

# MOSFET - Power, Single N-Channel, SUPERFET® V, Easy Drive, TO247-3L

## 600 V, 120 mΩ, 28 A

### NTHL120N60S5Z

#### Description

SUPERFET V MOSFET Easy Drive series combines excellent switching performance without sacrificing ease of use and EMI issues for both hard and soft switching topologies.

#### Features

- 650 V @  $T_J = 150^\circ\text{C}$
- Typ.  $R_{DS(on)} = 96\text{ m}\Omega$
- 100% Avalanche Tested
- Pb-Free, Halogen Free/BFR Free and are RoHS Compliant

#### Applications

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

#### ABSOLUTE MAXIMUM RATINGS ( $T_J = 25^\circ\text{C}$ , Unless otherwise noted)

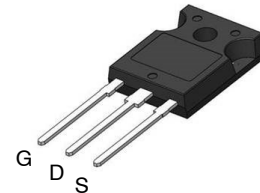
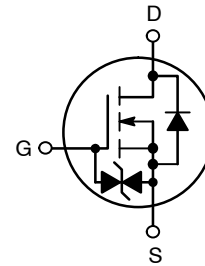
| Parameter   | Symbol                                 | Value                     | Unit             |
|---|--|---------------------------|------------------|
| Drain-to-Source Voltage   | $V_{DSS}$                              | 600                       | V                |
| Gate-to-Source Voltage  | DC                                     | $V_{GSS}$                 | $\pm 20$         |
|   |  | AC ( $f > 1\text{ Hz}$ )  | $\pm 20$         |
| Continuous Drain Current  | $I_D$                                  | $T_C = 25^\circ\text{C}$  | 28*              |
|   |  | $T_C = 100^\circ\text{C}$ | 17*              |
| Power Dissipation   | $P_D$                                  | 160                       | W                |
| Pulsed Drain Current (Note 1)   | $I_{DM}$                               | 81*                       | A                |
| Pulsed Source Current (Body Diode) (Note 1)                             | $I_{SM}$                               | 81*                       | A                |
| Operating Junction and Storage Temperature Range                        | $T_J, T_{STG}$                         | -55 to +150               | $^\circ\text{C}$ |
| Source Current (Body Diode)   | $I_S$                                  | 28*                       | A                |
| Single Pulse Avalanche Energy   | $I_L = 4.6\text{ A}, R_G = 25\ \Omega$ | $E_{AS}$                  | 191              |
| Avalanche Current   | $I_{AS}$                               | 4.6                       | A                |
| Repetitive Avalanche Energy (Note 1)                                    | $E_{AR}$                               | 1.6                       | mJ               |
| MOSFET dv/dt  | dv/dt                                  | 120                       | V/ns             |
| Peak Diode Recovery dv/dt (Note 2)                                      |  | 50                        |                  |
| Lead Temperature for Soldering Purposes (1/8" from case for 10 seconds) | $T_L$                                  | 260                       | $^\circ\text{C}$ |

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.  $I_{SD} \leq 11.5\text{ A}, di/dt \leq 200\text{ A}/\mu\text{s}, V_{DD} \leq 400\text{ V}$ , starting  $T_J = 25^\circ\text{C}$ .

| $V_{DSS}$ | $R_{DS(ON)}\text{ MAX}$ | $I_D\text{ MAX}$ |
|-----------|-------------------------|------------------|
| 600 V     | 120 mΩ @ 10 V           | 28 A             |



TO-247 Long Leads  
CASE 340CX

#### MARKING DIAGRAM



T120N60S5Z = Specific Device Code  
 A = Assembly Location  
 YWW = Data Code (Year & Week)  
 ZZ = Assembly Lot

#### ORDERING INFORMATION

| Device        | Package | Shipping        |
|---------------|---------|-----------------|
| NTHL120N60S5Z | TO-247  | 30 Units / Tube |

