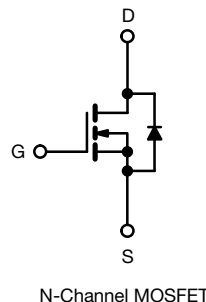
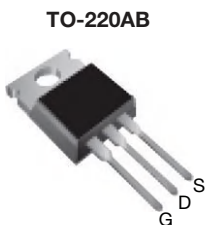


## IRF654BPBF-VB Datasheet Power MOSFET

| PRODUCT SUMMARY           |                        |      |
|---------------------------|------------------------|------|
| $V_{DS}$ (V)              | 250                    |      |
| $R_{DS(on)}$ ( $\Omega$ ) | $V_{GS} = 10\text{ V}$ | 0.19 |
| $Q_g$ max. (nC)           | 68                     |      |
| $Q_{gs}$ (nC)             | 11                     |      |
| $Q_{gd}$ (nC)             | 35                     |      |
| Configuration             | Single                 |      |

### FEATURES

- Dynamic dV/dt rating
- Repetitive avalanche rated
- Fast switching
- Ease of paralleling
- Simple drive requirements



| ABSOLUTE MAXIMUM RATINGS ( $T_C = 25\text{ }^\circ\text{C}$ , unless otherwise noted) |                  |                |                                   |                     |
|---|------------------|----------------|-----------------------------------|---------------------|
| PARAMETER   |                  | SYMBOL         | LIMIT                             | UNIT                |
| Drain-Source Voltage  |                  | $V_{DS}$       | 250                               | V                   |
| Gate-Source Voltage   |                  | $V_{GS}$       | $\pm 20$                          |                     |
| Continuous Drain Current  | $V_{GS}$ at 10 V | $I_D$          | $T_C = 25\text{ }^\circ\text{C}$  | 14                  |
|   |                  |                | $T_C = 100\text{ }^\circ\text{C}$ | 8.5                 |
| Pulsed Drain Current <sup>a</sup>   |                  | $I_{DM}$       | 56                                | A                   |
| Linear Derating Factor  |                  |                | 1.0                               | W/ $^\circ\text{C}$ |
| Single Pulse Avalanche Energy <sup>b</sup>  |                  | $E_{AS}$       | 550                               | mJ                  |
| Repetitive Avalanche Current <sup>a</sup>   |                  | $I_{AR}$       | 14                                | A                   |
| Repetitive Avalanche Energy <sup>a</sup>  |                  | $E_{AR}$       | 13                                | mJ                  |
| Maximum Power Dissipation   |                  | $P_D$          | 125                               | W                   |
| $T_C = 25\text{ }^\circ\text{C}$  |                  |                |                                   |                     |
| Peak Diode Recovery dV/dt <sup>c</sup>  |                  | dV/dt          | 4.8                               | V/ns                |
| Operating Junction and Storage Temperature Range                                      |                  | $T_J, T_{stg}$ | -55 to +150                       | $^\circ\text{C}$    |
| Soldering Recommendations (Peak temperature) <sup>d</sup>                             |                  | for 10 s       | 300                               |                     |
| 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).
- $V_{DD} = 50\text{ V}$ , starting  $T_J = 25\text{ }^\circ\text{C}$ ,  $L = 4.5\text{ mH}$ ,  $R_g = 25\text{ }\Omega$ ,  $I_{AS} = 14\text{ A}$  (see fig. 12).
- $I_{SD} \leq 14\text{ A}$ ,  $dI/dt \leq 150\text{ A}/\mu\text{s}$ ,  $V_{DD} \leq V_{DS}$ ,  $T_J \leq 150\text{ }^\circ\text{C}$ .
- 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  | $V_{DS}$            | $V_{GS} = 0\text{ V}, I_D = 250\text{ }\mu\text{A}$   |  | 250  | -    | -         | V             |
