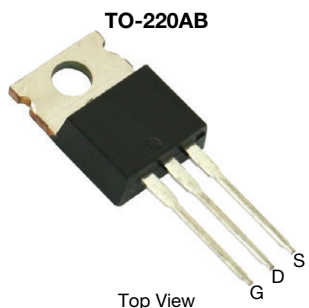


# N-Channel 40 V (D-S) MOSFET



## FEATURES

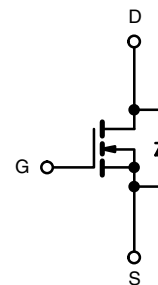
- TrenchFET® power MOSFET
- Maximum 175 °C junction temperature
- Excellent  $R_{DS(on)}$ - $Q_g$  and  $R_{DS(on)}$ - $Q_{oss}$  FOM reduce power loss from conduction and switching to enable high efficiency
- 100 %  $R_g$  and UIS tested
- Material categorization: for definitions of compliance please see [www.vishay.com/doc?999912](http://www.vishay.com/doc?999912)



**RoHS**  
COMPLIANT  
HALOGEN  
FREE

## APPLICATIONS

- Power supply
  - Secondary synchronous rectification
- DC/DC converter
- Power tools
- Motor drive switch
- Battery management



N-Channel MOSFET

## PRODUCT SUMMARY

$V_{DS}$ (V)	40
$R_{DS(on)}$ max. ( $\Omega$ ) at $V_{GS} = 10$ V	0.00179
$R_{DS(on)}$ max. ( $\Omega$ ) at $V_{GS} = 4.5$ V	0.00236
$Q_g$ typ. (nC)	130
$I_D$ (A)	150 <sup>d</sup>
Configuration	Single

## ORDERING INFORMATION

Package	TO-220
Lead (Pb)-free and halogen-free	SUP40012EL-GE3

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

PARAMETER	SYMBOL	LIMIT	UNIT
Drain-source voltage	$V_{DS}$	40	V
Gate-source voltage	$V_{GS}$	$\pm 20$	V
Continuous drain current ( $T_J = 150$ °C)	$I_D$	150 <sup>d</sup>	A
		150 <sup>d</sup>	
Pulsed drain current ( $t = 100$ $\mu$ s)	$I_{DM}$	300	A
Avalanche current	$I_{AS}$	50	A
Single avalanche energy <sup>a</sup>	$E_{AS}$	125	mJ
Maximum power dissipation <sup>a</sup>	$P_D$	150 <sup>b</sup>	W
		50 <sup>b</sup>	
Operating junction and storage temperature range	$T_J, T_{stg}$	-55 to +175	°C

## THERMAL RESISTANCE RATINGS

PARAMETER	SYMBOL	LIMIT	UNIT
Junction-to-ambient (PCB mount) <sup>c</sup>	$R_{thJA}$	40	°C/W
Junction-to-case (drain)	$R_{thJC}$	1	°C/W

### Notes

- Duty cycle  $\leq 1$  %
- See SOA curve for voltage derating
- When mounted on 1" square PCB (FR4 material)
- Package limited



