

# N-Channel 40-V (D-S) MOSFET with Sensing Diode

## PRODUCT SUMMARY

$V_{(BR)DSS}$ (V)	$r_{DS(on)}$ ( $\Omega$ )	$I_D$ (A)
40	0.0055 at $V_{GS} = 10$ V	60 <sup>a</sup>

## FEATURES

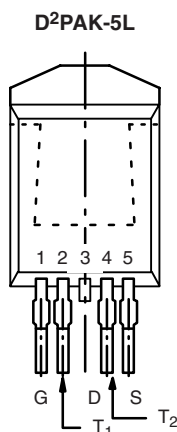
- TrenchFET<sup>®</sup> Power MOSFETS Plus Temperature Sensing Diode
- 175 °C Junction Temperature
- New Low Thermal Resistance Package



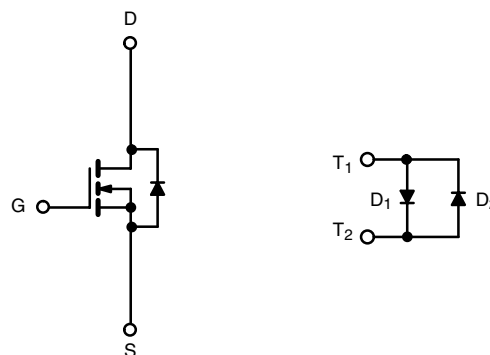
Available  
**RoHS\***  
COMPLIANT

## APPLICATIONS

- Industrial



Ordering Information: SUM60N04-06T-E3 (Lead (Pb)-free)



N-Channel MOSFET

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

Parameter	Symbol	Limit	Unit
Drain-Source Voltage	$V_{DS}$	40	V
Gate-Source Voltage	$V_{GS}$	$\pm 20$	
Continuous Drain Current ( $T_J = 175$ °C) <sup>d</sup>	$I_D$	$T_C = 25$ °C	A
		$T_C = 100$ °C	
Pulsed Drain Current	$I_{DM}$	250	
Continuous Diode Current (Diode Conduction) <sup>d</sup>	$I_S$	60 <sup>a</sup>	
Avalanche Current	$I_{AR}$	60 <sup>a</sup>	
Repetitive Avalanche Energy <sup>b</sup>	$E_{AR}$	180	mJ
Maximum Power Dissipation <sup>a</sup>	$P_D$	$T_C = 25$ °C	W
		$T_A = 25$ °C	
Operating Junction and Storage Temperature Range	$T_J, T_{stg}$	- 55 to 175	°C

## THERMAL RESISTANCE RATINGS

Parameter	Symbol	Limit	Unit
Junction-to-Ambient <sup>d</sup>	$R_{thJA}$	40	°C/W
Junction-to-Case	$R_{thJC}$	0.75	

Notes:

- Package limited.
- Duty cycle  $\leq 1$  %.
- See SOA curve for voltage derating.
- When mounted on 1" square PCB (FR-4 material).

\* Pb containing terminations are not RoHS compliant, exemptions may apply.

