

NUS3116MT

Main Switch Power MOSFET and Dual Charging BJT

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

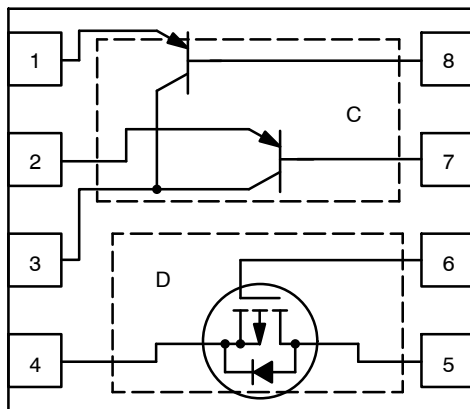
This device integrates one high performance power MOSFET and two low $V_{ce(sat)}$ transistors, greatly reducing the layout space and optimizing charging performance in the battery-powered portable electronics.

Features

- High Performance Power MOSFET
- Dual-Low $V_{ce(sat)}$ Transistors 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)



DFN8 3x3 Pin Connections
(Top View)

Figure 1. Simple Schematic



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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)

| V_{CE0} MAX | V_{EBO} MAX | I_C MAX |
|---------------|---------------|-----------|
| -30 V | -8.0 V | -2.0 A |

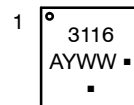
Low $V_{ce(sat)}$ PNP (USB)

| V_{CE0} MAX | V_{EBO} MAX | I_C MAX |
|---------------|---------------|-----------|
| -30 V | -8.0 V | -2.0 A |



DFN8
CASE 506BC

MARKING DIAGRAM



3116 = Device Code
 A = Assembly Location
 Y = Year
 WW = Work Week
 ■ = Pb-Free Package
 (Note: Microdot may be in either location)

ORDERING INFORMATION

| Device | Package | Shipping† |
|--------------|--------------------|------------------|
| NUS3116MTR2G | 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.

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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 | $T_A = 25^\circ\text{C}$ | 1.7 | W | |
| | | $t \leq 5\text{ s}$ | 2.2 | | |
| Continuous Drain Current (Note 2, Minimum Pad) | Steady State | $T_A = 25^\circ\text{C}$ | -4.4 | A | |
| | | $T_A = 85^\circ\text{C}$ | -3.2 | | |
| Power Dissipation (Note 2) | | $T_A = 25^\circ\text{C}$ | 1.14 | 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 | | $^\circ\text{C}$ | |
| 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 2) | $R_{\theta JA}$ | 110 | $^\circ\text{C/W}$ |
| Junction-to-Ambient – $t < 10\text{ s}$ (Note 2) | $R_{\theta JA}$ | 56 | $^\circ\text{C/W}$ |
| Junction-to-Ambient – Steady State (Note 1) | $R_{\theta JA}$ | 72 | $^\circ\text{C/W}$ |
| Junction-to-Ambient – $t < 10\text{ s}$ (Note 1) | $R_{\theta JA}$ | 40 | $^\circ\text{C/W}$ |

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

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

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

| Parameter | Symbol | Test Condition | Min | Typ | Max | Units |
|---|-------------------|--|---------------------------|-------|-----------|----------------------------|
| 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 3)

| | | | | | | |
|--|------------------|---|-------|-------|------|----------------------------|
| 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 μsec , Duty Cycle $\leq 2\%$

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

| Parameter | Symbol | Test Condition | Min | Typ | Max | Units |
|--|---------------------|---|-----|------|-----|-------|
| 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)} | | | 1.5 | | |
| Gate-to-Source Charge | Q _{GS} | | | 2.2 | | |
| Gate-to-Drain Charge | Q _{GD} | | | 2.9 | | |

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 | |

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

Dual-PNP Transistors Maximum Ratings (T_J = 25°C unless otherwise stated)

| Parameter | Symbol | Value | Units |
|--|-----------------------------------|------------|-------|
| Collector-Emitter Voltage | V _{CEO} | -30 | V |
| Collector-Base Voltage | V _{CBO} | -30 | V |
| Emitter-Base Voltage | V _{EBO} | -8.0 | V |
| Collector Current, Continuous | I _C | -2.0 | A |
| Collector Current, Pulsed (Note 4) | I _C | -6.0 | A |
| Operating Junction and Storage Temperature | T _J , T _{STG} | -55 to 150 | °C |
| Thermal Resistance Dissipation | P _D | 1.5 | W |
| Thermal Resistance (Note 5) | R _{θJA} | 83 | °C/W |
| Thermal Resistance Dissipation | P _D | 810 | mW |
| Thermal Resistance (Note 6) | R _{θJA} | 155 | °C/W |