# NTHL120N60S5Z

## THERMAL CHARACTERISTICS

| Parameter                                     | Symbol          | Value | Unit |
|---|-----------------|-------|------|
| Thermal Resistance, Junction-to-Case, Max.    | $R_{\theta JC}$ | 0.78  | °C/W |
| Thermal Resistance, Junction-to-Ambient, Max. | $R_{\theta JA}$ | 40    |      |

## ELECTRICAL CHARACTERISTICS ( $T_J = 25^\circ\text{C}$ unless otherwise noted)

| Parameter | Symbol | Test Conditions | Min | Typ | Max | Unit |
|-----------|--------|-----------------|-----|-----|-----|------|
|-----------|--------|-----------------|-----|-----|-----|------|

### OFF CHARACTERISTICS

|   |                                   |  |     |     |    |       |
|---|-----------------------------------|--|-----|-----|----|-------|
| Drain-to-Source Breakdown Voltage                         | $V_{(BR)DSS}$                     | $V_{GS} = 0\text{ V}, I_D = 1\text{ mA}, T_J = 25^\circ\text{C}$     | 600 | -   | -  | V     |
| Drain-to-Source Breakdown Voltage Temperature Coefficient | $\Delta V_{(BR)DSS} / \Delta T_J$ | $I_D = 10\text{ mA}$ , Referenced to $25^\circ\text{C}$              | -   | 630 | -  | mV/°C |
| Zero Gate Voltage Drain Current                           | $I_{DSS}$                         | $V_{GS} = 0\text{ V}, V_{DS} = 600\text{ V}, T_J = 25^\circ\text{C}$ | -   | -   | 1  | μA    |
| Gate-to-Source Leakage Current                            | $I_{GSS}$                         | $V_{GS} = \pm 20\text{ V}, V_{DS} = 0\text{ V}$                      | -   | -   | ±5 | μA    |

### ON CHARACTERISTICS

|                               |              |   |     |      |     |    |
|-------------------------------|--------------|---|-----|------|-----|----|
| Drain-to-Source On Resistance | $R_{DS(on)}$ | $V_{GS} = 10\text{ V}, I_D = 11.5\text{ A}, T_J = 25^\circ\text{C}$ | -   | 96   | 120 | mΩ |
| Gate Threshold Voltage        | $V_{GS(th)}$ | $V_{GS} = V_{DS}, I_D = 2.2\text{ mA}, T_J = 25^\circ\text{C}$      | 2.4 | -    | 4.0 | V  |
| Forward Trans-conductance     | $g_{FS}$     | $V_{DS} = 20\text{ V}, I_D = 11.5\text{ A}$                         | -   | 17.1 | -   | S  |

### CHARGES, CAPACITANCES & GATE RESISTANCE

|                                   |               |  |   |      |     |    |
|-----------------------------------|---------------|--|---|------|-----|----|
| Input Capacitance                 | $C_{ISS}$     | $V_{DS} = 400\text{ V}, V_{GS} = 0\text{ V}, f = 250\text{ kHz}$                   | -   | 2088 | -   | pF |
| Output Capacitance                | $C_{OSS}$     |  | -   | 35   | -   |    |
| Time Related Output Capacitance   | $C_{OSS(tr)}$ | $I_D = \text{Constant}, V_{DS} = 0\text{ V to } 400\text{ V}, V_{GS} = 0\text{ V}$ | -   | 547  | -   |    |
| Energy Related Output Capacitance | $C_{OSS(er)}$ |  | $V_{DS} = 0\text{ V to } 400\text{ V}, V_{GS} = 0\text{ V}$ | -    | 59  |    |
| Total Gate Charge                 | $Q_{G(tot)}$  | $V_{DD} = 400\text{ V}, I_D = 11.5\text{ A}, V_{GS} = 10\text{ V}$                 | -   | 40   | -   | nC |
| Gate-to-Source Charge             | $Q_{GS}$      |  | -   | 9    | -   |    |
| Gate-to-Drain Charge              | $Q_{GD}$      |  | -   | 11   | -   |    |
| Gate Resistance                   | $R_G$         |  | $f = 1\text{ MHz}$  | -    | 3.5 |    |

