# MOSFET – Power, N-Channel, SUPERFET® III

## 800 V, 360 mΩ, 13 A

# NTPF360N80S3Z

ON Semiconductor®

www.onsemi.com

### Description

800 V SUPERFET III MOSFET is ON Semiconductor's high performance MOSFET family offering 800 V breakdown voltage.

New 800 V SUPERFET III MOSFET which is optimized for primary switch of flyback converter, enables lower switching losses and case temperature without sacrificing EMI performance thanks to its optimized design. In addition, internal Zener Diode significantly improves ESD capability.

This new family of 800 V SUPERFET III MOSFET enables to make more efficient, compact, cooler and more robust applications because of its remarkable performance in switching power applications such as Laptop adapter, Audio, Lighting, ATX power and industrial power supplies.

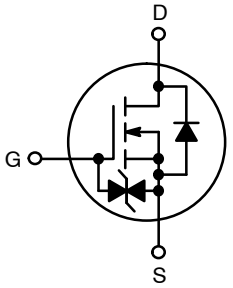
### Features

- Typ. $R_{DS(on)}$ = 300 mΩ
- Ultra Low Gate Charge (Typ. $Q_g$ = 25.3 nC)
- Low Stored Energy in Output Capacitance (Eoss = 2.72 μJ @ 400 V)
- 100% Avalanche Tested
- ESD Improved Capability with Zener Diode
- RoHS Compliant

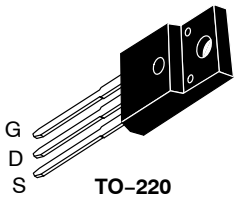
### Applications

- Adapters / Chargers
- LED Lighting
- AUX Power
- Audio
- Industrial Power

| $V_{(BR)DSS}$ | $R_{DS(ON)}$ MAX | $I_D$ MAX |
|---|---|---|
| 800 V | 360 mΩ | 13 A |

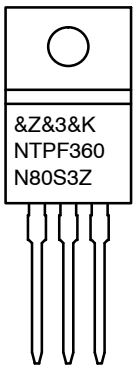



POWER MOSFET




TO−220
CASE 221D

### MARKING DIAGRAM




| | |
|---|---|
| &Z | = Assembly Plant Code |
| &3 | = Data Code (Year & Week) |
| &K | = Lot |
| NTPF360N80S3Z | = Specific Device Code |

### ORDERING INFORMATION

See detailed ordering and shipping information on page 2 of this data sheet.

**ABSOLUTE MAXIMUM RATINGS** ($T_J$ = 25°C, unless otherwise noted)

| Symbol | Parameter | | Value | Unit |
|---|---|---|---|---|
| $V_{DSS}$ | Drain−to−Source Voltage | | 800 | V |
| $V_{GS}$ | Gate−to−Source Voltage | DC | ±20 | V |
| | | AC (f > 1 Hz) | ±30 | |
| $I_D$ | Drain Current | Continuous ($T_C$ = 25°C) | 13* | A |
| | | Continuous ($T_C$ = 100°C) | 8.2* | |
| $I_{DM}$ | Drain Current | Pulsed (Note 1) | 32.5* | A |
| $E_{AS}$ | Single Pulsed Avalanche Energy (Note 2) | | 40 | mJ |
| $I_{AS}$ | Avalanche Current (Note 2) | | 2.0 | A |
| $E_{AR}$ | Repetitive Avalanche Energy (Note 1) | | 0.31 | mJ |
| dv/dt | MOSFET dv/dt | | 100 | V/ns |
| | Peak Diode Recovery dv/dt (Note 3) | | 10 | |
| $P_D$ | Power Dissipation | ($T_C$ = 25°C) | 31 | W |
| | | Derate Above 25°C | 0.168 | W/°C |
| $T_J$, $T_{STG}$ | Operating and Storage Temperature Range | | −55 to +150 | °C |
| $T_L$ | Lead Temperature Soldering Reflow for Soldering Purposes (1/8″ from Case for 10 seconds) | | 260 | °C |

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.

*Drain current limited by maximum junction temperature

1. Repetitive rating: pulse−width limited by maximum junction temperature.
2. $I_{AS}$ = 2.0 A, $R_G$ = 25 Ω, starting $T_J$ = 25°C.
3. $I_{SD}$ ≤ 3.25 A, di/dt ≤ 200 A/μs, $V_{DD}$ ≤ 400 V, starting $T_J$ = 25°C.

