

# 4 Amps, 600 Volts N-CHANNEL POWER MOSFET

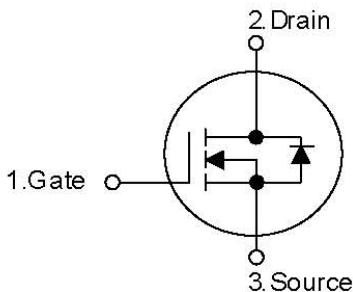
## DESCRIPTION

The Artschip 4N60 is a high voltage MOSFET and is designed to have better characteristics, such as fast switching time, low gate charge, low on-state resistance and have a high rugged avalanche characteristics. This power MOSFET is usually used at high speed switching applications in power supplies, PWM motor controls, high efficient DC to DC converters and bridge circuits.

## FEATURES

- \*  $R_{DS(ON)} = 2.5\Omega @ V_{GS} = 10 V$
- \* Ultra low gate charge ( typical 15 nC )
- \* Low reverse transfer Capacitance (  $C_{RSS} =$  typical 8.0 pF )
- \* Fast switching capability
- \* Avalanche energy Specified
- \* Improved dv/dt capability, high ruggedness

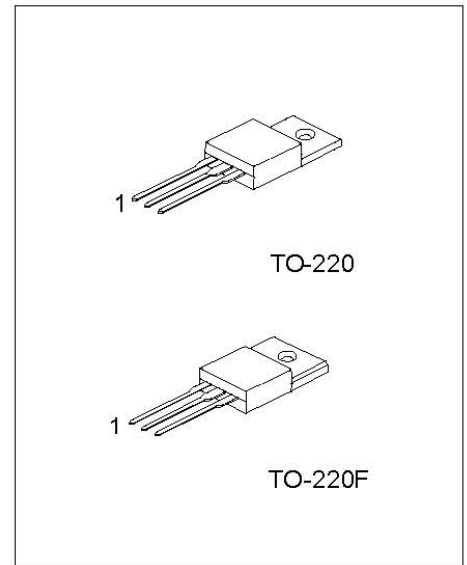
## SYMBOL



## ORDERING INFORMATION

Order Number		Package	Pin Assignment			Packing
Normal	Lead Free Plating		1	2	3	
4N60-TA3-T	4N60L-TA3-T	TO-220	G	D	S	Tube
4N60-TF3-T	4N60L-TF3-T	TO-220F	G	D	S	Tube

<p>4N60L-TA3-T</p>	<p>(1) Packing Type</p> <p>(2) Package Type</p> <p>(3) Lead Plating</p>	<p>(1) T: Tube, R: Tape Reel</p> <p>(2) TA3: TO-220, TF3: TO-220F</p> <p>(3) L: Lead Free Plating Blank Pb/Sn</p>
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\*Pb-free plating product number: 4N60L

**■ 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
Avalanche Current - (Note 1)	$I_{AR}$	4.4	A
Continuous Drain Current	$I_D$	$T_C = 25^\circ\text{C}$	A
		$T_C = 100^\circ\text{C}$	A
Pulsed Drain Current, $T_P$ Limited by $T_{JMAX}$ - (Note 1)	$I_{DM}$	16	A
Avalanche Energy, Single Pulsed (Note 2)	$E_{AS}$	260	mJ
Avalanche Energy, Repetitive, Limited by $T_{JMAX}$	$E_{AR}$	10.6	mJ
Peak Diode Recovery $dv/dt$ (Note 3)	$dv/dt$	4.5	V/ns
Power Dissipation ( $T_C = 25^\circ\text{C}$ )	$P_D$	106	W
Junction Temperature	$T_J$	+150	$^\circ\text{C}$
Storage Temperature	$T_{STG}$	-55 ~ +150	$^\circ\text{C}$

Note 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.

