

**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**

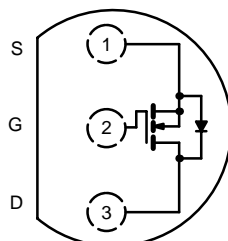
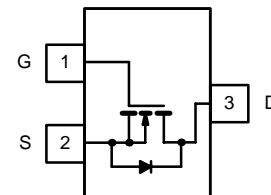
- Low On-Resistance: 2.5  $\Omega$
- Low Threshold: 2.1 V
- Low Input Capacitance: 22 pF
- Fast Switching Speed: 7 ns
- Low Input and Output Leakage

**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

**TO-226AA  
(TO-92)**Top View  
2N7000**TO-236  
(SOT-23)**

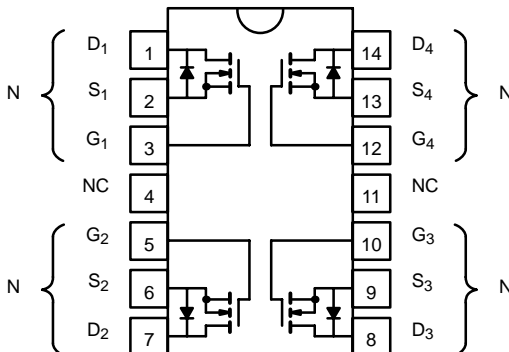
Top View

Marking Code: 72w//

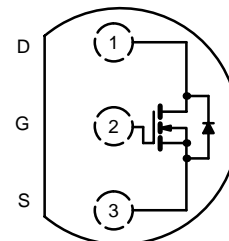
72 = Part Number Code for 2N7002

w = Week Code

// = Lot Traceability

**Dual-In-Line**

Top View

Plastic: VQ1000J  
Sidebrazed: VQ1000P**TO-92-18RM  
(TO-18 Lead Form)**

Top View

BS170

ABSOLUTE MAXIMUM RATINGS ( $T_A = 25^\circ\text{C}$ UNLESS OTHERWISE NOTED)								
Parameter	Symbol	2N7000	2N7002	Single		Total Quad	BS170	Unit
				VQ1000J	VQ1000P	VQ1000J/P		
Drain-Source Voltage	$V_{DS}$	60	60	60	60		60	V
Gate-Source Voltage—Non-Repetitive	$V_{GSM}$	$\pm 40$	$\pm 40$	$\pm 30$			$\pm 25$	
Gate-Source Voltage—Continuous	$V_{GS}$	$\pm 20$	$\pm 20$	$\pm 20$	$\pm 20$		$\pm 20$	
Continuous Drain Current ( $T_J = 150^\circ\text{C}$ )	$T_A = 25^\circ\text{C}$	$I_D$	0.2	0.115	0.225	0.225	0.5	A
	$T_A = 100^\circ\text{C}$		0.13	0.073	0.14	0.14	0.175	
Pulsed Drain Current <sup>a</sup>	$I_{DM}$	0.5	0.8	1	1			
Power Dissipation	$T_A = 25^\circ\text{C}$	$P_D$	0.4	0.2	1.3	1.3	2	W
	$T_A = 100^\circ\text{C}$		0.16	0.08	0.52	0.52	0.8	
Thermal Resistance, Junction-to-Ambient	$R_{thJA}$	312.5	625	96	96	62.5	156	$^\circ\text{C/W}$
Operating Junction and Storage Temperature Range	$T_J, T_{stg}$	-55 to 150						$^\circ\text{C}$

Notes

a. Pulse width limited by maximum junction temperature.

b.  $t_p \leq 50 \mu\text{s}$ .SPECIFICATIONS—2N7000 AND 2N7002 ( $T_A = 25^\circ\text{C}$  UNLESS OTHERWISE NOTED)