**THERMAL RESISTANCE RATINGS**

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $R_{\theta JC}$ | Junction−to−Case − Steady State | 4.04 | °C/W |
| $R_{\theta JA}$ | Junction−to−Ambient − Steady State | 62.5 | |

**PACKAGE MARKING AND ORDERING INFORMATION**

| Part Number | Top Marking | Package | Packing Method | Reel Size | Tape Width | Quantity |
|---|---|---|---|---|---|---|
| NTPF360N80S3Z | NTPF360N80S3Z | TO−220F | Tube | N/A | N/A | 50 Units |

**ELECTRICAL CHARACTERISTICS** ($T_J$ = 25°C unless otherwise noted)

| Symbol | Parameter | Test Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | | |
| $BV_{DSS}$ | Drain−to−Source Breakdown Voltage | $V_{GS}$ = 0 V, $I_D$ = 1 mA, $T_J$ = 25°C | 800 | | | V |
| | | $V_{GS}$ = 0 V, $I_D$ = 1 mA, $T_J$ = 150°C | 900 | | | V |
| $\Delta BV_{DSS}$ / $\Delta T_J$ | Breakdown Voltage Temperature Coefficient | $I_D$ = 1 mA, Referenced to 25°C | | 1.1 | | V/°C |
| $I_{DSS}$ | Zero Gate Voltage Drain Current | $V_{DS}$ = 800 V, $V_{GS}$ = 0 V | | | 1 | μA |
| | | $V_{DS}$ = 640 V, $T_C$ = 125°C | | 0.8 | | |
| $I_{GSS}$ | Gate−to−Body Leakage Current | $V_{GS}$ = ±20 V, $V_{DS}$ = 0 V | | | 1 | μA |
| **ON CHARACTERISTICS** | | | | | | |
| $V_{GS(th)}$ | Gate Threshold Voltage | $V_{GS}$ = $V_{DS}$, $I_D$ = 0.3 mA | 2.2 | | 3.8 | V |
| $R_{DS(on)}$ | Static Drain−to−Source On Resistance | $V_{GS}$ = 10 V, $I_D$ = 6.5 A | | 300 | 360 | mΩ |
| $g_{FS}$ | Forward Transconductance | $V_{DS}$ = 20 V, $I_D$ = 6.5 A | | 13.8 | | S |
| **DYNAMIC CHARACTERISTICS** | | | | | | |
| $C_{iss}$ | Input Capacitance | $V_{DS}$ = 400 V, $V_{GS}$ = 0 V, f = 250 kHz | | 1143 | | pF |
| $C_{oss}$ | Output Capacitance | | | 18.1 | | pF |
| $C_{oss(eff.)}$ | Effective Output Capacitance | $V_{DS}$ = 0 V to 400 V, $V_{GS}$ = 0 V | | 236.4 | | pF |
| $C_{oss(er.)}$ | Energy Related Output Capacitance | $V_{DS}$ = 0 V to 400 V, $V_{GS}$ = 0 V | | 34 | | pF |
| $Q_{g(tot)}$ | Total Gate Charge at 10 V | $V_{DS}$ = 400 V, $I_D$ = 6.5 A, $V_{GS}$ = 10 V (Note 4) | | 25.3 | | nC |
| $Q_{gs}$ | Gate−to−Source Gate Charge | | | 5.3 | | nC |
| $Q_{gd}$ | Gate−to−Drain “Miller” Charge | | | 8.3 | | nC |
| ESR | Equivalent Series Resistance | f = 1 MHz | | 4 | | Ω |
| **SWITCHING CHARACTERISTICS** | | | | | | |
| $t_{d(on)}$ | Turn-On Delay Time | $V_{DD}$ = 400 V, $I_D$ = 6.5 A, $V_{GS}$ = 10 V, $R_g$ = 25 Ω (Note 4) | | 21.2 | | ns |
| $t_r$ | Turn-On Rise Time | | | 18.5 | | ns |
| $t_{d(off)}$ | Turn-Off Delay Time | | | 110 | | ns |
| $t_f$ | Turn-Off Fall Time | | | 17.7 | | ns |
| **SOURCE-DRAIN DIODE CHARACTERISTICS** | | | | | | |
| $I_S$ | Maximum Continuous Source−to−Drain Diode Forward Current | | | | 13 | A |
| $I_{SM}$ | Maximum Pulsed Source−to−Drain Diode Forward Current | | | | 32.5 | A |
| $V_{SD}$ | Source−to−Drain Diode Forward Voltage | $V_{GS}$ = 0 V, $I_{SD}$ = 6.5 A | | | 1.2 | V |
| $t_{rr}$ | Reverse Recovery Time | $V_{GS}$ = 0 V, $I_{SD}$ = 3.25 A, $dI_F/dt$ = 100 A/μs | | 370 | | ns |
| $Q_{rr}$ | Reverse Recovery Charge | | | 3.0 | | μC |

