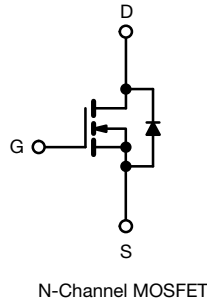
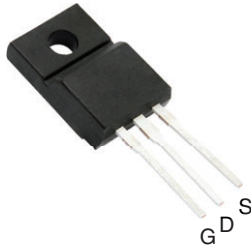


## EF Series Power MOSFET With Fast Body Diode

**TO-220 FULLPAK**


### FEATURES

- 4<sup>th</sup> generation E series technology
- Low figure-of-merit (FOM)  $R_{on} \times Q_g$
- Low effective capacitance ( $C_{o(er)}$ )
- Reduced switching and conduction losses
- Avalanche energy rated (UIS)
- Material categorization: for definitions of compliance please see [www.vishay.com/doc?99912](http://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
  - Motor drives
  - Battery chargers
  - Solar (PV inverters)

### PRODUCT SUMMARY

$V_{DS}$ (V) at $T_J$ max.	650	
$R_{DS(on)}$ typ. ( $\Omega$ ) at 25 °C	$V_{GS} = 10$ V	0.059
$Q_g$ max. (nC)	77	
$Q_{gs}$ (nC)	19	
$Q_{gd}$ (nC)	16	
Configuration	Single	

### ORDERING INFORMATION

Package	TO-220 FULLPAK
Lead (Pb)-free and halogen-free	SiHF068N60EF-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	$V_{GS}$	$\pm 30$	
Continuous drain current ( $T_J = 150$ °C) <sup>e</sup>	$V_{GS}$ at 10 V	$T_C = 25$ °C	16
		$T_C = 100$ °C	10
Pulsed drain current <sup>a</sup>	$I_{DM}$	115	A
Linear derating factor		0.31	
Single pulse avalanche energy <sup>b</sup>	$E_{AS}$	226	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	$dV/dt$	$T_J = 125$ °C	100
Reverse diode $dV/dt$ <sup>d</sup>		50	
Soldering recommendations (peak temperature) <sup>c</sup>	For 10 s	260	°C
Mounting torque, M3 screw		0.6	Nm

#### Notes

- Repetitive rating; pulse width limited by maximum junction temperature
- $V_{DD} = 120$  V, starting  $T_J = 25$  °C,  $L = 28.2$  mH,  $R_g = 25$   $\Omega$ ,  $I_{AS} = 4$  A
- 1.6 mm from case
- $I_{SD} \leq I_D$ ,  $di/dt = 210$  A/ $\mu$ s, starting  $T_J = 25$  °C
- Limited by maximum junction temperature



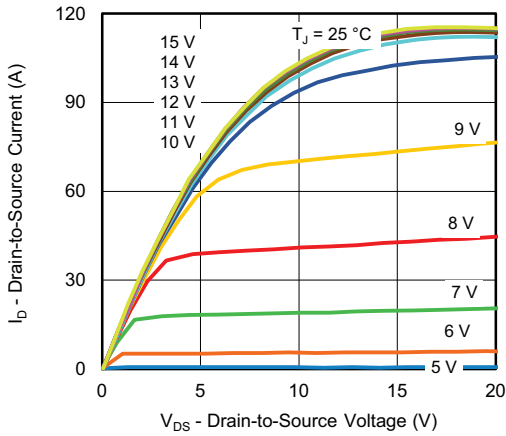
THERMAL RESISTANCE RATINGS			
PARAMETER	SYMBOL	LIMIT	UNIT
Maximum junction-to-ambient	R <sub>thJA</sub>	65	°C/W
Maximum junction-to-case (drain)	R <sub>thJC</sub>	3.2	

