

NUS5531MT

Main Switch Power MOSFET and Single Charging BJT

-12 V, -6.2 A, Single P-Channel FET with Single PNP low $V_{ce(sat)}$ Transistor, 3x3 mm WDFN Package

This device integrates one high performance power MOSFET and one low $V_{ce(sat)}$ transistor, greatly reducing the layout space and optimizing charging performance in battery-powered portable electronics.

Features

- High Performance Power MOSFET
- Single Low $V_{ce(sat)}$ Transistor as Charging Power Mux
- 3.0x3.0x0.8 mm WDFN Package
- Independent Pin-out Provides Circuit Flexibility
- Low Profile (<0.8 mm) for Easy Fit in Thin Environments
- This is a Pb-Free Device

Applications

- Main Switch and Battery Charging Mux for Portable Electronics
- Optimized for Commercial PMUs from Top Suppliers (See Figure 2)

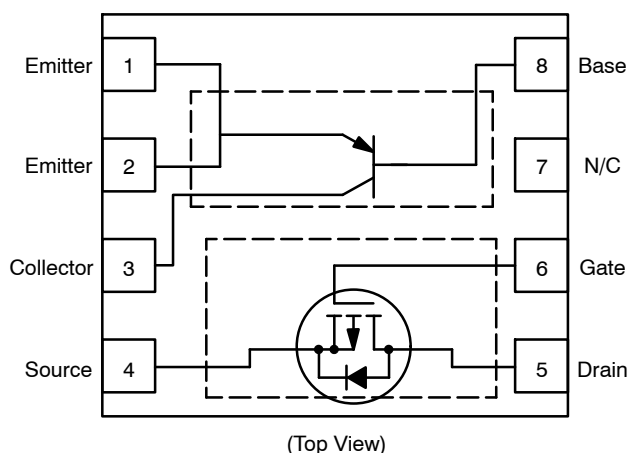


Figure 1. Simple Schematic



ON Semiconductor®

<http://onsemi.com>

MOSFET

$V_{(BR)DSS}$	$R_{DS(on)}$ TYP	I_D MAX
-12 V	32 mΩ @ -4.5 V	-6.2 A
	44 mΩ @ -2.5 V	

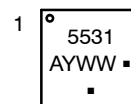
Low $V_{ce(sat)}$ PNP (Wall/USB)

V_{CE0} MAX	V_{EBO} MAX	I_C MAX
-20 V	-7.0 V	-2.0 A



WDFN8
CASE 506BC

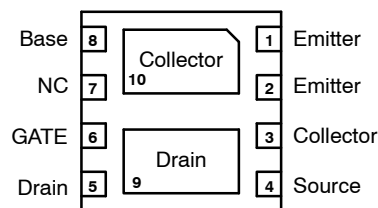
MARKING DIAGRAM



5531 = Device Code
A = Assembly Location
Y = Year
WW = Work Week
▪ = Pb-Free Package

(Note: Microdot may be in either location)

PIN ASSIGNMENT



ORDERING INFORMATION

Device	Package	Shipping†
NUS5531MTR2G	WDFN8 (Pb-Free)	3000/Tape & Reel

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specification Brochure, BRD8011/D.

NUS5531MT

P-Channel Power MOSFET Maximum Ratings ($T_J = 25^\circ\text{C}$ unless otherwise stated)

Parameter		Symbol	Value	Units	
Drain-to-Source Voltage		V_{DSS}	-12	V	
Gate-to-Source Voltage		V_{GS}	± 8.0	V	
Continuous Drain Current (Note 1)	Steady State	$T_A = 25^\circ\text{C}$	-5.47	A	
		$T_A = 85^\circ\text{C}$	-4.0		
	$t \leq 5 \text{ s}$	$T_A = 25^\circ\text{C}$	-6.2		
Power Dissipation (Note 1)	Steady State	$T_A = 25^\circ\text{C}$	1.46	W	
	$t \leq 10 \text{ s}$		2.1		
Continuous Drain Current (Note 2)	Steady State	$T_A = 25^\circ\text{C}$	-4.4	A	
		$T_A = 85^\circ\text{C}$	-3.2		
Power Dissipation (Note 3)	$T_A = 25^\circ\text{C}$		P_D	0.418	W
Pulsed Drain Current	$t_p = 10 \mu\text{s}$		I_{DM}	-25	A
Operating Junction and Storage Temperature		T_J, T_{STG}	-55 to 150	$^\circ\text{C}$	
Operating Case Temperature (Note 3)		T_C	-55 to 125	$^\circ\text{C}$	
Source Current (Body Diode) ²		I_S	-2.8	A	
Lead Temperature for Soldering Purposes (1/8" from case for 10 s)		T_L	260	$^\circ\text{C}$	

THERMAL RESISTANCE RATINGS

Parameter	Symbol	Max	Units
Junction-to-Ambient – Steady State (Note 3)	$R_{\theta JA}$	299	$^\circ\text{C}/\text{W}$
Junction-to-Ambient – $t < 10 \text{ s}$ (Note 3)	$R_{\theta JA}$	81.4	$^\circ\text{C}/\text{W}$
Junction-to-Ambient – Steady State (Note 1)	$R_{\theta JA}$	85.5	$^\circ\text{C}/\text{W}$
Junction-to-Ambient – $t < 10 \text{ s}$ (Note 1)	$R_{\theta JA}$	58.7	$^\circ\text{C}/\text{W}$
Junction-to-Case – $t < 10 \text{ s}$ (Note 3)	ψ_{JC}	26	$^\circ\text{C}/\text{W}$

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

- Surface-mounted on FR4 board using 1 in sq pad size (Cu area = 1.127 sq in [1 oz] including traces).
- Surface-mounted on FR4 board using 0.5 in sq pad size, 1 oz. Cu.
- Surface-mounted on FR4 board using 50 sq mm pad size, 1 oz. Cu.