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

4. Essentially independent of operating temperature typical characteristics.

## TYPICAL CHARACTERISTICS

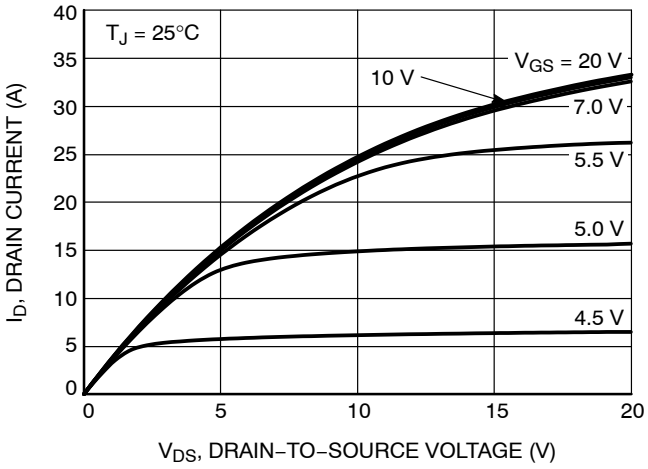



**Figure 1. On−Region Characteristics**

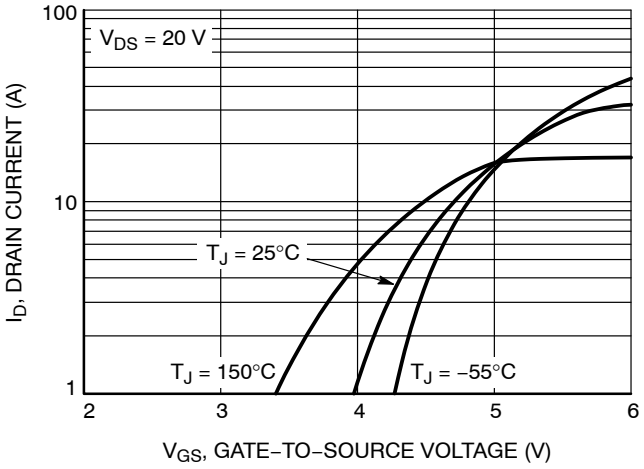



**Figure 2. Transfer Characteristics**

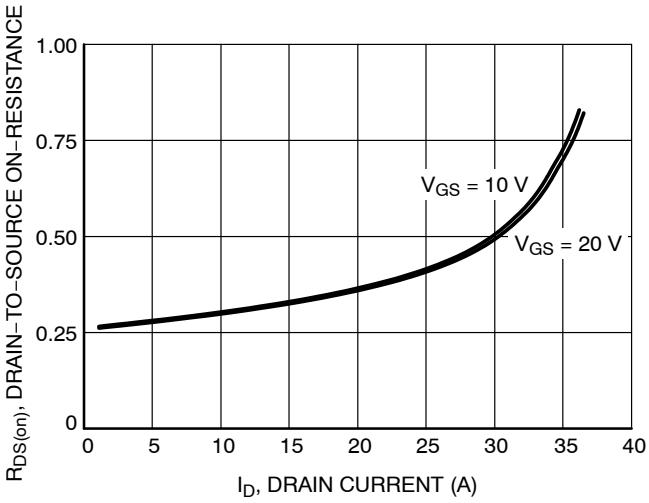



**Figure 3. On Resistance vs. Drain Current**

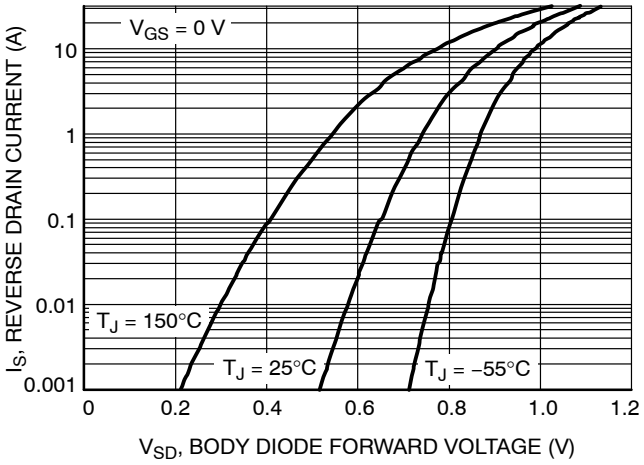



**Figure 4. Diode Forward Voltage vs. Current**

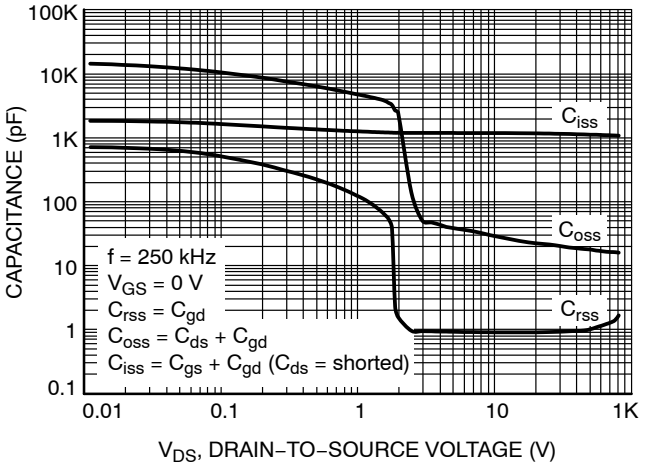