4. Single Pulse: Pulse Width = 1 ms

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

6. Surface-mounted on FR4 board using the minimum recommended pad size of 100 mm², 1 oz. Cu.

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

| Parameter | Symbol | Test Condition | Min | Typ | Max | Units |
|-----------|--------|----------------|-----|-----|-----|-------|
|-----------|--------|----------------|-----|-----|-----|-------|

OFF CHARACTERISTICS

| | | | | | | |
|----------------------------------|-----------|---------------------------------|------|--|------|---------------|
| Collector-Emitter Voltage | V_{CE0} | $I_C = -10\text{ mA}, I_B = 0$ | -30 | | | V |
| Collector-Base Voltage | V_{CBO} | $I_C = -0.1\text{ mA}, I_E = 0$ | -30 | | | V |
| Emitter-Base Voltage | V_{EBO} | $I_E = -0.1\text{ mA}, I_C = 0$ | -8.0 | | | V |
| Collector-Emitter Cutoff Current | I_{CES} | $V_{CES} = -30\text{ V}$ | | | -0.1 | μA |

ON CHARACTERISTICS

| | | | | | | |
|--------------------------------------|---------------|---|-----|-----|------|----|
| DC Current Gain (Note 7) | h_{FE} | $I_C = -1.0\text{ A}, V_{CE} = -2.0\text{ V}$ | 100 | 200 | | - |
| DC Current Gain (Note 7) | h_{FE} | $I_C = -2.0\text{ A}, V_{CE} = -2.0\text{ V}$ | 100 | 200 | | - |
| Collector-Emitter Saturation Voltage | $V_{CE(sat)}$ | $I_C = -1.0\text{ A}, I_B = -0.01\text{ A}$ | | | 0.22 | V |
| Collector-Emitter Saturation Voltage | $V_{CE(sat)}$ | $I_C = -1.0\text{ A}, I_B = -0.1\text{ A}$ | | | 0.12 | V |
| Collector-Emitter Saturation Voltage | $V_{CE(sat)}$ | $I_C = -2.0\text{ A}, I_B = -0.2\text{ A}$ | | | 0.24 | V |
| Input Capacitance | C_{ibo} | $V_{EB} = -0.5\text{ V}, f = 1.0\text{ MHz}$ | | 240 | 400 | pF |
| Output Capacitance | C_{obo} | $V_{CB} = -3.0\text{ V}, f = 1.0\text{ MHz}$ | | 50 | 100 | pF |

