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August 2014

FCP20N60 / FCPF20N60

N-Channel SuperFET[®] MOSFET

600 V, 20 A, 190 mΩ

Features

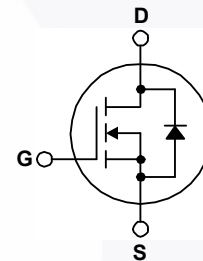
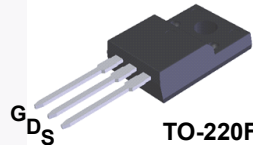
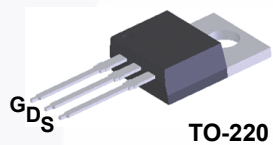
- 650V @ $T_J = 150^\circ\text{C}$
- Typ. $R_{DS(on)} = 150\text{ m}\Omega$
- Ultra Low Gate Charge (Typ. $Q_g = 75\text{ nC}$)
- Low Effective Output Capacitance (Typ. $C_{oss(eff.)} = 165\text{ pF}$)
- 100% Avalanche Tested

Applications

- Solar Inverter
- AC-DC Power Supply

Description

SuperFET[®] MOSFET is Fairchild Semiconductor's first generation of high voltage super-junction (SJ) MOSFET family that is utilizing charge balance technology for outstanding low on-resistance and lower gate charge performance. This technology is tailored to minimize conduction loss, provide superior switching performance, dv/dt rate and higher avalanche energy. Consequently, SuperFET MOSFET is very suitable for the switching power applications such as PFC, server/telecom power, FPD TV power, ATX power and industrial power applications.



Absolute Maximum Ratings

| Symbol | Parameter | FCP20N60 | FCPF20N60 | Unit |
|----------------|---|--|-----------|---------------------|
| V_{DSS} | Drain-Source Voltage | 600 | | V |
| I_D | Drain Current | - Continuous ($T_C = 25^\circ\text{C}$) | 20 | 20* |
| | | - Continuous ($T_C = 100^\circ\text{C}$) | 12.5 | 12.5* |
| I_{DM} | Drain Current - Pulsed (Note 1) | 60 | 60* | A |
| V_{GSS} | Gate-Source Voltage | ± 30 | | V |
| E_{AS} | Single Pulsed Avalanche Energy (Note 2) | 690 | | mJ |
| I_{AR} | Avalanche Current (Note 1) | 20 | | A |
| E_{AR} | Repetitive Avalanche Energy (Note 1) | 20.8 | | mJ |
| dv/dt | Peak Diode Recovery dv/dt (Note 3) | 4.5 | | V/ns |
| P_D | Power Dissipation ($T_C = 25^\circ\text{C}$) - Derate Above 25°C | 208 | 39 | W |
| | | 1.67 | 0.3 | W/ $^\circ\text{C}$ |
| T_J, T_{STG} | Operating and Storage Temperature Range | -55 to +150 | | $^\circ\text{C}$ |
| T_L | Maximum Lead Temperature for Soldering, 1/8" from Case for 5 Seconds | 300 | | $^\circ\text{C}$ |

*Drain current limited by maximum junction temperature.

Thermal Characteristics

| Symbol | Parameter | FCP20N60 | FCPF20N60 | Unit |
|-----------------|---|----------|-----------|---------------------------|
| $R_{\theta JC}$ | Thermal Resistance, Junction-to-Case | 0.6 | 3.2 | $^\circ\text{C}/\text{W}$ |
| $R_{\theta JA}$ | Thermal Resistance, Junction-to-Ambient | 62.5 | 62.5 | $^\circ\text{C}/\text{W}$ |

FCP20N60 / FCPF20N60 — N-Channel SuperFET[®] MOSFET

Package Marking and Ordering Information

| Part Number | Top Mark | Package | Packing Method | Reel Size | Tape Width | Quantity |
|-------------|-----------|---------|----------------|-----------|------------|----------|
| FCP20N60 | FCP20N60 | TO-220 | Tube | N/A | N/A | 50 units |
| FCPF20N60 | FCPF20N60 | TO-220F | Tube | N/A | N/A | 50 units |

Electrical Characteristics $T_C = 25^\circ\text{C}$ unless otherwise noted.

| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Unit |
|--------|-----------|-----------------|------|------|------|------|
|--------|-----------|-----------------|------|------|------|------|

