

## Power MOS Field-Effect Transistors

N-Channel Enhancement-Mode  
Power Field-Effect Transistors

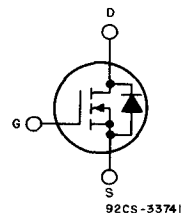
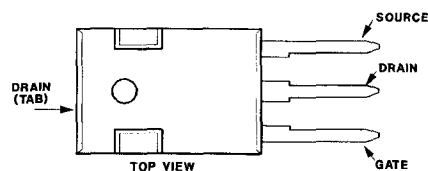
14 A and 16 A, 350 V – 400 V

 $r_{DS(on)} = 0.3 \Omega$  and  $0.4 \Omega$ **Features:**

- SOA is power-dissipation limited
- Nanosecond switching speeds
- Linear transfer characteristics
- High input impedance
- Majority carrier device

The IRFP350, IRFP351, IRFP352, and IRFP353 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.

**N-CHANNEL ENHANCEMENT MODE****TERMINAL DIAGRAM****TERMINAL DESIGNATION****JEDEC TO-247****Absolute Maximum Ratings**

| Parameter                                                          | IRFP350 | IRFP351                                   | IRFP352 | IRFP353 | Units  |
|--------------------------------------------------------------------|---------|-------------------------------------------|---------|---------|--------|
| $V_{DS}$ Drain - Source Voltage ①                                  | 400     | 350                                       | 400     | 350     | V      |
| $V_{DGR}$ Drain - Gate Voltage ( $R_{GS} = 20 \text{ K}\Omega$ ) ① | 400     | 350                                       | 400     | 350     | V      |
| $I_D @ T_C = 25^\circ\text{C}$ Continuous Drain Current            | 16      |                                           | 14      |         | A      |
| $I_D @ T_C = 100^\circ\text{C}$ Continuous Drain Current           | 10      |                                           | 8.9     |         | A      |
| $I_{DM}$ Pulsed Drain Current ②                                    | 64      |                                           | 56      |         | A      |
| $V_{GS}$ Gate - Source Voltage                                     |         | $\pm 20$                                  |         |         | V      |
| $P_D @ T_C = 25^\circ\text{C}$ Max. Power Dissipation              |         | 180                                       |         |         | W      |
| Linear Derating Factor                                             |         | 1.4                                       |         |         | W/°C ③ |
| $I_{LM}$ Inductive Current, Clamped                                | 64      | (See Fig. 14) $L = 100\mu\text{H}$        | 56      |         | A      |
| $T_J$ Operating Junction and Storage Temperature Range             |         | -55 to 150                                |         |         | °C     |
| $T_{stg}$ Lead Temperature                                         |         | 300 (0.063 in. (1.6mm) from case for 10s) |         |         | °C     |

