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

## 650 V, 65 A, 40 mΩ

# NTH4L040N65S3F

### Description

SUPERFET III MOSFET is ON Semiconductor's brand−new high voltage super−junction (SJ) MOSFET family that is utilizing charge balance technology for outstanding low on-resistance and lower gate charge performance. This advanced technology is tailored to minimize conduction loss, provide superior switching performance, and withstand extreme dv/dt rate.

Consequently, SUPERFET III MOSFET is very suitable for the various power system for miniaturization and higher efficiency.

SUPERFET III FRFET MOSFET's optimized reverse recovery performance of body diode can remove additional component and improve system reliability.

### Features

- 700 V @ $T_J$ = 150°C
- Typ. $R_{DS(on)}$ = 32 mΩ
- Ultra Low Gate Charge (Typ. $Q_g$ = 158 nC)
- Low Effective Output Capacitance (Typ. $C_{oss(eff.)}$ = 1366 pF)
- 100% Avalanche Tested
- These Devices are Pb−Free and are RoHS Compliant

### Applications

- Telecom / Server Power Supplies
- Industrial Power Supplies
- EV Charger
- UPS / Solar

**ON Semiconductor®**

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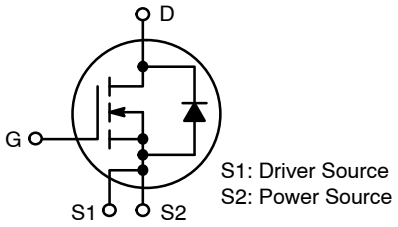
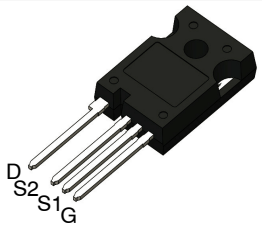
| $V_{DSS}$ | $R_{DS(ON)}$ MAX | $I_D$ MAX |
|---|---|---|
| 650 V | 40 mΩ | 65 A |

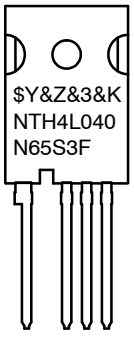



**POWER MOSFET**




**TO−247−4LD**
**CASE 340CJ**

### MARKING DIAGRAM




| | |
|---|---|
| $Y | = ON Semiconductor Logo |
| &Z | = Assembly Plant Code |
| &3 | = Data Code (Year & Week) |
| &K | = Lot |
| NTH4L040N65S3F | = Specific Device Code |

### ORDERING INFORMATION

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

**ABSOLUTE MAXIMUM RATINGS** ($T_C$ = 25°C, Unless otherwise noted)

| Symbol | Parameter | | Value | Unit |
|---|---|---|---|---|
| $V_{DSS}$ | Drain to Source Voltage | | 650 | V |
| $V_{GSS}$ | Gate to Source Voltage | – DC | ±30 | V |
| | | – AC (f > 1 Hz) | ±30 | |
| $I_D$ | Drain Current | – Continuous ($T_C$ = 25°C) | 65 | A |
| | | – Continuous ($T_C$ = 100°C) | 45 | |
| $I_{DM}$ | Drain Current | – Pulsed (Note 1) | 162.5 | A |
| $E_{AS}$ | Single Pulsed Avalanche Energy (Note 2) | | 1009 | mJ |
| $I_{AS}$ | Avalanche Current (Note 2) | | 9 | A |
| $E_{AR}$ | Repetitive Avalanche Energy (Note 1) | | 4.46 | mJ |
| dv/dt | MOSFET dv/dt | | 100 | V/ns |
| | Peak Diode Recovery dv/dt (Note 3) | | 50 | |
| $P_D$ | Power Dissipation | ($T_C$ = 25°C) | 446 | W |
| | | – Derate Above 25°C | 3.57 | W/°C |
| $T_J$, $T_{STG}$ | Operating and Storage Temperature Range | | –55 to +150 | °C |
| $T_L$ | Maximum Lead Temperature for Soldering, 1/8″ from Case for 5 seconds | | 300 | °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.

1. Repetitive rating: pulse−width limited by maximum junction temperature.
2. $I_{AS}$ = 9 A, $R_G$ = 25 Ω, starting $T_J$ = 25°C.
3. $I_{SD}$ ≤ 32.5 A, di/dt ≤ 200 A/μs, $V_{DD}$ ≤ 400 V, starting $T_J$ = 25°C.

