

EF Series Power MOSFET With Fast Body Diode



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 | 0.061 |
| Q_g max. (nC) | 189 | |
| Q_{gs} (nC) | 26 | |
| Q_{gd} (nC) | 55 | |
| Configuration | Single | |

ORDERING INFORMATION

| | |
|---------------------------------|-----------------|
| Package | TO-220AB |
| Lead (Pb)-free and halogen-free | SiHP38N60EF-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 | V |
| Continuous drain current ($T_J = 150$ °C) | V_{GS} at 10 V | $T_C = 25$ °C | 40 |
| | | $T_C = 100$ °C | 25 |
| Pulsed drain current ^a | I_{DM} | 111 | A |
| Linear derating factor | | 2.5 | W/°C |
| Single pulse avalanche energy ^b | E_{AS} | 508 | mJ |
| Maximum power dissipation | P_D | 313 | 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 | 100 |
| Reverse diode dv/dt ^d | | 50 | |
| Soldering recommendations (peak temperature) ^c | For 10 s | 260 | °C |

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 , $I_{AS} = 6.0$ A
- 1.6 mm from case
- $I_{SD} = 23.5$ A, $di/dt = 250$ A/ μ s, starting $T_J = 25$ °C

THERMAL RESISTANCE RATINGS

| PARAMETER | SYMBOL | TYP. | MAX. | UNIT |
|----------------------------------|------------|------|------|------|
| Maximum junction-to-ambient | R_{thJA} | - | 40 | °C/W |
| Maximum junction-to-case (drain) | R_{thJC} | - | 0.4 | |

| SPECIFICATIONS ($T_J = 25\text{ }^\circ\text{C}$, unless otherwise noted) | | | | | | | |
|------------------------------------------------------------------------------------|---------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------|-------|-----------|---------------------|-----|
| PARAMETER | SYMBOL | TEST CONDITIONS | MIN. | TYP. | MAX. | UNIT | |
| Static | | | | | | | |
| Drain-source breakdown voltage | V_{DS} | $V_{GS} = 0\text{ V}, I_D = 250\text{ }\mu\text{A}$ | 600 | - | - | V | |
| V_{DS} temperature coefficient | $\Delta V_{DS}/T_J$ | Reference to $25\text{ }^\circ\text{C}, I_D = 10\text{ mA}$ | - | 0.72 | - | V/ $^\circ\text{C}$ | |
| Gate-source threshold voltage (N) | $V_{GS(th)}$ | $V_{DS} = V_{GS}, I_D = 250\text{ }\mu\text{A}$ | 2 | - | 4 | V | |
| Gate-source leakage | I_{GSS} | $V_{GS} = \pm 20\text{ V}$ | - | - | ± 100 | nA | |
| | | $V_{GS} = \pm 30\text{ V}$ | - | - | ± 1 | μA | |
| Zero gate voltage drain current | I_{DSS} | $V_{DS} = 480\text{ V}, V_{GS} = 0\text{ V}$ | - | - | 1 | μA | |
| | | $V_{DS} = 480\text{ V}, V_{GS} = 0\text{ V}, T_J = 125\text{ }^\circ\text{C}$ | - | - | 2 | mA | |
| Drain-source on-state resistance | $R_{DS(on)}$ | $V_{GS} = 10\text{ V}, I_D = 23.5\text{ A}$ | - | 0.061 | 0.070 | Ω | |
| Forward transconductance ^a | g_{fs} | $V_{DS} = 30\text{ V}, I_D = 23.5\text{ A}$ | - | 13 | - | S | |
| Dynamic | | | | | | | |
| Input capacitance | C_{iss} | $V_{GS} = 0\text{ V}, V_{DS} = 100\text{ V}, f = 1\text{ MHz}$ | - | 3576 | - | pF | |
| Output capacitance | C_{oss} | | - | 167 | - | | |
| Reverse transfer capacitance | C_{rss} | | - | 5 | - | | |
| Effective output capacitance, energy related ^a | $C_{o(er)}$ | | $V_{DS} = 0\text{ V to } 480\text{ V}, V_{GS} = 0\text{ V}$ | - | 104 | | - |
| Effective output capacitance, time related ^b | $C_{o(tr)}$ | | | - | 535 | | - |
| Total gate charge | Q_g | $V_{GS} = 10\text{ V}, I_D = 23.5\text{ A}, V_{DS} = 480\text{ V}$ | - | 126 | 189 | nC | |
| Gate-source charge | Q_{gs} | | - | 26 | - | | |
| Gate-drain charge | Q_{gd} | | - | 55 | - | | |
| Turn-on delay time | $t_{d(on)}$ | $V_{DD} = 480\text{ V}, I_D = 23.5\text{ A}, V_{GS} = 10\text{ V}, R_g = 9.1\text{ }\Omega$ | - | 35 | 70 | ns | |
| Rise time | t_r | | - | 63 | 126 | | |
| Turn-off delay time | $t_{d(off)}$ | | - | 143 | 286 | | |
| Fall time | t_f | | - | 67 | 134 | | |
| Gate input resistance | R_g | | $f = 1\text{ MHz}, \text{open drain}$ | 0.2 | 0.5 | | 1.0 |
| Drain-Source Body Diode Characteristics | | | | | | | |
| Continuous source-drain diode current | I_S | MOSFET symbol showing the integral reverse p - n junction diode  | - | - | 40 | A | |
| Pulsed diode forward current | I_{SM} | | - | - | 111 | | |
| Diode forward voltage | V_{SD} | $T_J = 25\text{ }^\circ\text{C}, I_S = 23.5\text{ A}, V_{GS} = 0\text{ V}$ | - | - | 1.2 | V | |
| Reverse recovery time | t_{rr} | $T_J = 25\text{ }^\circ\text{C}, I_F = I_S = 23.5\text{ A}, di/dt = 100\text{ A}/\mu\text{s}, V_R = 400\text{ V}$ | - | 160 | 320 | ns | |
| Reverse recovery charge | Q_{rr} | | - | 1.2 | 2.4 | μC | |
| Reverse recovery current | I_{RRM} | | - | 14.3 | - | 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)