## IRFP350, IRFP351, IRFP352, IRFP353

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

| Parameter                                                      | Type    | Min. | Typ. | Max. | Units         | Test Conditions                                                                                                                                                                   |
|----------------------------------------------------------------|---------|------|------|------|---------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| BV <sub>DSS</sub> Drain - Source Breakdown Voltage             | IRFP350 | 400  | —    | —    | V             | $V_{GS} = 0\text{V}$<br>$I_D = 250\text{ }\mu\text{A}$                                                                                                                            |
|                                                                | IRFP352 | —    | —    | —    | —             |                                                                                                                                                                                   |
|                                                                | IRFP351 | 350  | —    | —    | V             |                                                                                                                                                                                   |
|                                                                | IRFP353 | —    | —    | —    | —             |                                                                                                                                                                                   |
| V <sub>GS(th)</sub> Gate Threshold Voltage                     | ALL     | 2.0  | —    | 4.0  | V             | $V_{DS} = V_{GS}$ , $I_D = 250\text{ }\mu\text{A}$                                                                                                                                |
| I <sub>GSS</sub> Gate-Source Leakage Forward                   | ALL     | —    | —    | 500  | nA            | $V_{GS} = 20\text{V}$                                                                                                                                                             |
| I <sub>GSS</sub> Gate-Source Leakage Reverse                   | ALL     | —    | —    | -500 | nA            | $V_{GS} = -20\text{V}$                                                                                                                                                            |
| I <sub>DSS</sub> 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 <sub>D(on)</sub> On-State Drain Current ④                    | IRFP350 | 16   | —    | —    | A             | $V_{DS} > I_{D(on)} \times R_{DS(on)max}$ , $V_{GS} = 10\text{V}$                                                                                                                 |
|                                                                | IRFP351 | —    | —    | —    | —             |                                                                                                                                                                                   |
|                                                                | IRFP352 | 14   | —    | —    | A             |                                                                                                                                                                                   |
|                                                                | IRFP353 | —    | —    | —    | —             |                                                                                                                                                                                   |
| R <sub>DS(on)</sub> Static Drain-Source On-State Resistance ④  | IRFP350 | —    | 0.25 | 0.30 | $\Omega$      | $V_{GS} = 10\text{V}$ , $I_D = 8.9\text{A}$                                                                                                                                       |
|                                                                | IRFP351 | —    | —    | —    | —             |                                                                                                                                                                                   |
|                                                                | IRFP352 | —    | 0.30 | 0.40 | $\Omega$      |                                                                                                                                                                                   |
|                                                                | IRFP353 | —    | —    | —    | —             |                                                                                                                                                                                   |
| g <sub>fs</sub> Forward Transconductance ④                     | ALL     | 8.0  | 12   | —    | S(Ω)          | $V_{DS} = 2 \times V_{GS}$ , $I_{DS} = 8.0$                                                                                                                                       |
| C <sub>iss</sub> Input Capacitance                             | ALL     | —    | 2400 | —    | pF            | $V_{GS} = 0\text{V}$ , $V_{DS} = 25\text{V}$ , $f = 1.0\text{ MHz}$                                                                                                               |
| C <sub>oss</sub> Output Capacitance                            | ALL     | —    | 460  | —    | pF            | See Fig. 10                                                                                                                                                                       |
| C <sub>rss</sub> Reverse Transfer Capacitance                  | ALL     | —    | 99   | —    | pF            |                                                                                                                                                                                   |
| t <sub>d(on)</sub> Turn-On Delay Time                          | ALL     | —    | 12   | 18   | ns            | $V_{DD} = 200\text{V}$ , $I_D = 15\text{A}$ , $R_G = 6.2\Omega$ , $R_D = 13\Omega$                                                                                                |
| t <sub>r</sub> Rise Time                                       | ALL     | —    | 51   | 77   | ns            | See Fig. 16                                                                                                                                                                       |
| t <sub>d(off)</sub> Turn-Off Delay Time                        | ALL     | —    | 75   | 110  | ns            | (MOSFET switching times are essentially independent of operating temperature.)                                                                                                    |
| t <sub>f</sub> Fall Time                                       | ALL     | —    | 47   | 71   | ns            |                                                                                                                                                                                   |
| Q <sub>g</sub> Total Gate Charge (Gate-Source Plus Gate-Drain) | ALL     | —    | 87   | 130  | nC            | $V_{GS} = 10\text{V}$ , $I_D = 15\text{A}$ , $V_{DS} = 0.8\text{ Max. Rating}$ . See Fig. 17 for test circuit. (Gate charge is essentially independent of operating temperature.) |
| Q <sub>gs</sub> Gate-Source Charge                             | ALL     | —    | 10   | 15   | nC            |                                                                                                                                                                                   |
| Q <sub>gd</sub> Gate-Drain ("Miller") Charge                   | ALL     | —    | 33   | 50   | nC            |                                                                                                                                                                                   |
| L <sub>D</sub> Internal Drain Inductance                       | ALL     | —    | 5.0  | —    | nH            | Measured from the drain lead, 6 mm (0.25 in.) from package to center of die.                                                                                                      |
| L <sub>S</sub> Internal Source Inductance                      | ALL     | —    | 13   | —    | nH            | Measured from the source lead, 6 mm (0.25 in.) from package to source bonding pad.                                                                                                |

