



Is Now Part of

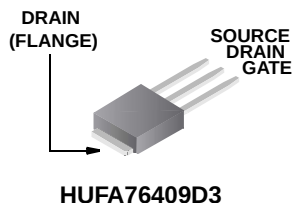
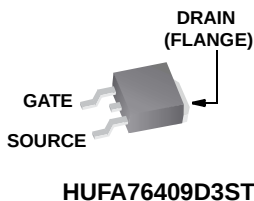
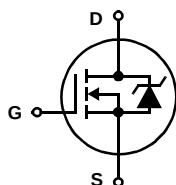


ON Semiconductor®

**To learn more about ON Semiconductor, please visit our website at
www.onsemi.com**

ON Semiconductor and the ON Semiconductor logo are trademarks of Semiconductor Components Industries, LLC dba ON Semiconductor or its subsidiaries in the United States and/or other countries. ON Semiconductor owns the rights to a number of patents, trademarks, copyrights, trade secrets, and other intellectual property. A listing of ON Semiconductor's product/patent coverage may be accessed at www.onsemi.com/site/pdf/Patent-Marking.pdf. ON Semiconductor reserves the right to make changes without further notice to any products herein. ON Semiconductor makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does ON Semiconductor assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. Buyer is responsible for its products and applications using ON Semiconductor products, including compliance with all laws, regulations and safety requirements or standards, regardless of any support or applications information provided by ON Semiconductor. "Typical" parameters which may be provided in ON Semiconductor data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. ON Semiconductor does not convey any license under its patent rights nor the rights of others. ON Semiconductor products are not designed, intended, or authorized for use as a critical component in life support systems or any FDA Class 3 medical devices or medical devices with a same or similar classification in a foreign jurisdiction or any devices intended for implantation in the human body. Should Buyer purchase or use ON Semiconductor products for any such unintended or unauthorized application, Buyer shall indemnify and hold ON Semiconductor and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that ON Semiconductor was negligent regarding the design or manufacture of the part. ON Semiconductor is an Equal Opportunity/Affirmative Action Employer. This literature is subject to all applicable copyright laws and is not for resale in any manner.

**17A, 60V, 0.071 Ohm, N-Channel, Logic
Level UltraFET Power MOSFETs**

Packaging
JEDEC TO-251AA

JEDEC TO-252AA

Symbol

Features

- Ultra Low On-Resistance
 - $r_{DS(ON)} = 0.063\Omega$, $V_{GS} = 10V$
 - $r_{DS(ON)} = 0.071\Omega$, $V_{GS} = 5V$
- Simulation Models
 - Temperature Compensated PSPICE® and SABER™ Electrical Models
 - Spice and SABER Thermal Impedance Models
 - www.fairchildsemi.com
- Peak Current vs Pulse Width Curve
- UIS Rating Curve
- Switching Time vs R_{GS} Curves

Ordering Information

PART NUMBER	PACKAGE	BRAND
HUFA76409D3	TO-251AA	76409D
HUFA76409D3ST	TO-252AA	76409D

Absolute Maximum Ratings $T_C = 25^\circ\text{C}$, Unless Otherwise Specified

	HUFA76409D3, HUFA76409D3SS	UNITS
Drain to Source Voltage (Note 1)	V_{DSS} 60	V
Drain to Gate Voltage ($R_{GS} = 20k\Omega$) (Note 1)	V_{DGR} 60	V
Gate to Source Voltage	V_{GS} ± 16	V
Drain Current		
Continuous ($T_C = 25^\circ\text{C}$, $V_{GS} = 5V$)	I_D 17	A
Continuous ($T_C = 25^\circ\text{C}$, $V_{GS} = 10V$) (Figure 2)	I_D 18	A
Continuous ($T_C = 135^\circ\text{C}$, $V_{GS} = 5V$)	I_D 8	A
Continuous ($T_C = 135^\circ\text{C}$, $V_{GS} = 4.5V$) (Figure 2)	I_D 8	A
Pulsed Drain Current	I_{DM} Figure 4	
Pulsed Avalanche Rating	UIS Figures 6, 17, 18	
Power Dissipation	P_D 49	W
Derate Above 25°C	0.327	W/ $^\circ\text{C}$
Operating and Storage Temperature	T_J, T_{STG} -55 to 175	$^\circ\text{C}$
Maximum Temperature for Soldering		
Leads at 0.063in (1.6mm) from Case for 10s.	T_L 300	$^\circ\text{C}$
Package Body for 10s, See Techbrief TB334.	T_{pkg} 260	$^\circ\text{C}$

NOTE:

1. $T_J = 25^\circ\text{C}$ to 150°C .

CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.

This product has been designed to meet the extreme test conditions and environment demanded by the automotive industry. For a copy of the requirements, see AEC Q101 at: <http://www.aecouncil.com/>

Reliability data can be found at: <http://www.fairchildsemi.com/products/discrete/reliability/index.html>.

All Fairchild semiconductor products are manufactured, assembled and tested under ISO9000 and QS9000 quality systems certification.

