

# APT6029BLLG-VB Datasheet

## 600V SJ\_Multi-EPI TO247 Single-N MOSFET

### PRODUCT SUMMARY

|                                    |                 |      |
|------------------------------------|-----------------|------|
| $V_{DS}$ (V) at $T_J$ max.         | 600             |      |
| $R_{DS(on)}$ at 25 °C ( $\Omega$ ) | $V_{GS} = 10$ V | 0.15 |
| $Q_g$ max. (nC)                    | 70              |      |
| $Q_{gs}$ (nC)                      | 7.8             |      |
| $Q_{gd}$ (nC)                      | 9               |      |
| Configuration                      | Single          |      |

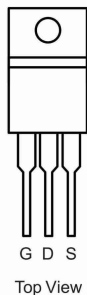
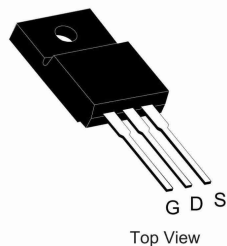
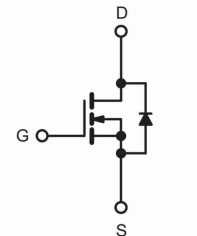
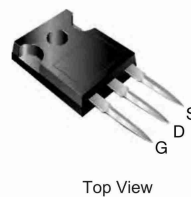
### FEATURES

- Low figure-of-merit (FOM)  $R_{on} \times Q_g$
- Low input capacitance ( $C_{iss}$ )
- Reduced switching and conduction losses
- Ultra low gate charge ( $Q_g$ )
- Avalanche energy rated (UIS)


**RoHS**

### APPLICATIONS

- Server and telecom power supplies
- Switch mode power supplies (SMPS)
- Power factor correction power supplies (PFC)
- Lighting
  - High-intensity discharge (HID)
  - Fluorescent ballast lighting
- Industrial

**TO-220AB**

**TO-220 FULLPAK**

**TO-247AC**


N-Channel MOSFET

### ABSOLUTE MAXIMUM RATINGS ( $T_C = 25$ °C, unless otherwise noted)

| PARAMETER                                                 |                         |                         |                | SYMBOL                            | LIMIT       | UNIT |
|-----------------------------------------------------------|-------------------------|-------------------------|----------------|-----------------------------------|-------------|------|
| Drain-Source Voltage                                      |                         |                         |                | V <sub>DS</sub>                   | 600         | V    |
| Gate-Source Voltage                                       |                         |                         |                | V <sub>GS</sub>                   | ± 30        |      |
| Continuous Drain Current (T <sub>J</sub> = 150 °C)        | V <sub>GS</sub> at 10 V | T <sub>C</sub> = 25 °C  | I <sub>D</sub> | 20                                | A           |      |
|                                                           |                         | T <sub>C</sub> = 100 °C |                | 10                                |             |      |
| Pulsed Drain Current <sup>a</sup>                         |                         |                         |                | I <sub>DM</sub>                   | 62          |      |
| Linear Derating Factor                                    |                         |                         |                |                                   | 1.67        | W/°C |
| Single Pulse Avalanche Energy <sup>b</sup>                |                         |                         |                | E <sub>AS</sub>                   | 485         | mJ   |
| Maximum Power Dissipation                                 |                         |                         |                | P <sub>D</sub>                    | 205/35      | W    |
| Operating Junction and Storage Temperature Range          |                         |                         |                | T <sub>J</sub> , T <sub>stg</sub> | -55 to +150 | °C   |
| Drain-Source Voltage Slope                                | T <sub>J</sub> = 125 °C |                         |                | dV/dt                             | 37          | V/ns |
| Reverse Diode dV/dt <sup>d</sup>                          |                         |                         |                |                                   | 4.5         |      |
| Soldering Recommendations (Peak Temperature) <sup>c</sup> | for 10 s                |                         |                |                                   | 300         | °C   |

