

# Bi-Directional N-Channel 30-V (D-S) MOSFET

## PRODUCT SUMMARY

$V_{S1S2}$ (V)	$R_{S1S2(on)}$ ( $\Omega$ )	$I_{S1S2}$ (A)
30	0.045 at $V_{GS} = 4.5$ V	4.9
	0.060 at $V_{GS} = 2.5$ V	4.2

## FEATURES

- TrenchFET® Power MOSFET
- Ultra-Low  $R_{SS(on)}$  and 22.5 m $\Omega$  Maximum Effective On-Resistance
- ESD Protected: 4000 V
- MICRO FOOT® Chipscale Packaging Reduces Footprint Area, Profile (0.65 mm) and On-Resistance Per Footprint Area

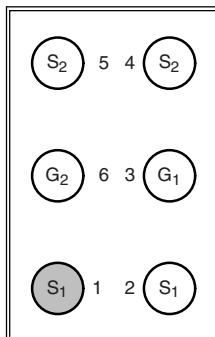

**RoHS**  
COMPLIANT

## APPLICATIONS

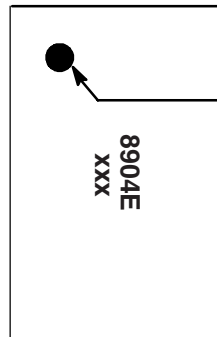
- Battery Protection Circuit
- 1-2 Cell Li+/LiP Battery Pack for Portable Devices

### MICRO FOOT

Bump Side View



Backside View

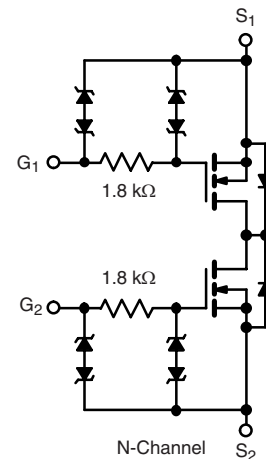


#### Device Marking:

8904E = P/N Code  
xxx = Date/Lot Traceability Code

#### Ordering Information:

Si8904EDB-T2-E1 (Lead (Pb)-free)



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

Parameter	Symbol	5 s	Steady State	Unit
Source1- Source2 Voltage	$V_{S1S2}$	30		V
Gate-Source Voltage	$V_{GS}$	$\pm 12$		
Continuous Source1- Source2 Current ( $T_J = 150$ °C) <sup>a</sup>	$I_{S1S2}$	4.9	3.8	A
		3.5	2.7	
Pulsed Source1- Source2 Current	$I_{SM}$	25		
Maximum Power Dissipation <sup>a</sup>	$P_D$	1.7	1	W
		0.8	0.5	
Operating Junction and Storage Temperature Range	$T_J, T_{stg}$	- 55 to 150		°C
Package Reflow Conditions <sup>c</sup>	IR/Convection	260		

## THERMAL RESISTANCE RATINGS

Parameter	Symbol	Typical	Maximum	Unit
Maximum Junction-to-Ambient <sup>a</sup>	$R_{thJA}$	60	75	°C/W
		95	120	
Maximum Junction-to-Foot <sup>b</sup>	$R_{thJF}$	18	22	

Notes:

a. Surface Mounted on 1" x 1" FR4 board.

b. The foot is defined as the top surface of the package.

c. Refer to IPC/JEDEC (J-STD-020C), no manual or hand soldering.