MOSFET SPECIFICATIONS $T_J = 25\text{ }^{\circ}\text{C}$ , unless otherwise noted						
Parameter	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
Static						
Drain-Source Breakdown Voltage	$V_{(BR)DSS}$	$V_{GS} = 0\text{ V}$ , $I_D = 250\text{ }\mu\text{A}$	40			V
Gate-Threshold Voltage	$V_{GS(th)}$	$V_{DS} = V_{GS}$ , $I_{DS} = 250\text{ }\mu\text{A}$	2			
Gate-Body Leakage	$I_{GSS}$	$V_{DS} = 0\text{ V}$ , $V_{GS} = \pm 20\text{ V}$			$\pm 100$	nA
Zero Gate Voltage Drain Current	$I_{DSS}$	$V_{DS} = 32\text{ V}$ , $V_{GS} = 0\text{ V}$			1	$\mu\text{A}$
		$V_{DS} = 32\text{ V}$ , $V_{GS} = 0\text{ V}$ , $T_J = 125\text{ }^{\circ}\text{C}$			50	
		$V_{DS} = 32\text{ V}$ , $V_{GS} = 0\text{ V}$ , $T_J = 175\text{ }^{\circ}\text{C}$			500	
On-State Drain Current <sup>a</sup>	$I_{D(on)}$	$V_{DS} = 5\text{ V}$ , $V_{GS} = 10\text{ V}$	120			A
Drain-Source On-State Resistance <sup>a</sup>	$r_{DS(on)}$	$V_{GS} = 10\text{ V}$ , $I_D = 25\text{ A}$		0.0044	0.0055	$\Omega$
		$V_{GS} = 10\text{ V}$ , $I_D = 25\text{ A}$ , $T_J = 125\text{ }^{\circ}\text{C}$			0.0088	
		$V_{GS} = 10\text{ V}$ , $I_D = 25\text{ A}$ , $T_J = 175\text{ }^{\circ}\text{C}$			0.011	
Sense Diode Forward Voltage	$V_{FD1}$	$I_F = 50\text{ }\mu\text{A}$	655		715	mV
	$V_{FD2}$	$I_F = 25\text{ }\mu\text{A}$	600		660	
Sense Diode Forward Voltage Increase	$\Delta V_F$	From $I_F = 25\text{ }\mu\text{A}$ to $I_F = 50\text{ }\mu\text{A}$	30		80	
Forward Transconductance <sup>a</sup>	$g_{fs}$	$V_{DS} = 15\text{ V}$ , $I_D = 20\text{ A}$		35		S
Dynamic <sup>b</sup>						
Input Capacitance	$C_{iss}$	$V_{GS} = 0\text{ V}$ , $V_{DS} = 25\text{ V}$ , $f = 1\text{ MHz}$		6400		pF
Output Capacitance	$C_{oss}$			1100		
Reverse Transfer Capacitance	$C_{rss}$			630		
Total Gate Charge <sup>c</sup>	$Q_g$	$V_{DS} = 20\text{ V}$ , $V_{GS} = 10\text{ V}$ , $I_D = 25\text{ A}$		115	150	nC
Gate-Source Charge <sup>c</sup>	$Q_{gs}$			35		
Gate-Drain Charge <sup>c</sup>	$Q_{gd}$			35		
Turn-On Delay Time <sup>c</sup>	$t_{d(on)}$	$V_{DD} = 20\text{ V}$ , $R_L = 0.8\text{ }\Omega$ $I_D \cong 25\text{ A}$ , $V_{GEN} = 10\text{ V}$ , $R_G = 2.5\text{ }\Omega$		15	20	ns
Rise Time <sup>c</sup>	$t_r$			150	210	
Turn-Off Delay Time <sup>c</sup>	$t_{d(off)}$			60	85	
Fall Time <sup>c</sup>	$t_f$			80	110	
Source-Drain Diode Ratings and Characteristics $T_C = 25\text{ }^{\circ}\text{C}$ <sup>b</sup>						
Continuous Current	$I_S$				60	A
Pulsed Current	$I_{SM}$				200	
Forward Voltage <sup>a</sup>	$V_{SD}$	$I_F = 60\text{ A}$ , $V_{GS} = 0\text{ V}$		1.0	1.5	V
Reverse Recovery Time	$t_{rr}$	$I_F = 60\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$		45	70	ns
Peak Reverse Recovery Current	$I_{RM(REC)}$			2.5	5	A
Reverse Recovery Charge	$Q_{rr}$			0.06	0.18	$\mu\text{C}$