P-Channel MOSFET Electrical Characteristics ($T_J = 25^\circ\text{C}$ unless otherwise specified)

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
-----------	--------	----------------	-----	-----	-----	------

OFF CHARACTERISTICS

Drain-to-Source Breakdown Voltage	$V_{(BR)DSS}$	$V_{GS} = 0 \text{ V}, I_D = -250 \mu\text{A}$	-12.0			V
Drain-to-Source Breakdown Voltage Temperature Coefficient	$V_{(BR)DSS}/T_J$	$I_D = -250 \mu\text{A}, \text{ref to } 25^\circ\text{C}$		-10.1		$\text{mV}/^\circ\text{C}$
Zero Gate Voltage Drain Current	I_{DSS}	$V_{GS} = 0 \text{ V}, V_{DS} = -12 \text{ V}$	$T_J = 25^\circ\text{C}$		-1.0	μA
			$T_J = 125^\circ\text{C}$		-10	
Gate-to-Source Leakage Current	I_{GSS}	$V_{DS} = 0 \text{ V}, V_{GS} = \pm 8 \text{ V}$			± 200	nA

ON CHARACTERISTICS (Note 4)

Gate Threshold Voltage	$V_{GS(TH)}$	$V_{GS} = V_{DS}, I_D = -250 \mu\text{A}$	-0.45	-0.67	-1.1	V
Negative Threshold Temperature Coefficient	$V_{GS(TH)}/T_J$			2.68		$\text{mV}/^\circ\text{C}$
Drain-to-Source On Resistance	$R_{DS(on)}$	$V_{GS} = -4.5 \text{ V}, I_D = -3.0 \text{ A}$		32	40	$\text{m}\Omega$
		$V_{GS} = -2.5 \text{ V}, I_D = -3.0 \text{ A}$		44	50	
Forward Transconductance	g_{FS}	$V_{DS} = -16 \text{ V}, I_D = -3.0 \text{ A}$		5.9		S

- Pulsed Condition: Pulse Width = 300 μs , Duty Cycle $\leq 2\%$

NUS5531MT

P-Channel MOSFET Electrical Characteristics (T_J = 25°C unless otherwise specified)

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
-----------	--------	----------------	-----	-----	-----	------

CHARGES, CAPACITANCES AND GATE RESISTANCE

Input Capacitance	C _{ISS}	V _{GS} = 0 V, f = 1.0 MHz, V _{DS} = -12 V		1329		pF
Output Capacitance	C _{OSS}			200		
Reverse Transfer Capacitance	C _{RSS}			116		
Total Gate Charge	Q _{G(tot)}	V _{GS} = -4.5 V, V _{DS} = -12 V, I _D = -3.0 A		13		nC
Threshold Gate Charge	Q _{G(th)}			1.1		
Gate-to-Source Charge	Q _{GS}			1.7		
Gate-to-Drain Charge	Q _{GD}			2.5		

SWITCHING CHARACTERISTICS

Turn-On Delay Time	t _{d(on)}	V _{GS} = -4.5 V, V _{DD} = -12 V, I _D = -3.0 A, R _G = 3.0		8		ns
Rise Time	t _r			17.5		
Turn-Off Delay Time	t _{d(off)}			80		
Fall Time	t _f			56.5		

DRAIN-SOURCE DIODE CHARACTERISTICS

Forward Recovery Voltage	V _{SD}	V _{GS} = 0 V, I _S = -1.0 A	T _J = 25°C		-0.66	-1.2	V
			T _J = 125°C		-0.54		
Reverse Recovery Time	t _{rr}	V _{GS} = 0 V, dI _{SD} /dt = 100 A/μs, I _S = -1.0 A		70.8		ns	
Charge Time	t _a			14.3			
Discharge Time	t _b			56.4			
Reverse Recovery Charge	Q _{RR}			44			nC

Single-PNP Transistor Maximum Ratings (T_J = 25°C unless otherwise stated)

Parameter	Symbol	Value	Units
Collector-Emitter Voltage	V _{CEO}	-20	V
Collector-Base Voltage	V _{CB0}	-20	V
Emitter-Base Voltage	V _{EBO}	-7.0	V
Collector Current, Continuous	I _C	-2.0	A
Collector Current, Peak	I _C	-4.0	A
Operating Junction and Storage Temperature	T _J , T _{STG}	-55 to 150	°C
Power Dissipation, T _A = 25°C (Note 5)	P _D	1.58	W
Thermal Resistance (Note 5)	R _{θJA}	61.5	°C/W
Power Dissipation, T _A = 25°C (Note 6)	P _D	0.43	W
Thermal Resistance (Note 6)	R _{θJA}	293	°C/W

5. Surface-mounted on FR4 board using 1 in sq pad size (Cu area = 1.127 sq in [1 oz] including traces)
 6. Surface-mounted on FR4 board using 50 sq mm pad size, 1 oz. Cu.

