

EF Series Power MOSFET With Fast Body Diode

Thin-Lead TO-220 FULLPAK


N-Channel MOSFET

FEATURES

- Low figure-of-merit (FOM) $R_{on} \times Q_g$
- Low input capacitance (C_{iss})
- Reduced switching and conduction losses
- Ultra low gate charge (Q_g)
- Avalanche energy rated (UIS)
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912


RoHS
 COMPLIANT
 HALOGEN
FREE

APPLICATIONS

- Server and telecom power supplies
- Switch mode power supplies (SMPS)
- Power factor correction power supplies (PFC)
- Lighting
 - High-intensity discharge (HID)
 - Fluorescent ballast lighting
- Industrial
 - Welding
 - Induction heating
 - Motor drives
 - Battery chargers
 - Renewable energy
 - Solar (PV inverters)

PRODUCT SUMMARY

| | | |
|---|-----------------|-------|
| V_{DS} (V) at T_J max. | 650 | |
| $R_{DS(on)}$ typ. (Ω) at 25 °C | $V_{GS} = 10$ V | 0.158 |
| Q_g max. (nC) | 96 | |
| Q_{gs} (nC) | 9 | |
| Q_{gd} (nC) | 21 | |
| Configuration | Single | |

ORDERING INFORMATION

| | |
|---------------------------------|--------------------------|
| Package | Thin-Lead TO-220 FULLPAK |
| Lead (Pb)-free and halogen-free | SiHA22N60EF-GE3 |

ABSOLUTE MAXIMUM RATINGS ($T_C = 25$ °C, unless otherwise noted)


| PARAMETER | SYMBOL | LIMIT | UNIT |
|---|------------------|----------------|------|
| Drain-source voltage | V_{DS} | 600 | V |
| Gate-source voltage | V_{GS} | ± 30 | |
| Continuous drain current ($T_J = 150$ °C) ^e | V_{GS} at 10 V | $T_C = 25$ °C | 19 |
| | | $T_C = 100$ °C | 12 |
| Pulsed drain current ^a | I_{DM} | 46 | A |
| Linear derating factor | | 0.26 | W/°C |
| Single pulse avalanche energy ^b | E_{AS} | 144 | mJ |
| Maximum power dissipation | P_D | 33 | W |
| Operating junction and storage temperature range | T_J, T_{stg} | -55 to +150 | °C |
| Drain-source voltage slope | dv/dt | $T_J = 125$ °C | 70 |
| Reverse diode dv/dt ^d | | 50 | |
| Soldering recommendations (peak temperature) ^c | For 10 s | 260 | °C |
| Mounting torque, M3 screw | | 0.6 | Nm |

Notes

- Repetitive rating; pulse width limited by maximum junction temperature
- $V_{DD} = 140$ V, starting $T_J = 25$ °C, $L = 28.2$ mH, $R_g = 25$ Ω , $I_{AS} = 3.2$ A
- 1.6 mm from case
- $I_{SD} \leq I_D$, $di/dt = 400$ A/ μ s, starting $T_J = 25$ °C
- Limited by maximum junction temperature



| THERMAL RESISTANCE RATINGS | | | | |
|----------------------------------|-------------------|------|------|------|
| PARAMETER | SYMBOL | TYP. | MAX. | UNIT |
| Maximum junction-to-ambient | R _{thJA} | - | 65 | °C/W |
| Maximum junction-to-case (drain) | R _{thJC} | - | 3.8 | |