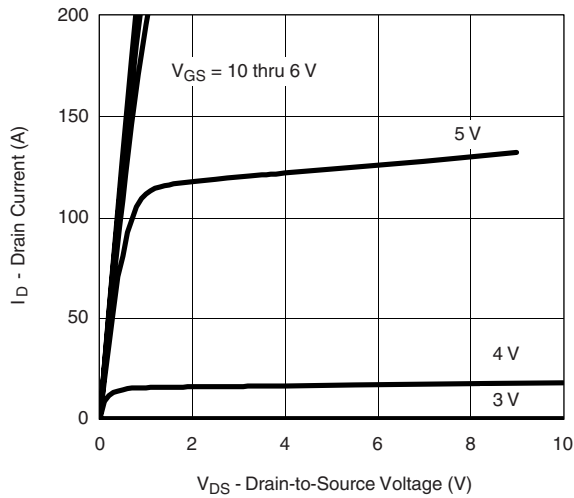
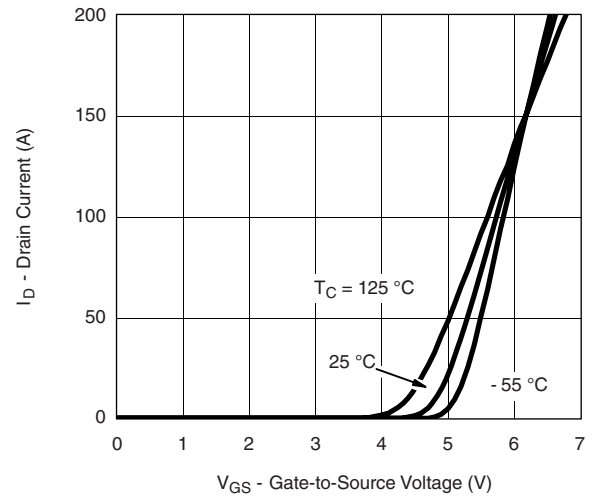
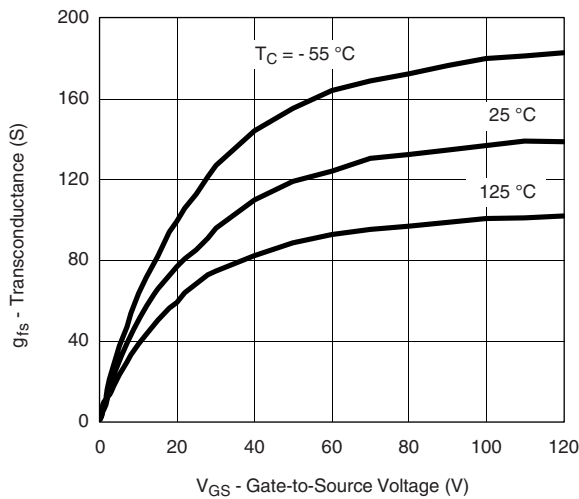
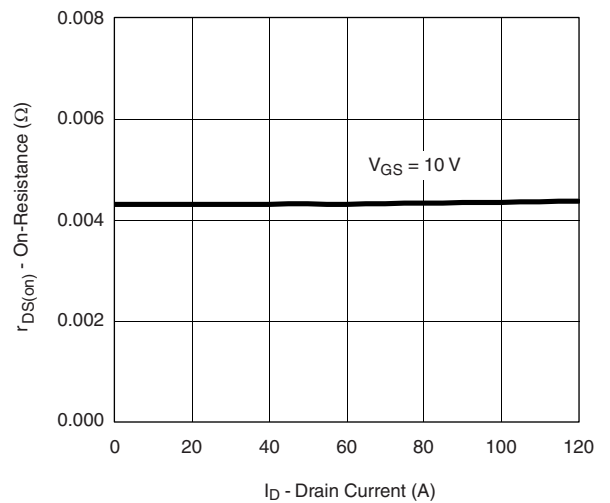
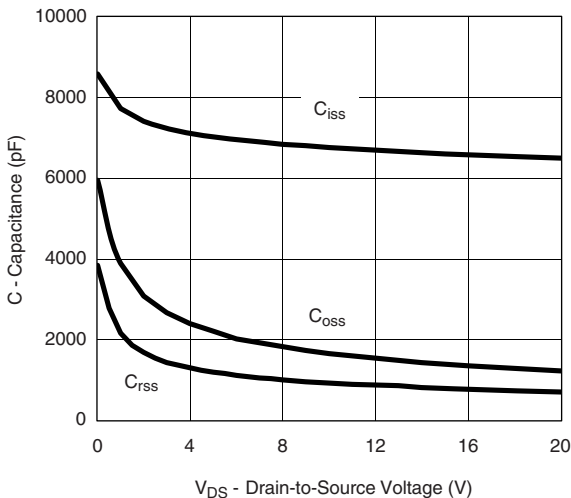
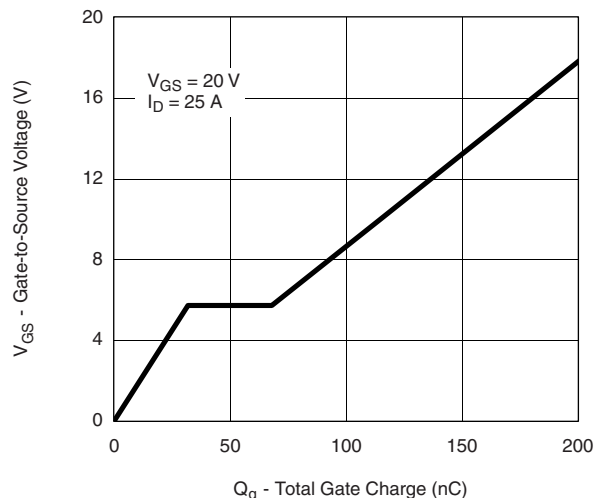
## Notes:

