



## N-Channel 60-V (D-S) MOSFET

PRODUCT SUMMARY				
Part Number	$V_{(BR)DSS}$ Min (V)	$r_{DS(on)}$ Max ( $\Omega$ )	$V_{GS(th)}$ (V)	$I_D$ (A)
2N7000	60	5 @ $V_{GS} = 10$ V	0.8 to 3	0.2
2N7002		7.5 @ $V_{GS} = 10$ V	1 to 2.5	0.115
VQ1000J		5.5 @ $V_{GS} = 10$ V	0.8 to 2.5	0.225
VQ1000P		5.5 @ $V_{GS} = 10$ V	0.8 to 2.5	0.225
BS170		5 @ $V_{GS} = 10$ V	0.8 to 3	0.5

### FEATURES

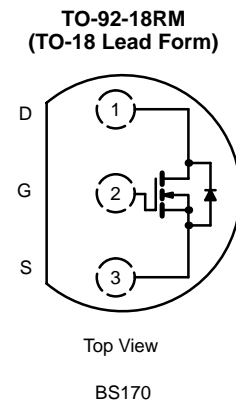
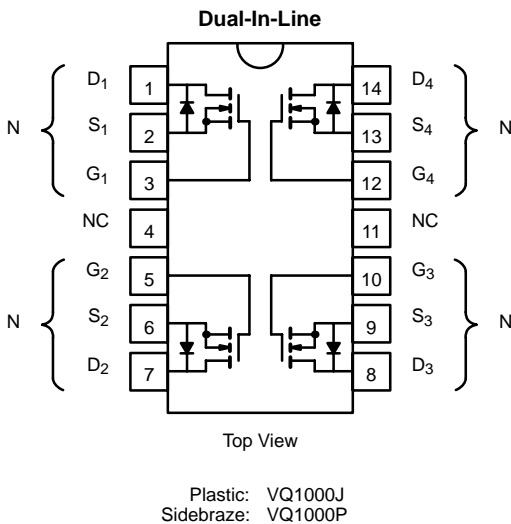
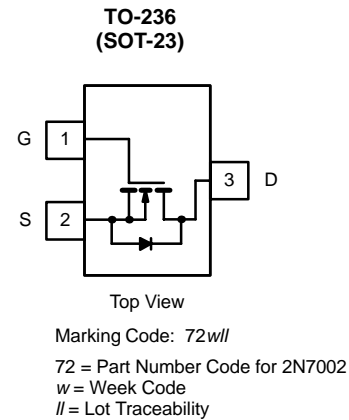
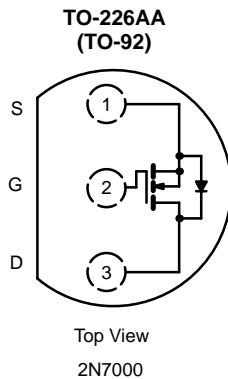
- Low On-Resistance: 2.5  $\Omega$
- Low Threshold: 2.1 V
- Low Input Capacitance: 22 pF
- Fast Switching Speed: 7 ns
- Low Input and Output Leakage

### BENEFITS

- Low Offset Voltage
- Low-Voltage Operation
- Easily Driven Without Buffer
- High-Speed Circuits
- Low Error Voltage

### APPLICATIONS

- Direct Logic-Level Interface: TTL/CMOS
- Drivers: Relays, Solenoids, Lamps, Hammers, Displays, Memories, Transistors, etc.
- Battery Operated Systems
- Solid-State Relays





