

# 4NM60A

Preliminary

Power MOSFET

## 4.0A, 600V N-CHANNEL SUPER-JUNCTION MOSFET

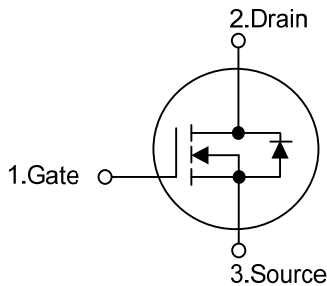
### DESCRIPTION

The **4NM60A** is a Super Junction MOSFET Structure and is designed to have better characteristics, such as fast switching time, low gate charge, low on-state resistance and a high rugged avalanche characteristics. This power MOSFET is usually used at DC-DC, AC-DC converters for power applications.

### FEATURES

- \*  $R_{DS(ON)} < 1.4\Omega @ V_{GS} = 10V, I_D = 2.0A$
- \* Fast Switching Capability
- \* Avalanche Energy Specified
- \* Improved dv/dt Capability, High Ruggedness

### SYMBOL

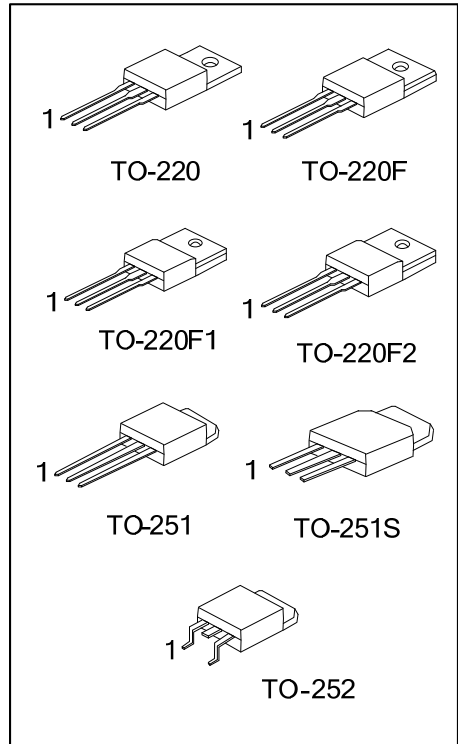


### ORDERING INFORMATION

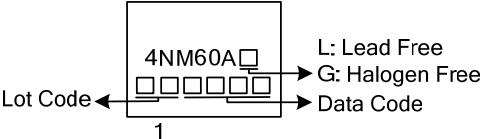
Ordering Number		Package	Pin Assignment			Packing
Lead Free	Halogen Free		1	2	3	
4NM60AL-TA3-T	4NM60AG-TA3-T	TO-220	G	D	S	Tube
4NM60AL-TF3-T	4NM60AG-TF3-T	TO-220F	G	D	S	Tube
4NM60AL-TF1-T	4NM60AG-TF1-T	TO-220F1	G	D	S	Tube
4NM60AL-TF2-T	4NM60AG-TF2-T	TO-220F2	G	D	S	Tube
4NM60AL-TM3-T	4NM60AG-TM3-T	TO-251	G	D	S	Tube
4NM60AL-TMS-T	4NM60AG-TMS-T	TO-251S	G	D	S	Tube
4NM60AL-TN3-R	4NM60AG-TN3-R	TO-252	G	D	S	Tape Reel

Note: Pin Assignment: G: Gate D: Drain S: Source

<p>4NM60AL-TA3-T</p> <p>(1)Packing Type</p> <p>(2)Package Type</p> <p>(3)Green Package</p>	<p>(1) T: Tube, R: Tape Reel</p> <p>(2) TA3: TO-220, TF3: TO-220F, TF1: TO-220F1, TF2: TO-220F2, TM3: TO-251, TMS: TO-251S, TN3: TO-252</p> <p>(3) L: Lead Free, G: Halogen Free and Lead Free</p>
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■ MARKING