7. Pulsed Condition: Pulse Width = 300 μsec , Duty Cycle $\leq 2\%$

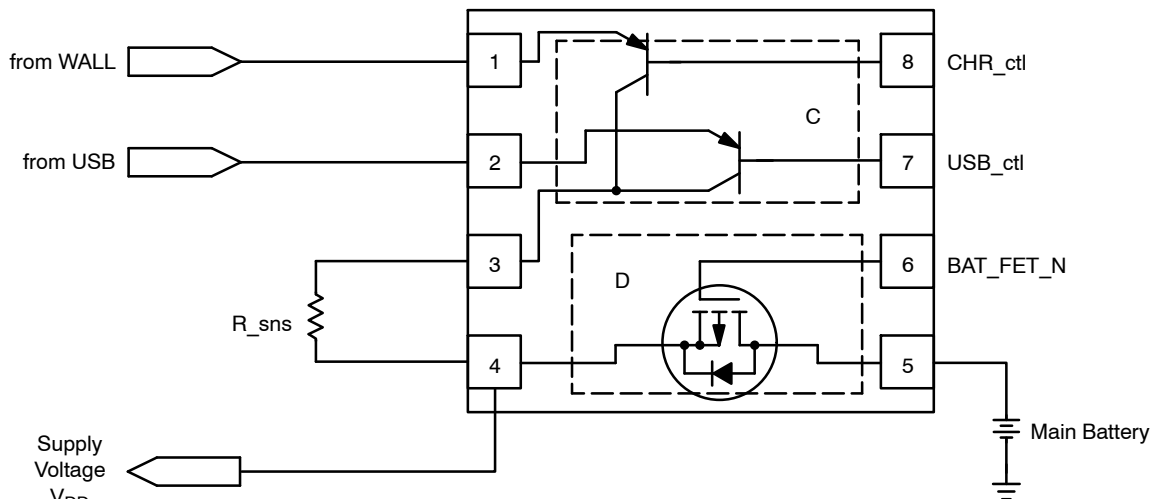


Figure 2. Typical Application Circuit

TYPICAL CHARACTERISTICS - MOSFET

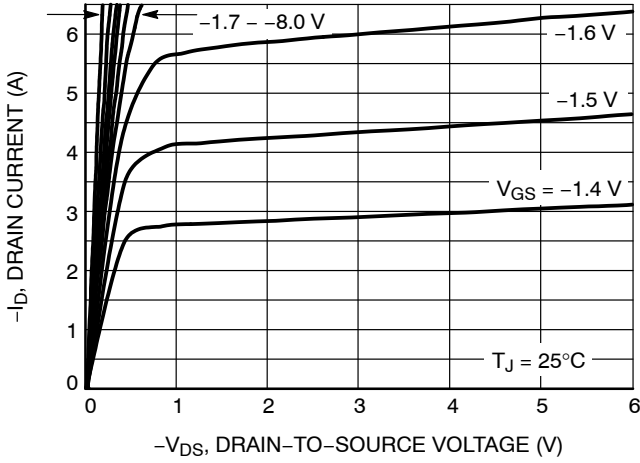


Figure 3. On-Region Characteristics

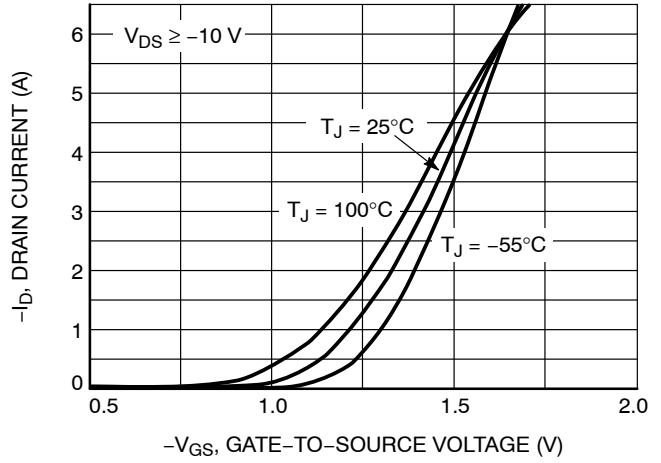


Figure 4. Transfer Characteristics

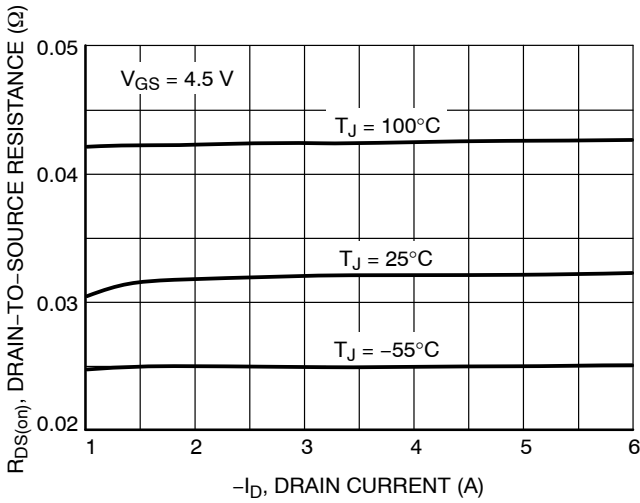


Figure 5. On-Resistance vs. Drain Current