NUS5531MT

Single-PNP Transistor Electrical Characteristics ($T_J = 25^\circ\text{C}$ unless otherwise stated)

Parameter	Symbol	Test Condition	Min	Typ	Max	Units
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage	$V_{br_{CEO}}$	$I_C = -10\text{ mA}, I_B = 0$	-20			V
Collector-Base Breakdown Voltage	$V_{br_{CBO}}$	$I_C = -0.1\text{ mA}, I_E = 0$	-20			V
Emitter-Base Breakdown Voltage	$V_{br_{EBO}}$	$I_E = -0.1\text{ mA}, I_C = 0$	-7.0			V
Collector-Emitter Cutoff Current	I_{CES}	$V_{CES} = -15\text{ V}$			-0.1	μA

ON CHARACTERISTICS

DC Current Gain (Note 7)	h_{FE}	$I_C = -1.0\text{ A}, V_{CE} = -2.0\text{ V}$	180			-
DC Current Gain (Note 7)	h_{FE}	$I_C = -2.0\text{ A}, V_{CE} = -2.0\text{ V}$	150			-
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C = -1.0\text{ A}, I_B = -0.01\text{ A}$		-0.10	-0.12	V
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C = -1.0\text{ A}, I_B = -0.1\text{ A}$		-0.065	-0.09	V
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C = -2.0\text{ A}, I_B = -0.2\text{ A}$		-0.13	-0.18	V
Base-Emitter Saturation Voltage (Note 7)	$V_{BE(sat)}$	$I_C = -1.0\text{ A}, I_B = -0.01\text{ A}$			-0.9	V
Base-Emitter Turn-On Voltage (Note 7)	$V_{BE(on)}$	$I_C = -1.0\text{ A}, I_B = -2.0\text{ A}$			-0.9	V
Cutoff Frequency (Note 8)	f_T	$I_C = -100\text{ mA}, V_{CE} = -5.0\text{ V}$ $f = 100\text{ MHz}$	100			MHz
Input Capacitance (Note 8)	C_{ibo}	$V_{EB} = -0.5\text{ V}, f = 1.0\text{ MHz}$			330	pF
Output Capacitance (Note 8)	C_{obo}	$V_{CB} = -3.0\text{ V}, f = 1.0\text{ MHz}$			100	pF