SPECIFICATIONS (T <sub>J</sub> = 25 °C, unless otherwise noted)						
PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNIT
Static						
Drain-source breakdown voltage	V <sub>DS</sub>	V <sub>GS</sub> = 0 V, I <sub>D</sub> = 250 μA	40	-	-	V
Gate threshold voltage	V <sub>GS(th)</sub>	V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 250 μA	1	-	2.5	
Gate-body leakage	I <sub>GSS</sub>	V <sub>DS</sub> = 0 V, V <sub>GS</sub> = ± 20 V	-	-	± 250	nA
Zero gate voltage drain current	I <sub>DSS</sub>	V <sub>DS</sub> = 30 V, V <sub>GS</sub> = 0 V	-	-	1	μA
		V <sub>DS</sub> = 30 V, V <sub>GS</sub> = 0 V, T <sub>J</sub> = 125 °C	-	-	150	
		V <sub>DS</sub> = 30 V, V <sub>GS</sub> = 0 V, T <sub>J</sub> = 175 °C	-	-	5	mA
On-state drain current <sup>a</sup>	I <sub>D(on)</sub>	V <sub>DS</sub> ≥ 10 V, V <sub>GS</sub> = 10 V	120	-	-	A
Drain-source on-state resistance <sup>a</sup>	R <sub>DS(on)</sub>	V <sub>GS</sub> = 10 V, I <sub>D</sub> = 30 A	-	0.00149	0.00179	Ω
		V <sub>GS</sub> = 4.5 V, I <sub>D</sub> = 20 A	-	0.00196	0.00236	
Forward transconductance <sup>a</sup>	g <sub>fs</sub>	V <sub>DS</sub> = 15 V, I <sub>D</sub> = 30 A	-	230	-	S
Dynamic <sup>b</sup>						
Input capacitance	C <sub>iss</sub>	V <sub>GS</sub> = 0 V, V <sub>DS</sub> = 20 V, f = 1 MHz	-	10 930	-	pF
Output capacitance	C <sub>oss</sub>		-	2041	-	
Reverse transfer capacitance	C <sub>rss</sub>		-	101	-	
Total gate charge <sup>c</sup>	Q <sub>g</sub>	V <sub>DS</sub> = 20 V, V <sub>GS</sub> = 10 V, I <sub>D</sub> = 20 A	-	130	195	nC
Gate-source charge <sup>c</sup>	Q <sub>gs</sub>		-	33.6	-	
Gate-drain charge <sup>c</sup>	Q <sub>gd</sub>		-	6.7	-	
Output charge	Q <sub>oss</sub>	V <sub>DS</sub> = 20 V, V <sub>GS</sub> = 0 V	-	64	96	
Gate resistance	R <sub>g</sub>	f = 1 MHz	0.36	1.8	3.6	Ω
Turn-on delay time <sup>c</sup>	t <sub>d(on)</sub>	V <sub>DD</sub> = 20 V, R <sub>L</sub> = 2 Ω I <sub>D</sub> ≅ 10 A, V <sub>GEN</sub> = 10 V, R <sub>g</sub> = 1 Ω	-	25	50	ns
Rise time <sup>c</sup>	t <sub>r</sub>		-	12	24	
Turn-off delay time <sup>c</sup>	t <sub>d(off)</sub>		-	65	130	
Fall time <sup>c</sup>	t <sub>f</sub>		-	18	36	
Drain-Source Body Diode Ratings and Characteristics <sup>b</sup> (T <sub>C</sub> = 25 °C)						
Pulsed current (t = 100 μs)	I <sub>SM</sub>		-	-	300	A
Forward voltage <sup>a</sup>	V <sub>SD</sub>	I <sub>F</sub> = 10 A, V <sub>GS</sub> = 0 V	-	0.8	1.5	V
Reverse recovery time	t <sub>rr</sub>	I <sub>F</sub> = 10 A, di/dt = 100 A/μs	-	58	116	ns
Peak reverse recovery charge	I <sub>RM(REC)</sub>		-	2.1	4.2	A
Reverse recovery charge	Q <sub>rr</sub>		-	72	144	nC
Reverse recovery fall time	t <sub>a</sub>		-	32	-	ns
Reverse recovery rise time	t <sub>b</sub>		-	26	-	

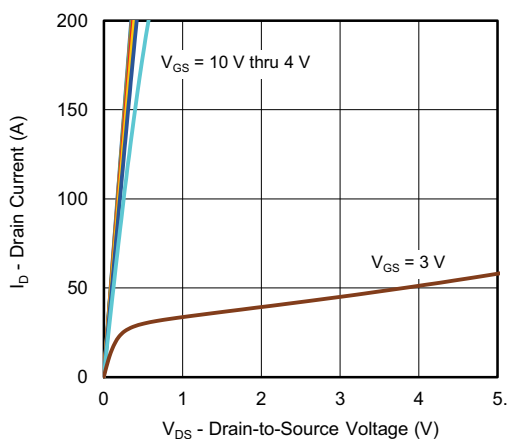
**Notes**

- a. Pulse test; pulse width  $\leq 300\text{ }\mu\text{s}$ , duty cycle  $\leq 2\%$   
b. Guaranteed by design, not subject to production testing  
c. Independent of operating temperature