SPECIFICATIONS (T <sub>J</sub> = 25 °C, unless otherwise noted)						
PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNIT
<b>Static</b>						
Drain-source breakdown voltage	V <sub>DS</sub>	V <sub>GS</sub> = 0 V, I <sub>D</sub> = 250 μA	600	-	-	V
V <sub>DS</sub> temperature coefficient	ΔV <sub>DS</sub> /T <sub>J</sub>	Reference to 25 °C, I <sub>D</sub> = 1 mA	-	0.63	-	V/°C
Gate-source threshold voltage (N)	V <sub>GS(th)</sub>	V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 250 μA	3	-	5	V
Gate-source leakage	I <sub>GSS</sub>	V <sub>GS</sub> = ± 20 V	-	-	± 100	nA
		V <sub>GS</sub> = ± 30 V	-	-	± 1	μA
Zero gate voltage drain current	I <sub>DSS</sub>	V <sub>DS</sub> = 480 V, V <sub>GS</sub> = 0 V	-	-	1	μA
		V <sub>DS</sub> = 480 V, V <sub>GS</sub> = 0 V, T <sub>J</sub> = 125 °C	-	-	2	mA
Drain-source on-state resistance	R <sub>DS(on)</sub>	V <sub>GS</sub> = 10 V   I <sub>D</sub> = 16 A	-	0.059	0.068	Ω
Forward transconductance	g <sub>fs</sub>	V <sub>DS</sub> = 30 V, I <sub>D</sub> = 16 A	-	9	-	S
<b>Dynamic</b>						
Input capacitance	C <sub>iss</sub>	V <sub>GS</sub> = 0 V, V <sub>DS</sub> = 100 V, f = 1 MHz	-	2628	-	pF
Output capacitance	C <sub>oss</sub>		-	122	-	
Reverse transfer capacitance	C <sub>rss</sub>		-	7	-	
Effective output capacitance, energy related <sup>a</sup>	C <sub>o(er)</sub>		-	87	-	
Effective output capacitance, time related <sup>b</sup>	C <sub>o(tr)</sub>	V <sub>DS</sub> = 0 V to 480 V, V <sub>GS</sub> = 0 V	-	543	-	
Total gate charge	Q <sub>g</sub>	V <sub>GS</sub> = 10 V   I <sub>D</sub> = 16 A, V <sub>DS</sub> = 480 V	-	51	77	nC
Gate-source charge	Q <sub>gs</sub>		-	19	-	
Gate-drain charge	Q <sub>gd</sub>		-	16	-	
Turn-on delay time	t <sub>d(on)</sub>	V <sub>DD</sub> = 480 V, I <sub>D</sub> = 16 A, V <sub>GS</sub> = 10 V, R <sub>g</sub> = 9.1 Ω	-	27	54	ns
Rise time	t <sub>r</sub>		-	55	83	
Turn-off delay time	t <sub>d(off)</sub>		-	53	80	
Fall time	t <sub>f</sub>		-	35	70	
Gate input resistance	R <sub>g</sub>		f = 1 MHz, open drain	0.3	0.7	
<b>Drain-Source Body Diode Characteristics</b>						
Continuous source-drain diode current	I <sub>S</sub>	MOSFET symbol showing the integral reverse p - n junction diode 	-	-	41	A
Pulsed diode forward current	I <sub>SM</sub>		-	-	115	
Diode forward voltage	V <sub>SD</sub>	T <sub>J</sub> = 25 °C, I <sub>S</sub> = 16 A, V <sub>GS</sub> = 0 V	-	-	1.2	V
Reverse recovery time	t <sub>rr</sub>	T <sub>J</sub> = 25 °C, I <sub>F</sub> = I <sub>S</sub> = 16 A, di/dt = 100 A/μs, V <sub>R</sub> = 400 V	-	152	304	ns
Reverse recovery charge	Q <sub>rr</sub>		-	1	2	μC
Reverse recovery current	I <sub>RRM</sub>		-	14	-	A

