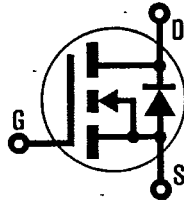


INTERNATIONAL RECTIFIER

T-35-25

INTERNATIONAL RECTIFIER **HEXFET® TRANSISTORS IRFD210****N-CHANNEL  
HEXDIP™**1-WATT RATED POWER MOSFETs  
(4 PIN, DUAL-IN-LINE PLASTIC PACKAGE)**IRFD213**

4-PIN DIP

**200 Volt, 1.5 Ohm, 1-Watt HEXDIP**

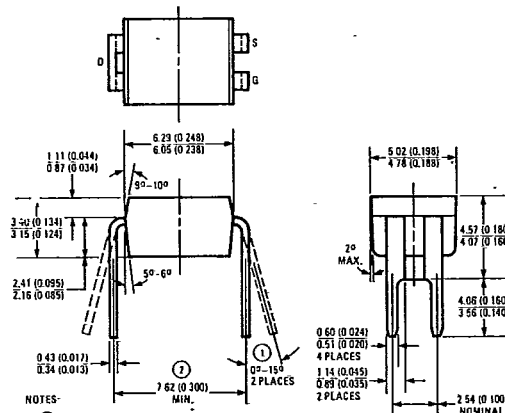
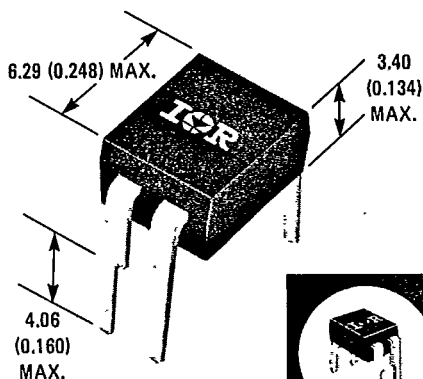
HEXFET technology is the key to International Rectifier's advanced line of power MOSFET transistors. Efficient geometry and unique processing of the HEXFET design achieve a very low on-state resistance combined with high transconductance and great device ruggedness. HEXFETs feature all of the established advantages of MOSFETs such as voltage control, very fast switching, ease of paralleling, and temperature stability of the electrical parameters.

The HEXDIP 4-pin, Dual-In-Line Package brings the advantages of HEXFETs to high volume applications where automatic PC Board insertion is desirable, such as circuit boards for computers, printers, telecommunications equipment and consumer products. Their compatibility with automatic insertion equipment, low-profile and end-stackable features represent the state-of-the-art in power device packaging

- For Automatic Insertion
- Compact Plastic Package
- End Stackable
- Fast Switching
- Low Drive Current
- Easily Paralleled
- Excellent Temperature Stability

**Product Summary**

| Part Number | V <sub>DS</sub> | R <sub>DS(on)</sub> | I <sub>D</sub> |
|-------------|-----------------|---------------------|----------------|
| IRFD210     | 200V            | 1.5Ω                | 0.6A           |
| IRFD213     | 150V            | 2.4Ω                | 0.45A          |

**CASE STYLE AND DIMENSIONS**

NOTES:

- ① APPLIES TO SPREAD OF LEADS PRIOR TO INSTALLATION.
- ② APPLIES TO INSTALLED LEAD CENTERS

Case Style HD-1 (Similar to JEDEC Outline MO-001AN)  
Dimensions in Millimeters and (Inches)