#### Notes

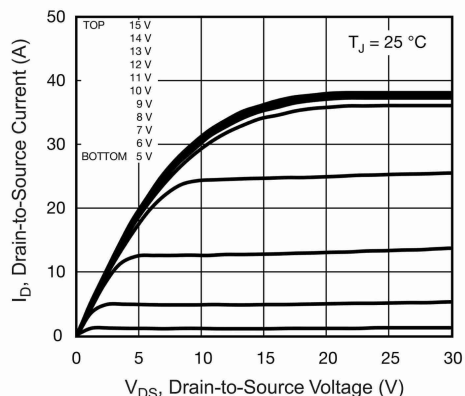
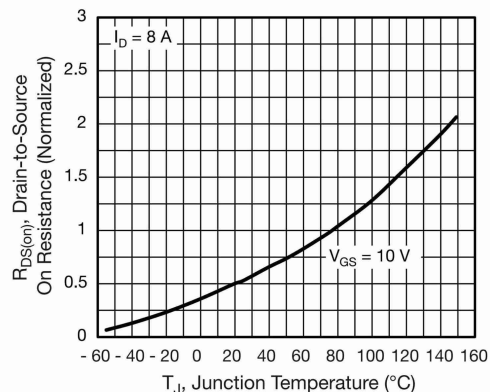
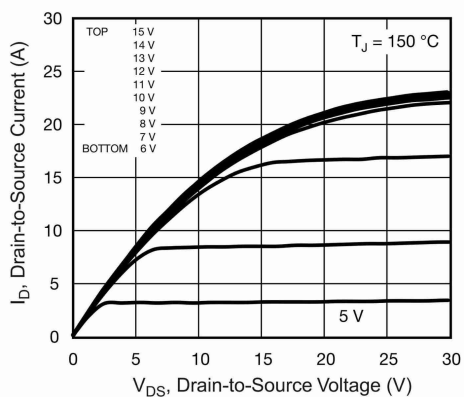
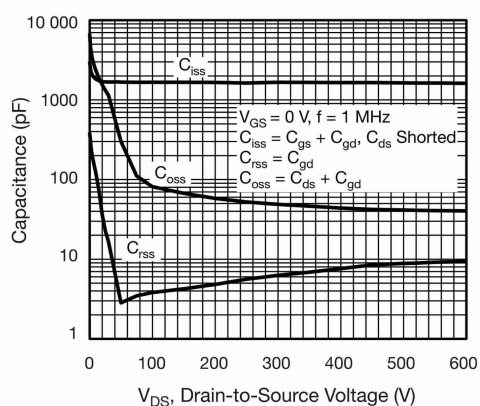
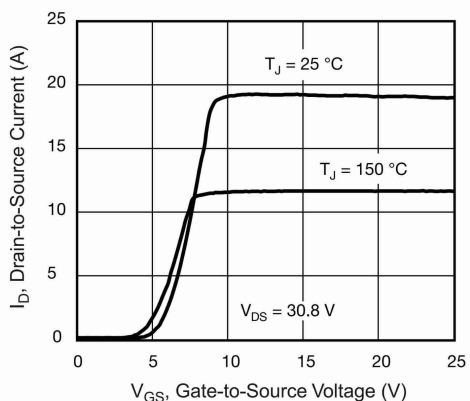
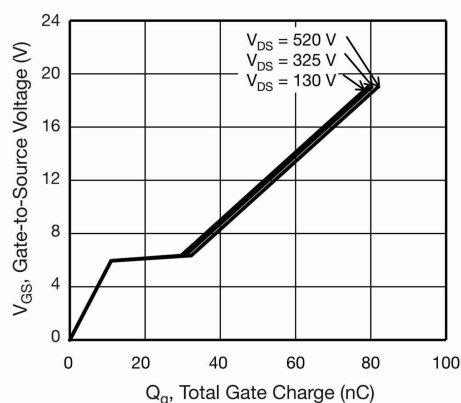
- Repetitive rating; pulse width limited by maximum junction temperature.
- $V_{DS} = 50$  V, starting  $T_J = 25$  °C,  $L = 28.2$  mH,  $R_g = 25$   $\Omega$ ,  $I_{AS} = 4.5$  A.
- 1.6 mm from case.
- $I_{SD} \leq I_D$ ,  $dI/dt = 100$  A/ $\mu$ s, starting  $T_J = 25$  °C.

| THERMAL RESISTANCE RATINGS       |            |      |      |      |
|----------------------------------|------------|------|------|------|
| PARAMETER                        | SYMBOL     | TYP. | MAX. | UNIT |
| Maximum Junction-to-Ambient      | $R_{thJA}$ | -    | 62   | °C/W |
| Maximum Junction-to-Case (Drain) | $R_{thJC}$ | -    | 0.7  |      |