### SWITCHING CHARACTERISTICS

|                     |              |   |   |    |   |    |
|---------------------|--------------|---|---|----|---|----|
| Turn-On Delay Time  | $t_{d(on)}$  | $V_{GS} = 0/10\text{ V}, V_{DD} = 400\text{ V}, I_D = 11.5\text{ A}, R_G = 7.5\text{ }\Omega$ | - | 23 | - | ns |
| Rise Time           | $t_r$        |   | - | 13 | - |    |
| Turn-Off Delay Time | $t_{d(off)}$ |   | - | 78 | - |    |
| Fall Time           | $t_f$        |   | - | 3  | - |    |

### SOURCE-TO-DRAIN DIODE CHARACTERISTICS

|                         |          |  |   |      |     |    |
|-------------------------|----------|--|---|------|-----|----|
| Forward Diode Voltage   | $V_{SD}$ | $V_{GS} = 0\text{ V}, I_{SD} = 11.5\text{ A}, T_J = 25^\circ\text{C}$                                  | - | -    | 1.2 | V  |
| Reverse Recovery Time   | $t_{RR}$ | $V_{GS} = 0\text{ V}, I_{SD} = 11.5\text{ A}, di/dt = 100\text{ A}/\mu\text{s}, V_{DD} = 400\text{ V}$ | - | 277  | -   | ns |
| Reverse Recovery Charge | $Q_{RR}$ |  | - | 3664 | -   | 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.