# IRFD210, IRFD213 Devices

11E D 4855452 0008387 9

## Absolute Maximum Ratings

## INTERNATIONAL RECTIFIER

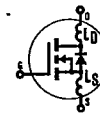
T-35-25

| Parameter                                                           | IRFD210                                              | IRFD213 | Units            |
|---------------------------------------------------------------------|------------------------------------------------------|---------|------------------|
| $V_{DS}$ Drain — Source Voltage ①                                   | 200                                                  | 150     | V                |
| $V_{DGR}$ Drain — Gate Voltage ( $R_{GS} = 20\text{ k}\Omega$ ) ①   | 200                                                  | 150     | V                |
| $I_D @ T_A = 25^\circ\text{C}$ Continuous Drain Current             | 0.6                                                  | 0.45    | A                |
| $I_{DM}$ Pulsed Drain Current                                       | 2.5                                                  | 1.8     | A                |
| $V_{GS}$ Gate — Source Voltage                                      | $\pm 20$                                             |         | V                |
| $P_D @ T_A = 25^\circ\text{C}$ Max. Power Dissipation               | 1.0 (See Fig. 13)                                    |         | W                |
| Linear Derating Factor                                              | 0.008 (See Fig. 13)                                  |         | W/K ③            |
| $I_{LM}$ Inductive Current, Clamped                                 | (See Fig. 14 and 15) $L = 100\mu\text{H}$<br>2.5 1.8 |         | A                |
| $T_J$ Operating Junction and<br>$T_{stg}$ Storage Temperature Range | -55 to 150                                           |         | $^\circ\text{C}$ |
| Lead Temperature                                                    | 300 (0.063 in. (1.6mm) from case for 10s)            |         | $^\circ\text{C}$ |

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

| Parameter                                                | Type    | Min. | Typ. | Max. | Units         | Test Conditions                                                                                                                                                               |
|----------------------------------------------------------|---------|------|------|------|---------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| $BV_{DSS}$ Drain — Source Breakdown Voltage              | IRFD210 | 200  | —    | —    | V             | $V_{GS} = 0\text{V}$                                                                                                                                                          |
|                                                          | IRFD213 | 150  | —    | —    | 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     | —    | —    | 500  | nA            | $V_{GS} = 20\text{V}$                                                                                                                                                         |
| $I_{GSS}$ Gate — Source Leakage Reverse                  | ALL     | —    | —    | -500 | 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                     | IRFD210 | 0.6  | —    | —    | A             | $V_{DS} > I_{D(on)} \times R_{DS(on)}$ max., $V_{GS} = 10\text{V}$                                                                                                            |
|                                                          | IRFD213 | 0.45 | —    | —    | A             |                                                                                                                                                                               |
| $R_{DS(on)}$ Static Drain — Source On-State Resistance ② | IRFD210 | —    | 1.0  | 1.5  | $\Omega$      | $V_{GS} = 10\text{V}$ , $I_D = 0.3\text{A}$                                                                                                                                   |
|                                                          | IRFD213 | —    | 1.5  | 2.4  | $\Omega$      |                                                                                                                                                                               |
| $g_{fs}$ Forward Transconductance ②                      | ALL     | 0.5  | 0.8  | —    | S (U)         | $V_{DS} > I_{D(on)} \times R_{DS(on)}$ max., $I_D = 0.3\text{A}$                                                                                                              |
| $C_{iss}$ Input Capacitance                              | ALL     | —    | 135  | 150  | pF            | $V_{GS} = 0\text{V}$ , $V_{DS} = 25\text{V}$ , $f = 1.0\text{ MHz}$<br>See Fig. 9                                                                                             |
| $C_{oss}$ Output Capacitance                             | ALL     | —    | 60   | 80   | pF            |                                                                                                                                                                               |
| $C_{rss}$ Reverse Transfer Capacitance                   | ALL     | —    | 16   | 25   | pF            |                                                                                                                                                                               |
| $t_{d(on)}$ Turn-On Delay Time                           | ALL     | —    | 8.0  | 15   | ns            | $V_{DD} = 0.5 BV_{DSS}$ , $I_D = 0.3\text{A}$ , $Z_\theta = 50\Omega$<br>See Fig. 16<br>(MOSFET switching times are essentially independent of operating temperature.)        |
| $t_r$ Rise Time                                          | ALL     | —    | 15   | 25   | ns            |                                                                                                                                                                               |
| $t_{d(off)}$ Turn-Off Delay Time                         | ALL     | —    | 10   | 15   | ns            |                                                                                                                                                                               |
| $t_f$ Fall Time                                          | ALL     | —    | 8.0  | 15   | ns            |                                                                                                                                                                               |
| $Q_g$ Total Gate Charge (Gate-Source Plus Gate-Drain)    | ALL     | —    | 5.0  | 7.5  | nC            | $V_{GS} = 10\text{V}$ , $I_D = 2.5\text{A}$ , $V_{DS} = 0.8$ Max. Rating.<br>See Fig. 17 for test circuit. (Gate charge is essentially independent of operating temperature.) |
| $Q_{gs}$ Gate-Source Charge                              | ALL     | —    | 2.0  | —    | nC            |                                                                                                                                                                               |
| $Q_{gd}$ Gate-Drain ("Miller") Charge                    | ALL     | —    | 3.0  | —    | nC            |                                                                                                                                                                               |
| $L_D$ Internal Drain Inductance                          | ALL     | —    | 4.0  | —    | nH            | Measured from the drain lead, 2.0mm (0.08 in.) from package to center of die.                                                                                                 |
| $L_S$ Internal Source Inductance                         | ALL     | —    | 6.0  | —    | nH            | Measured from the source lead, 2.0mm (0.08 in.) from package to source bonding pad.                                                                                           |

Modified MOSFET symbol showing the internal device inductances.