3

## Thermal Resistance

|                                       |     |   |      |      |                      |                                             |
|---------------------------------------|-----|---|------|------|----------------------|---------------------------------------------|
| R <sub>thJC</sub> Junction-to-Case    | ALL | — | —    | 0.70 | $^\circ\text{C/W}$ ⑤ |                                             |
| R <sub>thCS</sub> Case-to-Sink        | ALL | — | 0.10 | —    | $^\circ\text{C/W}$ ⑤ | Mounting surface flat, smooth, and greased. |
| R <sub>thJA</sub> Junction-to-Ambient | ALL | — | —    | 80   | $^\circ\text{C/W}$ ⑤ | Typical socket mount                        |
| Mounting Torque                       | ALL | — | —    | 10   | in. • lbs.           | Standard 6-32 screw                         |

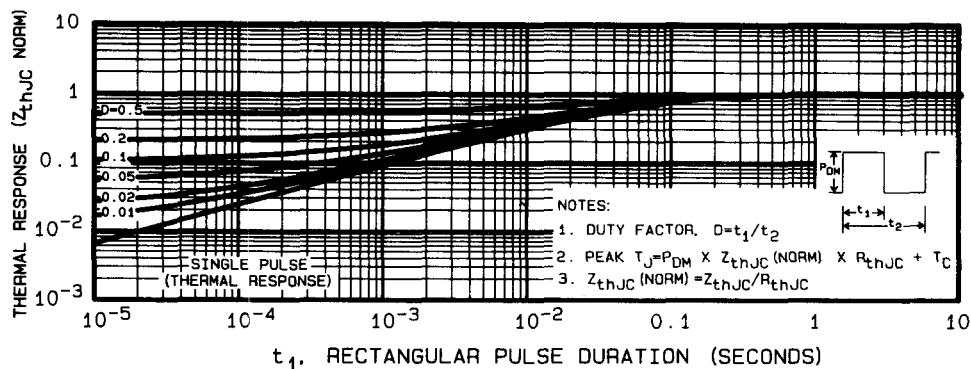
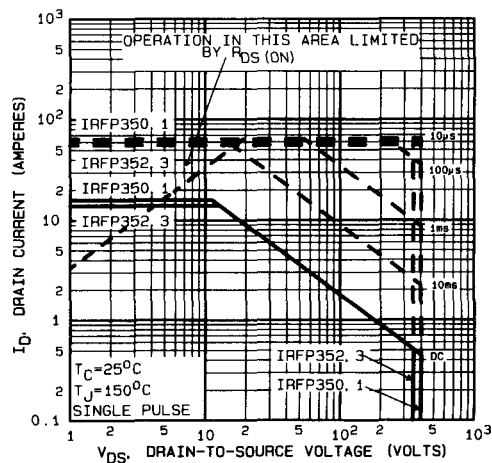
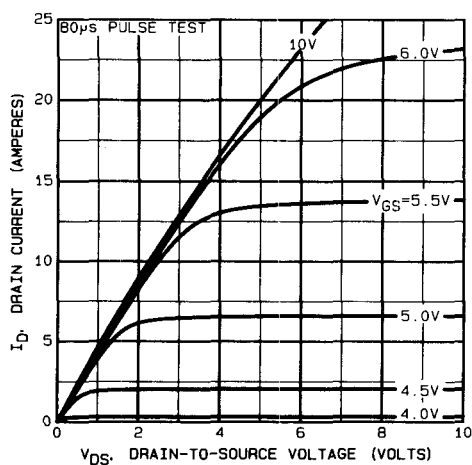
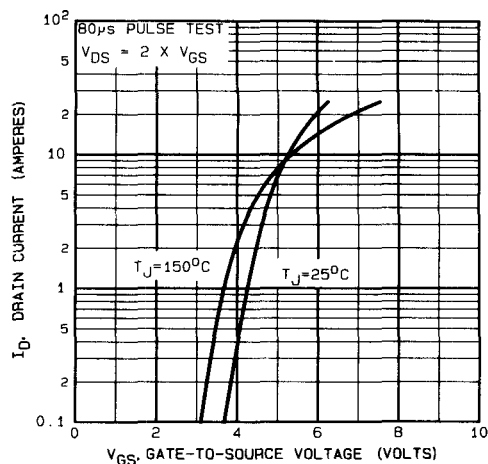
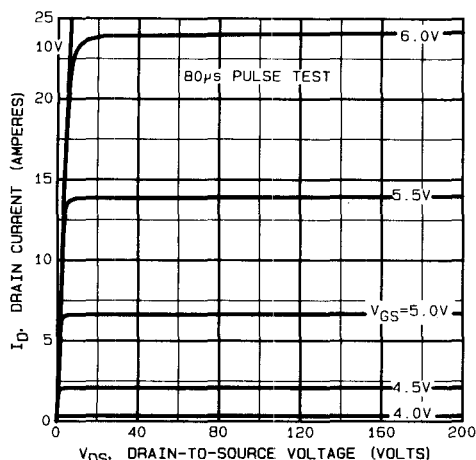
## Source-Drain Diode Ratings and Characteristics