HUFA76409D3, HUFA76409D3ST

Electrical Specifications $T_C = 25^{\circ}\text{C}$, Unless Otherwise Specified

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNITS	
OFF STATE SPECIFICATIONS							
Drain to Source Breakdown Voltage	BV _{DSS}	I _D = 250μA, V _{GS} = 0V (Figure 12)	60	-	-	V	
		I _D = 250μA, V _{GS} = 0V , T _C = -40 ⁰ C (Figure 12)	55	-	-	V	
Zero Gate Voltage Drain Current	I _{DSS}	V _{DS} = 55V, V _{GS} = 0V	-	-	1	μA	
		V _{DS} = 50V, V _{GS} = 0V, T _C = 150 ⁰ C	-	-	250	μA	
Gate to Source Leakage Current	I _{GSS}	V _{GS} = ±16V	-	-	±100	nA	
ON STATE SPECIFICATIONS							
Gate to Source Threshold Voltage	V _{GS(TH)}	V _{GS} = V _{DS} , I _D = 250μA (Figure 11)	1	-	3	V	
Drain to Source On Resistance	r _{DS(ON)}	I _D = 18A, V _{GS} = 10V (Figures 9, 10)	-	0.052	0.063	Ω	
		I _D = 8A, V _{GS} = 5V (Figure 9)	-	0.060	0.071	Ω	
		I _D = 8A, V _{GS} = 4.5V (Figure 9)	-	0.064	0.075	Ω	
THERMAL SPECIFICATIONS							
Thermal Resistance Junction to Case	R _{θJC}	TO-251AA, TO-252AA	-	-	3.06	⁰ C/W	
Thermal Resistance Junction to Ambient	R _{θJA}		-	-	100	⁰ C/W	
SWITCHING SPECIFICATIONS (V _{GS} = 4.5V)							
Turn-On Time	t _{ON}	V _{DD} = 30V, I _D = 8A V _{GS} = 4.5V, R _{GS} = 22Ω (Figures 15, 21, 22)	-	-	153	ns	
Turn-On Delay Time	t _{d(ON)}		-	13	-	ns	
Rise Time	t _r		-	89	-	ns	
Turn-Off Delay Time	t _{d(OFF)}		-	22	-	ns	
Fall Time	t _f		-	37	-	ns	
Turn-Off Time	t _{OFF}		-	-	89	ns	
SWITCHING SPECIFICATIONS (V _{GS} = 10V)							
Turn-On Time	t _{ON}	V _{DD} = 30V, I _D = 18A V _{GS} = 10V, R _{GS} = 24Ω (Figures 16, 21, 22)	-	-	59	ns	
Turn-On Delay Time	t _{d(ON)}		-	5.3	-	ns	
Rise Time	t _r		-	34	-	ns	
Turn-Off Delay Time	t _{d(OFF)}		-	41	-	ns	
Fall Time	t _f		-	50	-	ns	
Turn-Off Time	t _{OFF}		-	-	136	ns	
GATE CHARGE SPECIFICATIONS							
Total Gate Charge	Q _{g(TOT)}	V _{GS} = 0V to 10V	V _{DD} = 30V, I _D = 8A, I _{g(REF)} = 1.0mA (Figures 14, 19, 20)	-	12	15	nC
Gate Charge at 5V	Q _{g(5)}	V _{GS} = 0V to 5V		-	6.8	8.2	nC
Threshold Gate Charge	Q _{g(TH)}	V _{GS} = 0V to 1V		-	0.54	0.65	nC
Gate to Source Gate Charge	Q _{gs}			-	1.7	-	nC
Gate to Drain “Miller” Charge	Q _{gd}			-	3	-	nC
CAPACITANCE SPECIFICATIONS							
Input Capacitance	C _{ISS}	V _{DS} = 25V, V _{GS} = 0V, f = 1MHz (Figure 13)	-	485	-	pF	
Output Capacitance	C _{OSS}		-	130	-	pF	
Reverse Transfer Capacitance	C _{RSS}		-	28	-	pF	

Source to Drain Diode Specifications

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNITS
Source to Drain Diode Voltage	V_{SD}	$I_{SD} = 8\text{A}$	-	-	1.25	V
		$I_{SD} = 4\text{A}$	-	-	1.0	V
Reverse Recovery Time	t_{rr}	$I_{SD} = 8\text{A}$, $dI_{SD}/dt = 100\text{A}/\mu\text{s}$	-	-	70	ns
Reverse Recovered Charge	Q_{RR}	$I_{SD} = 8\text{A}$, $dI_{SD}/dt = 100\text{A}/\mu\text{s}$	-	-	165	nC