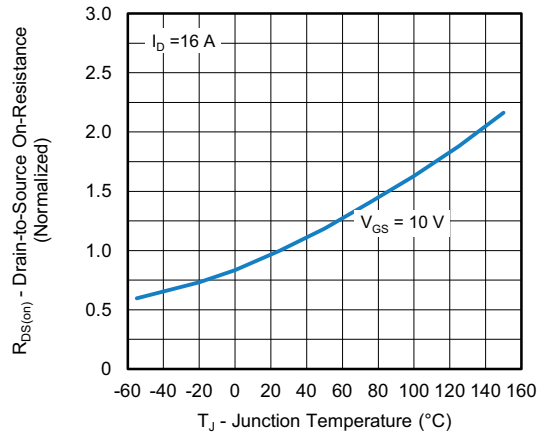
**Notes**

- a. C<sub>oss(er)</sub> is a fixed capacitance that gives the same energy as C<sub>oss</sub> while V<sub>DS</sub> is rising from 0 % to 80 % V<sub>DSS</sub>
- b. C<sub>oss(tr)</sub> is a fixed capacitance that gives the same charging time as C<sub>oss</sub> while V<sub>DS</sub> is rising from 0 % to 80 % V<sub>DSS</sub>

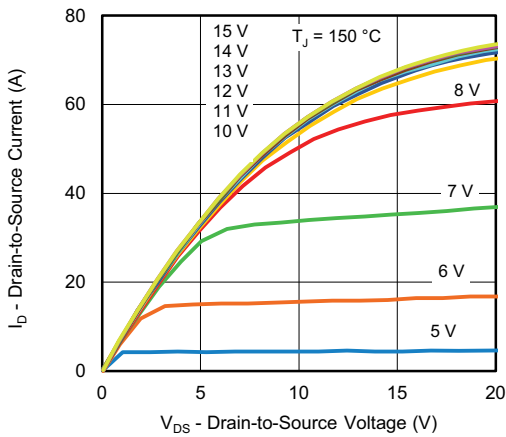
**TYPICAL CHARACTERISTICS** (25 °C, unless otherwise noted)



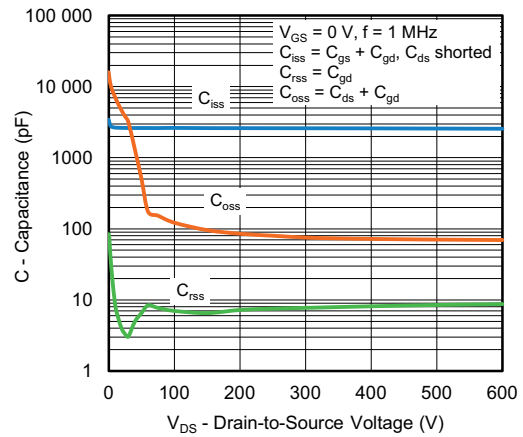
**Fig. 1 - Typical Output Characteristics**



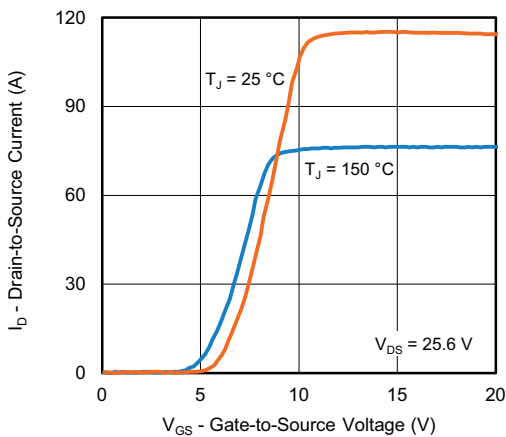
**Fig. 4 - Normalized On-Resistance vs. Temperature**



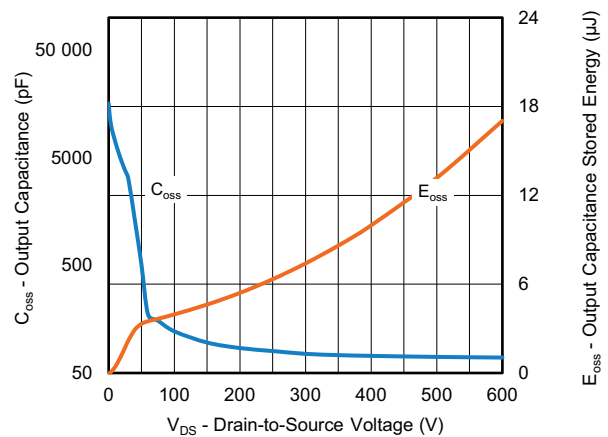
**Fig. 2 - Typical Output Characteristics**