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

PARAMETER		SYMBOL	RATINGS	UNIT
Drain-Source Voltage		$V_{DSS}$	600	V
Gate-Source Voltage		$V_{GSS}$	$\pm 30$	V
Drain Current	Continuous	$I_D$	4.0	A
	Pulsed (Note2)	$I_{DM}$	16	A
Avalanche Current (Note 2)		$I_{AR}$	1.3	A
Avalanche Energy	Single Pulsed (Note3)	$E_{AS}$	122	mJ
Peak Diode Recovery dv/dt (Note4)		dv/dt	4.6	V/ns
Power Dissipation	TO-220	$P_D$	106	W
	TO-220F		34	W
	TO-220F1/TO-220F2		36	W
	TO-251/TO-251S		50	W
	TO-252			
Junction Temperature		$T_J$	+150	$^\circ\text{C}$
Storage Temperature		$T_{STG}$	-55 ~ +150	$^\circ\text{C}$

Notes: 1. Absolute maximum ratings are those values beyond which the device could be permanently damaged.

Absolute maximum ratings are stress ratings only and functional device operation is not implied.

2. Repetitive Rating : Pulse width limited by maximum junction temperature.

3.  $L=144\text{mH}$ ,  $I_{AS}=1.3\text{A}$ ,  $V_{DD}=50\text{V}$ ,  $R_G=25\ \Omega$ , Starting  $T_J = 25^\circ\text{C}$

4.  $I_{SD}\leq 4.0\text{A}$ ,  $di/dt\leq 200\text{A}/\mu\text{s}$ ,  $V_{DD}\leq BV_{DSS}$ , Starting  $T_J = 25^\circ\text{C}$

■ THERMAL RESISTANCES CHARACTERISTICS

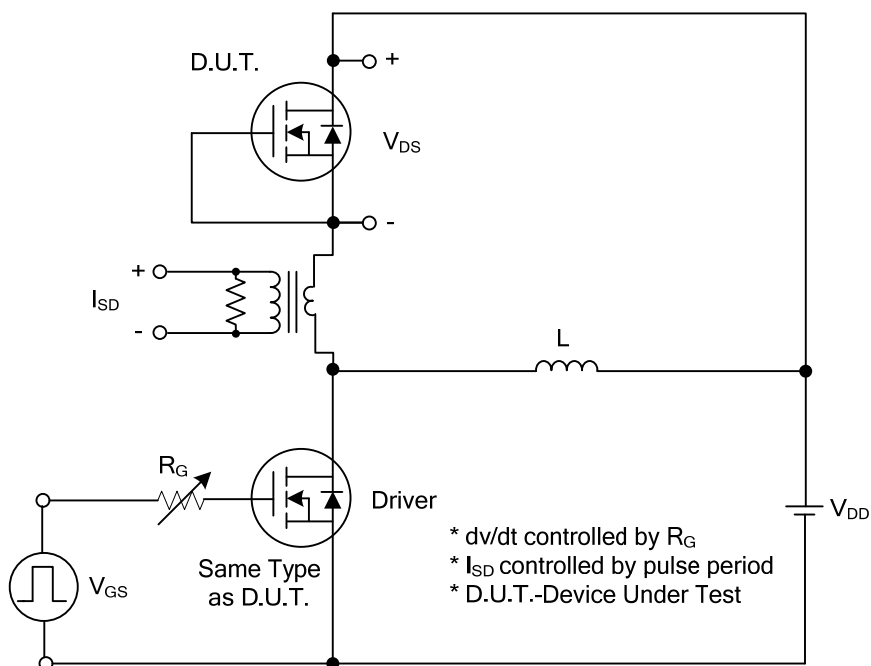
PARAMETER		SYMBOL	RATINGS	UNIT
Junction to Ambient	TO-220/TO-220F TO-220F1/TO-220F2	$\theta_{JA}$	62.5	$^\circ\text{C}/\text{W}$
	TO-251/TO-251S TO-252		110	$^\circ\text{C}/\text{W}$
	TO-220		1.18	$^\circ\text{C}/\text{W}$
Junction to Case	TO-220F/TO-220F1	$\theta_{JC}$	3.67	$^\circ\text{C}/\text{W}$
	TO-220F2		3.47	$^\circ\text{C}/\text{W}$
	TO-251/TO-251S		2.5	$^\circ\text{C}/\text{W}$
	TO-252			