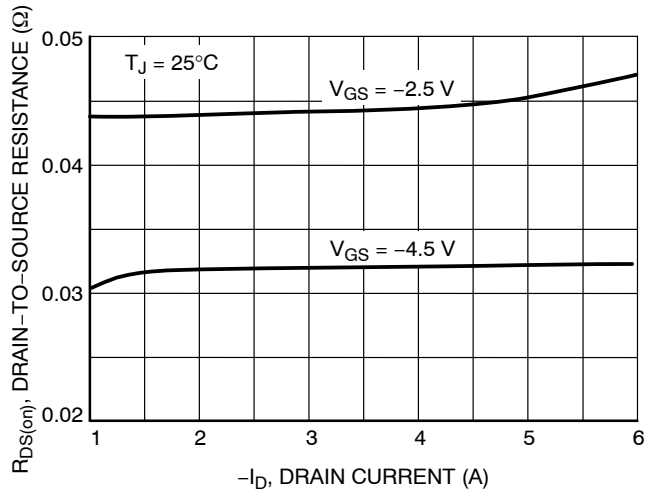


Figure 6. On-Resistance vs. Drain Current and Gate Voltage

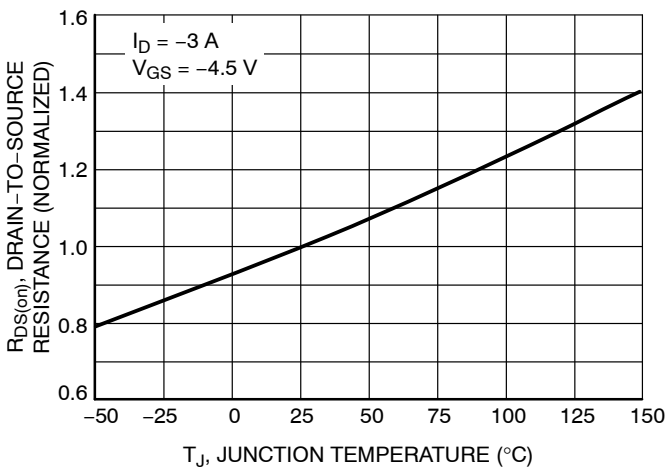


Figure 7. On-Resistance Variation with Temperature

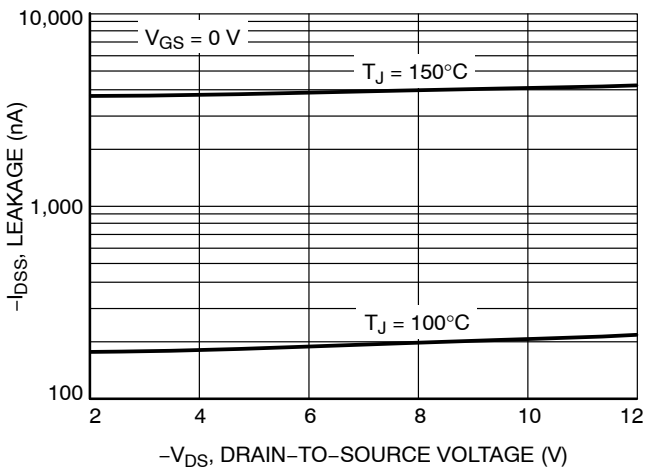


Figure 8. Drain-to-Source Leakage Current vs. Voltage

TYPICAL CHARACTERISTICS - MOSFET

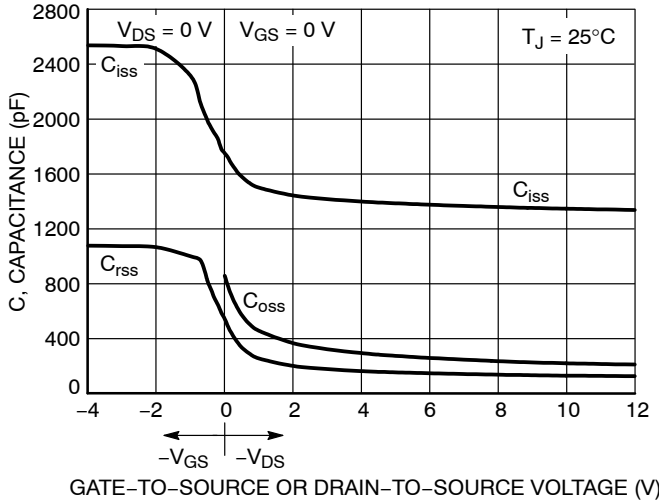


Figure 9. Capacitance Variation

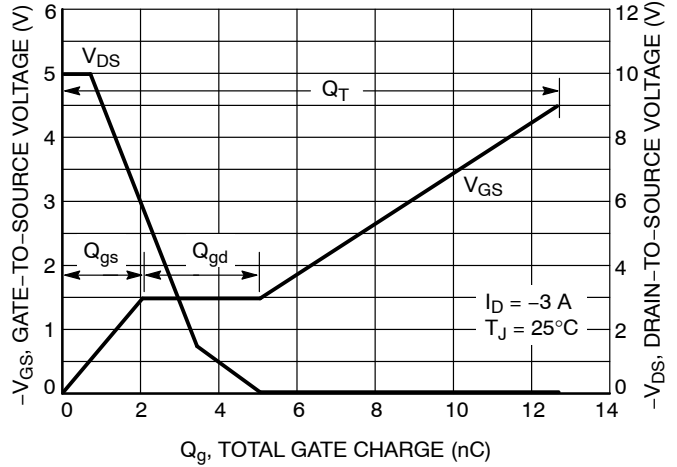