Parameter	Symbol	Test Conditions	Typ <sup>a</sup>	Limits				Unit
				2N7000		2N7002		
				Min	Max	Min	Max	
Static								
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	
		T <sub>C</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> = 4.5 V	0.35	0.075				A
		V <sub>DS</sub> = 7.5 V, V <sub>GS</sub> = 10 V	1			0.5		
Drain-Source On-Resistance <sup>b</sup>	r <sub>DS(on)</sub>	V <sub>GS</sub> = 4.5 V, I <sub>D</sub> = 0.075 A	4.5		5.3			Ω
		V <sub>GS</sub> = 5 V, I <sub>D</sub> = 0.05 A	3.2				7.5	
		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					
Dynamic								
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 ( $T_A = 25^\circ\text{C}$  UNLESS OTHERWISE NOTED)**

Parameter	Symbol	Test Conditions	Typ <sup>a</sup>	Limits				Unit
				2N7000		2N7002		
				Min	Max	Min	Max	
Switching <sup>d</sup>								
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	

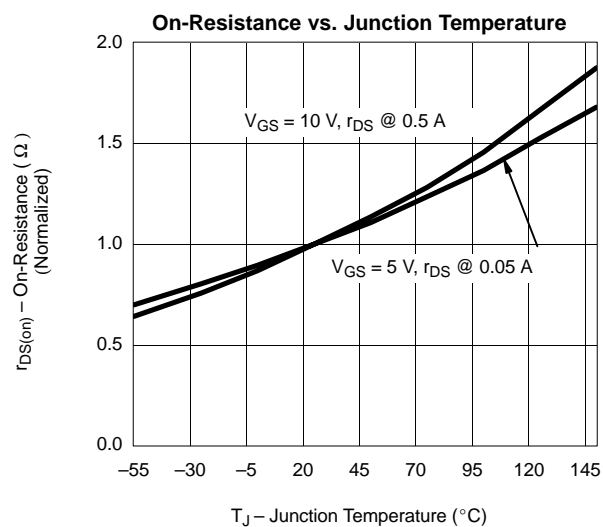
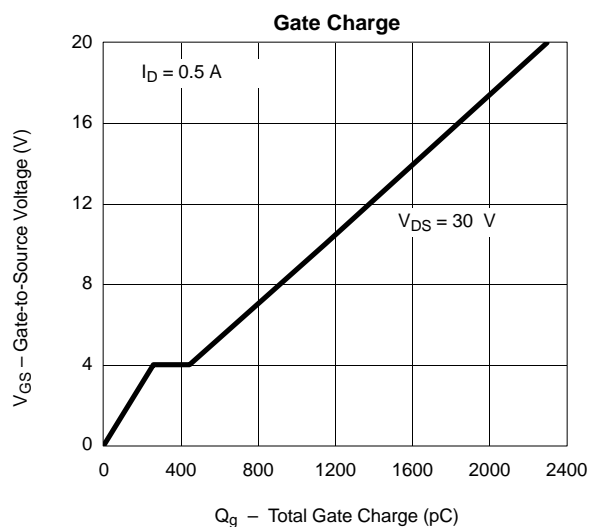
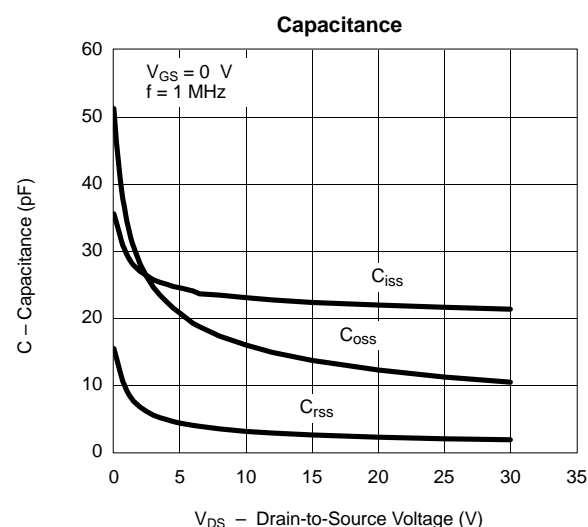
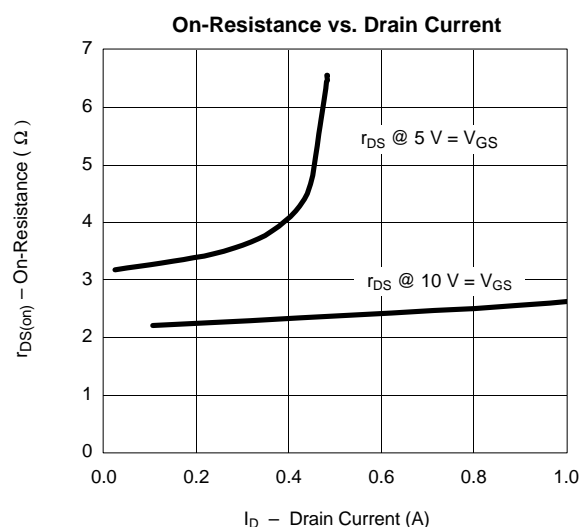
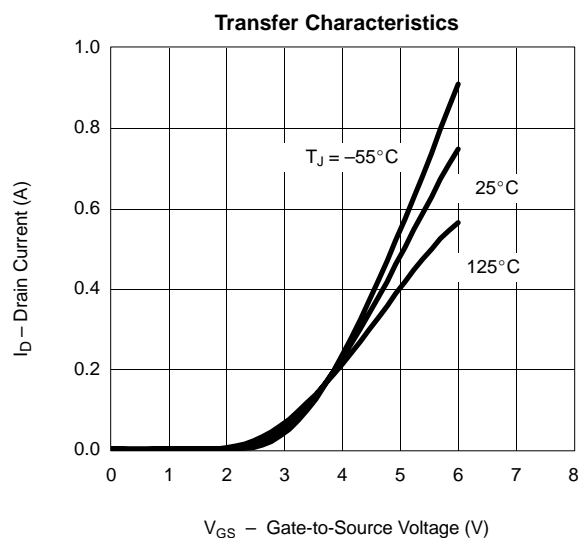
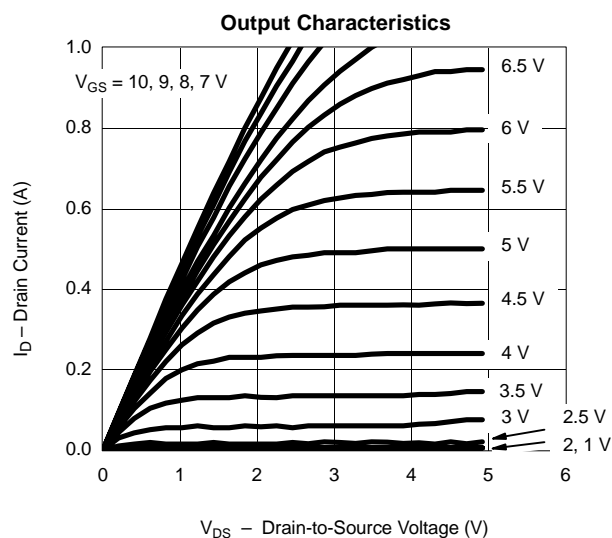
**SPECIFICATIONS—VQ1000J/P AND BS170 ( $T_A = 25^\circ\text{C}$  UNLESS OTHERWISE NOTED)**