ABSOLUTE MAXIMUM RATINGS (T <sub>A</sub> = 25 °C UNLESS OTHERWISE NOTED)									
Parameter	Symbol	2N7000	2N7002	Single		Total Quad	BS170	Unit	
				VQ1000J	VQ1000P	VQ1000J/P			
Drain-Source Voltage	V <sub>DS</sub>	60	60	60	60		60	V	
Gate-Source Voltage—Non-Repetitive	V <sub>GSM</sub>	±40	±40	±30			±25		
Gate-Source Voltage—Continuous	V <sub>GS</sub>	±20	±20	±20	±20		±20		
Continuous Drain Current (T <sub>J</sub> = 150 °C)	T <sub>A</sub> = 25 °C	I <sub>D</sub>	0.2	0.115	0.225	0.225		0.5	A
	T <sub>A</sub> = 100 °C		0.13	0.073	0.14	0.14		0.175	
Pulsed Drain Current <sup>a</sup>	I <sub>DM</sub>	0.5	0.8	1	1				
Power Dissipation	T <sub>A</sub> = 25 °C	P <sub>D</sub>	0.4	0.2	1.3	1.3	2	0.83	W
	T <sub>A</sub> = 100 °C		0.16	0.08	0.52	0.52	0.8		
Thermal Resistance, Junction-to-Ambient	R <sub>thJA</sub>	312.5	625	96	96	62.5	156	°C/W	
Operating Junction and Storage Temperature Range	T <sub>J</sub> , T <sub>stg</sub>	-55 to 150							°C

Notes

- a. Pulse width limited by maximum junction temperature.
- b. t<sub>p</sub> ≤ 50 μs.

SPECIFICATIONS—2N7000 AND 2N7002 (T <sub>A</sub> = 25 °C UNLESS OTHERWISE NOTED)								
Parameter	Symbol	Test Conditions	Typ <sup>a</sup>	Limits				Unit
				2N7000		2N7002		
				Min	Max	Min	Max	
<b>Static</b>								
Drain-Source Breakdown Voltage	V <sub>(BR)DSS</sub>	V <sub>GS</sub> = 0 V, I <sub>D</sub> = 10 μA	70	60		60		V
Gate-Threshold Voltage	V <sub>GS(th)</sub>	V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 1 mA	2.1	0.8	3			
		V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 0.25 mA	2.0			1	2.5	
Gate-Body Leakage	I <sub>GSS</sub>	V <sub>DS</sub> = 0 V, V <sub>GS</sub> = ±15 V			±10			nA
		V <sub>DS</sub> = 0 V, V <sub>GS</sub> = ±20 V					±100	
Zero Gate Voltage Drain Current	I <sub>DSS</sub>	V <sub>DS</sub> = 48 V, V <sub>GS</sub> = 0 V			1			μA
		T <sub>C</sub> = 125 °C			1000			
		V <sub>DS</sub> = 60 V, V <sub>GS</sub> = 0 V					1	
On-State Drain Current <sup>b</sup>	I <sub>D(on)</sub>	V <sub>DS</sub> = 10 V, V <sub>GS</sub> = 4.5 V	0.35	0.075				A
		V <sub>DS</sub> = 7.5 V, V <sub>GS</sub> = 10 V	1			0.5		
		V <sub>GS</sub> = 4.5 V, I <sub>D</sub> = 0.075 A	4.5		5.3			
Drain-Source On-Resistance <sup>b</sup>	r <sub>DS(on)</sub>	V <sub>GS</sub> = 5 V, I <sub>D</sub> = 0.05 A	3.2				7.5	Ω
		T <sub>C</sub> = 125 °C	5.8				13.5	
		V <sub>GS</sub> = 10 V, I <sub>D</sub> = 0.5 A	2.4		5		7.5	
		T <sub>J</sub> = 125 °C	4.4		9		13.5	
Forward Transconductance <sup>b</sup>	g <sub>fs</sub>	V <sub>DS</sub> = 10 V, I <sub>D</sub> = 0.2 A		100		80		mS
Common Source Output Conductance <sup>b</sup>	g <sub>os</sub>	V <sub>DS</sub> = 5 V, I <sub>D</sub> = 0.05 A	0.5					
<b>Dynamic</b>								
Input Capacitance	C <sub>iss</sub>	V <sub>DS</sub> = 25 V, V <sub>GS</sub> = 0 V f = 1 MHz	22		60		50	pF
Output Capacitance	C <sub>oss</sub>		11		25		25	
Reverse Transfer Capacitance	C <sub>rss</sub>		2		5		5	

