

## Power MOSFET

**TO-220AB**


N-Channel MOSFET

### FEATURES

- Low gate charge  $Q_g$  results in simple drive requirement
- Improved gate, avalanche, and dynamic  $dV/dt$  ruggedness
- Fully characterized capacitance and avalanche voltage and current
- Effective  $C_{oss}$  specified
- Material categorization: for definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)


 Available  
**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

### APPLICATIONS

- Switch mode power supply (SMPS)
- Uninterruptable power supply
- High speed power switching

### TYPICAL SMPS TOPOLOGIES

- Two transistor forward
- Half bridge
- Full bridge

### PRODUCT SUMMARY

|                           |                 |      |
|---------------------------|-----------------|------|
| $V_{DS}$ (V)              | 500             |      |
| $R_{DS(on)}$ ( $\Omega$ ) | $V_{GS} = 10$ V | 0.85 |
| $Q_g$ max. (nC)           | 38              |      |
| $Q_{gs}$ (nC)             | 9.0             |      |
| $Q_{gd}$ (nC)             | 18              |      |
| Configuration             | Single          |      |

### ORDERING INFORMATION

|                                 |                |
|---------------------------------|----------------|
| Package                         | TO-220AB       |
| Lead (Pb)-free                  | IRF840APbF     |
| Lead (Pb)-free and halogen-free | IRF840APbF-BE3 |


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

| PARAMETER   | SYMBOL           | LIMIT          | UNIT        |       |
|---|------------------|----------------|-------------|-------|
| Drain-source voltage                                      | $V_{DS}$         | 500            | V           |       |
| Gate-source voltage                                       | $V_{GS}$         | $\pm 30$       |             |       |
| Continuous drain current                                  | $V_{GS}$ at 10 V | $T_C = 25$ °C  | 8.0         | A     |
|   |                  | $T_C = 100$ °C | 5.1         |       |
| Pulsed drain current <sup>a</sup>                         | $I_{DM}$         | 32             |             |       |
| Linear derating factor                                    |                  | 1.0            | W/°C        |       |
| Single pulse avalanche energy <sup>b</sup>                | $E_{AS}$         | 510            | mJ          |       |
| Repetitive avalanche current <sup>a</sup>                 | $I_{AR}$         | 8.0            | A           |       |
| Repetitive avalanche energy <sup>a</sup>                  | $E_{AR}$         | 13             | mJ          |       |
| Maximum power dissipation                                 | $T_C = 25$ °C    | $P_D$          | 125         | W     |
| Peak diode recovery $dV/dt$ <sup>c</sup>                  |                  | $dV/dt$        | 5.0         | V/ns  |
| Operating junction and storage temperature range          |                  | $T_J, T_{stg}$ | -55 to +150 | °C    |
| Soldering recommendations (peak temperature) <sup>d</sup> | For 10 s         |                | 300         |       |
| Mounting torque   | 6-32 or M3 screw |                | 10          |       |
|   |                  |                | 1.1         | N · m |

### Notes

- Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11)
- $V_{DD} = 50$  V, starting  $T_J = 25$  °C,  $L = 16$  mH,  $R_g = 25$   $\Omega$ ,  $I_{AS} = 8.0$  A (see fig. 12)
- $I_{SD} \leq 8.0$  A,  $dI/dt \leq 100$  A/ $\mu$ s,  $V_{DD} \leq V_{DS}$ ,  $T_J \leq 150$  °C
- 1.6 mm from case

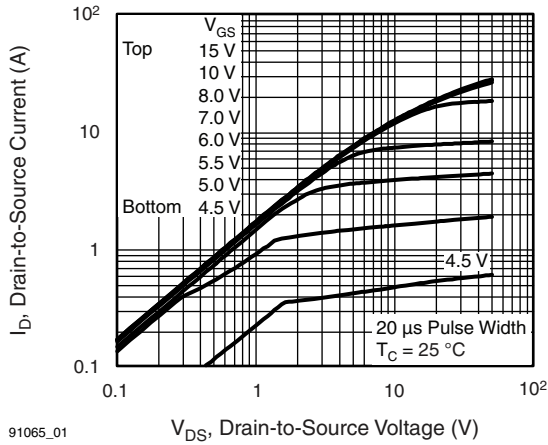
| THERMAL RESISTANCE RATINGS          |            |      |      |      |
|-------------------------------------|------------|------|------|------|
| PARAMETER                           | SYMBOL     | TYP. | MAX. | UNIT |
| Maximum junction-to-ambient         | $R_{thJA}$ | -    | 62   | °C/W |
| Case-to-sink, flat, greased surface | $R_{thCS}$ | 0.50 | -    |      |
| Maximum junction-to-case (drain)    | $R_{thJC}$ | -    | 1.0  |      |

