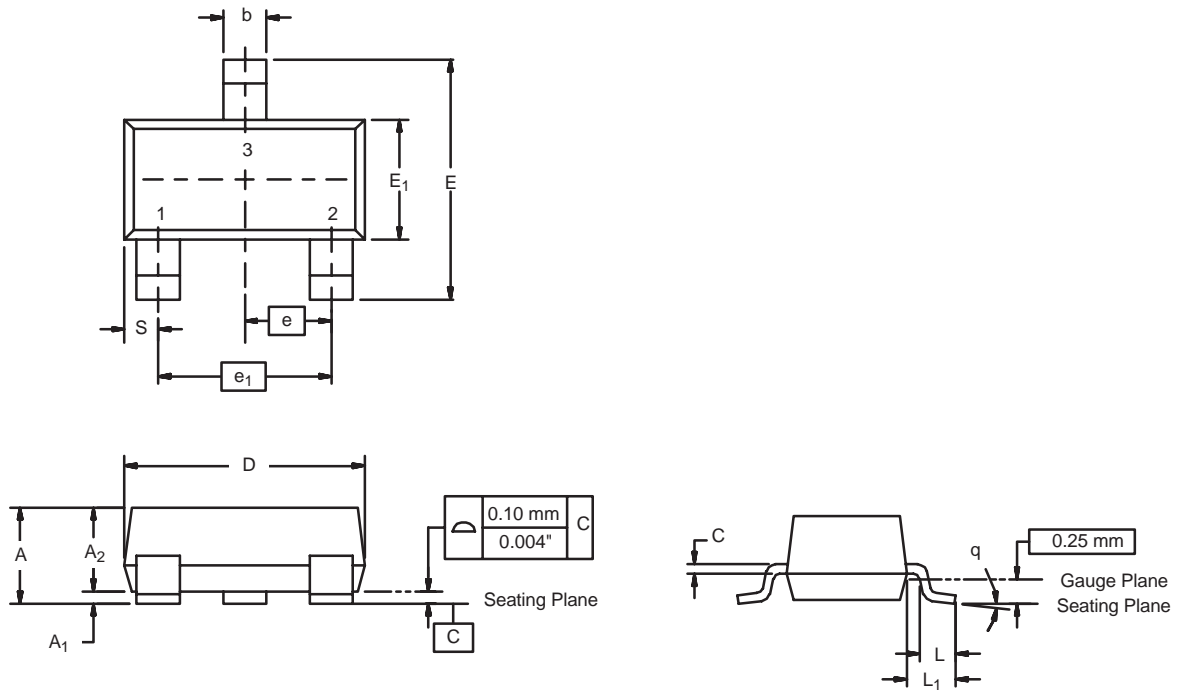
Peak Diode Recovery dV/dt Test Circuit



* $V_{GS} = -5V$ for logic level and $-3V$ drive devices

Fig. 14 - For P-Channel

SOT-23 (TO-236): 3-LEAD



| Dim | MILLIMETERS | | INCHES | |
|----------------|-------------|------|------------|-------|
| | Min | Max | Min | Max |
| A | 0.89 | 1.12 | 0.035 | 0.044 |
| A ₁ | 0.01 | 0.10 | 0.0004 | 0.004 |
| A ₂ | 0.88 | 1.02 | 0.0346 | 0.040 |
| b | 0.35 | 0.50 | 0.014 | 0.020 |
| c | 0.085 | 0.18 | 0.003 | 0.007 |
| D | 2.80 | 3.04 | 0.110 | 0.120 |
| E | 2.10 | 2.64 | 0.083 | 0.104 |
| E ₁ | 1.20 | 1.40 | 0.047 | 0.055 |
| e | 0.95 BSC | | 0.0374 Ref | |
| e ₁ | 1.90 BSC | | 0.0748 Ref | |
| L | 0.40 | 0.60 | 0.016 | 0.024 |
| L ₁ | 0.64 Ref | | 0.025 Ref | |
| S | 0.50 Ref | | 0.020 Ref | |
| q | 3° | 8° | 3° | 8° |

ECN: S-03946-Rev. K, 09-Jul-01
DWG: 5479

RECOMMENDED MINIMUM PADS FOR SOT-23



Recommended Minimum Pads
Dimensions in Inches/(mm)

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