

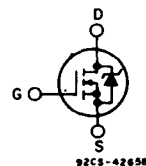
## Avalanche Energy Rated N-Channel Power MOSFETs

27A and 24A, 60V-100V  
 $r_{DS(on)} = 0.085\Omega$  and  $0.11\Omega$

### Features:

- Single pulse avalanche energy rated
- SOA is power-dissipation limited
- Nanosecond switching speeds
- Linear transfer characteristics
- High input impedance

### N-CHANNEL ENHANCEMENT MODE

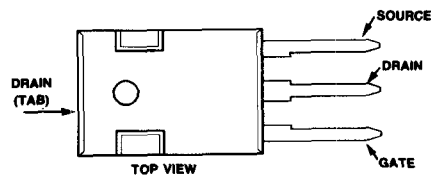


TERMINAL DIAGRAM

The IRFP140R, IRFP141R, IRFP142R and IRFP143R are advanced power MOSFETs designed, tested, and guaranteed to withstand a specified level of energy in the breakdown avalanche mode of operation. These are n-channel enhancement-mode silicon-gate power field-effect transistors designed for applications such as switching regulators, switching converters, motor drivers, relay drivers, and drivers for high-power bipolar switching transistors requiring high speed and low gate-drive power. These types can be operated directly from integrated circuits.

The IRFP-types are supplied in the JEDEC TO-247 plastic package.

### TERMINAL DESIGNATION



JEDEC TO-247

### Absolute Maximum Ratings

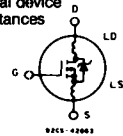
| Parameter                       |                                                         | IRFP140R                                  | IRFP141R | IRFP142R | IRFP143R | Units               |
|---------------------------------|---------------------------------------------------------|-------------------------------------------|----------|----------|----------|---------------------|
| $V_{DS}$                        | Drain - Source Voltage ①                                | 100                                       | 60       | 100      | 60       | V                   |
| $V_{DGR}$                       | Drain - Gate Voltage ( $R_{GS} = 20\text{ K}\Omega$ ) ① | 100                                       | 60       | 100      | 60       | V                   |
| $I_D @ T_C = 25^\circ\text{C}$  | Continuous Drain Current                                | 27                                        | 27       | 24       | 24       | A                   |
| $I_D @ T_C = 100^\circ\text{C}$ | Continuous Drain Current                                | 17                                        | 17       | 15       | 15       | A                   |
| $I_{DM}$                        | Pulsed Drain Current ③                                  | 108                                       | 108      | 96       | 96       | A                   |
| $V_{GS}$                        | Gate - Source Voltage                                   | $\pm 20$                                  |          |          |          | V                   |
| $P_D @ T_C = 25^\circ\text{C}$  | Max. Power Dissipation                                  | 125 (See Fig. 14)                         |          |          |          | W                   |
|                                 | Linear Derating Factor                                  | 1.0 (See Fig. 14)                         |          |          |          | W/ $^\circ\text{C}$ |
| $E_{AS}$                        | Single Pulse Avalanche Energy Rating ④                  | 100                                       |          |          |          | mJ                  |
| $T_J$                           | Operating Junction and                                  | -55 to 150                                |          |          |          | $^\circ\text{C}$    |
| $T_{stg}$                       | Storage Temperature Range                               |                                           |          |          |          |                     |
|                                 | Lead Temperature                                        | 300 (0.063 in. (1.6mm) from case for 10s) |          |          |          | $^\circ\text{C}$    |

