

N-Channel 60 V (D-S) MOSFET

PRODUCT SUMMARY

V_{DS} (V)	$R_{DS(on)}$ (Ω)	I_D (mA)
60	3 at $V_{GS} = 10$ V	240

FEATURES

- **Halogen-free According to IEC 61249-2-21 Definition**
- Low On-Resistance: 3 Ω
- Low Threshold: 2 V (typ.)
- Low Input Capacitance: 25 pF
- Fast Switching Speed: 7.5 ns
- Low Input and Output Leakage
- Compliant to RoHS Directive 2002/95/EC



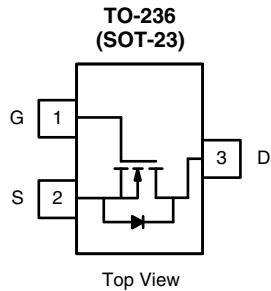
RoHS
COMPLIANT
HALOGEN
FREE
Available

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, Display, Memories, Transistors, etc.
- Battery Operated Systems
- Solid-State Relays



Marking Code: 7E

Ordering Information: 2N7002E-T1-E3 (Lead (Pb)-free)
2N7002E-T1-GE3 (Lead (Pb)-free and Halogen-free)

ABSOLUTE MAXIMUM RATINGS ($T_A = 25$ °C, unless otherwise noted)

Parameter	Symbol	Limit	Unit
Drain-Source Voltage	V_{DS}	60	V
Gate-Source Voltage	V_{GS}	± 20	
Continuous Drain Current ($T_J = 150$ °C)	I_D	$T_A = 25$ °C	240
		$T_A = 70$ °C	190
Pulsed Drain Current ^a	I_{DM}	1300	mA
Power Dissipation	P_D	$T_A = 25$ °C	0.35
		$T_A = 70$ °C	0.22
Thermal Resistance, Junction-to-Ambient	R_{thJA}	357	°C/W
Operating Junction and Storage Temperature Range	T_J, T_{stg}	- 55 to 150	°C

Notes:

a. Pulse width limited by maximum junction temperature.