Parameter	Symbol	Test Conditions	Typ <sup>a</sup>	Limits				Unit
				VQ1000J/P		BS170		
				Min	Max	Min	Max	
Static								
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			
		V <sub>DS</sub> = 60 V, V <sub>GS</sub> = 0 V			10			
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
Drain-Source On-Resistance <sup>b</sup>	r <sub>DS(on)</sub>	V <sub>GS</sub> = 5 V, I <sub>D</sub> = 0.2 A	4		7.5			Ω
		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			
Forward Transconductance <sup>b</sup>	g <sub>fs</sub>	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					
Dynamic								
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			
Switching <sup>d</sup>								
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**

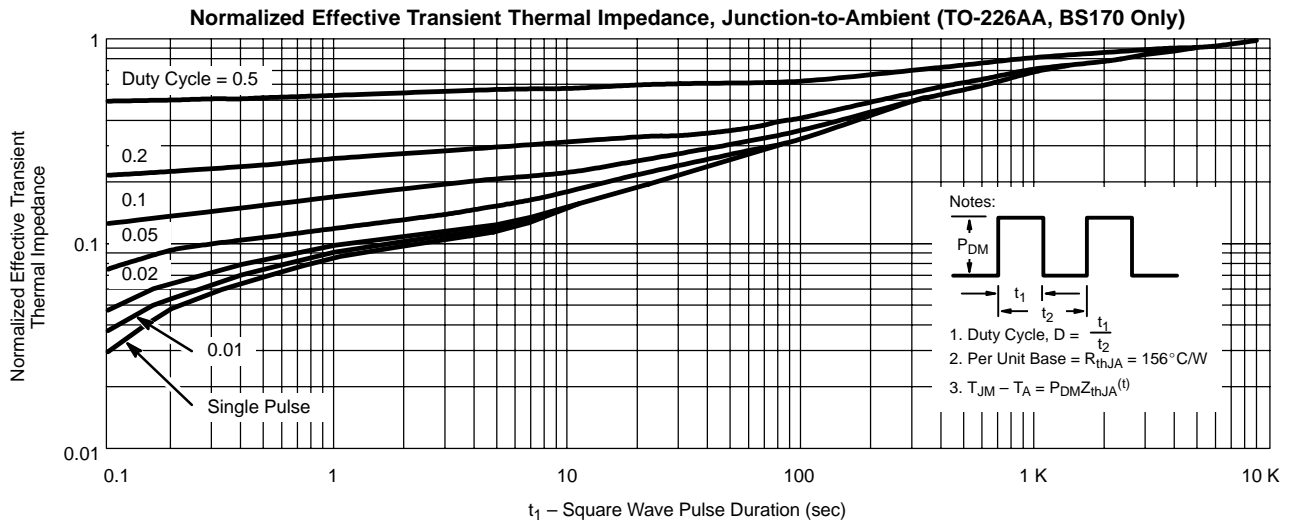
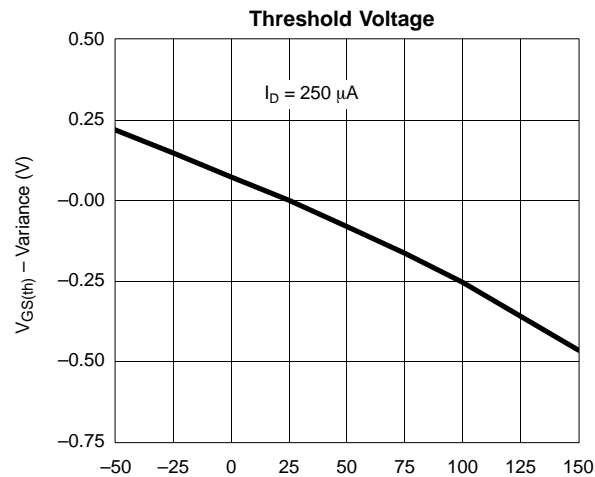
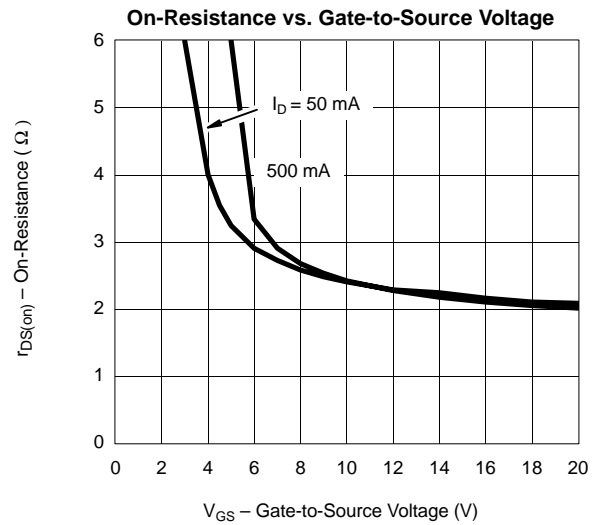
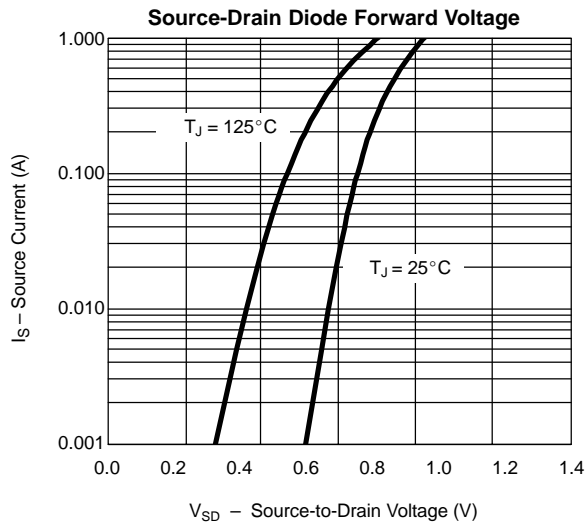
- a. For DESIGN AID ONLY, not subject to production testing.  
b. Pulse test:  $PW \leq 80\ \mu\text{s}$  duty cycle  $\leq 1\%$ .  
c. This parameter not registered with JEDEC.  
d. Switching time is essentially independent of operating temperature.