| SPECIFICATIONS ( $T_J = 25\text{ }^\circ\text{C}$ , unless otherwise noted) |                       |   |  |      |      |           |               |
|---|-----------------------|---|--|------|------|-----------|---------------|
| PARAMETER   | SYMBOL                | TEST CONDITIONS   |  | MIN. | TYP. | MAX.      | UNIT          |
| <b>Static</b>   |                       |   |  |      |      |           |               |
| Drain-source breakdown voltage  | $V_{DS}$              | $V_{GS} = 0\text{ V}$ , $I_D = 250\text{ }\mu\text{A}$  |  | 500  | -    | -         | V             |
| $V_{DS}$ temperature coefficient  | $\Delta V_{DS}/T_J$   | Reference to $25\text{ }^\circ\text{C}$ , $I_D = 1\text{ mA}$   |  | -    | 0.58 | -         | V/°C          |
| Gate-source threshold voltage   | $V_{GS(th)}$          | $V_{DS} = V_{GS}$ , $I_D = 250\text{ }\mu\text{A}$  |  | 2.0  | -    | 4.0       | V             |
| Gate-source leakage   | $I_{GSS}$             | $V_{GS} = \pm 30\text{ V}$  |  | -    | -    | $\pm 100$ | nA            |
| Zero gate voltage drain current   | $I_{DSS}$             | $V_{DS} = 500\text{ V}$ , $V_{GS} = 0\text{ V}$   |  | -    | -    | 25        | $\mu\text{A}$ |
|   |                       | $V_{DS} = 400\text{ V}$ , $V_{GS} = 0\text{ V}$ , $T_J = 125\text{ }^\circ\text{C}$   |  | -    | -    | 250       |               |
| Drain-source on-state resistance  | $R_{DS(on)}$          | $V_{GS} = 10\text{ V}$  | $I_D = 4.8\text{ A}^b$   | -    | -    | 0.85      | $\Omega$      |
| Forward transconductance  | $g_{fs}$              | $V_{DS} = 50\text{ V}$ , $I_D = 4.8\text{ A}^b$   |  | 3.7  | -    | -         | S             |
| <b>Dynamic</b>  |                       |   |  |      |      |           |               |
| Input capacitance   | $C_{iss}$             | $V_{GS} = 0\text{ V}$ ,<br>$V_{DS} = 25\text{ V}$ ,<br>$f = 1.0\text{ MHz}$ , see fig. 5  |  | -    | 1018 | -         | pF            |
| Output capacitance  | $C_{oss}$             |   |  | -    | 155  | -         |               |
| Reverse transfer capacitance  | $C_{riss}$            |   |  | -    | 8.0  | -         |               |
| Output capacitance  | $C_{oss}$             | $V_{GS} = 0\text{ V}$ ; $V_{DS} = 1.0\text{ V}$ , $f = 1.0\text{ MHz}$  |  | -    | 1490 | -         |               |
| Output capacitance  | $C_{oss}$             | $V_{GS} = 0\text{ V}$ ; $V_{DS} = 400\text{ V}$ , $f = 1.0\text{ MHz}$  |  | -    | 42   | -         |               |
| Effective output capacitance  | $C_{oss\text{ eff.}}$ | $V_{GS} = 0\text{ V}$ ; $V_{DS} = 0\text{ V to } 400\text{ V}^c$  |  | -    | 56   | -         |               |
| Total gate charge   | $Q_g$                 | $V_{GS} = 10\text{ V}$  | $I_D = 8\text{ A}$ , $V_{DS} = 400\text{ V}$ ,<br>see fig. 6 and 13 <sup>b</sup> | -    | -    | 38        | nC            |
| Gate-source charge  | $Q_{gs}$              |   |  | -    | -    | 9.0       |               |
| Gate-drain charge   | $Q_{gd}$              |   |  | -    | -    | 18        |               |
| Turn-on delay time  | $t_{d(on)}$           | $V_{DD} = 250\text{ V}$ , $I_D = 8\text{ A}$<br>$R_g = 9.1\text{ }\Omega$ , $R_D = 31\text{ }\Omega$ , see fig. 10 <sup>b</sup>                       |  | -    | 11   | -         | ns            |
| Rise time   | $t_r$                 |   |  | -    | 23   | -         |               |
| Turn-off delay time   | $t_{d(off)}$          |   |  | -    | 26   | -         |               |
| Fall time   | $t_f$                 |   |  | -    | 19   | -         |               |
| Gate input resistance   | $R_g$                 | $f = 1\text{ MHz}$ , open drain   |  | 0.7  | -    | 3.7       | $\Omega$      |
| <b>Drain-Source Body Diode Characteristics</b>                              |                       |   |  |      |      |           |               |
| Continuous source-drain diode current                                       | $I_S$                 | MOSFET symbol showing the integral reverse p - n junction diode  |  | -    | -    | 8.0       | A             |
| Pulsed diode forward current <sup>a</sup>                                   | $I_{SM}$              |   |  | -    | -    | 32        |               |
| Body diode voltage  | $V_{SD}$              | $T_J = 25\text{ }^\circ\text{C}$ , $I_S = 8\text{ A}$ , $V_{GS} = 0\text{ V}^b$   |  | -    | -    | 2.0       | V             |
| Body diode reverse recovery time  | $t_{rr}$              | $T_J = 25\text{ }^\circ\text{C}$ , $I_F = 8\text{ A}$ , $dI/dt = 100\text{ A}/\mu\text{s}^b$  |  | -    | 422  | 633       | ns            |
| Body diode reverse recovery charge  | $Q_{rr}$              |   |  | -    | 2.16 | 3.24      | $\mu\text{C}$ |
| Forward turn-on time  | $t_{on}$              | Intrinsic turn-on time is negligible (turn-on is dominated by $L_S$ and $L_D$ )   |  |      |      |           |               |