Figure 10. Gate-to-Source and Drain-to-Source Voltage vs. Total Charge

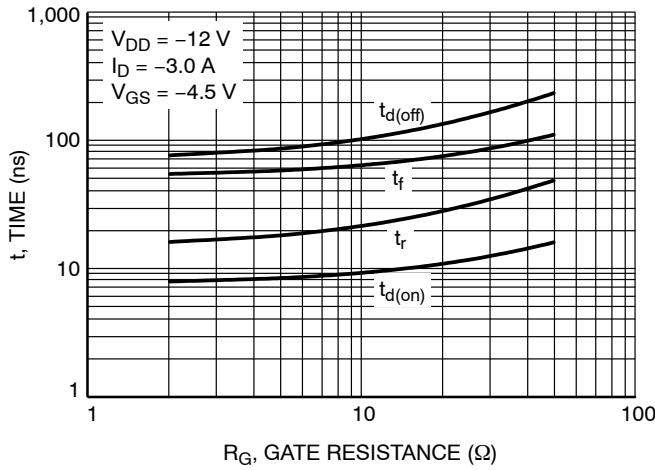


Figure 11. Resistive Switching Time Variation vs. Gate Resistance

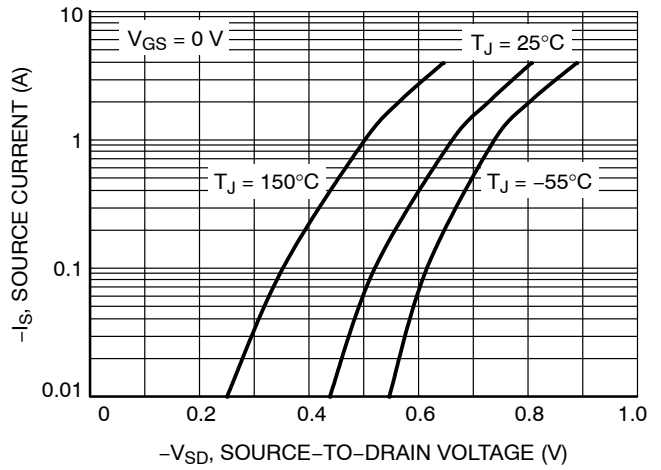
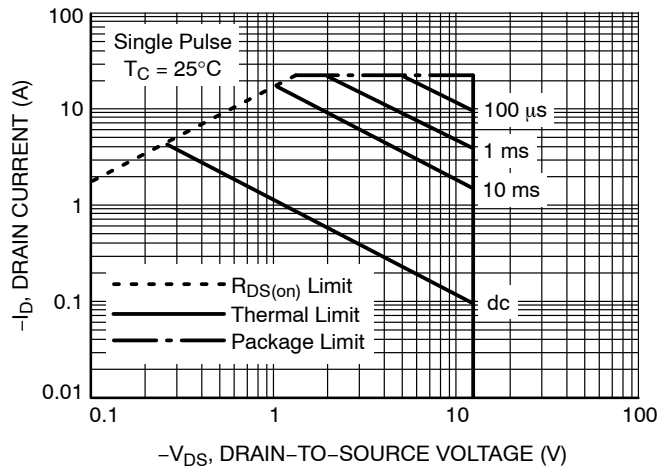


Figure 12. Diode Forward Voltage vs. Current



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

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TYPICAL CHARACTERISTICS - MOSFET