| $V_{DS}$ Temperature Coefficient  | $\Delta V_{DS}/T_J$ | Reference to $25\text{ }^\circ\text{C}, I_D = 1\text{ mA}$  |  | -    | 0.34 | -         | 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   | $I_{GSS}$           | $V_{GS} = \pm 20\text{ V}$  |  | -    | -    | $\pm 100$ | nA            |
| Zero Gate Voltage Drain Current   | $I_{DSS}$           | $V_{DS} = 250\text{ V}, V_{GS} = 0\text{ V}$  |  | -    | -    | 25        | $\mu\text{A}$ |
|   |                     | $V_{DS} = 200\text{ V}, V_{GS} = 0\text{ V}, T_J = 125\text{ }^\circ\text{C}$   |  | -    | -    | 250       |               |
| Drain-Source On-State Resistance  | $R_{DS(on)}$        | $V_{GS} = 10\text{ V}$  | $I_D = 8.4\text{ A}^b$   | -    | 0.19 | -         | $\Omega$      |
| Forward Transconductance  | $g_{fs}$            | $V_{DS} = 50\text{ V}, I_D = 8.4\text{ A}^b$  |  | 6.7  | -    | -         | S             |
| <b>Dynamic</b>  |                     |   |  |      |      |           |               |
| Input Capacitance   | $C_{iss}$           | $V_{GS} = 0\text{ V}, V_{DS} = 25\text{ V}, f = 1.0\text{ MHz}, \text{ see fig. 5}$   |  | -    | 1300 | -         | pF            |
| Output Capacitance  | $C_{oss}$           |   |  | -    | 330  | -         |               |
| Reverse Transfer Capacitance  | $C_{rss}$           |   |  | -    | 85   | -         |               |
| Total Gate Charge   | $Q_g$               | $V_{GS} = 10\text{ V}$  | $I_D = 7.9\text{ A}, V_{DS} = 200\text{ V}, \text{ see fig. 6 and 13}^b$ | -    | -    | 68        | nC            |
| Gate-Source Charge  | $Q_{gs}$            |   |  | -    | -    | 11        |               |
| Gate-Drain Charge   | $Q_{gd}$            |   |  | -    | -    | 35        |               |
| Turn-On Delay Time  | $t_{d(on)}$         | $V_{DD} = 125\text{ V}, I_D = 7.9\text{ A}, R_g = 9.1\text{ }\Omega, R_D = 8.7\text{ }\Omega, \text{ see fig. 10}^b$                                    |  | -    | 11   | -         | ns            |
| Rise Time   | $t_r$               |   |  | -    | 24   | -         |               |
| Turn-Off Delay Time   | $t_{d(off)}$        |   |  | -    | 53   | -         |               |
| Fall Time   | $t_f$               |   |  | -    | 49   | -         |               |
| 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  | -         |               |
| Gate Input Resistance   | $R_g$               | $f = 1\text{ MHz}, \text{ open drain}$  |  | 0.3  | -    | 1.2       | $\Omega$      |
| <b>Drain-Source Body Diode Characteristics</b>                              |                     |   |  |      |      |           |               |
| Continuous Source-Drain Diode Current                                       | $I_S$               | MOSFET symbol showing the integral reverse p - n junction diode    |  | -    | -    | 14        | A             |
| Pulsed Diode Forward Current <sup>a</sup>                                   | $I_{SM}$            |   |  | -    | -    | 56        |               |
| Body Diode Voltage  | $V_{SD}$            | $T_J = 25\text{ }^\circ\text{C}, I_S = 14\text{ A}, V_{GS} = 0\text{ V}^b$  |  | -    | -    | 1.8       | V             |
| Body Diode Reverse Recovery Time  | $t_{rr}$            | $T_J = 25\text{ }^\circ\text{C}, I_F = 7.9\text{ A}, dI/dt = 100\text{ A}/\mu\text{s}^b$  |  | -    | 250  | 500       | ns            |
| Body Diode Reverse Recovery Charge  | $Q_{rr}$            |   |  | -    | 2.3  | 4.6       | $\mu\text{C}$ |
| Forward Turn-On Time  | $t_{on}$            | Intrinsic turn-on time is negligible (turn-on is dominated by $L_S$ and $L_D$ )   |  |      |      |           |               |

**Notes**

- 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)



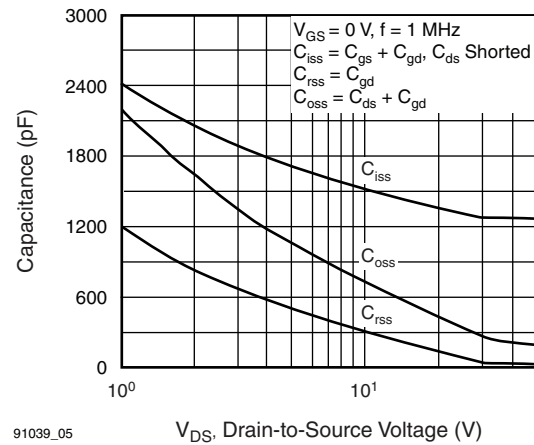
**Fig. 1 - Typical Output Characteristics, T<sub>C</sub> = 25 °C**