## IRFP140R, IRFP141R, IRFP142R, IRFP143R

Electrical Characteristics @  $T_c = 25^\circ\text{C}$  (Unless Otherwise Specified)

| Parameter                                              | Type                 | Min. | Typ. | Max.  | Units         | Test Conditions                                                                                                                                                                |
|--------------------------------------------------------|----------------------|------|------|-------|---------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| $BV_{DS}$ Drain - Source Breakdown Voltage             | IRFP140R<br>IRFP142R | 100  | —    | —     | V             | $V_{GS} = 0\text{V}$                                                                                                                                                           |
|                                                        | IRFP141R<br>IRFP143R | 60   | —    | —     | V             | $I_D = 250\mu\text{A}$                                                                                                                                                         |
| $V_{GS(th)}$ Gate Threshold Voltage                    | ALL                  | 2.0  | —    | 4.0   | V             | $V_{DS} = V_{GS}, I_D = 250\mu\text{A}$                                                                                                                                        |
| $I_{GSS}$ Gate-Source Leakage Forward                  | ALL                  | —    | —    | 100   | nA            | $V_{GS} = 20\text{V}$                                                                                                                                                          |
| $I_{GSS}$ Gate-Source Leakage Reverse                  | ALL                  | —    | —    | -100  | nA            | $V_{GS} = -20\text{V}$                                                                                                                                                         |
| $I_{DSS}$ Zero Gate Voltage Drain Current              | ALL                  | —    | —    | 250   | $\mu\text{A}$ | $V_{DS} = \text{Max. Rating}, V_{GS} = 0\text{V}$                                                                                                                              |
|                                                        |                      | —    | —    | 1000  | $\mu\text{A}$ | $V_{DS} = \text{Max. Rating} \times 0.8, V_{GS} = 0\text{V}, T_c = 125^\circ\text{C}$                                                                                          |
| $I_{D(on)}$ On-State Drain Current ②                   | IRFP140R<br>IRFP141R | 27   | —    | —     | A             | $V_{DS} > I_{D(on)} \times R_{DS(on)max}, V_{GS} = 10\text{V}$                                                                                                                 |
|                                                        | IRFP142R<br>IRFP143R | 24   | —    | —     | A             |                                                                                                                                                                                |
|                                                        | ALL                  | —    | —    | —     | —             |                                                                                                                                                                                |
| $R_{DS(on)}$ Static Drain-Source On-State Resistance ② | IRFP140R<br>IRFP141R | —    | 0.07 | 0.085 | $\Omega$      | $V_{GS} = 10\text{V}, I_D = 15\text{A}$                                                                                                                                        |
|                                                        | IRFP142R<br>IRFP143R | —    | 0.09 | 0.11  | $\Omega$      |                                                                                                                                                                                |
|                                                        | ALL                  | —    | —    | —     | —             |                                                                                                                                                                                |
| $g_{fs}$ Forward Transconductance ②                    | ALL                  | 6.0  | 10   | —     | S(V)          | $V_{DS} > I_{D(on)} \times R_{DS(on)max}, I_D = 15\text{A}$                                                                                                                    |
| $C_{iss}$ Input Capacitance                            | ALL                  | —    | 1275 | —     | pF            | $V_{GS} = 0\text{V}, V_{DS} = 25\text{V}, f = 1.0\text{MHz}$                                                                                                                   |
| $C_{oss}$ Output Capacitance                           | ALL                  | —    | 550  | —     | pF            | See Fig. 10                                                                                                                                                                    |
| $C_{rss}$ Reverse Transfer Capacitance                 | ALL                  | —    | 160  | —     | pF            |                                                                                                                                                                                |
| $t_{d(on)}$ Turn-On Delay Time                         | ALL                  | —    | 16   | 30    | ns            | $V_{DD} \approx 30\text{V}, I_D = 15\text{A}, Z_\theta = 4.7\Omega$<br>See Fig. 17<br>(MOSFET switching times are essentially independent of operating temperature.)           |
| $t_r$ Rise Time                                        | ALL                  | —    | 27   | 60    | ns            |                                                                                                                                                                                |
| $t_{d(off)}$ Turn-Off Delay Time                       | ALL                  | —    | 38   | 80    | ns            |                                                                                                                                                                                |
| $t_f$ Fall Time                                        | ALL                  | —    | 14   | 30    | ns            |                                                                                                                                                                                |
| $Q_g$ Total Gate Charge (Gate-Source Plus Gate-Drain)  | ALL                  | —    | 38   | 60    | nC            | $V_{GS} = 10\text{V}, I_D = 34\text{A}, V_{DS} = 0.8\text{ Max. Rating}$ .<br>See Fig. 18 for test circuit. (Gate charge is essentially independent of operating temperature.) |
| $Q_{gs}$ Gate-Source Charge                            | ALL                  | —    | 17   | —     | nC            |                                                                                                                                                                                |
| $Q_{gd}$ Gate-Drain ("Miller") Charge                  | ALL                  | —    | 21   | —     | nC            |                                                                                                                                                                                |
| $L_D$ Internal Drain Inductance                        | ALL                  | —    | 5.0  | —     | nH            | Measured between the contact screw on header that is closer to source and gate pins and center of die.                                                                         |
| $L_S$ Internal Source Inductance                       | ALL                  | —    | 12.5 | —     | nH            | Measured from the source pin, 6 mm (0.25 in.) from header and source bonding pad.                                                                                              |

