

## Automotive P-Channel 60 V (D-S) 175 °C MOSFET

PRODUCT SUMMARY	
$V_{DS}$ (V)	- 60
$R_{DS(on)}$ ( $\Omega$ ) at $V_{GS} = -10$ V	0.335
$R_{DS(on)}$ ( $\Omega$ ) at $V_{GS} = -4.5$ V	0.500
$I_D$ (A)	- 1.7
Configuration	Single

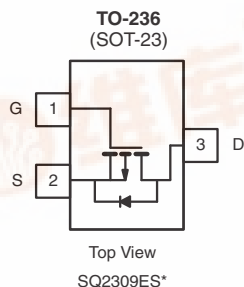
### FEATURES

- Halogen-free According to IEC 61249-2-21 Definition
- TrenchFET® Power MOSFET
- Compliant to RoHS Directive 2002/95/EC
- AEC-Q101 Qualified<sup>c</sup>

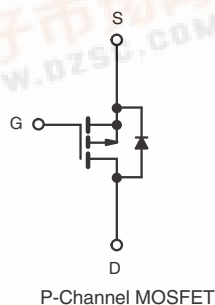
AUTOMOTIVE GRADE



RoHS  
COMPLIANT  
HALOGEN  
FREE



\* Marking Code:8Pxxx



ORDERING INFORMATION	
Package	SOT-23
Lead (Pb)-free and Halogen-free	SQ2309ES-T1-GE3

ABSOLUTE MAXIMUM RATINGS ( $T_C = 25$ °C, unless otherwise noted)			
PARAMETER	SYMBOL	LIMIT	UNIT
Drain-Source Voltage	$V_{DS}$	- 60	V
Gate-Source Voltage	$V_{GS}$	$\pm 20$	
Continuous Drain Current	$I_D$	$T_C = 25$ °C	- 1.7
		$T_C = 125$ °C	- 1.0
Continuous Source Current (Diode Conduction)	$I_S$	- 2.6	A
Pulsed Drain Current <sup>a</sup>	$I_{DM}$	- 6.8	
Single Pulse Avalanche Current	$I_{AS}$	- 15	
Single Pulse Avalanche Energy	$E_{AS}$	11	mJ
Maximum Power Dissipation <sup>a</sup>	$P_D$	$T_C = 25$ °C	2.0
		$T_C = 125$ °C	0.6
Operating Junction and Storage Temperature Range	$T_J, T_{stg}$	- 55 to + 175	°C

THERMAL RESISTANCE RATINGS			
PARAMETER	SYMBOL	LIMIT	UNIT
Junction-to-Ambient	$R_{thJA}$	166	°C/W
Junction-to-Foot (Drain)	$R_{thJF}$	73	

### Notes

- Pulse test; pulse width  $\leq 300$   $\mu$ s, duty cycle  $\leq 2$  %.
- When mounted on 1" square PCB (FR-4 material).
- Parametric verification ongoing.



