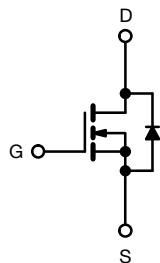
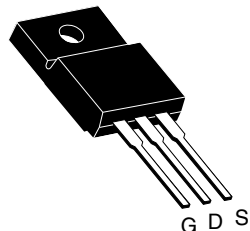


EF Series Power MOSFET With Fast Body Diode

TO-220 FULLPAK

N-Channel MOSFET

FEATURES

- A specific on resistance ($m\Omega\text{-cm}^2$) reduction of 25 %
- 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

PRODUCT SUMMARY

| | | |
|---|------------------------|-------|
| V_{DS} (V) at T_J max. | 650 | |
| $R_{DS(on)}$ typ. (Ω) at 25 °C | $V_{GS} = 10\text{ V}$ | 0.084 |
| Q_g max. (nC) | 134 | |
| Q_{gs} (nC) | 16 | |
| Q_{gd} (nC) | 48 | |
| Configuration | Single | |

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)

ORDERING INFORMATION

| | |
|---------------------------------|-----------------|
| Package | TO-220 FULLPAK |
| Lead (Pb)-free and halogen-free | SiHF35N60EF-GE3 |

ABSOLUTE MAXIMUM RATINGS ($T_C = 25\text{ °C}$, unless otherwise noted)

| PARAMETER | SYMBOL | LIMIT | UNIT |
|---|------------------|-----------------------|------|
| Drain-source voltage | V_{DS} | 600 | V |
| Gate-source voltage | V_{GS} | ± 30 | |
| Continuous drain current ($T_J = 150\text{ °C}$) ^e | V_{GS} at 10 V | $T_C = 25\text{ °C}$ | A |
| | | $T_C = 100\text{ °C}$ | |
| Pulsed drain current ^a | I_{DM} | 80 | |
| Linear derating factor | | 2.0 | W/°C |
| Single pulse avalanche energy ^b | E_{AS} | 298 | mJ |
| Maximum power dissipation | P_D | 39 | W |
| Operating junction and storage temperature range | T_J, T_{stg} | -55 to +150 | °C |
| Drain-source voltage slope | dv/dt | $T_J = 125\text{ °C}$ | V/ns |
| Reverse diode dv/dt ^d | | | |
| Soldering recommendations (peak temperature) ^c | | For 10 s | °C |
| Mounting torque | | M3 screw | Nm |


Notes

- Repetitive rating; pulse width limited by maximum junction temperature
- $V_{DD} = 140\text{ V}$, starting $T_J = 25\text{ °C}$, $L = 28.2\text{ mH}$, $R_g = 25\text{ }\Omega$, $I_{AS} = 4.6\text{ A}$
- 1.6 mm from case
- $I_{SD} = 17\text{ A}$, $di/dt = 300\text{ A}/\mu\text{s}$, starting $T_J = 25\text{ °C}$
- Limited by maximum junction temperature