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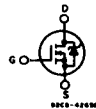


## Thermal Resistance

|                                     |     |   |     |     |                    |                                             |
|-------------------------------------|-----|---|-----|-----|--------------------|---------------------------------------------|
| $R_{\theta JC}$ Junction-to-Case    | ALL | — | —   | 1.0 | $^\circ\text{C/W}$ |                                             |
| $R_{\theta CS}$ Case-to-Sink        | ALL | — | 0.1 | —   | $^\circ\text{C/W}$ | Mounting surface flat, smooth, and greased. |
| $R_{\theta JA}$ Junction-to-Ambient | ALL | — | —   | 30  | $^\circ\text{C/W}$ | Free Air Operation                          |

## Source-Drain Diode Ratings and Characteristics

|                                              |                      |   |     |     |               |                                                                                                     |
|----------------------------------------------|----------------------|---|-----|-----|---------------|-----------------------------------------------------------------------------------------------------|
| $I_S$ Continuous Source Current (Body Diode) | IRFP140R<br>IRFP141R | — | —   | 27  | A             | Modified MOSFET symbol showing the integral reverse P-N junction rectifier.                         |
|                                              | IRFP142R<br>IRFP143R | — | —   | 24  | A             |                                                                                                     |
| $I_{SM}$ Pulse Source Current (Body Diode) ③ | IRFP140R<br>IRFP141R | — | —   | 108 | A             |                                                                                                     |
|                                              | IRFP142R<br>IRFP143R | — | —   | 96  | A             |                                                                                                     |
|                                              | ALL                  | — | —   | —   | —             |                                                                                                     |
| $V_{SD}$ Diode Forward Voltage ②             | IRFP140R<br>IRFP141R | — | —   | 2.5 | V             | $T_c = 25^\circ\text{C}, I_S = 27\text{A}, V_{GS} = 0\text{V}$                                      |
|                                              | IRFP142R<br>IRFP143R | — | —   | 2.3 | V             | $T_c = 25^\circ\text{C}, I_S = 24\text{A}, V_{GS} = 0\text{V}$                                      |
| $t_{rr}$ Reverse Recovery Time               | ALL                  | — | 500 | —   | ns            | $T_J = 150^\circ\text{C}, I_F = 27\text{A}, dI_F/dt = 100\text{A}/\mu\text{s}$                      |
| $Q_{RR}$ Reverse Recovered Charge            | ALL                  | — | 2.9 | —   | $\mu\text{C}$ | $T_J = 150^\circ\text{C}, I_F = 27\text{A}, dI_F/dt = 100\text{A}/\mu\text{s}$                      |
| $t_{on}$ Forward Turn-on Time                | ALL                  | — | —   | —   | —             | Intrinsic turn-on time is negligible.<br>Turn-on speed is substantially controlled by $L_S + L_D$ . |

①  $T_J = 25^\circ\text{C}$  to  $150^\circ\text{C}$ . ② Pulse Test: Pulse width  $\leq 300\mu\text{s}$ , Duty Cycle  $\leq 2\%$ .