VNBF06

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



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





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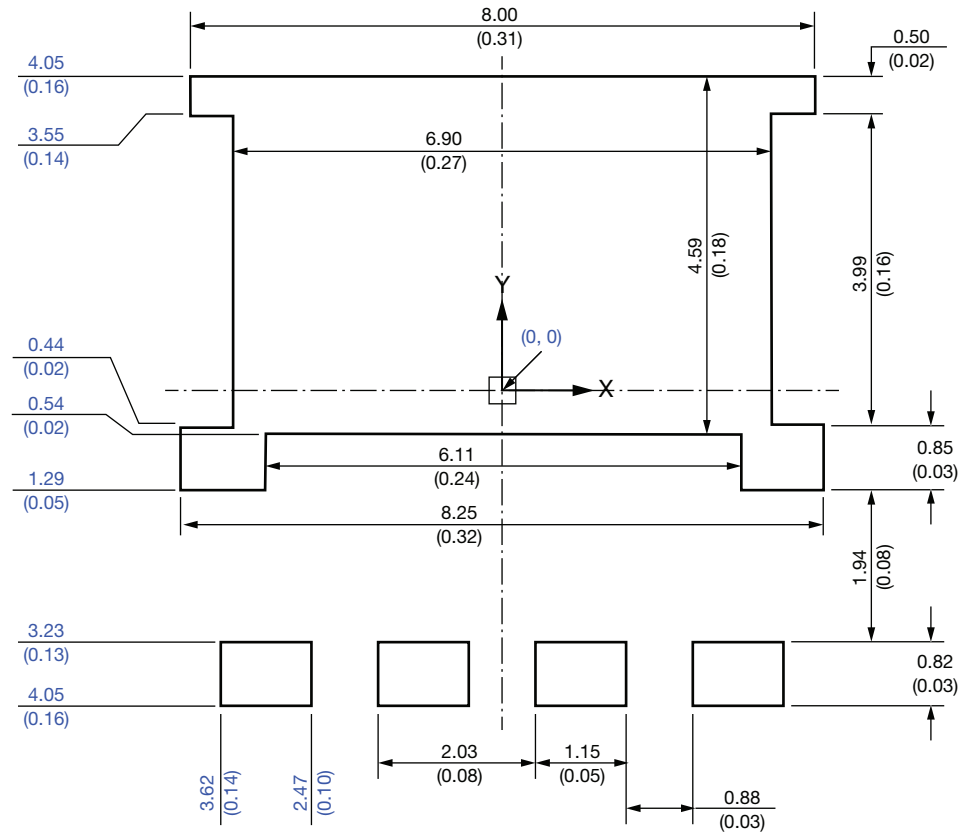
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## Recommended Minimum PADs for PowerPAK® 8 x 8L Single



Dimensions in millimeters (inches)

### Note

- Linear dimensions are in black, the same information is provided in ordinate dimensions which are in blue.



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