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

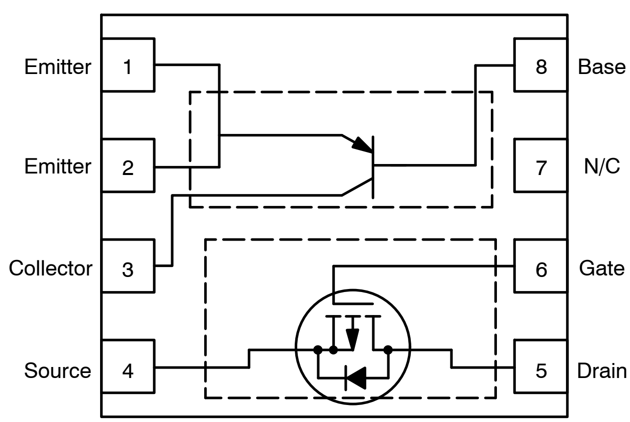
This device integrates one high performance power MOSFET and one low $V_{ce(sat)}$ transistor, greatly reducing the layout space and optimizing charging performance in battery−powered portable electronics.

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)



(Top View)

Figure 1. Simple Schematic

ON Semiconductor®

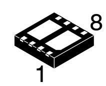
http://onsemi.com

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	

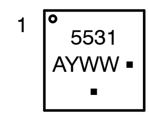
Low $V_{ce(sat)}$ PNP (Wall/USB)

V_{CEO} MAX	V_{EBO} MAX	I_C MAX
−20 V	−7.0 V	−2.0 A



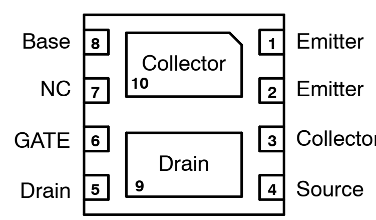
WDFN8
CASE 506BC

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



(Bottom View)

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.

P−Channel Power MOSFET Maximum Ratings (T_J = 25°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°C	I_D	−5.47	A
		T_A = 85°C		−4.0	
	t ≤ 5 s	T_A = 25°C		−6.2	
Power Dissipation (Note 1)	Steady State	T_A = 25°C	P_D	1.46	W
	t ≤ 10 s			2.1	
Continuous Drain Current (Note 2)	Steady State	T_A = 25°C	I_D	−4.4	A
		T_A = 85°C		−3.2	
Power Dissipation (Note 3)	T_A = 25°C		P_D	0.418	W
Pulsed Drain Current	t_p = 10 μs		I_{DM}	−25	A
Operating Junction and Storage Temperature			T_J, T_{STG}	−55 to 150	°C
Operating Case Temperature (Note 3)			T_C	−55 to 125	°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	°C

THERMAL RESISTANCE RATINGS

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

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

P−Channel MOSFET Electrical Characteristics (T_J = 25°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 V, I_D = −250 μA		−12.0			V
Drain−to−Source Breakdown Voltage Temperature Coefficient	$V_{(BR)DSS}/T_J$	I_D = −250 μA, ref to 25°C			−10.1		mV/°C
Zero Gate Voltage Drain Current	I_{DSS}	V_{GS} = 0 V, V_{DS} = −12 V	T_J = 25°C			−1.0	μA
			T_J = 125°C			−10	
Gate−to−Source Leakage Current	I_{GSS}	V_{DS} = 0 V, V_{GS} = ±8 V				±200	nA
ON CHARACTERISTICS (Note 4)							
Gate Threshold Voltage	$V_{GS(TH)}$	V_{GS} = V_{DS}, I_D = −250 μA		−0.45	−0.67	−1.1	V
Negative Threshold Temperature Coefficient	$V_{GS(TH)}/T_J$				2.68		mV/°C
Drain−to−Source On Resistance	$R_{DS(on)}$	V_{GS} = −4.5 V, I_D = −3.0 A			32	40	mΩ
		V_{GS} = −2.5 V, I_D = −3.0 A			44	50	
Forward Transconductance	g_{FS}	V_{DS} = −16 V, I_D = −3.0 A			5.9		S

4. Pulsed Condition: Pulse Width = 300 μsec, Duty Cycle ≤ 2%

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, dISD/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_{CBO}	−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)	$R_{\theta JA}$	61.5	°C/W
Power Dissipation, T_A = 25°C (Note 6)	P_D	0.43	W
Thermal Resistance (Note 6)	$R_{\theta JA}$	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.