③ Repetitive Rating: Pulse width limited by max. junction temperature. See Transient Thermal Impedance Curve (Fig. 5).

④  $V_{DD} = 10\text{V}$ , starting  $T_J = 25^\circ\text{C}$ ,  $L = 250\mu\text{H}$ ,  $R_{gs} = 50\Omega$ ,  $I_{peak} = 27\text{A}$ . See figures 15, 16.

IRFP140R, IRFP141R, IRFP142R, IRFP143R

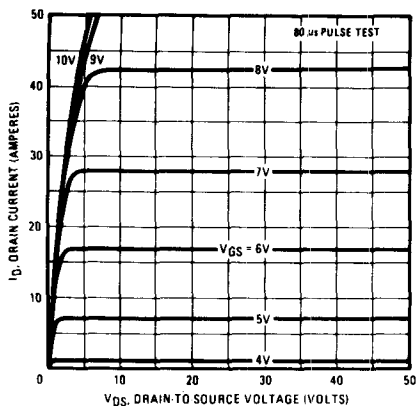


Fig. 1 - Typical output characteristics.

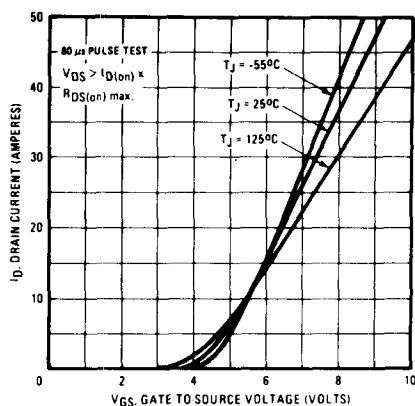


Fig. 2 - Typical transfer characteristics.

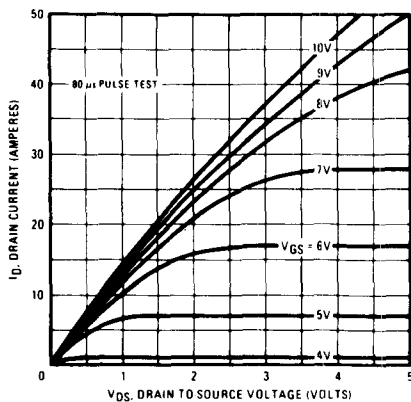


Fig. 3 - Typical saturation characteristics.

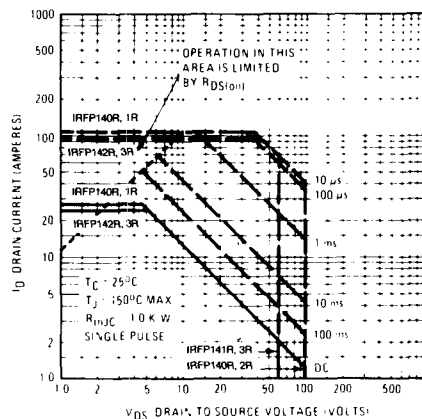


Fig. 4 - Maximum safe operating area.

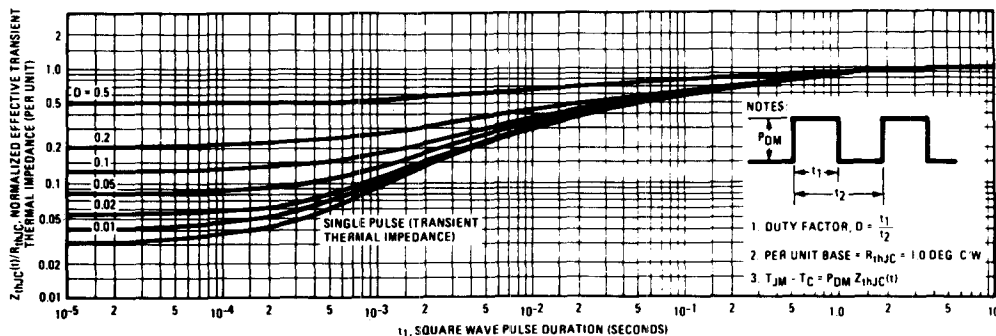


Fig. 5 - Maximum effective transient thermal impedance, junction-to-case vs. pulse duration.

