

## AP01N60P-VB Datasheet

### N-Channel 650 V (D-S)MOSFET

PRODUCT SUMMARY	
V <sub>DS</sub> (V)	650
R <sub>DS(on)</sub> (Ω)	V <sub>GS</sub> = 10 V      4
Q <sub>g</sub> (Max.) (nC)	11
Q <sub>gs</sub> (nC)	2.3
Q <sub>gd</sub> (nC)	5.2
Configuration	Single

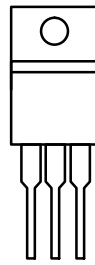
#### FEATURES

- Low Gate Charge Q<sub>g</sub> Results in Simple Drive Requirement
- Improved Gate, Avalanche and Dynamic dV/dt Ruggedness
- Fully Characterized Capacitance and Avalanche Voltage and Current
- Compliant to RoHS directive 2002/95/EC



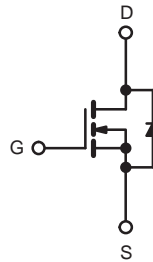
RoHS

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G D S

Top View




N-Channel MOSFET

ABSOLUTE MAXIMUM RATINGS T <sub>C</sub> = 25 °C, unless otherwise noted			
PARAMETER	SYMBOL	LIMIT	UNIT
Drain-Source Voltage	V <sub>DS</sub>	650	V
Gate-Source Voltage	V <sub>GS</sub>	± 30	
Continuous Drain Current <sup>e</sup>	V <sub>GS</sub> at 10 V	T <sub>C</sub> = 25 °C	A
Continuous Drain Current		T <sub>C</sub> = 100 °C	
Pulsed Drain Current <sup>a</sup>	I <sub>DM</sub>	8	
Linear Derating Factor		0.48	W/°C
Single Pulse Avalanche Energy <sup>b</sup>	E <sub>AS</sub>	165	mJ
Repetitive Avalanche Current <sup>a</sup>	I <sub>AR</sub>	2	A
Repetitive Avalanche Energy <sup>a</sup>	E <sub>AR</sub>	6	mJ
Maximum Power Dissipation	P <sub>D</sub>	45	W
Peak Diode Recovery dV/dt <sup>c</sup>	dV/dt	2.8	V/ns
Operating Junction and Storage Temperature Range	T <sub>J</sub> , T <sub>stg</sub>	- 55 to + 150	°C
Soldering Recommendations (Peak Temperature) <sup>d</sup>		300	
Mounting Torque	6-32 or M3 screw		10
			1.1

#### Notes

- Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11).
- Starting T<sub>J</sub> = 25 °C, L = 24 mH, R<sub>G</sub> = 25 Ω, I<sub>AS</sub> = 3.2 A (see fig. 12).
- I<sub>SD</sub> ≤ 3.2 A, dI/dt ≤ 90 A/μs, V<sub>DD</sub> ≤ V<sub>DS</sub>, T<sub>J</sub> ≤ 150 °C.
- 1.6 mm from case.
- Drain current limited by maximum junction temperature.

THERMAL RESISTANCE RATINGS				
PARAMETER	SYMBOL	TYP.	MAX.	UNIT
Maximum Junction-to-Ambient	$R_{thJA}$	-	65	°C/W
Maximum Junction-to-Case (Drain)	$R_{thJC}$	-	2.1	