| SPECIFICATIONS (T <sub>J</sub> = 25 °C, unless otherwise noted) |                                  |                                                                                                                                                          |                                               |      |      |       |      |
|-----------------------------------------------------------------|----------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------|------|------|-------|------|
| PARAMETER                                                       | SYMBOL                           | TEST CONDITIONS                                                                                                                                          |                                               | MIN. | TYP. | MAX.  | UNIT |
| Static                                                          |                                  |                                                                                                                                                          |                                               |      |      |       |      |
| Drain-Source Breakdown Voltage                                  | V <sub>DS</sub>                  | V <sub>GS</sub> = 0 V, I <sub>D</sub> = 250 μA                                                                                                           |                                               | 600  | -    | -     | V    |
| V <sub>DS</sub> Temperature Coefficient                         | ΔV <sub>DS</sub> /T <sub>J</sub> | Reference to 25 °C, I <sub>D</sub> = 1 mA                                                                                                                |                                               | -    | 0.75 | -     | V/°C |
| Gate-Source Threshold Voltage (N)                               | V <sub>GS(th)</sub>              | V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 250 μA                                                                                              |                                               | 2    | -    | 4     | V    |
| Gate-Source Leakage                                             | I <sub>GSS</sub>                 | V <sub>GS</sub> = ± 20 V                                                                                                                                 |                                               | -    | -    | ± 100 | nA   |
|                                                                 |                                  | V <sub>GS</sub> = ± 30 V                                                                                                                                 |                                               | -    | -    | ± 1   | μA   |
| Zero Gate Voltage Drain Current                                 | I <sub>DSS</sub>                 | V <sub>DS</sub> = 600 V, V <sub>GS</sub> = 0 V                                                                                                           |                                               | -    | -    | 1     | μA   |
|                                                                 |                                  | V <sub>DS</sub> = 520 V, V <sub>GS</sub> = 0 V, T <sub>J</sub> = 125 °C                                                                                  |                                               | -    | -    | 10    |      |
| Drain-Source On-State Resistance                                | R <sub>DS(on)</sub>              | V <sub>GS</sub> = 10 V                                                                                                                                   | I <sub>D</sub> = 8 A                          | -    | 0.15 | -     | Ω    |
| Forward Transconductance                                        | g <sub>fs</sub>                  | V <sub>DS</sub> = 30 V, I <sub>D</sub> = 8 A                                                                                                             |                                               | -    | 5.6  | -     | S    |
| Dynamic                                                         |                                  |                                                                                                                                                          |                                               |      |      |       |      |
| Input Capacitance                                               | C <sub>iss</sub>                 | V <sub>GS</sub> = 0 V,<br>V <sub>DS</sub> = 100 V,<br>f = 1 MHz                                                                                          |                                               | -    | 1440 | -     | pF   |
| Output Capacitance                                              | C <sub>oss</sub>                 |                                                                                                                                                          |                                               | -    | 80   | -     |      |
| Reverse Transfer Capacitance                                    | C <sub>rss</sub>                 |                                                                                                                                                          |                                               | -    | 4    | -     |      |
| Effective Output Capacitance, Energy Related <sup>a</sup>       | C <sub>o(er)</sub>               | V <sub>DS</sub> = 0 V to 520 V, V <sub>GS</sub> = 0 V                                                                                                    |                                               | -    | 63   | -     | pF   |
| Effective Output Capacitance, Time Related <sup>b</sup>         | C <sub>o(tr)</sub>               |                                                                                                                                                          |                                               | -    | 213  | -     |      |
| Total Gate Charge                                               | Q <sub>g</sub>                   | V <sub>GS</sub> = 10 V                                                                                                                                   | I <sub>D</sub> = 8 A, V <sub>DS</sub> = 520 V | -    | 48   | 96    | nC   |
| Gate-Source Charge                                              | Q <sub>gs</sub>                  |                                                                                                                                                          |                                               | -    | 11   | -     |      |
| Gate-Drain Charge                                               | Q <sub>gd</sub>                  |                                                                                                                                                          |                                               | -    | 21   | -     |      |
| Turn-On Delay Time                                              | t <sub>d(on)</sub>               | V <sub>DD</sub> = 520 V, I <sub>D</sub> = 8 A,<br>V <sub>GS</sub> = 10 V, R <sub>g</sub> = 9.1 Ω                                                         |                                               | -    | 18   | 25    | ns   |
| Rise Time                                                       | t <sub>r</sub>                   |                                                                                                                                                          |                                               | -    | 24   | 55    |      |
| Turn-Off Delay Time                                             | t <sub>d(off)</sub>              |                                                                                                                                                          |                                               | -    | 48   | 70    |      |
| Fall Time                                                       | t <sub>f</sub>                   |                                                                                                                                                          |                                               | -    | 25   | 40    |      |
| Gate Input Resistance                                           | R <sub>g</sub>                   | f = 1 MHz, open drain                                                                                                                                    |                                               | -    | 0.8  | -     | Ω    |
| Drain-Source Body Diode Characteristics                         |                                  |                                                                                                                                                          |                                               |      |      |       |      |
| Continuous Source-Drain Diode Current                           | I <sub>S</sub>                   | MOSFET symbol showing the integral reverse p - n junction diode<br> |                                               | -    | -    | 20    | A    |
| Pulsed Diode Forward Current                                    | I <sub>SM</sub>                  |                                                                                                                                                          |                                               | -    | -    | 60    |      |
| Diode Forward Voltage                                           | V <sub>SD</sub>                  | T <sub>J</sub> = 25 °C, I <sub>S</sub> = 8 A, V <sub>GS</sub> = 0 V                                                                                      |                                               | -    | -    | 1.5   | V    |
| Reverse Recovery Time                                           | t <sub>rr</sub>                  | T <sub>J</sub> = 25 °C, I <sub>F</sub> = I <sub>S</sub> = 8 A,<br>di/dt = 100 A/μs, V <sub>R</sub> = 400 V                                               |                                               | -    | 475  | -     | ns   |
| Reverse Recovery Charge                                         | Q <sub>rr</sub>                  |                                                                                                                                                          |                                               | -    | 5.8  | -     | μC   |
| Reverse Recovery Current                                        | I <sub>RRM</sub>                 |                                                                                                                                                          |                                               | -    | 35   | -     | A    |