7. Pulsed Condition: Pulse Width = 300 μsec , Duty Cycle $\leq 2\%$
 8. Guaranteed by design but not tested.

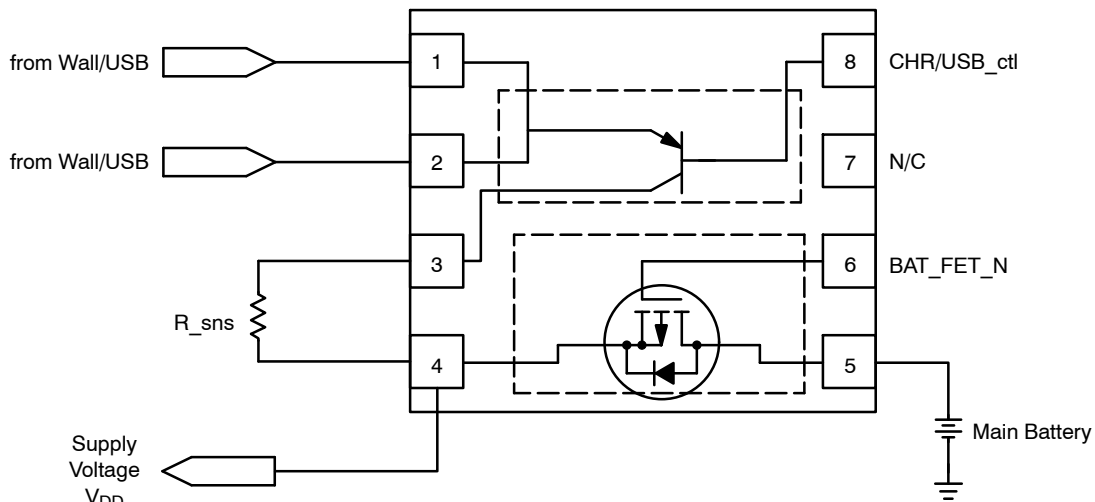


Figure 2. Typical Application Circuit

TYPICAL CHARACTERISTICS - MOSFET

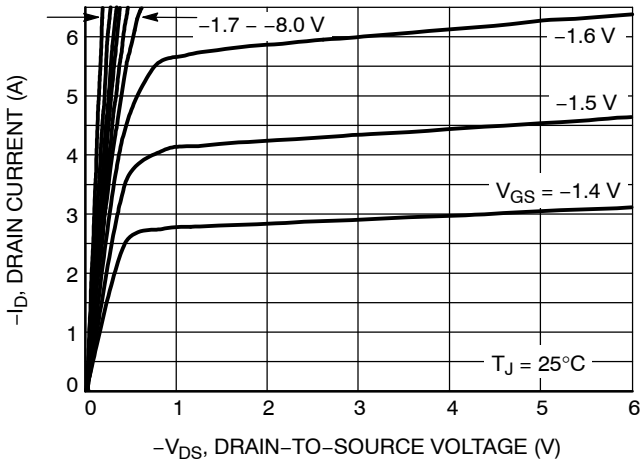


Figure 3. On-Region Characteristics

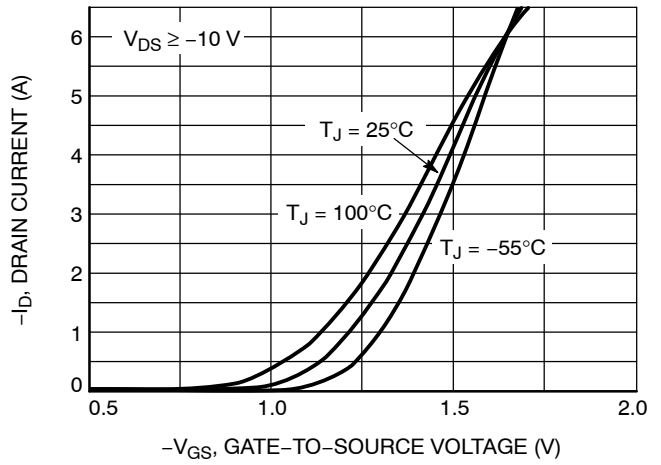


Figure 4. Transfer Characteristics

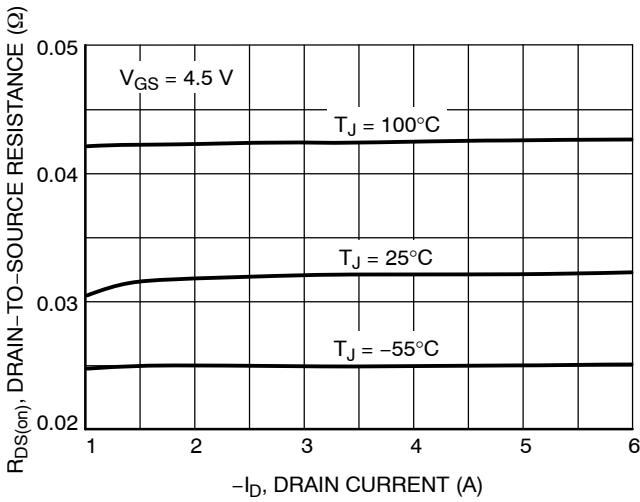


Figure 5. On-Resistance vs. Drain Current

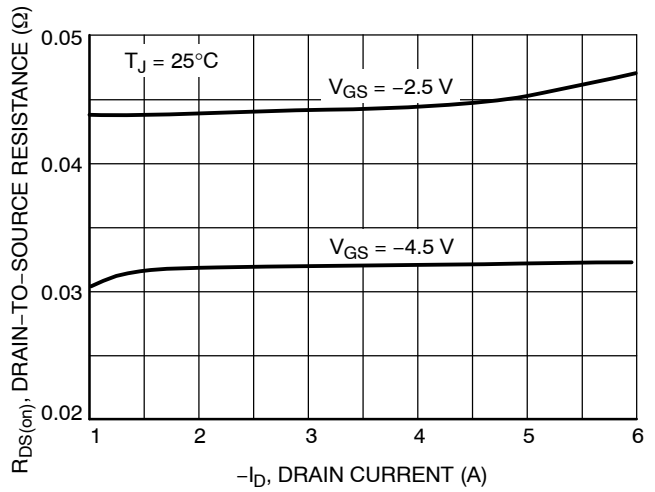


Figure 6. On-Resistance vs. Drain Current and Gate Voltage

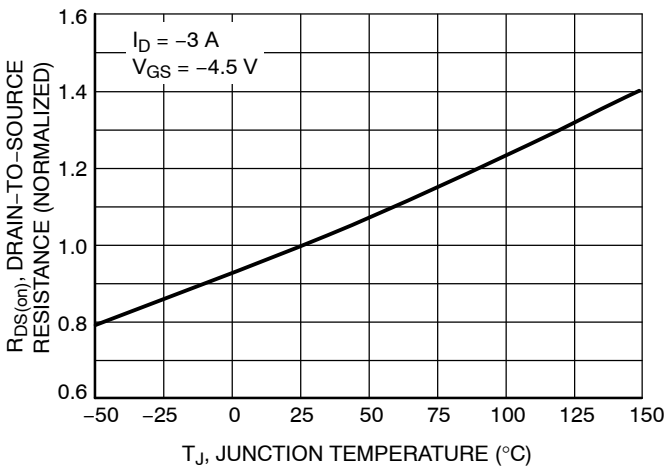


Figure 7. On-Resistance Variation with Temperature

