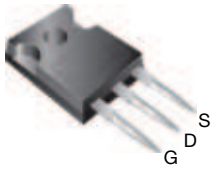
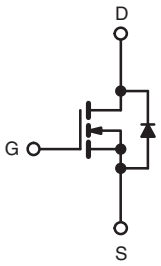
# Power MOSFET

TO-247AC




N-Channel MOSFET

## FEATURES

- Ultra low gate charge
- Reduced gate drive requirement
- Enhanced 30 $V_{GS}$ rating
- Reduced $C_{iss}$, $C_{oss}$, $C_{rss}$
- Isolated central mounting hole
- Dynamic dV/dt rated
- Repetitive avalanche rated
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912

RoHS* Available

**Note**

* This datasheet provides information about parts that are RoHS-compliant and / or parts that are non RoHS-compliant. For example, parts with lead (Pb) terminations are not RoHS-compliant. Please see the information / tables in this datasheet for details

## DESCRIPTION

This new series of low charge Power MOSFETs achieve significantly lower gate charge over conventional MOSFETs. Utilizing advanced MOSFETs technology the device improvements allow for reduced gate drive requirements, faster switching speeds and increased total system savings. These device improvements combined with the proven ruggedness and reliability of MOSFETs offer the designer a new standard in power transistors for switching applications.

The TO-247AC package is preferred for commercial-industrial applications where higher power levels preclude the use of TO-220AB devices. The TO-247AC is similar but superior to the earlier TO-218 package because of its isolated mounting hole.

| PRODUCT SUMMARY | | |
|---|---|---|
| $V_{DS}$ (V) | 400 | |
| $R_{DS(on)}$ (Ω) | $V_{GS}$ = 10 V | 0.30 |
| $Q_g$ (Max.) (nC) | 76 | |
| $Q_{gs}$ (nC) | 20 | |
| $Q_{gd}$ (nC) | 37 | |
| Configuration | Single | |

| ORDERING INFORMATION | |
|---|---|
| Package | TO-247AC |
| Lead (Pb)-free | IRFP350LCPbF |

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

| PARAMETER | | | SYMBOL | LIMIT | UNIT |
|---|---|---|---|---|---|
| Drain-source voltage | | | $V_{DS}$ | 400 | V |
| Gate-source voltage | | | $V_{GS}$ | ± 30 | |
| Continuous drain current | $V_{GS}$ at 10 V | $T_C$ = 25 °C | $I_D$ | 16 | A |
| | | $T_C$ = 100 °C | | 9.9 | |
| Pulsed drain Current [a] | | | $I_{DM}$ | 64 | |
| Linear derating factor | | | | 1.5 | W/°C |
| Single pulse avalanche energy [b] | | | $E_{AS}$ | 390 | mJ |
| Repetitive avalanche current [a] | | | $I_{AR}$ | 16 | A |
| Repetitive avalanche energy [a] | | | $E_{AR}$ | 19 | mJ |
| Maximum power dissipation | $T_C$ = 25 °C | | $P_D$ | 190 | W |
| Peak diode recovery dV/dt [c] | | | dV/dt | 4.0 | V/ns |
| Operating junction and storage temperature range | | | $T_J$, $T_{stg}$ | -55 to +150 | °C |
| Soldering recommendations (peak temperature) [d] | for 10 s | | | 300[d] | |
| Mounting torque | 6-32 or M3 screw | | | 10 | lbf · in |
| | | | | 1.1 | N · m |

**Notes**

a. Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11)
b. $V_{DD}$ = 25 V, starting $T_J$ = 25 °C, L = 2.7 mH, $R_g$ = 25 Ω, $I_{AS}$ = 16 A (see fig. 12)
c. $I_{SD}$ ≤ 16 A, dI/dt ≤ 200 A/µs, $V_{DD}$ ≤ $V_{DS}$, $T_J$ ≤ 150 °C
d. 1.6 mm from case



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## THERMAL RESISTANCE RATINGS

| PARAMETER | SYMBOL | TYP. | MAX. | UNIT |
|---|---|---|---|---|
| Maximum junction-to-ambient | $R_{thJA}$ | - | 40 | °C/W |
| Case-to-sink, flat, greased surface | $R_{thCS}$ | 0.24 | - | |
| Maximum junction-to-case (drain) | $R_{thJC}$ | - | 0.65 | |