**■ THERMAL DATA**

PARAMETER	SYMBOL	MIN	TYP	MAX	UNIT
Junction-to-Ambient	$\theta_{JA}$			62.5	$^\circ\text{C/W}$
Junction-to-Case	$\theta_{JC}$			3	$^\circ\text{C/W}$
Case-to-Sink	$\theta_{CS}$		0.5		$^\circ\text{C/W}$

**■ ELECTRICAL CHARACTERISTICS** ( $T_C = 25^\circ\text{C}$ , 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	$\mu\text{A}$	
		$V_{DS} = 480\text{ V}, T_C = 125^\circ\text{C}$			100	$\mu\text{A}$	
Gate-Source Leakage Current	Forward	$I_{GSS}$	$V_{GS} = 30\text{ V}, V_{DS} = 0\text{ V}$			100	nA
	Reverse		$V_{GS} = -30\text{ V}, V_{DS} = 0\text{ V}$			-100	nA
Breakdown Voltage Temperature Coefficient	$\Delta BV_{DSS}/\Delta T_J$	$I_D = 250\ \mu\text{A}$ , Referenced to $25^\circ\text{C}$		0.6		$\text{V}/^\circ\text{C}$	
<b>On Characteristics</b>							
Gate Threshold Voltage	$V_{GS(TH)}$	$V_{DS} = V_{GS}, I_D = 250\ \mu\text{A}$	2.0		4.0	V	
Drain-Source On-State Resistance	$R_{DS(ON)}$	$V_{GS} = 10\text{ V}, I_D = 2.2\text{ A}$			2.5	$\Omega$	
Forward Transconductance	$g_{FS}$	$V_{DS} = 50\text{ V}, I_D = 2.2\text{ A}$ (Note 4)		4.0		S	
<b>Dynamic Characteristics</b>							
Input Capacitance	$C_{ISS}$	$V_{DS} = 25\text{ V}, V_{GS} = 0\text{ V}, f = 1\text{ MHz}$		520	670	pF	
Output Capacitance	$C_{OSS}$			70	90	pF	
Reverse Transfer Capacitance	$C_{RSS}$			8	11	pF	
<b>Switching Characteristics</b>							
Turn-On Delay Time	$t_{D(ON)}$	$V_{DD} = 300\text{ V}, I_D = 4.0\text{ A}, R_G = 25\ \Omega$ (Note 4, 5)		13	35	ns	
Turn-On Rise Time	$t_r$			45	100	ns	
Turn-Off Delay Time	$t_{D(OFF)}$			25	60	ns	
Turn-Off Fall Time	$t_f$			35	80	ns	
Total Gate Charge	$Q_G$	$V_{DS} = 480\text{ V}, I_D = 4.0\text{ A}, V_{GS} = 10\text{ V}$ (Note 4, 5)		15	20	nC	
Gate-Source Charge	$Q_{GS}$			3.4		nC	
Gate-Drain Charge	$Q_{DD}$			7.1		nC	

**■ ELECTRICAL CHARACTERISTICS(Cont.)**

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
<b>Source- Drain Diode Ratings and Characteristics</b>						
Drain-Source Diode Forward Voltage	$V_{SD}$	$V_{GS} = 0\text{ V}, I_S = 4.4\text{ A}$			1.4	V
Maximum Continuous Drain-Source Diode Forward Current	$I_S$				4.4	A
Maximum Pulsed Drain-Source Diode Forward Current	$I_{SM}$				17.6	A
Reverse Recovery Time	$t_{RR}$	$V_{GS} = 0\text{ V}, I_S = 4.4\text{ A},$ $di_F/dt = 100\text{ A}/\mu\text{s}$ (Note 4)		250		ns
Reverse Recovery Charge	$Q_{RR}$			1.5		$\mu\text{C}$

- Notes:
1. Repetitive Rating : Pulse width limited by  $T_J$
  2.  $L = 25\text{mH}, I_{AS} = 4.4\text{A}, V_{DD} = 50\text{V}, R_G = 25\ \Omega$ , Starting  $T_J = 25^\circ\text{C}$
  3.  $I_{SD} \leq 4.4\text{A}, di/dt \leq 200\text{A}/\mu\text{s}, V_{DD} \leq BV_{DSS}$ , Starting  $T_J = 25^\circ\text{C}$
  4. Pulse Test: Pulse width  $\leq 300\mu\text{s}$ , Duty cycle  $\leq 2\%$
  5. Essentially independent of operating temperature