Off Characteristics

| | | | | | | |
|--------------------------------|---|--|-----|-----|-----------|---------------------------|
| BV_{DSS} | Drain to Source Breakdown Voltage | $I_D = 250 \mu\text{A}, V_{GS} = 0 \text{ V}, T_J = 25^\circ\text{C}$ | 600 | - | - | V |
| | | $I_D = 250 \mu\text{A}, V_{GS} = 0 \text{ V}, T_J = 150^\circ\text{C}$ | - | 650 | - | V |
| $\Delta BV_{DSS} / \Delta T_J$ | Breakdown Voltage Temperature Coefficient | $I_D = 250 \mu\text{A}$, Referenced to 25°C | - | 0.6 | - | $\text{V}/^\circ\text{C}$ |
| BV_{DS} | Drain-Source Avalanche Breakdown Voltage | $V_{GS} = 0 \text{ V}, I_D = 20 \text{ A}$ | - | 700 | - | V |
| I_{DSS} | Zero Gate Voltage Drain Current | $V_{DS} = 600 \text{ V}, V_{GS} = 0 \text{ V}$ | - | - | 1 | μA |
| | | $V_{DS} = 480 \text{ V}, T_C = 125^\circ\text{C}$ | - | - | 10 | |
| I_{GSS} | Gate to Body Leakage Current | $V_{GS} = \pm 30 \text{ V}, V_{DS} = 0 \text{ V}$ | - | - | ± 100 | nA |

On Characteristics

| | | | | | | |
|--------------|--------------------------------------|---|-----|------|------|----------|
| $V_{GS(th)}$ | Gate Threshold Voltage | $V_{GS} = V_{DS}, I_D = 250 \mu\text{A}$ | 3.0 | - | 5.0 | V |
| $R_{DS(on)}$ | Static Drain to Source On Resistance | $V_{GS} = 10 \text{ V}, I_D = 10 \text{ A}$ | - | 0.15 | 0.19 | Ω |
| g_{FS} | Forward Transconductance | $V_{DS} = 40 \text{ V}, I_D = 10 \text{ A}$ | - | 17 | - | S |

Dynamic Characteristics

| | | | | | | |
|-----------------|-------------------------------|---|---|------|------|----|
| C_{iss} | Input Capacitance | $V_{DS} = 25 \text{ V}, V_{GS} = 0 \text{ V}, f = 1 \text{ MHz}$ | - | 2370 | 3080 | pF |
| C_{oss} | Output Capacitance | | - | 1280 | 1665 | pF |
| C_{rSS} | Reverse Transfer Capacitance | | - | 95 | - | pF |
| C_{oss} | Output Capacitance | $V_{DS} = 480 \text{ V}, V_{GS} = 0 \text{ V}, f = 1 \text{ MHz}$ | - | 65 | 85 | pF |
| $C_{oss(eff.)}$ | Effective Output Capacitance | $V_{DS} = 0 \text{ V to } 400 \text{ V}, V_{GS} = 0 \text{ V}$ | - | 165 | - | pF |
| Q_g | Total Gate Charge at 10V | $V_{DS} = 480 \text{ V}, I_D = 20 \text{ A}, V_{GS} = 10 \text{ V}$ (Note 4) | - | 75 | 98 | nC |
| Q_{gs} | Gate to Source Gate Charge | | - | 13.5 | 18 | nC |
| Q_{gd} | Gate to Drain "Miller" Charge | | - | 36 | - | nC |

Switching Characteristics

| | | | | | | |
|--------------|---------------------|--|---|-----|-----|----|
| $t_{d(on)}$ | Turn-On Delay Time | $V_{DD} = 300 \text{ V}, I_D = 20 \text{ A}, V_{GS} = 10 \text{ V}, R_G = 25 \Omega$ (Note 4) | - | 62 | 135 | ns |
| t_r | Turn-On Rise Time | | - | 140 | 290 | ns |
| $t_{d(off)}$ | Turn-Off Delay Time | | - | 230 | 470 | ns |
| t_f | Turn-Off Fall Time | | - | 65 | 140 | ns |