## Thermal Resistance

|                                |     |   |   |     |       |                      |
|--------------------------------|-----|---|---|-----|-------|----------------------|
| $R_{thJA}$ Junction-to-Ambient | ALL | — | — | 120 | K/W ③ | Typical socket mount |
|--------------------------------|-----|---|---|-----|-------|----------------------|

## Source-Drain Diode Ratings and Characteristics

|                                              |         |                                                                                                  |     |      |               |                                                                                       |
|----------------------------------------------|---------|--------------------------------------------------------------------------------------------------|-----|------|---------------|---------------------------------------------------------------------------------------|
| $I_S$ Continuous Source Current (Body Diode) | IRFD210 | —                                                                                                | —   | 0.6  | A             | Modified MOSFET symbol showing the integral reverse P-N junction rectifier.           |
|                                              | IRFD213 | —                                                                                                | —   | 0.45 | A             |                                                                                       |
| $I_{SM}$ Pulse Source Current (Body Diode)   | IRFD210 | —                                                                                                | —   | 2.5  | A             |                                                                                       |
|                                              | IRFD213 | —                                                                                                | —   | 1.8  | A             |                                                                                       |
| $V_{SD}$ Diode Forward Voltage ②             | IRFD210 | —                                                                                                | —   | 2.0  | V             | $T_A = 25^\circ\text{C}$ , $I_S = 0.6\text{A}$ , $V_{GS} = 0\text{V}$                 |
|                                              | IRFD213 | —                                                                                                | —   | 1.8  | V             | $T_A = 25^\circ\text{C}$ , $I_S = 0.45\text{A}$ , $V_{GS} = 0\text{V}$                |
| $t_{rr}$ Reverse Recovery Time               | ALL     | —                                                                                                | 290 | —    | ns            | $T_J = 150^\circ\text{C}$ , $I_F = 0.6\text{A}$ , $dI_F/dt = 100\text{A}/\mu\text{s}$ |
| $Q_{RR}$ Reverse Recovered Charge            | ALL     | —                                                                                                | 2.0 | —    | $\mu\text{C}$ | $T_J = 150^\circ\text{C}$ , $I_F = 0.6\text{A}$ , $dI_F/dt = 100\text{A}/\mu\text{s}$ |
| $t_{on}$ Forward Turn-on Time                | ALL     | Intrinsic turn-on time is negligible. 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  $\text{KW} = ^\circ\text{C/W}$ ,  $\text{W/K} = \text{W}/^\circ\text{C}$