**THERMAL CHARACTERISTICS**

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case, Max. | 0.28 | °C/W |
| $R_{\theta JA}$ | Thermal Resistance, Junction to Ambient, Max. | 40 | |

**PACKAGE MARKING AND ORDERING INFORMATION**

| Part Number | Top Marking | Package | Packing Method | Reel Size | Tape Width | Quantity |
|---|---|---|---|---|---|---|
| NTH4L040N65S3F | NTH4L040N65S3F | TO−247 − 4LD | Tube | N/A | N/A | 30 Units |

**ELECTRICAL CHARACTERISTICS** ($T_C$ = 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 | 650 | | | V |
| | | $V_{GS}$ = 0 V, $I_D$ = 1 mA, $T_J$ = 150°C | 700 | | | V |
| $\Delta BV_{DSS}/\Delta T_J$ | Breakdown Voltage Temperature Coefficient | $I_D$ = 15 mA, Referenced to 25°C | | 0.63 | | V/°C |
| $I_{DSS}$ | Zero Gate Voltage Drain Current | $V_{DS}$ = 650 V, $V_{GS}$ = 0 V | | | 10 | μA |
| | | $V_{DS}$ = 520 V, $T_C$ = 125°C | | 213 | | |
| $I_{GSS}$ | Gate to Body Leakage Current | $V_{GS}$ = ±30 V, $V_{DS}$ = 0 V | | | ±100 | nA |
| **ON CHARACTERISTICS** | | | | | | |
| $V_{GS(th)}$ | Gate Threshold Voltage | $V_{GS}$ = $V_{DS}$, $I_D$ = 2.1 mA | 3.0 | | 5.0 | V |
| $R_{DS(on)}$ | Static Drain to Source On Resistance | $V_{GS}$ = 10 V, $I_D$ = 32.5 A | | 32 | 40 | mΩ |
| $g_{FS}$ | Forward Transconductance | $V_{DS}$ = 20 V, $I_D$ = 32.5 A | | 48 | | S |
| **DYNAMIC CHARACTERISTICS** | | | | | | |
| $C_{iss}$ | Input Capacitance | $V_{DS}$ = 400 V, $V_{GS}$ = 0 V, f = 1 MHz | | 5940 | | pF |
| $C_{oss}$ | Output Capacitance | | | 140 | | pF |
| $C_{oss(eff.)}$ | Effective Output Capacitance | $V_{DS}$ = 0 V to 400 V, $V_{GS}$ = 0 V | | 1366 | | pF |
| $C_{oss(er.)}$ | Energy Related Output Capacitance | $V_{DS}$ = 0 V to 400 V, $V_{GS}$ = 0 V | | 247 | | pF |
| $Q_{g(tot)}$ | Total Gate Charge at 10V | $V_{DS}$ = 400 V, $I_D$ = 32.5 A, $V_{GS}$ = 10 V (Note 4) | | 158 | | nC |
| $Q_{gs}$ | Gate to Source Gate Charge | | | 48 | | nC |
| $Q_{gd}$ | Gate to Drain “Miller” Charge | | | 60 | | nC |
| ESR | Equivalent Series Resistance | f = 1 MHz | | 1.1 | | Ω |
| **SWITCHING CHARACTERISTICS** | | | | | | |
| $t_{d(on)}$ | Turn-On Delay Time | $V_{DD}$ = 400 V, $I_D$ = 32.5 A, $V_{GS}$ = 10 V, $R_g$ = 2.2 Ω (Note 4) | | 44 | | ns |
| $t_r$ | Turn-On Rise Time | | | 23 | | ns |
| $t_{d(off)}$ | Turn-Off Delay Time | | | 96 | | ns |
| $t_f$ | Turn-Off Fall Time | | | 6 | | ns |
| **SOURCE-DRAIN DIODE CHARACTERISTICS** | | | | | | |
| $I_S$ | Maximum Continuous Source to Drain Diode Forward Current | | | | 65 | A |
| $I_{SM}$ | Maximum Pulsed Source to Drain Diode Forward Current | | | | 162.5 | A |
| $V_{SD}$ | Source to Drain Diode Forward Voltage | $V_{GS}$ = 0 V, $I_{SD}$ = 32.5 A | | | 1.3 | V |
| $t_{rr}$ | Reverse Recovery Time | $V_{DD}$ = 400 V, $I_{SD}$ = 32.5 A, $dI_F/dt$ = 100 A/μs | | 145 | | ns |
| $Q_{rr}$ | Reverse Recovery Charge | | | 737 | | nC |