Drain-Source Diode Characteristics

| | | | | | | |
|----------|--|--|---|------|-----|---------------|
| I_S | Maximum Continuous Drain to Source Diode Forward Current | - | - | 20 | A | |
| I_{SM} | Maximum Pulsed Drain to Source Diode Forward Current | - | - | 60 | A | |
| V_{SD} | Drain to Source Diode Forward Voltage | $V_{GS} = 0 \text{ V}, I_{SD} = 20 \text{ A}$ | - | - | 1.4 | V |
| t_{rr} | Reverse Recovery Time | $V_{GS} = 0 \text{ V}, I_{SD} = 20 \text{ A}, di_F/dt = 100 \text{ A}/\mu\text{s}$ | - | 530 | - | ns |
| Q_{rr} | Reverse Recovery Charge | | - | 10.5 | - | μC |

Notes:

- 1: Repetitive rating: pulse-width limited by maximum junction temperature.
- 2: $I_{AS} = 10 \text{ A}, V_{DD} = 50 \text{ V}, R_G = 25 \Omega$, starting $T_J = 25^\circ\text{C}$.
- 3: $I_{SD} \leq 20 \text{ A}, di/dt \leq 200 \text{ A}/\mu\text{s}, V_{DD} \leq BV_{DSS}$, starting $T_J = 25^\circ\text{C}$.
- 4: Essentially independent of operating temperature typical characteristics.

Typical Performance Characteristics

Figure 1. On-Region Characteristics

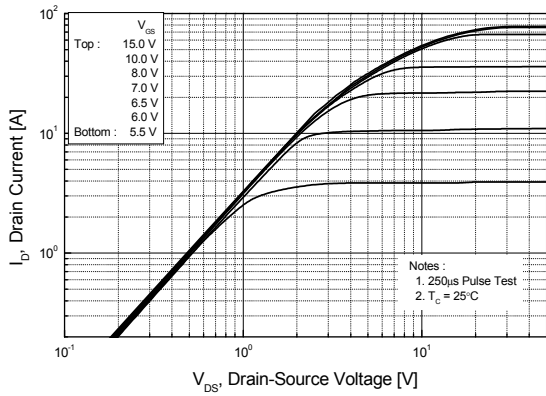


Figure 2. Transfer Characteristics

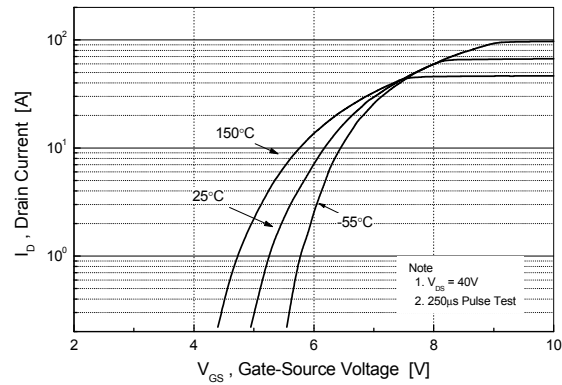


Figure 3. On-Resistance Variation vs. Drain Current and Gate Voltage

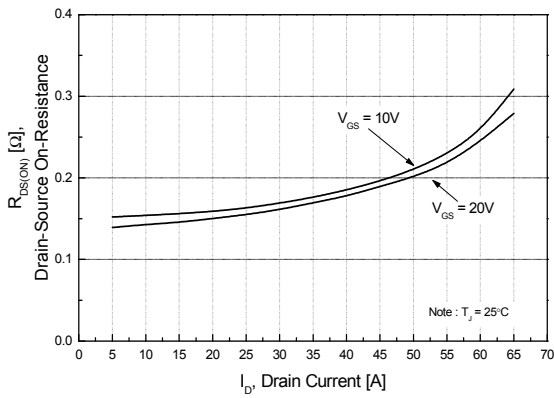


Figure 4. Body Diode Forward Voltage Variation vs. Source Current and Temperature