## SQ2309ES


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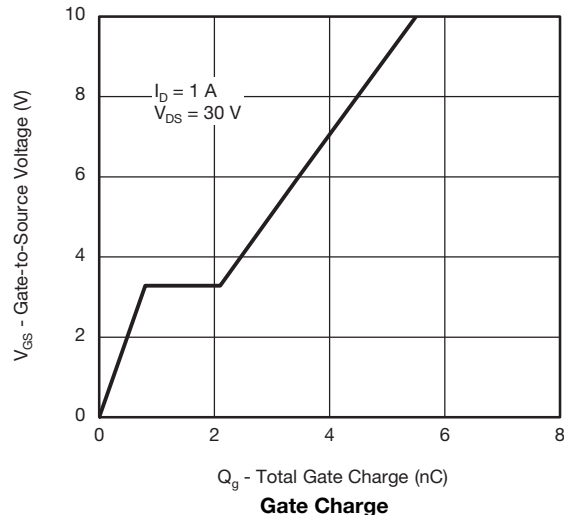
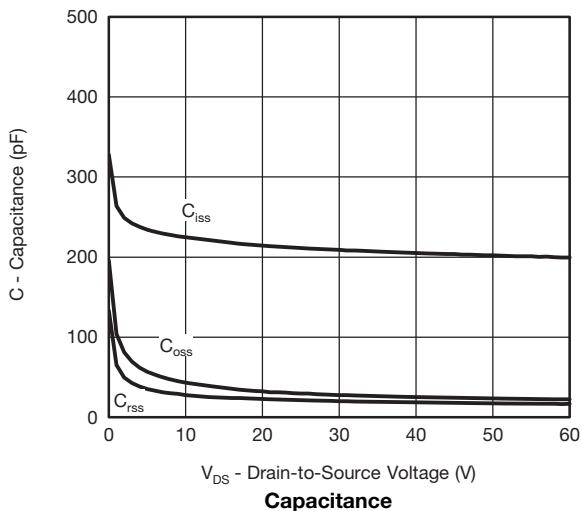
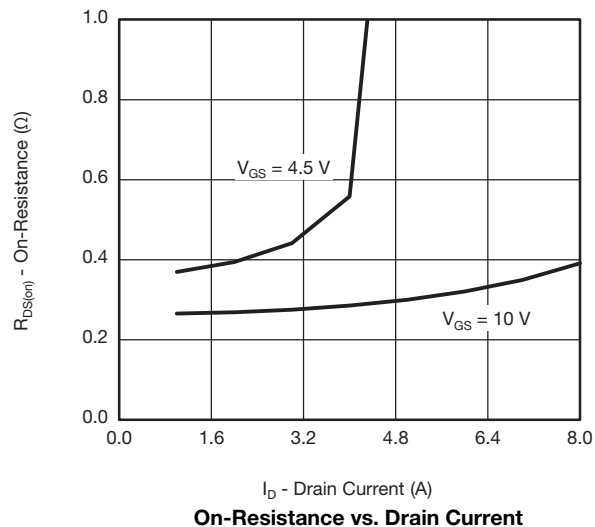
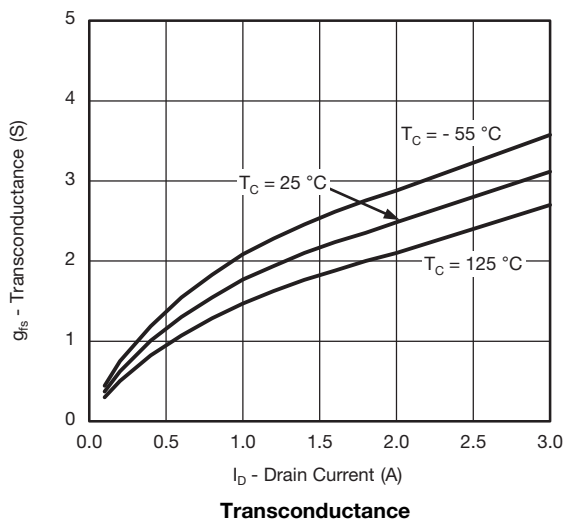
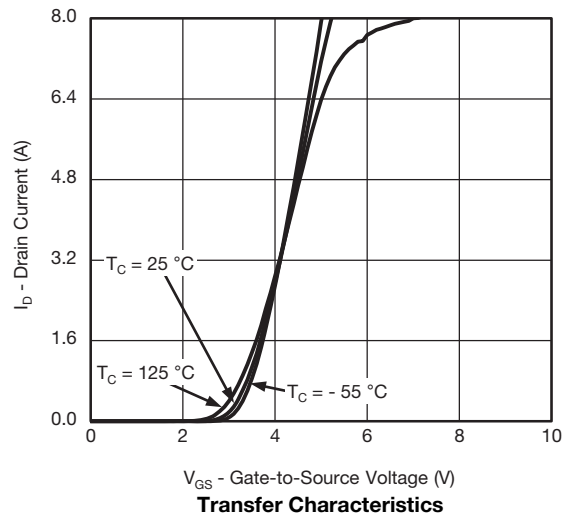
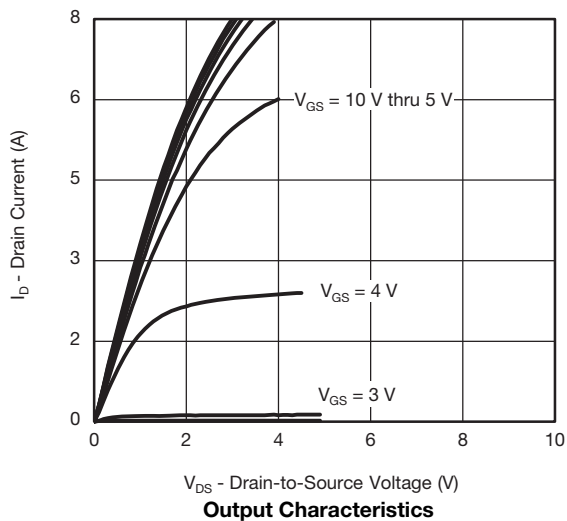
SPECIFICATIONS (T <sub>C</sub> = 25 °C, unless otherwise noted)							
PARAMETER	SYMBOL	TEST CONDITIONS		MIN.	TYP.	MAX.	UNIT
<b>Static</b>							
Drain-Source Breakdown Voltage	V <sub>DS</sub>	V <sub>GS</sub> = 0 V, I <sub>D</sub> = - 250 μA		- 60	-	-	V
Gate-Source Threshold Voltage	V <sub>GS(th)</sub>	V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = - 250 μA		- 1.5	- 2.0	- 2.5	
Gate-Source Leakage	I <sub>GSS</sub>	V <sub>DS</sub> = 0 V, V <sub>GS</sub> = ± 20 V		-	-	± 100	nA
Zero Gate Voltage Drain Current	I <sub>DSS</sub>	V <sub>GS</sub> = 0 V	V <sub>DS</sub> = - 60 V	-	-	- 1	μA
		V <sub>GS</sub> = 0 V	V <sub>DS</sub> = - 60 V, T <sub>J</sub> = 125 °C	-	-	- 50	
		V <sub>GS</sub> = 0 V	V <sub>DS</sub> = - 60 V, T <sub>J</sub> = 175 °C	-	-	- 150	
On-State Drain Current <sup>a</sup>	I <sub>D(on)</sub>	V <sub>GS</sub> = - 10 V	V <sub>DS</sub> ≤ - 5 V	- 5	-	-	A
Drain-Source On-State Resistance <sup>a</sup>	R <sub>DS(on)</sub>	V <sub>GS</sub> = - 10 V	I <sub>D</sub> = - 1.25 A	-	0.268	0.335	Ω
		V <sub>GS</sub> = - 10 V	I <sub>D</sub> = - 1.25 A, T <sub>J</sub> = 125 °C	-	-	0.567	