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 PERFORMANCE CHARACTERISTICS

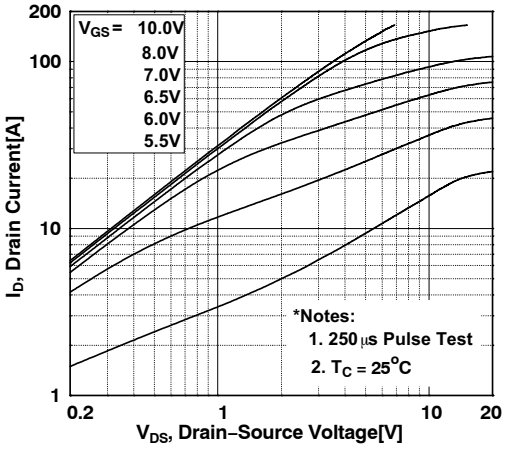



Figure 1. On−Region Characteristics

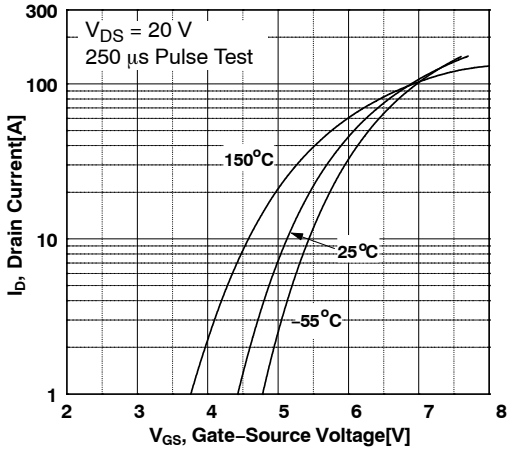



Figure 2. Transfer Characteristics

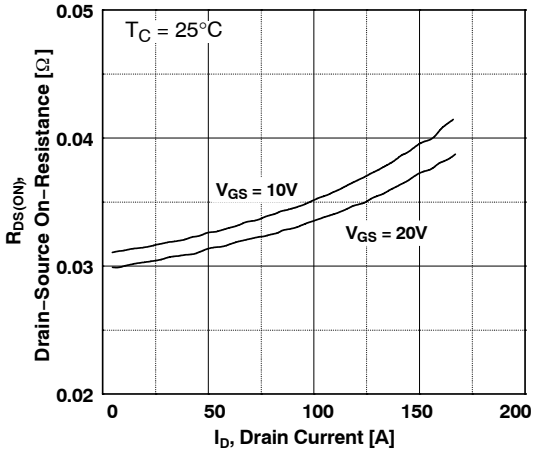



Figure 3. On−Resistance Variation vs. Drain Current and Gate Voltage

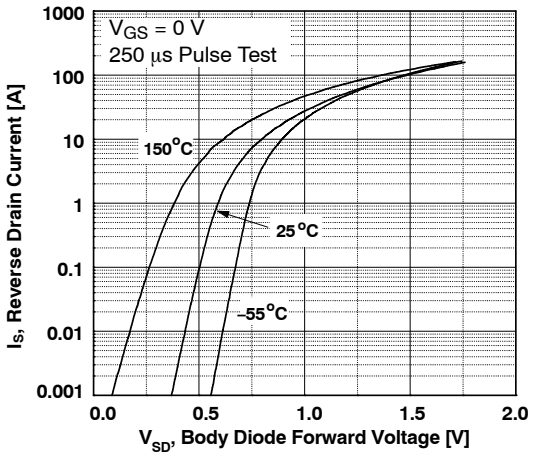



Figure 4. Body Diode Forward Voltage Variation vs. Source Current and Temperature