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



**Fig. 3 - Typical Transfer Characteristics**



**Fig. 6 - C<sub>oss</sub> and E<sub>oss</sub> vs. V<sub>DS</sub>**

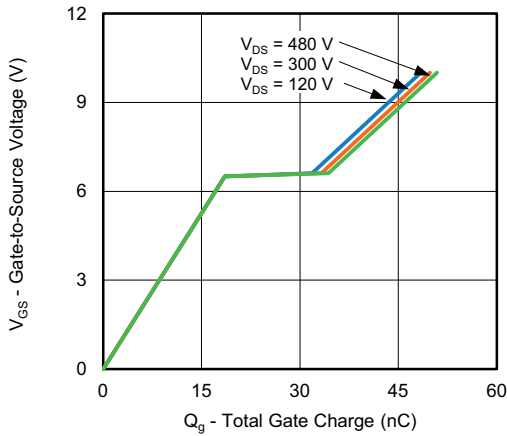


Fig. 7 - Typical Gate Charge vs. Gate-to-Source Voltage

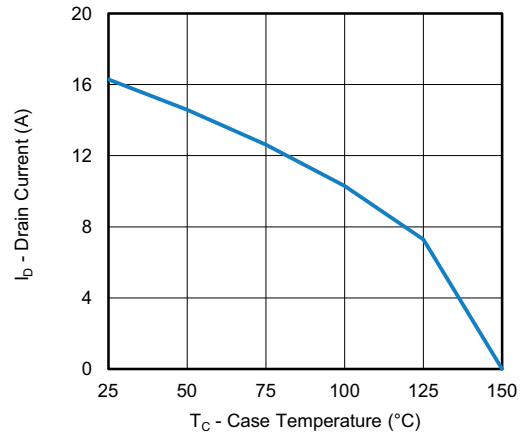


Fig. 10 - Maximum Drain Current vs. Case Temperature

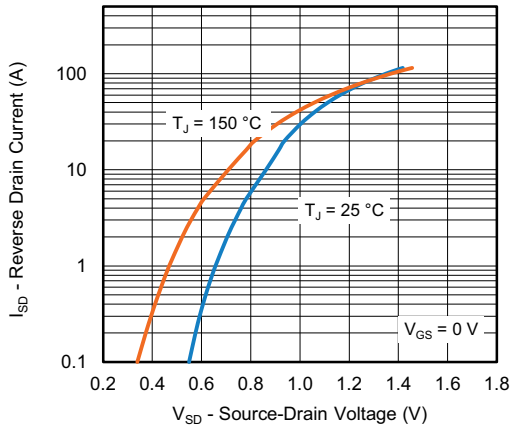


Fig. 8 - Typical Source-Drain Diode Forward Voltage

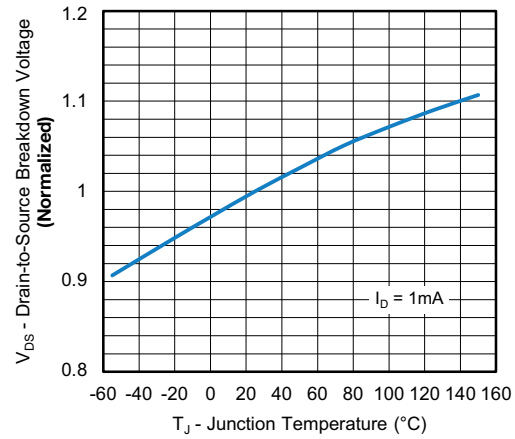


Fig. 11 - Temperature vs. Drain-to-Source Voltage

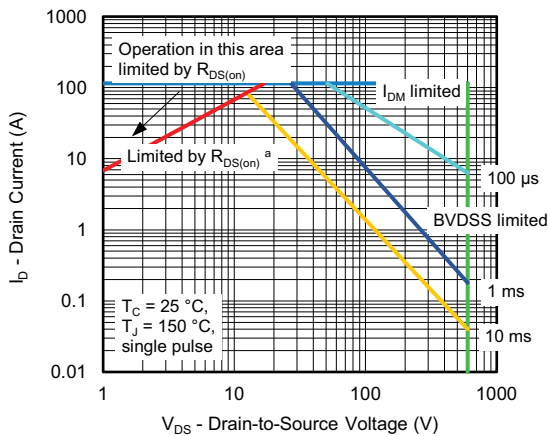


Fig. 9 - Maximum Safe Operating Area

**Note**

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

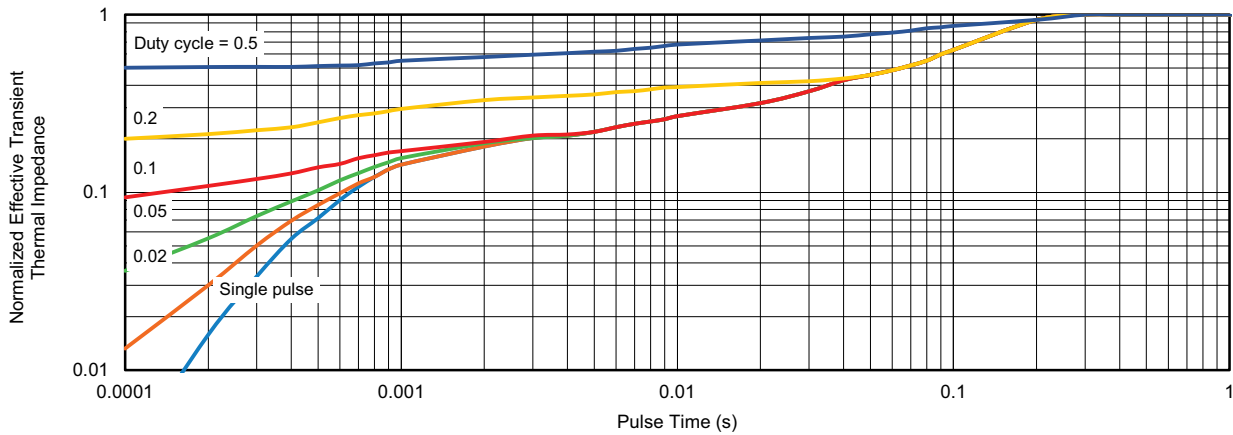


Fig. 12 - Normalized Thermal Transient Impedance, Junction-to-Case

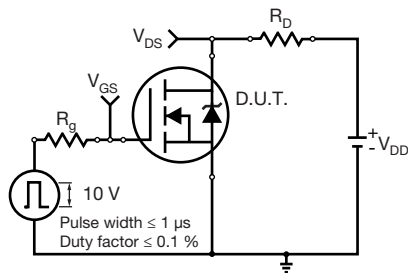


Fig. 13 - Switching Time Test Circuit

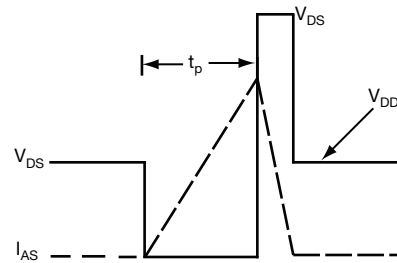


Fig. 16 - Unclamped Inductive Waveforms

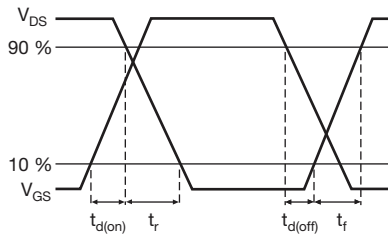


Fig. 14 - Switching Time Waveforms

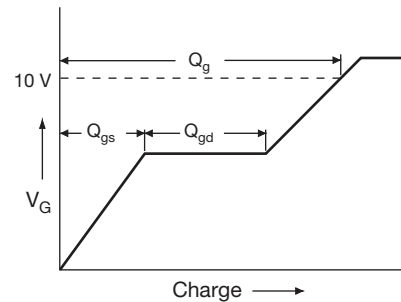