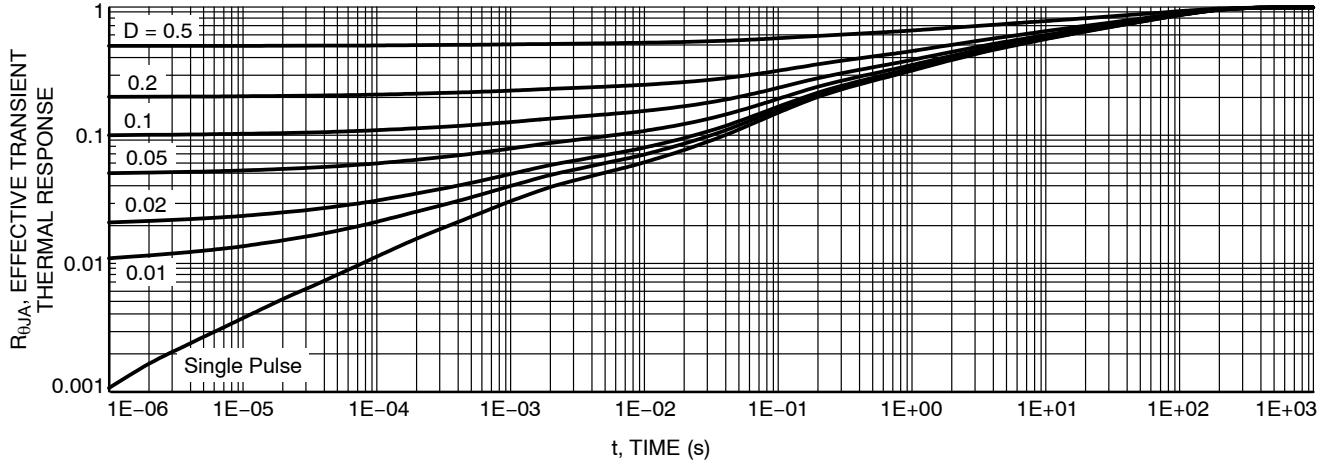


Figure 14. FET Thermal Response

TYPICAL CHARACTERISTICS – BJT

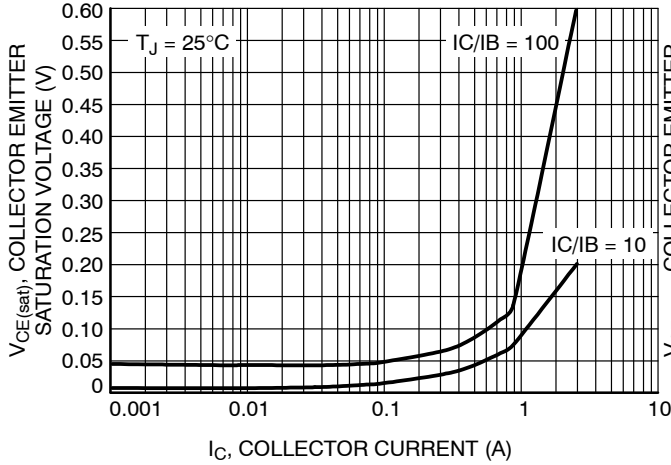


Figure 15. Collector Emitter Saturation Voltage vs. Collector Current

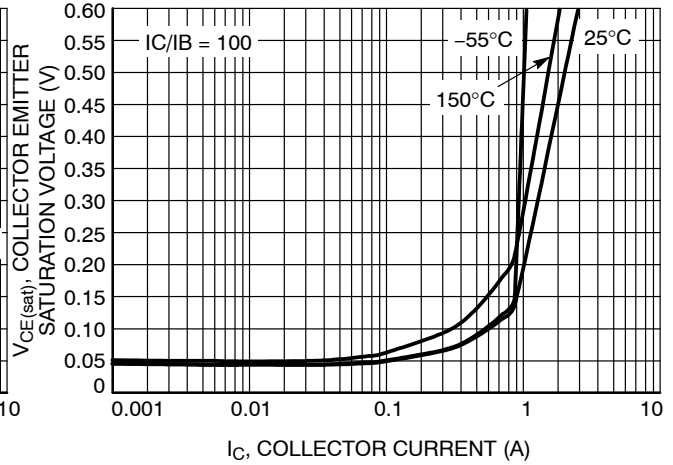


Figure 16. Collector Emitter Saturation Voltage vs. Collector Current

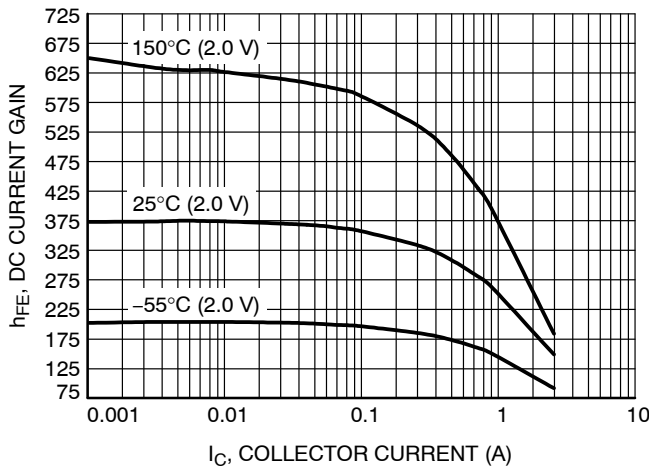