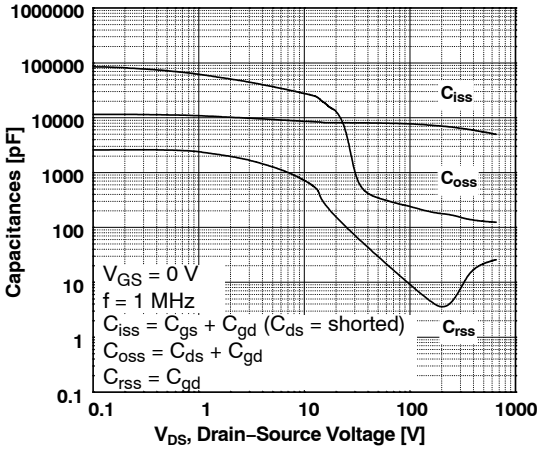



Figure 5. Capacitance Characteristics

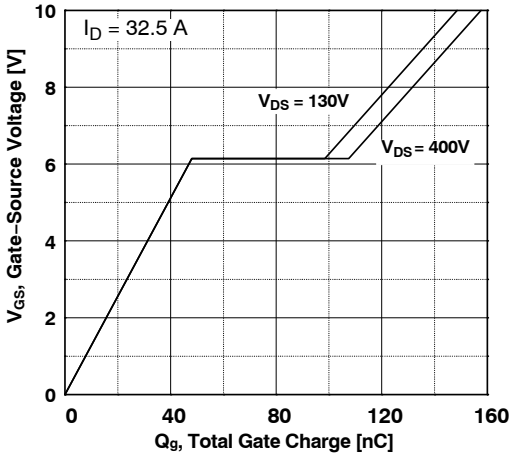



Figure 6. Gate Charge Characteristics

## TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

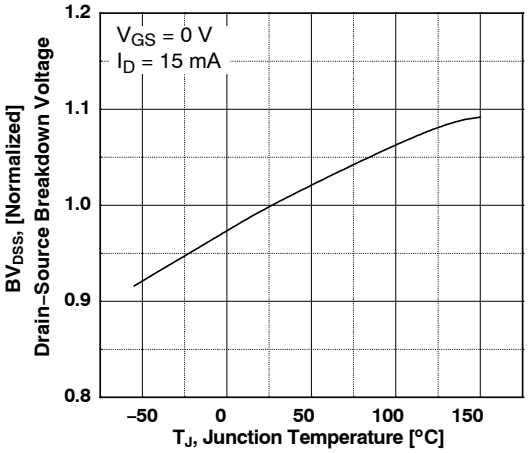



**Figure 7. Breakdown Voltage Variation vs. Temperature**

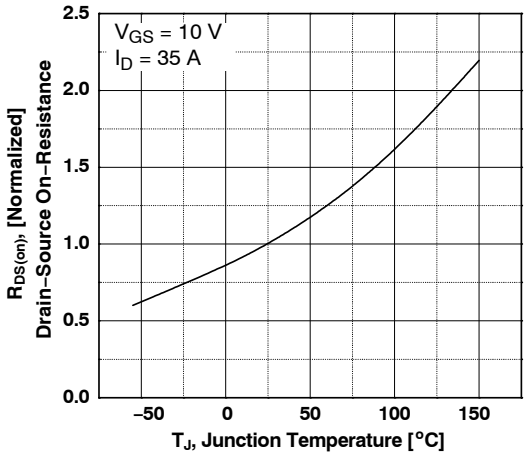



**Figure 8. On−Resistance Variation vs. Temperature**

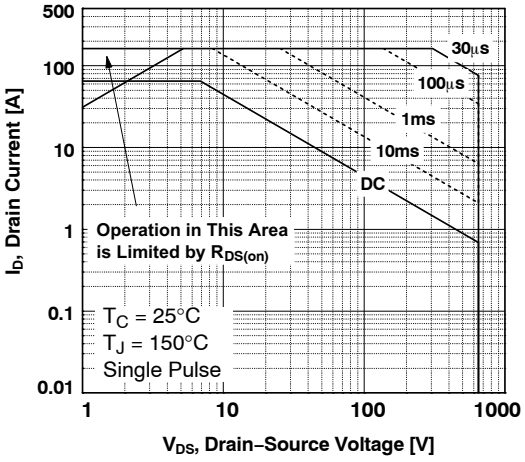