SPECIFICATIONS $T_J = 25^\circ\text{C}$ , unless otherwise noted							
PARAMETER	SYMBOL	TEST CONDITIONS		MIN.	TYP.	MAX.	UNIT
<b>Static</b>							
Drain-Source Breakdown Voltage	$V_{DS}$	$V_{GS} = 0\text{ V}, I_D = 250\ \mu\text{A}$		650	-	-	V
$V_{DS}$ Temperature Coefficient	$\Delta V_{DS}/T_J$	Reference to $25^\circ\text{C}$ , $I_D = 1\ \text{mA}^d$		-	670	-	mV/°C
Gate-Source Threshold Voltage	$V_{GS(th)}$	$V_{DS} = V_{GS}, I_D = 250\ \mu\text{A}$		2.0	-	4.0	V
Gate-Source Leakage	$I_{GSS}$	$V_{GS} = \pm 30\ \text{V}$		-	-	$\pm 100$	nA
Zero Gate Voltage Drain Current	$I_{DSS}$	$V_{DS} = 650\ \text{V}, V_{GS} = 0\ \text{V}$		-	-	25	$\mu\text{A}$
		$V_{DS} = 520\ \text{V}, V_{GS} = 0\ \text{V}, T_J = 125^\circ\text{C}$		-	-	250	
Drain-Source On-State Resistance	$R_{DS(on)}$	$V_{GS} = 10\ \text{V}$	$I_D = 1\ \text{A}^b$	-	4.0	-	$\Omega$
Forward Transconductance	$g_{fs}$	$V_{DS} = 50\ \text{V}, I_D = 1\ \text{A}$		3.9	-	-	S
<b>Dynamic</b>							
Input Capacitance	$C_{iss}$	$V_{GS} = 0\ \text{V},$ $V_{DS} = 25\ \text{V},$ $f = 1.0\ \text{MHz}$ , see fig. 5		-	417	-	pF
Output Capacitance	$C_{oss}$			-	45	-	
Reverse Transfer Capacitance	$C_{rss}$			-	5	-	
Output Capacitance	$C_{oss}$	$V_{GS} = 0\ \text{V}$	$V_{DS} = 1.0\ \text{V}, f = 1.0\ \text{MHz}$	-	912	-	pF
			$V_{DS} = 520\ \text{V}, f = 1.0\ \text{MHz}$	-	26	-	
Effective Output Capacitance	$C_{oss\ eff.}$	$V_{DS} = 0\ \text{V to } 520\ \text{V}^c$		-	42	-	
Total Gate Charge	$Q_g$	$V_{GS} = 10\ \text{V}$	$I_D = 1.2\ \text{A}, V_{DS} = 400\ \text{V}$ see fig. 6 and 13 <sup>b</sup>	-	-	11	nC
Gate-Source Charge	$Q_{gs}$			-	-	2.3	
Gate-Drain Charge	$Q_{gd}$			-	-	5.2	
Turn-On Delay Time	$t_{d(on)}$	$V_{DD} = 325\ \text{V}, I_D = 1.2\ \text{A}$ $R_G = 9.1\ \Omega, R_D = 62\ \Omega,$ see fig. 10 <sup>b</sup>		-	14	-	ns
Rise Time	$t_r$			-	20	-	
Turn-Off Delay Time	$t_{d(off)}$			-	34	-	
Fall Time	$t_f$			-	18	-	
<b>Drain-Source Body Diode Characteristics</b>							
Continuous Source-Drain Diode Current	$I_S$	MOSFET symbol showing the integral reverse p - n junction diode 	-	-	2	A	
Pulsed Diode Forward Current <sup>a</sup>	$I_{SM}$		-	-	8		
Body Diode Voltage	$V_{SD}$	$T_J = 25^\circ\text{C}, I_S = 3.2\ \text{A}, V_{GS} = 0\ \text{V}^b$		-	-	1.5	V
Body Diode Reverse Recovery Time	$t_{rr}$	$T_J = 25^\circ\text{C}, I_F = 3.2\ \text{A}, di/dt = 100\ \text{A}/\mu\text{s}^b$		-	180	230	ns
Body Diode Reverse Recovery Charge	$Q_{rr}$			-	2.1	3.2	$\mu\text{C}$
Forward Turn-On Time	$t_{on}$	Intrinsic turn-on time is negligible (turn-on is dominated by $L_S$ and $L_D$ )					

**Notes**

- Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11).
- Pulse width  $\leq 300\ \mu\text{s}$ ; duty cycle  $\leq 2\%$ .
- $C_{oss\ eff.}$  is a fixed capacitance that gives the same charging time as  $C_{oss}$  while  $V_{DS}$  is rising from 0 % to 80 %  $V_{DS}$ .
- $t = 60\ \text{s}, f = 60\ \text{Hz}$ .