## SPECIFICATIONS ($T_J$ = 25 °C, unless otherwise noted)

| PARAMETER | SYMBOL | TEST CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|---|---|---|---|---|---|---|
| **Static** | | | | | | |
| Drain-source breakdown voltage | $V_{DS}$ | $V_{GS}$ = 0 V, $I_D$ = 250 µA | 400 | - | - | V |
| $V_{DS}$ temperature coefficient | $\Delta V_{DS}/T_J$ | Reference to 25 °C, $I_D$ = 1 mA | - | 0.49 | - | V/°C |
| Gate-source threshold voltage | $V_{GS(th)}$ | $V_{DS}$ = $V_{GS}$, $I_D$ = 250 µA | 2.0 | - | 4.0 | V |
| Gate-source leakage | $I_{GSS}$ | $V_{GS}$ = ± 20 V | - | - | ± 100 | nA |
| Zero gate voltage drain current | $I_{DSS}$ | $V_{DS}$ = 400 V, $V_{GS}$ = 0 V | - | - | 25 | µA |
| | | $V_{DS}$ = 320 V, $V_{GS}$ = 0 V, $T_J$ = 125 °C | - | - | 250 | |
| Drain-source on-state resistance | $R_{DS(on)}$ | $V_{GS}$ = 10 V; $I_D$ = 9.6 A [b] | - | - | 0.30 | Ω |
| Forward transconductance | $g_{fs}$ | $V_{DS}$ = 50 V, $I_D$ = 9.6 A [b] | 8.1 | - | - | S |
| **Dynamic** | | | | | | |
| Input capacitance | $C_{iss}$ | $V_{GS}$ = 0 V, $V_{DS}$ = 25 V, f = 1.0 MHz, see fig. 5 | - | 2200 | - | pF |
| Output capacitance | $C_{oss}$ | | - | 390 | - | |
| Reverse transfer capacitance | $C_{rss}$ | | - | 31 | - | |
| Total Gate charge | $Q_g$ | $V_{GS}$ = 10 V; $I_D$ = 16 A, $V_{DS}$ = 320 V, see fig. 6 and 13 [b] | - | - | 76 | nC |
| Gate-source charge | $Q_{gs}$ | | - | - | 20 | |
| Gate-drain charge | $Q_{gd}$ | | - | - | 37 | |
| Turn-on delay time | $t_{d(on)}$ | $V_{DD}$ = 200 V, $I_D$ = 16 A, $R_g$ = 6.2 Ω, $R_D$ = 12 Ω, see fig. 10 [b] | - | 14 | - | ns |
| Rise time | $t_r$ | | - | 54 | - | |
| Turn-off delay time | $t_{d(off)}$ | | - | 33 | - | |
| Fall time | $t_f$ | | - | 35 | - | |
| **Drain-Source Body Diode Characteristics** | | | | | | |
| Continuous source-drain diode current | $I_S$ | MOSFET symbol showing the integral reverse p - n junction diode  | - | - | 16 | A |
| Pulsed diode forward current [a] | $I_{SM}$ | | - | - | 64 | |
| Body diode voltage | $V_{SD}$ | $T_J$ = 25 °C, $I_S$ = 16 A, $V_{GS}$ = 0 V [b] | - | - | 1.6 | V |
| Body diode reverse recovery time | $t_{rr}$ | $T_J$ = 25 °C, $I_F$ = 16 A, dI/dt = 100 A/µs [b] | - | 440 | 660 | ns |
| Body diode reverse recovery charge | $Q_{rr}$ | | - | 4.1 | 6.2 | 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 ≤ 300 µs; duty cycle ≤ 2 %



