

## NP60N04MUG-VB Datasheet

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

PRODUCT SUMMARY		
$V_{DS}$	40	V
$R_{DS(on)}$ $V_{GS} = 10\text{ V}$	6	m $\Omega$
$I_D$	110	A
Configuration	Single	

#### FEATURES

- Trench Power MOSFET
- 100 %  $R_g$  and UIS Tested

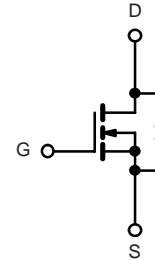
#### APPLICATIONS

- Synchronous Rectification
- Power Supplies



**RoHS**  
COMPLIANT

TO-220AB



N-Channel MOSFET

ABSOLUTE MAXIMUM RATINGS $T_A = 25\text{ }^{\circ}\text{C}$ , unless otherwise noted				
Parameter		Symbol	Limit	Unit
Drain-Source Voltage		$V_{DS}$	40	V
Gate-Source Voltage		$V_{GS}$	$\pm 20$	
Continuous Drain Current ( $T_J = 175\text{ }^{\circ}\text{C}$ )	$T_C = 25\text{ }^{\circ}\text{C}$	$I_D$	110 <sup>a, c</sup>	A
	$T_C = 70\text{ }^{\circ}\text{C}$		90 <sup>c</sup>	
	$T_A = 25\text{ }^{\circ}\text{C}$		31 <sup>b</sup>	
	$T_A = 70\text{ }^{\circ}\text{C}$		25 <sup>b</sup>	
Pulsed Drain Current		$I_{DM}$	270	
Avalanche Current Pulse		$I_{AS}$	85	
Single Pulse Avalanche Energy		$E_{AS}$	320	V
Continuous Source-Drain Diode Current	$T_C = 25\text{ }^{\circ}\text{C}$	$I_S$	110 <sup>a, c</sup>	A
	$T_A = 25\text{ }^{\circ}\text{C}$		2.6 <sup>b</sup>	
Maximum Power Dissipation	$T_C = 25\text{ }^{\circ}\text{C}$	$P_D$	312 <sup>a</sup>	W
	$T_C = 70\text{ }^{\circ}\text{C}$		200	
	$T_A = 25\text{ }^{\circ}\text{C}$		3.13 <sup>b</sup>	
	$T_A = 70\text{ }^{\circ}\text{C}$		2.0 <sup>b</sup>	
Operating Junction and Storage Temperature Range		$T_J, T_{stg}$	- 55 to 150	$^{\circ}\text{C}$

#### THERMAL RESISTANCE RATINGS

Parameter		Symbol	Typical	Maximum	Unit
Maximum Junction-to-Ambient <sup>b</sup>	Steady State	$R_{thJA}$	32	40	$^{\circ}\text{C/W}$
Maximum Junction-to-Case	Steady State	$R_{thJC}$	0.33	0.4	

Notes:

a. Based on  $T_C = 25\text{ }^{\circ}\text{C}$ .

b. Surface Mounted on 1" x 1" FR4 board.

c. Calculated based on maximum junction temperature. Package limitation current is 110 A.

SPECIFICATIONS $T_J = 25\text{ }^{\circ}\text{C}$ , unless otherwise noted						
Parameter	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
Static						
Drain-Source Breakdown Voltage	$V_{DS}$	$V_{GS} = 0\text{ V}, I_D = 250\text{ }\mu\text{A}$	40			V
$V_{DS}$ Temperature Coefficient	$\Delta V_{DS}/T_J$	$I_D = 250\text{ }\mu\text{A}$		41		mV/ $^{\circ}\text{C}$
$V_{GS(th)}$ Temperature Coefficient	$\Delta V_{GS(th)}/T_J$			- 8		
Gate-Source Threshold Voltage	$V_{GS(th)}$	$V_{DS} = V_{GS}, I_D = 250\text{ }\mu\text{A}$	1.2		2.5	V
Gate-Source Leakage	$I_{GSS}$	$V_{DS} = 0\text{ V}, V_{GS} = \pm 20\text{ V}$			$\pm 100$	nA
Zero Gate Voltage Drain Current	$I_{DSS}$	$V_{DS} = 40\text{ V}, V_{GS} = 0\text{ V}$			1	$\mu\text{A}$
		$V_{DS} = 40\text{ V}, V_{GS} = 0\text{ V}, T_J = 55\text{ }^{\circ}\text{C}$			10	
On-State Drain Current <sup>a</sup>	$I_{D(on)}$	$V_{DS} \geq 5\text{ V}, V_{GS} = 10\text{ V}$	120			A
Drain-Source On-State Resistance <sup>a</sup>	$R_{DS(on)}$	$V_{GS} = 10\text{ V}, I_D = 30\text{ A}$		6		m $\Omega$
		$V_{GS} = 4.5\text{ V}, I_D = 20\text{ A}$		7		
Forward Transconductance <sup>a</sup>	$g_{fs}$	$V_{DS} = 15\text{ V}, I_D = 30\text{ A}$		180		S
Dynamic <sup>b</sup>						
Input Capacitance	$C_{iss}$	$V_{DS} = 20\text{ V}, V_{GS} = 0\text{ V}, f = 1\text{ MHz}$		2900		pF
Output Capacitance	$C_{oss}$			750		
Reverse Transfer Capacitance	$C_{rss}$			310		
Total Gate Charge	$Q_g$	$V_{DS} = 20\text{ V}, V_{GS} = 10\text{ V}, I_D = 20\text{ A}$		130		nC
Gate-Source Charge	$Q_{gs}$			20		
Gate-Drain Charge	$Q_{gd}$			32		
Gate Resistance	$R_g$	$f = 1\text{ MHz}$		0.85	1.3	$\Omega$
Turn-On Delay Time	$t_{d(on)}$	$V_{DD} = 20\text{ V}, R_L = 1.0\text{ }\Omega$ $I_D \cong 20\text{ A}, V_{GEN} = 10\text{ V}, R_g = 1\text{ }\Omega$		20	30	ns
Rise Time	$t_r$			11	17	
Turn-Off Delay Time	$t_{d(off)}$			77	115	
Fall Time	$t_f$			10	15	
Turn-On Delay Time	$t_{d(on)}$	$V_{DD} = 20\text{ V}, R_L = 1.0\text{ }\Omega$ $I_D \cong 20\text{ A}, V_{GEN} = 4.5\text{ V}, R_g = 1\text{ }\Omega$		102	155	
Rise Time	$t_r$			62	95	
Turn-Off Delay Time	$t_{d(off)}$			180	270	
Fall Time	$t_f$			60	90	
Drain-Source Body Diode Characteristics						
Continuous Source-Drain Diode Current	$I_S$	$T_C = 25\text{ }^{\circ}\text{C}$			110	A
Pulse Diode Forward Current <sup>a</sup>	$I_{SM}$				200	
Body Diode Voltage	$V_{SD}$	$I_S = 20\text{ A}$		0.8	1.2	V
Body Diode Reverse Recovery Time	$t_{rr}$	$I_F = 20\text{ A}, di/dt = 100\text{ A}/\mu\text{s}, T_J = 25\text{ }^{\circ}\text{C}$		50	75	ns
Body Diode Reverse Recovery Charge	$Q_{rr}$			70	105	nC
Reverse Recovery Fall Time	$t_a$			30		ns
Reverse Recovery Rise Time	$t_b$			20		