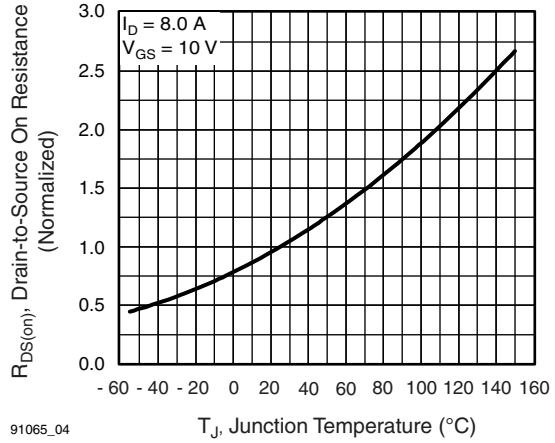
**Notes**

- Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11)
- Pulse width  $\leq 300\text{ }\mu\text{s}$ ; duty cycle  $\leq 2\%$
- $C_{oss\text{ eff.}}$  is a fixed capacitance that gives the same charging time as  $C_{oss}$  while  $V_{DS}$  is rising from 0 % to 80 %  $V_{DS}$

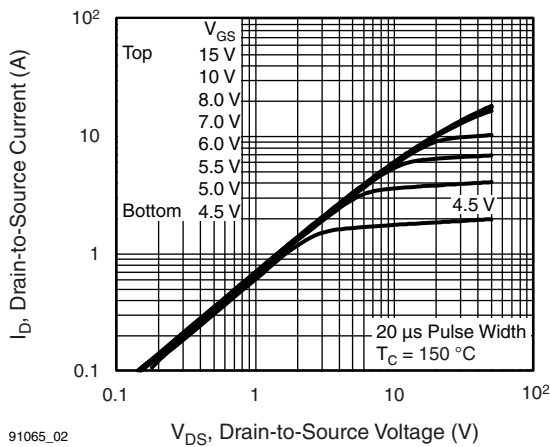
**TYPICAL CHARACTERISTICS** (25 °C, unless otherwise noted)