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

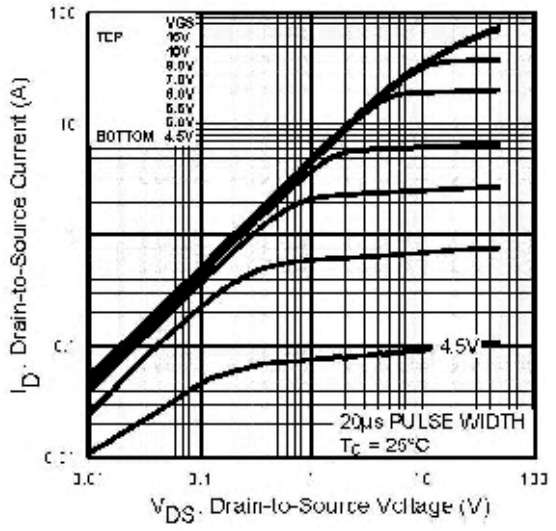



**Fig. 1 - Typical Output Characteristics, $T_C$ = 25 °C**

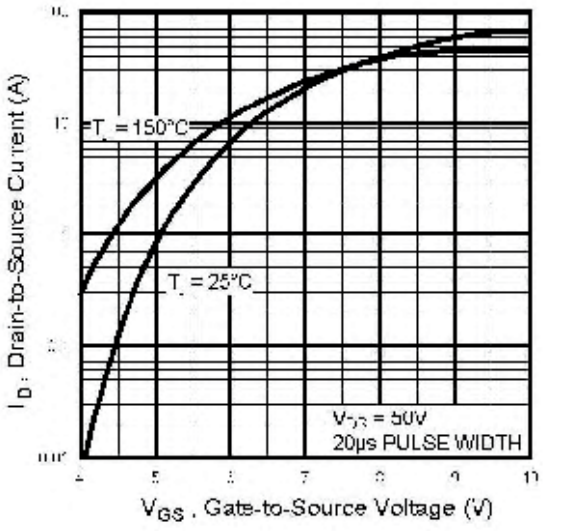



**Fig. 3 - Typical Transfer Characteristics**

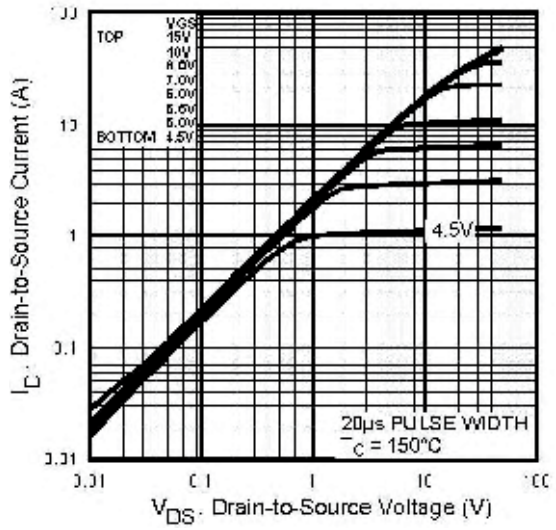



**Fig. 2 - Typical Output Characteristics, $T_C$ = 150 °C**

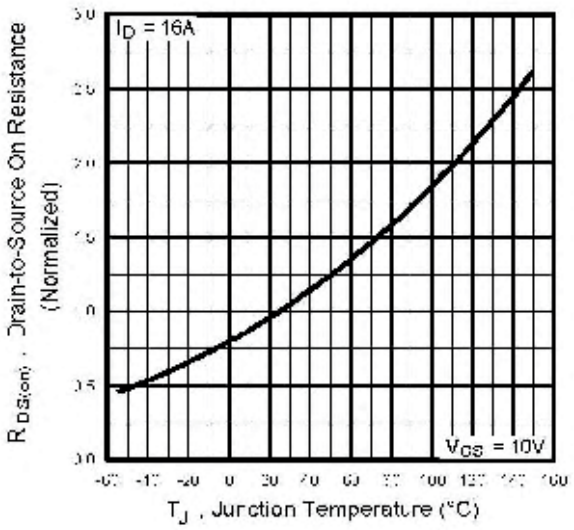



**Fig. 4 - Normalized On-Resistance vs. Temperature**



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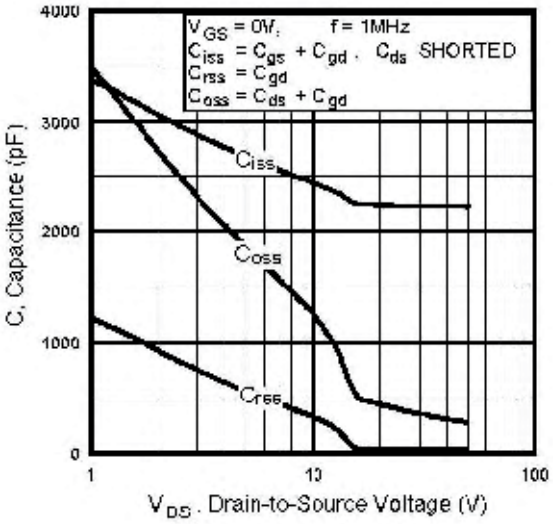



**Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage**

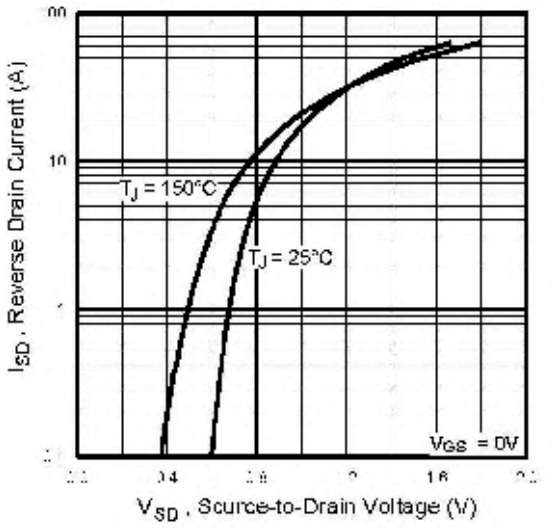



**Fig. 7 - Typical Source-Drain Diode Forward Voltage**

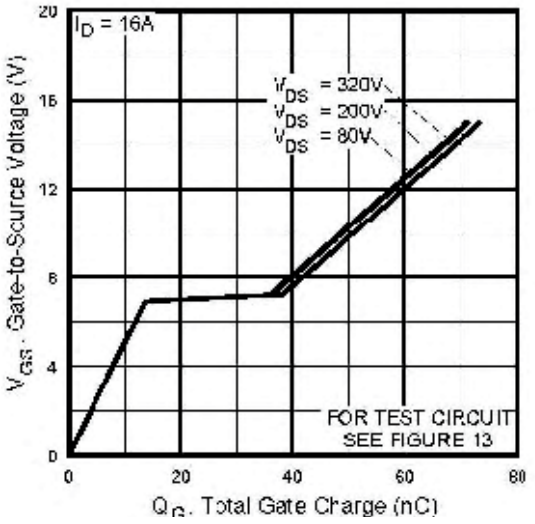



**Fig. 6 - Typical Gate Charge vs. Gate-to-Source Voltage**

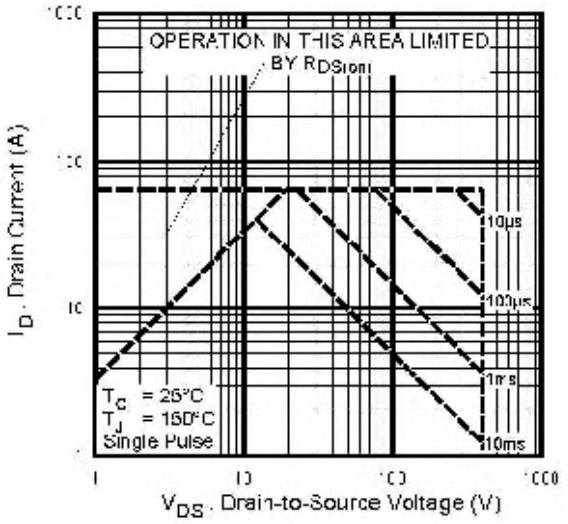



**Fig. 8 - Maximum Safe Operating Area**


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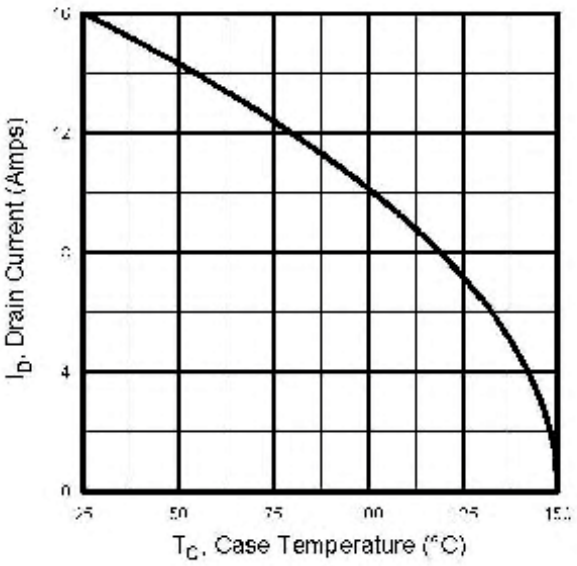



Fig. 9 - Maximum Drain Current vs. Case Temperature

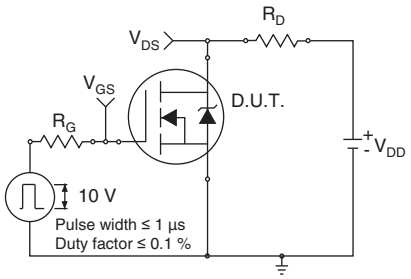



Fig. 10 - Switching Time Test Circuit

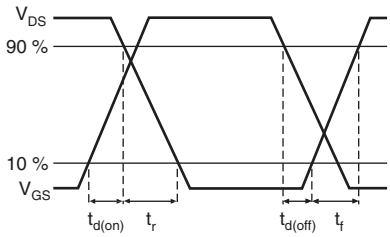



Fig. 11 - Switching Time Waveforms

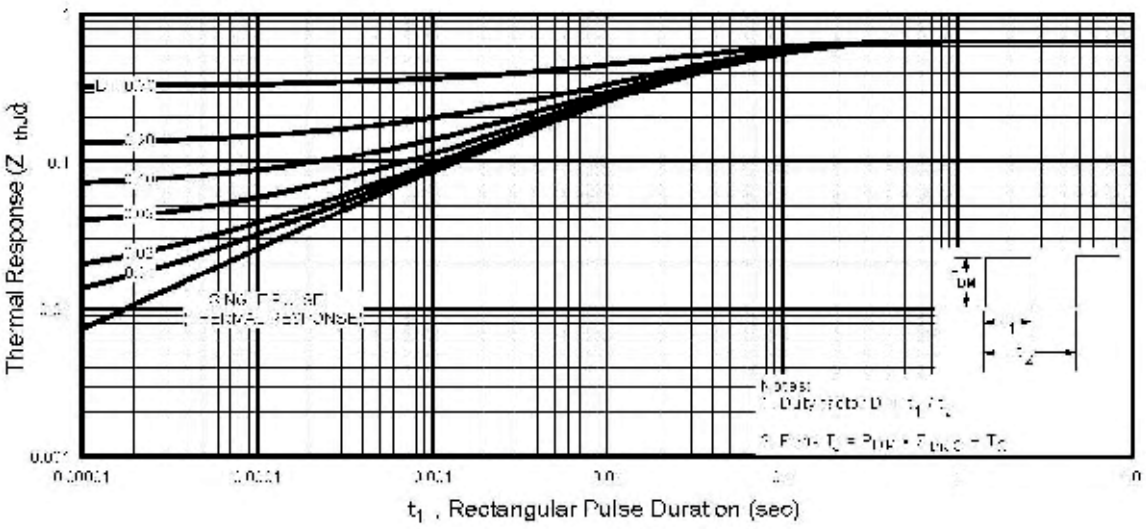



Fig. 12 - Maximum Effective Transient Thermal Impedance, Junction-to-Case



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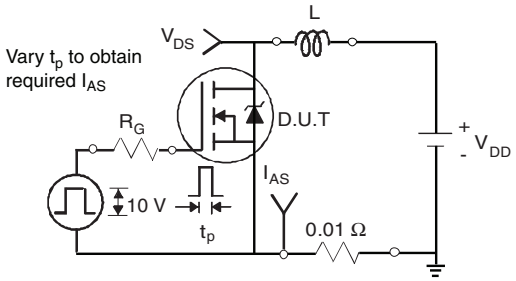