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.

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**



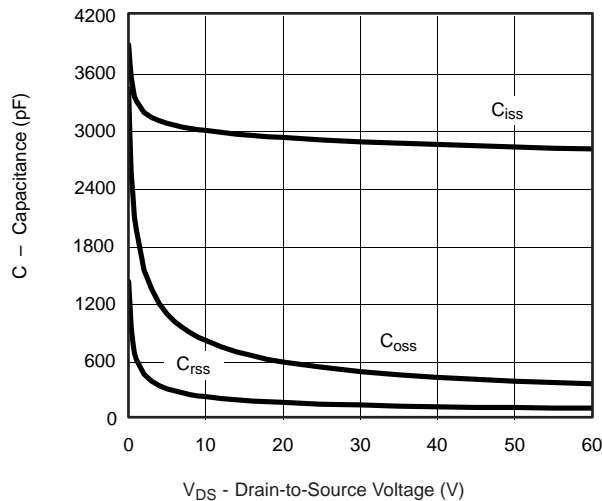
**Transfer Characteristics**



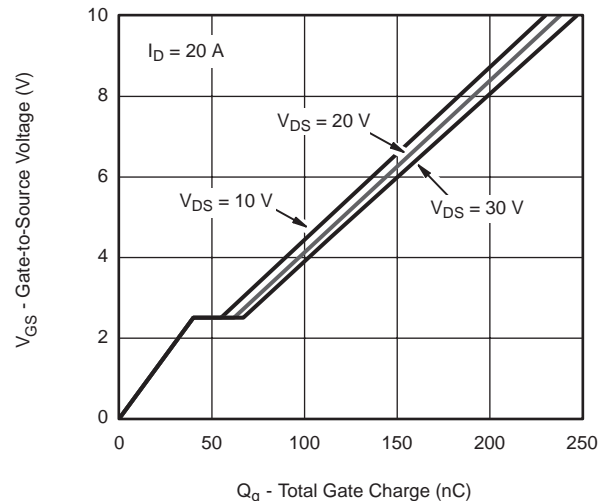
**Transconductance**



**On-Resistance vs. Drain Current**



**Capacitance**



**Gate Charge**

## TYPICAL CHARACTERISTICS 25 °C, unless otherwise noted



On-Resistance vs. Junction Temperature



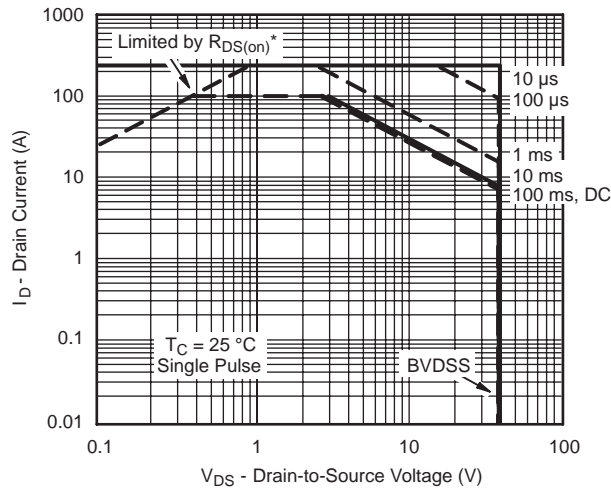
Forward Diode Voltage vs. Temperature



On-Resistance vs. Gate-to-Source Voltage



Threshold Voltage



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

Safe Operating Area, Junction-to-Ambient

## TYPICAL CHARACTERISTICS 25 °C, unless otherwise noted



\* The power dissipation  $P_D$  is based on  $T_{J(max)} = 150\text{ °C}$ , using junction-to-case thermal resistance, and is more useful in settling the upper dissipation limit for cases where additional heatsinking is used. It is used to determine the current rating, when this rating falls below the package limit.



## 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
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: X12-0208-Rev. N, 08-Oct-12  
DWG: 5471

**Notes**

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

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