Single−PNP Transistor Electrical Characteristics (T_J = 25°C unless otherwise stated)

Parameter	Symbol	Test Condition	Min	Typ	Max	Units
OFF CHARACTERISTICS						
Collector−Emitter Breakdown Voltage	Vbr_{CEO}	I_C = −10 mA, I_B = 0	−20			V
Collector−Base Breakdown Voltage	Vbr_{CBO}	I_C = −0.1 mA, I_E = 0	−20			V
Emitter−Base Breakdown Voltage	Vbr_{EBO}	I_E = −0.1 mA, I_C = 0	−7.0			V
Collector−Emitter Cutoff Current	I_{CES}	V_{CES} = −15 V			−0.1	μA
ON CHARACTERISTICS						
DC Current Gain (Note 7)	h_{FE}	I_C = −1.0 A, V_{CE} = −2.0 V	180			–
DC Current Gain (Note 7)	h_{FE}	I_C = −2.0 A, V_{CE} = −2.0 V	150			–
Collector−Emitter Saturation Voltage	$V_{CE(sat)}$	I_C = −1.0 A, I_B = −0.01 A		−0.10	−0.12	V
Collector−Emitter Saturation Voltage	$V_{CE(sat)}$	I_C = −1.0 A, I_B = −0.1 A		−0.065	−0.09	V
Collector−Emitter Saturation Voltage	$V_{CE(sat)}$	I_C = −2.0 A, I_B = −0.2 A		−0.13	−0.18	V
Base−Emitter Saturation Voltage (Note 7)	$V_{BE(sat)}$	I_C = −1.0 A, I_B = −0.01 A			−0.9	V
Base−Emitter Turn−On Voltage (Note 7)	$V_{BE(on)}$	I_C = −1.0 A, I_B = −2.0 A			−0.9	V
Cutoff Frequency (Note 8)	f_T	I_C = −100 mA, V_{CE} = −5.0 V f = 100 MHz	100			MHz
Input Capacitance (Note 8)	C_{ibo}	V_{EB} = −0.5 V, f = 1.0 MHz			330	pF
Output Capacitance (Note 8)	C_{obo}	V_{CB} = −3.0 V, f = 1.0 MHz			100	pF