**Notes**

- a.  $C_{oss(er)}$  is a fixed capacitance that gives the same energy as  $C_{oss}$  while  $V_{DS}$  is rising from 0 % to 80 %  $V_{DSS}$ .  
 b.  $C_{oss(tr)}$  is a fixed capacitance that gives the same charging time as  $C_{oss}$  while  $V_{DS}$  is rising from 0 % to 80 %  $V_{DSS}$ .

**TYPICAL CHARACTERISTICS** (25 °C, unless otherwise noted)

**Fig. 1 - Typical Output Characteristics**

**Fig. 4 - Normalized On-Resistance vs. Temperature**

**Fig. 2 - Typical Output Characteristics**

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

**Fig. 3 - Typical Transfer Characteristics**

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

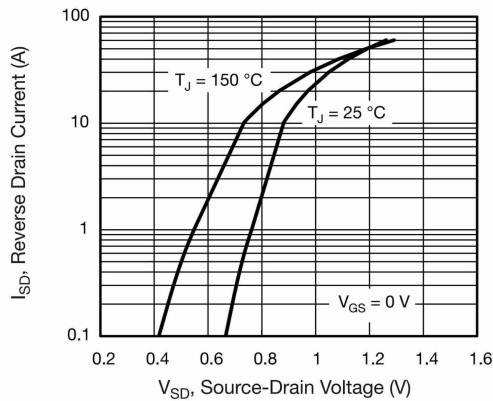


Fig. 7 - Typical Source-Drain Diode Forward Voltage

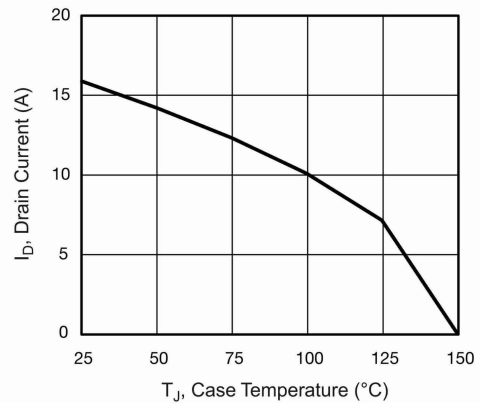


Fig. 9 - Maximum Drain Current vs. Case Temperature