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



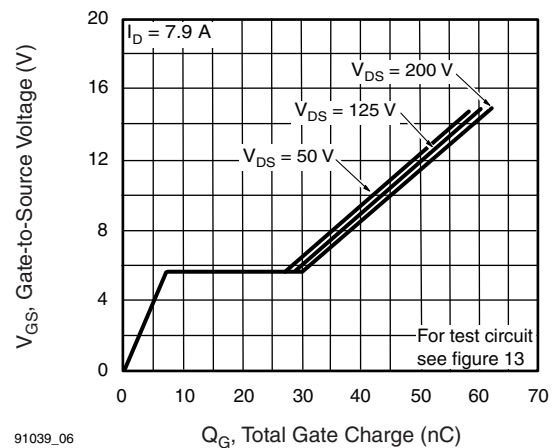
**Fig. 2 - Typical Output Characteristics, T<sub>C</sub> = 150 °C**



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



**Fig. 3 - Typical Transfer Characteristics**

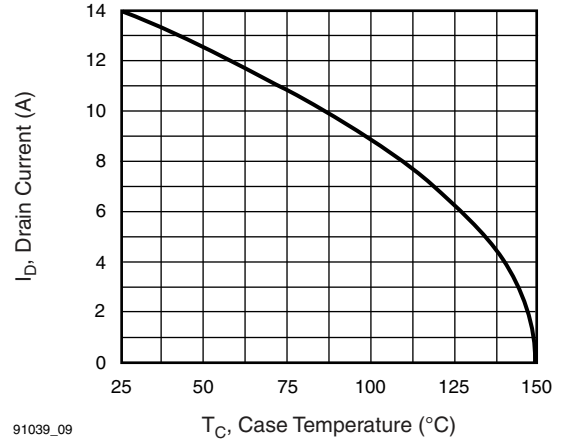


**Fig. 6 - Typical Gate Charge vs. Gate-to-Source Voltage**



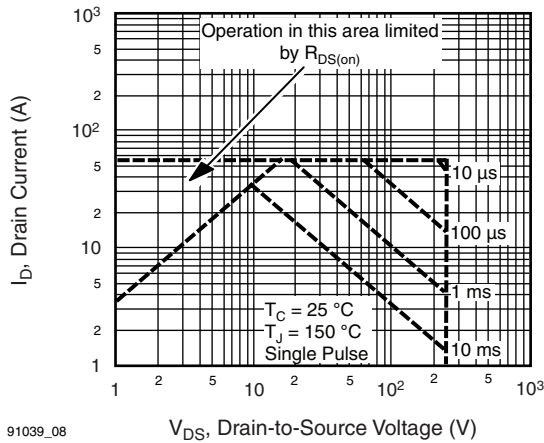
91039\_07

Fig. 7 - Typical Source-Drain Diode Forward Voltage



91039\_09

Fig. 9 - Maximum Drain Current vs. Case Temperature



91039\_08

Fig. 8 - Maximum Safe Operating Area

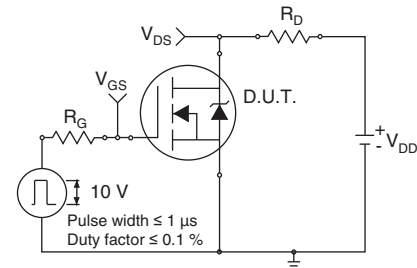


Fig. 10a - Switching Time Test Circuit

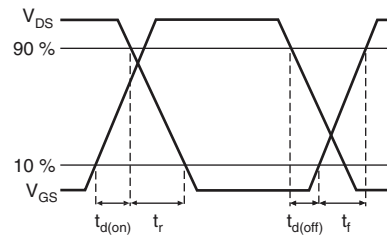


Fig. 10b - Switching Time Waveforms