# NTHL120N60S5Z

## TYPICAL CHARACTERISTICS

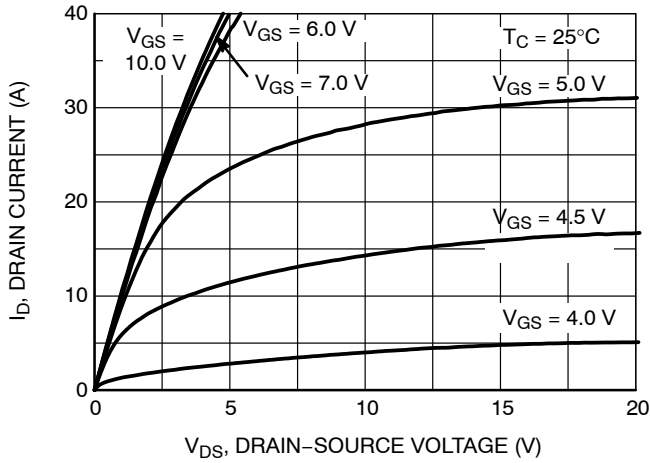


Figure 1. On-Region Characteristics

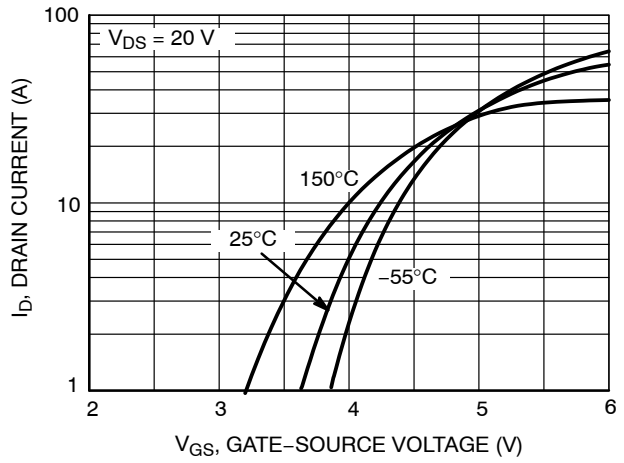


Figure 2. Transfer Characteristics

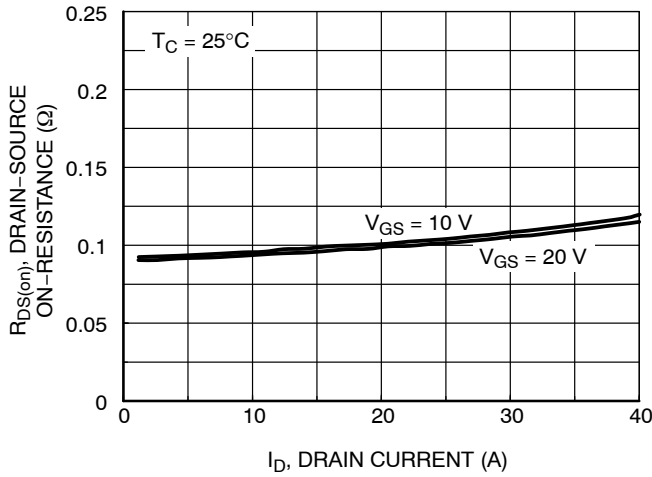


Figure 3. On-Resistance Variation vs. Drain Current and Gate Voltage

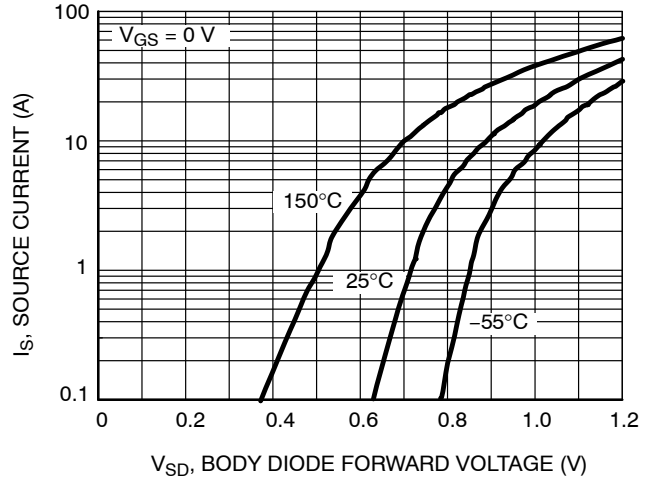


Figure 4. Body Diode Forward Voltage Variation vs. Source Current and Temperature