|                                                       |         |                                                                                                                      |     |      |               |                                                                                       |
|-------------------------------------------------------|---------|----------------------------------------------------------------------------------------------------------------------|-----|------|---------------|---------------------------------------------------------------------------------------|
| I <sub>S</sub> Continuous Source Current (Body Diode) | IRFP350 | —                                                                                                                    | —   | 16   | A             | Modified MOSFET symbol showing the integral reverse P-N junction rectifier.           |
|                                                       | IRFP351 | —                                                                                                                    | —   | —    | —             |                                                                                       |
|                                                       | IRFP352 | —                                                                                                                    | —   | 14   | A             |                                                                                       |
|                                                       | IRFP353 | —                                                                                                                    | —   | —    | —             |                                                                                       |
| I <sub>SM</sub> Pulse Source Current (Body Diode) ③   | IRFP350 | —                                                                                                                    | —   | 64   | A             |  |
|                                                       | IRFP351 | —                                                                                                                    | —   | —    | —             |                                                                                       |
|                                                       | IRFP352 | —                                                                                                                    | —   | 56   | A             |                                                                                       |
|                                                       | IRFP353 | —                                                                                                                    | —   | —    | —             |                                                                                       |
| V <sub>SD</sub> Diode Forward Voltage ②               | ALL     | —                                                                                                                    | —   | 1.6  | V             | $T_C = 25^\circ\text{C}$ , $I_S = 16\text{A}$ , $V_{GS} = 0\text{V}$                  |
| t <sub>rr</sub> Reverse Recovery Time                 | ALL     | 270                                                                                                                  | 600 | 1300 | ns            | $T_J = 25^\circ\text{C}$ , $I_F = 15\text{A}$ , $dI_F/dt = 100\text{A}/\mu\text{s}$   |
| Q <sub>RR</sub> Reverse Recovered Charge              | ALL     | 1.7                                                                                                                  | 3.8 | 8.1  | $\mu\text{C}$ | $T_J = 25^\circ\text{C}$ , $I_F = 15\text{A}$ , $dI_F/dt = 100\text{A}/\mu\text{s}$   |
| t <sub>on</sub> Forward Turn-On Time                  | ALL     | Intrinsic turn-on time is negligible. Turn-on speed is substantially controlled by L <sub>S</sub> + L <sub>D</sub> . |     |      |               |                                                                                       |

①  $T_J = 25^\circ\text{C}$  to  $150^\circ\text{C}$ .

② Repetitive Rating: Pulse width limited by max. junction temperature. See Transient Thermal Impedance Curve (Fig. 5).

③ @  $V_{DD} = 50\text{V}$ ,  $T_J = 25^\circ\text{C}$ ,  
L = 100  $\mu\text{H}$ ,  $R_G = 25\Omega$ ④ Pulse Test: Pulse width  $\leq 300\mu\text{s}$ ,  
Duty Cycle  $\leq 2\%$ .⑤  $\text{K/W} = ^\circ\text{C/W}$   
 $\text{W/K} = \text{W}/^\circ\text{C}$