Typical Performance Curves

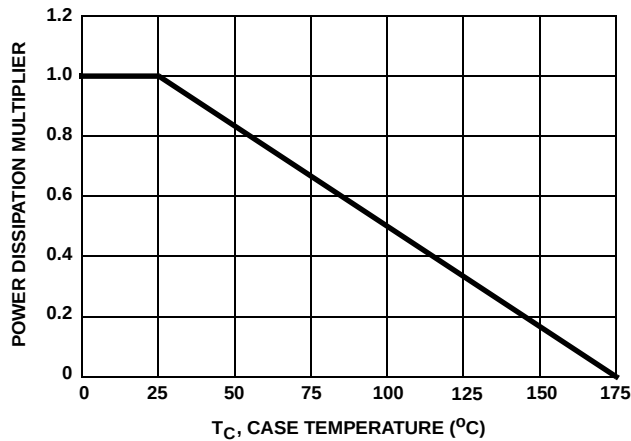


FIGURE 1. NORMALIZED POWER DISSIPATION vs CASE TEMPERATURE

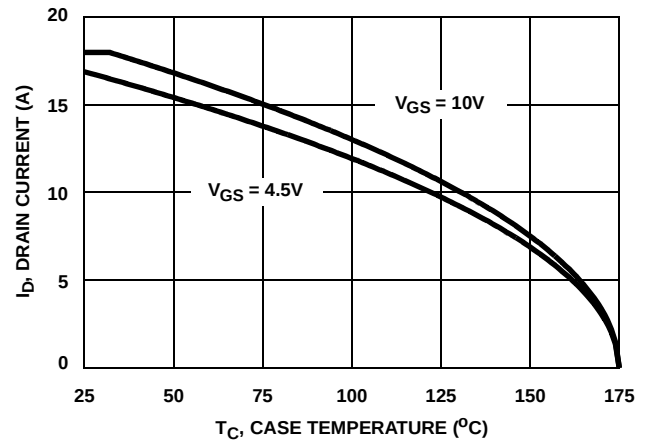


FIGURE 2. MAXIMUM CONTINUOUS DRAIN CURRENT vs CASE TEMPERATURE

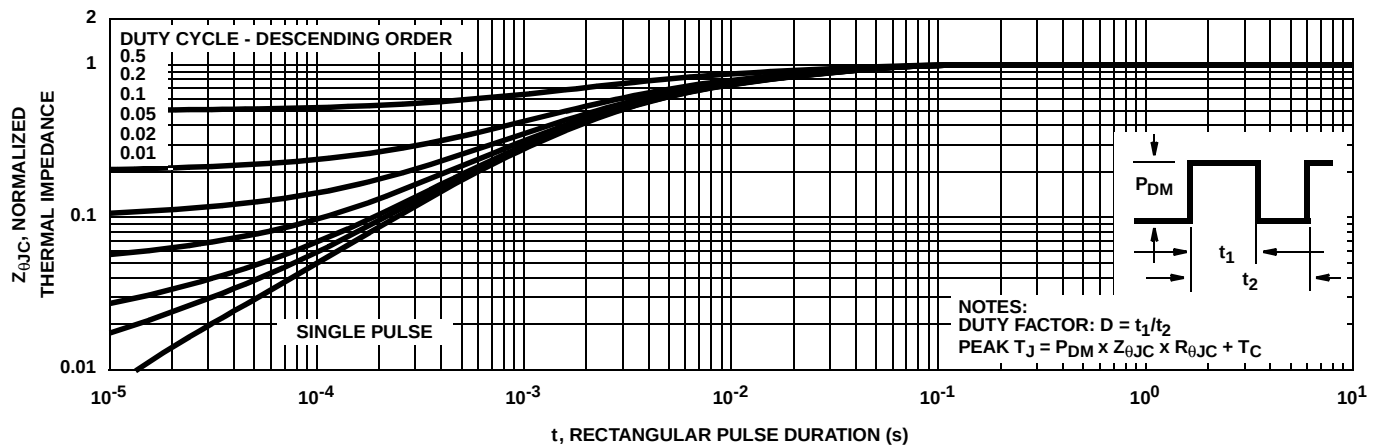


FIGURE 3. NORMALIZED MAXIMUM TRANSIENT THERMAL IMPEDANCE

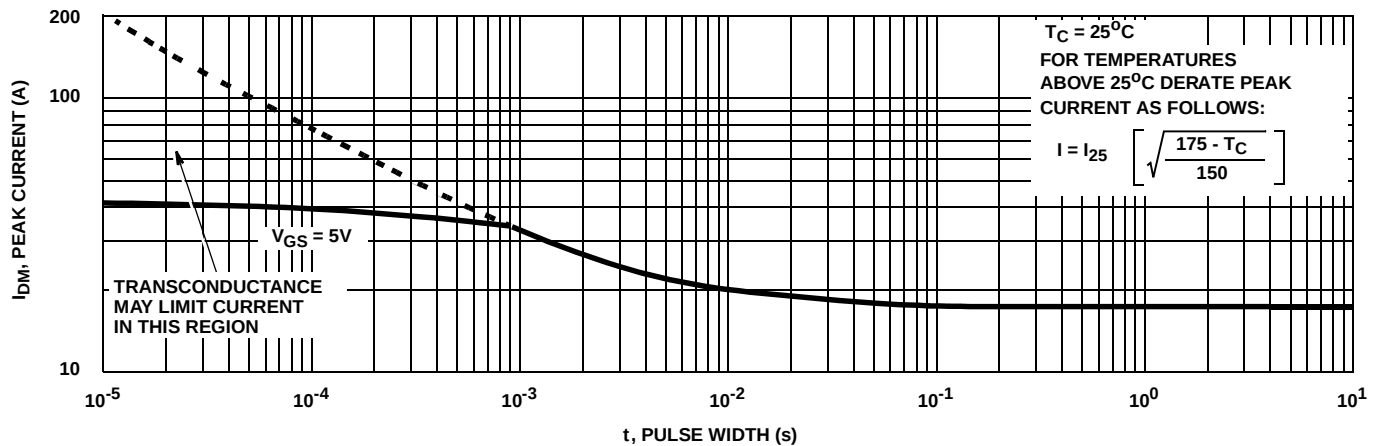


FIGURE 4. PEAK CURRENT CAPABILITY

Typical Performance Curves (Continued)

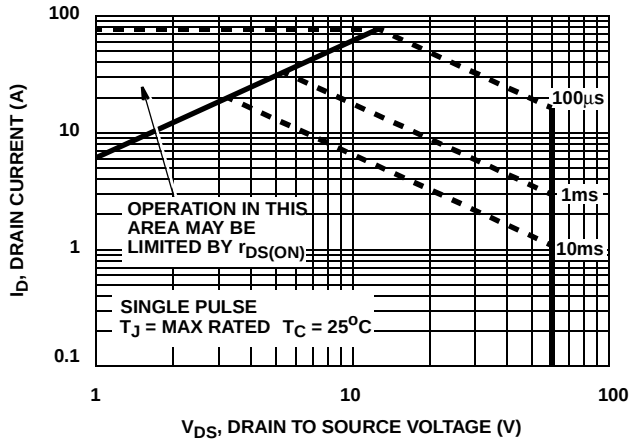
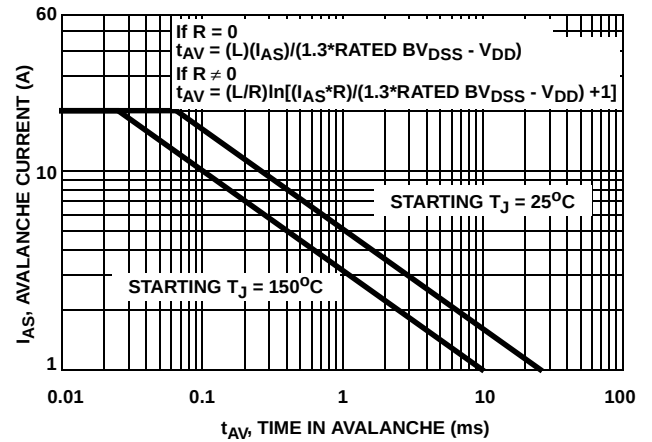


FIGURE 5. FORWARD BIAS SAFE OPERATING AREA



NOTE: Refer to Fairchild Application Notes AN9321 and AN9322.