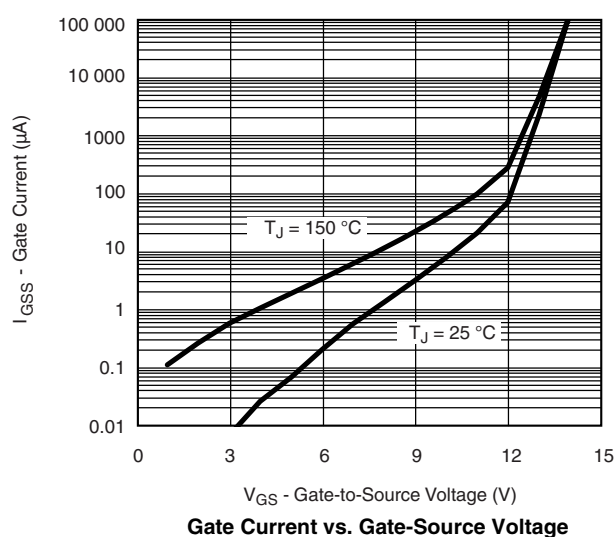
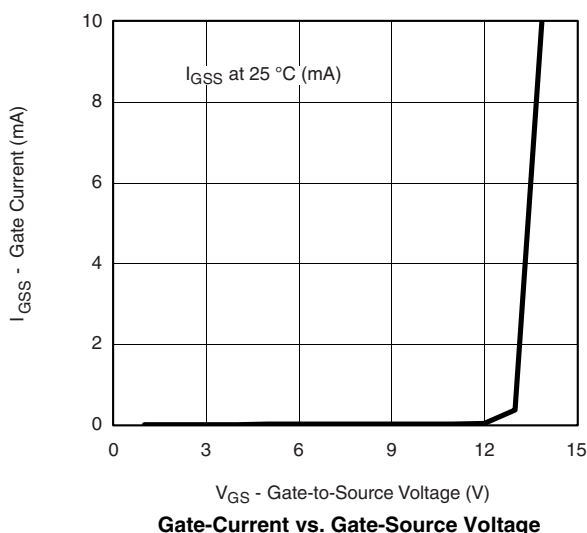
<b>SPECIFICATIONS</b> $T_J = 25\text{ }^{\circ}\text{C}$ , unless otherwise noted						
Parameter	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
<b>Static</b>						
Gate Threshold Voltage	$V_{GS(th)}$	$V_{SS} = V_{GS}$ , $I_D = 250\text{ }\mu\text{A}$	0.6		1.6	V
Gate-Body Leakage	$I_{GSS}$	$V_{SS} = 0\text{ V}$ , $V_{GS} = \pm 4.5\text{ V}$			$\pm 4$	$\mu\text{A}$
		$V_{SS} = 0\text{ V}$ , $V_{GS} = \pm 12\text{ V}$			$\pm 10$	mA
Zero Gate Voltage Source Current	$I_{S1S2}$	$V_{SS} = 30\text{ V}$ , $V_{GS} = 0\text{ V}$			1	$\mu\text{A}$
		$V_{SS} = 30\text{ V}$ , $V_{GS} = 0\text{ V}$ , $T_J = 85\text{ }^{\circ}\text{C}$			5	
On-State Source Current <sup>a</sup>	$I_{S(on)}$	$V_{SS} = 5\text{ V}$ , $V_{GS} = 4.5\text{ V}$	5			A
Source1- Source2 On-State Resistance <sup>a</sup>	$R_{S1S2(on)}$	$V_{GS} = 4.5\text{ V}$ , $I_{SS} = 1\text{ A}$		0.037	0.045	$\Omega$
		$V_{GS} = 2.5\text{ V}$ , $I_{SS} = 1\text{ A}$		0.048	0.060	
Forward Transconductance <sup>a</sup>	$g_{fs}$	$V_{SS} = 10\text{ V}$ , $I_{SS} = 1\text{ A}$		12		S
<b>Dynamic<sup>b</sup></b>						
Turn-On Delay Time	$t_{d(on)}$	$V_{SS} = 10\text{ V}$ , $R_L = 10\text{ }\Omega$ $I_{SS} \cong 1\text{ A}$ , $V_{GEN} = 4.5\text{ V}$ , $R_g = 6\text{ }\Omega$		1.6	2.4	$\mu\text{s}$
Rise Time	$t_r$			2	3	
Turn-Off Delay Time	$t_{d(off)}$			1.5	2.3	
Fall Time	$t_f$			3.7	5.6	

Notes:

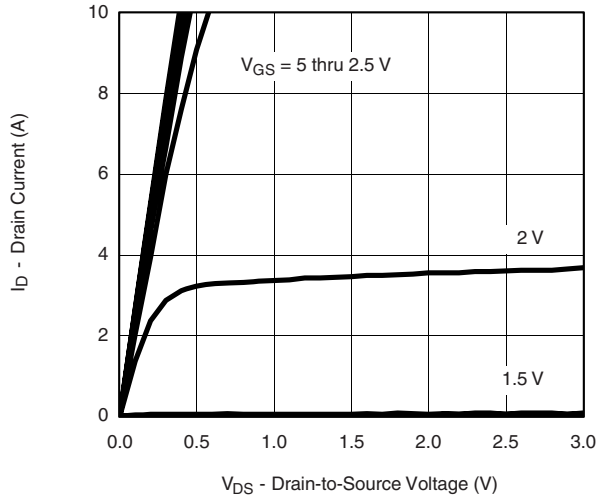
a. Pulse test; pulse width  $\leq 300\text{ }\mu\text{s}$ , duty cycle  $\leq 2\%$ .

b. Guaranteed by design, not subject to production testing.

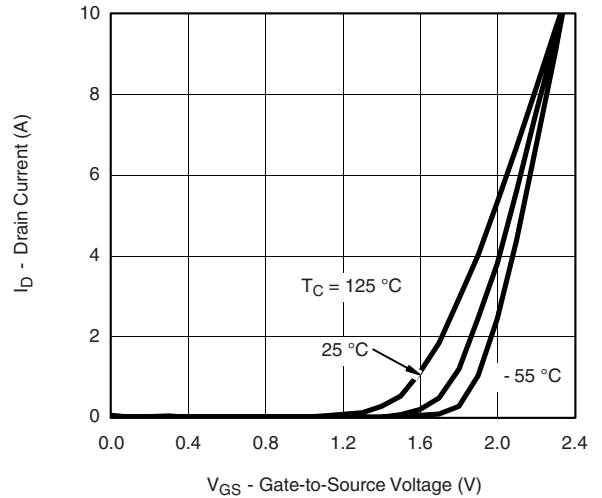
Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure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

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

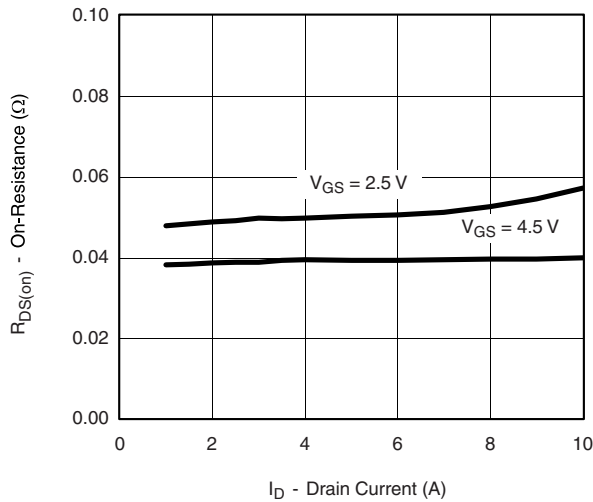
## TYPICAL CHARACTERISTICS 25 °C, unless otherwise noted