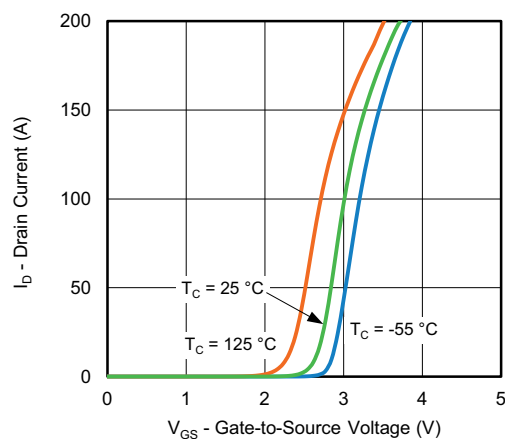
Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.



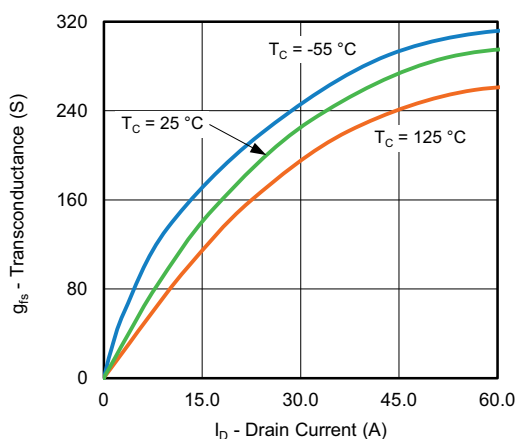
**TYPICAL CHARACTERISTICS** ( $T_A = 25\text{ }^{\circ}\text{C}$ , unless otherwise noted)