Fig. 17 - Basic Gate Charge Waveform

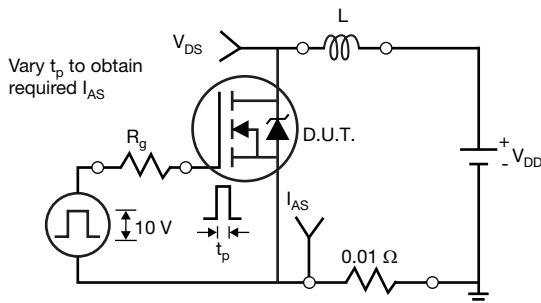


Fig. 15 - Unclamped Inductive Test Circuit

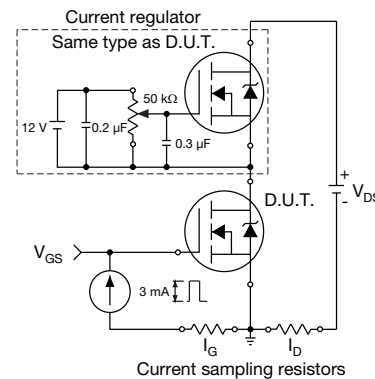


Fig. 18 - Gate Charge Test Circuit



**Note**

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

**Fig. 19 - For N-Channel**

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# TO-220 FULLPAK (High Voltage)

## OPTION 1: FACILITY CODE = 9



DIM.	MILLIMETERS		
	MIN.	NOM.	MAX.
A	4.60	4.70	4.80
b	0.70	0.80	0.91
b1	1.20	1.30	1.47
b2	1.10	1.20	1.30
C	0.45	0.50	0.63
D	15.80	15.87	15.97
e	2.54 BSC		
E	10.00	10.10	10.30
F	2.44	2.54	2.64
G	6.50	6.70	6.90
L	12.90	13.10	13.30
L1	3.13	3.23	3.33
Q	2.65	2.75	2.85
Q1	3.20	3.30	3.40
$\varnothing R$	3.08	3.18	3.28

### Notes

1. To be used only for process drawing
2. These dimensions apply to all TO-220 FULLPAK leadframe versions 3 leads
3. All critical dimensions should C meet  $C_{pk} > 1.33$
4. All dimensions include burrs and plating thickness
5. No chipping or package damage
6. Facility code will be the 1<sup>st</sup> character located at the 2<sup>nd</sup> row of the unit marking