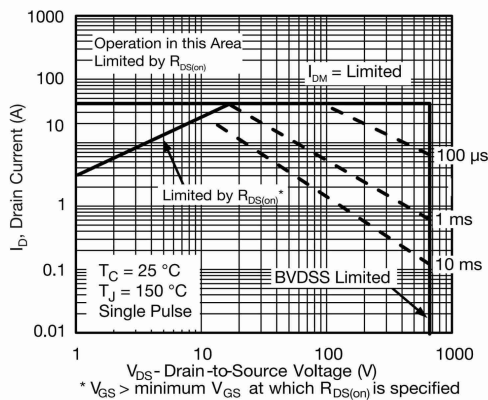


Fig. 8 - Maximum Safe Operating Area

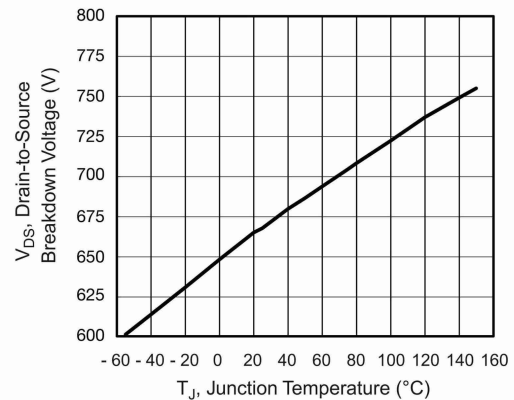


Fig. 10 - Temperature vs. Drain-to-Source Voltage

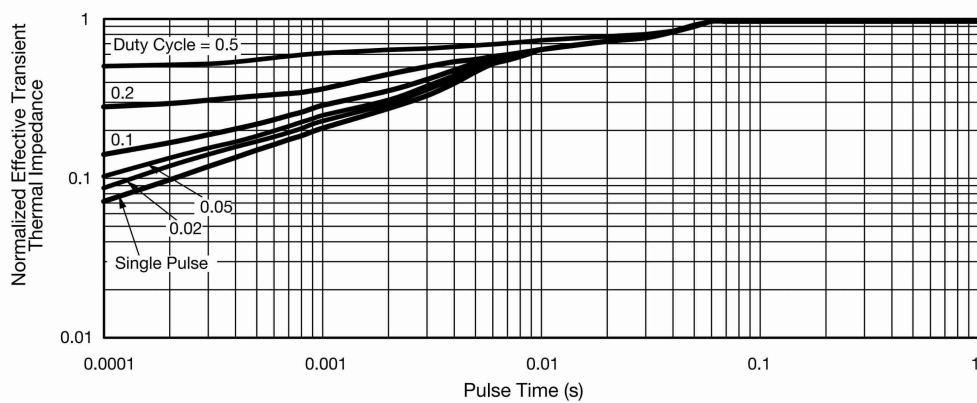


Fig. 11 - Normalized Thermal Transient Impedance, Junction-to-Case

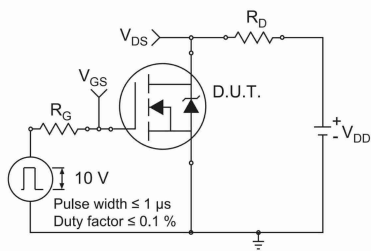


Fig. 12 - Switching Time Test Circuit

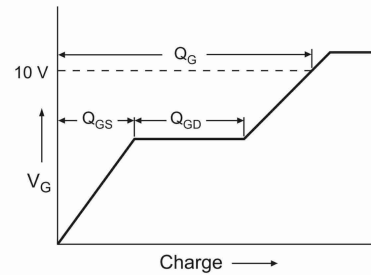


Fig. 16 - Basic Gate Charge Waveform

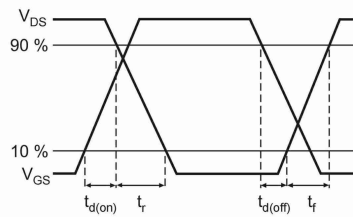


Fig. 13 - Switching Time Waveforms

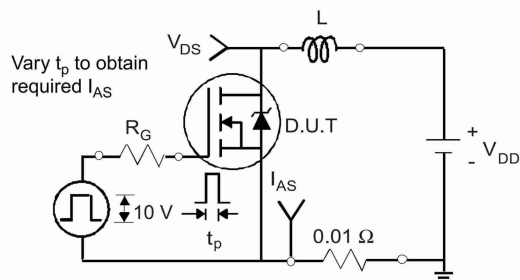


Fig. 14 - Unclamped Inductive Test Circuit

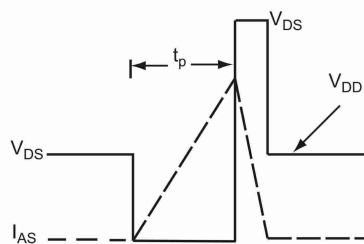


Fig. 15 - Unclamped Inductive Waveforms

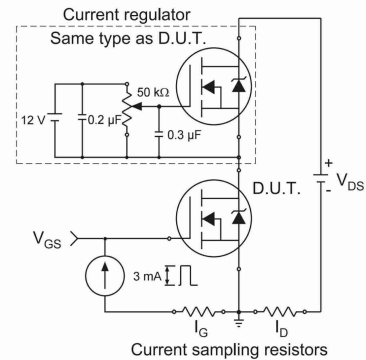
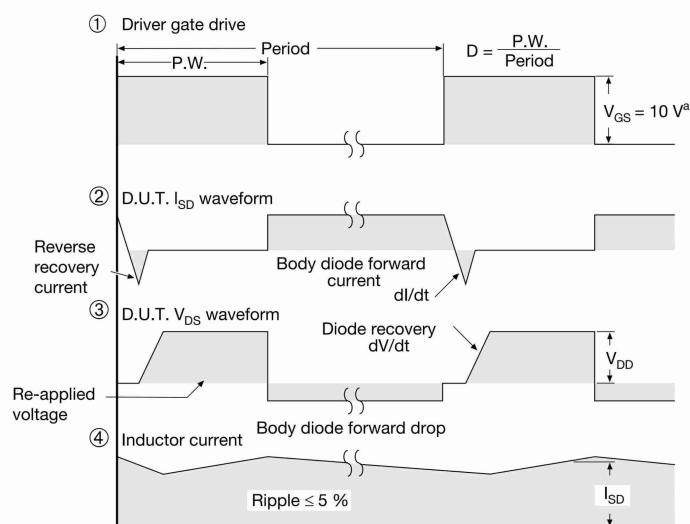
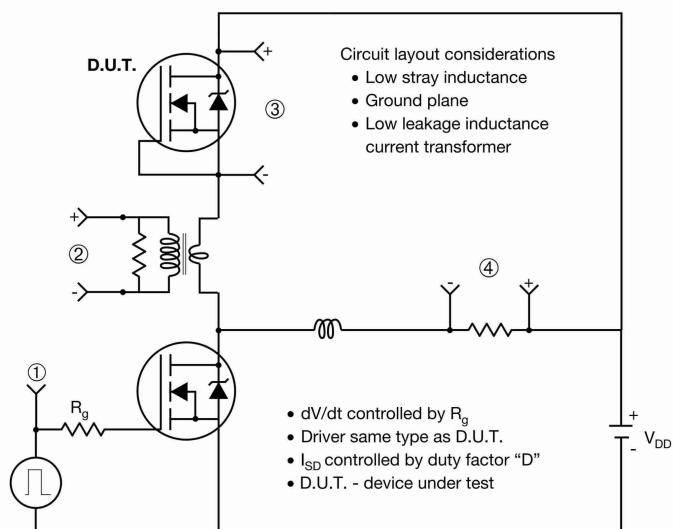


