

EF Series Power MOSFET With Fast Body Diode

D²PAK (TO-263)


N-Channel MOSFET

FEATURES

- A specific on resistance ($m\Omega\text{-cm}^2$) reduction of 25 %
- Low figure-of-merit (FOM) $R_{\text{on}} \times Q_g$
- 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 | |
| $R_{\text{DS(on)}}$ typ. (Ω) at 25 °C | $V_{\text{GS}} = 10 \text{ V}$ | 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 | D ² PAK (TO-263) |
| Lead (Pb)-free and halogen-free | SiHB35N60EF-GE3 |

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


| PARAMETER | SYMBOL | LIMIT | UNIT |
|---|-------------------------|------------------------------------|---------------------|
| Drain-source voltage | V_{DS} | 600 | V |
| Gate-source voltage | V_{GS} | ± 30 | |
| Continuous drain current ($T_J = 150 \text{ }^\circ\text{C}$) | V_{GS} at 10 V | $T_C = 25 \text{ }^\circ\text{C}$ | A |
| | | $T_C = 100 \text{ }^\circ\text{C}$ | |
| Pulsed drain current ^a | I_{DM} | 80 | |
| Linear derating factor | | 2.0 | W/ $^\circ\text{C}$ |
| Single pulse avalanche energy ^b | E_{AS} | 298 | mJ |
| Maximum power dissipation | P_D | 250 | W |
| Operating junction and storage temperature range | T_J, T_{stg} | -55 to +150 | $^\circ\text{C}$ |
| Drain-source voltage slope | dv/dt | $T_J = 125 \text{ }^\circ\text{C}$ | V/ns |
| Reverse diode dv/dt ^d | | | |
| Soldering recommendations (peak temperature) ^c | For 10 s | 260 | $^\circ\text{C}$ |

Notes

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



| THERMAL RESISTANCE RATINGS | | | | |
|----------------------------------|-------------------|------|------|------|
| PARAMETER | SYMBOL | TYP. | MAX. | UNIT |
| Maximum junction-to-ambient | R _{thJA} | - | 62 | °C/W |
| Maximum junction-to-case (drain) | R _{thJC} | - | 0.5 | |

| 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 = 10 mA | | - | 0.66 | - | 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 = 17 A | - | 0.084 | 0.097 | Ω |
| Forward transconductance ^a | g _{fs} | V _{DS} = 30 V, I _D = 17 A | | - | 8 | - | S |
| Dynamic | | | | | | | |
| Input capacitance | C _{iSS} | V _{GS} = 0 V, V _{DS} = 100 V, f = 1 MHz | | - | 2568 | - | pF |
| Output capacitance | C _{oss} | | | - | 113 | - | |
| Reverse transfer capacitance | C _{rSS} | | | - | 7 | - | |
| Effective output capacitance, energy related ^a | C _{o(er)} | | | - | 81 | - | |
| Effective output capacitance, time related ^b | C _{o(tr)} | V _{DS} = 0 V to 480 V, V _{GS} = 0 V | | - | 421 | - | |
| Total gate charge | Q _g | V _{GS} = 10 V | I _D = 17 A, V _{DS} = 480 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 V, I _D = 17 A, V _{GS} = 10 V, R _g = 9.1 Ω | | - | 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 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 °C, I _S = 17 A, V _{GS} = 0 V | | - | - | 1.2 | V |
| Reverse recovery time | t _{rr} | T _J = 25 °C, I _F = I _S = 17 A, di/dt = 100 A/μs, V _R = 400 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)