**Figure 9. Maximum Safe Operating Area**

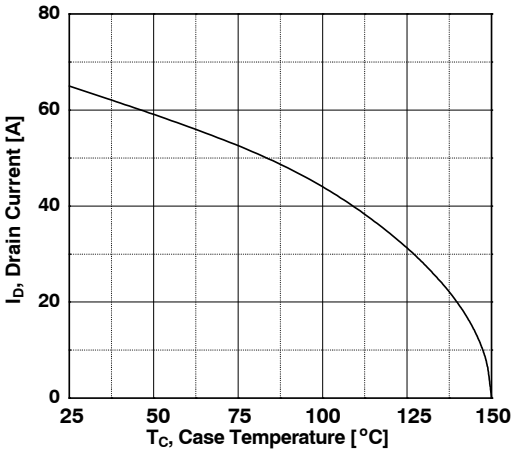



**Figure 10. Maximum Drain Current vs. Case Temperature**

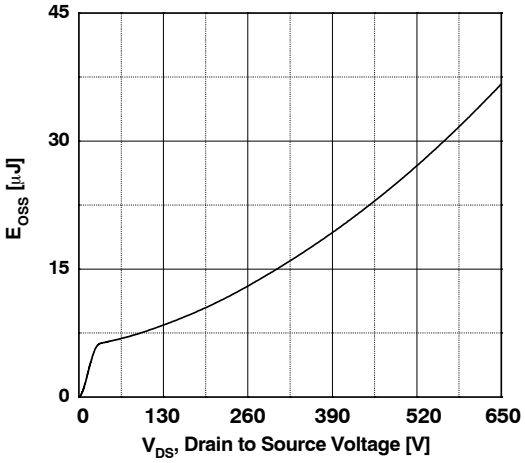



**Figure 11. Eoss vs. Drain to Source Voltage**

## TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

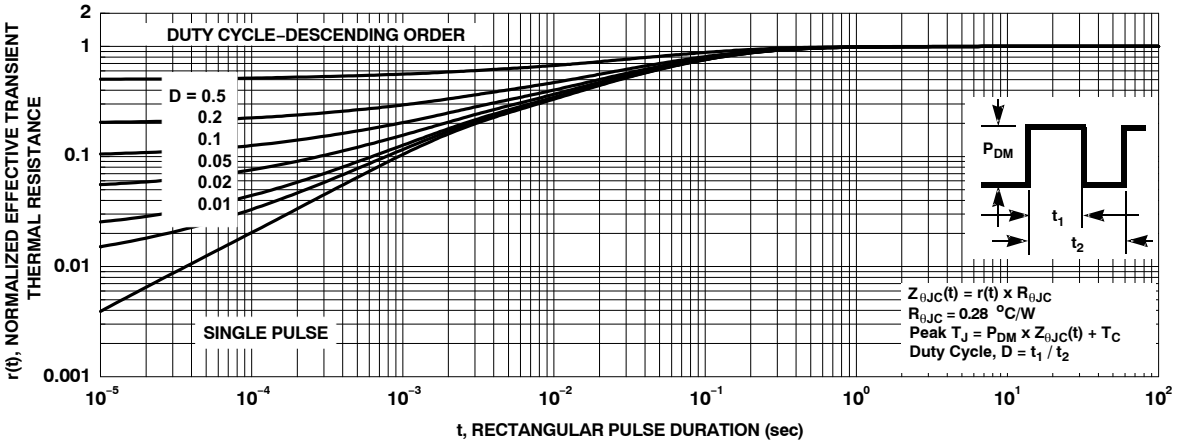



**Figure 12. Transient Thermal Response Curve**

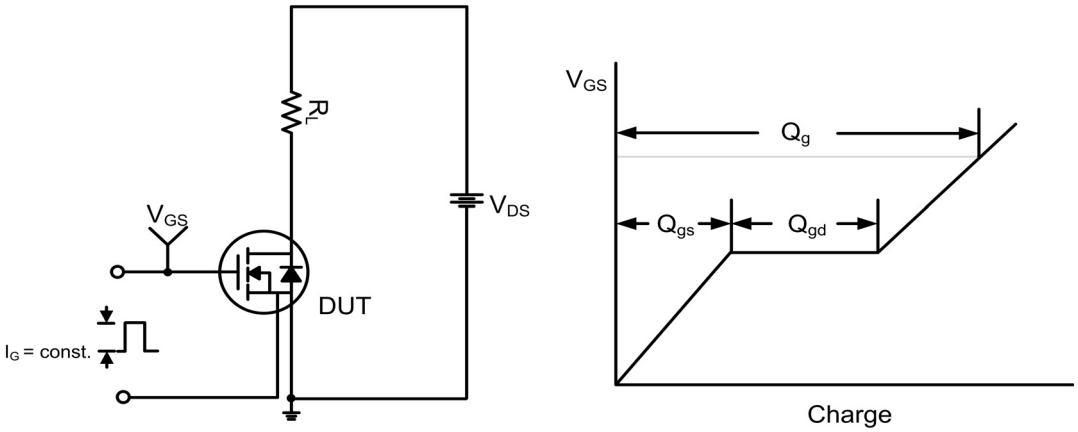