■ ELECTRICAL CHARACTERISTICS ( $T_J = 25^\circ\text{C}$ , unless otherwise specified)

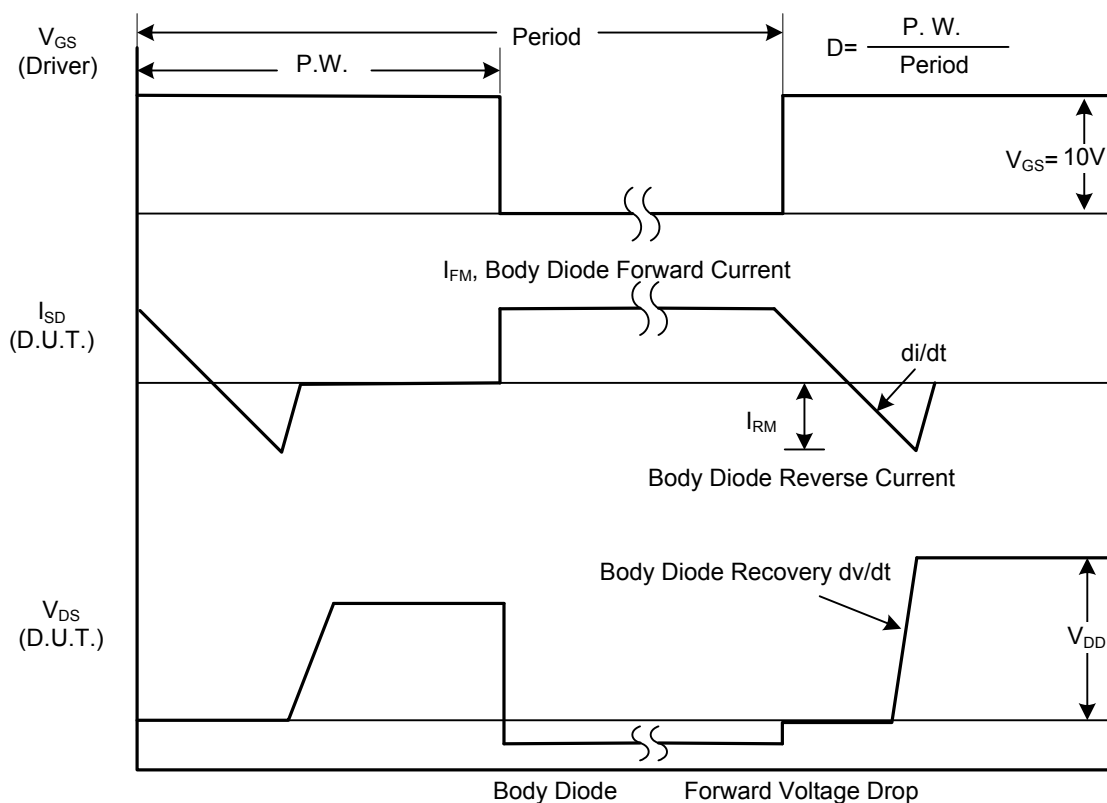
PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
<b>OFF CHARACTERISTICS</b>						
Drain-Source Breakdown Voltage	$BV_{DSS}$	$V_{GS} = 0\text{ V}, I_D = 250\mu\text{A}$	600			V
Drain-Source Leakage Current	$I_{DSS}$	$V_{DS} = 600\text{ V}, V_{GS} = 0\text{ V}$			10	$\mu\text{A}$
Gate-Source Leakage Current	Forward	$I_{GSS}$			100	nA
	Reverse					
		$V_{GS} = -30\text{ V}, V_{DS} = 0\text{ V}$			-100	nA
<b>ON CHARACTERISTICS</b>						
Gate Threshold Voltage	$V_{GS(TH)}$	$V_{DS} = V_{GS}, I_D = 250\mu\text{A}$	2.5		4.5	V
Static Drain-Source On-State Resistance	$R_{DS(ON)}$	$V_{GS} = 10\text{ V}, I_D = 2.0\text{A}$			1.4	$\Omega$
<b>DYNAMIC CHARACTERISTICS</b>						
Input Capacitance	$C_{ISS}$	$V_{GS} = 0\text{V}, V_{DS} = 25\text{V}, f = 1\text{MHz}$		256		pF
Output Capacitance	$C_{OSS}$			165		pF
Reverse Transfer Capacitance	$C_{RSS}$			16		pF