■ TEST CIRCUITS AND WAVEFORMS

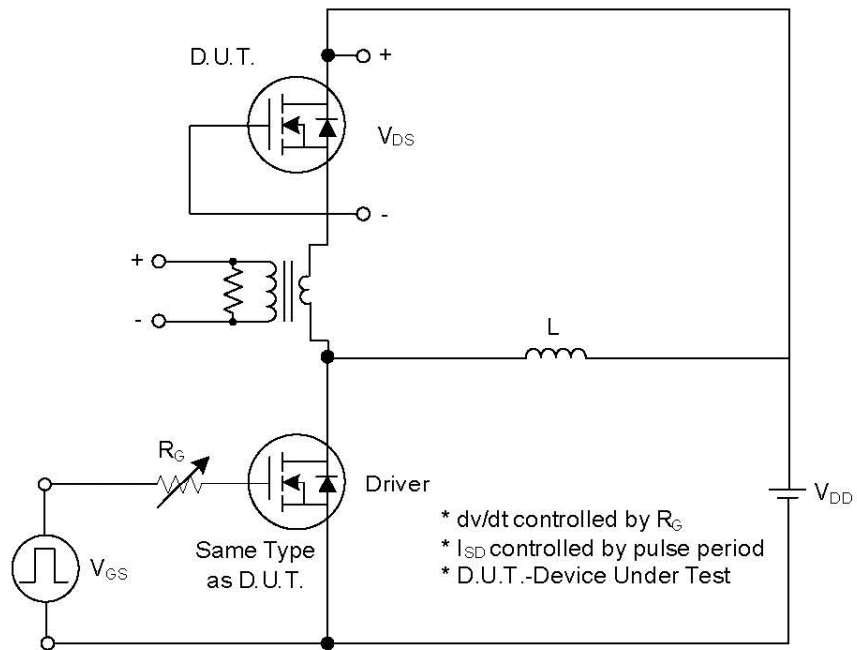


Fig. 1A Peak Diode Recovery  $dv/dt$  Test Circuit

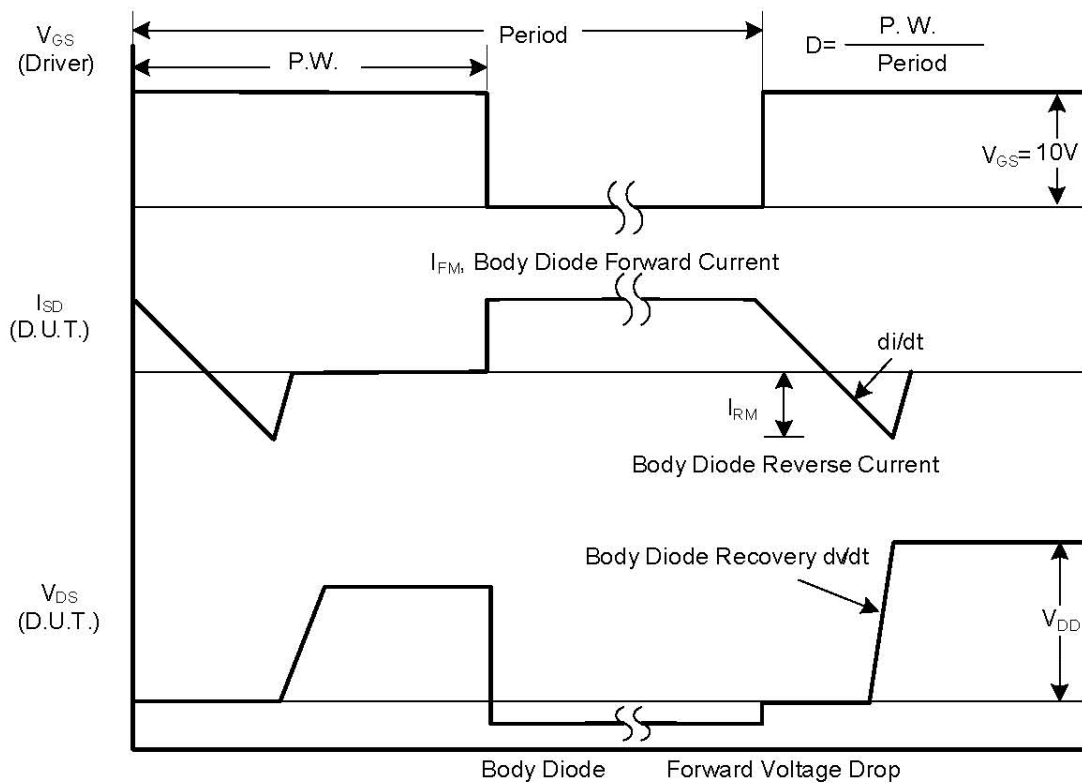


Fig. 1B Peak Diode Recovery  $dv/dt$  Waveforms

■ TEST CIRCUITS AND WAVEFORMS (Cont.)