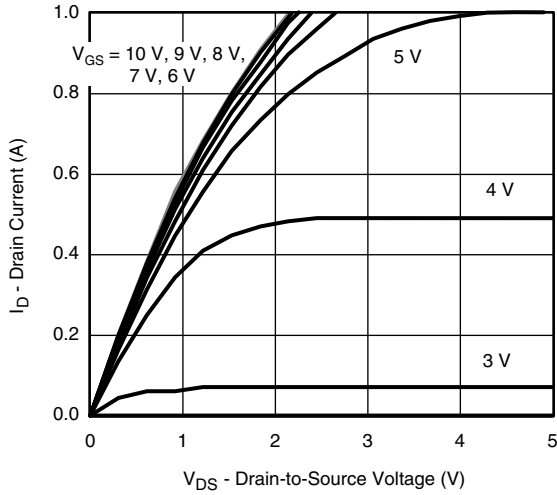
SPECIFICATIONS ($T_A = 25\text{ }^\circ\text{C}$, unless otherwise noted)						
Parameter	Symbol	Test Conditions	Limits			Unit
			Min.	Typ. ^a	Max.	
Static						
Drain-Source Breakdown Voltage	V_{DS}	$V_{GS} = 0\text{ V}, I_D = 10\text{ }\mu\text{A}$	60	68		V
Gate-Threshold Voltage	$V_{GS(th)}$	$V_{DS} = V_{GS}, I_D = 250\text{ }\mu\text{A}$	1	2	2.5	
Gate-Body Leakage	I_{GSS}	$V_{DS} = 0\text{ V}, V_{GS} = \pm 15\text{ V}$			± 10	nA
Zero Gate Voltage Drain Current	I_{DSS}	$V_{DS} = 60\text{ V}, V_{GS} = 0\text{ V}$			1	μA
		$V_{DS} = 60\text{ V}, V_{GS} = 0\text{ V}, T_J = 125\text{ }^\circ\text{C}$			500	
On-State Drain Current ^b	$I_{D(on)}$	$V_{GS} = 10\text{ V}, V_{DS} = 7.5\text{ V}$	800	1300		mA
		$V_{GS} = 4.5\text{ V}, V_{DS} = 10\text{ V}$	500	700		
Drain-Source On-Resistance ^b	$R_{DS(on)}$	$V_{GS} = 10\text{ V}, I_D = 250\text{ mA}$		1.2	3	Ω
		$V_{GS} = 4.5\text{ V}, I_D = 200\text{ mA}$		1.8	4	
Forward Transconductance ^b	g_{fs}	$V_{DS} = 15\text{ V}, I_D = 200\text{ mA}$		600		mS
Diode Forward Voltage	V_{SD}	$I_S = 200\text{ mA}, V_{GS} = 0\text{ V}$		0.85	1.2	V
Dynamic^a						
Total Gate Charge	Q_g	$V_{DS} = 10\text{ V}, V_{GS} = 4.5\text{ V}$ $I_D \cong 250\text{ mA}$		0.4	0.6	nC
Gate-Source Charge	Q_{gs}			0.06		
Gate-Drain Charge	Q_{gd}			0.06		
Input Capacitance	C_{iss}	$V_{DS} = 5\text{ V}, V_{GS} = 0\text{ V}, f = 1\text{ MHz}$		21		pF
Output Capacitance	C_{oss}			7		
Reverse Transfer Capacitance	C_{rss}			2.5		
Switching^{a, c}						
Turn-On Time	$t_{d(on)}$	$V_{DD} = 10\text{ V}, R_L = 40\text{ }\Omega$ $I_D \cong 250\text{ mA}, V_{GEN} = 10\text{ V}, R_g = 10\text{ }\Omega$		13	20	ns
Turn-Off Time	$t_{d(off)}$			18	25	

Notes:

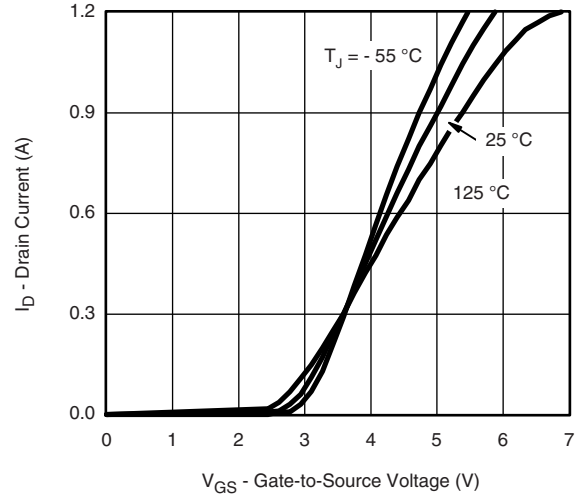
- For DESIGN AID ONLY, not subject to production testing.
- Pulse test: pulse width $\leq 300\text{ }\mu\text{s}$ duty cycle $\leq 2\%$.
- Switching time is essentially independent of operating temperature.

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.

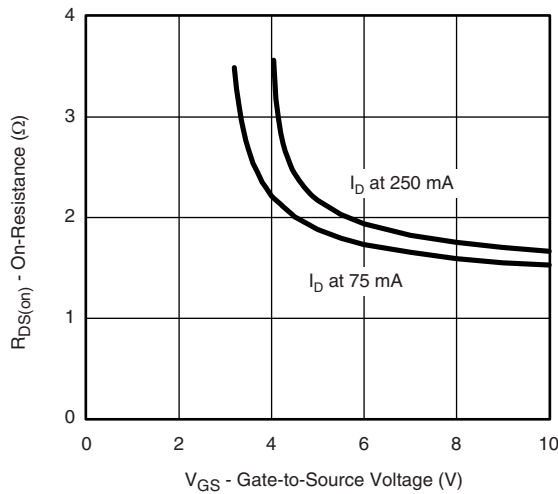
TYPICAL CHARACTERISTICS (25 °C, unless otherwise noted)