a. Pulse test; pulse width  $\leq 300\text{ }\mu\text{s}$ , duty cycle  $\leq 2\%$ .

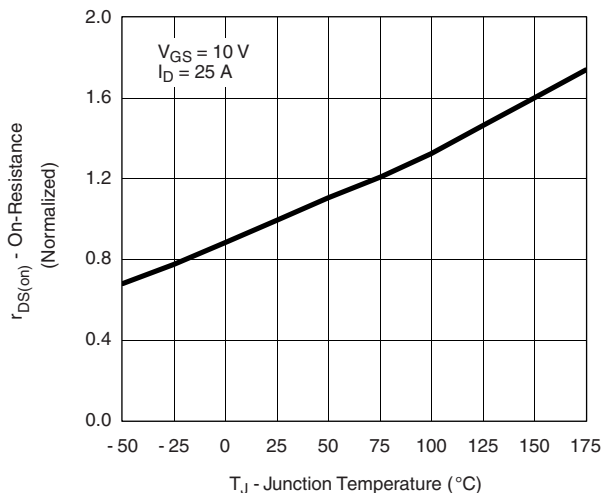
b. Guaranteed by design, not subject to production testing.

c. Independent of operating temperature.

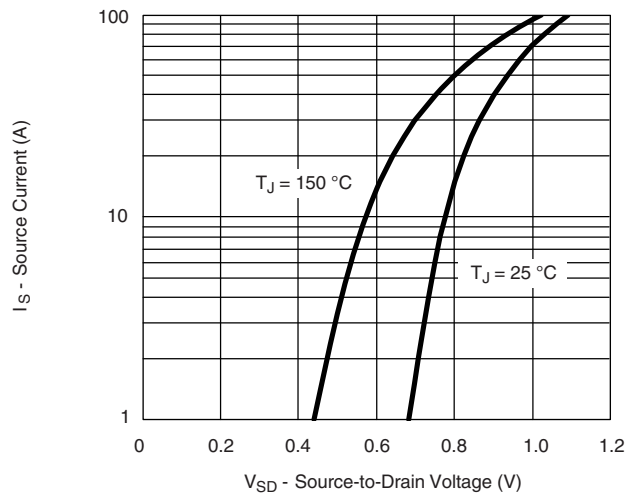
Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure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