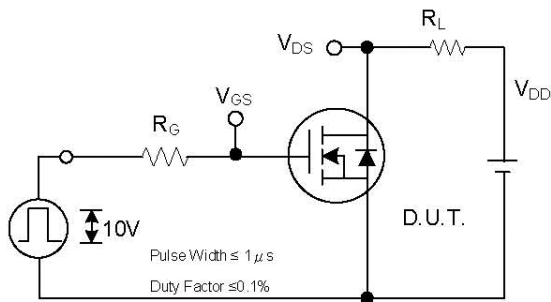


Fig. 2A Switching Test Circuit

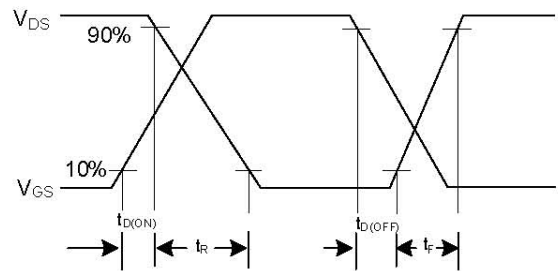


Fig. 2B Switching Waveforms

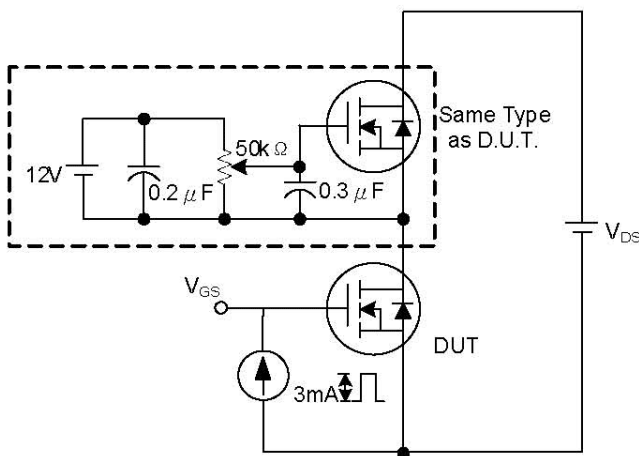


Fig. 3A Gate Charge Test Circuit

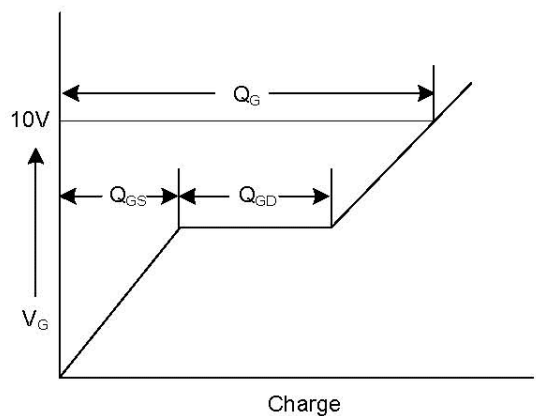


Fig. 3B Gate Charge Waveform

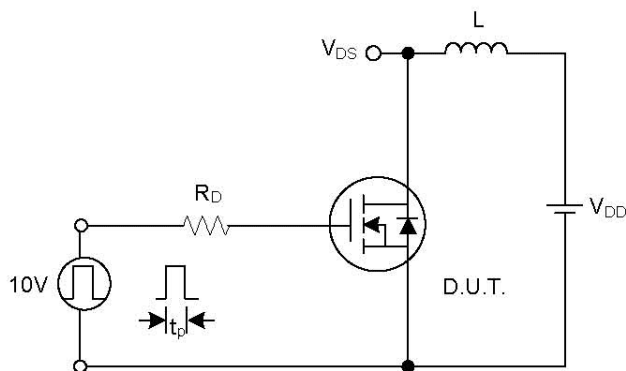


Fig. 4A Unclamped Inductive Switching Test Circuit

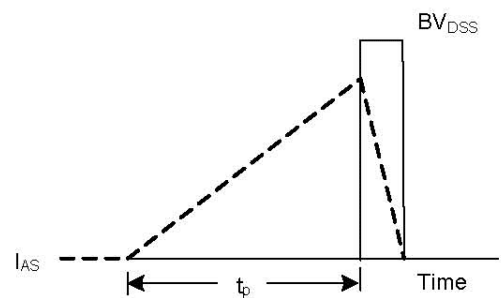
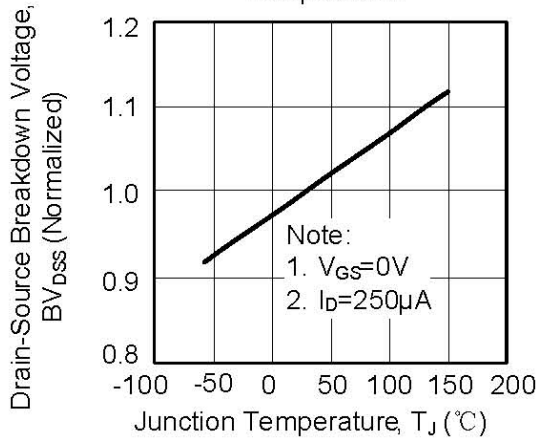