<b>SWITCHING CHARACTERISTICS</b>						
Total Gate Charge (Note 1)	$Q_G$	$V_{DS} = 50\text{V}, V_{GS} = 10\text{V}, I_D = 1.3\text{A}, I_G = 100\mu\text{A}$ (Note 1, 2)		37.5		nC
Gate to Source Charge	$Q_{GS}$			4.0		nC
Gate to Drain Charge	$Q_{GD}$			8.0		nC
Turn-ON Delay Time (Note 1)	$t_{D(ON)}$	$V_{DD} = 30\text{V}, V_{GS} = 10\text{V}, I_D = 0.5\text{A}, R_G = 25\Omega$ (Note 1, 2)		40		ns
Rise Time	$t_R$			50		ns
Turn-OFF Delay Time	$t_{D(OFF)}$			100		ns
Fall-Time	$t_F$			35		ns
<b>SOURCE- DRAIN DIODE RATINGS AND CHARACTERISTICS</b>						
Maximum Body-Diode Continuous Current	$I_S$				4.0	A
Maximum Body-Diode Pulsed Current	$I_{SM}$				16	A
Drain-Source Diode Forward Voltage (Note 1)	$V_{SD}$	$I_S = 4.0\text{A}, V_{GS} = 0\text{V}$			1.4	V
Body Diode Reverse Recovery Time (Note 1)	$t_{rr}$	$I_S = 4.0\text{A}, V_{GS} = 0\text{V}$		240		ns
Body Diode Reverse Recovery Charge	$Q_{rr}$	$di_F/dt = 100\text{A}/\mu\text{s}$		1.9		$\mu\text{C}$