FIGURE 6. UNCLAMPED INDUCTIVE SWITCHING CAPABILITY

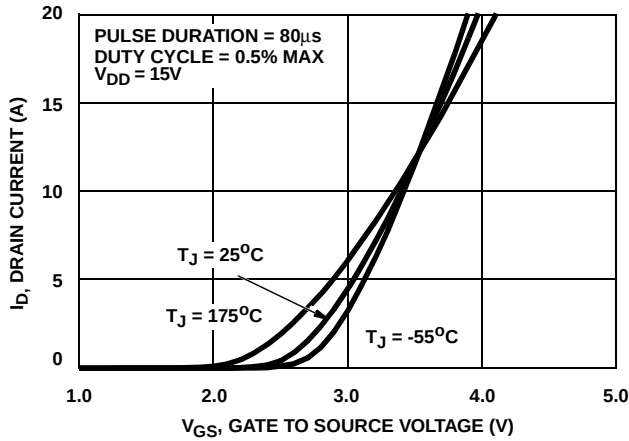


FIGURE 7. TRANSFER CHARACTERISTICS

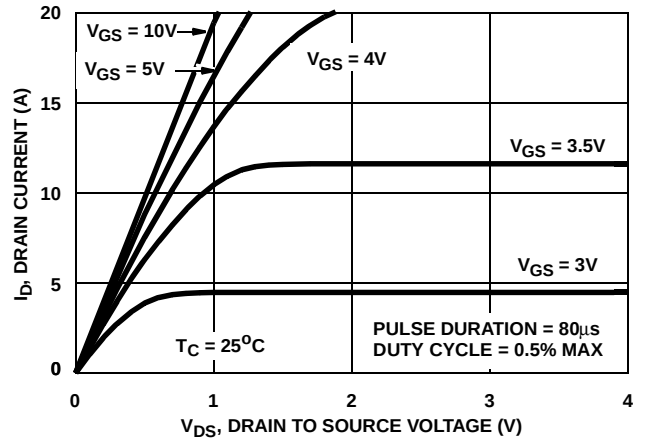


FIGURE 8. SATURATION CHARACTERISTICS

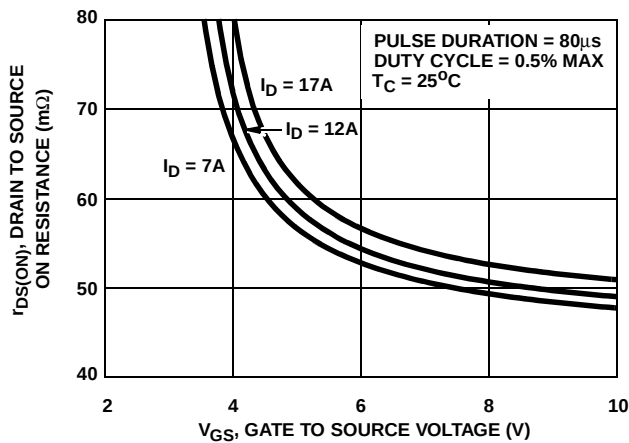


FIGURE 9. DRAIN TO SOURCE ON RESISTANCE vs. GATE VOLTAGE AND DRAIN CURRENT

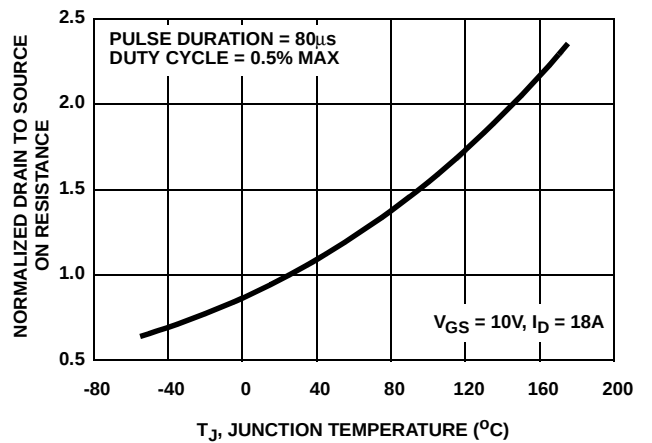


FIGURE 10. NORMALIZED DRAIN TO SOURCE ON RESISTANCE vs. JUNCTION TEMPERATURE

Typical Performance Curves (Continued)