| SPECIFICATIONS (T _J = 25 °C, unless otherwise noted) | | | | | | | |
|---|----------------------------------|---|--|-----------------------|-------|-------|------|
| PARAMETER | SYMBOL | TEST CONDITIONS | | MIN. | TYP. | MAX. | UNIT |
| Static | | | | | | | |
| Drain-source breakdown voltage | V _{DS} | V _{GS} = 0 V, I _D = 250 μA | | 600 | - | - | V |
| V _{DS} temperature coefficient | ΔV _{DS} /T _J | Reference to 25 °C, I _D = 1 mA | | - | 0.68 | - | V/°C |
| Gate-source threshold voltage (N) | V _{GS(th)} | V _{DS} = V _{GS} , I _D = 250 μA | | 2.0 | - | 4.0 | V |
| Gate-source leakage | I _{GSS} | V _{GS} = ± 20 V | | - | - | ± 100 | nA |
| | | V _{GS} = ± 30 V | | - | - | ± 1 | μA |
| Zero gate voltage drain current | I _{DSS} | V _{DS} = 480 V, V _{GS} = 0 V | | - | - | 1 | μA |
| | | V _{DS} = 480 V, V _{GS} = 0 V, T _J = 125 °C | | - | - | 500 | |
| Drain-source on-state resistance | R _{DS(on)} | V _{GS} = 10 V | I _D = 11 A | - | 0.158 | 0.182 | Ω |
| Forward transconductance ^a | g _{fs} | V _{DS} = 30 V, I _D = 11 A | | - | 5.8 | - | S |
| Dynamic | | | | | | | |
| Input capacitance | C _{iSS} | V _{GS} = 0 V, V _{DS} = 100 V, f = 1 MHz | | - | 1423 | - | pF |
| Output capacitance | C _{oss} | | | - | 73 | - | |
| Reverse transfer capacitance | C _{rSS} | | | - | 5 | - | |
| Effective output capacitance, energy related ^a | C _{o(er)} | | | - | 48 | - | |
| Effective output capacitance, time related ^b | C _{o(tr)} | | | - | 240 | - | |
| Total gate charge | Q _g | V _{GS} = 10 V | I _D = 11 A, V _{DS} = 480 V | - | 48 | 96 | nC |
| Gate-source charge | Q _{gs} | | | - | 9 | - | |
| Gate-drain charge | Q _{gd} | | | - | 21 | - | |
| Turn-on delay time | t _{d(on)} | V _{DD} = 480 V, I _D = 11 A, V _{GS} = 10 V, R _g = 9.1 Ω | | - | 15 | 30 | ns |
| Rise time | t _r | | | - | 21 | 42 | |
| Turn-off delay time | t _{d(off)} | | | - | 58 | 87 | |
| Fall time | t _f | | | - | 25 | 50 | |
| Gate input resistance | R _g | | | f = 1 MHz, open drain | | 0.3 | |
| Drain-Source Body Diode Characteristics | | | | | | | |
| Continuous source-drain diode current | I _S | MOSFET symbol showing the integral reverse p - n junction diode  | | - | - | 19 | A |
| Pulsed diode forward current | I _{SM} | | | - | - | 46 | |
| Diode forward voltage | V _{SD} | T _J = 25 °C, I _S = 11 A, V _{GS} = 0 V | | - | - | 1.2 | V |
| Reverse recovery time | t _{rr} | T _J = 25 °C, I _F = I _S = 11 A, di/dt = 100 A/μs, V _R = 400 V | | - | 113 | 226 | ns |
| Reverse recovery charge | Q _{rr} | | | - | 0.7 | 1.4 | μC |
| Reverse recovery current | I _{RRM} | | | - | 11 | - | A |

Notes

- a. C_{oss(er)} is a fixed capacitance that gives the same energy as C_{oss} while V_{DS} is rising from 0 % to 80 % V_{DSS}
- b. C_{oss(tr)} is a fixed capacitance that gives the same charging time as C_{oss} while V_{DS} is rising from 0 % to 80 % V_{DSS}

TYPICAL CHARACTERISTICS (25 °C, unless otherwise noted)