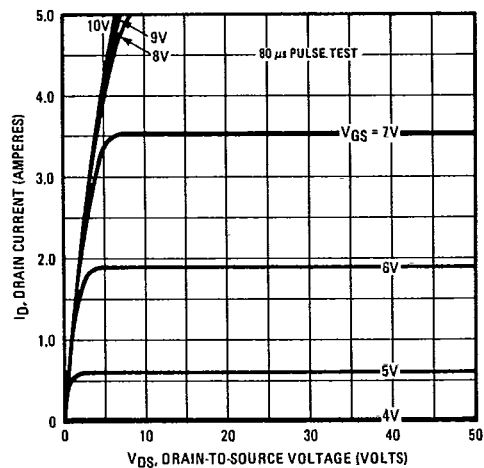


Fig. 1 - Typical Output Characteristics

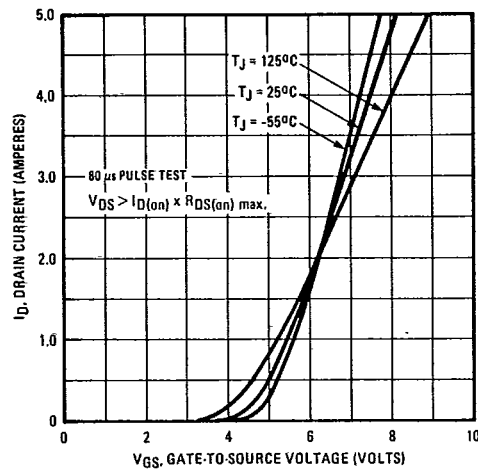


Fig. 2 - Typical Transfer Characteristics

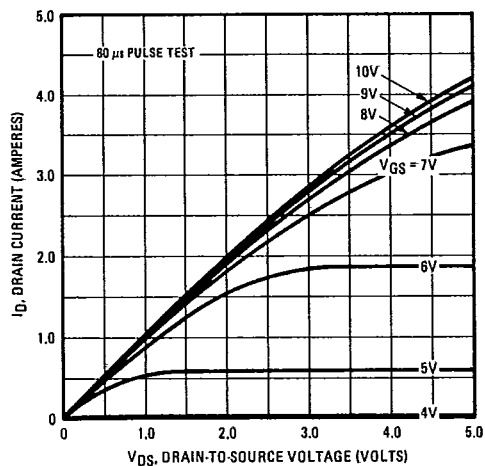


Fig. 3 - Typical Saturation Characteristics

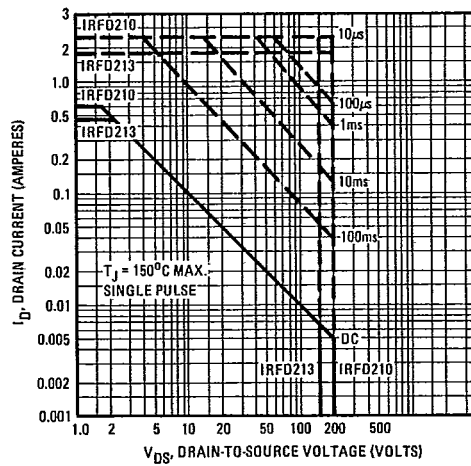


Fig. 4 - Maximum Safe Operating Area



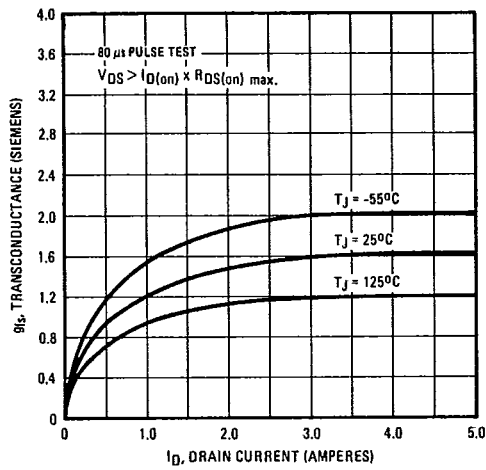


Fig. 5 — Typical Transconductance Vs. Drain Current