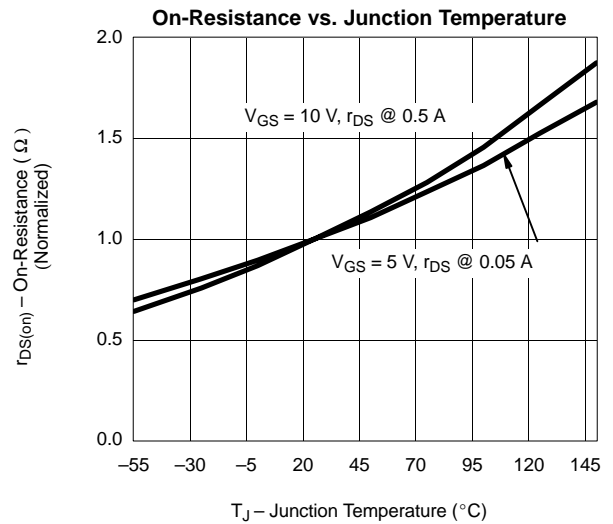
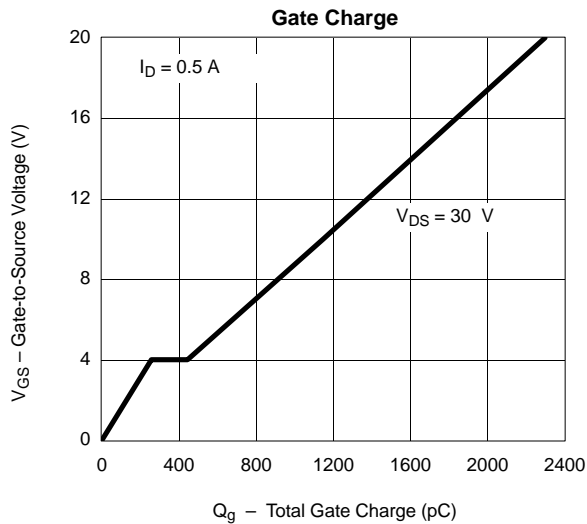
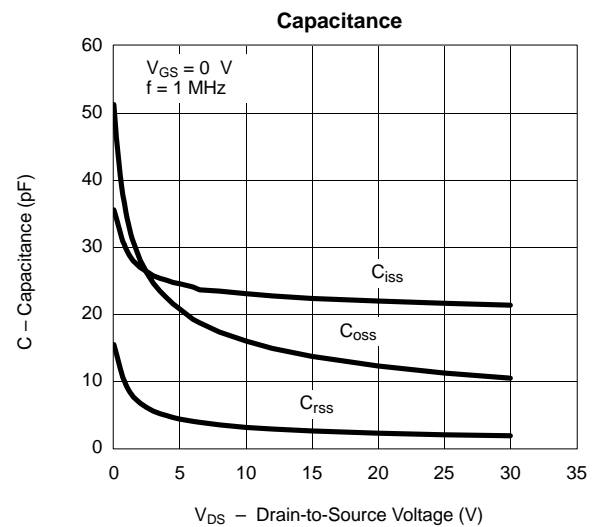