## IRFP350, IRFP351, IRFP352, IRFP353

3

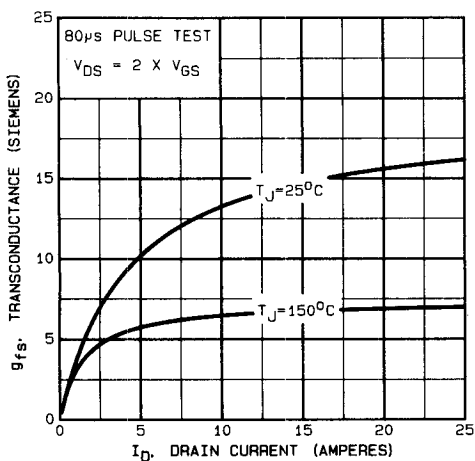


Fig. 6 - Typical Transconductance Vs. Drain Current

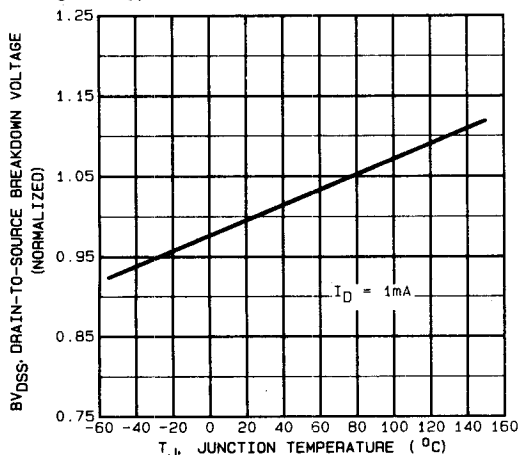


Fig. 8 - Breakdown Voltage Vs. Temperature

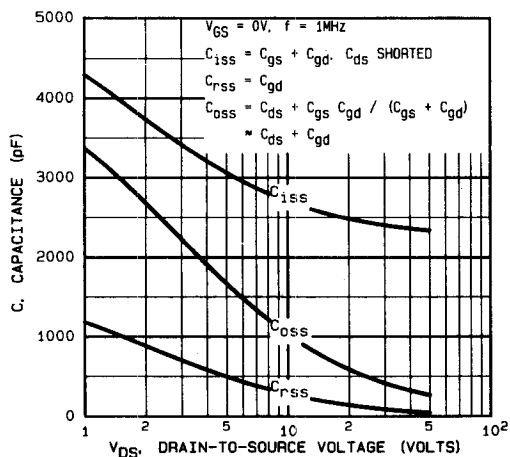


Fig. 10 - Typical Capacitance Vs. Drain-to-Source Voltage

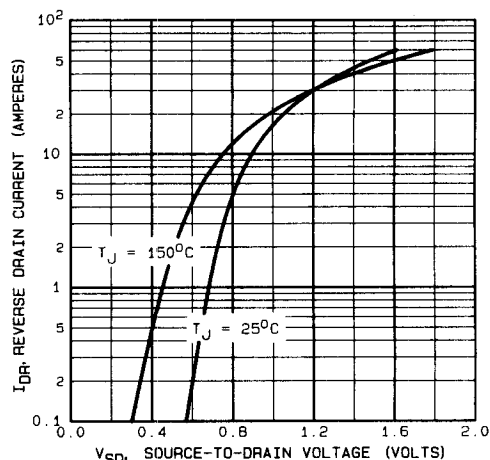


Fig. 7 - Typical Source-Drain Diode Forward Voltage

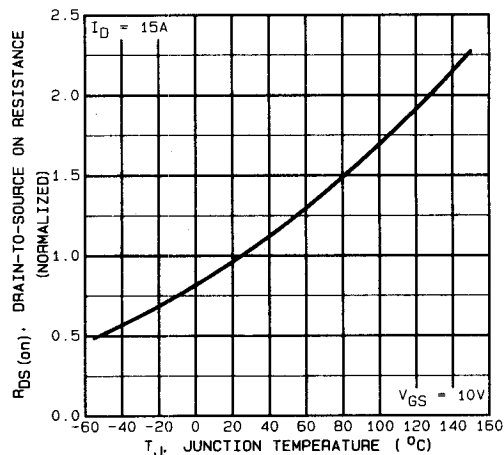


Fig. 9 - Normalized On-Resistance Vs. Temperature

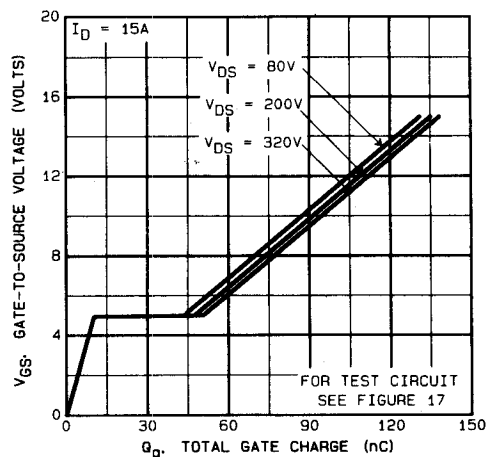


