

FRX130D, FRX130R, FRX130H

Radiation Hardened N-Channel Power MOSFETs

April 1998

Features

- 6A, 100V, $r_{DS(ON)} = 0.180\Omega$
- Second Generation Rad Hard MOSFET Results From New Design Concepts
- Gamma
 - Meets Pre-RAD Specifications to 100K RAD (Si)
 - Defined End-Point Specs at 300K RAD (Si) and 1000K RAD (Si)
 - Performance Permits Limited Use to 3000K RAD (Si)
- Dose Rate
 - Typically Survives $3E9$ RAD (Si)/s at 80% BV_{DSS}
 - Typically Survives $2E12$ if Current Limited to I_{DM}
- Photo Current
 - 1.50nA Per-RAD (Si)/s Typically
- Neutron
 - Maintain Pre-RAD Specifications for $3E13$ Neutrons/cm²
 - Usable to $3E14$ Neutrons/cm²

Ordering Information

| PART NUMBER | PACKAGE | BRAND |
|-------------|------------|----------|
| FRX130D1 | 18 Ld CLCC | FRX130D1 |
| FRX130D3 | 18 Ld CLCC | FRX130D3 |
| FRX130R1 | 18 Ld CLCC | FRX130R1 |
| FRX130R3 | 18 Ld CLCC | FRX130R3 |
| FRX130R4 | 18 Ld CLCC | FRX130R4 |
| FRX130H4 | 18 Ld CLCC | FRX130H4 |

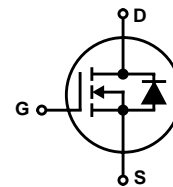
Description

The Intersil has designed a series of SECOND GENERATION hardened power MOSFETs of both N-Channel and P-Channel enhancement types with ratings from 100V to 500V, 1A to 60A, and on resistance as low as 25m Ω . Total dose hardness is offered at 100K RAD (Si) and 1000K RAD (Si) with neutron hardness ranging from 1E13n/cm² for 500V product to 1E14n/cm² for 100V product. Dose rate hardness (GAMMA DOT) exists for rates to 1E9 without current limiting and 2E12 with current limiting.

This MOSFET is an enhancement-mode silicon-gate power field effect transistor of the vertical DMOS (VDMOS) structure. It is specially designed and processed to exhibit minimal characteristic changes to total dose (GAMMA) and neutron (n^0) exposures. Design and processing efforts are also directed to enhance survival to heavy ion (SEU) and/or dose rate (GAMMA DOT) exposure.

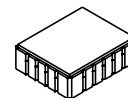
This part may be supplied as a die or in various packages other than shown above. Reliability screening is available as either non TX (commercial), TX equivalent of MIL-S-19500, TXV equivalent of MIL-S-19500, or space equivalent of MIL-S-19500. Contact the Intersil High-Reliability Marketing group for any desired deviations from the data sheet.

Symbol



Package

18 LEAD CLCC



FRX130D, FRX130R, FRX130H

Absolute Maximum Ratings $T_C = 25^\circ\text{C}$, Unless Otherwise Specified

| | FRX130D, R, H | UNITS |
|-------------------------------------------------------------------------------------|---------------|---------------------|
| Drain to Source Voltage | 100 | V |
| Drain to Gate Voltage ($R_{GS} = 20k\Omega$) | 100 | V |
| Continuous Drain Current | 6 | A |
| $T_C = 100^\circ\text{C}$ | 4 | A |
| Pulsed Drain Current | 18 | A |
| Gate to Source Voltage | ± 20 | V |
| Maximum Power Dissipation | 11.4 | W |
| $T_C = 100^\circ\text{C}$ | 4.5 | W |
| Linear Derating Factor | 0.09 | W/ $^\circ\text{C}$ |
| Single Pulsed Avalanche Current, $L = 100\mu\text{H}$, (See Test Figure) | 18 | A |
| Continuous Source Current (Body Diode) | 6 | A |
| Pulsed Source Current (Body Diode) | 18 | A |
| Operating and Storage Temperature | -55 to 150 | $^\circ\text{C}$ |
| Lead Temperature (During Soldering) | 300 | $^\circ\text{C}$ |

(Distance $>0.063\text{in}$ (1.6mm) from Case, 10s Max)

CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.