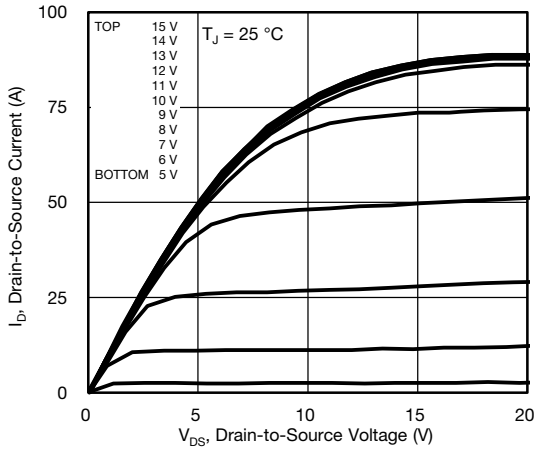


Fig. 1 - Typical Output Characteristics

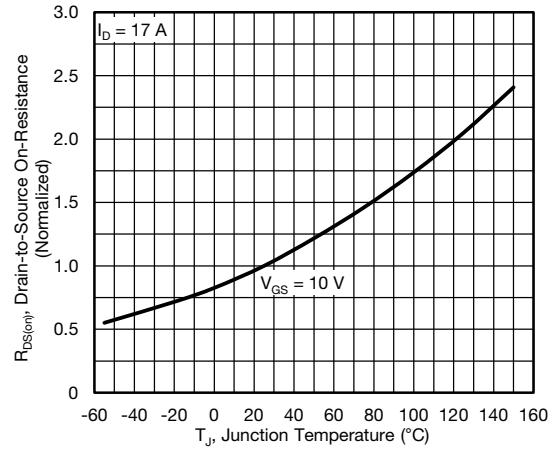


Fig. 4 - Normalized On-Resistance vs. Temperature

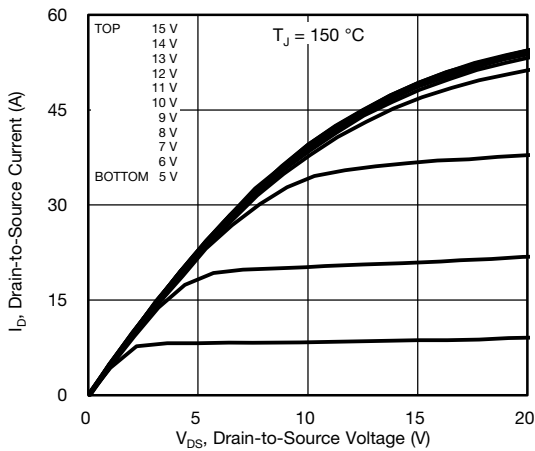


Fig. 2 - Typical Output Characteristics

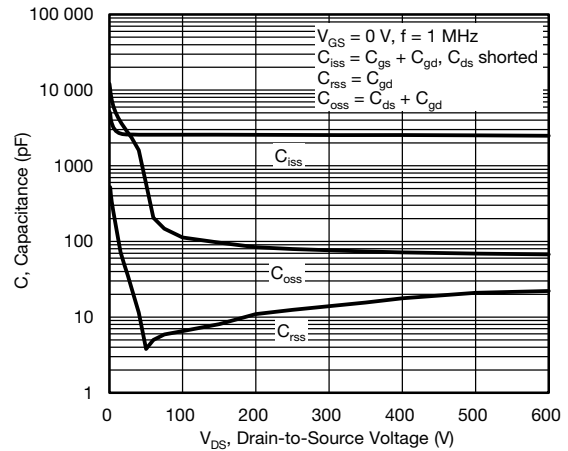


Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage

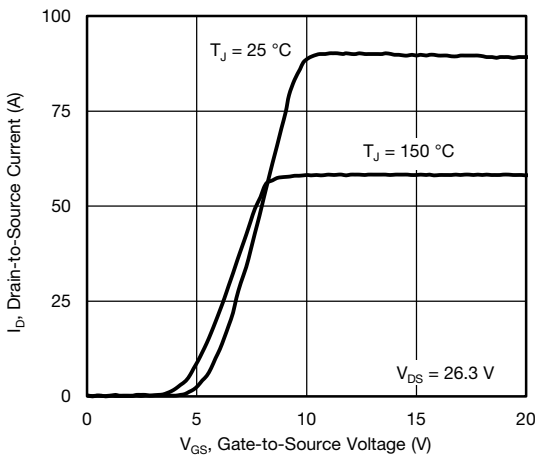


Fig. 3 - Typical Transfer Characteristics

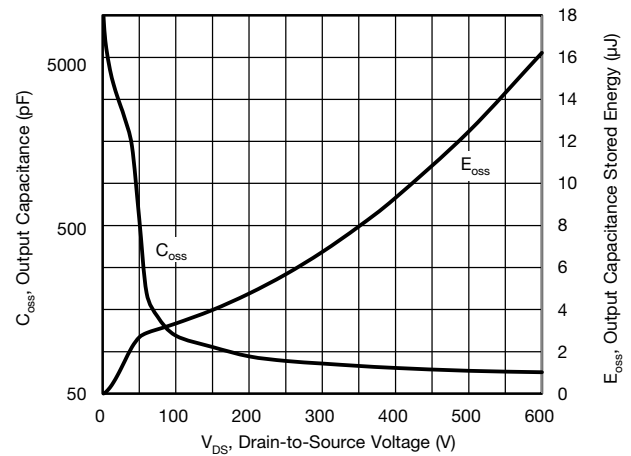


Fig. 6 - C_{oss} and E_{oss} vs. V_{DS}

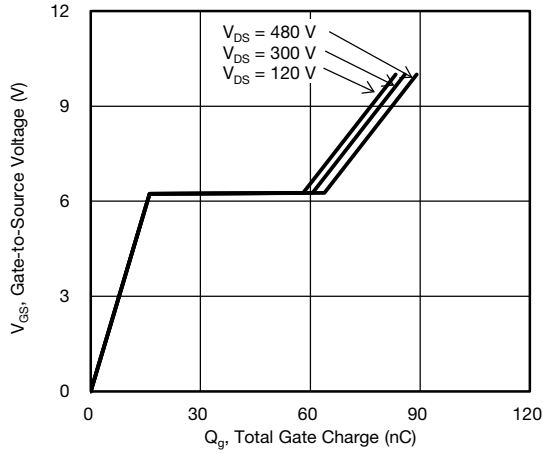


Fig. 7 - Typical Gate Charge vs. Gate-to-Source Voltage

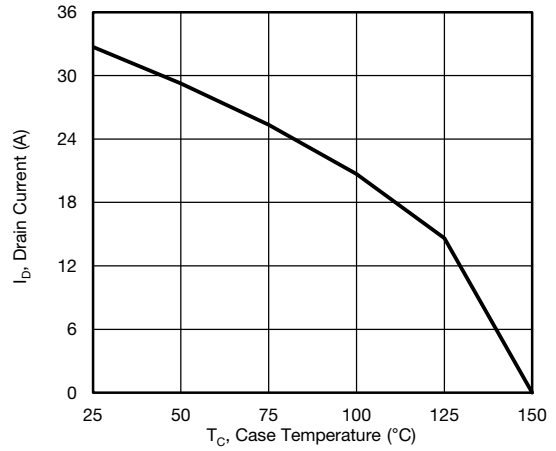


Fig. 10 - Maximum Drain Current vs. Case Temperature

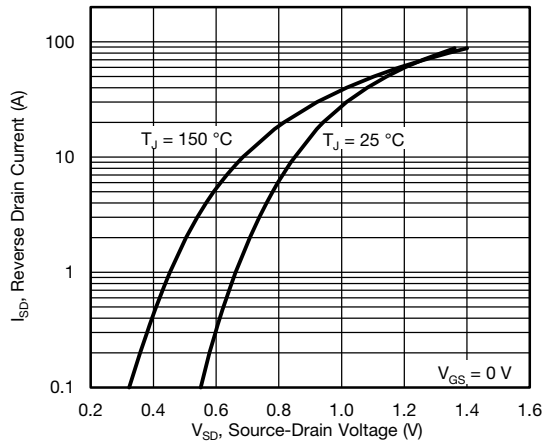


Fig. 8 - Typical Source-Drain Diode Forward Voltage

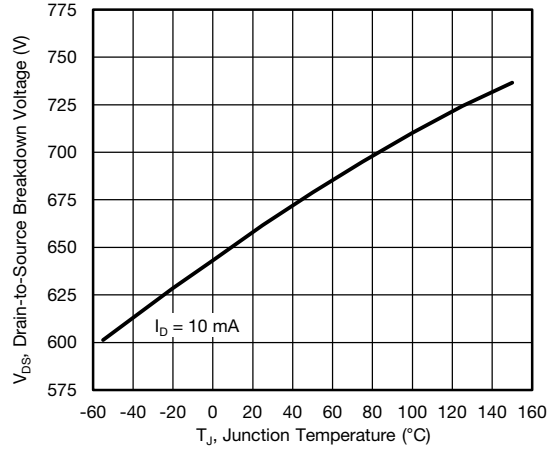


Fig. 11 - Temperature vs. Drain-to-Source Voltage

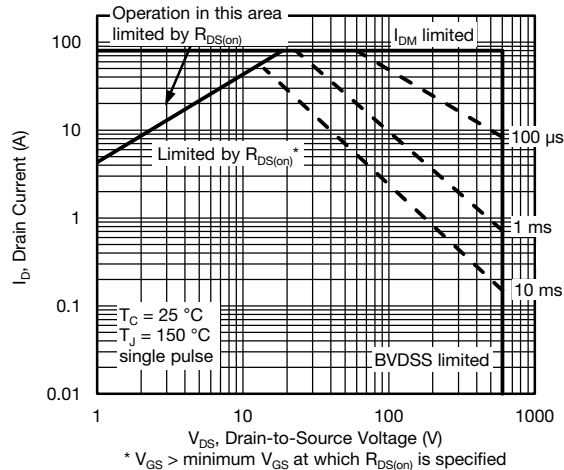


Fig. 9 - Maximum Safe Operating Area

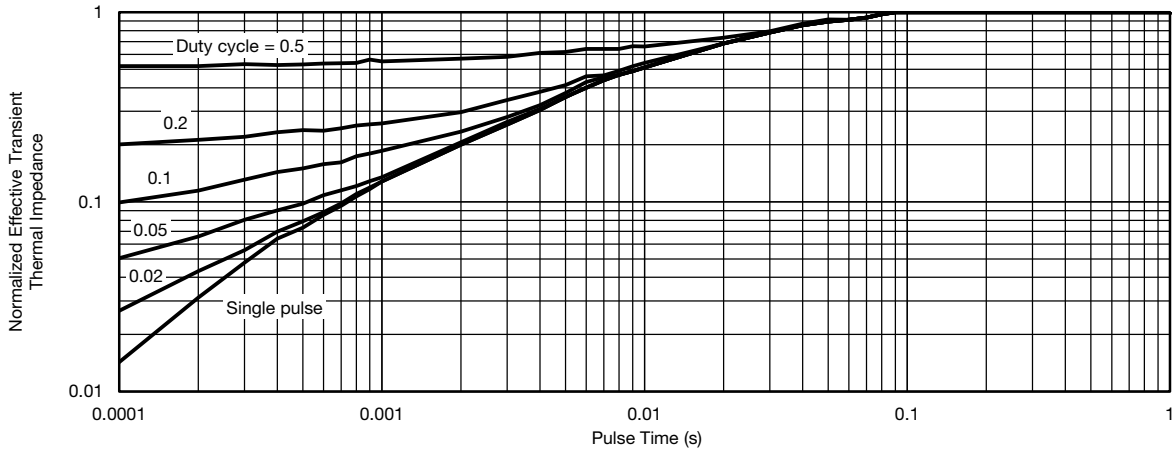


Fig. 12 - Normalized Transient Thermal Impedance, Junction-to-Case