**Fig. 13 - Unclamped Inductive Test Circuit**

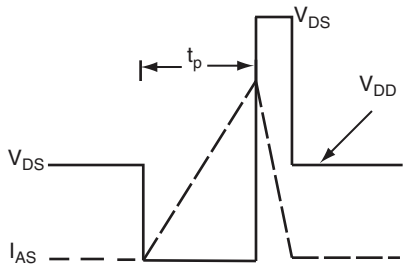



**Fig. 14 - Unclamped Inductive Waveforms**

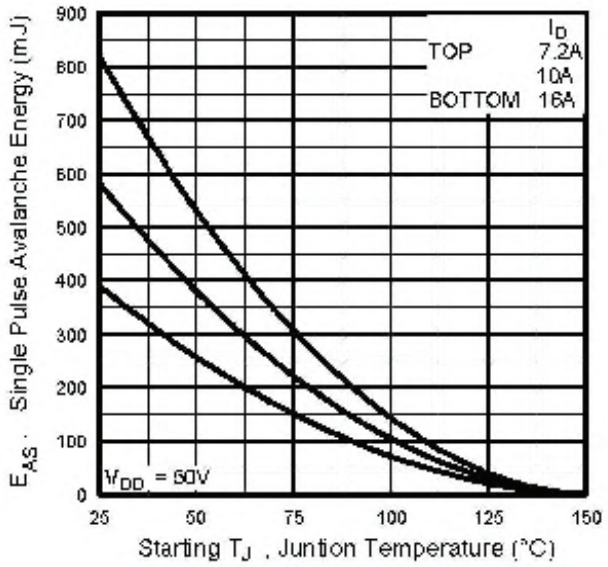



**Fig. 15 - Maximum Avalanche Energy vs. Drain Current**

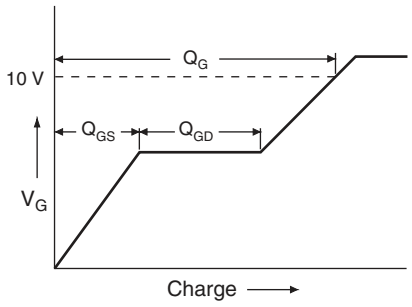



**Fig. 16 - Basic Gate Charge Waveform**

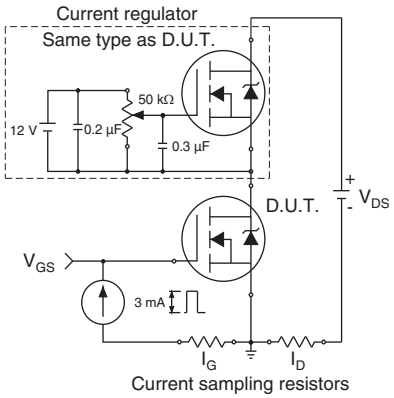
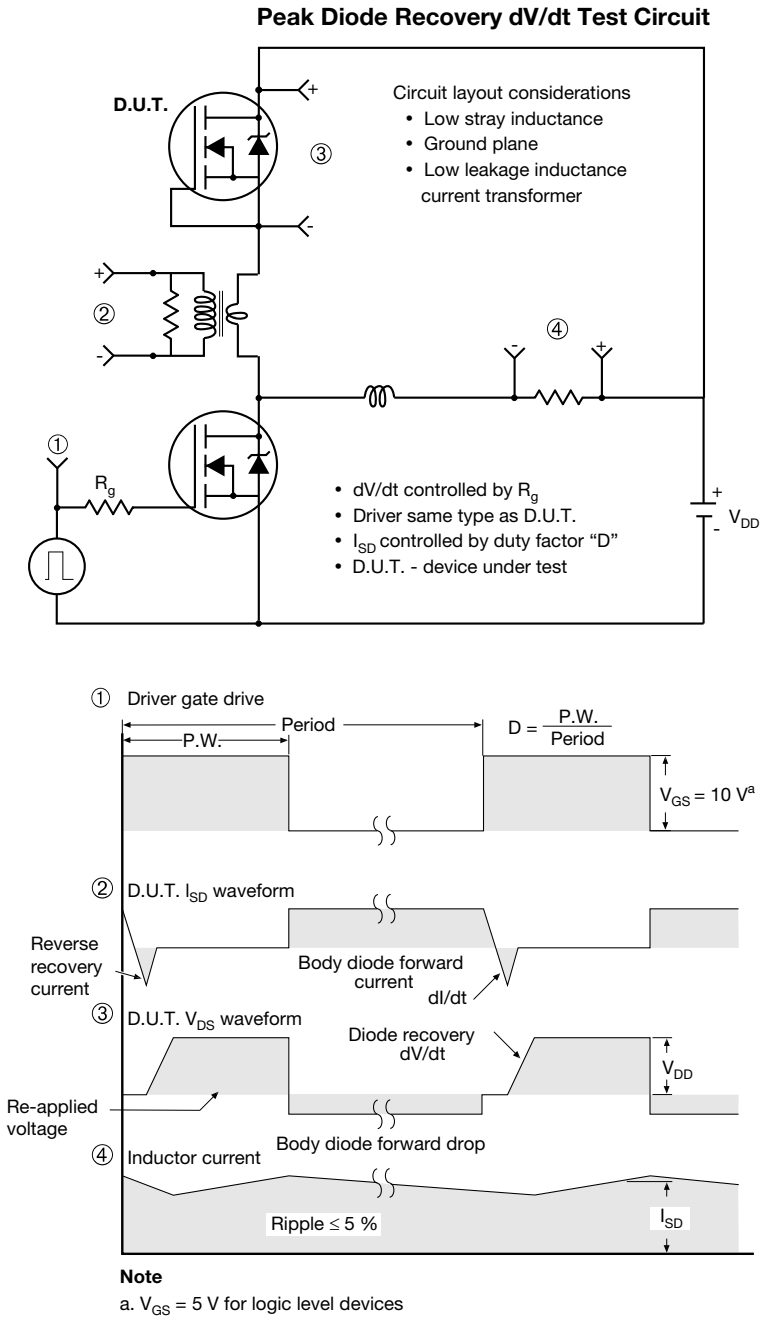