Fig. 17 - Gate Charge Test Circuit

### Peak Diode Recovery $dV/dt$ Test Circuit

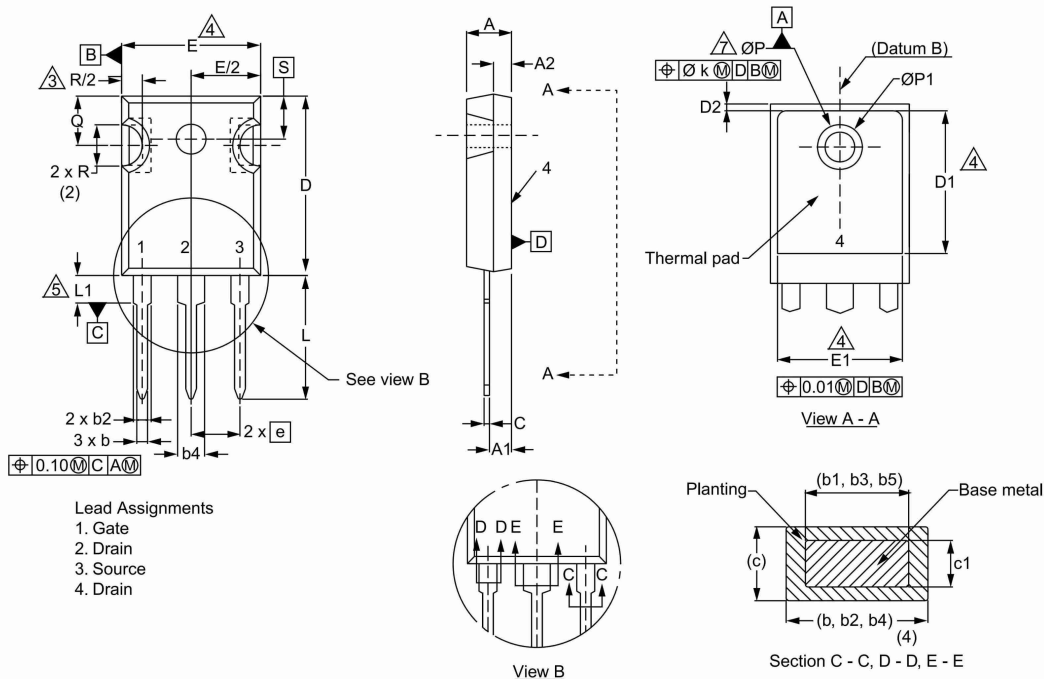


#### Note

a.  $V_{GS} = 5\text{ V}$  for logic level devices

Fig. 18 - For N-Channel

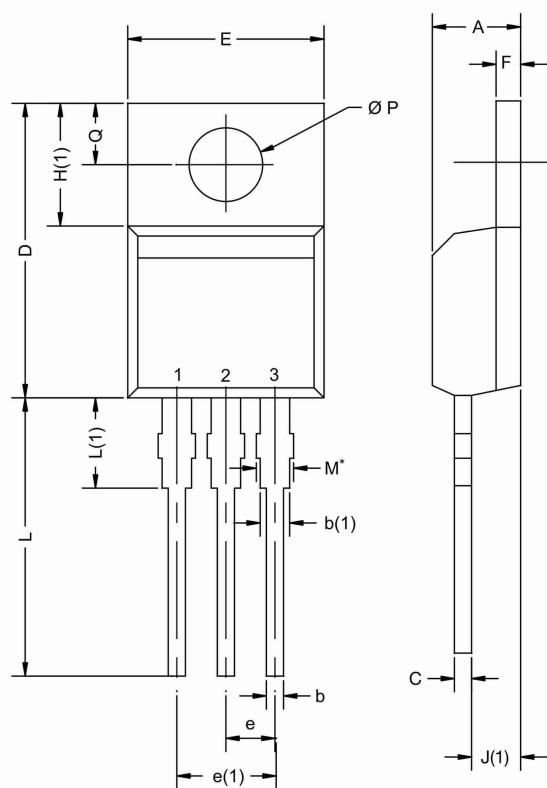
## TO-247AC (High Voltage)



| DIM. | MILLIMETERS |       | INCHES |       |
|------|-------------|-------|--------|-------|
|      | MIN.        | MAX.  | MIN.   | MAX.  |
| A    | 4.58        | 5.31  | 0.180  | 0.209 |
| A1   | 2.21        | 2.59  | 0.087  | 0.102 |
| A2   | 1.17        | 2.49  | 0.046  | 0.098 |
| b    | 0.99        | 1.40  | 0.039  | 0.055 |
| b1   | 0.99        | 1.35  | 0.039  | 0.053 |
| b2   | 1.53        | 2.39  | 0.060  | 0.094 |
| b3   | 1.65        | 2.37  | 0.065  | 0.093 |
| b4   | 2.42        | 3.43  | 0.095  | 0.135 |
| b5   | 2.59        | 3.38  | 0.102  | 0.133 |
| c    | 0.38        | 0.86  | 0.015  | 0.034 |
| c1   | 0.38        | 0.76  | 0.015  | 0.030 |
| D    | 19.71       | 20.82 | 0.776  | 0.820 |
| D1   | 13.08       | -     | 0.515  | -     |

| DIM. | MILLIMETERS |       | INCHES    |       |
|------|-------------|-------|-----------|-------|
|      | MIN.        | MAX.  | MIN.      | MAX.  |
| D2   | 0.51        | 1.30  | 0.020     | 0.051 |
| E    | 15.29       | 15.87 | 0.602     | 0.625 |
| E1   | 13.72       | -     | 0.540     | -     |
| e    | 5.46 BSC    |       | 0.215 BSC |       |
| Ø k  | 0.254       |       | 0.010     |       |
| L    | 14.20       | 16.25 | 0.559     | 0.640 |
| L1   | 3.71        | 4.29  | 0.146     | 0.169 |
| N    | 7.62 BSC    |       | 0.300 BSC |       |
| Ø P  | 3.51        | 3.66  | 0.138     | 0.144 |
| Ø P1 | -           | 7.39  | -         | 0.291 |
| Q    | 5.31        | 5.69  | 0.209     | 0.224 |
| R    | 4.52        | 5.49  | 0.178     | 0.216 |
| S    | 5.51 BSC    |       | 0.217 BSC |       |