		V <sub>GS</sub> = - 10 V	I <sub>D</sub> = - 1.25 A, T <sub>J</sub> = 175 °C	-	-	0.704	
		V <sub>GS</sub> = - 4.5 V	I <sub>D</sub> = - 1 A	-	0.370	0.500	
Forward Transconductance <sup>b</sup>	g <sub>fs</sub>	V <sub>DS</sub> = - 5 V, I <sub>D</sub> = - 1 A		-	1.8	-	S
<b>Dynamic<sup>b</sup></b>							
Input Capacitance	C <sub>iss</sub>	V <sub>GS</sub> = 0 V	V <sub>DS</sub> = - 25 V, f = 1 MHz	-	211	265	pF
Output Capacitance	C <sub>oss</sub>			-	30	40	
Reverse Transfer Capacitance	C <sub>rss</sub>			-	21	30	
Total Gate Charge <sup>c</sup>	Q <sub>g</sub>	V <sub>GS</sub> = - 10 V	V <sub>DS</sub> = - 30 V, I <sub>D</sub> = - 1 A	-	5.5	8.5	nC
Gate-Source Charge <sup>c</sup>	Q <sub>gs</sub>			-	0.8	-	
Gate-Drain Charge <sup>c</sup>	Q <sub>gd</sub>			-	1.3	-	
Turn-On Delay Time <sup>c</sup>	t <sub>d(on)</sub>	V <sub>DD</sub> = - 30 V, R <sub>L</sub> = 30 Ω I <sub>D</sub> ≅ - 3 A, V <sub>GEN</sub> = - 10 V, R <sub>g</sub> = 1 Ω		-	5	8	ns
Rise Time <sup>c</sup>	t <sub>r</sub>			-	9	14	
Turn-Off Delay Time <sup>c</sup>	t <sub>d(off)</sub>			-	12	18	
Fall Time <sup>c</sup>	t <sub>f</sub>			-	9	14	
<b>Source-Drain Diode Ratings and Characteristics<sup>b</sup></b>							
Pulsed Current <sup>a</sup>	I <sub>SM</sub>			-	-	- 6.8	A
Forward Voltage	V <sub>SD</sub>	I <sub>F</sub> = - 1.5 A, V <sub>GS</sub> = 0 V		-	- 0.85	- 1.2	V