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

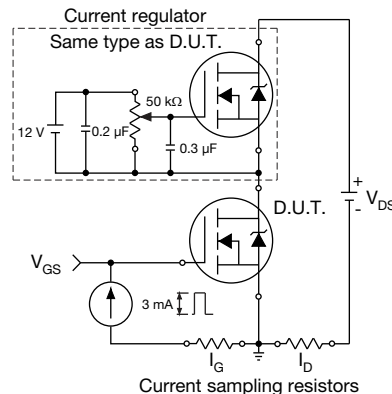


Fig. 18 - Gate Charge Test Circuit



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

Fig. 19 - For N-Channel

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Technology and Package Reliability represent a composite of all qualified locations. For related documents such as package/tape drawings, part marking, and reliability data, see www.vishay.com/ppg?92108.

TO-263AB (HIGH VOLTAGE)



| DIM. | MILLIMETERS | | INCHES | |
|------|-------------|------|--------|-------|
| | MIN. | MAX. | MIN. | MAX. |
| A | 4.06 | 4.83 | 0.160 | 0.190 |
| A1 | 0.00 | 0.25 | 0.000 | 0.010 |
| b | 0.51 | 0.99 | 0.020 | 0.039 |
| b1 | 0.51 | 0.89 | 0.020 | 0.035 |
| b2 | 1.14 | 1.78 | 0.045 | 0.070 |
| b3 | 1.14 | 1.73 | 0.045 | 0.068 |
| c | 0.38 | 0.74 | 0.015 | 0.029 |
| c1 | 0.38 | 0.58 | 0.015 | 0.023 |
| c2 | 1.14 | 1.65 | 0.045 | 0.065 |
| D | 8.38 | 9.65 | 0.330 | 0.380 |

| DIM. | MILLIMETERS | | INCHES | |
|------|-------------|-------|-----------|-------|