**Figure 5. Capacitance Characteristics**

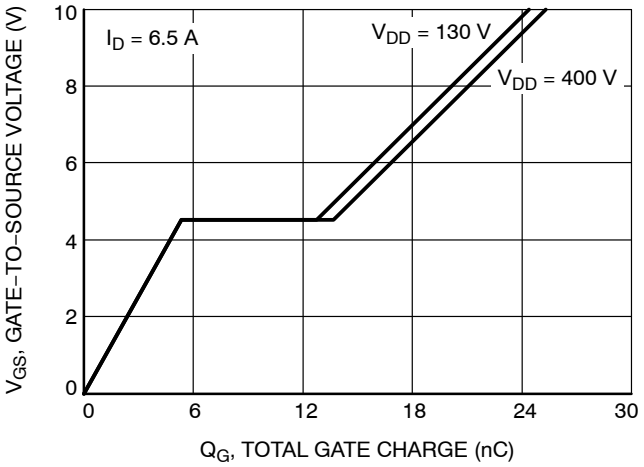



**Figure 6. Gate Charge Characteristics**

## TYPICAL CHARACTERISTICS

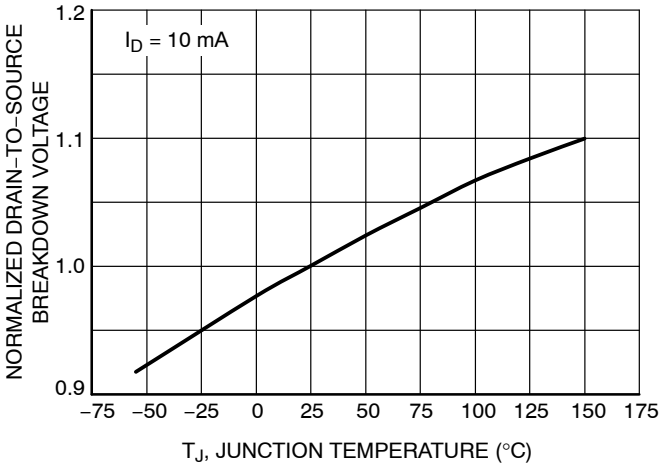



**Figure 7. Normalized $BV_{DSS}$ vs. Temperature**

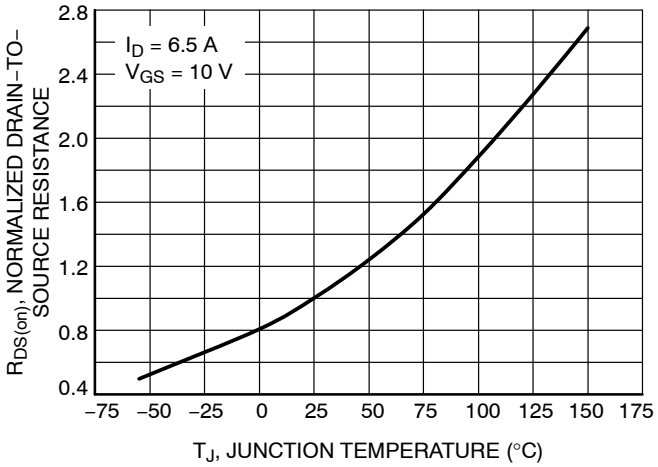



**Figure 8. On−Resistance Variation vs. Temperature**

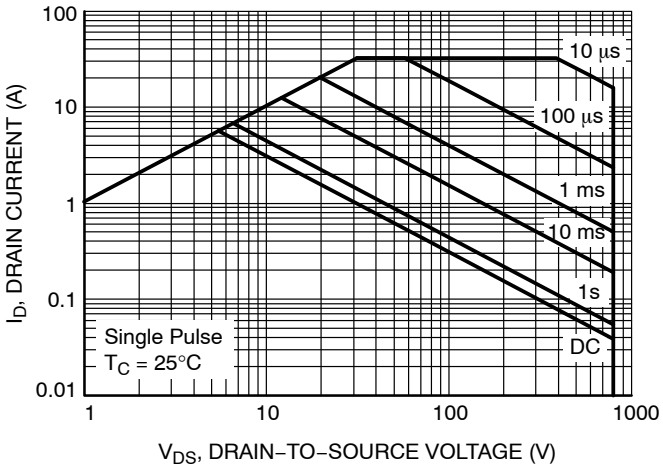



**Figure 9. Safe Operating Area**

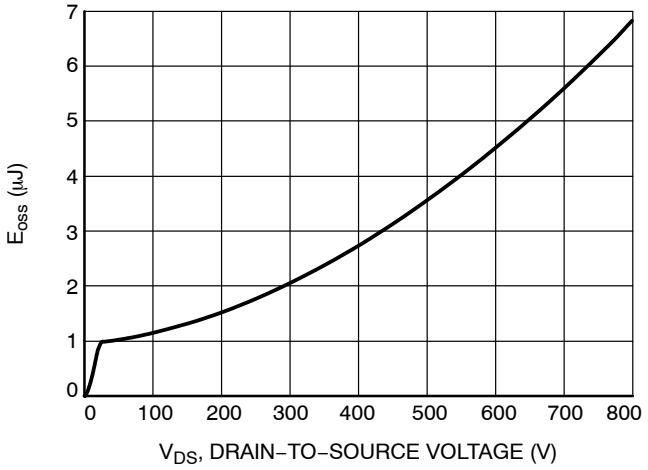



**Figure 10. $E_{oss}$ vs. Drain−to−Source Voltage**

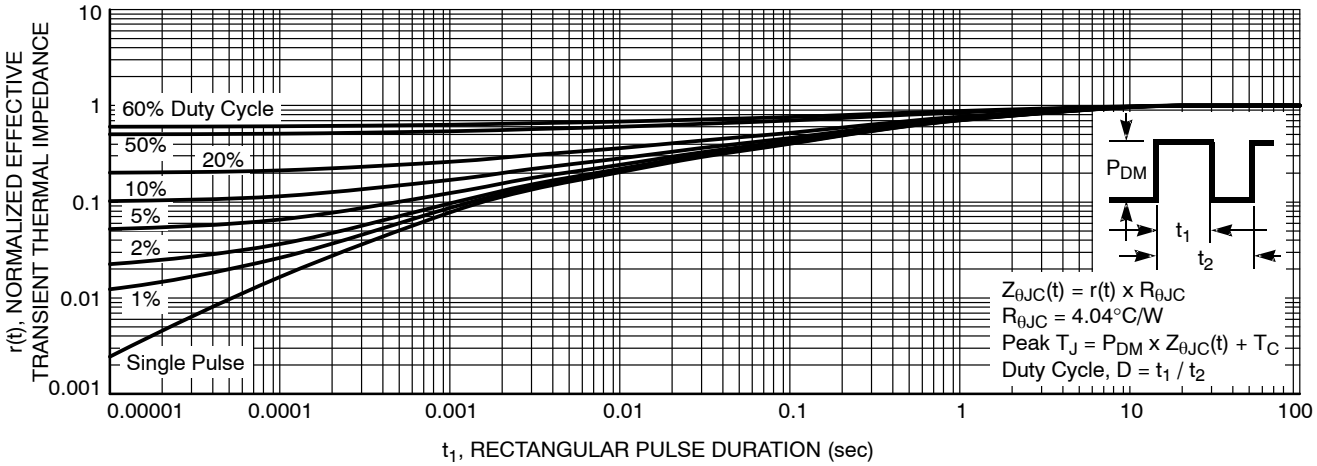