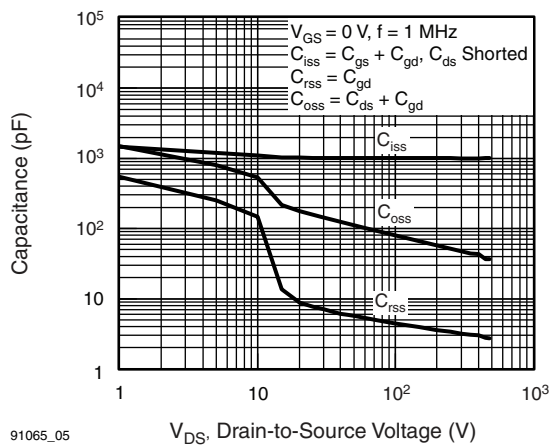
**Fig. 1 - Typical Output Characteristics,  $T_C = 25\text{ }^\circ\text{C}$**



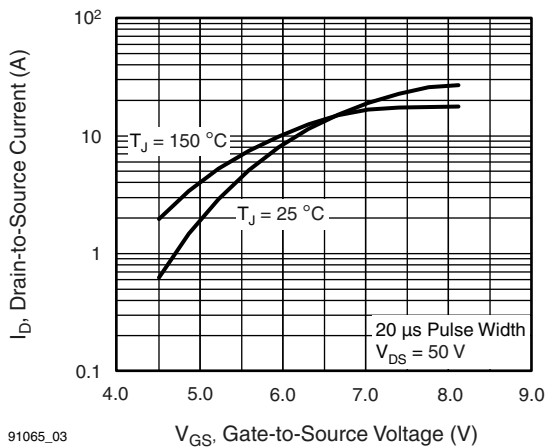
**Fig. 4 - Normalized On-Resistance vs. Temperature**



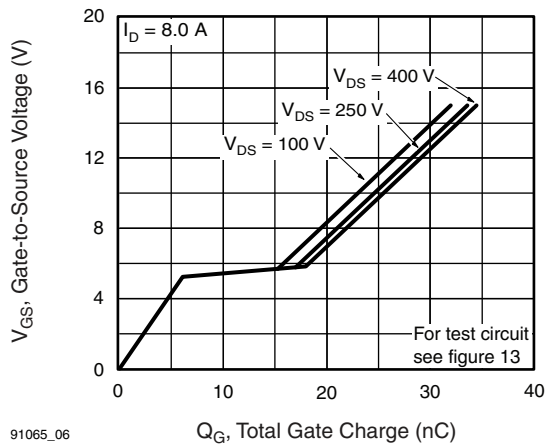
**Fig. 2 - Typical Output Characteristics,  $T_C = 150\text{ }^\circ\text{C}$**