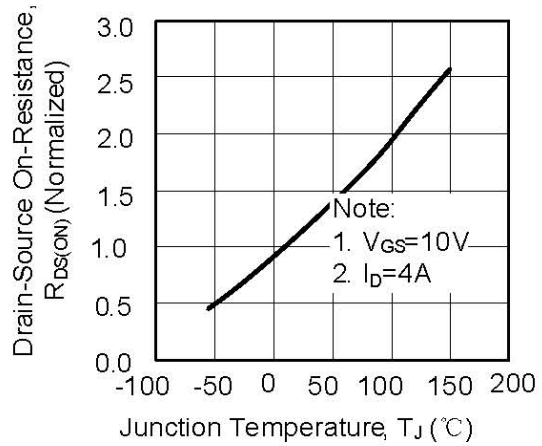
Fig. 4B Unclamped Inductive Switching Waveforms

■ **TYPICAL CHARACTERISTICS**

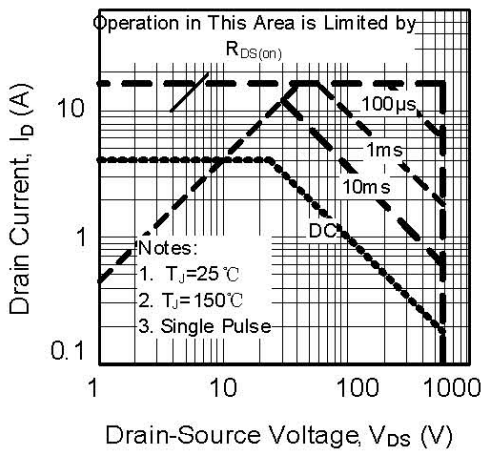
Breakdown Voltage Variation vs Temperature



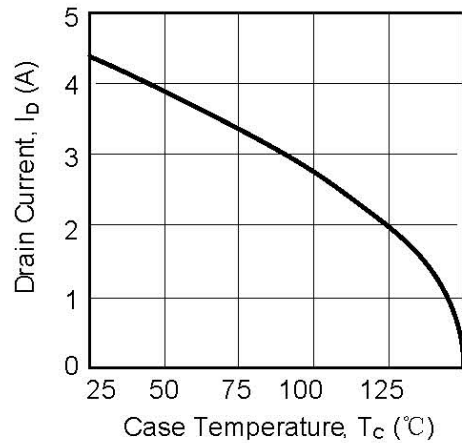
On-Resistance Junction Temperature



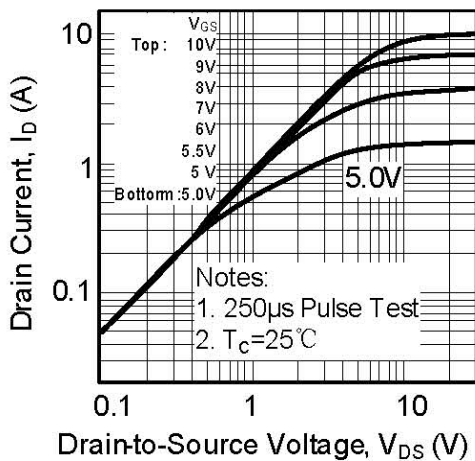
Maximum Safe Operating Area



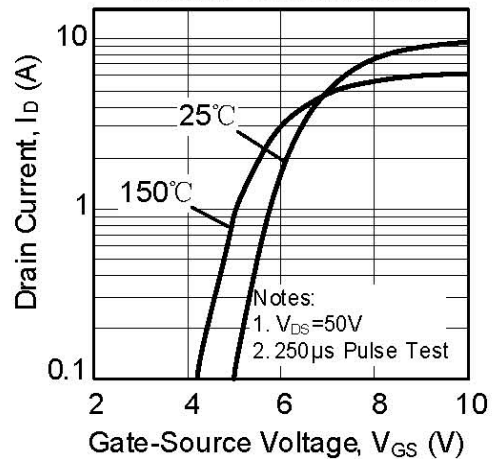
Maximum Drain Current vs Case Temperature