**THERMAL RESISTANCE RATINGS**

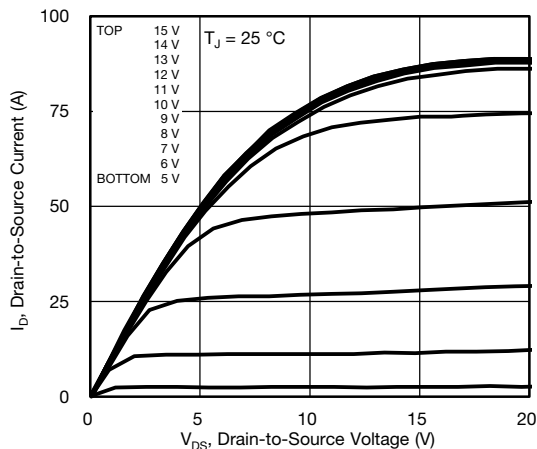
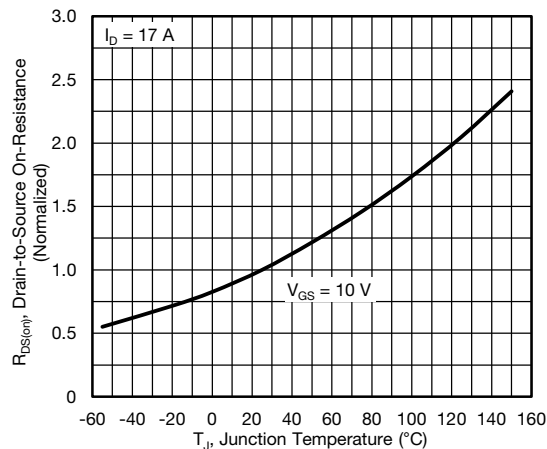
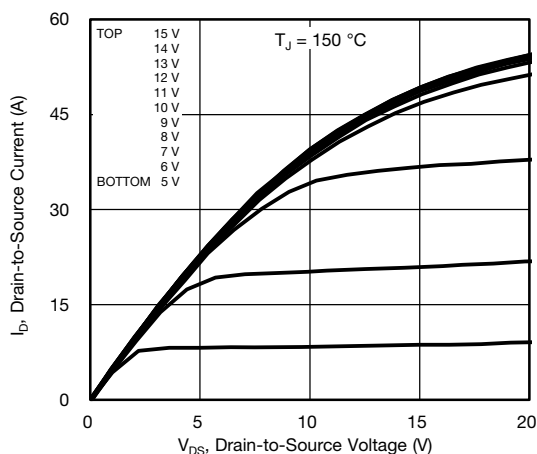
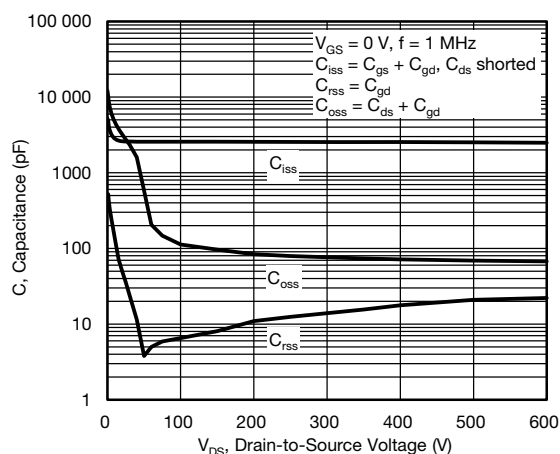
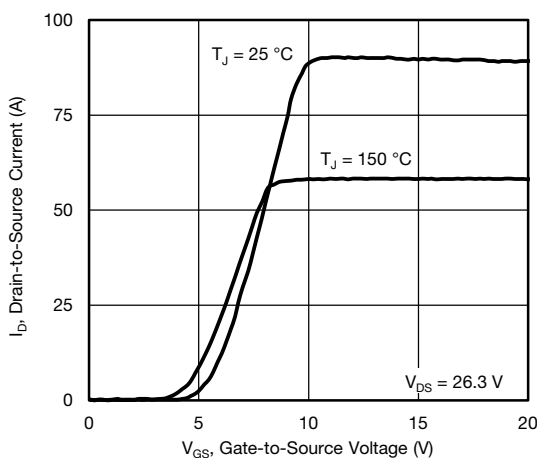
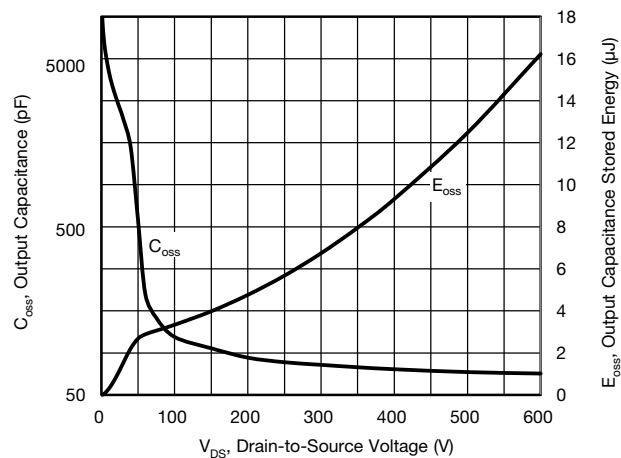
| PARAMETER | SYMBOL | TYP. | MAX. | UNIT |
|----------------------------------|------------|------|------|------|
| Maximum junction-to-ambient | R_{thJA} | - | 65 | °C/W |
| Maximum junction-to-case (drain) | R_{thJC} | - | 3.2 | |