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



**Fig. 3 - Typical Transfer Characteristics**



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

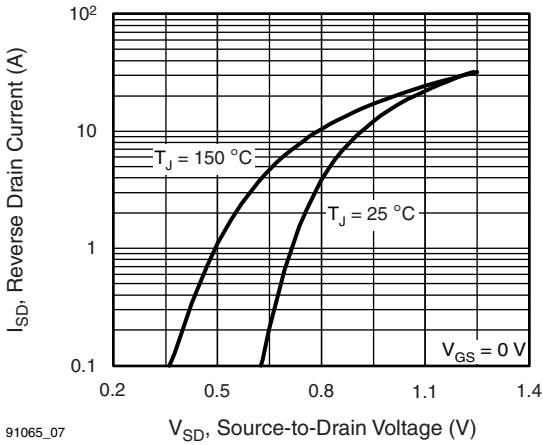


Fig. 7 - Typical Source-Drain Diode Forward Voltage

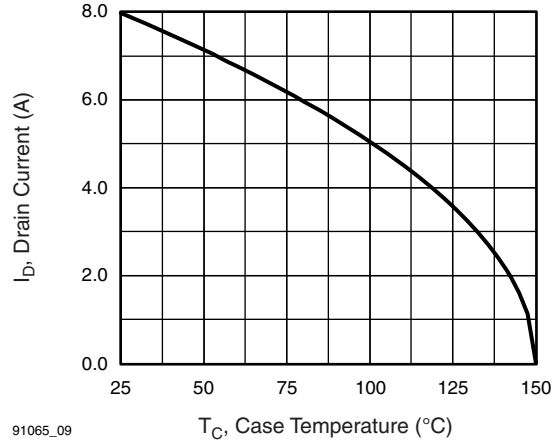


Fig. 9 - Maximum Drain Current vs. Case Temperature

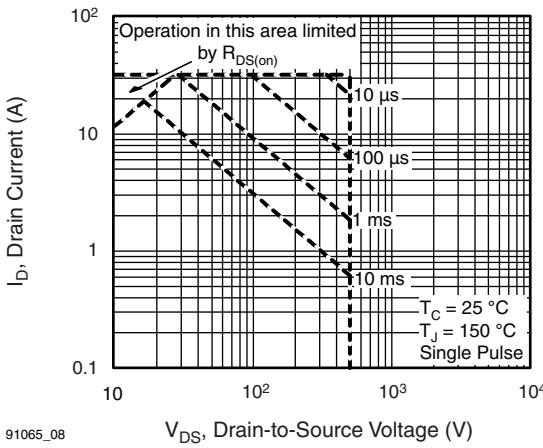


Fig. 8 - Maximum Safe Operating Area

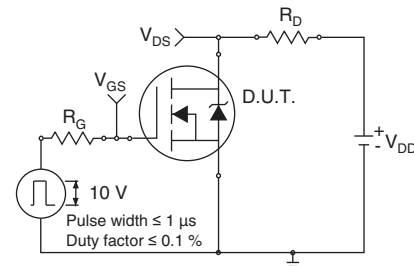


Fig. 10a - Switching Time Test Circuit

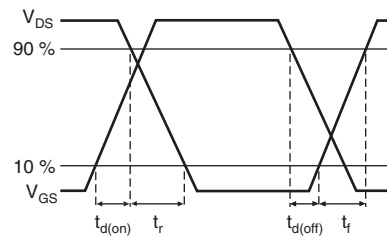