**Notes**

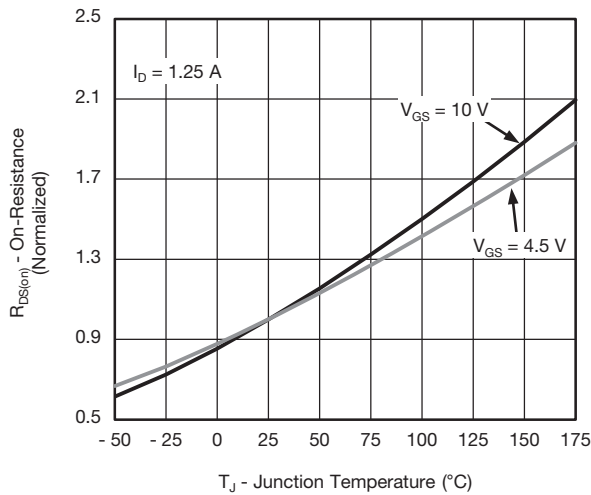
- Pulse test; pulse width ≤ 300 μs, duty cycle ≤ 2 %.
- Guaranteed by design, not subject to production testing.
- Independent of operating temperature.

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

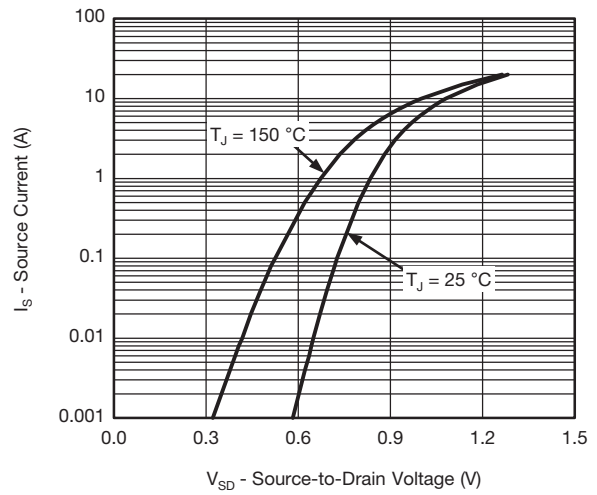
**TYPICAL CHARACTERISTICS** ( $T_A = 25\text{ }^\circ\text{C}$ , unless otherwise noted)



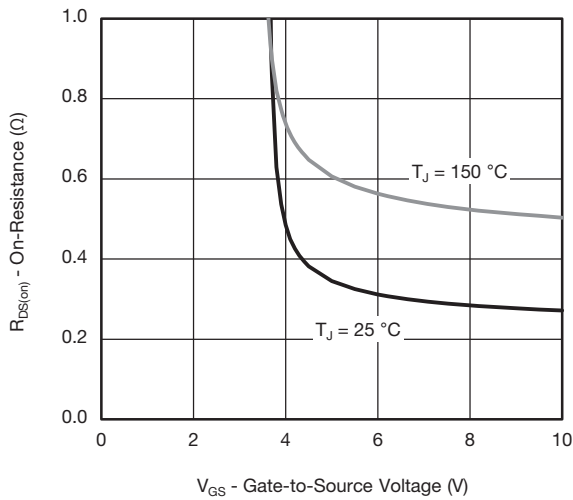
**TYPICAL CHARACTERISTICS** ( $T_A = 25\text{ }^\circ\text{C}$ , unless otherwise noted)