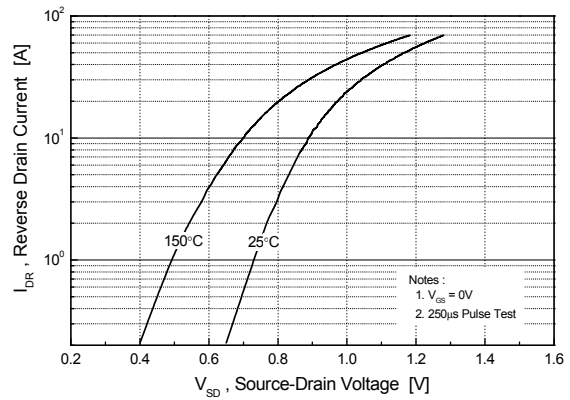


Figure 5. Capacitance Characteristics

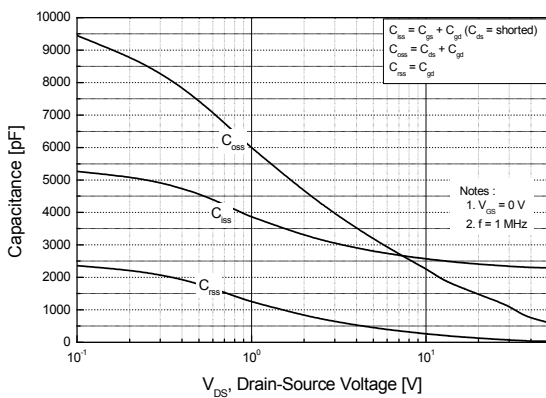
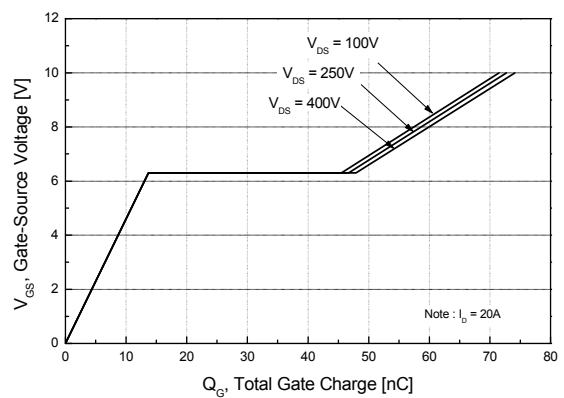


Figure 6. Gate Charge Characteristics



Typical Performance Characteristics (Continued)