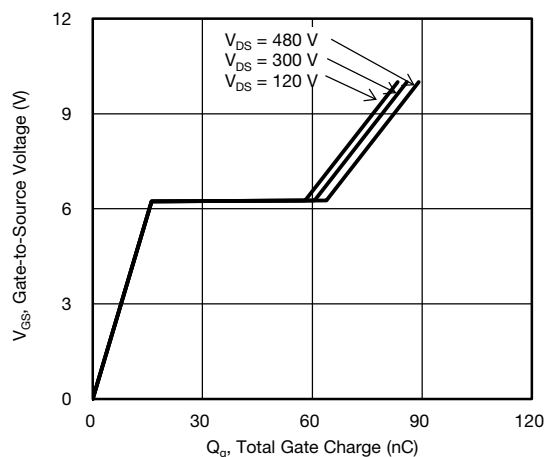
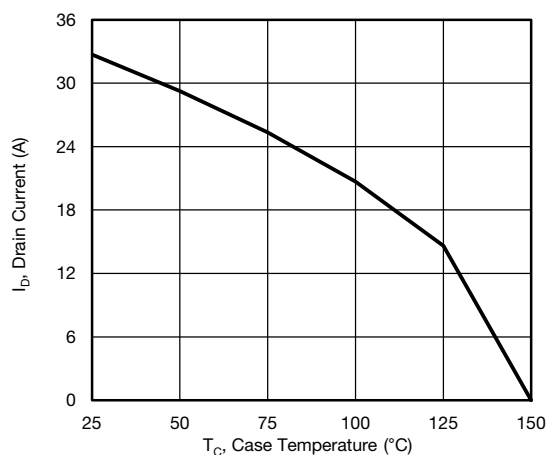
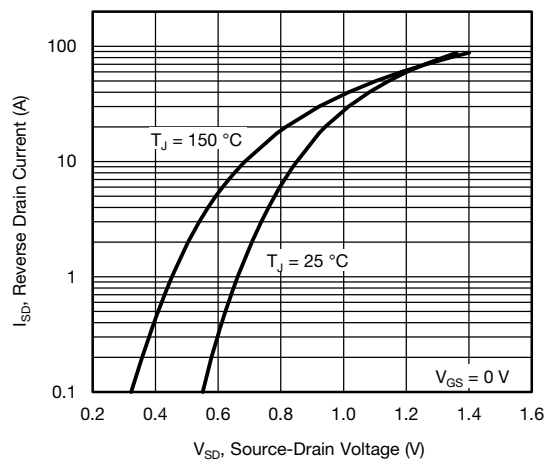
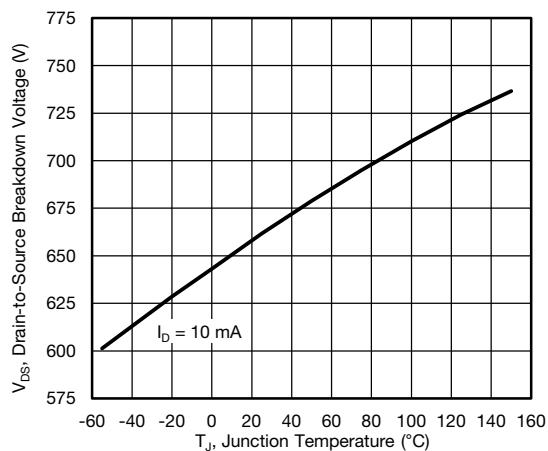
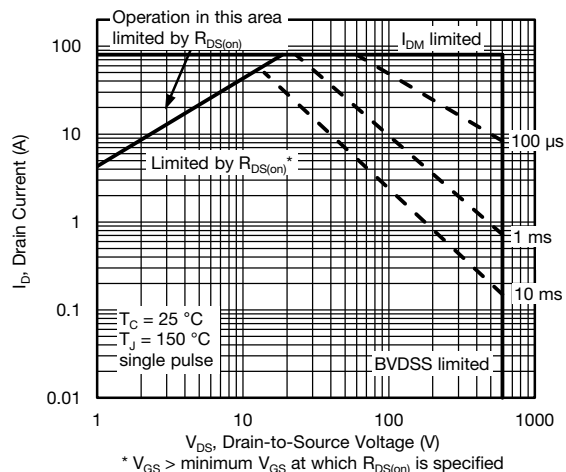
SPECIFICATIONS ($T_J = 25\text{ }^{\circ}\text{C}$, unless otherwise noted)