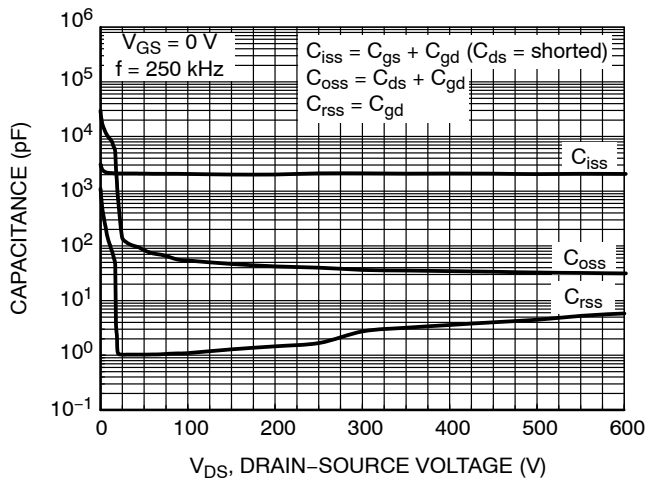


Figure 5. Capacitance Characteristics

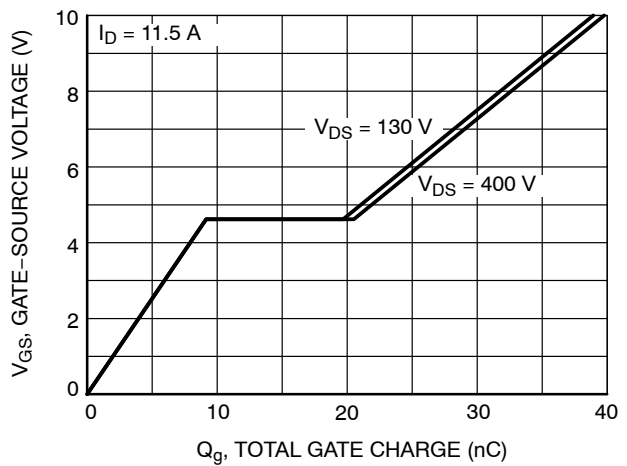


Figure 6. Gate Charge Characteristics

TYPICAL CHARACTERISTICS

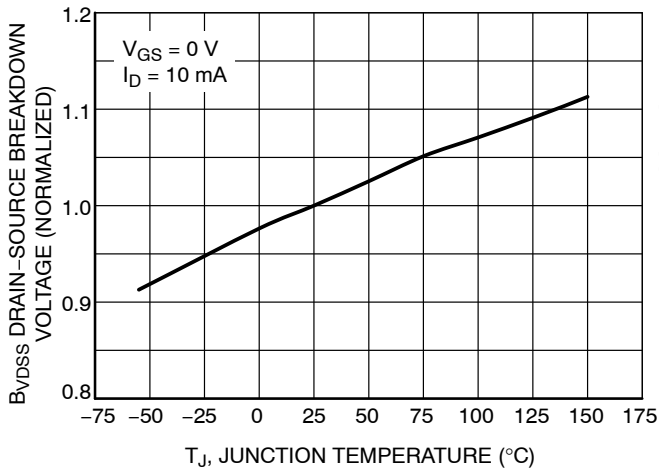


Figure 7. Breakdown Voltage Variation vs. Temperature

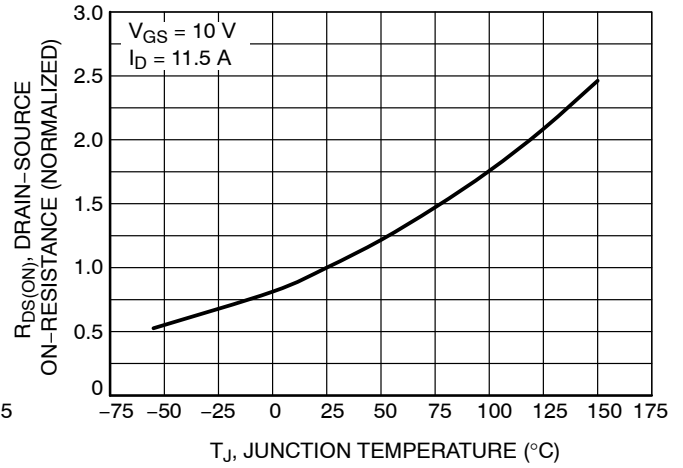


Figure 8. On-Resistance Variation vs. Temperature