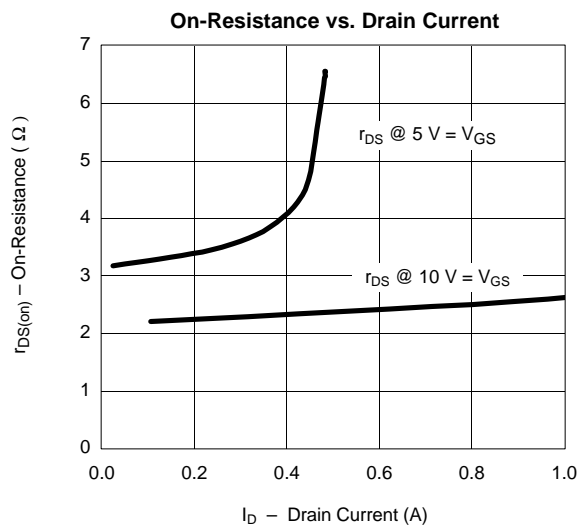
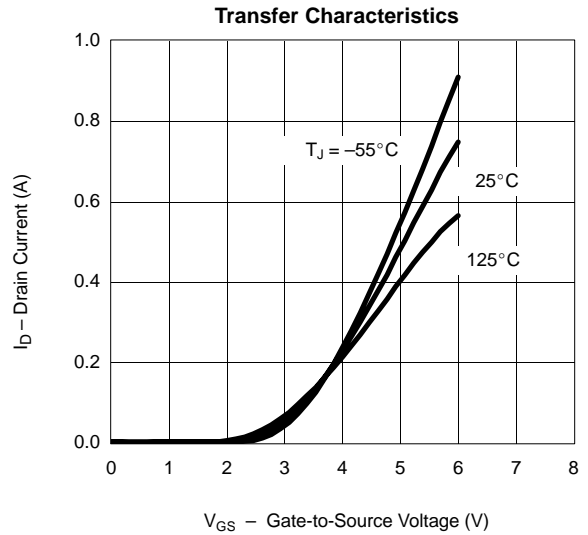
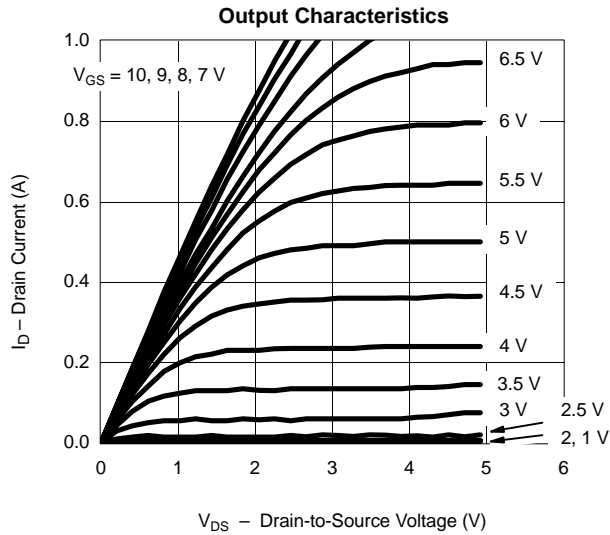