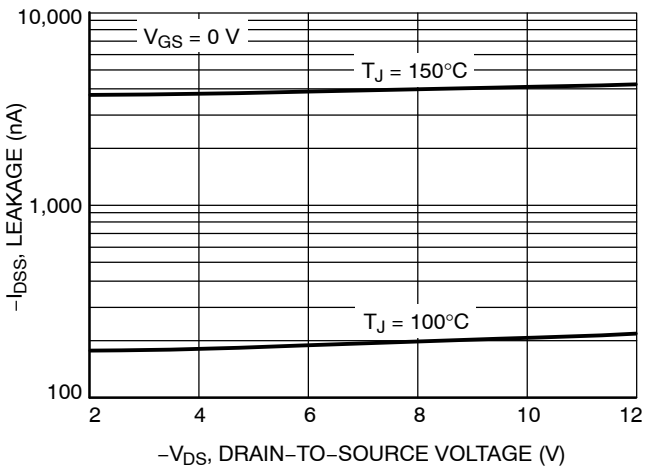


Figure 8. Drain-to-Source Leakage Current vs. Voltage

TYPICAL CHARACTERISTICS - MOSFET

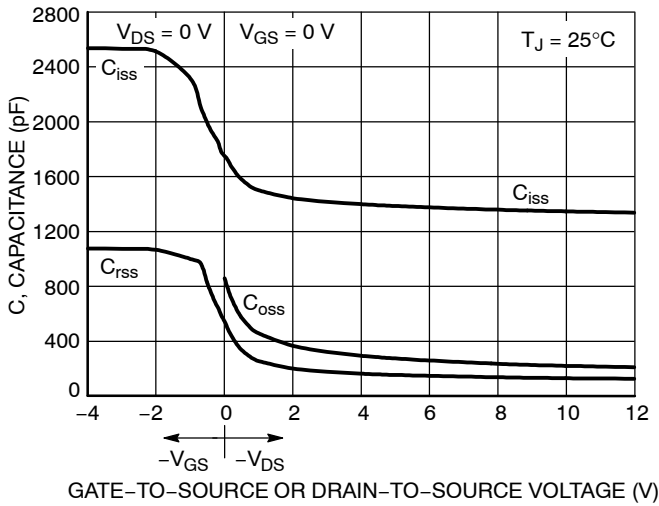


Figure 9. Capacitance Variation

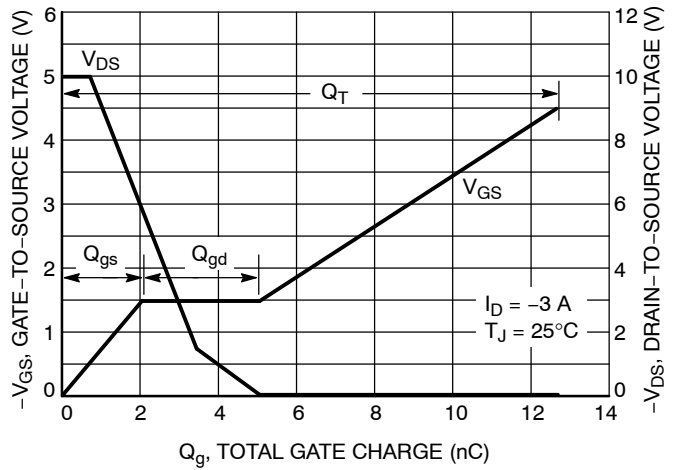


Figure 10. Gate-to-Source and Drain-to-Source Voltage vs. Total Charge

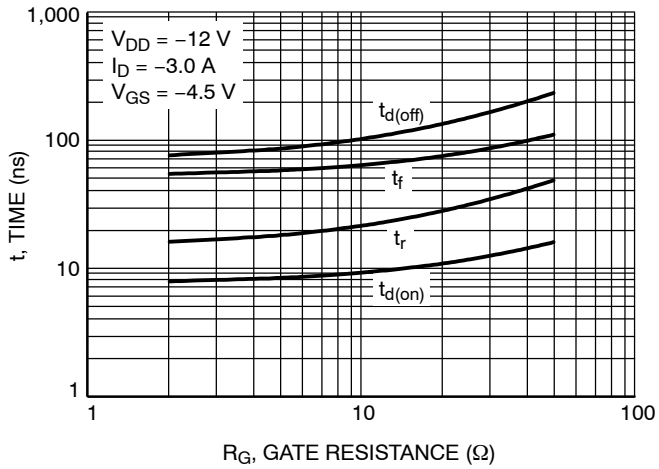


Figure 11. Resistive Switching Time Variation vs. Gate Resistance

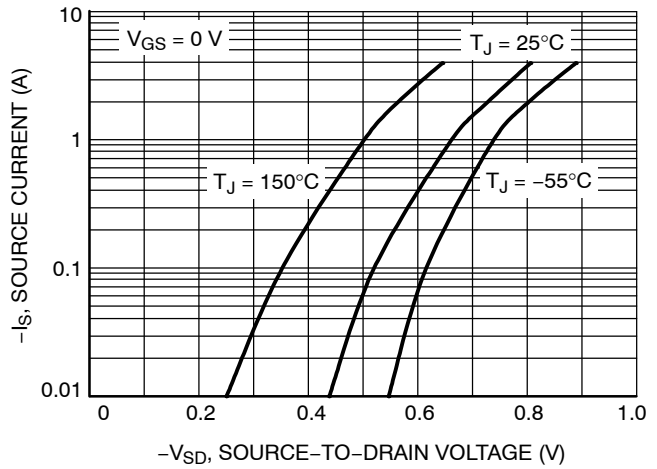
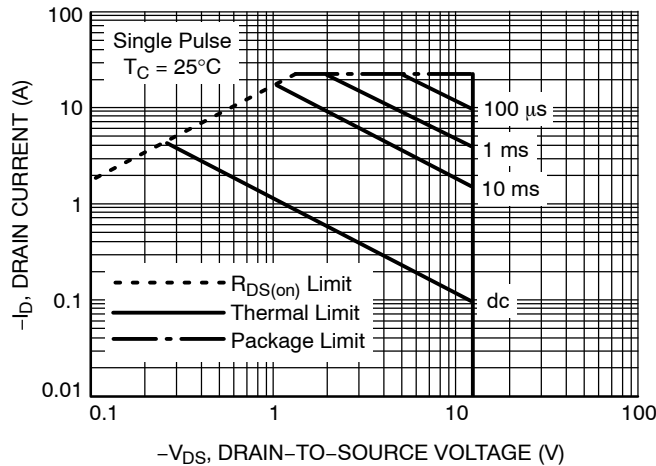


Figure 12. Diode Forward Voltage vs. Current



Mounted on 2" sq. FR4 board (0.5" sq. 2 oz. Cu single sided) with MOSFET die operating.