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



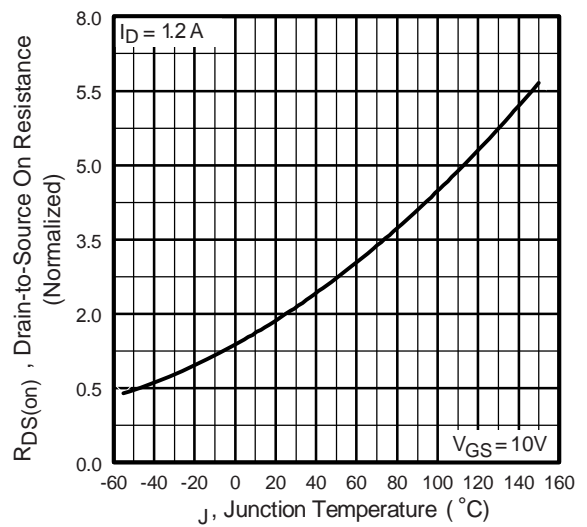
**Fig. 1 - Typical Output Characteristics**



**Fig. 3 - Typical Transfer Characteristics**



**Fig. 2 - Typical Output Characteristics**



**Fig. 4 - Normalized On-Resistance vs. Temperature**

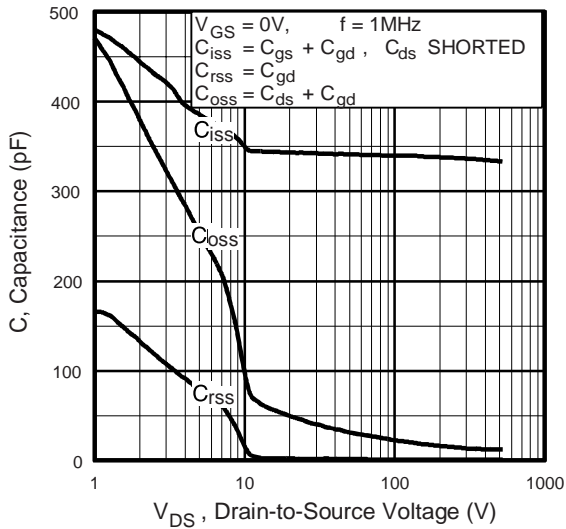


Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage



Fig. 7 - Typical Source-Drain Diode Forward Voltage

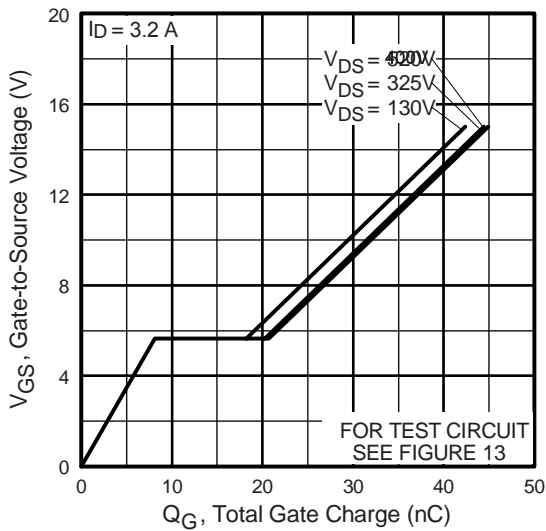


Fig. 6 - Typical Gate Charge vs. Gate-to-Source Voltage

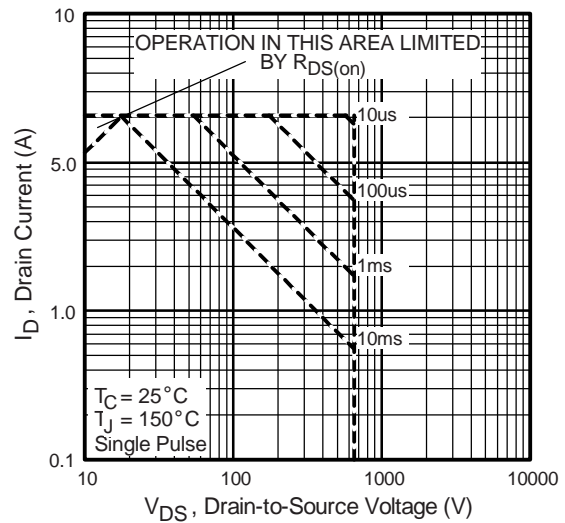


Fig. 8 - Maximum Safe Operating Area



Fig. 9 - Maximum Drain Current vs. Case Temperature



Fig. 10a - Switching Time Test Circuit



Fig. 10b - Switching Time Waveforms