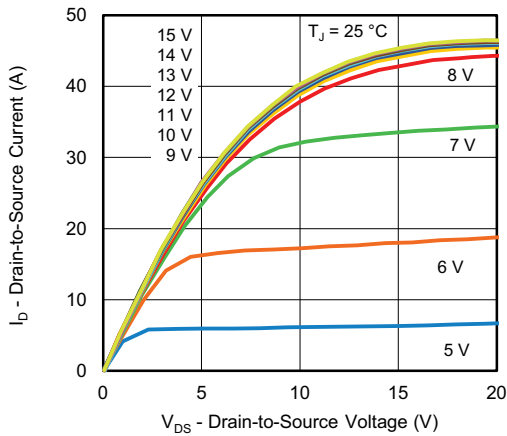


Fig. 1 - Typical Output Characteristics

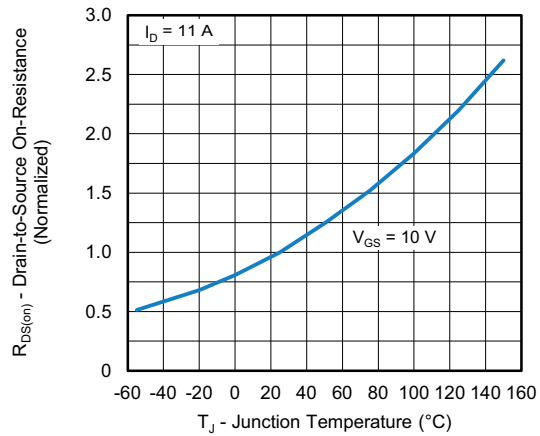


Fig. 4 - Normalized On-Resistance vs. Temperature

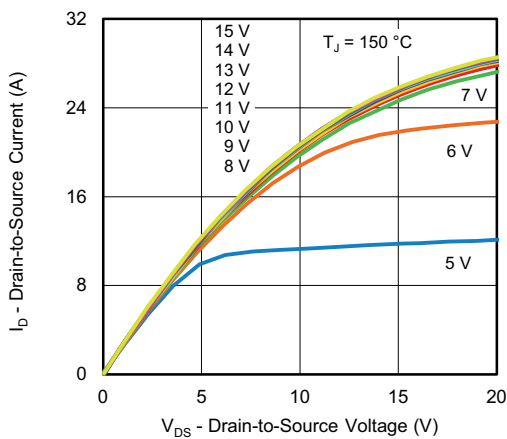


Fig. 2 - Typical Output Characteristics

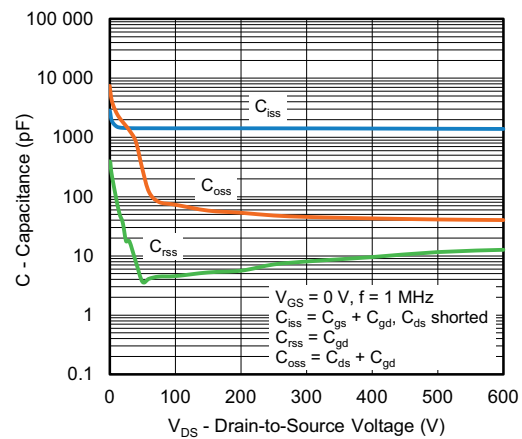


Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage

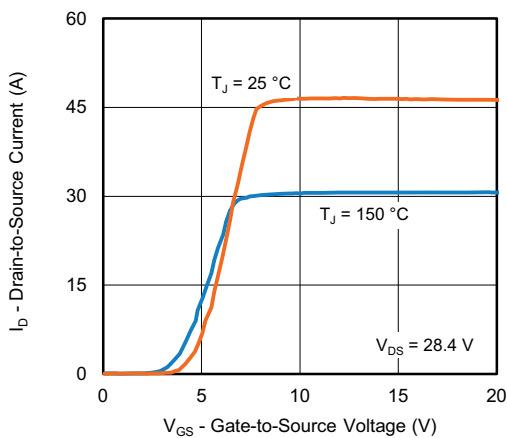


Fig. 3 - Typical Transfer Characteristics

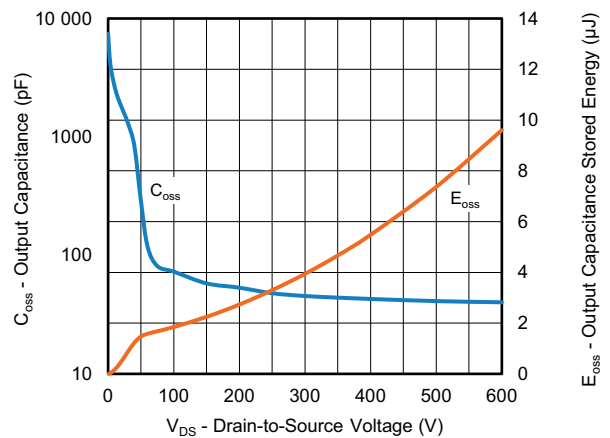


Fig. 6 - C_{oss} and E_{oss} vs. V_{DS}

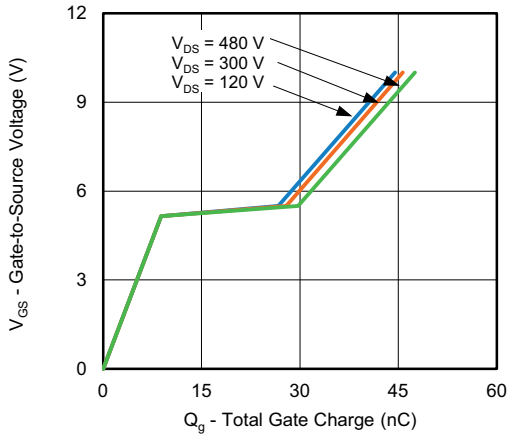


Fig. 7 - Typical Gate Charge vs. Gate-to-Source Voltage

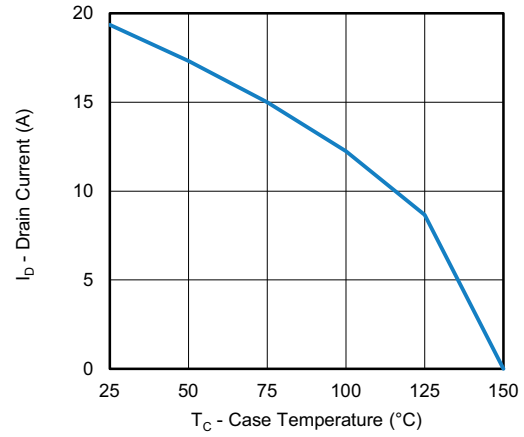


Fig. 10 - Maximum Drain Current vs. Case Temperature

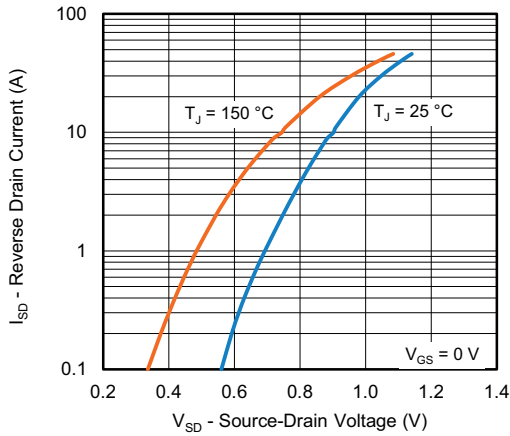


Fig. 8 - Typical Source-Drain Diode Forward Voltage

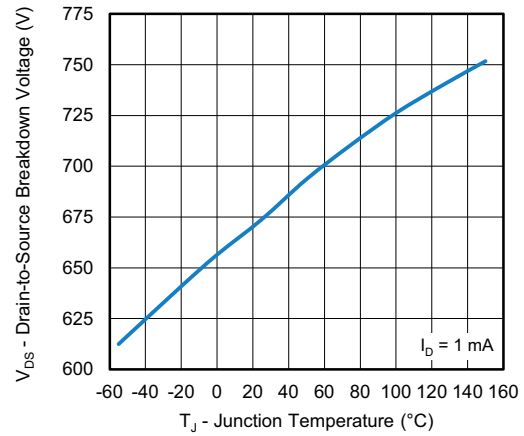