Fig. 10b - Switching Time Waveforms

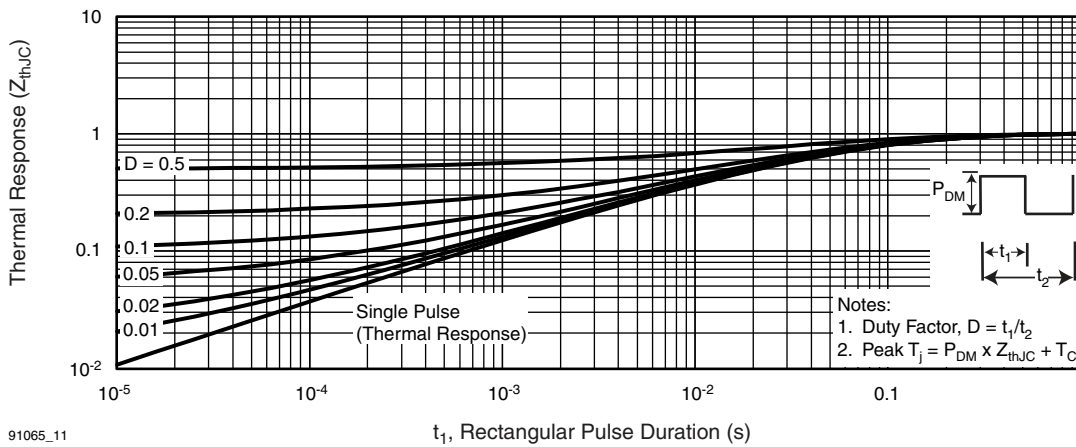


Fig. 11 - Maximum Effective Transient Thermal Impedance, Junction-to-Case

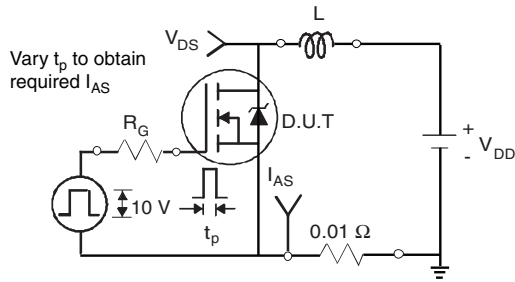


Fig. 12a - Unclamped Inductive Test Circuit

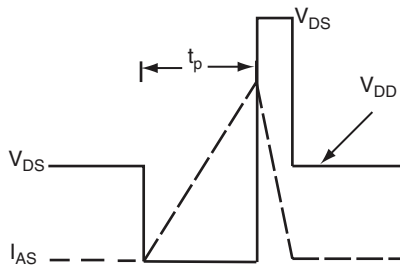
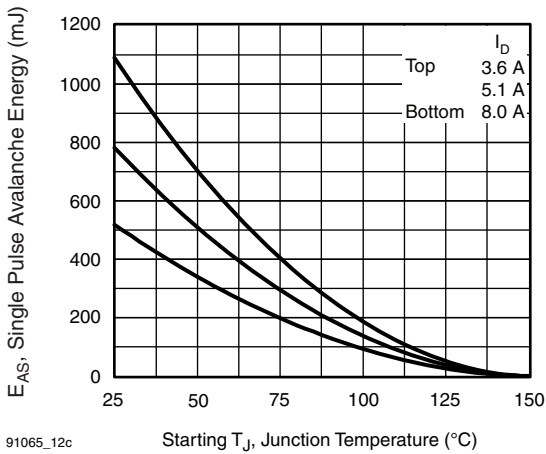


Fig. 12b - Unclamped Inductive Waveforms



91065\_12c

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

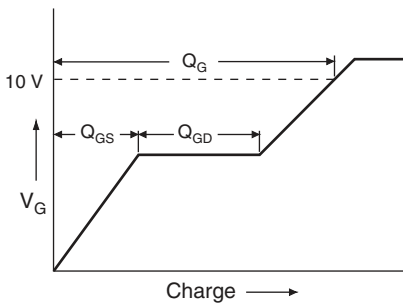
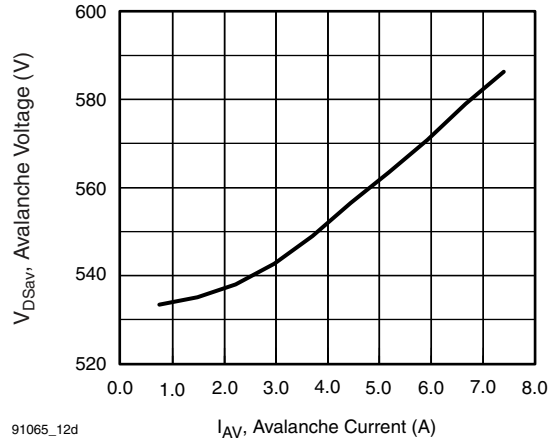