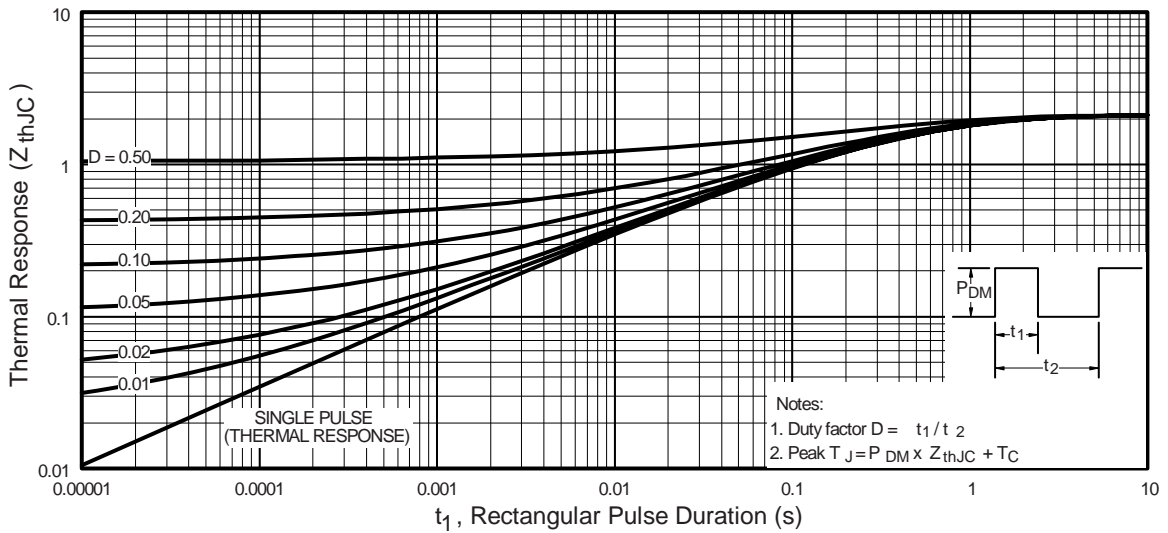


Fig. 11 - Maximum Effective Transient Thermal Impedance, Junction-to-Case



Fig. 12a - Unclamped Inductive Test Circuit



Fig. 12b - Unclamped Inductive Waveforms



Fig. 12c - Maximum Avalanche Energy vs. Drain Current



Fig. 12d - Typical Drain-to Source Voltage vs. Avalanche Current



Fig. 13a - Basic Gate Charge Waveform



Fig. 13b - Gate Charge Test Circuit

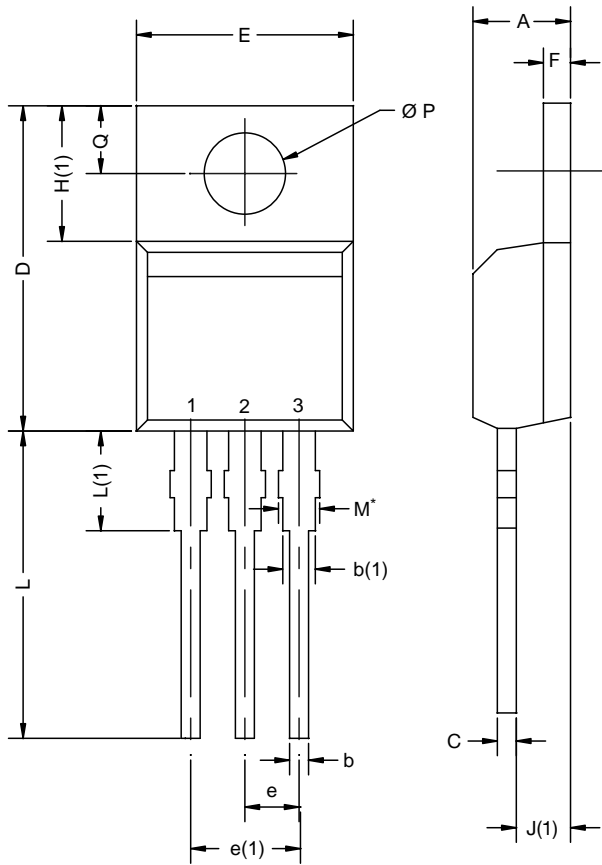
Peak Diode Recovery dV/dt Test Circuit



\*  $V_{GS} = 5\text{ V}$  for logic level devices

Fig. 14 - For N-Channel

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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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