SPECIFICATIONS—2N7000 AND 2N7002 (T <sub>A</sub> = 25 °C UNLESS OTHERWISE NOTED)								
Parameter	Symbol	Test Conditions	Typ <sup>a</sup>	Limits				Unit
				2N7000		2N7002		
				Min	Max	Min	Max	
<b>Switching<sup>d</sup></b>								
Turn-On Time	t <sub>ON</sub>	V <sub>DD</sub> = 15 V, R <sub>L</sub> = 25 Ω I <sub>D</sub> ≅ 0.5 A, V <sub>GEN</sub> = 10 V, R <sub>G</sub> = 25 Ω	7		10			ns
Turn-Off Time	t <sub>OFF</sub>		7		10			
Turn-On Time	t <sub>ON</sub>	V <sub>DD</sub> = 30 V, R <sub>L</sub> = 150 Ω I <sub>D</sub> ≅ 0.2 A, V <sub>GEN</sub> = 10 V, R <sub>G</sub> = 25 Ω	7				20	
Turn-Off Time	t <sub>OFF</sub>		11				20	

SPECIFICATIONS—VQ1000J/P AND BS170 (T <sub>A</sub> = 25 °C UNLESS OTHERWISE NOTED)								
Parameter	Symbol	Test Conditions	Typ <sup>a</sup>	Limits				Unit
				VQ1000J/P		BS170		
				Min	Max	Min	Max	
<b>Static</b>								
Drain-Source Breakdown Voltage	V <sub>(BR)DSS</sub>	V <sub>GS</sub> = 0 V, I <sub>D</sub> = 100 μA	70	60		60		V
Gate-Threshold Voltage	V <sub>GS(th)</sub>	V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 1 mA	2.1	0.8	2.5	0.8	3	
Gate-Body Leakage	I <sub>GSS</sub>	V <sub>DS</sub> = 0 V, V <sub>GS</sub> = ±10 V			±100			nA
		T <sub>J</sub> = 125 °C			±500			
Zero Gate Voltage Drain Current	I <sub>DSS</sub>	V <sub>DS</sub> = 0 V, V <sub>GS</sub> = ±15 V					±10	μA
		V <sub>DS</sub> = 25 V, V <sub>GS</sub> = 0 V					0.5	
		V <sub>DS</sub> = 48 V, V <sub>GS</sub> = 0 V, T <sub>J</sub> = 125 °C			500			
On-State Drain Current <sup>b</sup>	I <sub>D(on)</sub>	V <sub>DS</sub> = 10 V, V <sub>GS</sub> = 10 V	1	0.5				A
		V <sub>GS</sub> = 5 V, I <sub>D</sub> = 0.2 A	4		7.5			Ω
Drain-Source On-Resistance <sup>b</sup>	r <sub>DS(on)</sub>	V <sub>GS</sub> = 10 V, I <sub>D</sub> = 0.2 A	2.3				5	
		V <sub>GS</sub> = 10 V, I <sub>D</sub> = 0.3 A	2.3		5.5			
		T <sub>J</sub> = 125 °C	4.2		7.6			
		V <sub>DS</sub> = 10 V, I <sub>D</sub> = 0.2 A				100		mS
V <sub>DS</sub> = 10 V, I <sub>D</sub> = 0.5 A		100						
Common Source Output Conductance <sup>b</sup>	g <sub>os</sub>	V <sub>DS</sub> = 5 V, I <sub>D</sub> = 0.05 A	0.5					
<b>Dynamic</b>								
Input Capacitance	C <sub>iss</sub>	V <sub>DS</sub> = 25 V, V <sub>GS</sub> = 0 V f = 1 MHz	22		60		60	pF
Output Capacitance	C <sub>oss</sub>		11		25			
Reverse Transfer Capacitance	C <sub>rss</sub>		2		5			
<b>Switching<sup>d</sup></b>								
Turn-On Time	t <sub>ON</sub>	V <sub>DD</sub> = 15 V, R <sub>L</sub> = 23 Ω I <sub>D</sub> ≅ 0.6 A, V <sub>GEN</sub> = 10 V, R <sub>G</sub> = 25 Ω	7		10			ns
Turn-Off Time	t <sub>OFF</sub>		7		10			
Turn-On Time	t <sub>ON</sub>	V <sub>DD</sub> = 25 V, R <sub>L</sub> = 125 Ω I <sub>D</sub> ≅ 0.2 A, V <sub>GEN</sub> = 10 V, R <sub>G</sub> = 25 Ω	7				10	
Turn-Off Time	t <sub>OFF</sub>		7				10	