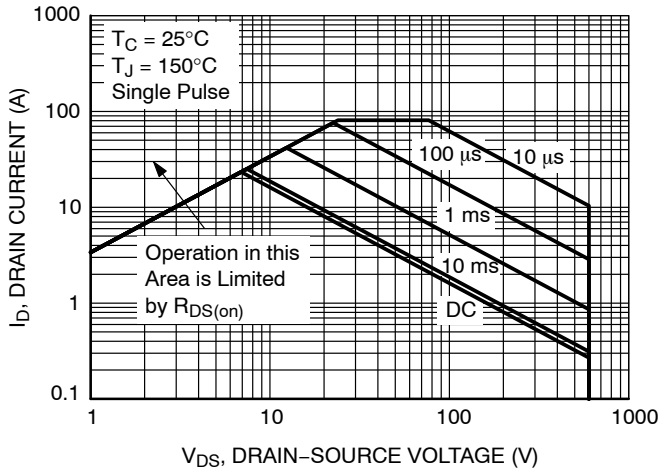


Figure 9. Maximum Safe Operating Area

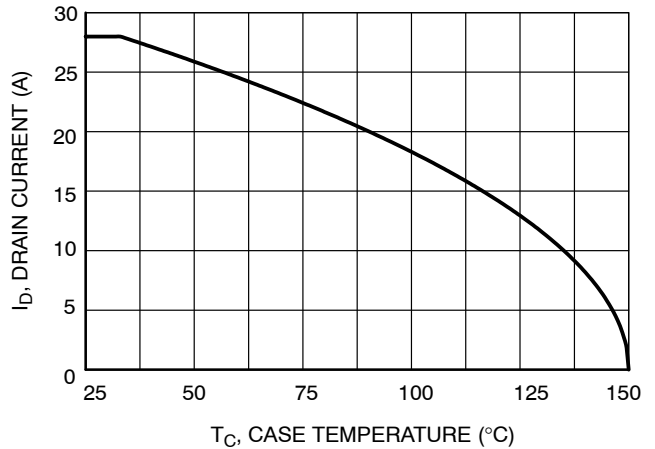


Figure 10. Maximum Drain Current vs. Case Temperature

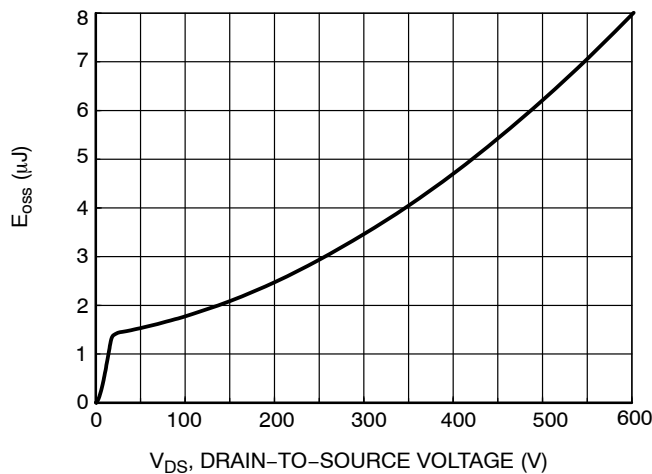


Figure 11.  $E_{OSS}$  vs. Drain to Source Voltage

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## TYPICAL CHARACTERISTICS