| | MIN. | MAX. | MIN. | MAX. |
| D1 | 6.86 | - | 0.270 | - |
| E | 9.65 | 10.67 | 0.380 | 0.420 |
| E1 | 6.22 | - | 0.245 | - |
| e | 2.54 BSC | | 0.100 BSC | |
| H | 14.61 | 15.88 | 0.575 | 0.625 |
| L | 1.78 | 2.79 | 0.070 | 0.110 |
| L1 | - | 1.65 | - | 0.066 |
| L2 | - | 1.78 | - | 0.070 |
| L3 | 0.25 BSC | | 0.010 BSC | |
| L4 | 4.78 | 5.28 | 0.188 | 0.208 |

ECN: S-82110-Rev. A, 15-Sep-08
DWG: 5970

Notes

1. Dimensioning and tolerancing per ASME Y14.5M-1994.
2. Dimensions are shown in millimeters (inches).
3. Dimension D and E do not include mold flash. Mold flash shall not exceed 0.127 mm (0.005") per side. These dimensions are measured at the outmost extremes of the plastic body at datum A.
4. Thermal PAD contour optional within dimension E, L1, D1 and E1.
5. Dimension b1 and c1 apply to base metal only.
6. Datum A and B to be determined at datum plane H.
7. Outline conforms to JEDEC outline to TO-263AB.

RECOMMENDED MINIMUM PADS FOR D²PAK: 3-Lead



Recommended Minimum Pads
Dimensions in Inches/(mm)

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