Electrical Specifications $T_C = 25^\circ\text{C}$, Unless Otherwise Specified

| PARAMETER | SYMBOL | TEST CONDITIONS | MIN | TYP | MAX | UNITS |
|-----------------------------------|----------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------|-----|-----|--------------------|---------------------------|
| Drain to Source Breakdown Voltage | BV_{DSS} | $I_D = 1\text{mA}$, $V_{GS} = 0\text{V}$ | 100 | - | - | V |
| Gate Threshold Voltage | $V_{GS(TH)}$ | $I_D = 1\text{mA}$, $V_{DS} = V_{GS}$ | 2.0 | | 4.0 | V |
| Gate-Body Leakage Forward | I_{GSSF} | $V_{GS} = +20\text{V}$ | - | | 100 | nA |
| Gate-Body Leakage Reverse | I_{GSSR} | $V_{GS} = -20\text{V}$ | - | | 100 | nA |
| Zero Gate Voltage Drain Current | I_{DSS1} I_{DSS2} I_{DSS3} | $V_{DS} = 100\text{V}$, $V_{GS} = 0$ $V_{DS} = 80\text{V}$, $V_{GS} = 0$ $V_{DS} = 80\text{V}$, $V_{GS} = 0$, $T_C = 125^\circ\text{C}$ | - | - | 1 0.025 0.25 | μA |
| Rated Avalanche Current | I_{AR} | Time = 20 μs | - | - | 18 | A |
| Drain to Source On-State Volts | $V_{DS(ON)}$ | $V_{GS} = 10\text{V}$, $I_D = 6\text{A}$ | - | - | 1.130 | V |
| Drain to Source On Resistance | $r_{DS(ON)}$ | $V_{GS} = 10\text{V}$, $I_D = 4\text{A}$ | - | - | 0.180 | Ω |
| Turn-On Delay Time | $t_{d(ON)}$ | $V_{DD} = 50\text{V}$, $I_D = 6\text{A}$ | - | - | 30 | ns |
| Rise Time | t_r | Pulse Width = 3 μs | - | - | 100 | |
| Turn-Off Delay Time | $t_{d(OFF)}$ | Period = 300 μs , $R_g = 25\Omega$ | - | - | 200 | |
| Fall Time | t_f | $0 \leq V_{GS} \leq 10$ (See Test Circuit) | - | - | 100 | |
| Gate-Charge Threshold | $Q_{g(TH)}$ | $V_{DD} = 50\text{V}$, $I_D = 6\text{A}$ $I_{GS1} = I_{GS2}$ $0 \leq V_{GS} \leq 20$ | 1 | - | 4 | nc |
| Gate-Charge On State | $Q_{g(ON)}$ | | 17 | - | 70 | |
| Gate-Charge Total | Q_{gM} | | 32 | - | 128 | |
| Plateau Voltage | V_{GP} | | 3 | - | 12 | V |
| Gate-Charge Source | Q_{gS} | | 3 | - | 14 | nc |
| Gate-Charge Drain | Q_{gD} | | 8 | - | 32 | |
| Diode Forward Voltage | V_{SD} | $I_D = 6\text{A}$, $V_{GD} = 0$ | 0.6 | - | 1.8 | V |
| Reverse Recovery Time | t_{rr} | $I = 6\text{A}$; $di/dt = 100\text{A}/\mu\text{s}$ | - | - | 400 | ns |
| Junction To Case | $R_{\theta JC}$ | | - | - | 11 | $^\circ\text{C}/\text{W}$ |
| Junction To Ambient | $R_{\theta JA}$ | Free Air Operation | - | - | 250 | |

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Typical Performance Curves Unless Otherwise Specified