Fig. 11 - Temperature vs. Drain-to-Source Voltage

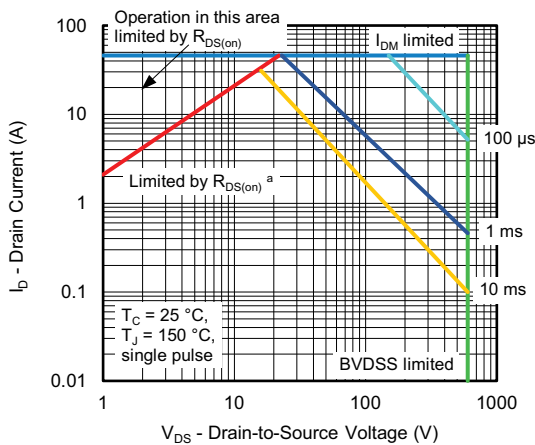


Fig. 9 - Maximum Safe Operating Area

Note

a. $V_{GS} >$ minimum V_{GS} at which $R_{DS(on)}$ is specified

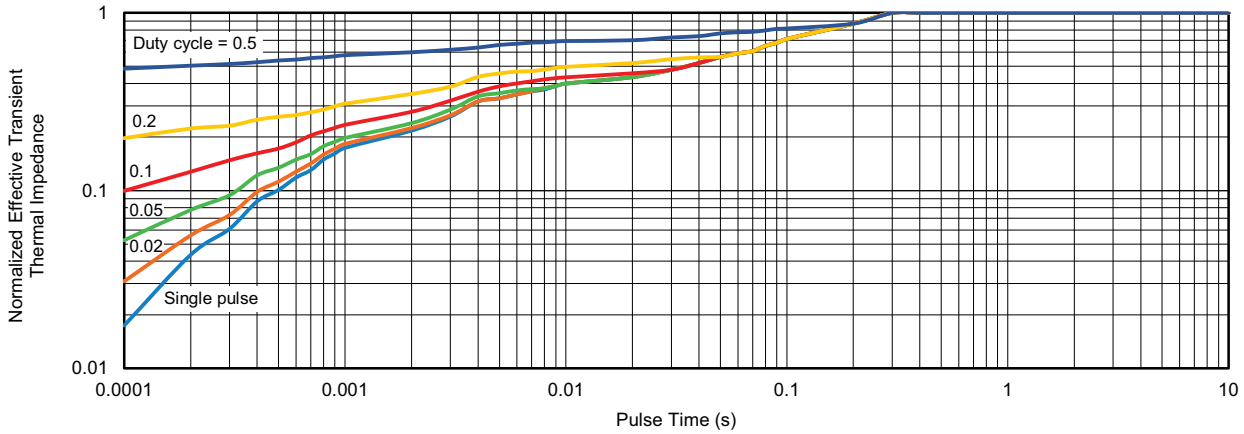


Fig. 12 - Normalized Transient Thermal Impedance, Junction-to-Case



Fig. 13 - Switching Time Test Circuit

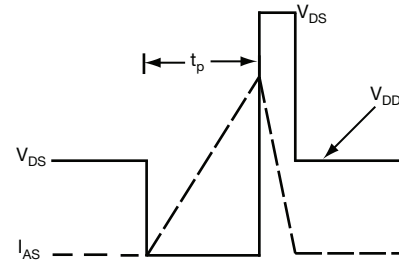


Fig. 16 - Unclamped Inductive Waveforms

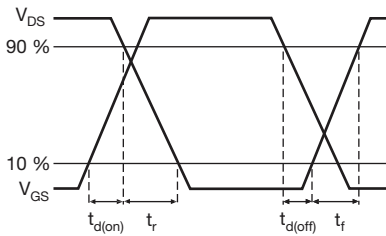


Fig. 14 - Switching Time Waveforms

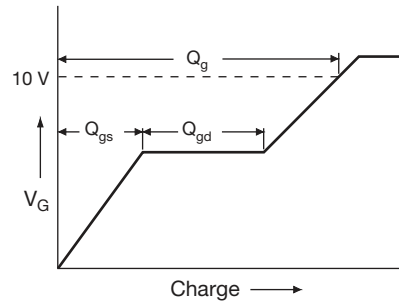


Fig. 17 - Basic Gate Charge Waveform

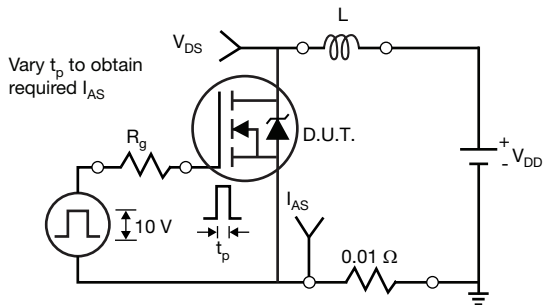


Fig. 15 - Unclamped Inductive Test Circuit

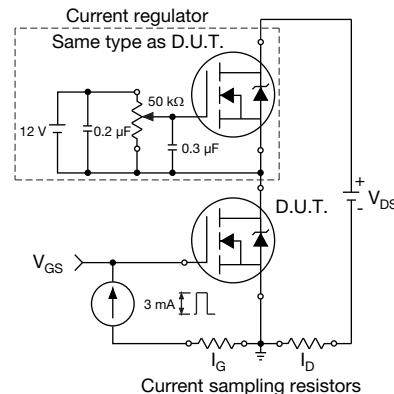


Fig. 18 - Gate Charge Test Circuit



Note

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