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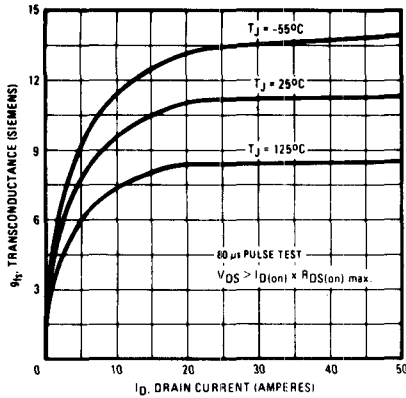


Fig. 6 - Typical transconductance vs. drain current.

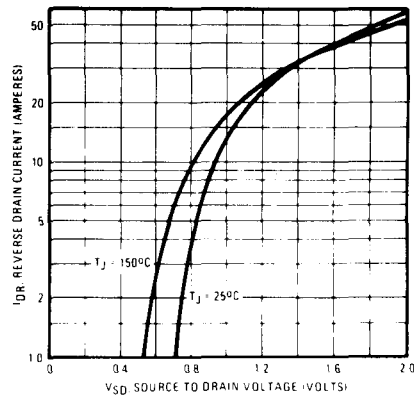


Fig. 7 - Typical source-drain diode forward voltage.

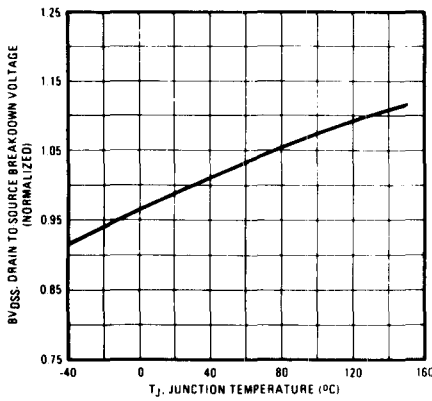


Fig. 8 - Breakdown voltage vs. temperature.

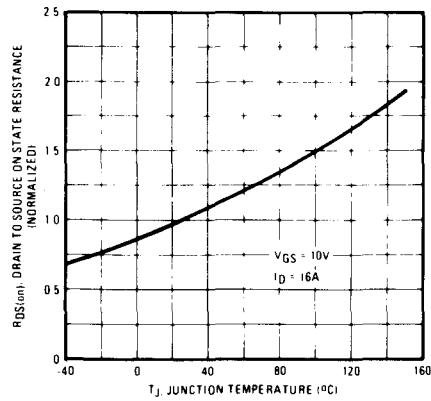


Fig. 9 - Normalized on-resistance vs. temperature.

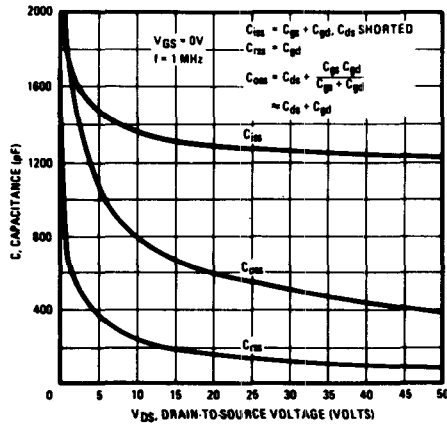


Fig. 10 - Typical capacitance vs. drain-to-source voltage.

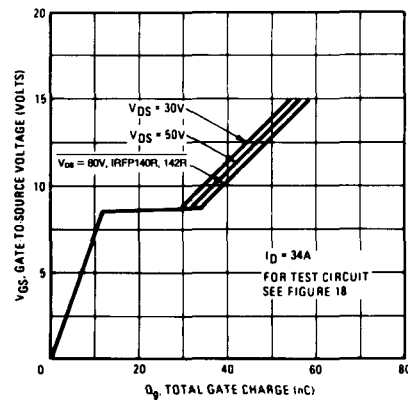


Fig. 11 - Typical gate charge vs. gate-to-source voltage.