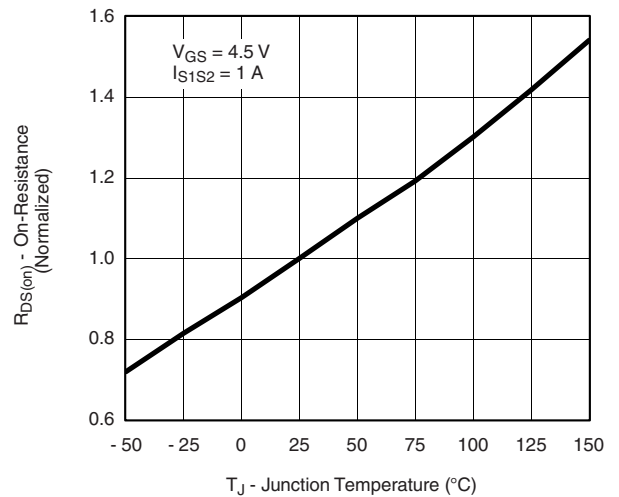
**Output Characteristics**



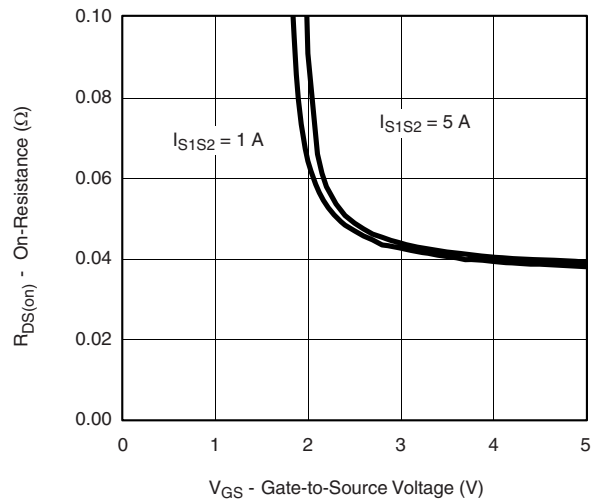
**Transfer Characteristics**



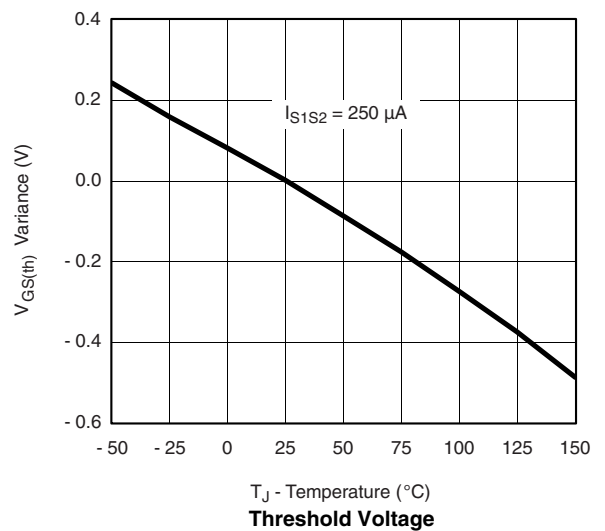