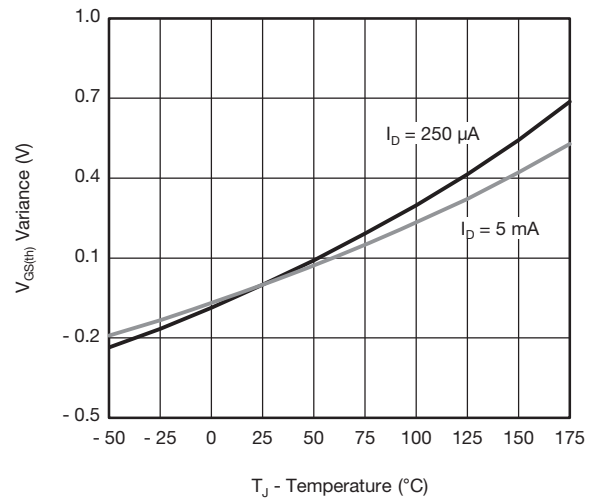
**On-Resistance vs. Junction Temperature**



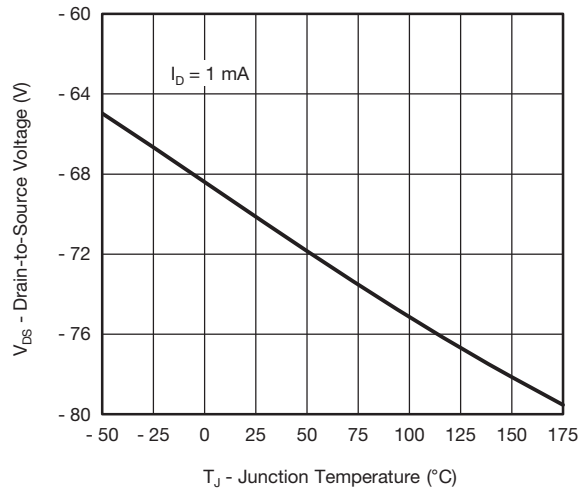
**Source Drain Diode Forward Voltage**



**On-Resistance vs. Gate-to-Source Voltage**

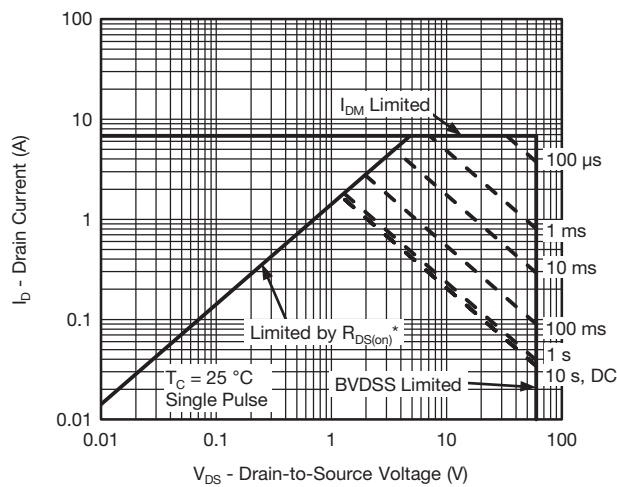


**Threshold Voltage**



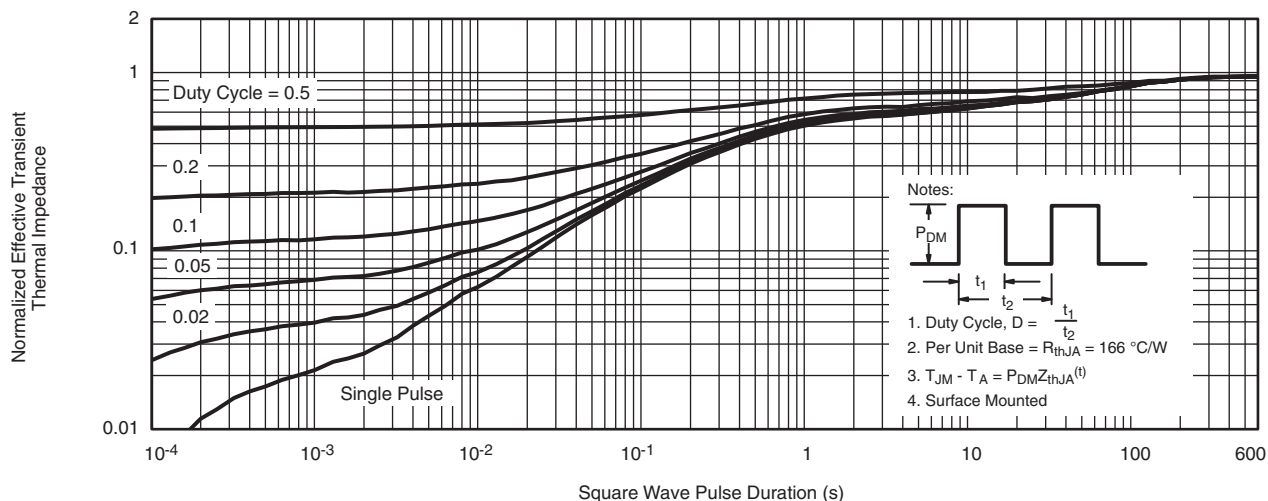
**Drain Source Breakdown vs. Junction Temperature**