Figure 13. Maximum Rated Forward Biased Safe Operating Area

NUS5531MT

TYPICAL CHARACTERISTICS - MOSFET

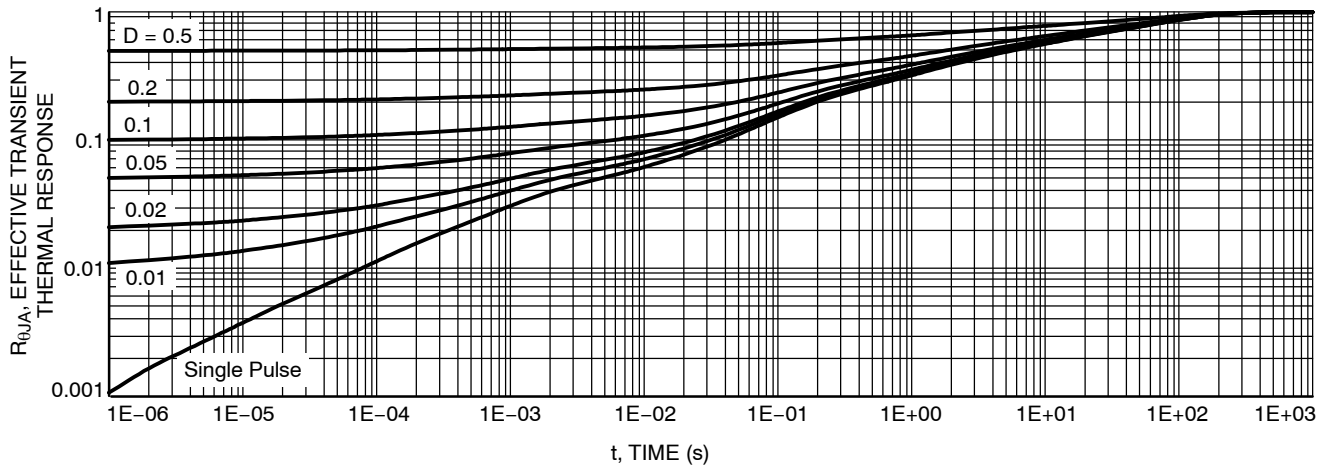


Figure 14. FET Thermal Response

TYPICAL CHARACTERISTICS – BJT

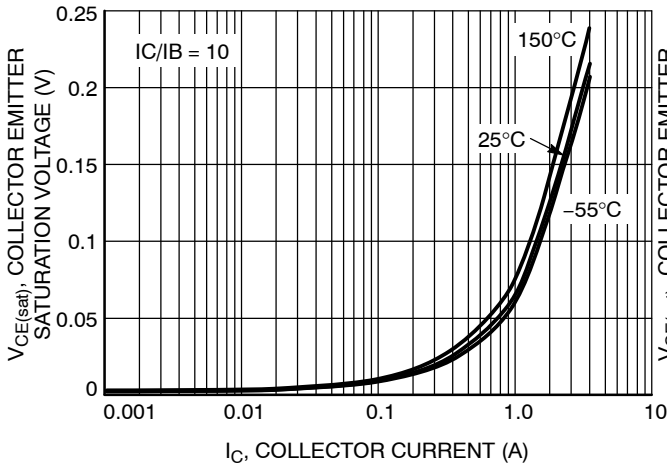


Figure 15. Collector Emitter Saturation Voltage vs. Collector Current

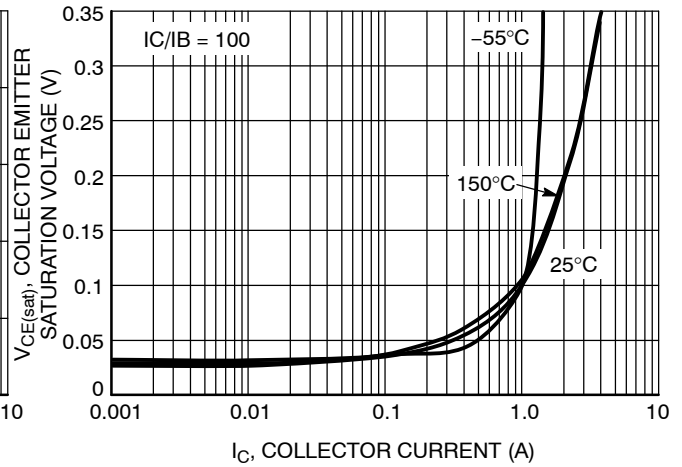


Figure 16. Collector Emitter Saturation Voltage vs. Collector Current

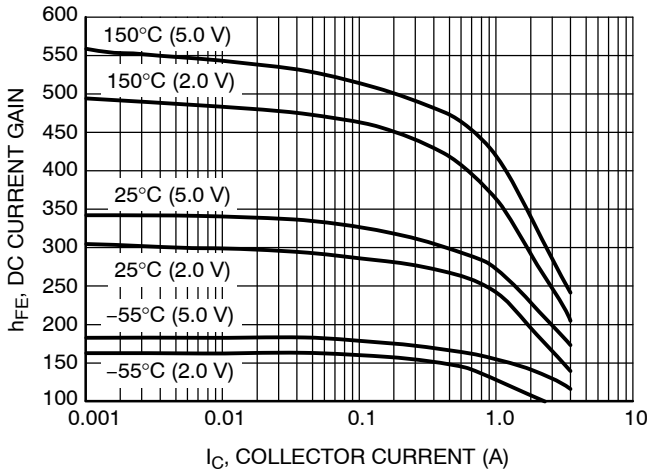


Figure 17. DC Current Gain vs. Collector Current

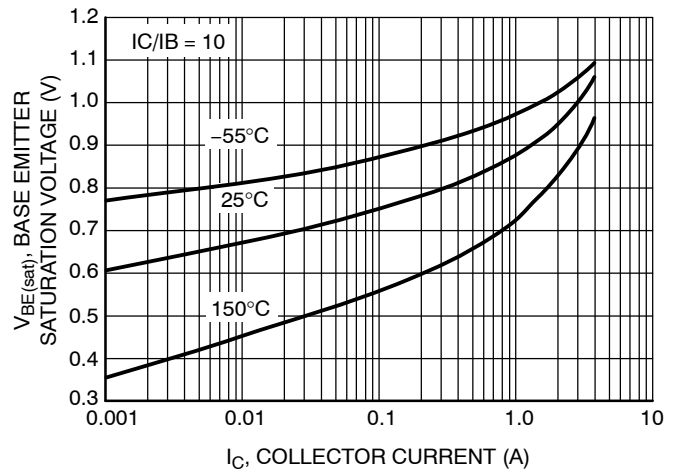