| 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 $25\text{ }^\circ\text{C}$, $I_D = 10\text{ mA}$ | | - | 0.66 | - | V/ $^\circ\text{C}$ |
| Gate-source threshold voltage (N) | $V_{GS(th)}$ | $V_{DS} = V_{GS}$, $I_D = 250\text{ }\mu\text{A}$ | | 2.0 | - | 4.0 | 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 |
| | | $V_{DS} = 480\text{ V}$, $V_{GS} = 0\text{ V}$, $T_J = 125\text{ }^\circ\text{C}$ | | - | - | 500 | |
| Drain-source on-state resistance | $R_{DS(on)}$ | $V_{GS} = 10\text{ V}$ | $I_D = 17\text{ A}$ | - | 0.084 | 0.097 | Ω |
| Forward transconductance ^a | g_{fs} | $V_{DS} = 30\text{ V}$, $I_D = 17\text{ A}$ | | - | 8 | - | S |
| Dynamic | | | | | | | |
| Input capacitance | C_{iss} | $V_{GS} = 0\text{ V}$, $V_{DS} = 100\text{ V}$, $f = 1\text{ MHz}$ | | - | 2568 | - | pF |
| Output capacitance | C_{oss} | | | - | 113 | - | |
| Reverse transfer capacitance | C_{rss} | | | - | 7 | - | |
| Effective output capacitance, energy related ^a | $C_{o(er)}$ | $V_{DS} = 0\text{ V to } 480\text{ V}$, $V_{GS} = 0\text{ V}$ | | - | 81 | - | |
| Effective output capacitance, time related ^b | $C_{o(tr)}$ | | | - | 421 | - | |
| Total gate charge | Q_g | $V_{GS} = 10\text{ V}$ | $I_D = 17\text{ A}$, $V_{DS} = 480\text{ V}$ | - | 89 | 134 | nC |
| Gate-source charge | Q_{gs} | | | - | 16 | - | |
| Gate-drain charge | Q_{gd} | | | - | 48 | - | |
| Turn-on delay time | $t_{d(on)}$ | $V_{DD} = 480\text{ V}$, $I_D = 17\text{ A}$, $V_{GS} = 10\text{ V}$, $R_g = 9.1\text{ }\Omega$ | | - | 28 | 56 | ns |
| Rise time | t_r | | | - | 85 | 170 | |
| Turn-off delay time | $t_{d(off)}$ | | | - | 96 | 192 | |
| Fall time | t_f | | | - | 61 | 122 | |
| Gate input resistance | R_g | $f = 1\text{ MHz}$, open drain | | 0.2 | 0.5 | 1.0 | Ω |
| Drain-Source Body Diode Characteristics | | | | | | | |
| Continuous source-drain diode current | I_S | MOSFET symbol showing the integral reverse p - n junction diode  | | - | - | 32 | A |
| Pulsed diode forward current | I_{SM} | | | - | - | 80 | |
| Diode forward voltage | V_{SD} | $T_J = 25\text{ }^\circ\text{C}$, $I_S = 17\text{ A}$, $V_{GS} = 0\text{ V}$ | | - | - | 1.2 | V |
| Reverse recovery time | t_{rr} | $T_J = 25\text{ }^\circ\text{C}$, $I_F = I_S = 17\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$, $V_R = 400\text{ V}$ | | - | 150 | 300 | ns |
| Reverse recovery charge | Q_{rr} | | | - | 1.1 | 2.2 | μC |
| Reverse recovery current | I_{RRM} | | | - | 14 | - | 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