**Figure 11. Transient Thermal Impedance**

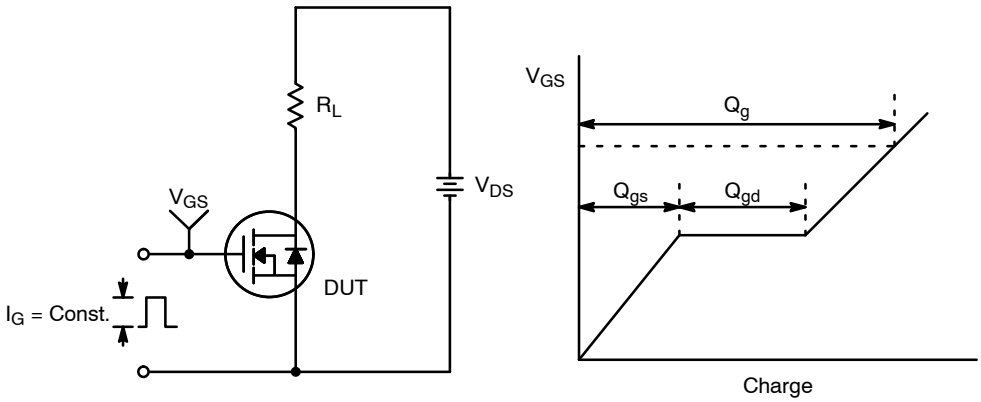



**Figure 12. Gate Charge Test Circuit & Waveform**

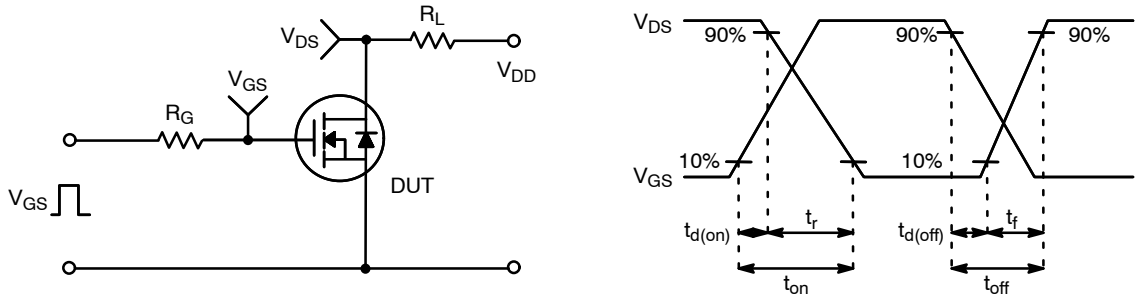



**Figure 13. Resistive Switching Test Circuit & Waveforms**

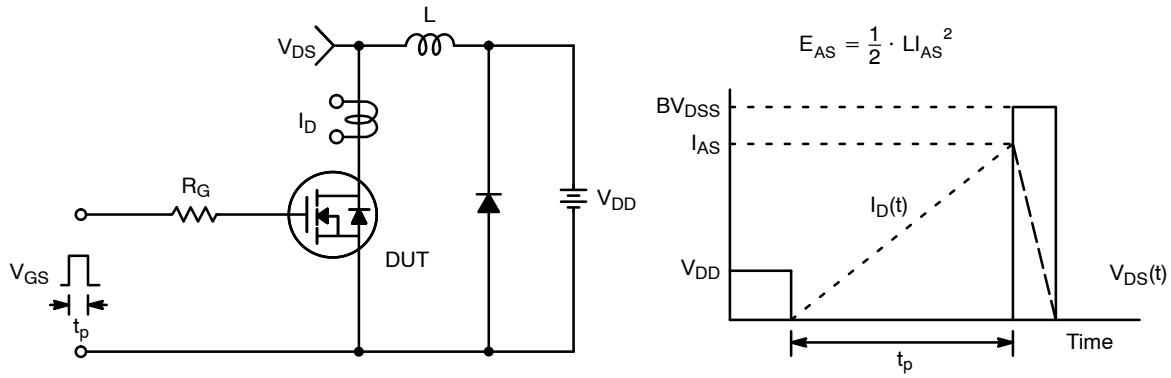



**Figure 14. Unclamped Inductive Switching Test Circuit & Waveforms**

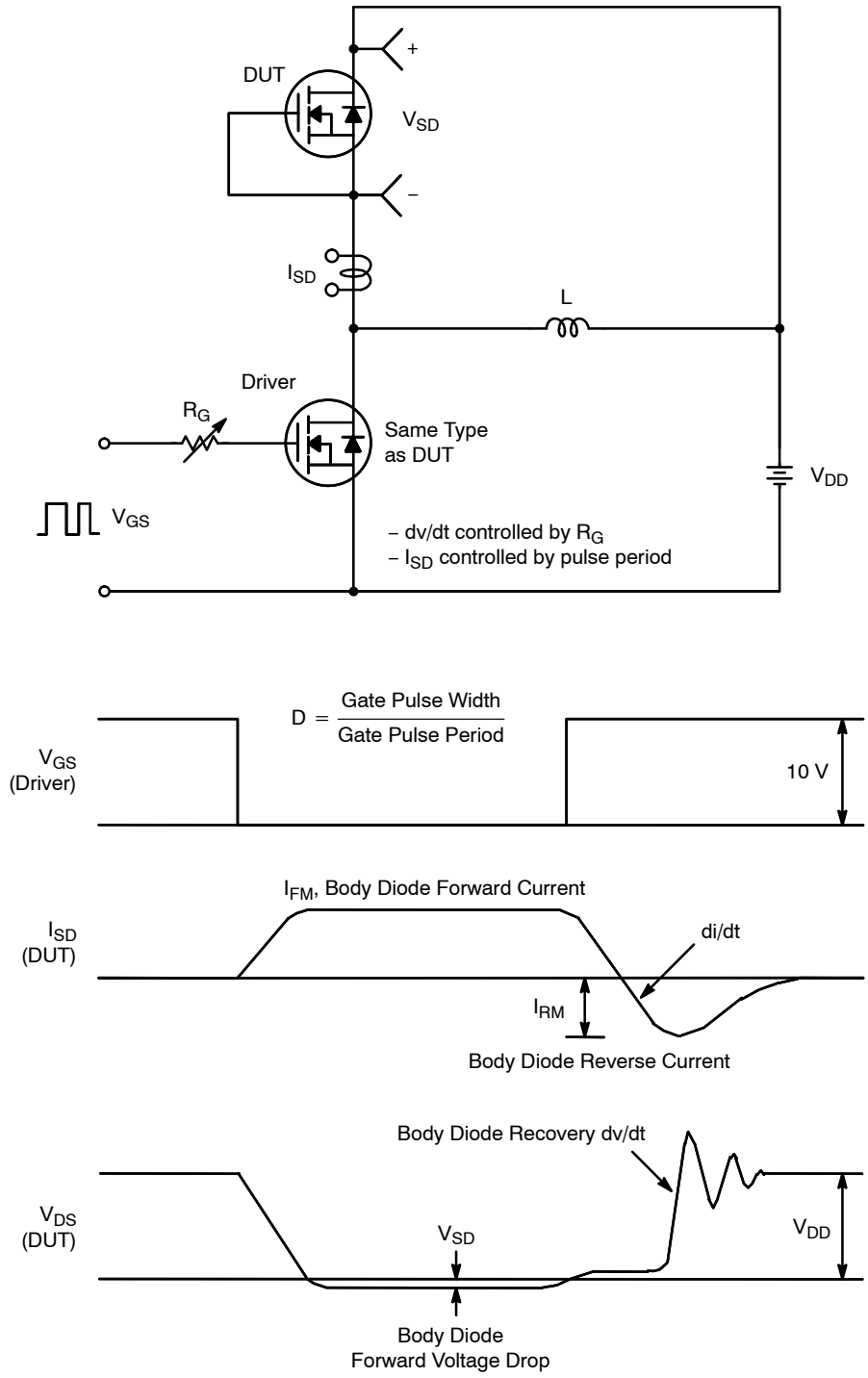


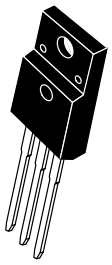

**Figure 15. Peak Diode Recovery dv/dt Test Circuit & Waveforms**

# MECHANICAL CASE OUTLINE
## PACKAGE DIMENSIONS

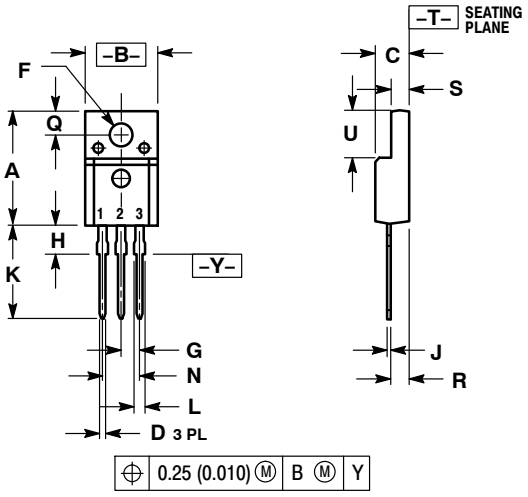