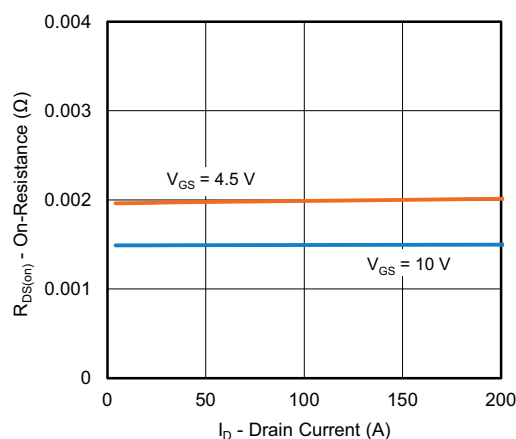
**Output Characteristics**



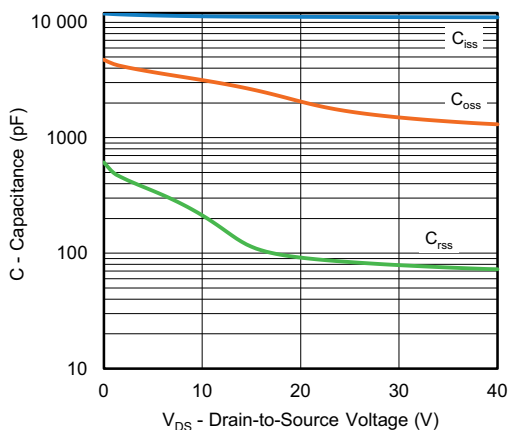
**Transfer Characteristics**



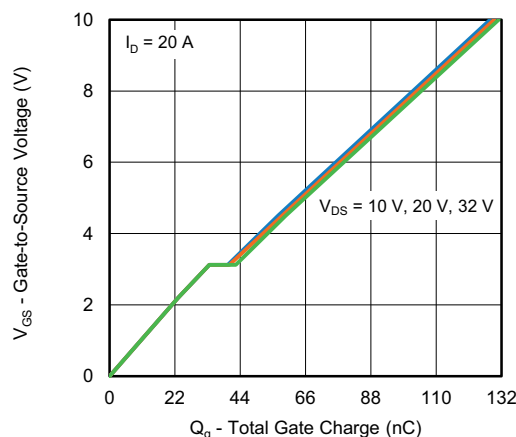
**Transconductance**



**On-Resistance vs. Drain Current**



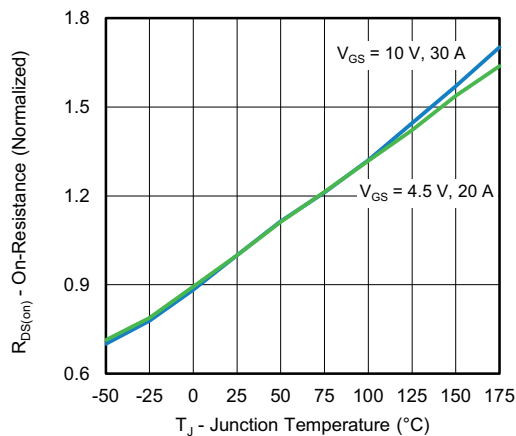
**Capacitance**



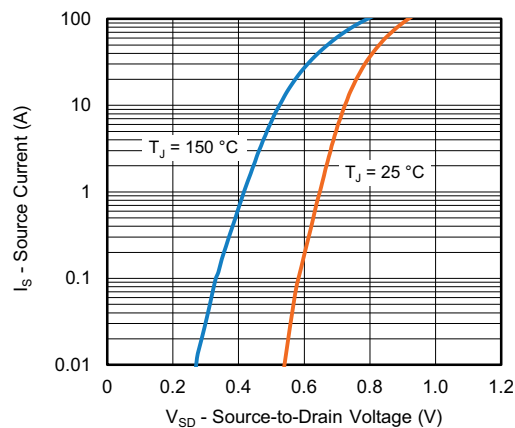
**Gate Charge**



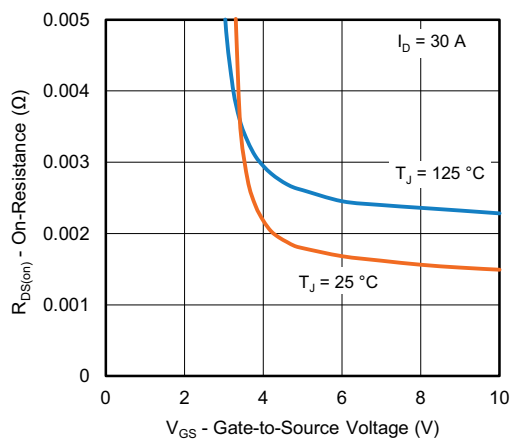
**TYPICAL CHARACTERISTICS** ( $T_A = 25\text{ }^{\circ}\text{C}$ , unless otherwise noted)



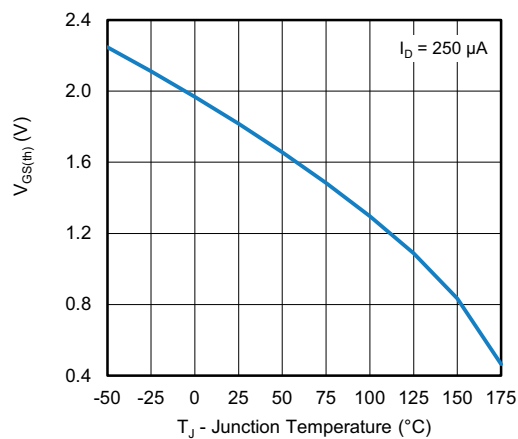
**On-Resistance vs. Junction Temperature**