91039\_11

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



Fig. 12a - Unclamped Inductive Test Circuit



Fig. 12b - Unclamped Inductive Waveforms



91039\_12c

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

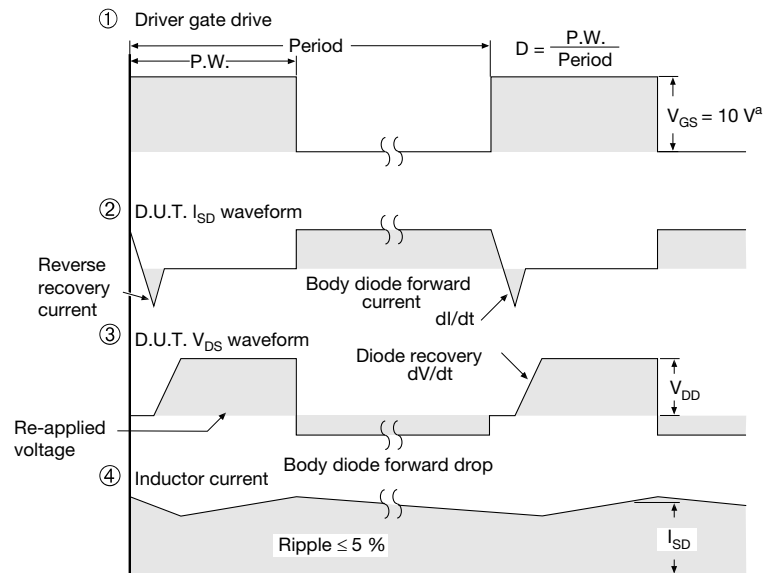
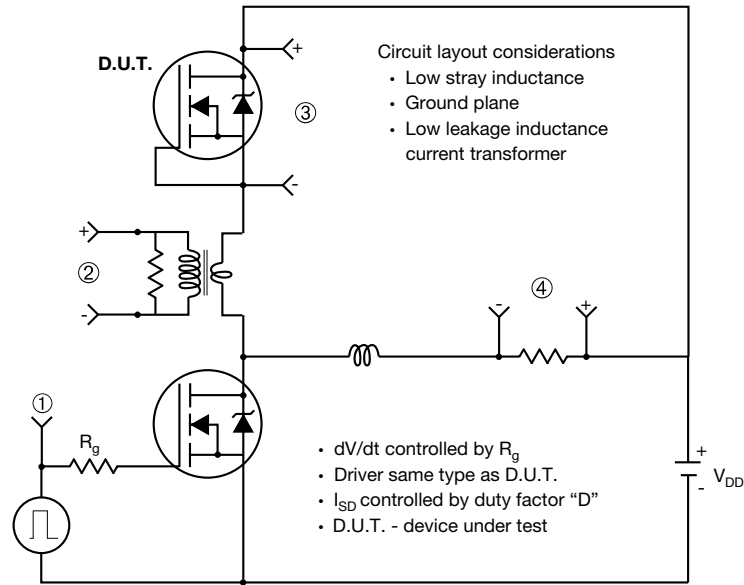


Fig. 13a - Basic Gate Charge Waveform



Fig. 13b - Gate Charge Test Circuit

Peak Diode Recovery dV/dt Test Circuit

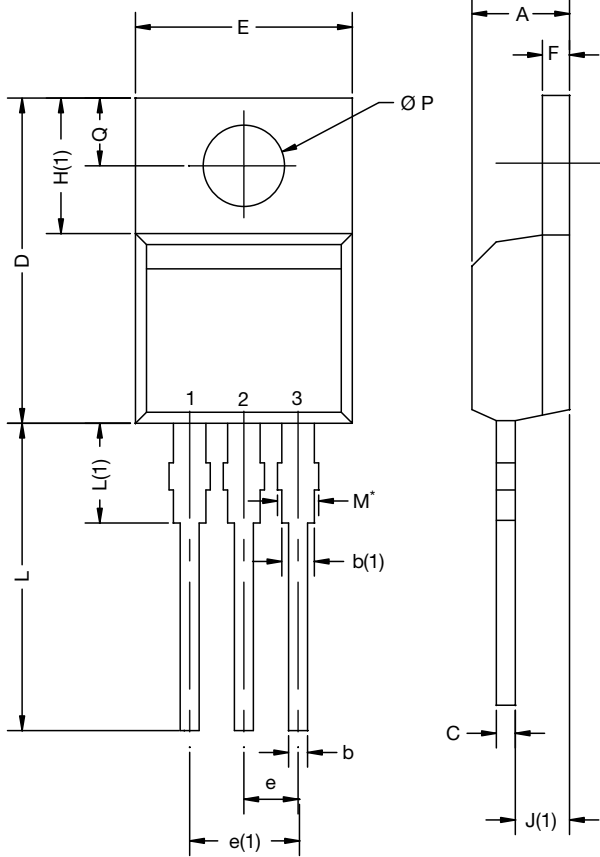


Note

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

Fig. 14 - For N-Channel

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: X15-0364-Rev. C, 14-Dec-15  
DWG: 6031

**Note**

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

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