**Figure 13. Gate Charge Test Circuit & Waveform**

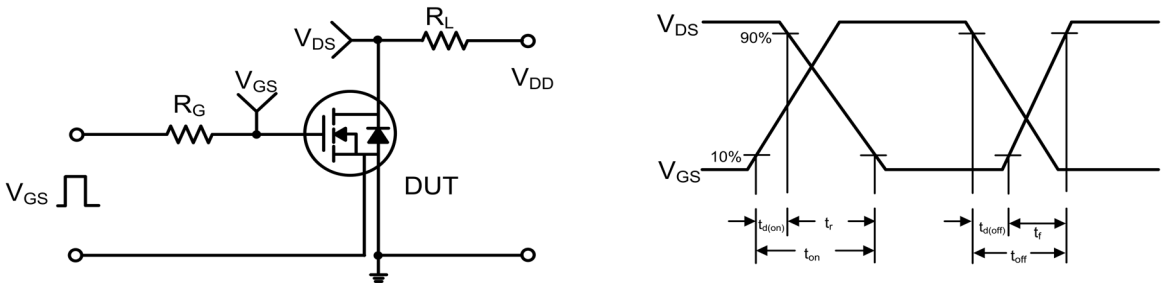



**Figure 14. Resistive Switching Test Circuit & Waveforms**

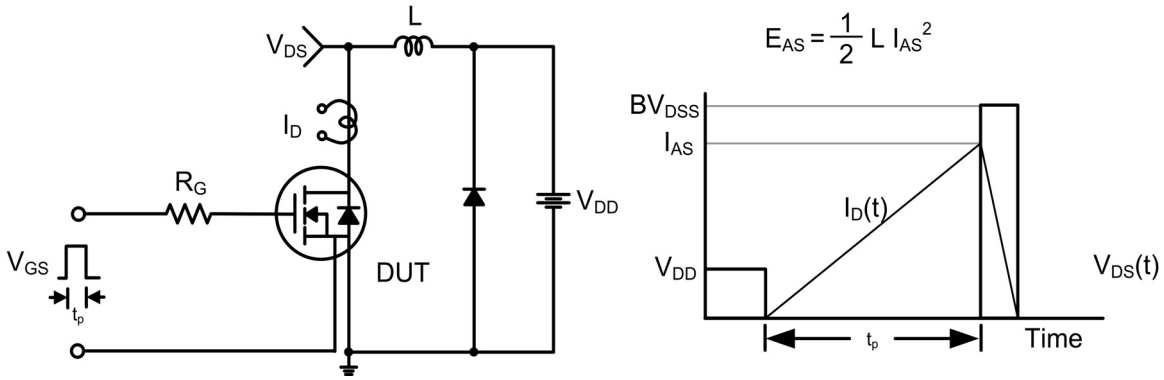



**Figure 15. Unclamped Inductive Switching Test Circuit & Waveforms**

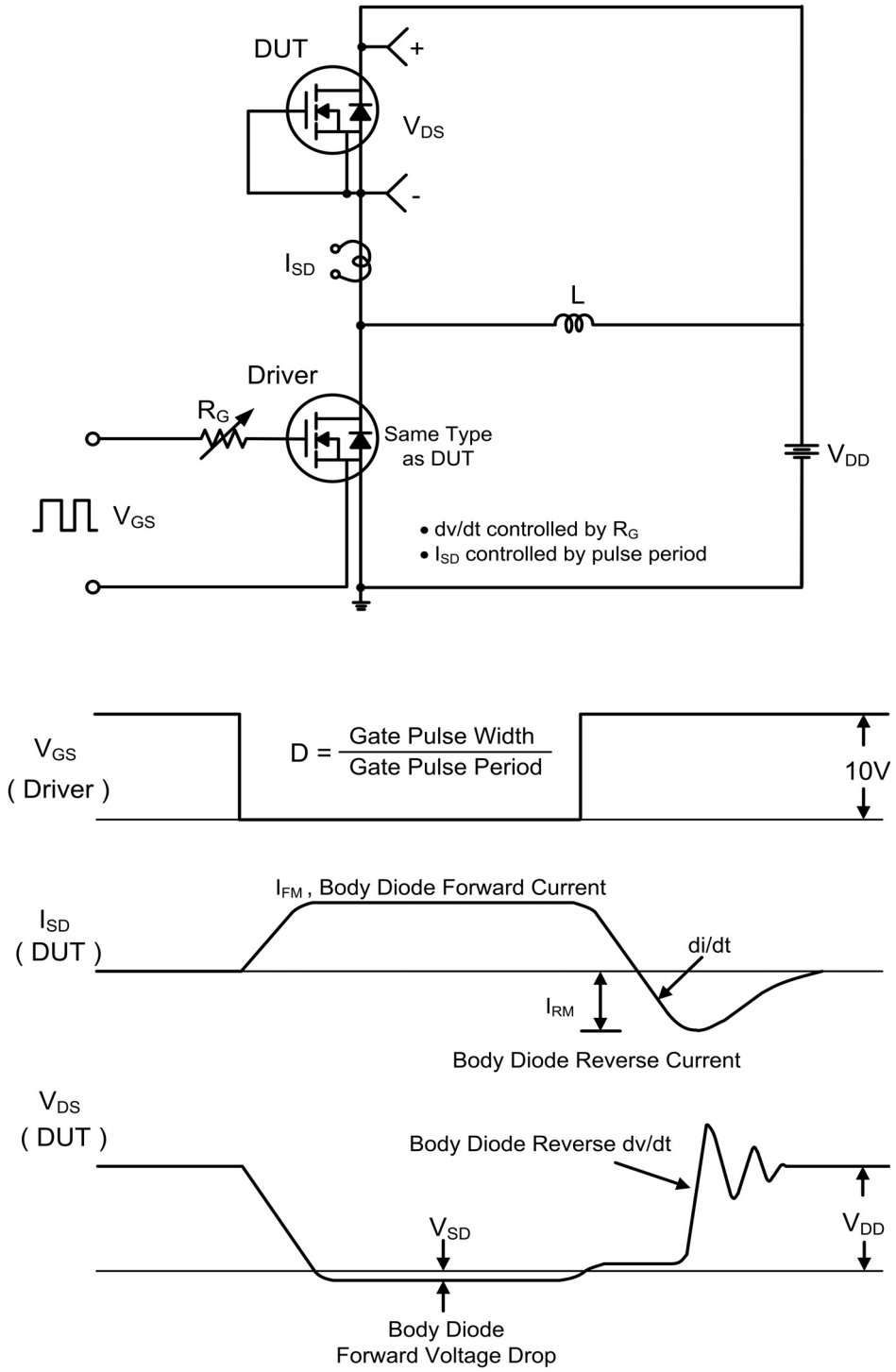


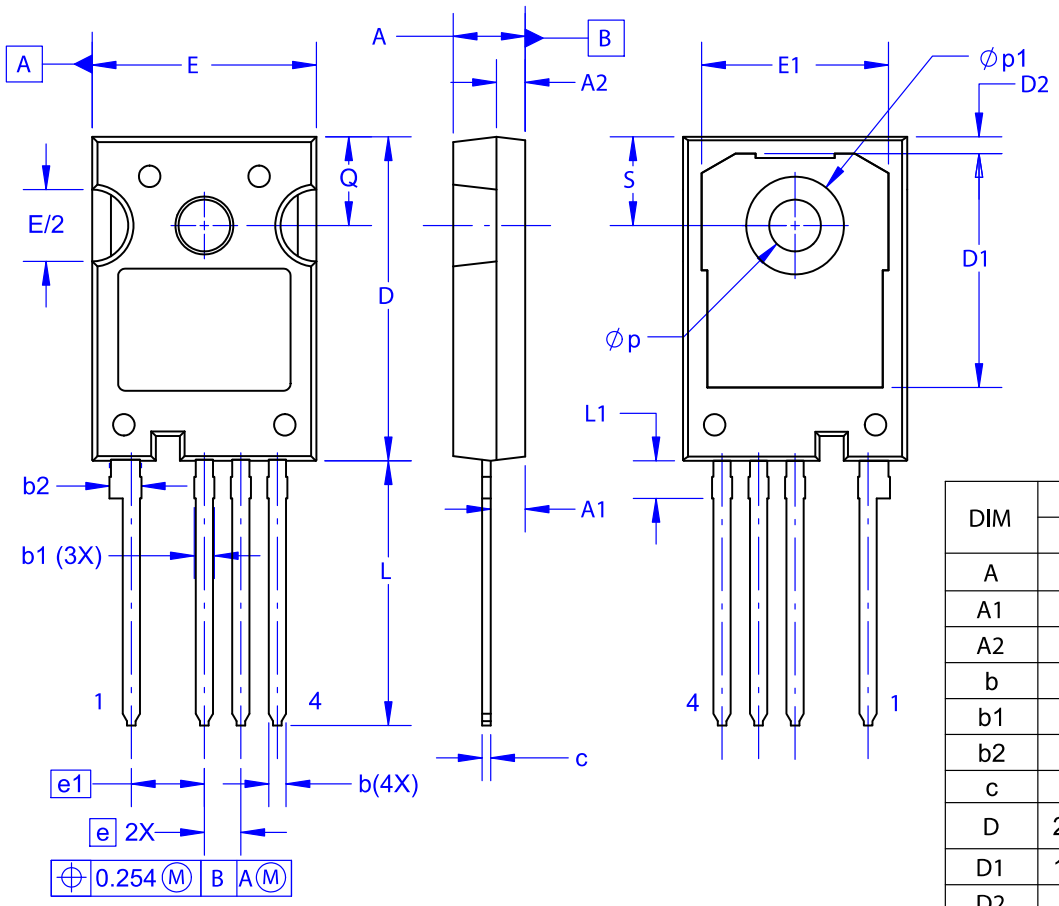

**Figure 16. Peak Diode Recovery dv/dt Test Circuit & Waveforms**

# MECHANICAL CASE OUTLINE
## PACKAGE DIMENSIONS

ON Semiconductor®

**TO−247−4LD**
CASE 340CJ