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

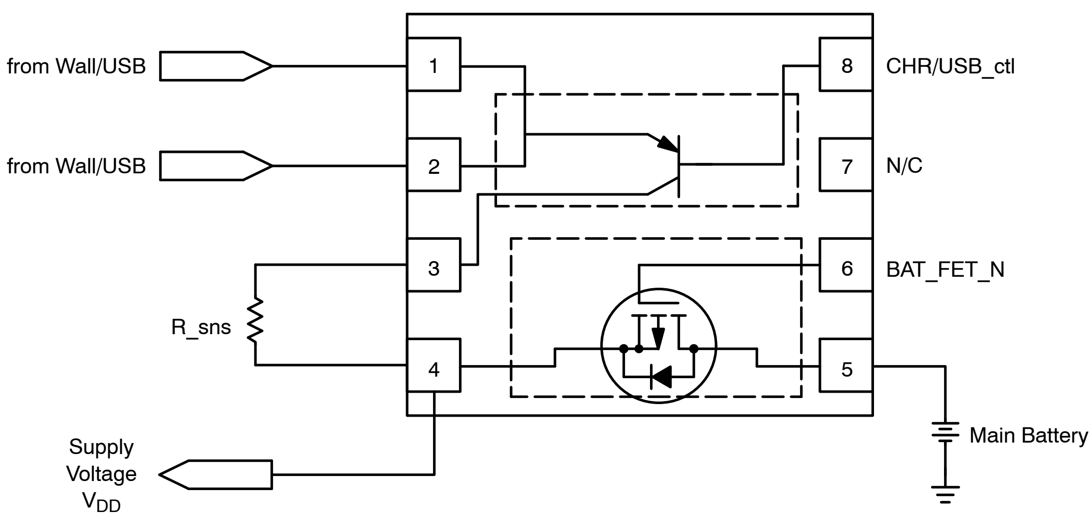


Figure 2. Typical Application Circuit

TYPICAL CHARACTERISTICS – MOSFET

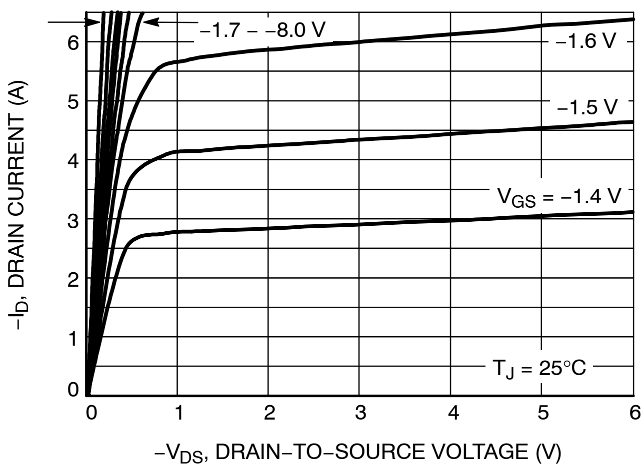


Figure 3. On−Region Characteristics

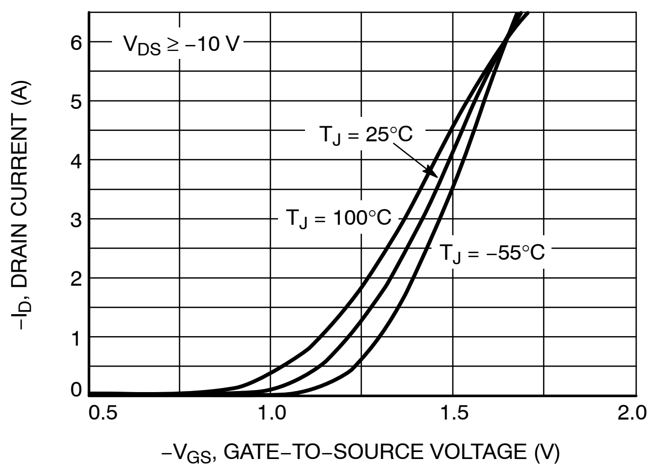


Figure 4. Transfer Characteristics

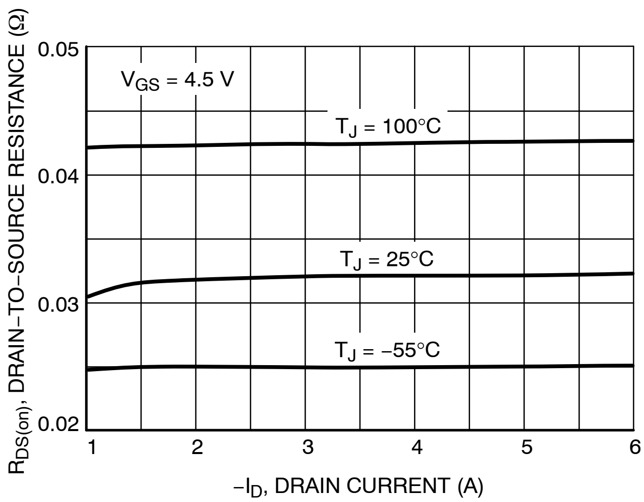