ON Semiconductor®

**TO−220 FULLPAK**
CASE 221D−03
ISSUE K

DATE 27 FEB 2009



SCALE 1:1




NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH
3. 221D−01 THRU 221D−02 OBSOLETE, NEW STANDARD 221D−03.

| | INCHES | | MILLIMETERS | |
|---|---|---|---|---|
| DIM | MIN | MAX | MIN | MAX |
| A | 0.617 | 0.635 | 15.67 | 16.12 |
| B | 0.392 | 0.419 | 9.96 | 10.63 |
| C | 0.177 | 0.193 | 4.50 | 4.90 |
| D | 0.024 | 0.039 | 0.60 | 1.00 |
| F | 0.116 | 0.129 | 2.95 | 3.28 |
| G | 0.100 BSC | | 2.54 BSC | |
| H | 0.118 | 0.135 | 3.00 | 3.43 |
| J | 0.018 | 0.025 | 0.45 | 0.63 |
| K | 0.503 | 0.541 | 12.78 | 13.73 |
| L | 0.048 | 0.058 | 1.23 | 1.47 |
| N | 0.200 BSC | | 5.08 BSC | |
| Q | 0.122 | 0.138 | 3.10 | 3.50 |
| R | 0.099 | 0.117 | 2.51 | 2.96 |
| S | 0.092 | 0.113 | 2.34 | 2.87 |
| U | 0.239 | 0.271 | 6.06 | 6.88 |

STYLE 1:
PIN 1. GATE
2. DRAIN
3. SOURCE

STYLE 2:
PIN 1. BASE
2. COLLECTOR
3. EMITTER

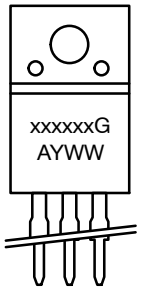
STYLE 3:
PIN 1. ANODE
2. CATHODE
3. ANODE

STYLE 4:
PIN 1. CATHODE
2. ANODE
3. CATHODE

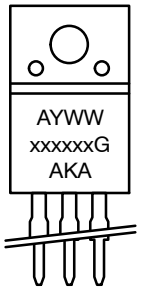
STYLE 5:
PIN 1. CATHODE
2. ANODE
3. GATE

STYLE 6:
PIN 1. MT 1
2. MT 2
3. GATE

## MARKING DIAGRAMS




**Bipolar**




**Rectifier**

| | |
|---|---|
| xxxxxx | = Specific Device Code |
| G | = Pb−Free Package |
| A | = Assembly Location |
| Y | = Year |
| WW | = Work Week |

| | |
|---|---|
| A | = Assembly Location |
| Y | = Year |
| WW | = Work Week |
| xxxxxx | = Device Code |
| G | = Pb−Free Package |
| AKA | = Polarity Designator |

| | | |
|---|---|---|
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| **DESCRIPTION:** | **TO−220 FULLPAK** | **PAGE 1 OF 1** |

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