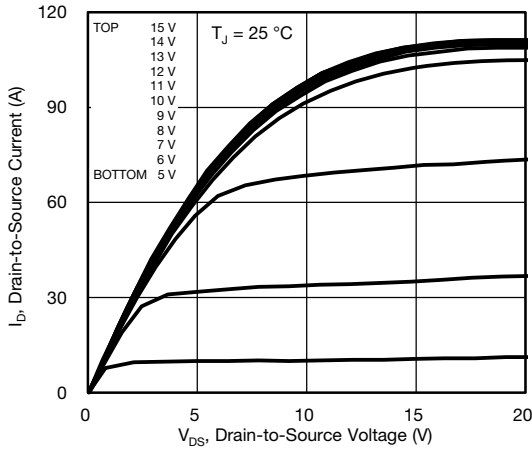


Fig. 1 - Typical Output Characteristics

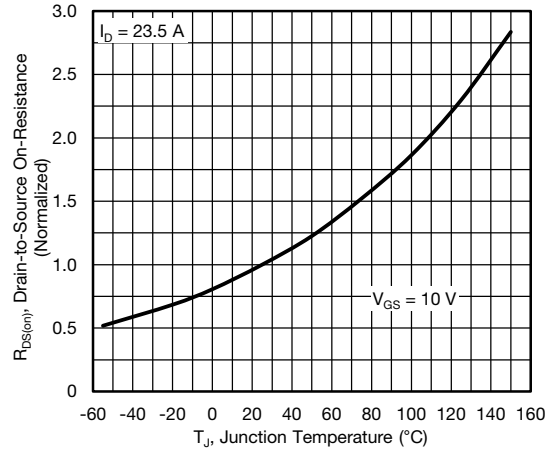


Fig. 4 - Normalized On-Resistance vs. Temperature

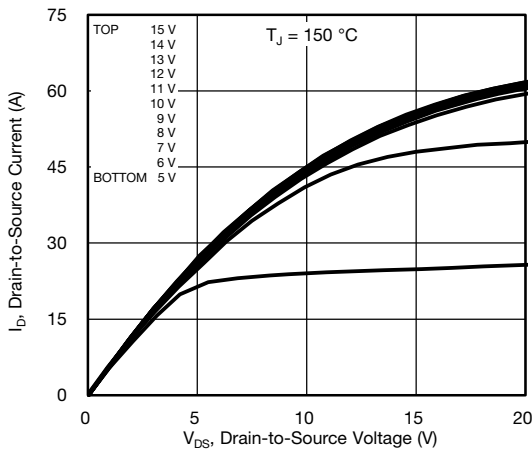


Fig. 2 - Typical Output Characteristics

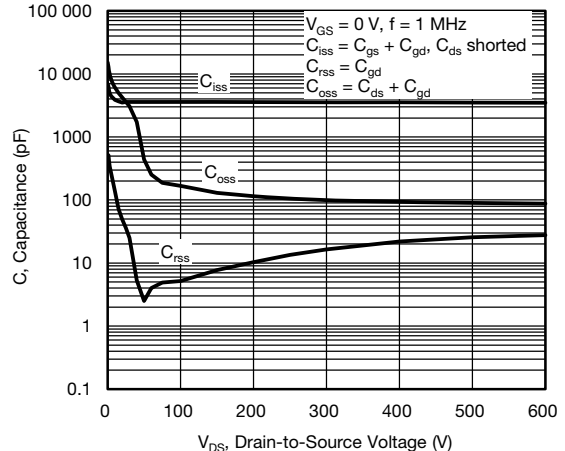


Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage

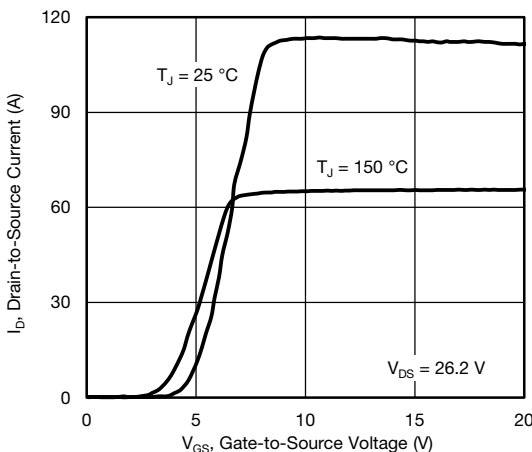


Fig. 3 - Typical Transfer Characteristics

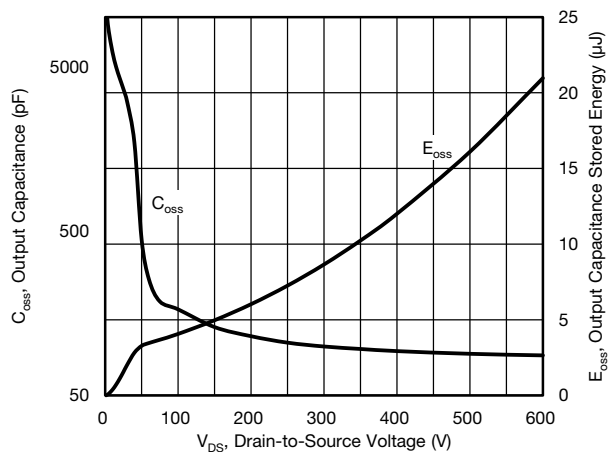


Fig. 6 - C_{oss} and E_{oss} vs. V_{DS}

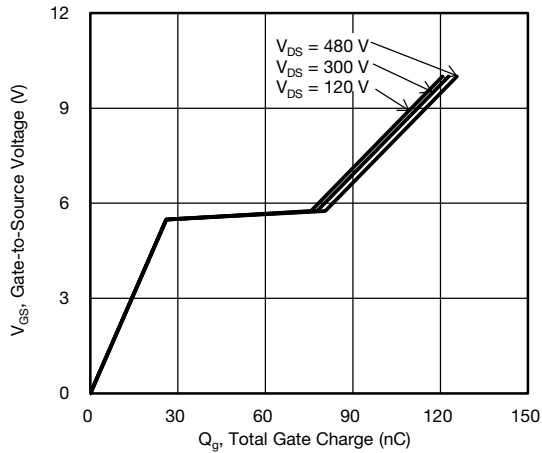


Fig. 7 - Typical Gate Charge vs. Gate-to-Source Voltage