Figure 18. Base Emitter Saturation Voltage vs. Collector Current

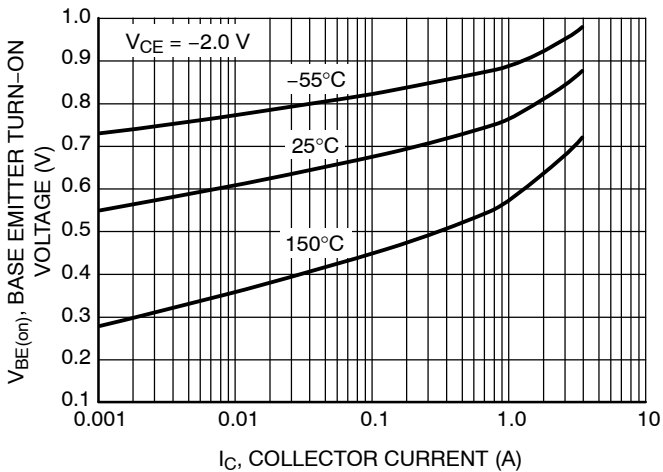


Figure 19. Base Emitter Turn-On Voltage vs. Collector Current

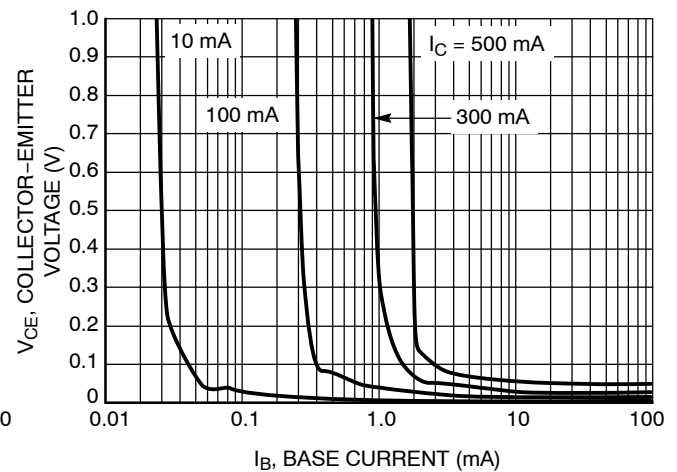


Figure 20. Saturation Region

NUS5531MT

TYPICAL CHARACTERISTICS - BJT

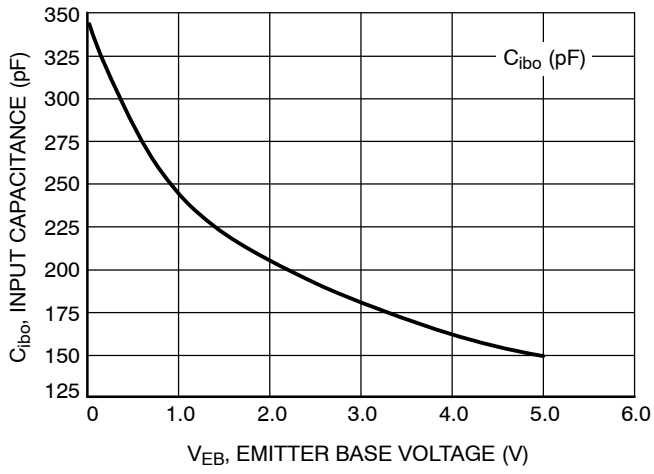


Figure 21. Input Capacitance

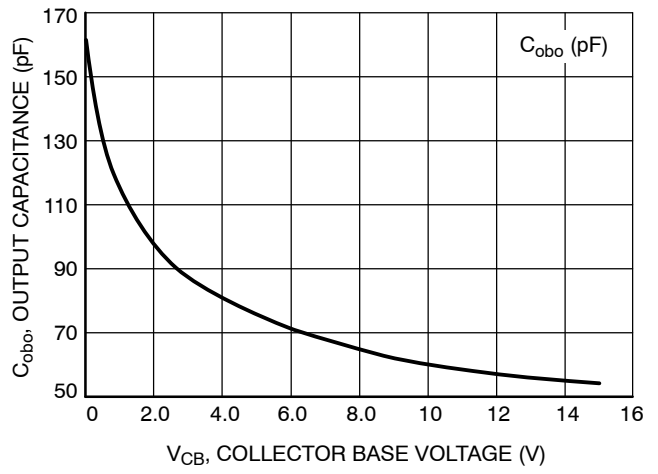


Figure 22. Output Capacitance

MECHANICAL CASE OUTLINE

PACKAGE DIMENSIONS

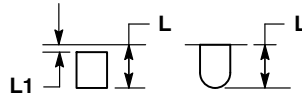
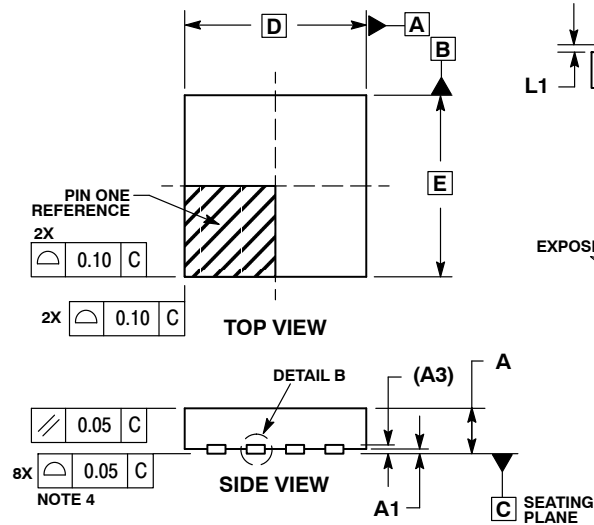
ON Semiconductor®