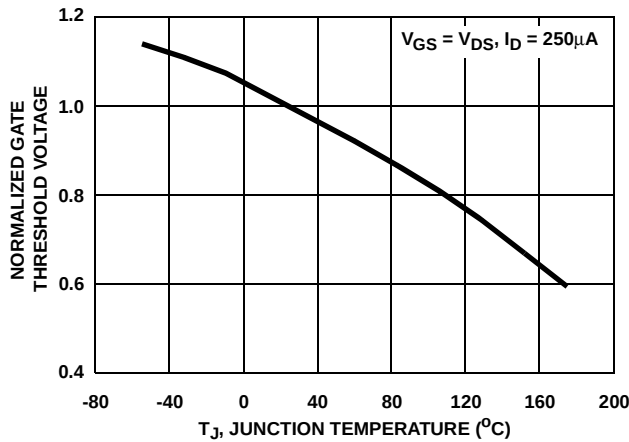


FIGURE 11. NORMALIZED GATE THRESHOLD VOLTAGE vs JUNCTION TEMPERATURE

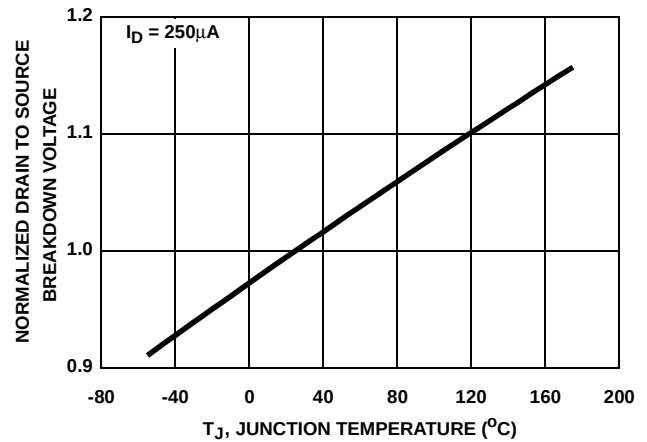


FIGURE 12. NORMALIZED DRAIN TO SOURCE BREAKDOWN VOLTAGE vs JUNCTION TEMPERATURE

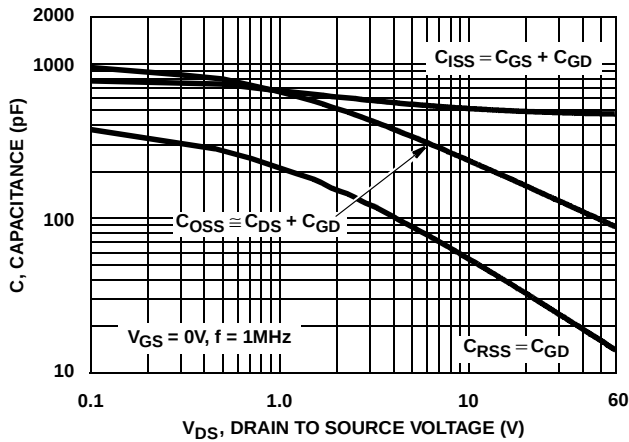
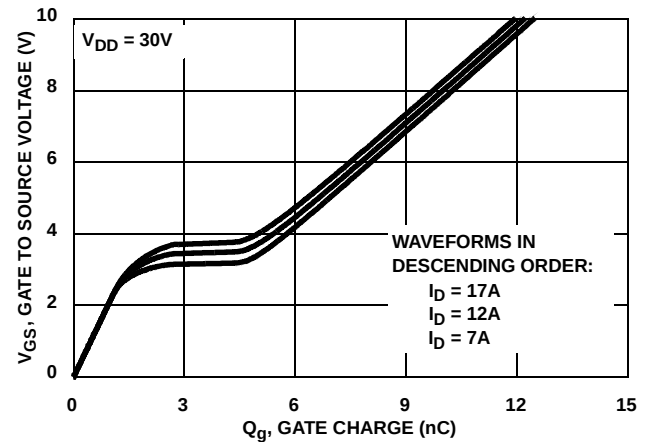


FIGURE 13. CAPACITANCE vs DRAIN TO SOURCE VOLTAGE



NOTE: Refer to Fairchild Application Notes AN7254 and AN7260.