**On-Resistance vs. Drain Current**



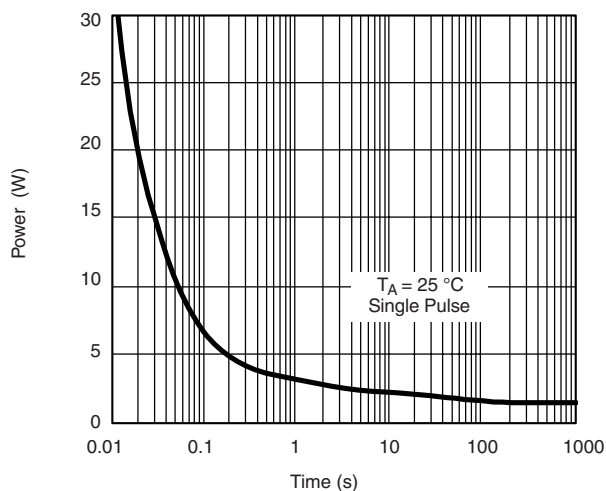
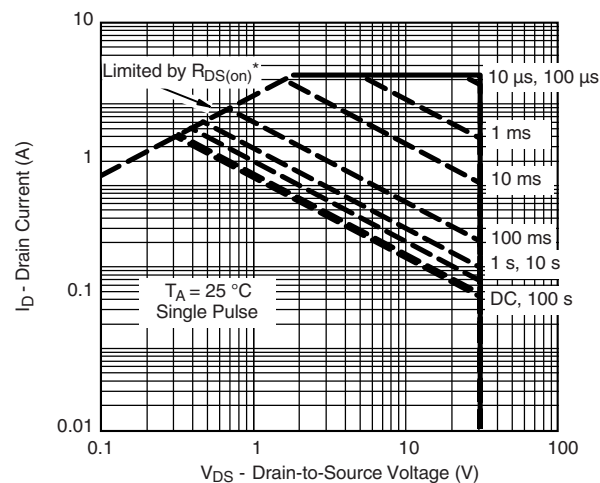
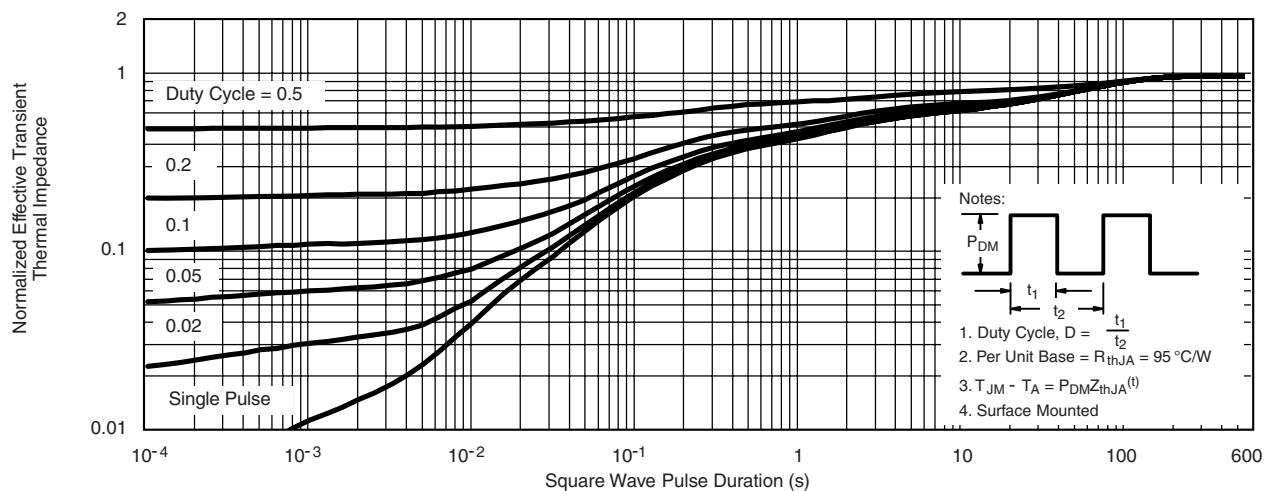
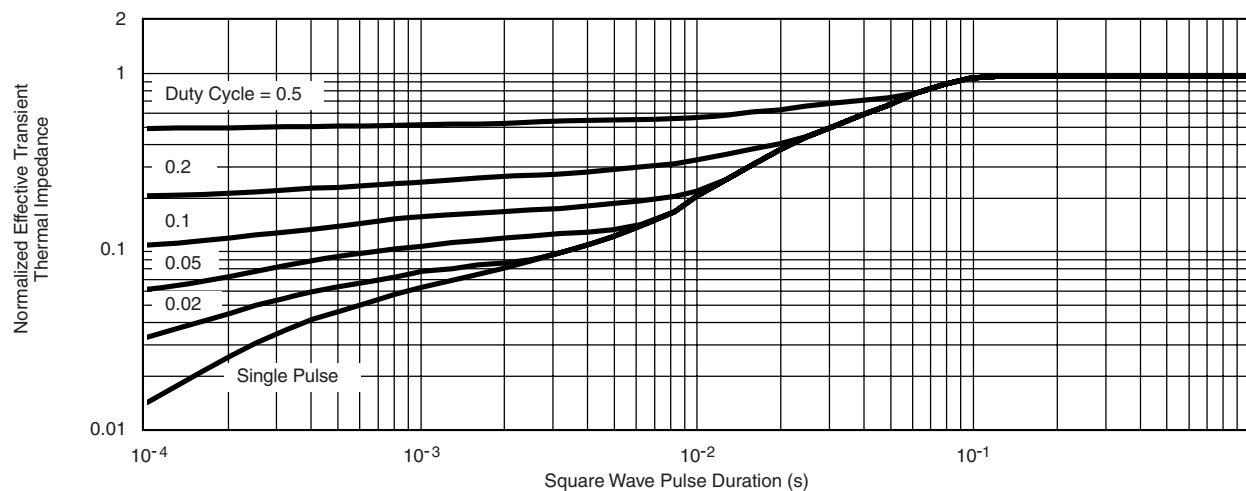
**On-Resistance vs. Junction Temperature**