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

**Output Characteristics**

**Transfer Characteristics**

**Transconductance**

**On-Resistance vs. Drain Current**

**Capacitance**

**Gate Charge**

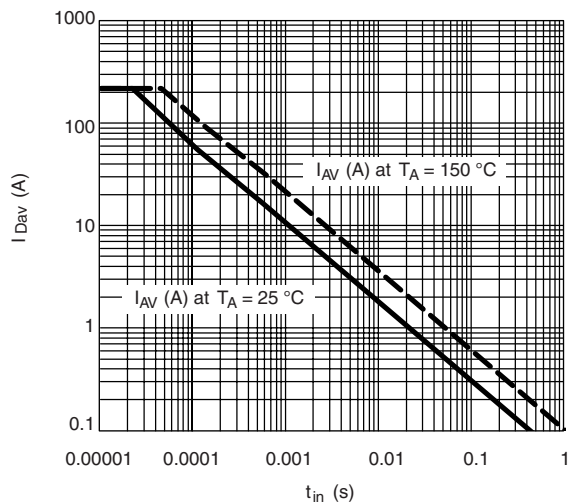
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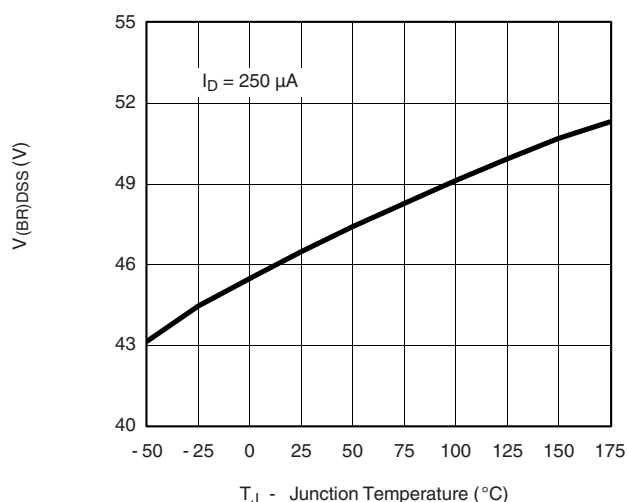
On-Resistance vs. Junction Temperature