**Fig. 17 - Gate Charge Test Circuit**


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**Note**

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

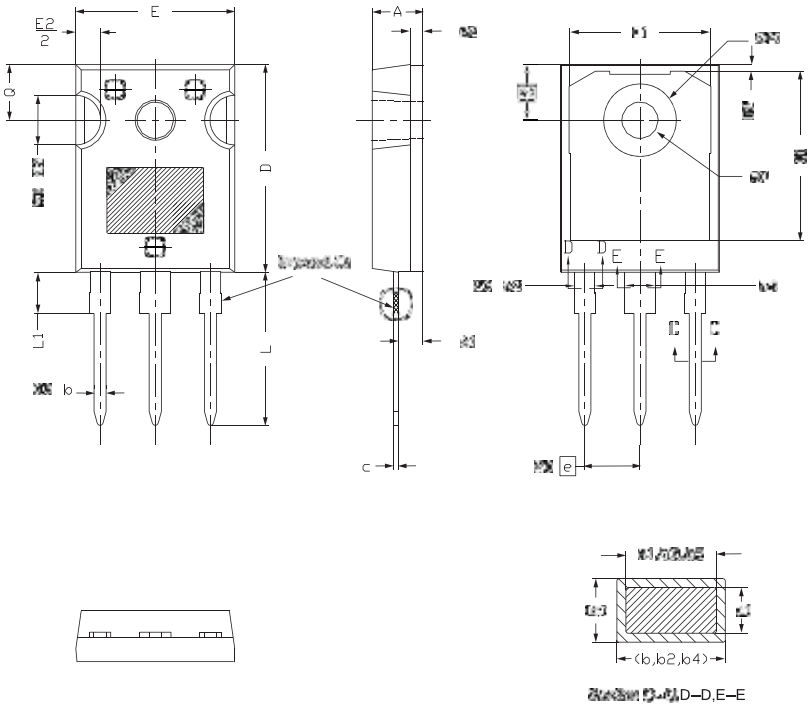
**Fig. 18 - For N-Channel**

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# TO-247AC (High Voltage)

## VERSION 1: FACILITY CODE = 9




| | MILLIMETERS | | | |
|---|---|---|---|---|
| DIM. | MIN. | NOM. | MAX. | NOTES |
| A | 4.83 | 5.02 | 5.21 | |
| A1 | 2.29 | 2.41 | 2.55 | |
| A2 | 1.17 | 1.27 | 1.37 | |
| b | 1.12 | 1.20 | 1.33 | |
| b1 | 1.12 | 1.20 | 1.28 | |
| b2 | 1.91 | 2.00 | 2.39 | 6 |
| b3 | 1.91 | 2.00 | 2.34 | |
| b4 | 2.87 | 3.00 | 3.22 | 6, 8 |
| b5 | 2.87 | 3.00 | 3.18 | |
| c | 0.40 | 0.50 | 0.60 | 6 |
| c1 | 0.40 | 0.50 | 0.56 | |
| D | 20.40 | 20.55 | 20.70 | 4 |

| | MILLIMETERS | | | |
|---|---|---|---|---|
| DIM. | MIN. | NOM. | MAX. | NOTES |
| D1 | 16.46 | 16.76 | 17.06 | 5 |
| D2 | 0.56 | 0.66 | 0.76 | |
| E | 15.50 | 15.70 | 15.87 | 4 |
| E1 | 13.46 | 14.02 | 14.16 | 5 |
| E2 | 4.52 | 4.91 | 5.49 | 3 |
| e | 5.46 BSC | | | |
| L | 14.90 | 15.15 | 15.40 | |
| L1 | 3.96 | 4.06 | 4.16 | 6 |
| Ø P | 3.56 | 3.61 | 3.65 | 7 |
| Ø P1 | 7.19 ref. | | | |
| Q | 5.31 | 5.50 | 5.69 | |
| S | 5.51 BSC | | | |