Fig. 11 - Typical Gate Charge Vs. Gate-to-Source Voltage

## IRFP350, IRFP351, IRFP352, IRFP353

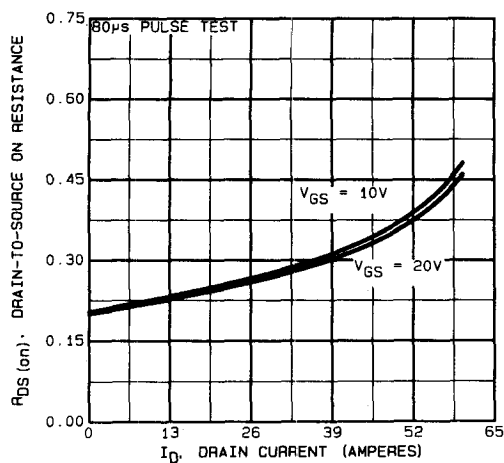


Fig. 12 — Typical On-Resistance Vs. Drain Current

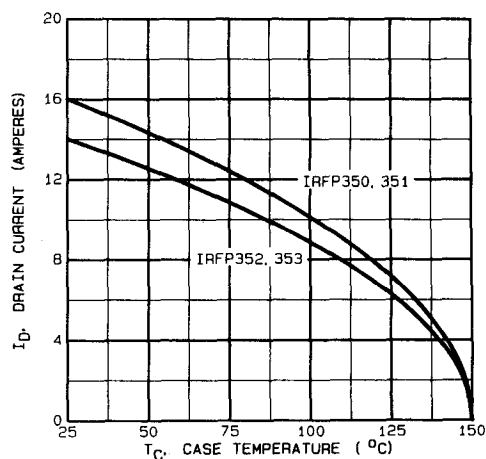


Fig. 13 — Maximum Drain Current Vs. Case Temperature

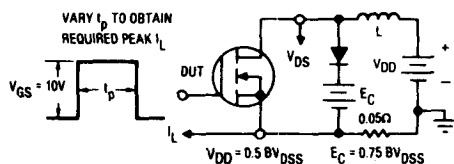


Fig. 14 — Clamped Inductive Test Circuit

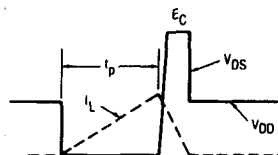


Fig. 15 — Clamped Inductive Waveforms

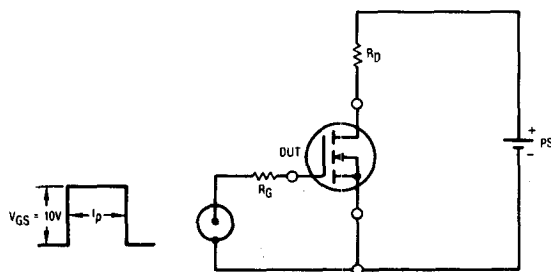


Fig. 16 — Switching Time Test Circuit

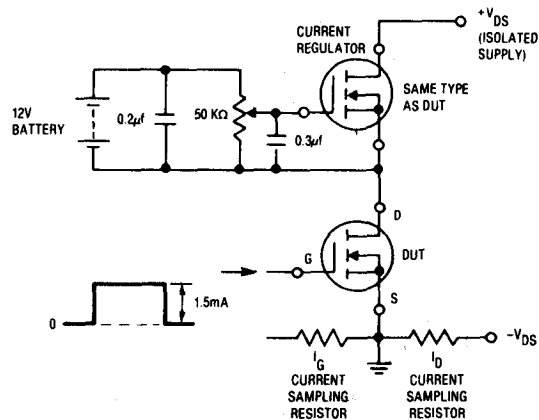


Fig. 17 — Gate Charge Test Circuit