Fig. 19 - For N-Channel

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TO-220 FULLPAK Thin Lead



| SYMBOL | DIMENSIONS | | | |
|--------|-------------|-------|--------|-------|
| | MILLIMETERS | | INCHES | |
| | MIN. | MAX. | MIN. | MAX. |
| A | 4.30 | 4.70 | 0.169 | 0.185 |
| A1 | 2.50 | 2.90 | 0.098 | 0.114 |
| A2 | 2.40 | 2.80 | 0.094 | 0.110 |
| b | 0.60 | 0.80 | 0.024 | 0.031 |
| b2 | 0.60 | 0.90 | 0.024 | 0.035 |
| c | - | 0.60 | - | 0.024 |
| D | 8.30 | 8.70 | 0.327 | 0.342 |
| d1 | 14.70 | 15.30 | 0.579 | 0.602 |
| d2 | 2.90 | 3.10 | 0.114 | 0.122 |
| d3 | 3.30 | 3.70 | 0.130 | 0.146 |
| E | 9.70 | 10.30 | 0.382 | 0.406 |
| e | 2.50 | 2.70 | 0.098 | 0.106 |
| L | 13.40 | 13.80 | 0.528 | 0.543 |
| L1 | 1.00 | 2.80 | 0.039 | 0.110 |
| Ø P | 3.00 | 3.40 | 0.118 | 0.134 |

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