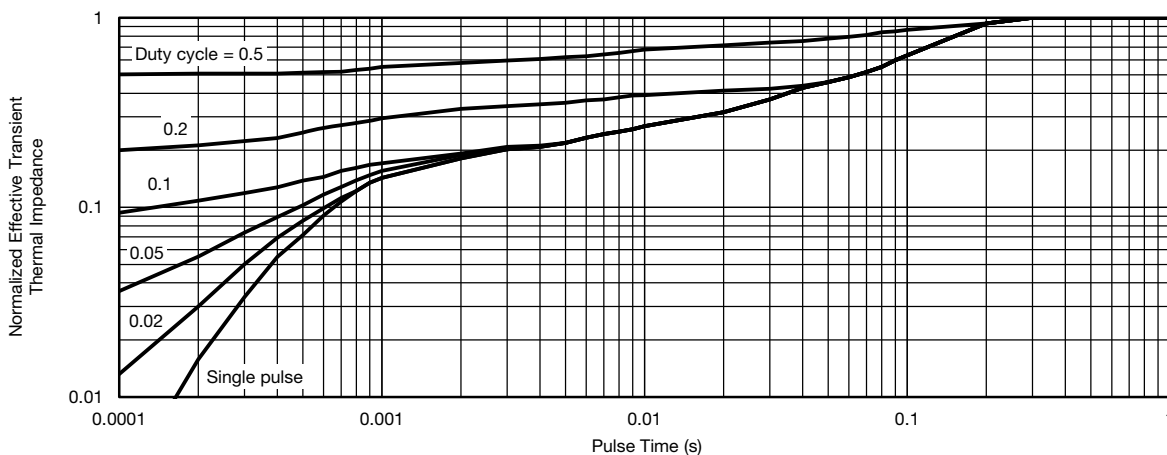
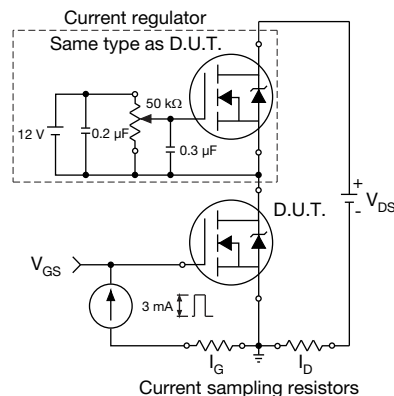

Fig. 12 - Normalized Transient Thermal Impedance, Junction-to-Case

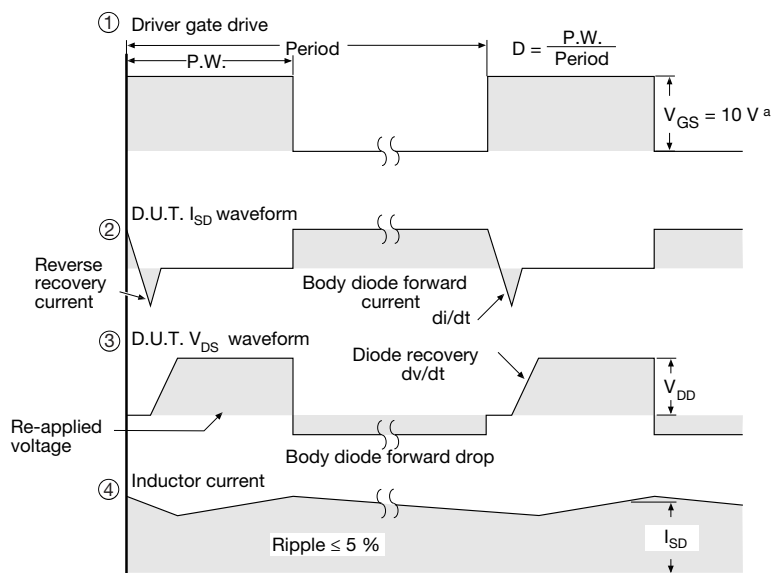
Fig. 13 - Switching Time Test Circuit

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


Fig. 19 - For N-Channel



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