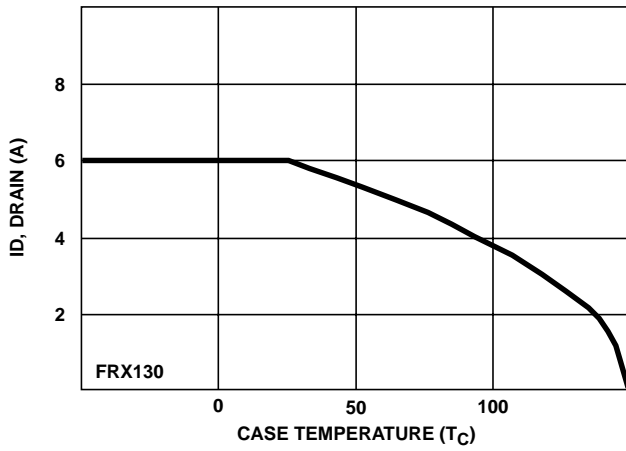


FIGURE 1. MAXIMUM CONTINUOUS DRAIN CURRENT vs CASE TEMPERATURE

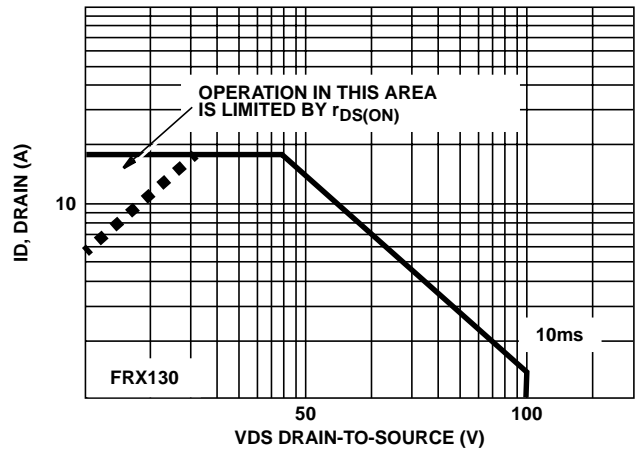


FIGURE 2. SAFE OPERATING AREA CURVE CASE TEMPERATURE = 25°C

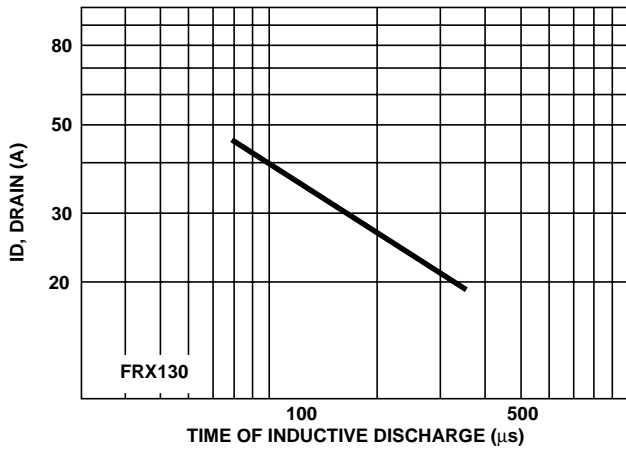


FIGURE 3. TYPICAL UNCLAMPED INDUCTIVE SWITCHING FAILURE ONSET AVALANCHE MODE

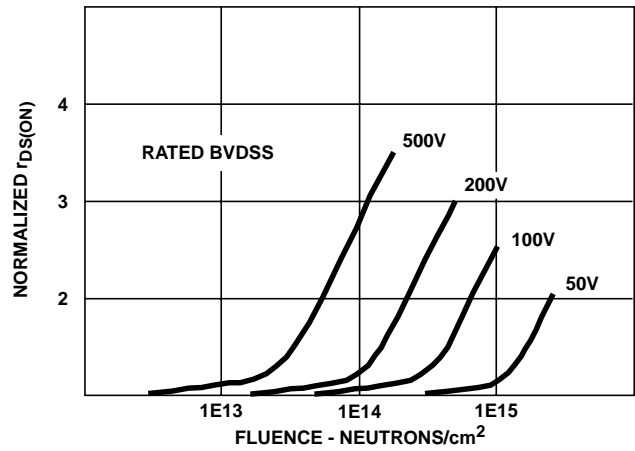


FIGURE 4. NORMALIZED ON-RESISTANCE vs NEUTRON FLUENCE N-CHANNEL

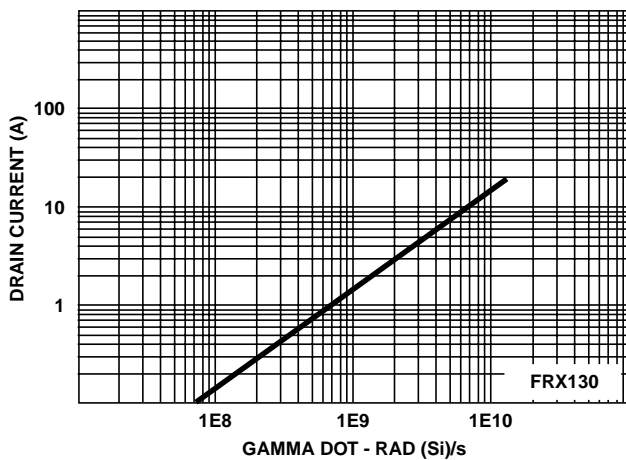


FIGURE 5. TYPICAL PHOTO CURRENT vs GAMMA RATE

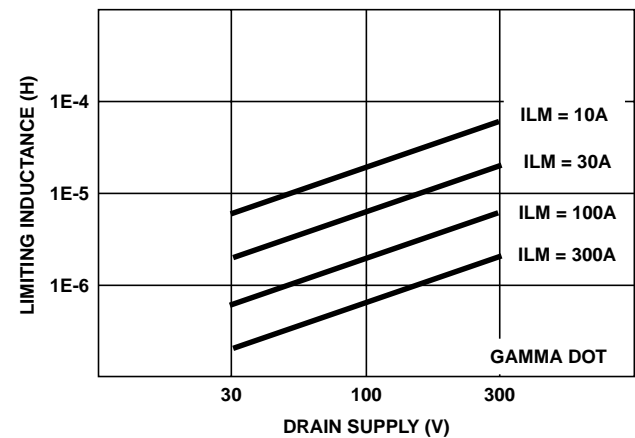


FIGURE 6. DRAIN INDUCTANCE REQUIRED TO LIMIT GAMMA DOT CURRENT TO I_{LM}

Test Circuits and Waveforms

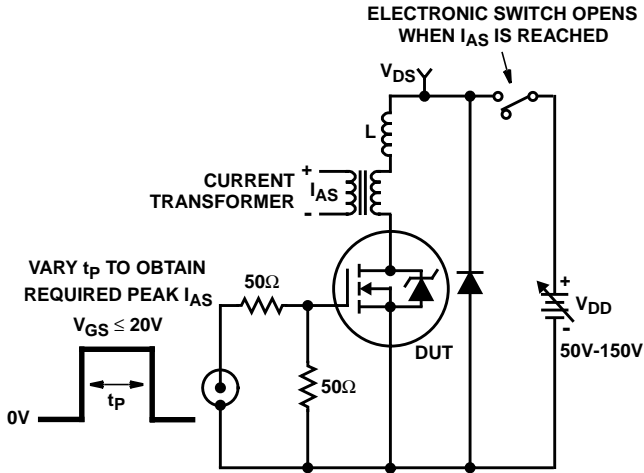


FIGURE 7. UNCLAMPED ENERGY TEST CIRCUIT

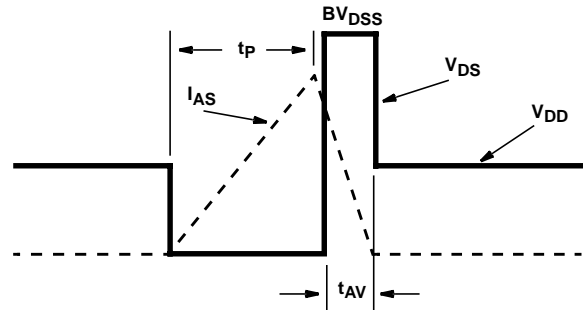


FIGURE 8. UNCLAMPED ENERGY WAVEFORMS

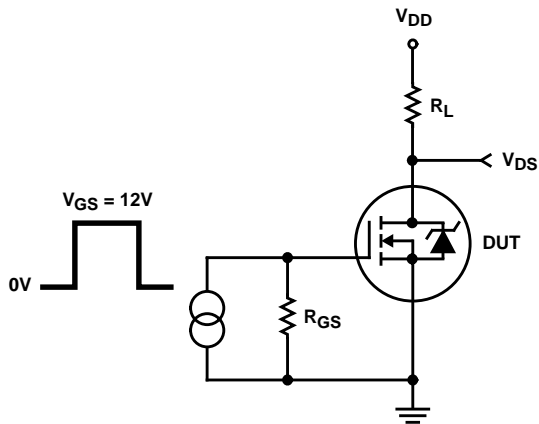