FIGURE 14. GATE CHARGE WAVEFORMS FOR CONSTANT GATE CURRENT

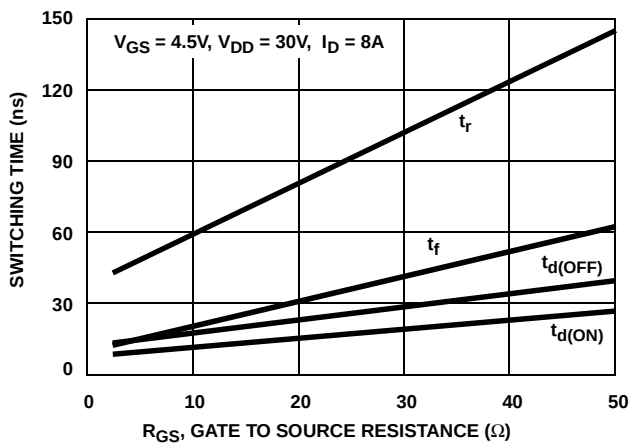


FIGURE 15. SWITCHING TIME vs GATE RESISTANCE

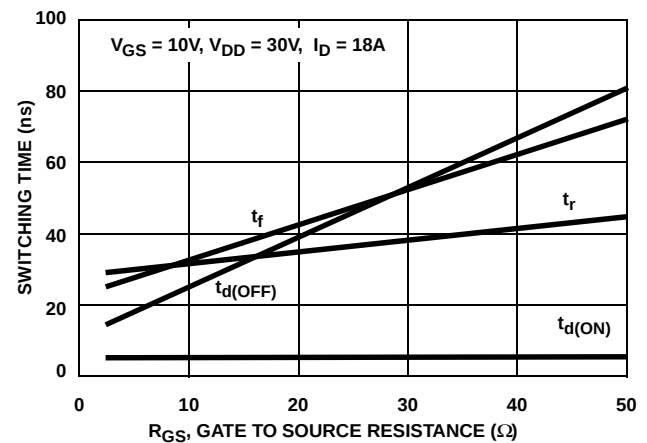


FIGURE 16. SWITCHING TIME vs GATE RESISTANCE

Test Circuits and Waveforms

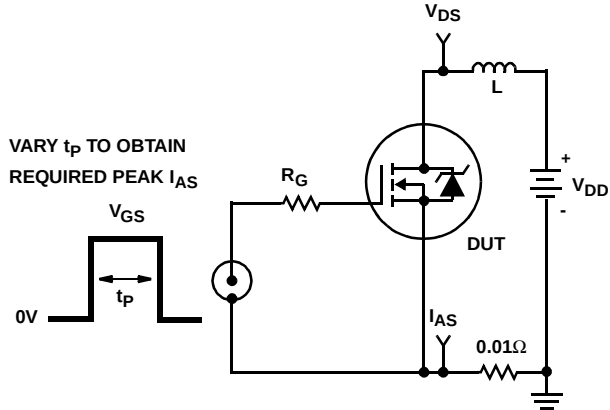


FIGURE 17. UNCLAMPED ENERGY TEST CIRCUIT

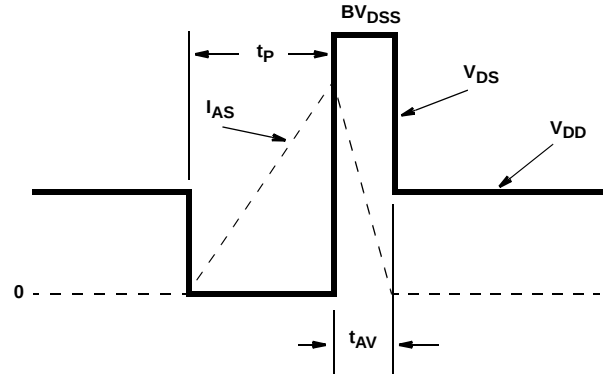


FIGURE 18. UNCLAMPED ENERGY WAVEFORMS

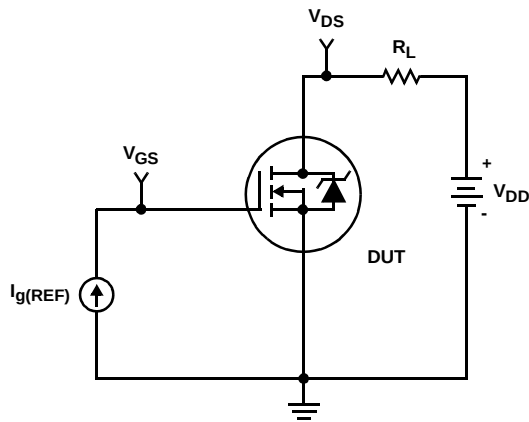


FIGURE 19. GATE CHARGE TEST CIRCUIT

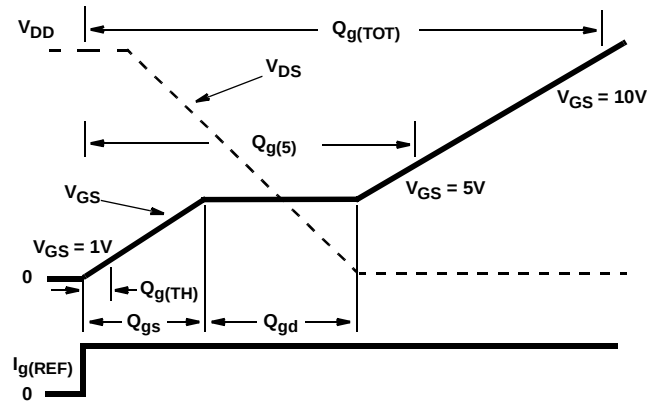


FIGURE 20. GATE CHARGE WAVEFORMS

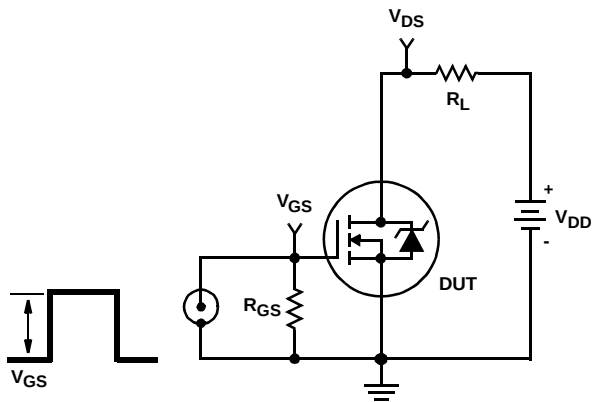


FIGURE 21. SWITCHING TIME TEST CIRCUIT

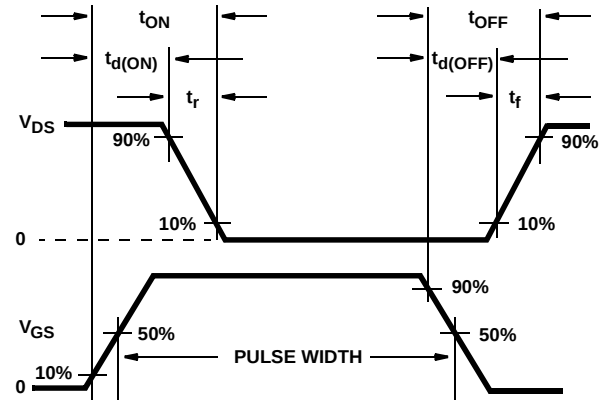


FIGURE 22. SWITCHING TIME WAVEFORM

PSPICE Electrical Model

.SUBCKT HUFA76409D 2 1 3 ; rev 23 August 1999

CA 12 8 6.30e-10
CB 15 14 6.30e-10
CIN 6 8 4.60e-10

DBODY 7 5 DBODYMOD
DBREAK 5 11 DBREAKMOD
DPLCAP 10 5 DPLCAPMOD

EBREAK 11 7 17 18 66.55
EDS 14 8 5 8 1
EGS 13 8 6 8 1
ESG 6 10 6 8 1
EVTHRES 6 21 19 8 1
EVTEMP 20 6 18 22 1

IT 8 17 1

LDRAIN 2 5 1.00e-9
LGATE 1 9 3.73e-9
LSOURCE 3 7 3.43e-9

MMED 16 6 8 8 MMEDMOD
MSTRO 16 6 8 8 MSTROMOD
MWEAK 16 21 8 8 MWEAKMOD

RBREAK 17 18 RBREAKMOD 1
RDRAIN 50 16 RDRAINMOD 1.88e-2
RGATE 9 20 3.76
RLDRAIN 2 5 10
RLGATE 1 9 37.3
RLSOURCE 3 7 34.3
RSLC1 5 51 RSLCMOD 1e-6
RSLC2 5 50 1e3
RSOURCE 8 7 RSOURCEMOD 2.40e-2
RVTHRES 22 8 RVTHRESMOD 1
RVTEMP 18 19 RVTEMPMOD 1

S1A 6 12 13 8 S1AMOD
S1B 13 12 13 8 S1BMOD
S2A 6 15 14 13 S2AMOD
S2B 13 15 14 13 S2BMOD

VBAT 22 19 DC 1

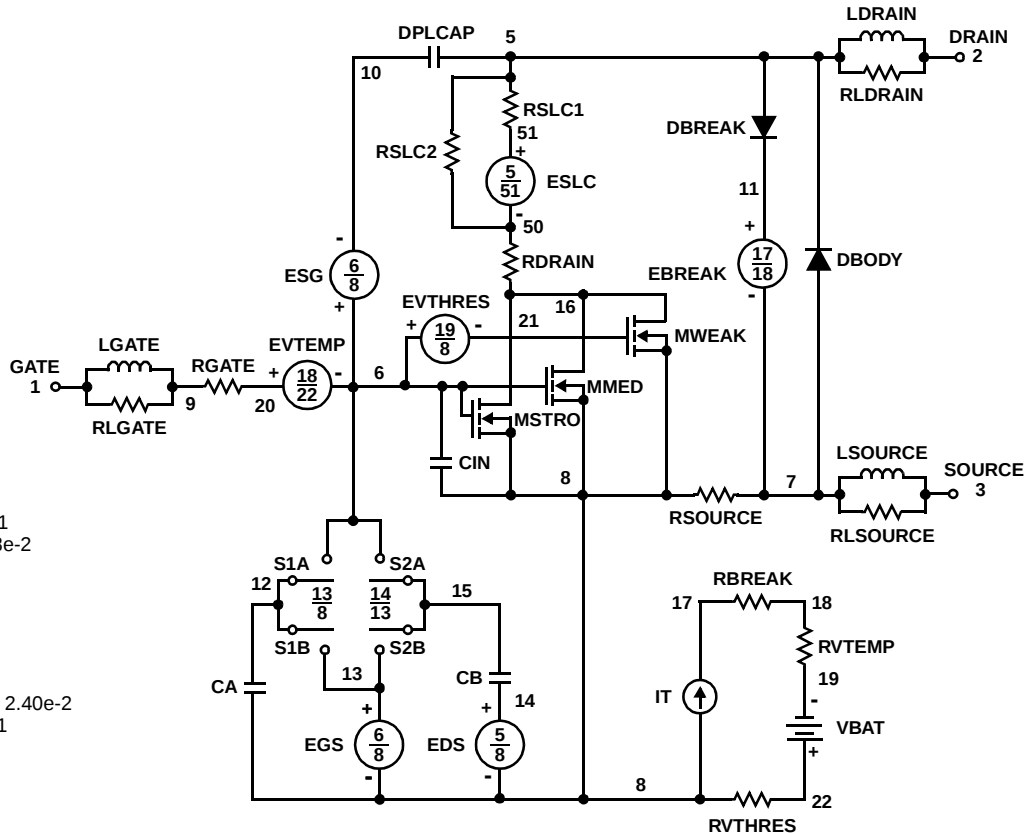
ESLC 51 50 VALUE={(V(5,51)/ABS(V(5,51)))*(PWR(V(5,51)/(1e-6*43),3))}