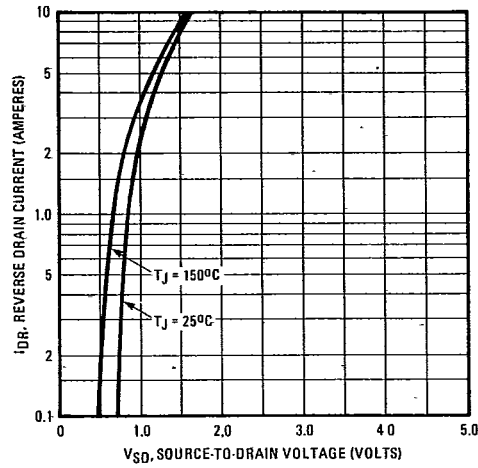


Fig. 6 — Typical Source-Drain Diode Forward Voltage

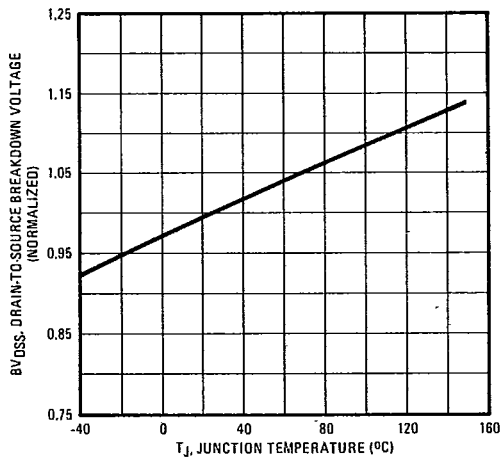


Fig. 7 — Breakdown Voltage Vs. Temperature

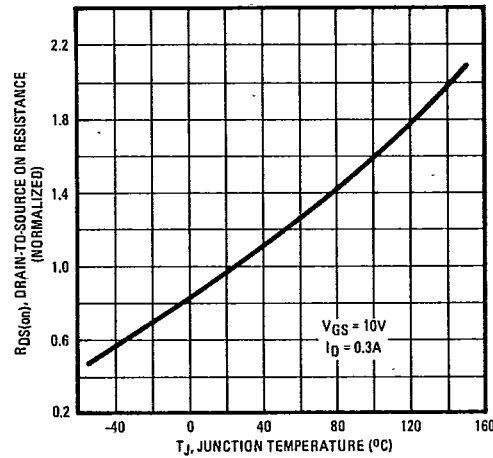


Fig. 8 — Normalized On-Resistance Vs. Temperature

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## IRFD210, IRFD213 Devices

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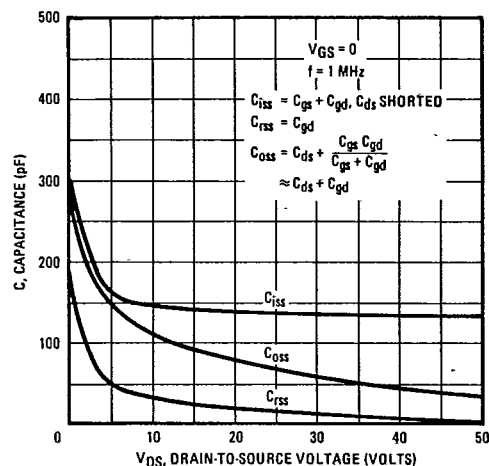