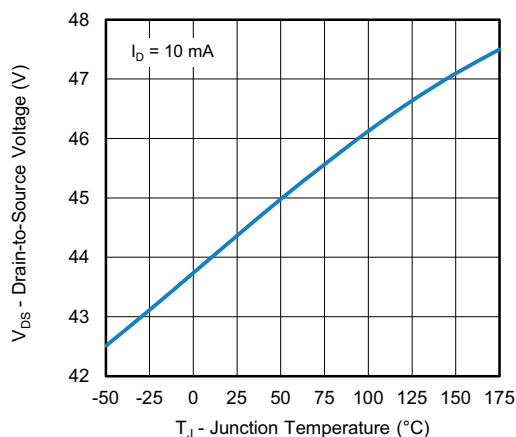
**Source Drain Diode Forward Voltage**



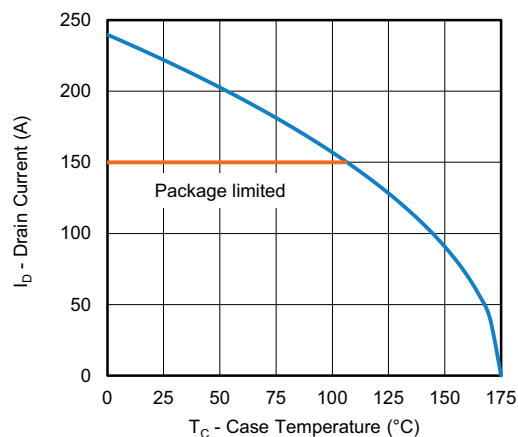
**On-Resistance vs. Gate-to-Source Voltage**



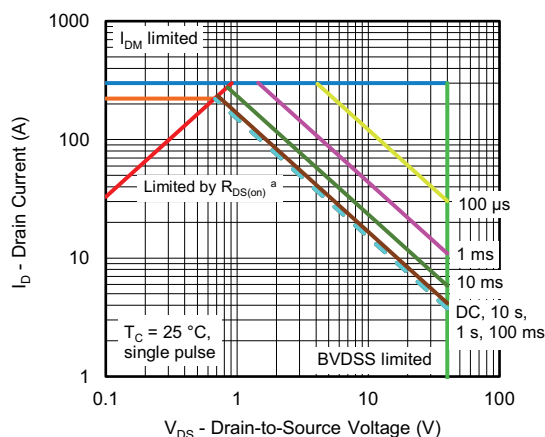
**Threshold Voltage**



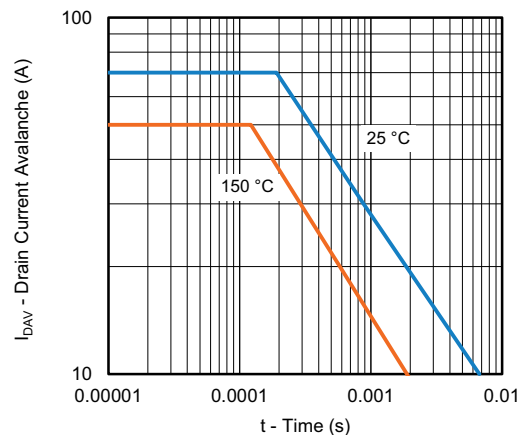
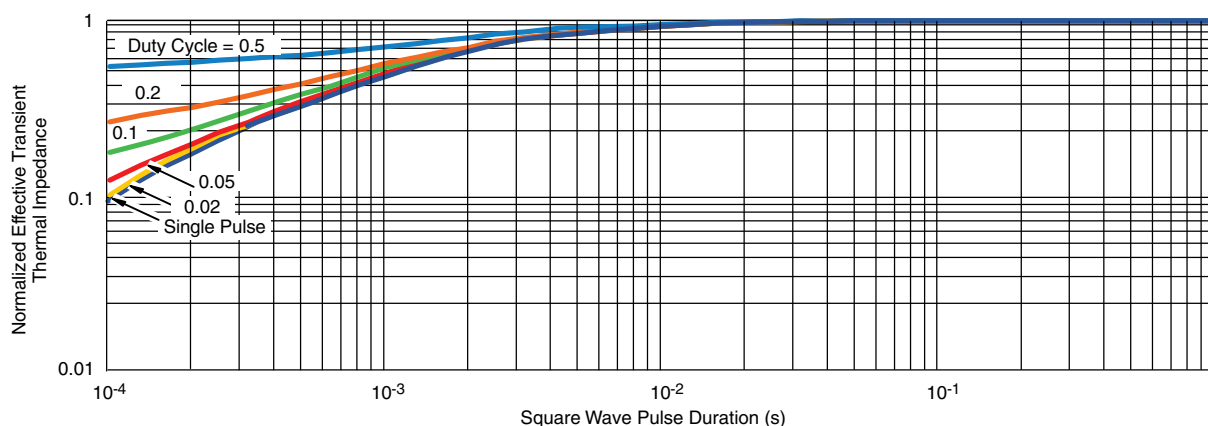
**Drain Source Breakdown vs. Junction Temperature**