**THERMAL RATINGS** ( $T_A = 25\text{ }^\circ\text{C}$ , unless otherwise noted)

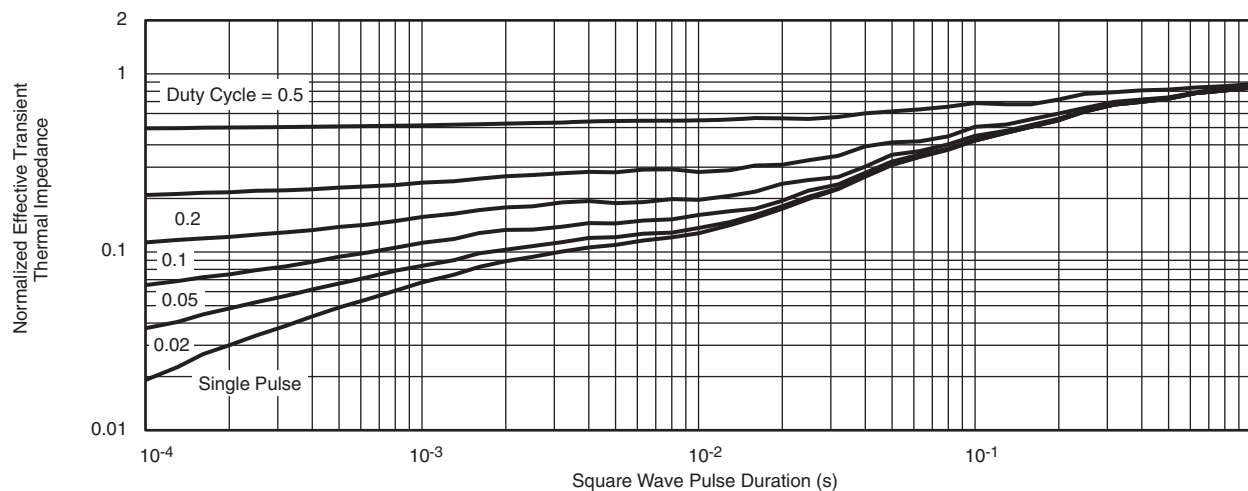


\*  $V_{GS} >$  minimum  $V_{GS}$  at which  $R_{DS(on)}$  is specified

**Safe Operating Area**



**Normalized Thermal Transient Impedance, Junction-to-Ambient**

**THERMAL RATINGS** ( $T_A = 25\text{ }^\circ\text{C}$ , unless otherwise noted)

**Normalized Thermal Transient Impedance, Junction-to-Foot**
**Note**

- The characteristics shown in the two graphs
  - Normalized Transient Thermal Impedance Junction-to-Ambient ( $25\text{ }^\circ\text{C}$ )
  - Normalized Transient Thermal Impedance Junction-to-Foot ( $25\text{ }^\circ\text{C}$ )
 are given for general guidelines only to enable the user to get a "ball park" indication of part capabilities. The data are extracted from single pulse transient thermal impedance characteristics which are developed from empirical measurements. The latter is valid for the part mounted on printed circuit board - FR4, size 1" x 1" x 0.062", double sided with 2 oz. copper, 100 % on both sides. The part capabilities can widely vary depending on actual application parameters and operating conditions.

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