FIGURE 9. RESISTIVE SWITCHING TEST CIRCUIT

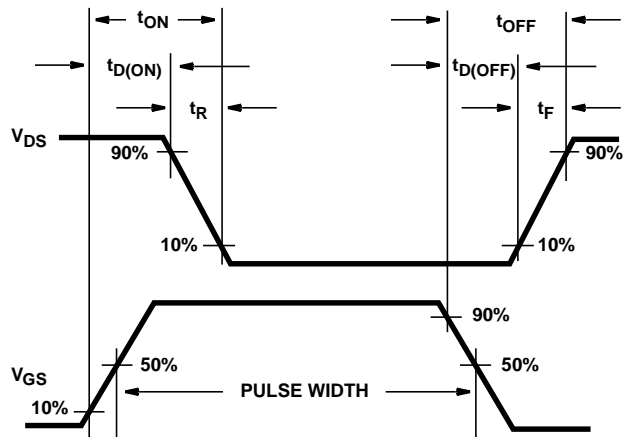
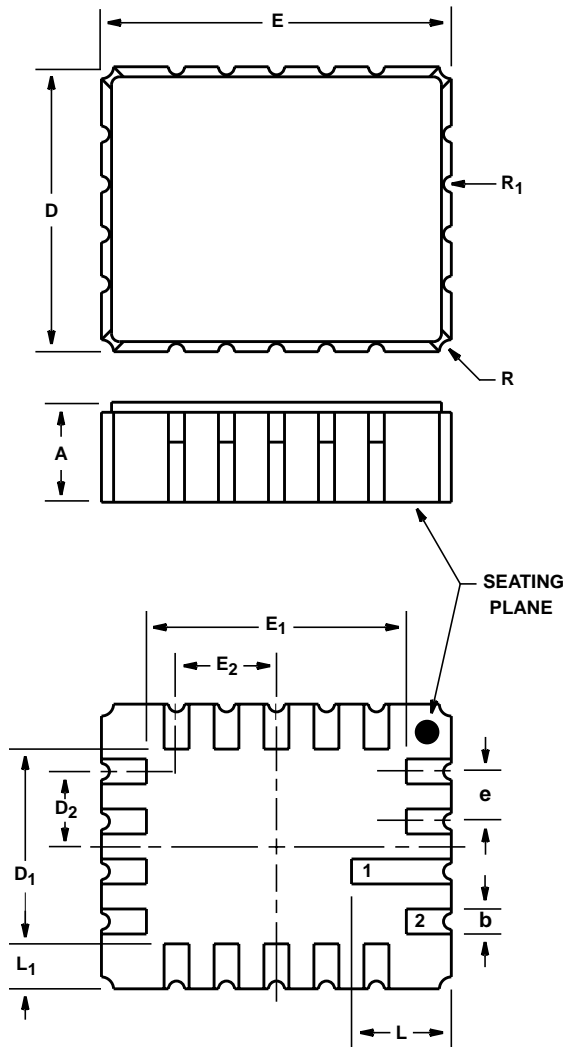


FIGURE 10. RESISTIVE SWITCHING WAVEFORMS

FRX130D, FRX130R, FRX130H

18 Pin CLCC

18 PIN CERAMIC LEADLESS CHIP CARRIER



| SYMBOL | INCHES | | MILLIMETERS | | NOTES |
|----------------|-----------|-------|-------------|------|-------|
| | MIN | MAX | MIN | MAX | |
| A | 0.092 | 0.112 | 2.34 | 2.84 | - |
| b | 0.020 | 0.030 | 0.51 | 0.76 | - |
| D | 0.275 | 0.295 | 6.99 | 7.49 | - |
| D ₁ | 0.175 | 0.215 | 4.45 | 5.46 | - |
| D ₂ | 0.070 | 0.080 | 1.78 | 2.03 | - |
| E | 0.340 | 0.360 | 8.64 | 9.14 | - |
| E ₁ | 0.240 | 0.280 | 6.10 | 7.11 | - |
| E ₂ | 0.095 | 0.105 | 2.42 | 2.66 | - |
| e | 0.050 BSC | | 1.27 BSC | | - |
| L | 0.085 | 0.115 | 2.16 | 2.92 | - |
| L ₁ | 0.035 | 0.055 | 0.89 | 1.39 | - |
| R | 0.007 | 0.017 | 0.18 | 0.43 | 4 |
| R ₁ | 0.003 | 0.013 | 0.08 | 0.33 | 4 |

NOTES:

1. No current JEDEC outline for this package.
2. All exposed metallized areas shall be plated with a minimum of 50 microinches of gold over nickel unless otherwise stated.
3. Metallized castellations shall be connected to the seating plane and extend upward toward top of package.
4. Corner shape (notch, radius, square, etc.) may vary at the manufacturer's option.
5. Unless otherwise specified, a minimum clearance of 0.010 inches (0.25mm) shall be maintained between all metallized areas.
6. Controlling dimension: Inch.
7. Revision 1 dated 6-93.

| ELEMENT | PAD | PINS CONNECTED |
|---------|-----|------------------------------------|
| GATE | A | 5 |
| DRAIN | B | 1, 2, 3, 4, 16, 17, 18 |
| SOURCE | C | 6, 7, 8, 9, 10, 11, 12, 13, 14, 15 |

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