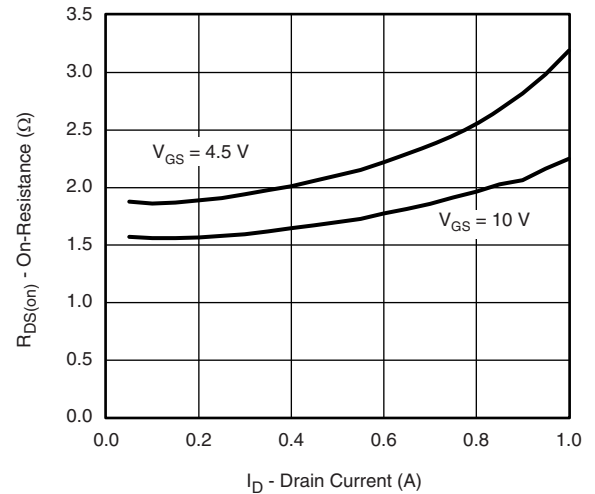
Output Characteristics



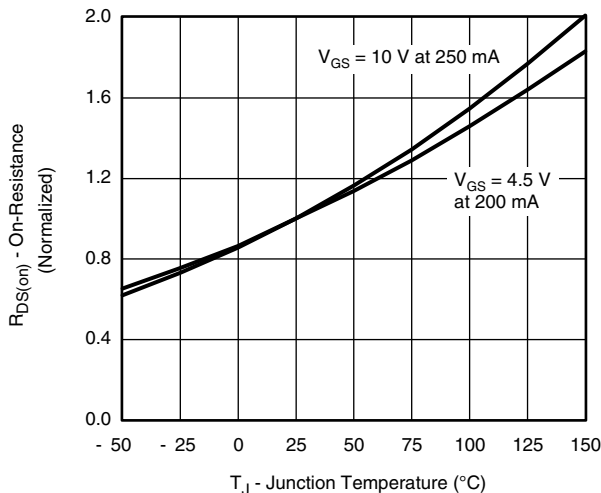
Transfer Characteristics



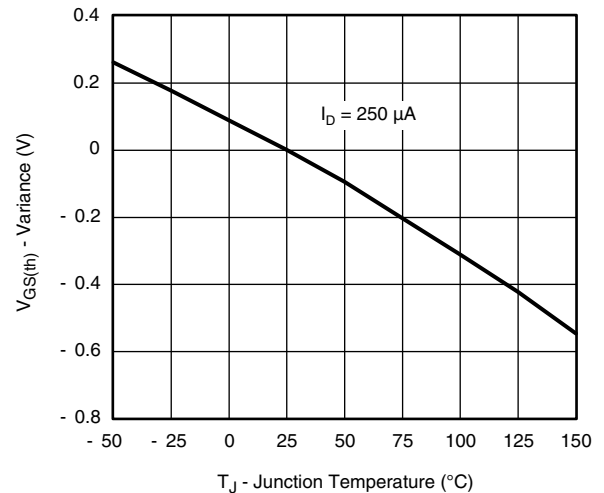
On-Resistance vs. Gate-Source Voltage



On-Resistance vs. Drain Current