**Notes**

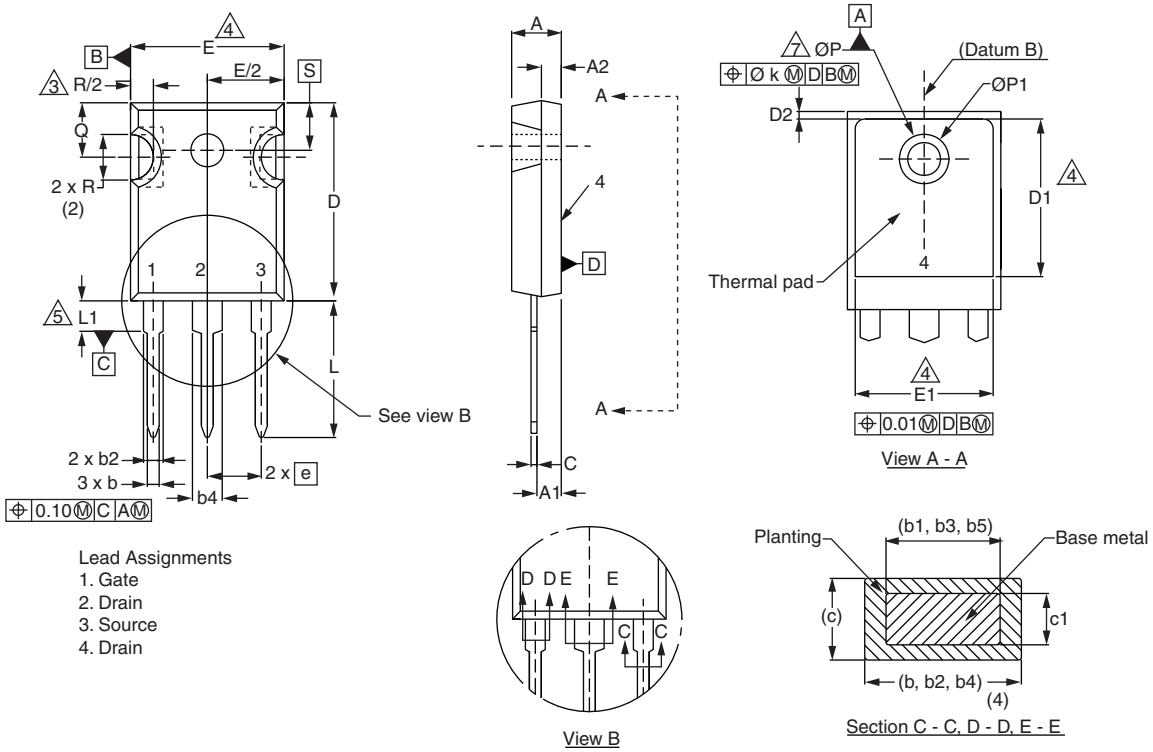
(1) Package reference: JEDEC® TO247, variation AC
(2) All dimensions are in mm
(3) Slot required, notch may be rounded
(4) Dimension D and E do not include mold flash. Mold flash shall not exceed 0.127 mm per side. These dimensions are measured at the outermost extremes of the plastic body
(5) Thermal pad contour optional with dimensions D1 and E1
(6) Lead finish uncontrolled in L1
(7) Ø P to have a maximum draft angle of 1.5° to the top of the part with a maximum hole diameter of 3.91 mm
(8) Dimension b2 and b4 does not include dambar protrusion. Allowable dambar protrusion shall be 0.1 mm total in excess of b2 and b4 dimension at maximum material condition



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## VERSION 2: FACILITY CODE = Y