## TO-220AB



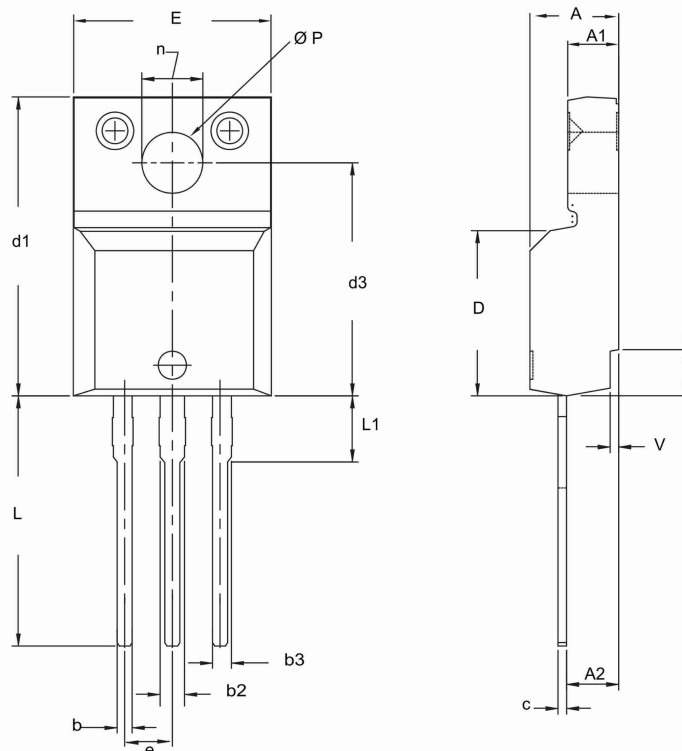
| DIM.            | MILLIMETERS |       | INCHES |       |
|-----------------|-------------|-------|--------|-------|
|                 | MIN.        | MAX.  | MIN.   | MAX.  |
| A               | 4.25        | 4.65  | 0.167  | 0.183 |
| b               | 0.69        | 1.01  | 0.027  | 0.040 |
| b(1)            | 1.20        | 1.73  | 0.047  | 0.068 |
| c               | 0.36        | 0.61  | 0.014  | 0.024 |
| D               | 14.85       | 15.49 | 0.585  | 0.610 |
| E               | 10.04       | 10.51 | 0.395  | 0.414 |
| e               | 2.41        | 2.67  | 0.095  | 0.105 |
| e(1)            | 4.88        | 5.28  | 0.192  | 0.208 |
| F               | 1.14        | 1.40  | 0.045  | 0.055 |
| H(1)            | 6.09        | 6.48  | 0.240  | 0.255 |
| J(1)            | 2.41        | 2.92  | 0.095  | 0.115 |
| L               | 13.35       | 14.02 | 0.526  | 0.552 |
| L(1)            | 3.32        | 3.82  | 0.131  | 0.150 |
| $\varnothing P$ | 3.54        | 3.94  | 0.139  | 0.155 |
| Q               | 2.60        | 3.00  | 0.102  | 0.118 |

ECN: X12-0208-Rev. N, 08-Oct-12

DWG: 5471

### Notes

\* M = 1.32 mm to 1.62 mm (dimension including protrusion)  
 Heatsink hole for HVM

**TO-220 FULLPAK (HIGH VOLTAGE)**

| DIM. | MILLIMETERS |        | INCHES    |       |
|------|-------------|--------|-----------|-------|
|      | MIN.        | MAX.   | MIN.      | MAX.  |
| A    | 4.570       | 4.830  | 0.180     | 0.190 |
| A1   | 2.570       | 2.830  | 0.101     | 0.111 |
| A2   | 2.510       | 2.850  | 0.099     | 0.112 |
| b    | 0.622       | 0.890  | 0.024     | 0.035 |
| b2   | 1.229       | 1.400  | 0.048     | 0.055 |
| b3   | 1.229       | 1.400  | 0.048     | 0.055 |
| c    | 0.440       | 0.629  | 0.017     | 0.025 |
| D    | 8.650       | 9.800  | 0.341     | 0.386 |
| d1   | 15.88       | 16.120 | 0.622     | 0.635 |
| d3   | 12.300      | 12.920 | 0.484     | 0.509 |
| E    | 10.360      | 10.630 | 0.408     | 0.419 |
| e    | 2.54 BSC    |        | 0.100 BSC |       |
| L    | 13.200      | 13.730 | 0.520     | 0.541 |
| L1   | 3.100       | 3.500  | 0.122     | 0.138 |
| n    | 6.050       | 6.150  | 0.238     | 0.242 |
| Ø P  | 3.050       | 3.450  | 0.120     | 0.136 |
| u    | 2.400       | 2.500  | 0.094     | 0.098 |
| v    | 0.400       | 0.500  | 0.016     | 0.020 |

ECN: X09-0126-Rev. B, 26-Oct-09  
DWG: 5972

**Notes**

1. To be used only for process drawing.
2. These dimensions apply to all TO-220, FULLPAK leadframe versions 3 leads.
3. All critical dimensions should C meet  $C_{pk} > 1.33$ .
4. All dimensions include burrs and plating thickness.
5. No chipping or package damage.

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## Material Category Policy

**Taiwan VBsemi ElectronicsCo., Ltd., hereby certify that all of the products are determined to be RoHS compliant and meets the definition of restrictions under Directive of the European Parliament 2011/65/ EU,2011 Nian.6.8 Ri Yue restrict the use of certain hazardous substances in electrical and electronic equipment (EEE) -modification, unless otherwise specified as inconsistent.(www.VBsemi.com)**

**Please note that some documents may still refer to Taiwan VBsemiRoHS Directive 2002/95/EC.We confirm that all products identified as consistent with the Directive 2002/95 / EC European Directive 2011/65/.**

**Taiwan VBsemi Electronics Co., Ltd. hereby certify that all of its products comply identified as halogen-free halogen-free standards required by the JEDEC JS709A. Please note that some Taiwanese VBsemi documents still refer to the definition of IEC 61249-2-21,and we are sure that all products conform to confirm compliance with IEC 61249-2-21standard level JS709A.**