Figure 7. Breakdown Voltage Variation vs. Temperature

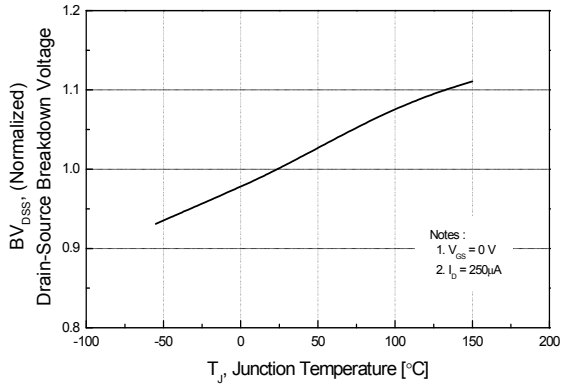


Figure 8. On-Resistance Variation vs. Temperature

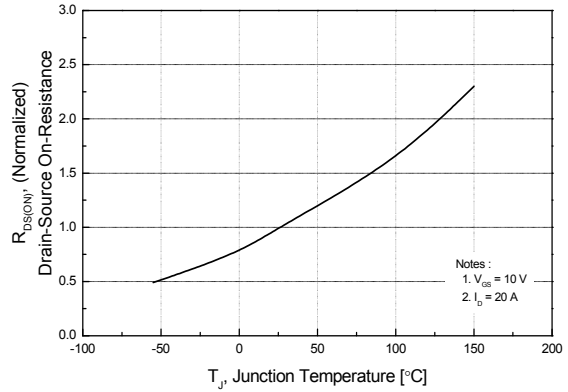


Figure 9-1. Maximum Safe Operating Area for FCP20N60

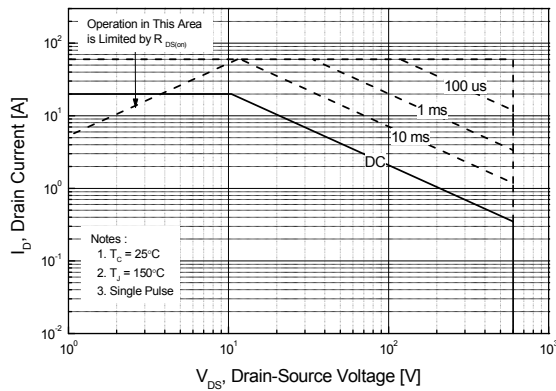


Figure 9-2. Maximum Safe Operating Area for FCPF20N60

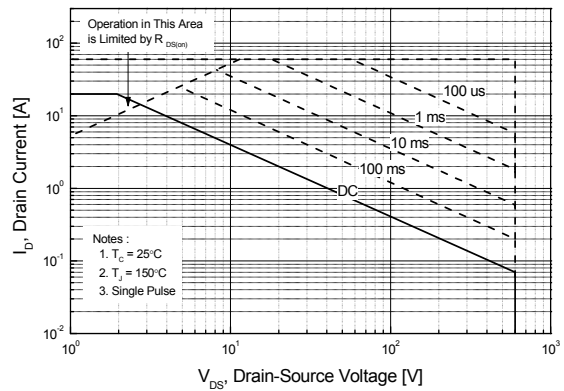
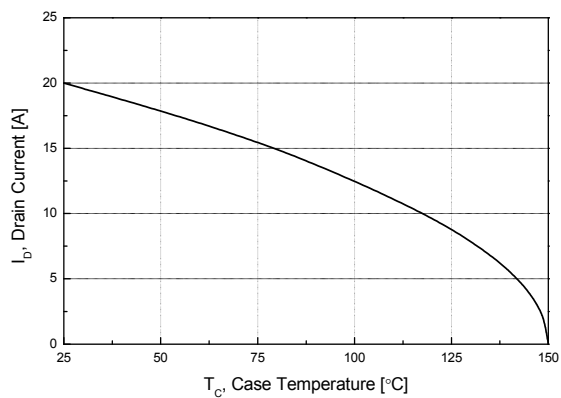


Figure 10. Maximum Drain Current vs. Case Temperature



Typical Performance Characteristics (Continued)

Figure 11-1. Transient Thermal Response Curve for FCP20N60

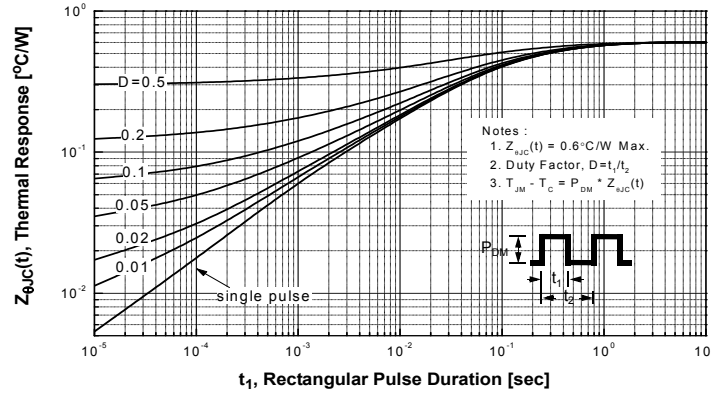
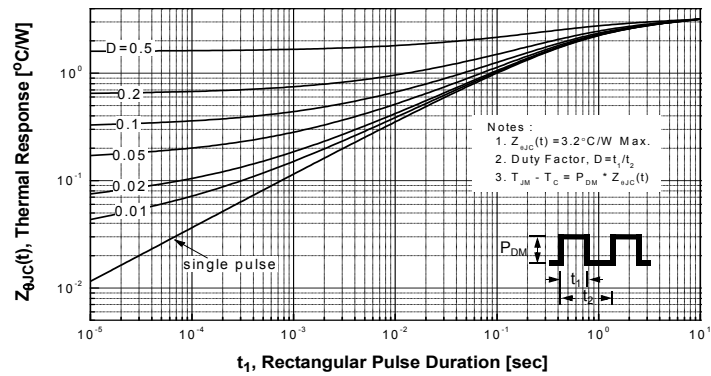