Figure 5. On−Resistance vs. Drain Current

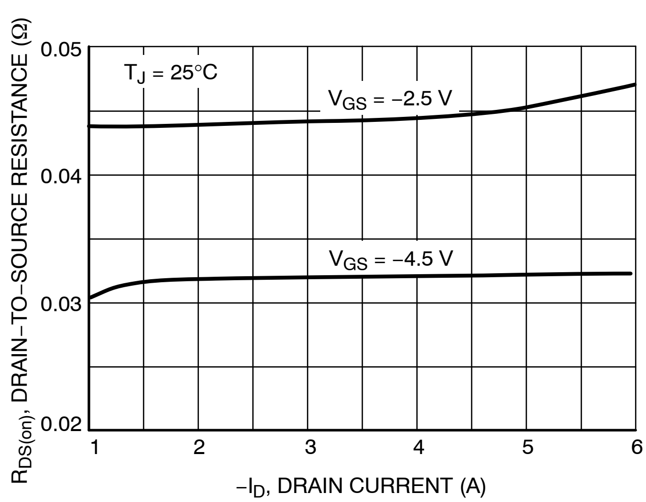


Figure 6. On−Resistance vs. Drain Current and Gate Voltage

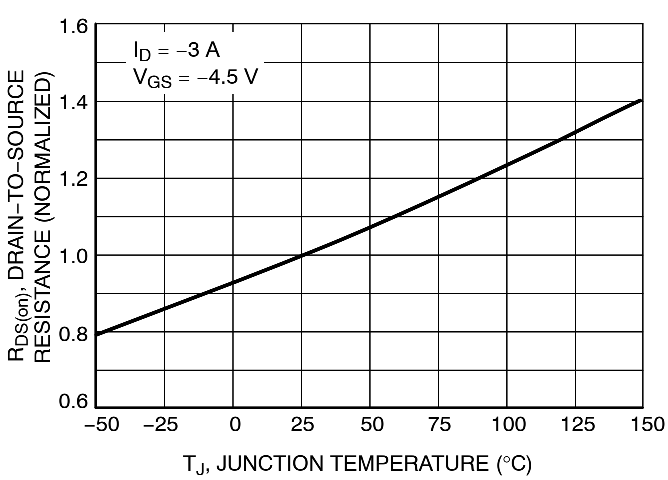


Figure 7. On−Resistance Variation with Temperature

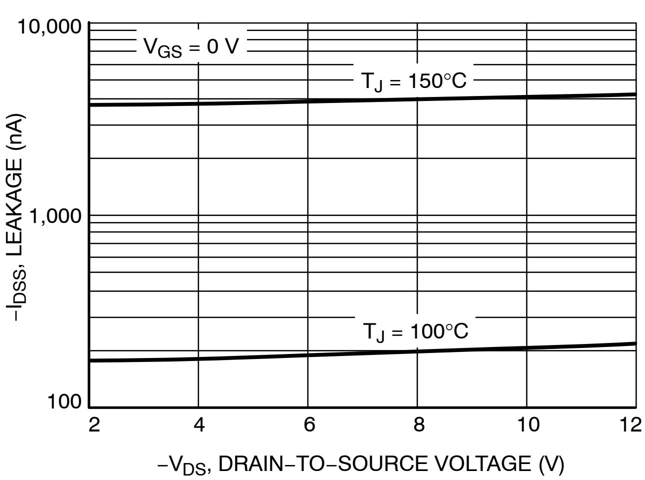


Figure 8. Drain−to−Source Leakage Current vs. Voltage

TYPICAL CHARACTERISTICS − MOSFET