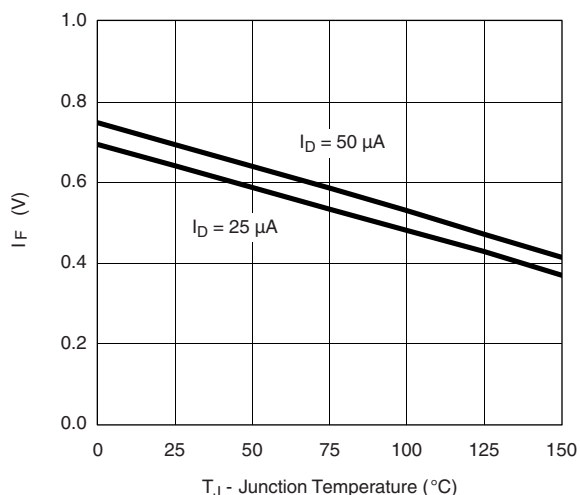
Source-Drain Diode Forward Voltage



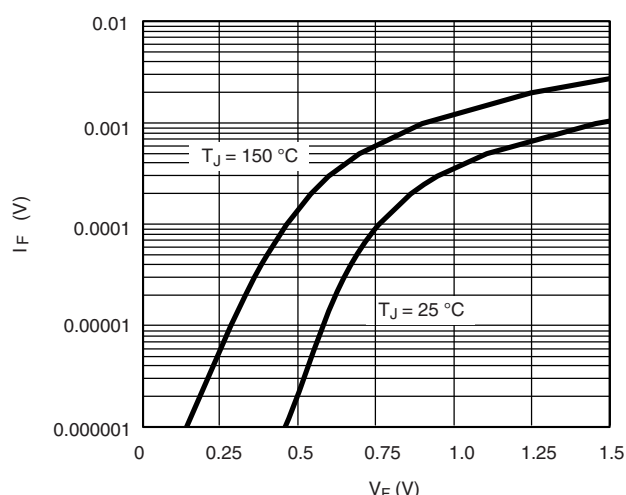
Avalanche Current vs. Time



Drain Source Breakdown vs. Junction Temperature



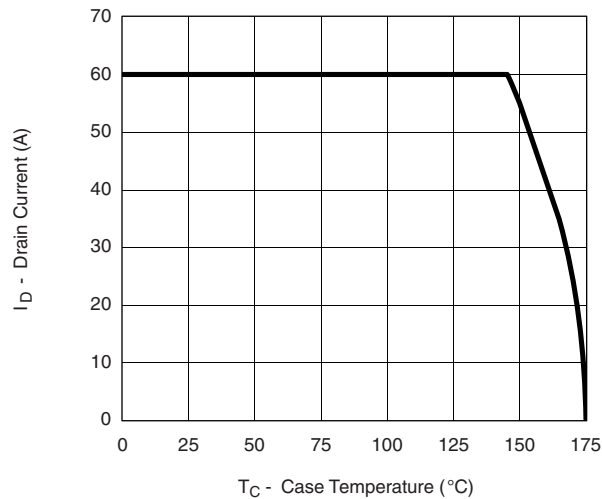
Sense Diode Forward Voltage vs. Temperature



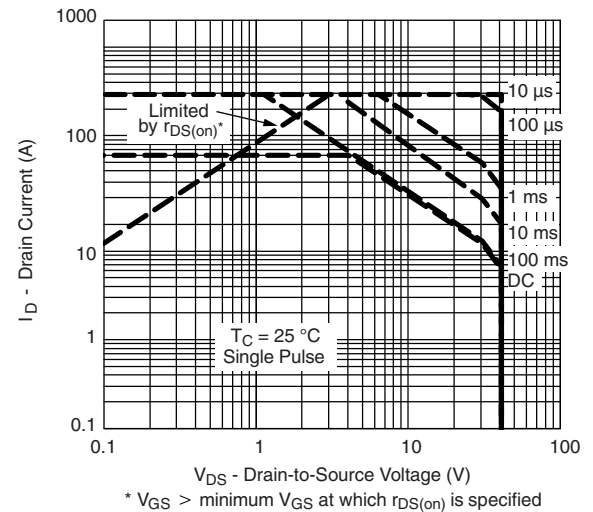
Sense Diode Forward Voltage



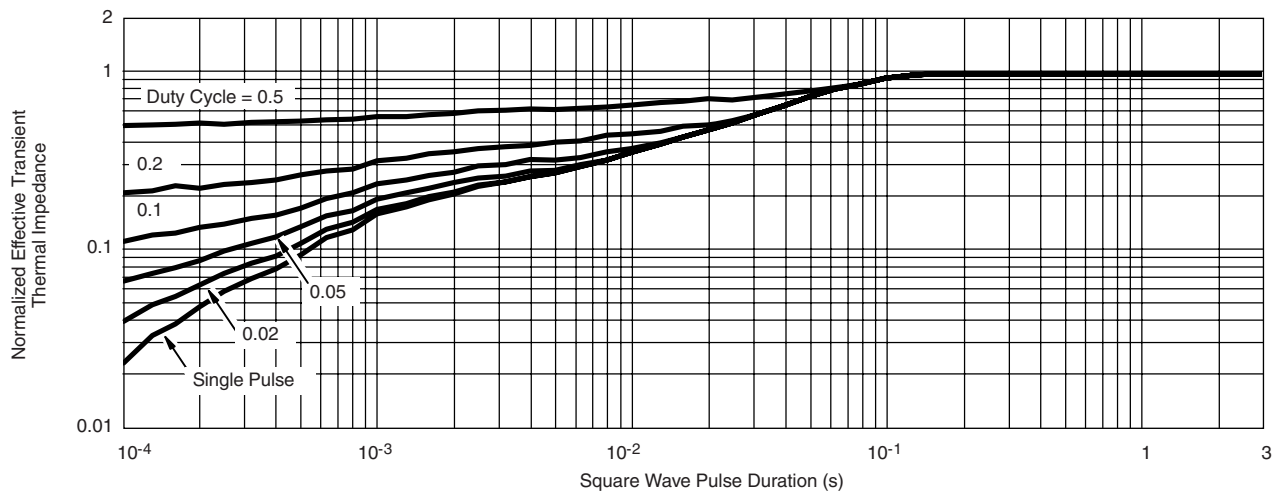
## THERMAL RATINGS



Maximum Avalanche and Drain Current  
vs. Case Temperature



Safe Operating Area



Normalized Thermal Transient Impedance, Junction-to-Case

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