Figure 17. DC Current Gain vs. Collector Current

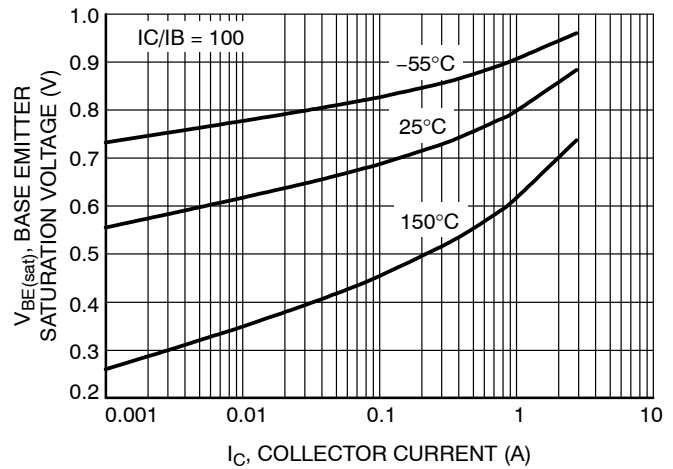


Figure 18. Base Emitter Saturation Voltage vs. Collector Current

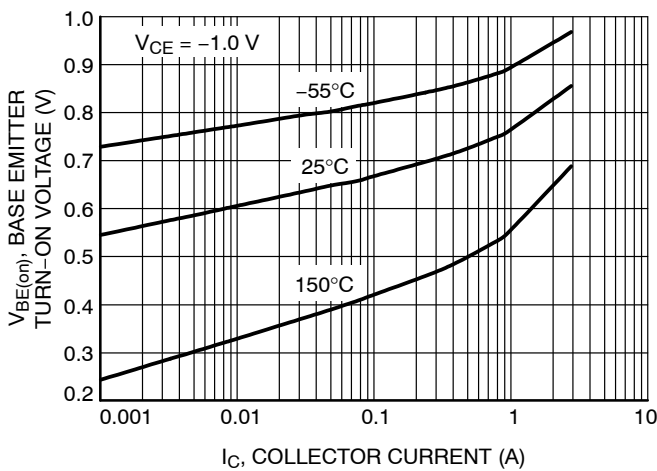


Figure 19. Base Emitter Turn-On Voltage vs. Collector Current

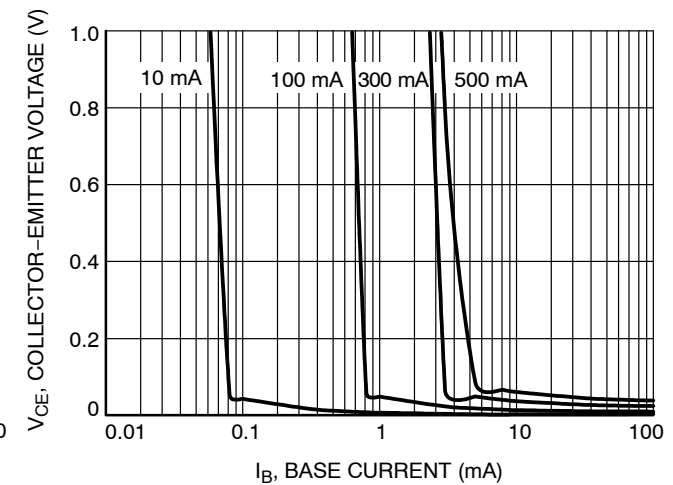


Figure 20. Saturation Region

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TYPICAL CHARACTERISTICS - BJT