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

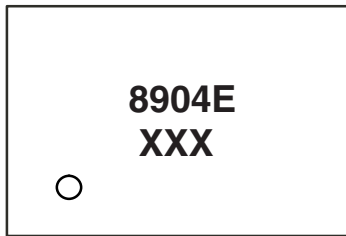
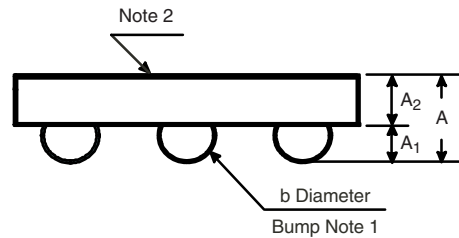
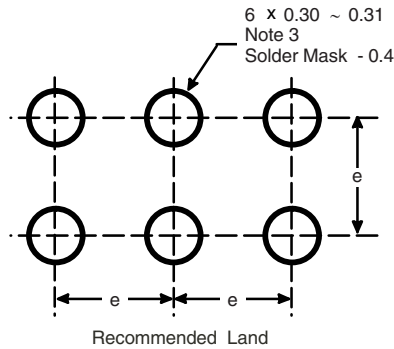


**Threshold Voltage**

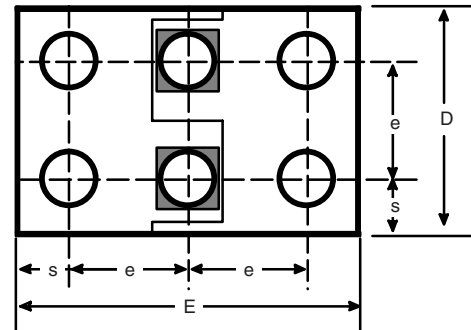
**TYPICAL CHARACTERISTICS** 25 °C, unless otherwise noted**Single Pulse Power, Junction-to-Ambient**\*  $V_{GS} >$  minimum  $V_{GS}$  at which  $R_{DS(on)}$  is specified**Safe Operating Area****Normalized Thermal Transient Impedance, Junction-to-Ambient****Normalized Thermal Transient Impedance, Junction-to-Foot**

## PACKAGE OUTLINE

### MICRO FOOT: 6-BUMP (2 x 3, 0.8 mm PITCH)



Mark on Backside of Die



#### Notes (Unless Otherwise Specified):

1. 6 solder bumps are 95.5/3.8/0.7 Sn/Ag/Cu.
2. Backside surface is coated with a Ag/Ni/Ti layer.
3. Non-solder mask defined copper landing pad.
4. Laser marks on the silicon die back.

Dim.	Millimeters <sup>a</sup>		Inches	
	Min.	Max.	Min.	Max.
A	0.600	0.650	0.0236	0.0256
A <sub>1</sub>	0.260	0.290	0.102	0.114
A <sub>2</sub>	0.340	0.360	0.0134	0.0142
b	0.370	0.410	0.0146	0.0161
D	1.520	1.600	0.0598	0.0630
E	2.320	2.400	0.0913	0.0945
e	0.750	0.850	0.0295	0.0335
s	0.380	0.400	0.0150	0.0157

#### Notes:

- a. Use millimeters as the primary measurement.

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