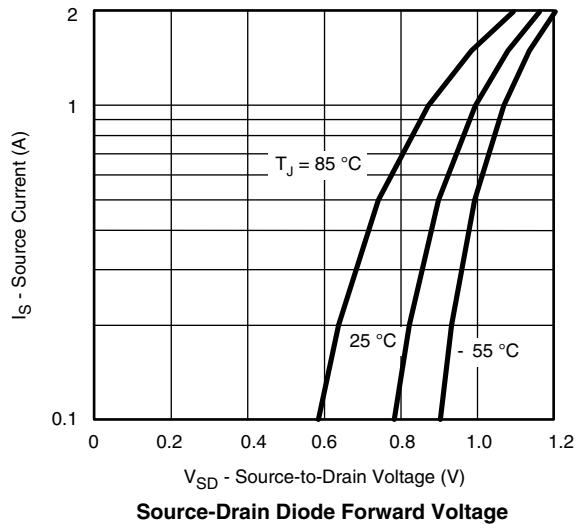
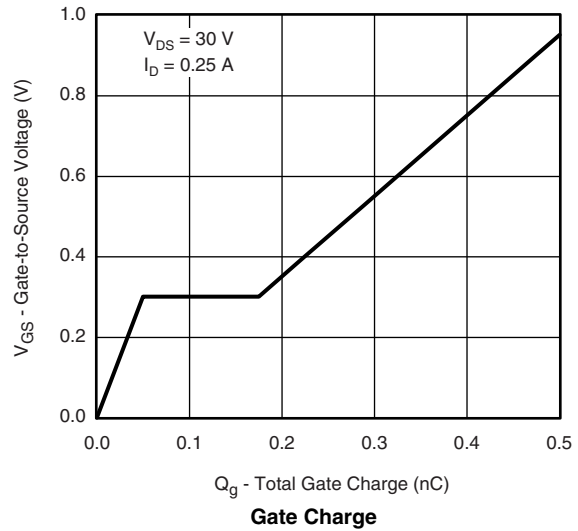
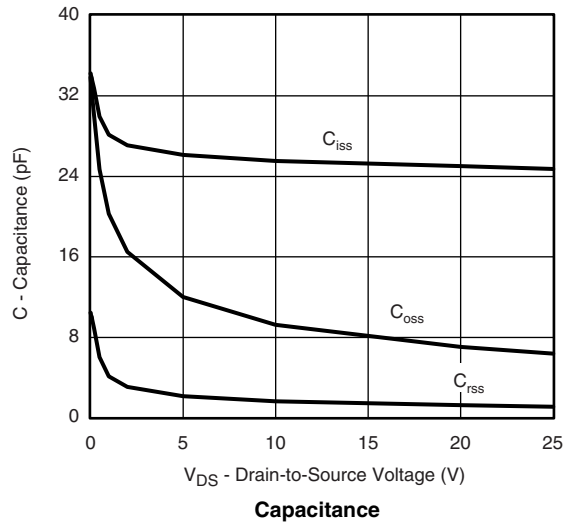


On-Resistance vs. Junction Temperature



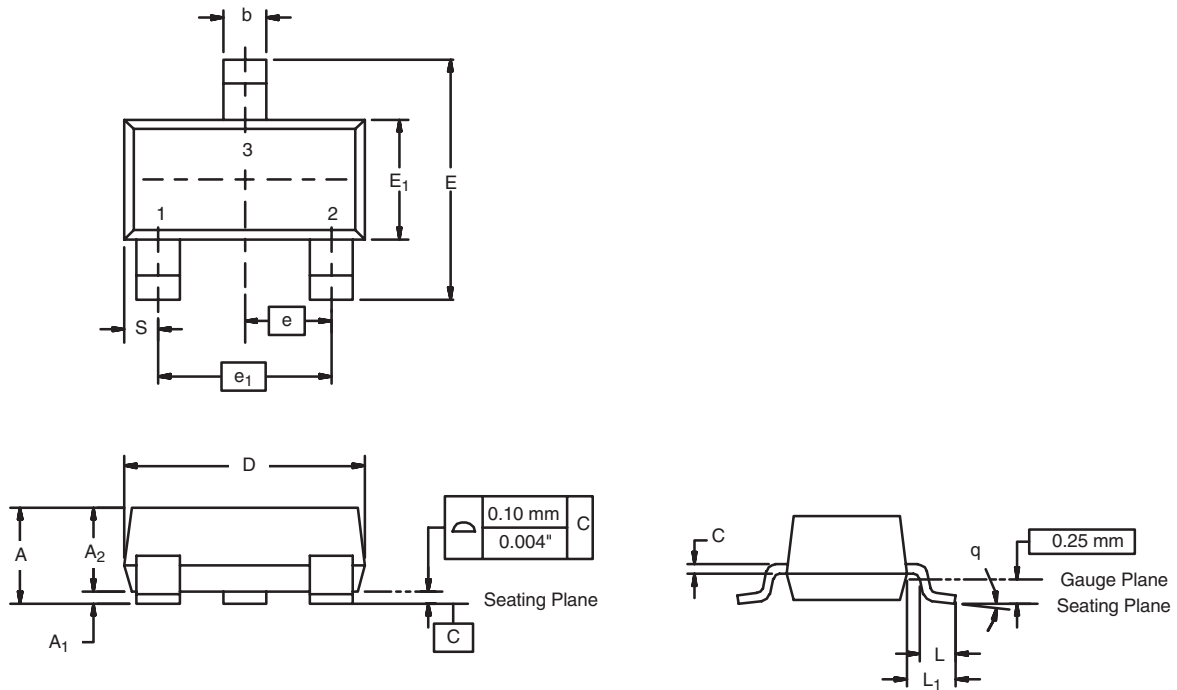
Threshold Voltage Variance Over Temperature