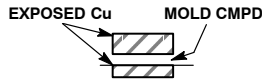
SCALE 2:1

WDFN8, 3x3, 0.65P
CASE 506BC-01
ISSUE A

DATE 28 MAY 2008



DETAIL A
OPTIONAL
CONSTRUCTIONS

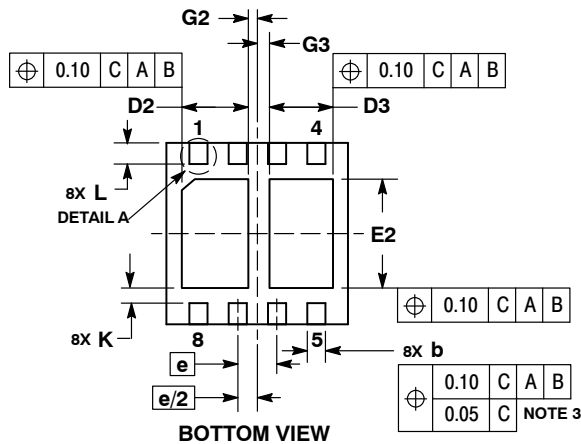


DETAIL B
OPTIONAL
CONSTRUCTIONS

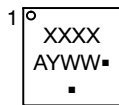
NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. DIMENSION b APPLIES TO PLATED TERMINAL AND IS MEASURED BETWEEN 0.15 AND 0.30mm.
4. COPLANARITY APPLIES TO THE EXPOSED PAD AS WELL AS THE TERMINALS.

MILLIMETERS		
DIM	MIN	MAX
A	0.70	0.80
A1	0.00	0.05
A3	0.20	REF
b	0.25	0.35
D	3.00	BSC
D2	1.00	1.20
D3	0.95	1.15
E	3.00	BSC
E2	1.70	1.90
e	0.65	BSC
G2	0.15	BSC
G3	0.20	BSC
K	0.20	---
L	0.25	0.45
L1	---	0.15



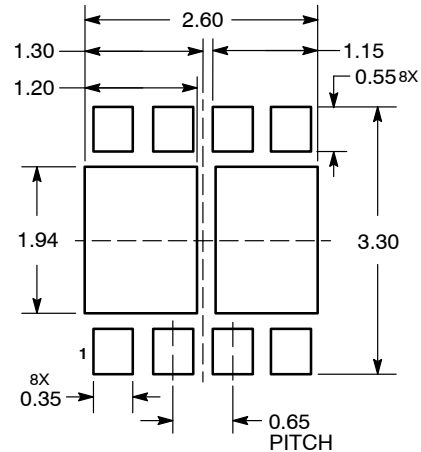
GENERIC MARKING DIAGRAM*



- XXXX = Specific Device Code
- A = Assembly Location
- Y = Year
- WW = Work Week
- = Pb-Free Package

*This information is generic. Please refer to device data sheet for actual part marking.
Pb-Free indicator, "G" or microdot "▪", may or may not be present.

SOLDERING FOOTPRINT*



DIMENSIONS: MILLIMETERS

*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

DOCUMENT NUMBER:	98AON23220D	Electronic versions are uncontrolled except when accessed directly from the Document Repository. Printed versions are uncontrolled except when stamped "CONTROLLED COPY" in red.
DESCRIPTION:	WDFN8, 3X3, 0.65P, DUAL FLAG	PAGE 1 OF 1

ON Semiconductor and ON are trademarks of Semiconductor Components Industries, LLC dba ON Semiconductor or its subsidiaries in the United States and/or other countries. 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. ON Semiconductor does not convey any license under its patent rights nor the rights of others.

onsemi, **Onsemi**, and other names, marks, and brands are registered and/or common law trademarks of Semiconductor Components Industries, LLC dba "**onsemi**" or its affiliates and/or subsidiaries in the United States and/or other countries. **onsemi** owns the rights to a number of patents, trademarks, copyrights, trade secrets, and other intellectual property. A listing of **onsemi**'s product/patent coverage may be accessed at www.onsemi.com/site/pdf/Patent-Marking.pdf. **onsemi** reserves the right to make changes at any time to any products or information herein, without notice. The information herein is provided "as-is" and **onsemi** makes no warranty, representation or guarantee regarding the accuracy of the information, product features, availability, functionality, or suitability of its products for any particular purpose, nor does **onsemi** 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 **onsemi** products, including compliance with all laws, regulations and safety requirements or standards, regardless of any support or applications information provided by **onsemi**. "Typical" parameters which may be provided in **onsemi** 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. **onsemi** does not convey any license under any of its intellectual property rights nor the rights of others. **onsemi** 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 **onsemi** products for any such unintended or unauthorized application, Buyer shall indemnify and hold **onsemi** 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 **onsemi** was negligent regarding the design or manufacture of the part. **onsemi** 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:

Email Requests to: orderlit@onsemi.com

onsemi Website: www.onsemi.com

TECHNICAL SUPPORT

North American Technical Support:
Voice Mail: 1 800-282-9855 Toll Free USA/Canada
Phone: 011 421 33 790 2910

Europe, Middle East and Africa Technical Support:

Phone: 00421 33 790 2910

For additional information, please contact your local Sales Representative