Figure 11-2. Transient Thermal Response Curve for FCPF20N60



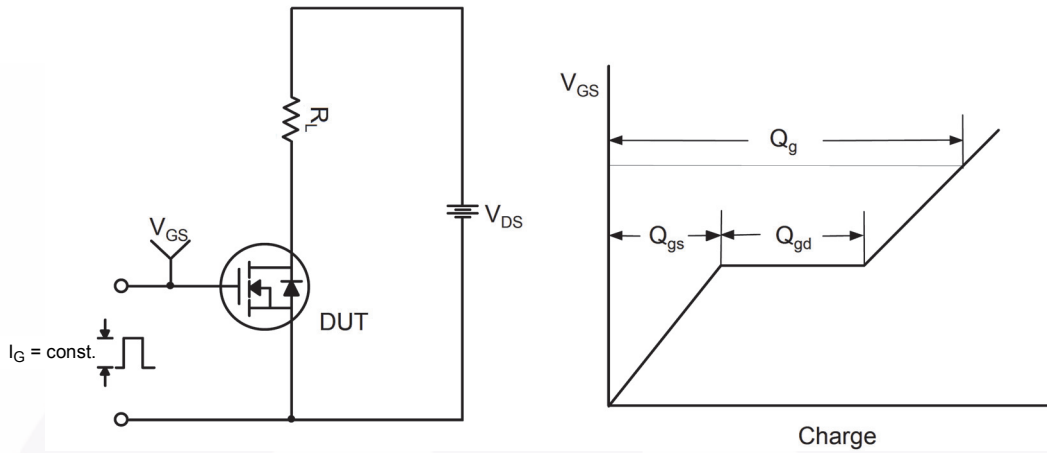


Figure 12. Gate Charge Test Circuit & Waveform

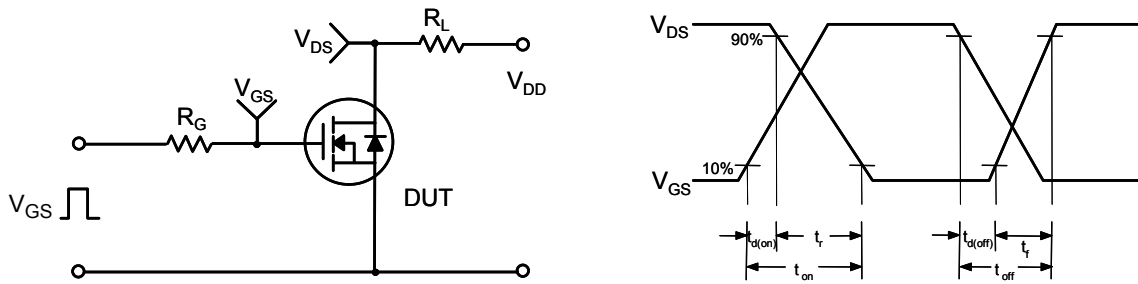


Figure 13. Resistive Switching Test Circuit & Waveforms

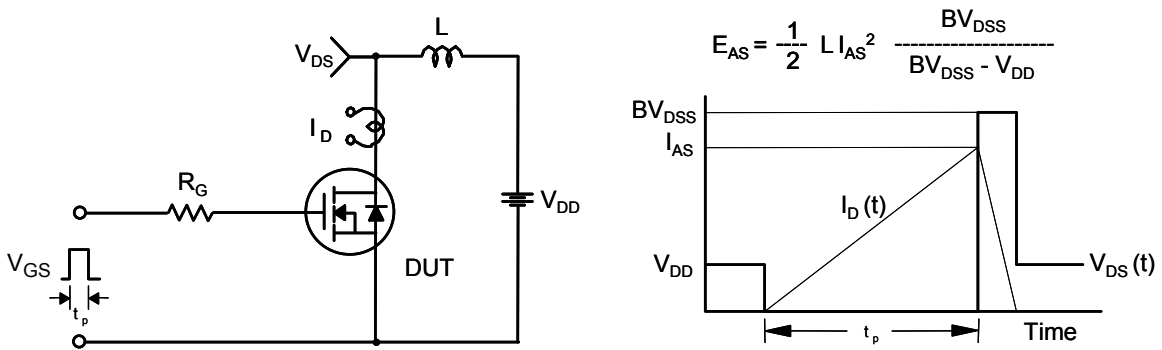


Figure 14. Unclamped Inductive Switching Test Circuit & Waveforms



Figure 15. Peak Diode Recovery dv/dt Test Circuit & Waveforms



- NOTES:
- A) REFERENCE JEDEC, TO-220, VARIATION AB
 - B) ALL DIMENSIONS ARE IN MILLIMETERS.
 - C) DIMENSIONS COMMON TO ALL PACKAGE SUPPLIERS EXCEPT WHERE NOTED [].
 - D) LOCATION OF MOLDED FEATURE MAY VARY (LOWER LEFT CORNER, LOWER CENTER AND CENTER OF THE PACKAGE)
 - E) DOES NOT COMPLY JEDEC STANDARD VALUE.
 - F) "A1" DIMENSIONS AS BELOW:
 SINGLE GAUGE = 0.51 - 0.61
 DUAL GAUGE = 1.10 - 1.45
 - G) DRAWING FILE NAME: TO220B03REV9
 - H) PRESENCE IS SUPPLIER DEPENDENT
 - I) SUPPLIER DEPENDENT MOLD LOCKING HOLES IN HEATSINK.

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