**Current De-rating**

**THERMAL RATINGS** ( $T_A = 25\text{ }^{\circ}\text{C}$ , unless otherwise noted)**Safe Operating Area****Note**

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

**Single Pulse Avalanche Current Capability vs. Time****Normalized Thermal Transient Impedance, Junction-to-Case****Note**

- The characteristics shown in the two graphs
    - Normalized Transient Thermal Impedance Junction to Ambient ( $25\text{ }^{\circ}\text{C}$ )
    - Normalized Transient Thermal Impedance Junction to Case ( $25\text{ }^{\circ}\text{C}$ )
- are given for general guidelines only to enable the user to get a "ball park" indication of part capabilities. The data are extracted from single pulse transient thermal impedance characteristics which are developed from empirical measurements. The latter is valid for the part mounted on printed circuit board - FR4, size 1" x 1" x 0.062", double sided with 2 oz. copper, 100 % on both sides. The part capabilities can widely vary depending on actual application parameters and operating conditions

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## TO-220AB

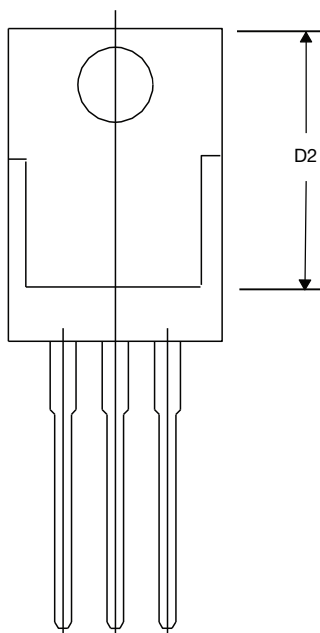


DIM.	MILLIMETERS		INCHES	
	MIN.	MAX.	MIN.	MAX.
A	4.25	4.65	0.167	0.183
b	0.69	1.01	0.027	0.040
b(1)	1.20	1.73	0.047	0.068
c	0.36	0.61	0.014	0.024
D	14.85	15.49	0.585	0.610
D2	12.19	12.70	0.480	0.500
E	10.04	10.51	0.395	0.414
e	2.41	2.67	0.095	0.105
e(1)	4.88	5.28	0.192	0.208
F	1.14	1.40	0.045	0.055
H(1)	6.09	6.48	0.240	0.255
J(1)	2.41	2.92	0.095	0.115
L	13.35	14.02	0.526	0.552
L(1)	3.32	3.82	0.131	0.150
Ø P	3.54	3.94	0.139	0.155
Q	2.60	3.00	0.102	0.118

ECN: T14-0413-Rev. P, 16-Jun-14  
DWG: 5471

### Note

\* M = 1.32 mm to 1.62 mm (dimension including protrusion)  
Heatsink hole for HVM





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