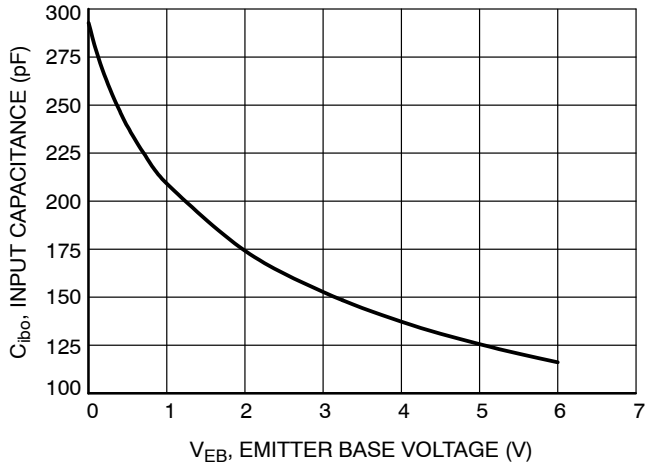


Figure 21. Input Capacitance

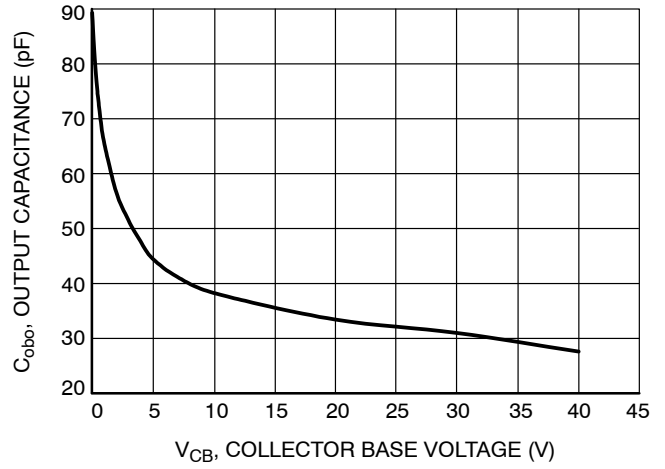


Figure 22. Output Capacitance

MECHANICAL CASE OUTLINE

PACKAGE DIMENSIONS

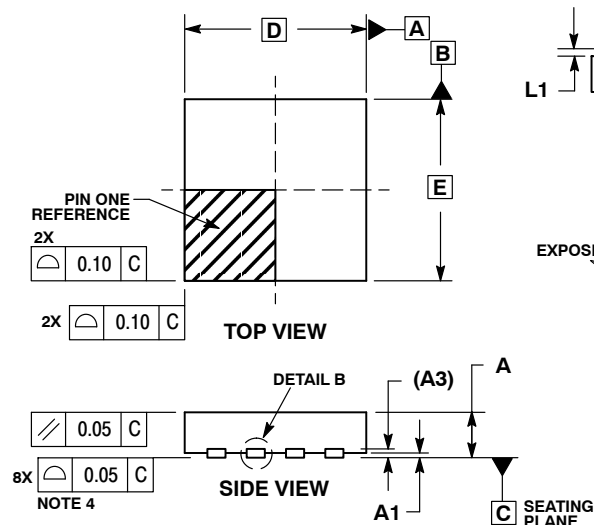
ON Semiconductor®



SCALE 2:1

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

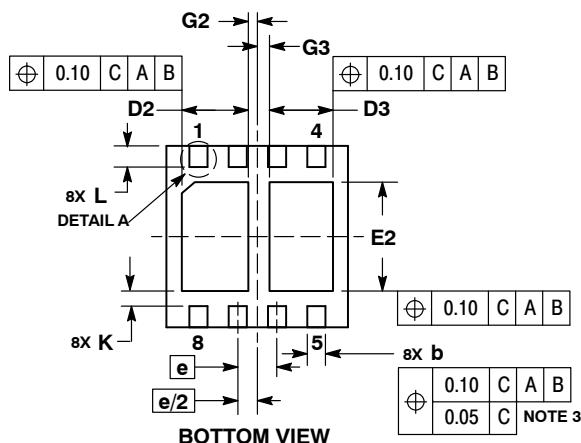
DATE 28 MAY 2008



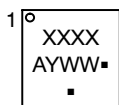
NOTES:

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 |



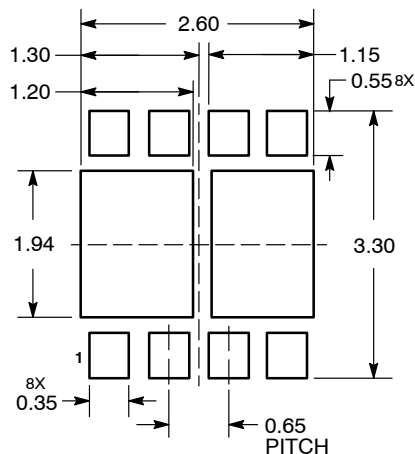
GENERIC MARKING DIAGRAM*



- 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.

| | | |
|-------------------------|-------------------------------------|--|
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| DESCRIPTION: | WDFN8, 3X3, 0.65P, DUAL FLAG | PAGE 1 OF 1 |

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