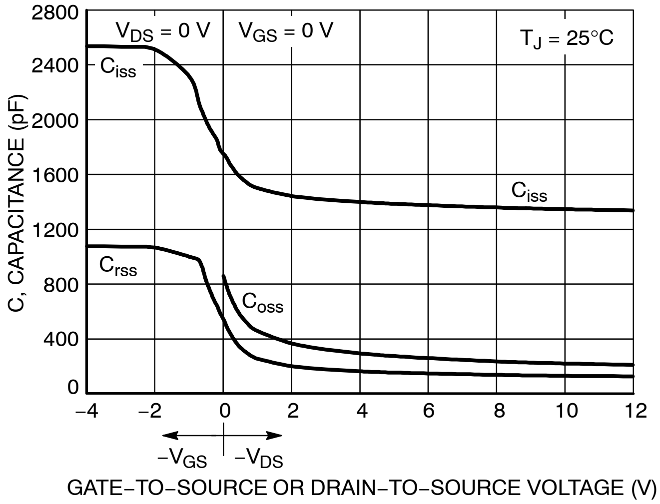


Figure 9. Capacitance Variation

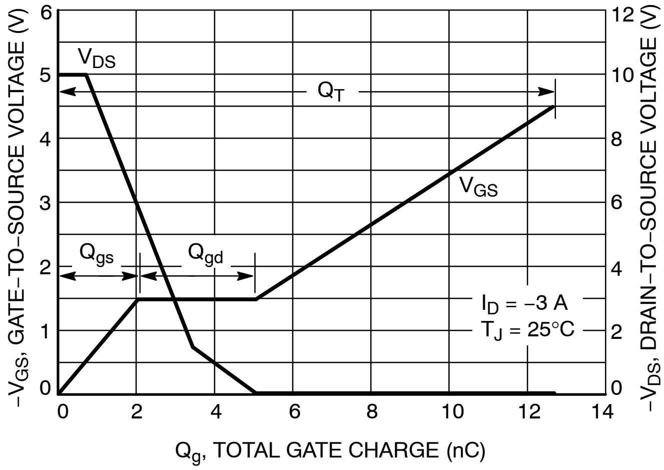


Figure 10. Gate−to−Source and Drain−to−Source Voltage vs. Total Charge

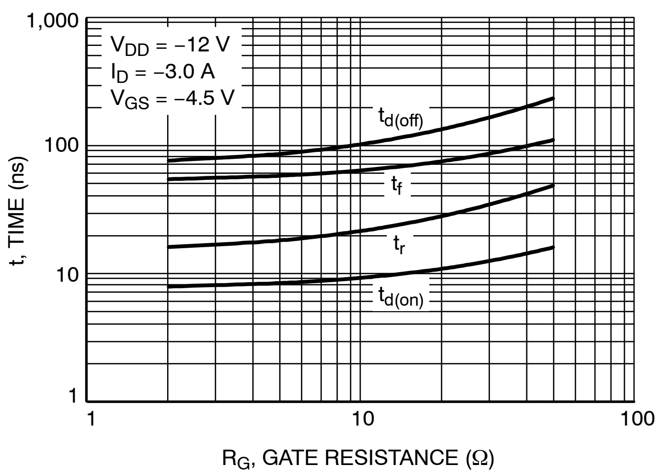


Figure 11. Resistive Switching Time Variation vs. Gate Resistance

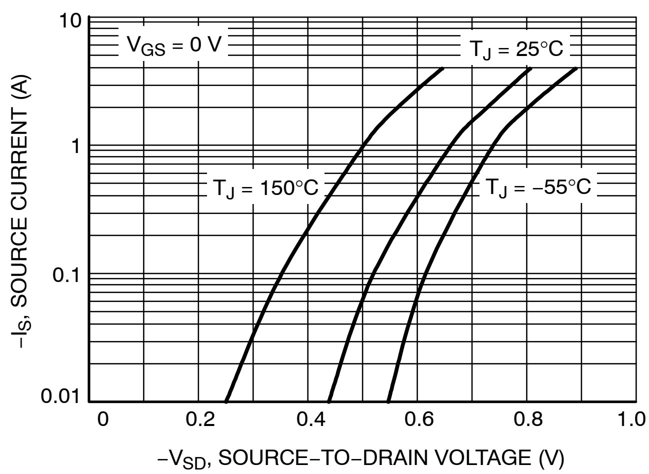
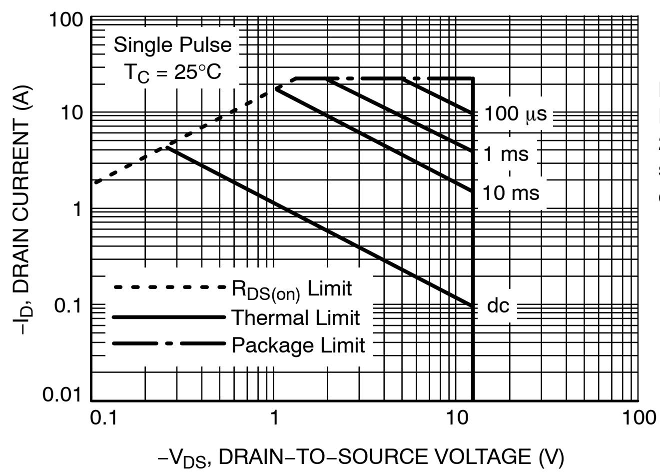