On-State Characteristics



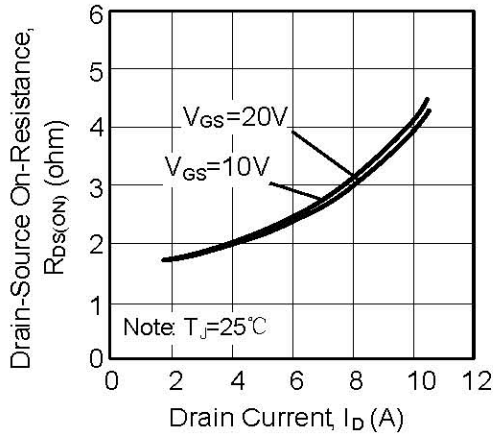
Transfer Characteristics



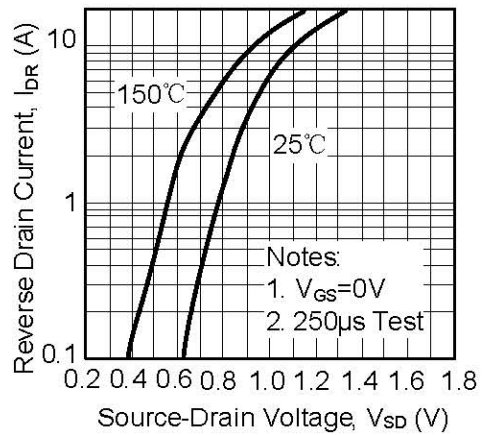


■ TYPICAL CHARACTERISTICS(Cont.)

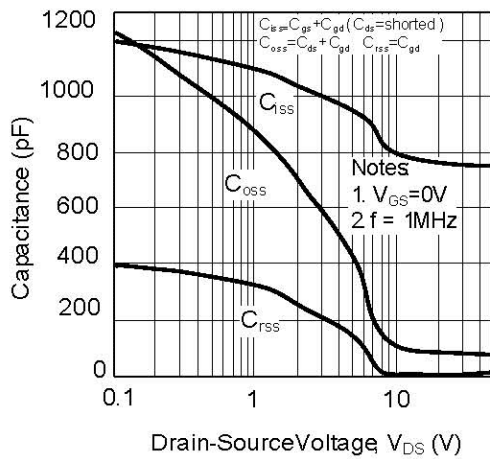
On-Resistance Variation vs Drain Current and Gate Voltage



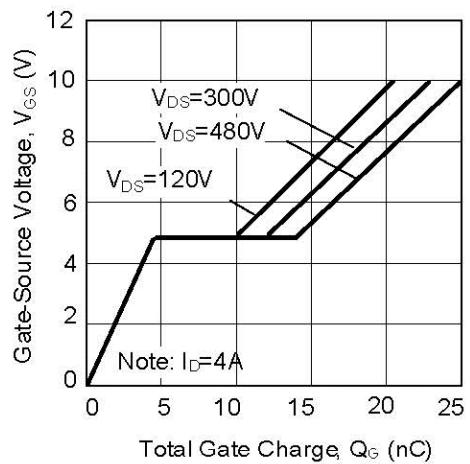
On State Current vs. Allowable Case Temperature



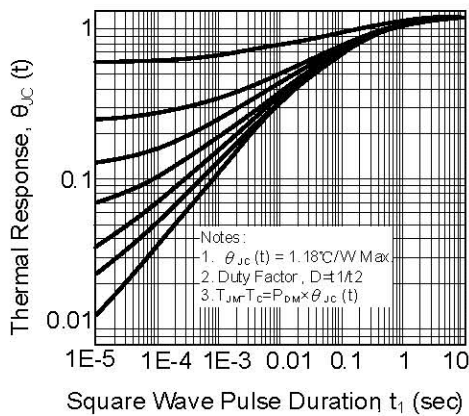
Capacitance Characteristics (Non-Repetitive)



Gate Charge Characteristics



Transient Thermal Response Curve



Power Dissipation