ISSUE A

DATE 16 SEP 2019




| DIM | MILLIMETERS | | |
|---|---|---|---|
| | MIN | NOM | MAX |
| A | 4.80 | 5.00 | 5.20 |
| A1 | 2.10 | 2.40 | 2.70 |
| A2 | 1.80 | 2.00 | 2.20 |
| b | 1.07 | 1.20 | 1.33 |
| b1 | 1.20 | 1.40 | 1.60 |
| b2 | 2.02 | 2.22 | 2.42 |
| c | 0.50 | 0.60 | 0.70 |
| D | 22.34 | 22.54 | 22.74 |
| D1 | 16.00 | 16.25 | 16.50 |
| D2 | 0.97 | 1.17 | 1.37 |
| e | 2.54 BSC | | |
| e1 | 5.08 BSC | | |
| E | 15.40 | 15.60 | 15.80 |
| E1 | 12.80 | 13.00 | 13.20 |
| E/2 | 4.80 | 5.00 | 5.20 |
| L | 18.22 | 18.42 | 18.62 |
| L1 | 2.42 | 2.62 | 2.82 |
| p | 3.40 | 3.60 | 3.80 |
| p1 | 6.60 | 6.80 | 7.00 |
| Q | 5.97 | 6.17 | 6.37 |
| S | 5.97 | 6.17 | 6.37 |

NOTES:

A. NO INDUSTRY STANDARD APPLIES TO THIS PACKAGE.
B. DIMENSIONS ARE EXCLUSIVE OF BURRS,MOLD FLASH,AND TIE BAR EXTRUSIONS.
C. ALL DIMENSIONS ARE IN MILLIMETERS.
D. DRAWING CONFORMS TO ASME Y14.5-2009.

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