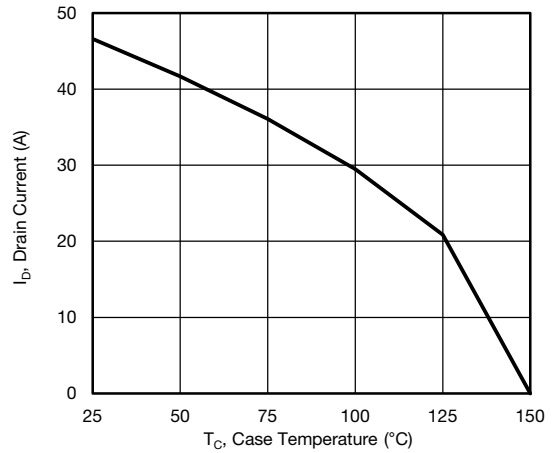


Fig. 10 - Maximum Drain Current vs. Case Temperature

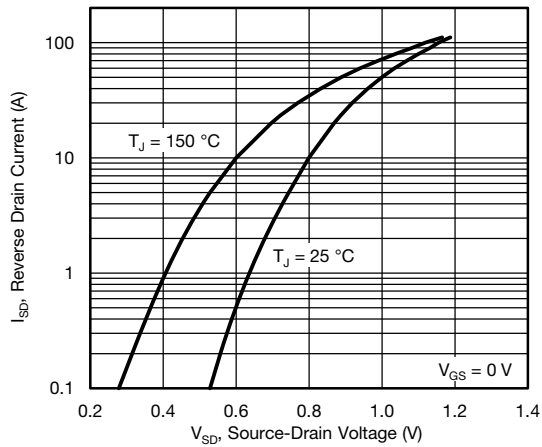


Fig. 8 - Typical Source-Drain Diode Forward Voltage

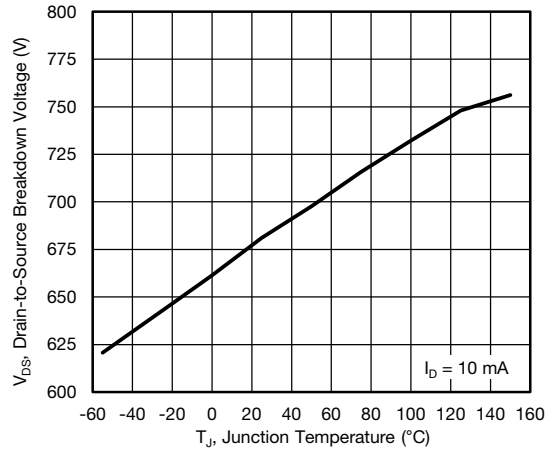


Fig. 11 - Temperature vs. Drain-to-Source Voltage

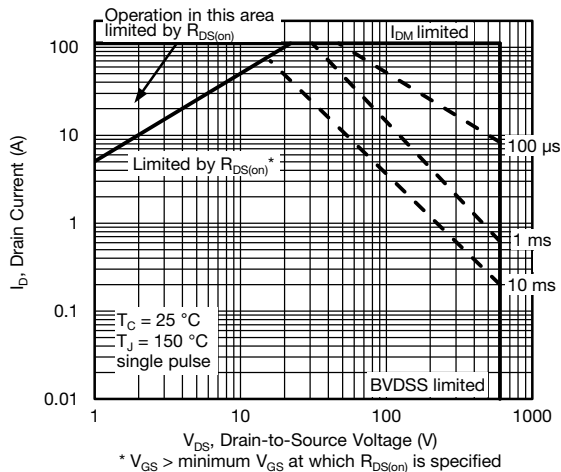


Fig. 9 - Maximum Safe Operating Area

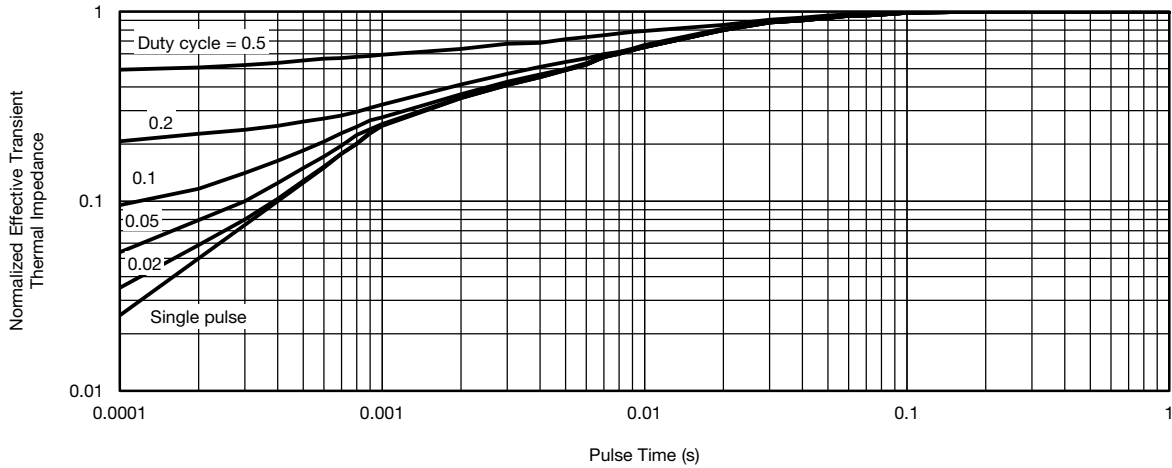


Fig. 12 - Normalized Transient Thermal Impedance, Junction-to-Case



Fig. 13 - Switching Time Test Circuit



Fig. 16 - Unclamped Inductive Waveforms

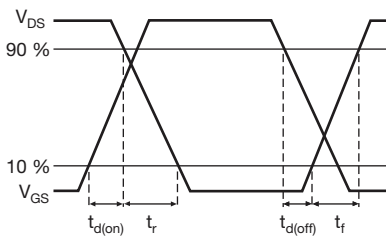