- Notes: 1. Pulse Test: Pulse width  $\leq 300\mu\text{s}$ , Duty cycle  $\leq 2\%$   
 2. Essentially independent of operating temperature

■ TEST CIRCUITS AND WAVEFORMS

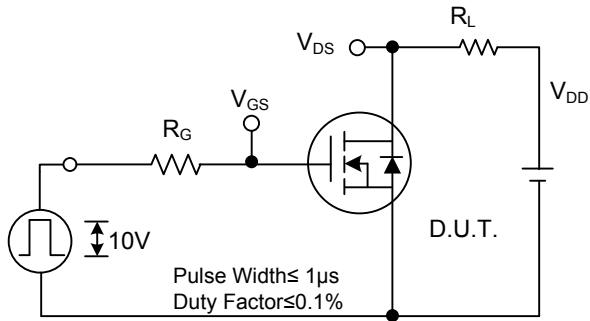


Peak Diode Recovery dv/dt Test Circuit

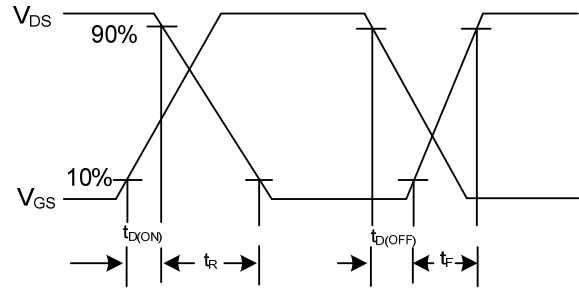


Peak Diode Recovery dv/dt Waveforms

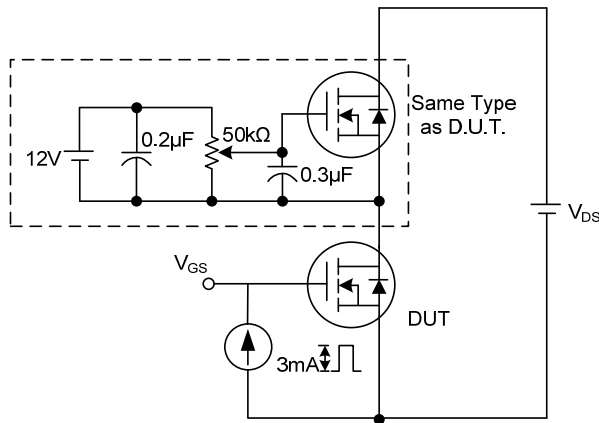
■ TEST CIRCUITS AND WAVEFORMS (Cont.)



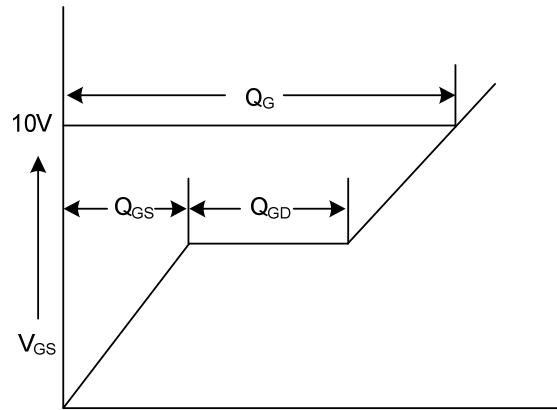
Switching Test Circuit



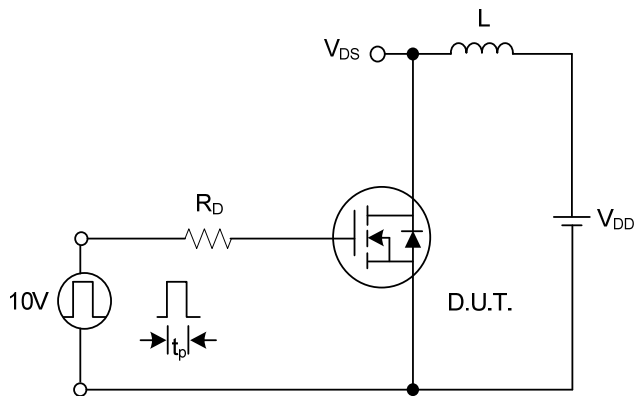
Switching Waveforms



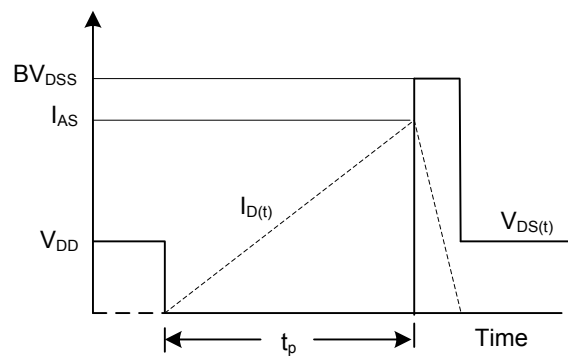
Gate Charge Test Circuit



Gate Charge Waveform



Unclamped Inductive Switching Test Circuit



Unclamped Inductive Switching Waveforms