Fig. 12d - Basic Gate Charge Waveform



91065\_12d

Fig. 13a - Typical Drain-to-Source Voltage vs. Avalanche Current

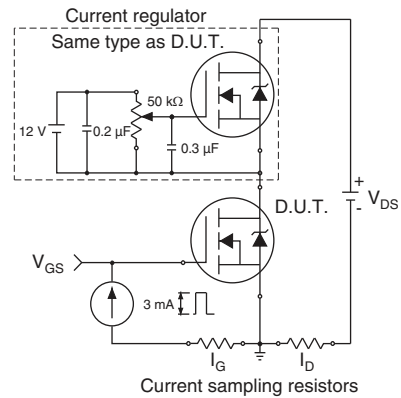
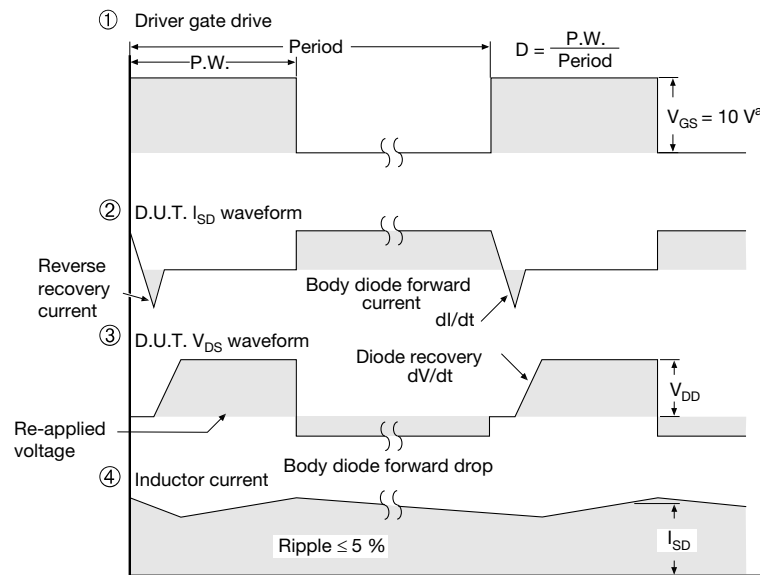
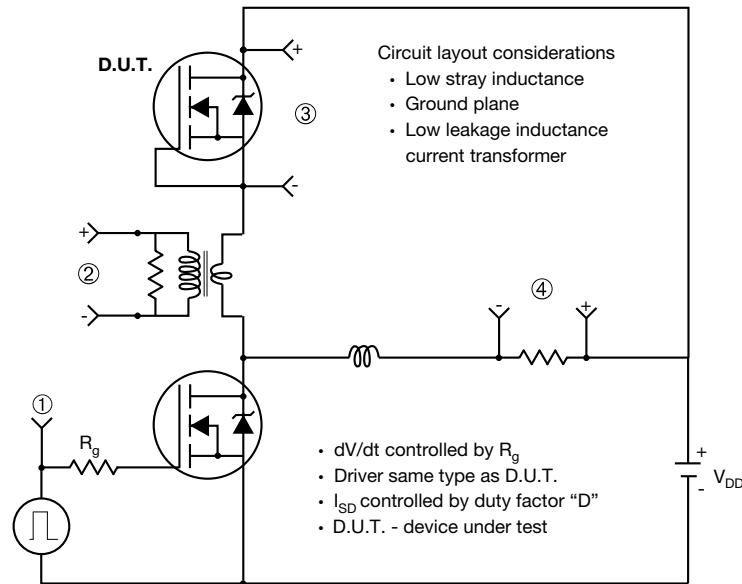


Fig. 13b - Gate Charge Test Circuit

Peak Diode Recovery dV/dt Test Circuit



Note

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

Fig. 14 - For N-Channel

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# TO-220-1



| DIM. | MILLIMETERS |       | INCHES |       |
|------|-------------|-------|--------|-------|
|      | MIN.        | MAX.  | MIN.   | MAX.  |
| A    | 4.24        | 4.65  | 0.167  | 0.183 |
| b    | 0.69        | 1.02  | 0.027  | 0.040 |
| b(1) | 1.14        | 1.78  | 0.045  | 0.070 |
| c    | 0.36        | 0.61  | 0.014  | 0.024 |
| D    | 14.33       | 15.85 | 0.564  | 0.624 |
| E    | 9.96        | 10.52 | 0.392  | 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) | 6.10        | 6.71  | 0.240  | 0.264 |
| J(1) | 2.41        | 2.92  | 0.095  | 0.115 |
| L    | 13.36       | 14.40 | 0.526  | 0.567 |
| L(1) | 3.33        | 4.04  | 0.131  | 0.159 |
| Ø P  | 3.53        | 3.94  | 0.139  | 0.155 |
| Q    | 2.54        | 3.00  | 0.100  | 0.118 |

ECN: E21-0621-Rev. D, 04-Nov-2021  
 DWG: 6031

**Note**

- M\* = 0.052 inches to 0.064 inches (dimension including protrusion), heatsink hole for HVM



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