## IRFP140R, IRFP141R, IRFP142R, IRFP143R

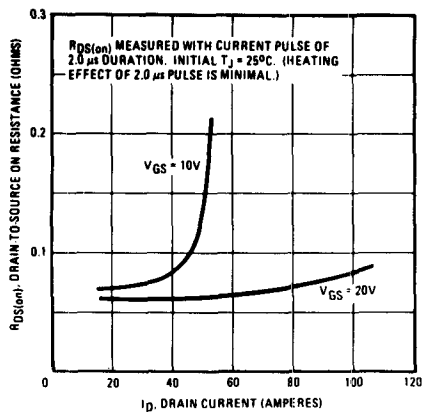


Fig. 12 - Typical on-resistance vs. drain current.

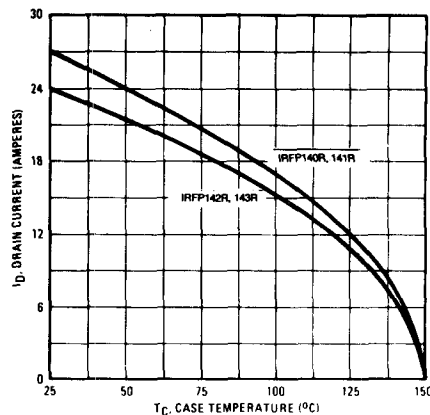


Fig. 13 - Maximum drain current vs. case temperature.

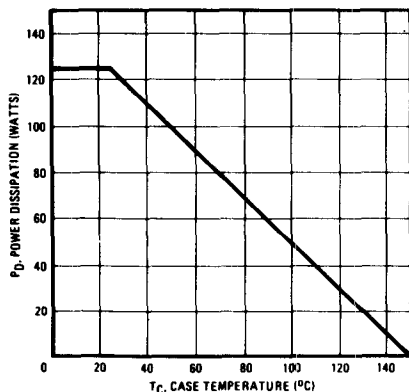


Fig. 14 - Power vs. temperature derating curve.

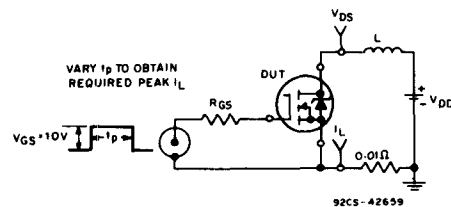


Fig. 15 - Unclamped energy test circuit.

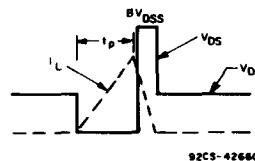


Fig. 16 - Unclamped energy waveforms.

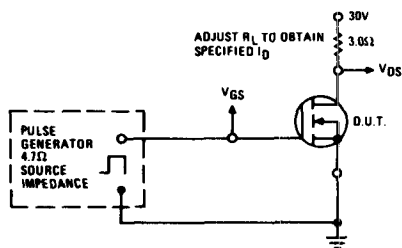


Fig. 17 - Switching time test circuit.

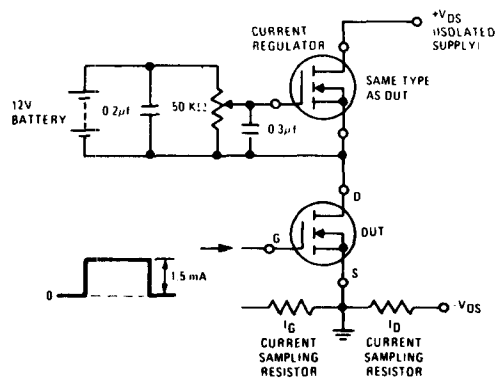


Fig. 18 - Gate charge test circuit.