Figure 12. Diode Forward Voltage vs. Current



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

TYPICAL CHARACTERISTICS – MOSFET

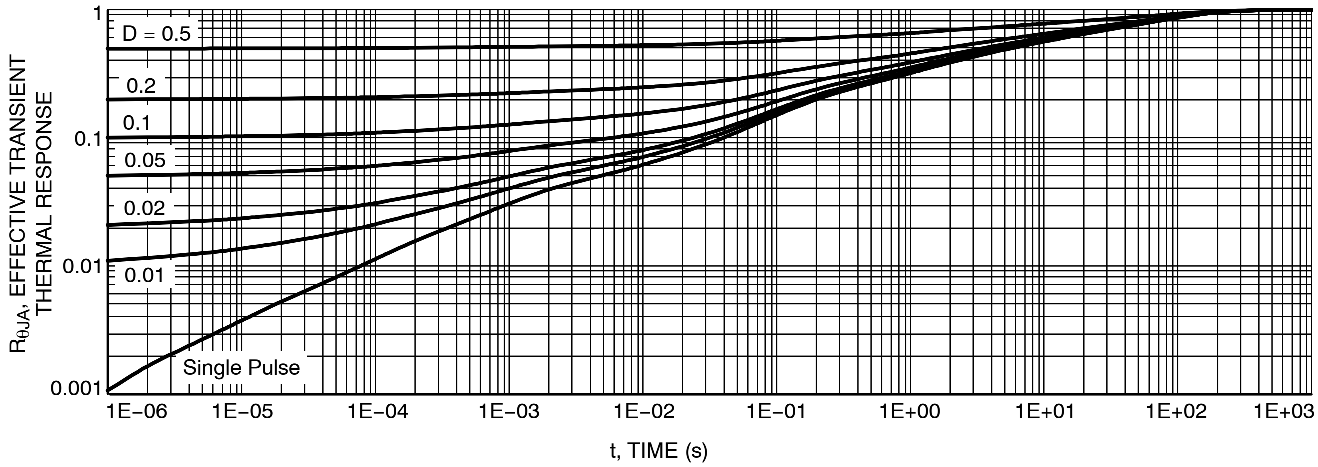


Figure 14. FET Thermal Response

TYPICAL CHARACTERISTICS − BJT

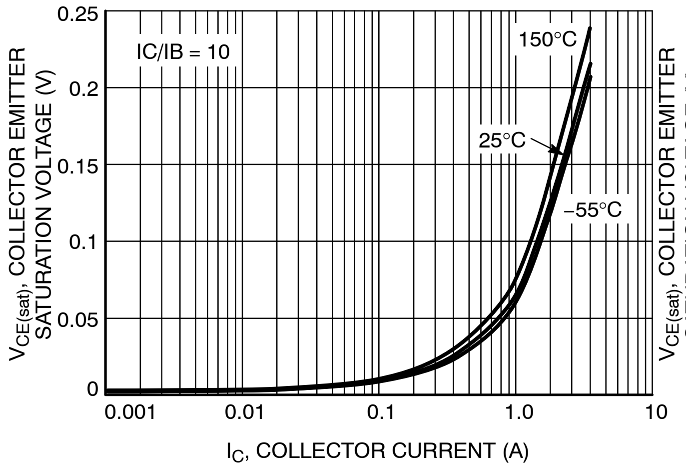


Figure 15. Collector Emitter Saturation Voltage vs. Collector Current

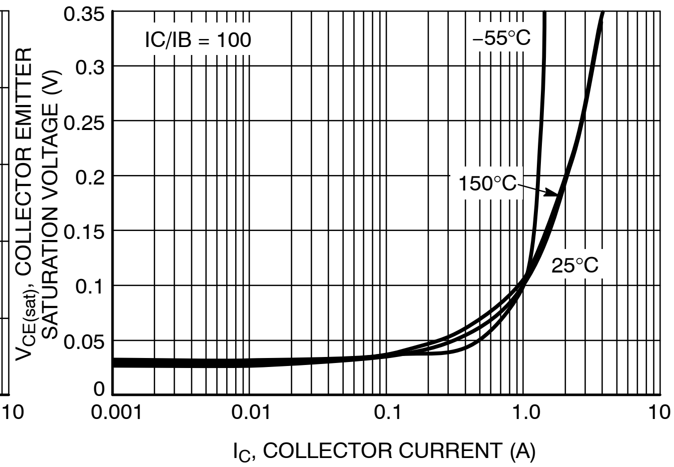


Figure 16. Collector Emitter Saturation Voltage vs. Collector Current