Fig. 14 - Switching Time Waveforms

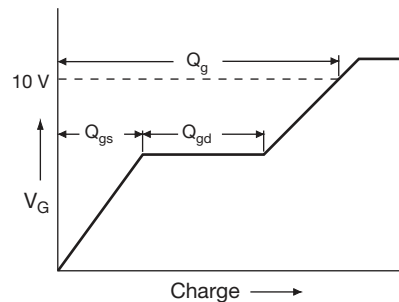


Fig. 17 - Basic Gate Charge Waveform

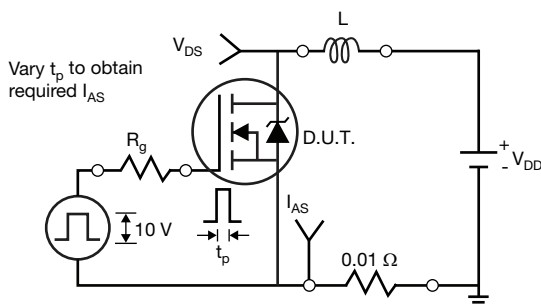


Fig. 15 - Unclamped Inductive Test Circuit



Fig. 18 - Gate Charge Test Circuit



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

Fig. 19 - For N-Channel

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TO-220-1



| DIM. | MILLIMETERS | | INCHES | |
|------|-------------|-------|--------|-------|
| | MIN. | MAX. | MIN. | MAX. |
| A | 4.24 | 4.65 | 0.167 | 0.183 |
| b | 0.69 | 1.02 | 0.027 | 0.040 |
| b(1) | 1.14 | 1.78 | 0.045 | 0.070 |
| c | 0.36 | 0.61 | 0.014 | 0.024 |
| D | 14.33 | 15.85 | 0.564 | 0.624 |
| E | 9.96 | 10.52 | 0.392 | 0.414 |
| e | 2.41 | 2.67 | 0.095 | 0.105 |
| e(1) | 4.88 | 5.28 | 0.192 | 0.208 |
| F | 1.14 | 1.40 | 0.045 | 0.055 |
| H(1) | 6.10 | 6.71 | 0.240 | 0.264 |
| J(1) | 2.41 | 2.92 | 0.095 | 0.115 |
| L | 13.36 | 14.40 | 0.526 | 0.567 |
| L(1) | 3.33 | 4.04 | 0.131 | 0.159 |
| Ø P | 3.53 | 3.94 | 0.139 | 0.155 |
| Q | 2.54 | 3.00 | 0.100 | 0.118 |

ECN: E21-0621-Rev. D, 04-Nov-2021
DWG: 6031

Note

- M* = 0.052 inches to 0.064 inches (dimension including protrusion), heatsink hole for HVM



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