TYPICAL CHARACTERISTICS (25 °C, unless otherwise noted)



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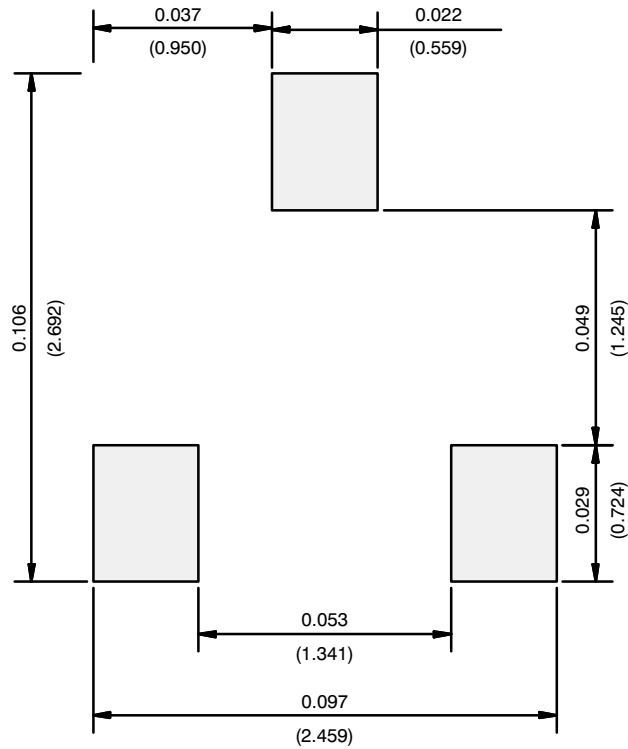
SOT-23 (TO-236): 3-LEAD



Dim	MILLIMETERS		INCHES	
	Min	Max	Min	Max
A	0.89	1.12	0.035	0.044
A ₁	0.01	0.10	0.0004	0.004
A ₂	0.88	1.02	0.0346	0.040
b	0.35	0.50	0.014	0.020
c	0.085	0.18	0.003	0.007
D	2.80	3.04	0.110	0.120
E	2.10	2.64	0.083	0.104
E ₁	1.20	1.40	0.047	0.055
e	0.95 BSC		0.0374 Ref	
e ₁	1.90 BSC		0.0748 Ref	
L	0.40	0.60	0.016	0.024
L ₁	0.64 Ref		0.025 Ref	
S	0.50 Ref		0.020 Ref	
q	3°	8°	3°	8°

ECN: S-03946-Rev. K, 09-Jul-01
 DWG: 5479

RECOMMENDED MINIMUM PADS FOR SOT-23



Recommended Minimum Pads
Dimensions in Inches/(mm)

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