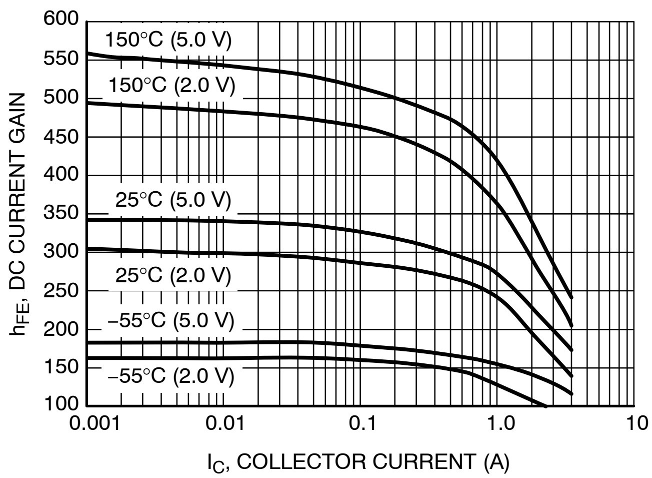


Figure 17. DC Current Gain vs. Collector Current

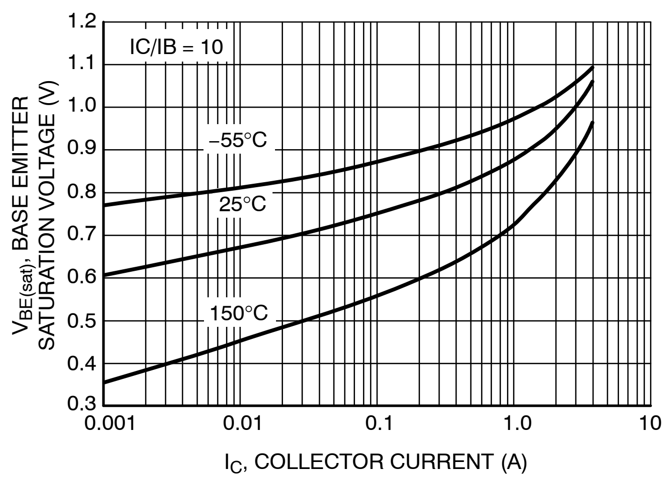


Figure 18. Base Emitter Saturation Voltage vs. Collector Current

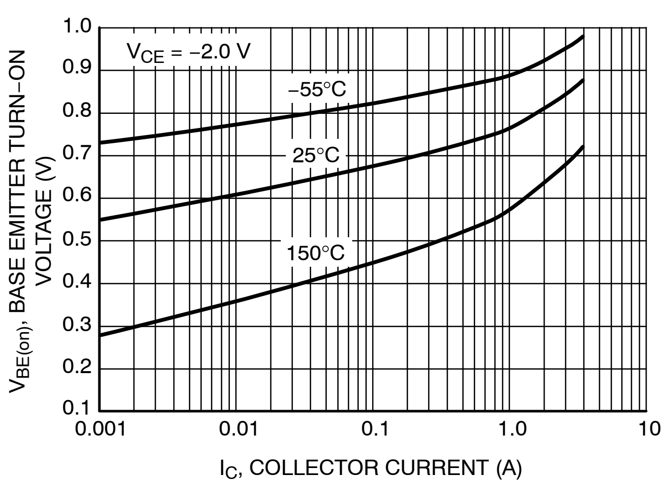


Figure 19. Base Emitter Turn−On Voltage vs. Collector Current

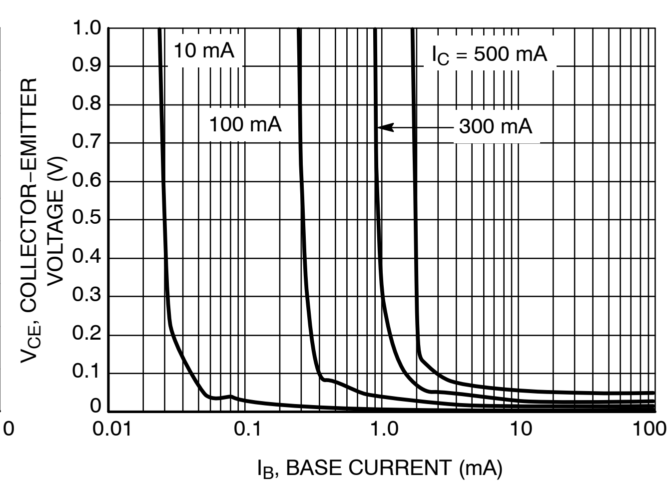


Figure 20. Saturation Region

TYPICAL CHARACTERISTICS – BJT

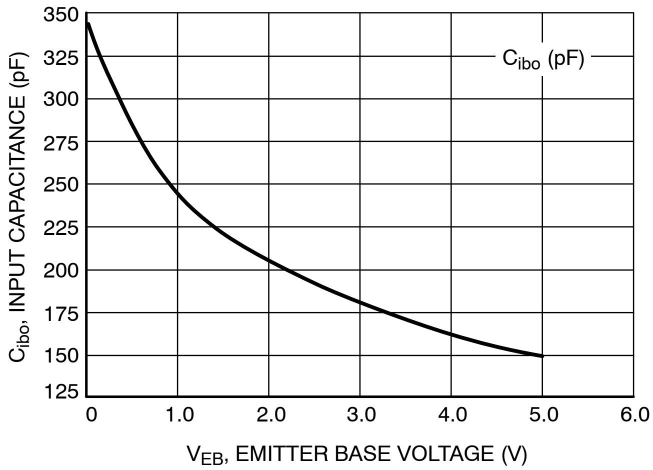