.MODEL DBODYMOD D (IS = 3.84e-13 RS = 1.56e-2 TRS1 = -1.0e-3 TRS2 = 7.0e-6 CJO = 6.4e-10 TT = 5.10e-8 XTI = 4.35 M = 0.52)
.MODEL DBREAKMOD D (RS = 3.70e-1 TRS1 = 9.10e-4 TRS2 = -1e-6)
.MODEL DPLCAPMOD D (CJO = 3.70e-1 OIS = 1e-3 ON = 10 M = 0.79)
.MODEL MMEDMOD NMOS (VTO = 2.08 KP = 3.2 IS = 1e-30 N = 10 TOX = 1 L = 1u W = 1u RG = 3.76)
.MODEL MSTROMOD NMOS (VTO = 2.40 KP = 28 IS = 1e-30 N = 10 TOX = 1 L = 1u W = 1u)
.MODEL MWEAKMOD NMOS (VTO = 1.80 KP = 0.08 IS = 1e-30 N = 10 TOX = 1 L = 1u W = 1u RG = 37.6 RS = 0.1)
.MODEL RBREAKMOD RES (TC1 = 1.13e-3 TC2 = -3.00e-7)
.MODEL RDRAINMOD RES (TC1 = 9.80e-3 TC2 = 2.85e-5)
.MODEL RSLCMOD RES (TC1 = 5.00e-3 TC2 = 5.05e-6)
.MODEL RSOURCEMOD RES (TC1 = 1.5e-3 TC2 = 1e-6)
.MODEL RVTHRESMOD RES (TC1 = -1.48e-3 TC2 = -8.30e-6)
.MODEL RVTEMPMOD RES (TC1 = -1.68e-3 TC2 = 8e-7)

.MODEL S1AMOD VSWITCH (RON = 1e-5 ROFF = 0.1 VON = -5 VOFF = -2.8)
.MODEL S1BMOD VSWITCH (RON = 1e-5 ROFF = 0.1 VON = -2.8 VOFF = -5)
.MODEL S2AMOD VSWITCH (RON = 1e-5 ROFF = 0.1 VON = -0.5 VOFF = 0.5)
.MODEL S2BMOD VSWITCH (RON = 1e-5 ROFF = 0.1 VON = 0.5 VOFF = -0.5)

.ENDS

NOTE: For further discussion of the PSPICE model, consult **A New PSPICE Sub-Circuit for the Power MOSFET Featuring Global Temperature Options**; IEEE Power Electronics Specialist Conference Records, 1991, written by William J. Hepp and C. Frank Wheatley.



SPICE Thermal Model

REV 10 September 1999

HUFA76409T

CTHERM1 th 6 9.50e-4
 CHERM2 6 5 2.40e-3
 CHERM3 5 4 3.90e-3
 CHERM4 4 3 4.10e-3
 CHERM5 3 2 5.60e-3
 CHERM6 2 tl 4.00e-2

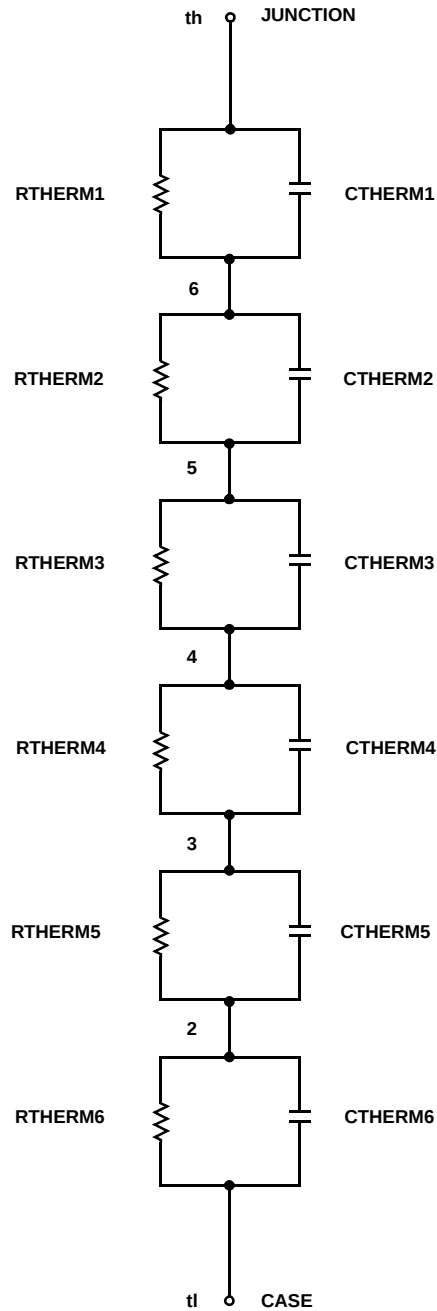
RHERM1 th 6 2.00e-2
 RHERM2 6 5 1.10e-1
 RHERM3 5 4 2.75e-1
 RHERM4 4 3 5.53e-1
 RHERM5 3 2 7.25e-1
 RHERM6 2 tl 7.56e-1