Lead Assignments
1. Gate
2. Drain
3. Source
4. Drain

| | MILLIMETERS | | |
|---|---|---|---|
| DIM. | MIN. | MAX. | NOTES |
| A | 4.58 | 5.31 | |
| A1 | 2.21 | 2.59 | |
| A2 | 1.17 | 2.49 | |
| b | 0.99 | 1.40 | |
| b1 | 0.99 | 1.35 | |
| b2 | 1.53 | 2.39 | |
| b3 | 1.65 | 2.37 | |
| b4 | 2.42 | 3.43 | |
| b5 | 2.59 | 3.38 | |
| c | 0.38 | 0.86 | |
| c1 | 0.38 | 0.76 | |
| D | 19.71 | 20.82 | |
| D1 | 13.08 | - | |

| | MILLIMETERS | | |
|---|---|---|---|
| DIM. | MIN. | MAX. | NOTES |
| D2 | 0.51 | 1.30 | |
| E | 15.29 | 15.87 | |
| E1 | 13.72 | - | |
| e | 5.46 BSC | | |
| Ø k | 0.254 | | |
| L | 14.20 | 16.25 | |
| L1 | 3.71 | 4.29 | |
| Ø P | 3.51 | 3.66 | |
| Ø P1 | - | 7.39 | |
| Q | 5.31 | 5.69 | |
| R | 4.52 | 5.49 | |
| S | 5.51 BSC | | |
| | | | |

**Notes**

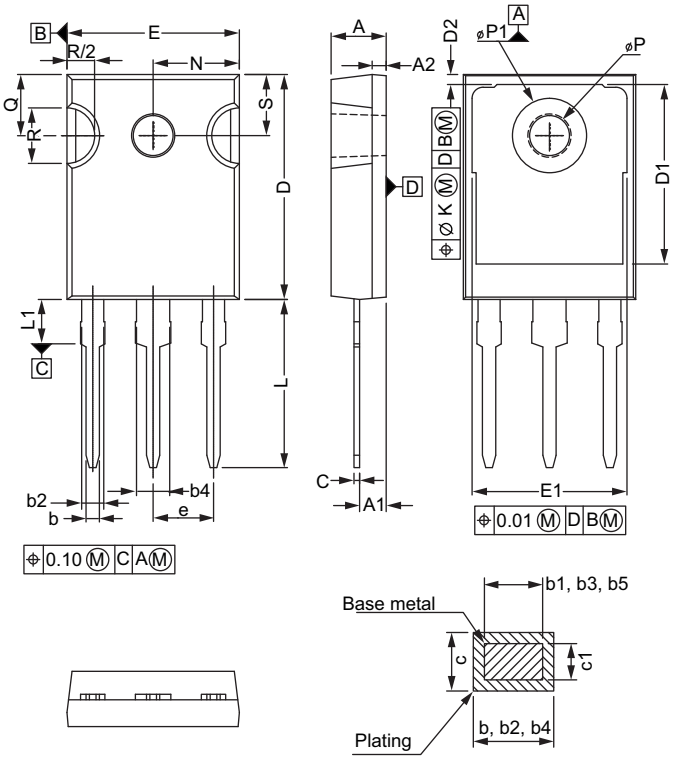
(1) Dimensioning and tolerancing per ASME Y14.5M-1994
(2) Contour of slot optional
(3) Dimension D and E do not include mold flash. Mold flash shall not exceed 0.127 mm (0.005") per side. These dimensions are measured at the outermost extremes of the plastic body
(4) Thermal pad contour optional with dimensions D1 and E1
(5) Lead finish uncontrolled in L1
(6) Ø P to have a maximum draft angle of 1.5 to the top of the part with a maximum hole diameter of 3.91 mm (0.154")
(7) Outline conforms to JEDEC outline TO-247 with exception of dimension c



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## VERSION 3: FACILITY CODE = N




| | MILLIMETERS | |
|---|---|---|
| DIM. | MIN. | MAX. |
| A | 4.65 | 5.31 |
| A1 | 2.21 | 2.59 |
| A2 | 1.17 | 1.37 |
| b | 0.99 | 1.40 |
| b1 | 0.99 | 1.35 |
| b2 | 1.65 | 2.39 |
| b3 | 1.65 | 2.34 |
| b4 | 2.59 | 3.43 |
| b5 | 2.59 | 3.38 |
| c | 0.38 | 0.89 |
| c1 | 0.38 | 0.84 |
| D | 19.71 | 20.70 |
| D1 | 13.08 | - |

| | MILLIMETERS | |
|---|---|---|
| DIM. | MIN. | MAX. |
| D2 | 0.51 | 1.35 |
| E | 15.29 | 15.87 |
| E1 | 13.46 | - |
| e | 5.46 BSC | |
| k | 0.254 | |
| L | 14.20 | 16.10 |
| L1 | 3.71 | 4.29 |
| N | 7.62 BSC | |
| P | 3.56 | 3.66 |
| P1 | - | 7.39 |
| Q | 5.31 | 5.69 |
| R | 4.52 | 5.49 |
| S | 5.51 BSC | |

ECN: E22-0452-Rev. G, 31-Oct-2022
DWG: 5971

**Notes**

(1) Dimensioning and tolerancing per ASME Y14.5M-1994
(2) Contour of slot optional
(3) Dimension D and E do not include mold flash. Mold flash shall not exceed 0.127 mm (0.005") per side. These dimensions are measured at the outermost extremes of the plastic body
(4) Thermal pad contour optional with dimensions D1 and E1
(5) Lead finish uncontrolled in L1
(6) Ø P to have a maximum draft angle of 1.5 to the top of the part with a maximum hole diameter of 3.91 mm (0.154")



For technical questions, contact: hvm@vishay.com

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