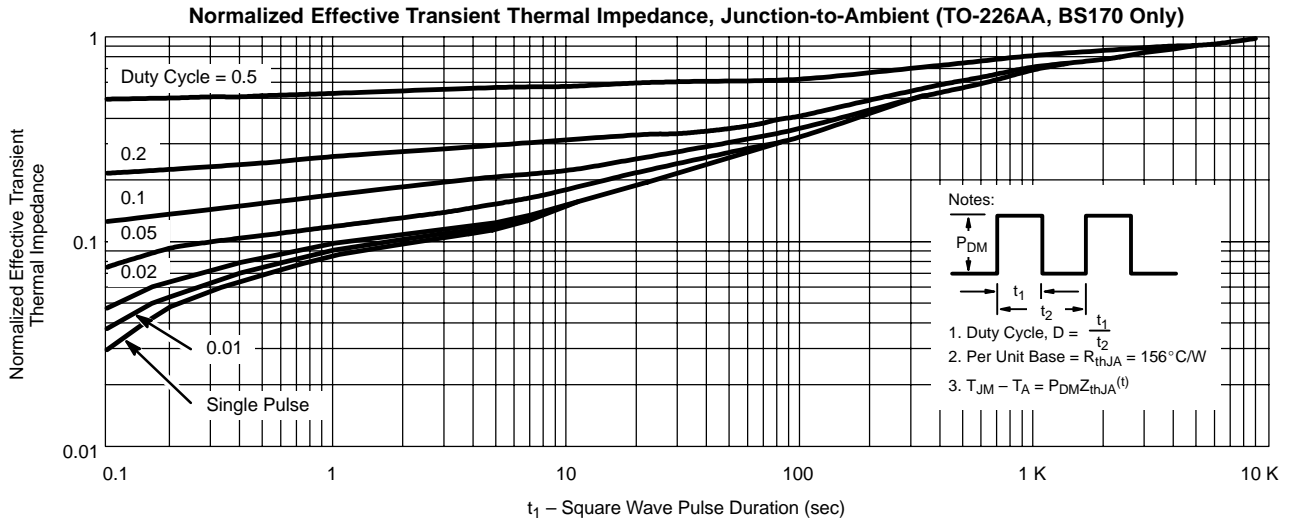
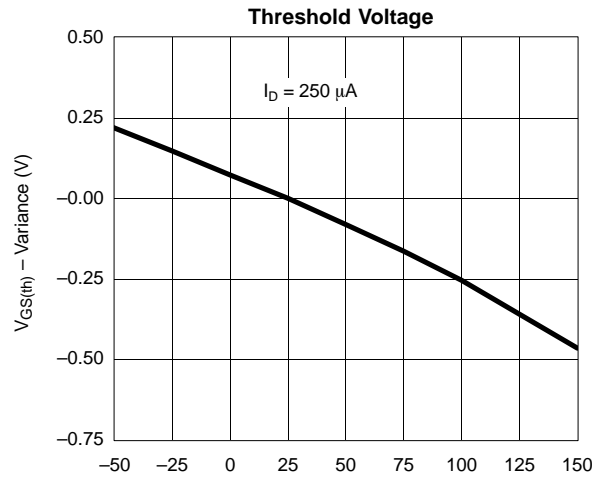
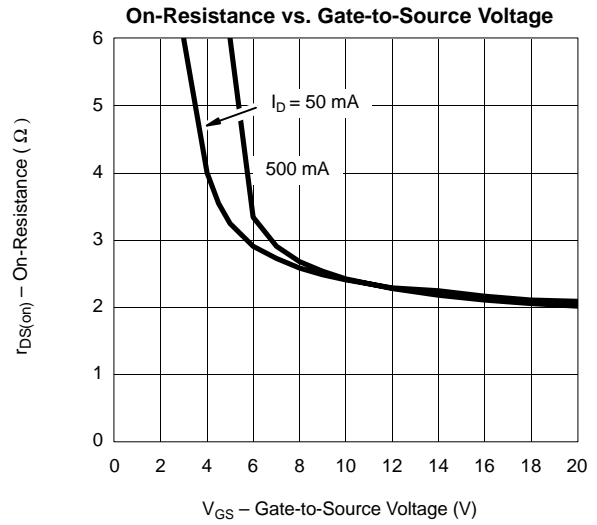
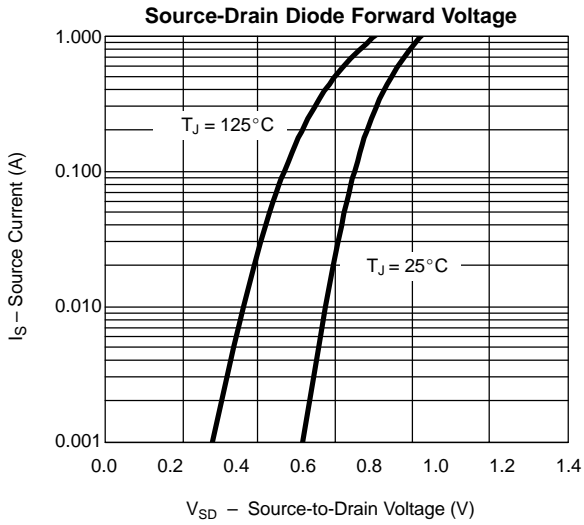
Notes  
a. For DESIGN AID ONLY, not subject to production testing.  
b. Pulse test: PW ≤ 80 μs duty cycle ≤ 1%.  
c. This parameter not registered with JEDEC.  
d. Switching time is essentially independent of operating temperature.

**TYPICAL CHARACTERISTICS ( $T_A = 25^\circ\text{C}$  UNLESS OTHERWISE NOTED)**





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