Fig. 9 — Typical Capacitance Vs. Drain-to-Source Voltage

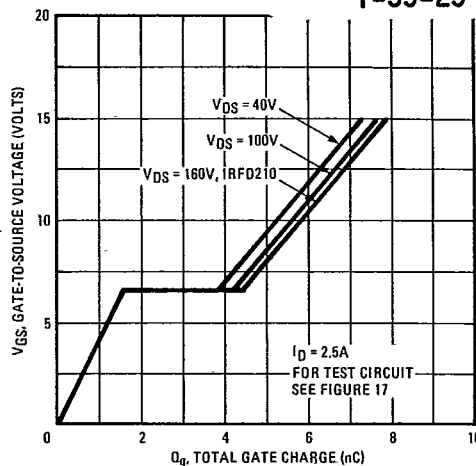


Fig. 10 — Typical Gate Charge Vs. Gate-to-Source Voltage

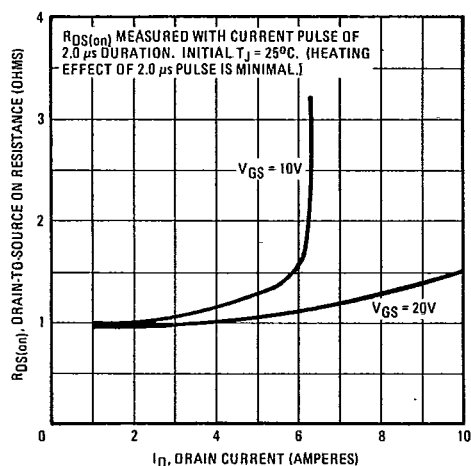


Fig. 11 — Typical On-Resistance Vs. Drain Current

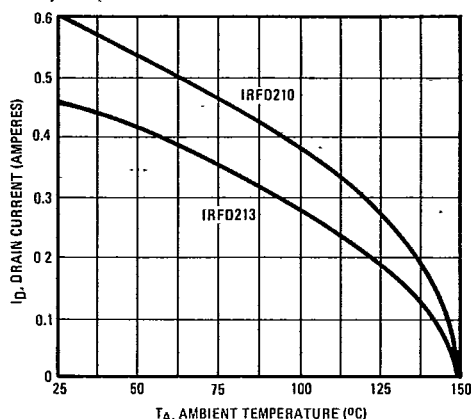


Fig. 12 — Maximum Drain Current Vs. Case Temperature

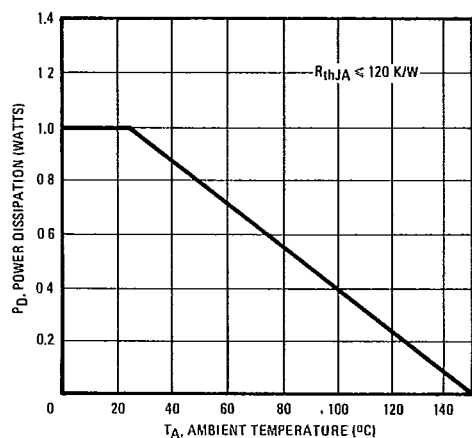


Fig. 13 — Power Vs. Temperature Derating Curve

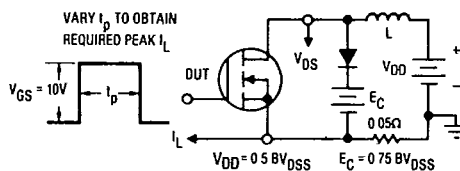


Fig. 14 — Clamped Inductive Test Circuit

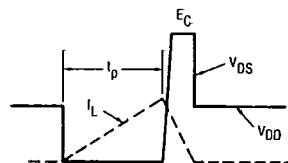


Fig. 15 — Clamped Inductive Waveforms

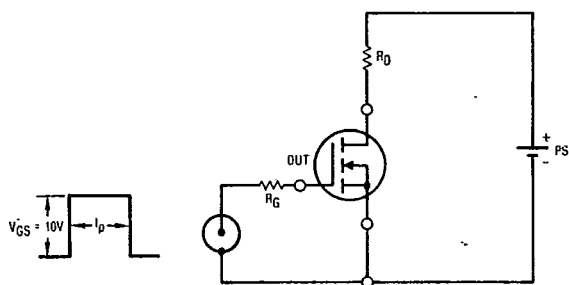


Fig. 16 - Switching Time Test Circuit

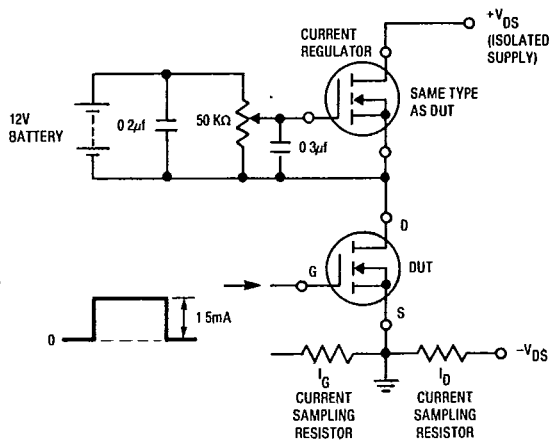
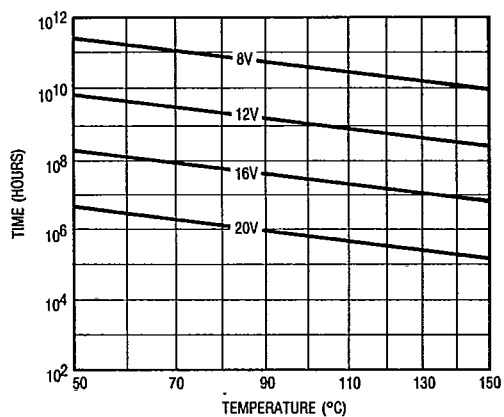
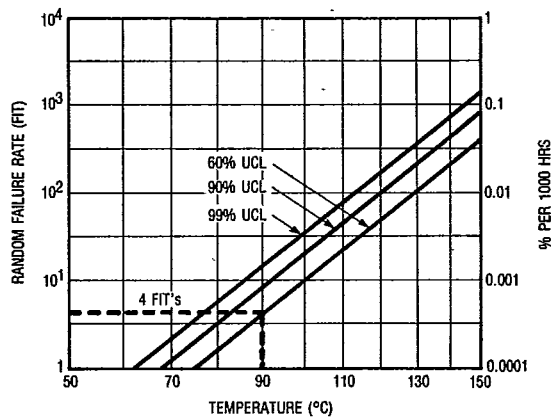


Fig. 17 - Gate Charge Test Circuit



\*Fig. 18 - Typical Time to Accumulated 1% Gate Failure



\*Fig. 19 - Typical High Temperature Reverse Bias (HTRB) Failure Rate

\*The data shown is correct as of April 15, 1987. This information is updated on a quarterly basis; for the latest reliability data, please contact your local IR field office.