Figure 21. Input Capacitance

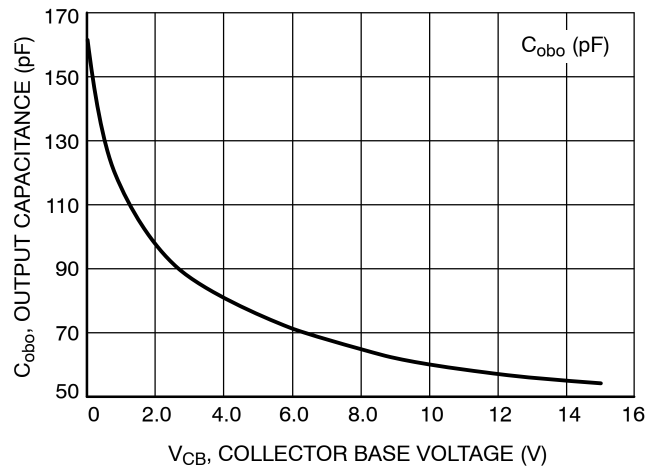
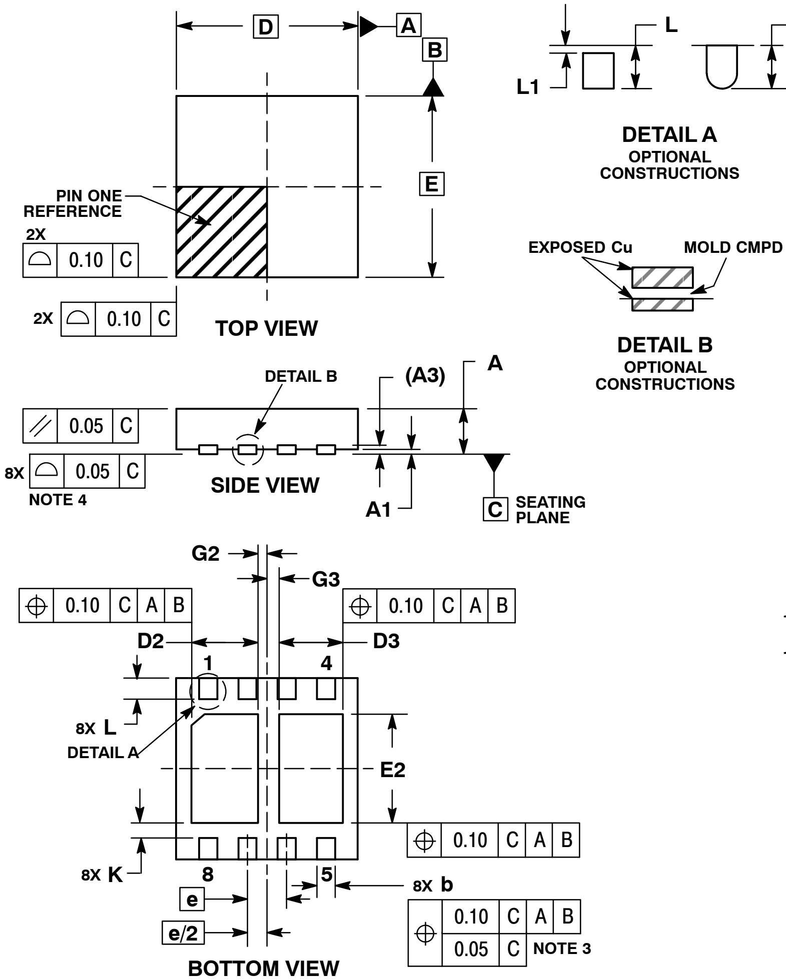


Figure 22. Output Capacitance

PACKAGE DIMENSIONS

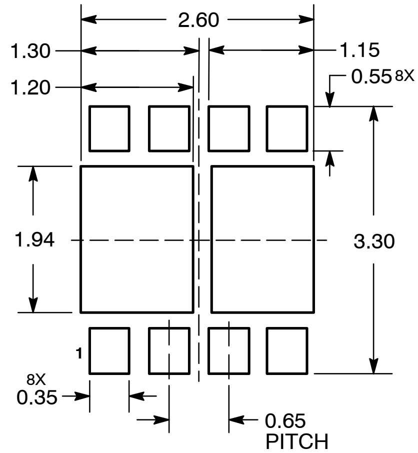
WDFN8, 3x3, 0.65P
CASE 506BC−01
ISSUE A



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

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.

PUBLICATION ORDERING INFORMATION

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