OPTION 2: FACILITY CODE = Y



DIM.	MILLIMETERS		INCHES	
	MIN.	MAX.	MIN.	MAX.
A	4.570	4.830	0.180	0.190
A1	2.570	2.830	0.101	0.111
A2	2.510	2.850	0.099	0.112
b	0.622	0.890	0.024	0.035
b2	1.229	1.400	0.048	0.055
b3	1.229	1.400	0.048	0.055
c	0.440	0.629	0.017	0.025
D	8.650	9.800	0.341	0.386
d1	15.88	16.120	0.622	0.635
d3	12.300	12.920	0.484	0.509
E	10.360	10.630	0.408	0.419
e	2.54 BSC		0.100 BSC	
L	13.200	13.730	0.520	0.541
L1	3.100	3.500	0.122	0.138
n	6.050	6.150	0.238	0.242
Ø P	3.050	3.450	0.120	0.136
u	2.400	2.500	0.094	0.098
V	0.400	0.500	0.016	0.020

ECN: E19-0180-Rev. D, 08-Apr-2019  
DWG: 5972

Notes

1. To be used only for process drawing
2. These dimensions apply to all TO-220 FULLPAK leadframe versions 3 leads
3. All critical dimensions should C meet  $C_{pk} > 1.33$
4. All dimensions include burrs and plating thickness
5. No chipping or package damage
6. Facility code will be the 1<sup>st</sup> character located at the 2<sup>nd</sup> row of the unit marking





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