SABER Thermal Model

SABER thermal model HUFA76409T

```
template thermal_model th tl
thermal_c th, tl
{
    ctherm.therm1 th 6 = 9.50e-4
    ctherm.therm2 6 5 = 2.40e-3
    ctherm.therm3 5 4 = 3.90e-3
    ctherm.therm4 4 3 = 4.10e-3
    ctherm.therm5 3 2 = 5.60e-3
    ctherm.therm6 2 tl = 4.00e-2

    rtherm.rtherm1 th 6 = 2.00e-2
    rtherm.rtherm2 6 5 = 1.10e-1
    rtherm.rtherm3 5 4 = 2.75e-1
    rtherm.rtherm4 4 3 = 5.53e-1
    rtherm.rtherm5 3 2 = 7.25e-1
    rtherm.rtherm6 2 tl = 7.56e-1
}
```



TRADEMARKS

The following are registered and unregistered trademarks Fairchild Semiconductor owns or is authorized to use and is not intended to be an exhaustive list of all such trademarks.

ACE ^{Ex} TM	FAST [®]	OPTOLOGIC TM	SMART START TM	VCX TM
Bottomless TM	FAST ^r TM	OPTOPLANAR TM	STAR*POWER TM	
CoolFET TM	FRFET TM	PACMAN TM	Stealth TM	
CROSSVOLT TM	GlobalOptoisolator TM	POP TM	SuperSOT TM -3	
DenseTrench TM	GTO TM	Power247 TM	SuperSOT TM -6	
DOME TM	HiSeC TM	PowerTrench [®]	SuperSOT TM -8	
EcoSPARK TM	ISOPLANAR TM	QFET TM	SyncFET TM	
E ² CMOS TM	LittleFET TM	QS TM	TinyLogic TM	
EnSigna TM	MicroFET TM	QT Optoelectronics TM	TruTranslation TM	
FACT TM	MicroPak TM	Quiet Series TM	UHC TM	
FACT Quiet Series TM	MICROWIRE TM	SILENT SWITCHER [®]	UltraFET [®]	

STAR*POWER is used under license

DISCLAIMER

FAIRCHILD SEMICONDUCTOR RESERVES THE RIGHT TO MAKE CHANGES WITHOUT FURTHER NOTICE TO ANY PRODUCTS HEREIN TO IMPROVE RELIABILITY, FUNCTION OR DESIGN. FAIRCHILD DOES NOT ASSUME ANY LIABILITY ARISING OUT OF THE APPLICATION OR USE OF ANY PRODUCT OR CIRCUIT DESCRIBED HEREIN; NEITHER DOES IT CONVEY ANY LICENSE UNDER ITS PATENT RIGHTS, NOR THE RIGHTS OF OTHERS.

LIFE SUPPORT POLICY

FAIRCHILD'S PRODUCTS ARE NOT AUTHORIZED FOR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS WITHOUT THE EXPRESS WRITTEN APPROVAL OF FAIRCHILD SEMICONDUCTOR CORPORATION. As used herein:

1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, or (c) whose failure to perform when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in significant injury to the user.
2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

PRODUCT STATUS DEFINITIONS

Definition of Terms

Datasheet Identification	Product Status	Definition
Advance Information	Formative or In Design	This datasheet contains the design specifications for product development. Specifications may change in any manner without notice.
Preliminary	First Production	This datasheet contains preliminary data, and supplementary data will be published at a later date. Fairchild Semiconductor reserves the right to make changes at any time without notice in order to improve design.
No Identification Needed	Full Production	This datasheet contains final specifications. Fairchild Semiconductor reserves the right to make changes at any time without notice in order to improve design.
Obsolete	Not In Production	This datasheet contains specifications on a product that has been discontinued by Fairchild semiconductor. The datasheet is printed for reference information only.

ON Semiconductor and  are trademarks of Semiconductor Components Industries, LLC dba ON Semiconductor or its subsidiaries in the United States and/or other countries. ON Semiconductor owns the rights to a number of patents, trademarks, copyrights, trade secrets, and other intellectual property. A listing of ON Semiconductor's product/patent coverage may be accessed at www.onsemi.com/site/pdf/Patent-Marking.pdf. ON Semiconductor reserves the right to make changes without further notice to any products herein. ON Semiconductor makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does ON Semiconductor assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. Buyer is responsible for its products and applications using ON Semiconductor products, including compliance with all laws, regulations and safety requirements or standards, regardless of any support or applications information provided by ON Semiconductor. "Typical" parameters which may be provided in ON Semiconductor data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. ON Semiconductor does not convey any license under its patent rights nor the rights of others. ON Semiconductor products are not designed, intended, or authorized for use as a critical component in life support systems or any FDA Class 3 medical devices or medical devices with a same or similar classification in a foreign jurisdiction or any devices intended for implantation in the human body. Should Buyer purchase or use ON Semiconductor products for any such unintended or unauthorized application, Buyer shall indemnify and hold ON Semiconductor and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that ON Semiconductor was negligent regarding the design or manufacture of the part. ON Semiconductor is an Equal Opportunity/Affirmative Action Employer. This literature is subject to all applicable copyright laws and is not for resale in any manner.

PUBLICATION ORDERING INFORMATION

LITERATURE FULFILLMENT:

Literature Distribution Center for ON Semiconductor
19521 E. 32nd Pkwy, Aurora, Colorado 80011 USA
Phone: 303-675-2175 or 800-344-3860 Toll Free USA/Canada
Fax: 303-675-2176 or 800-344-3867 Toll Free USA/Canada
Email: orderlit@onsemi.com

N. American Technical Support: 800-282-9855 Toll Free
USA/Canada
Europe, Middle East and Africa Technical Support:
Phone: 421 33 790 2910
Japan Customer Focus Center
Phone: 81-3-5817-1050

ON Semiconductor Website: www.onsemi.com

Order Literature: <http://www.onsemi.com/orderlit>

For additional information, please contact your local Sales Representative