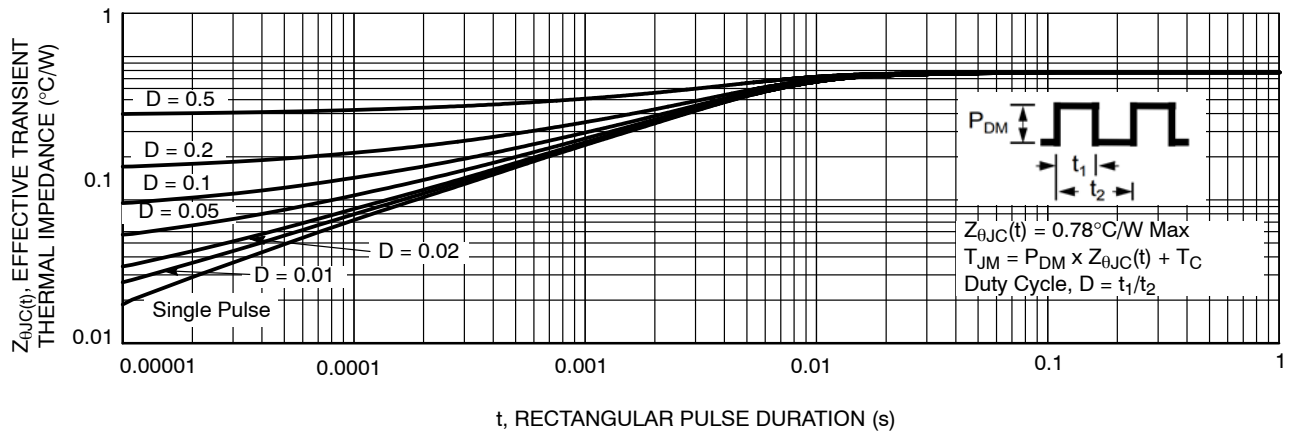


Figure 12. Transient Thermal Impedance

# NTHL120N60S5Z

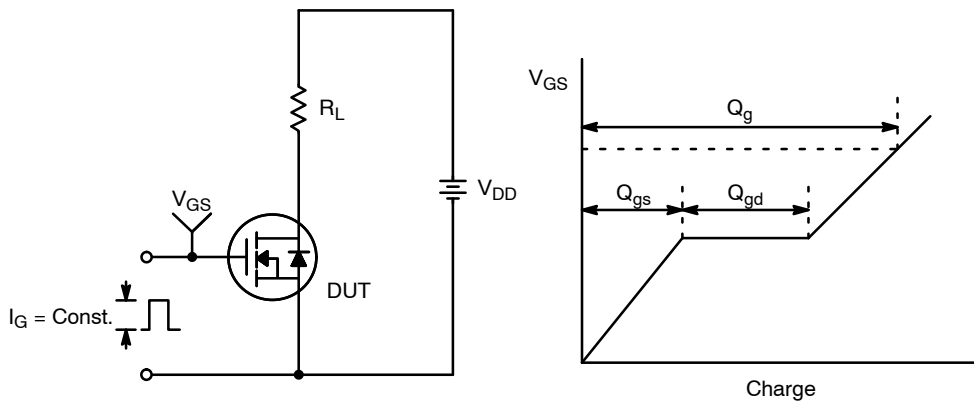


Figure 13. Gate Charge Test Circuit & Waveform

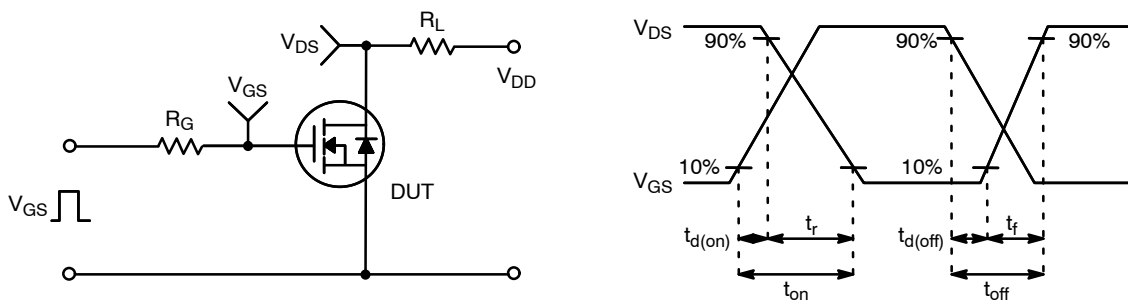


Figure 14. Resistive Switching Test Circuit & Waveforms

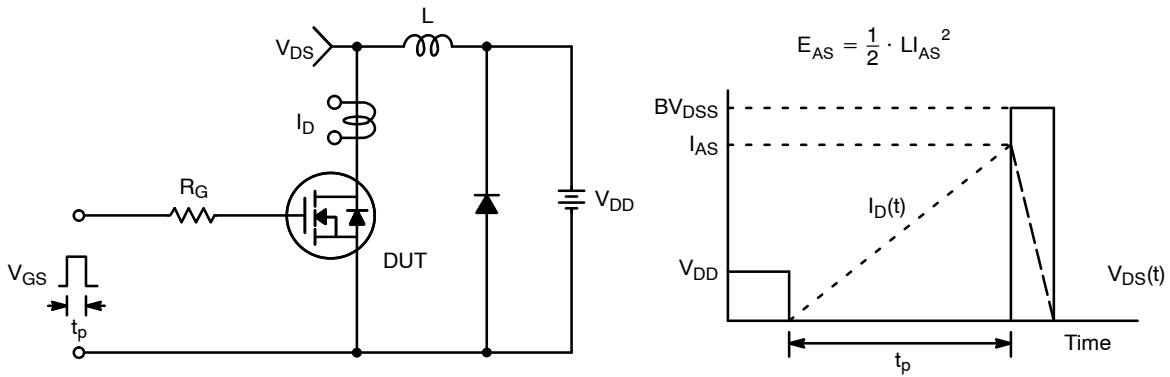
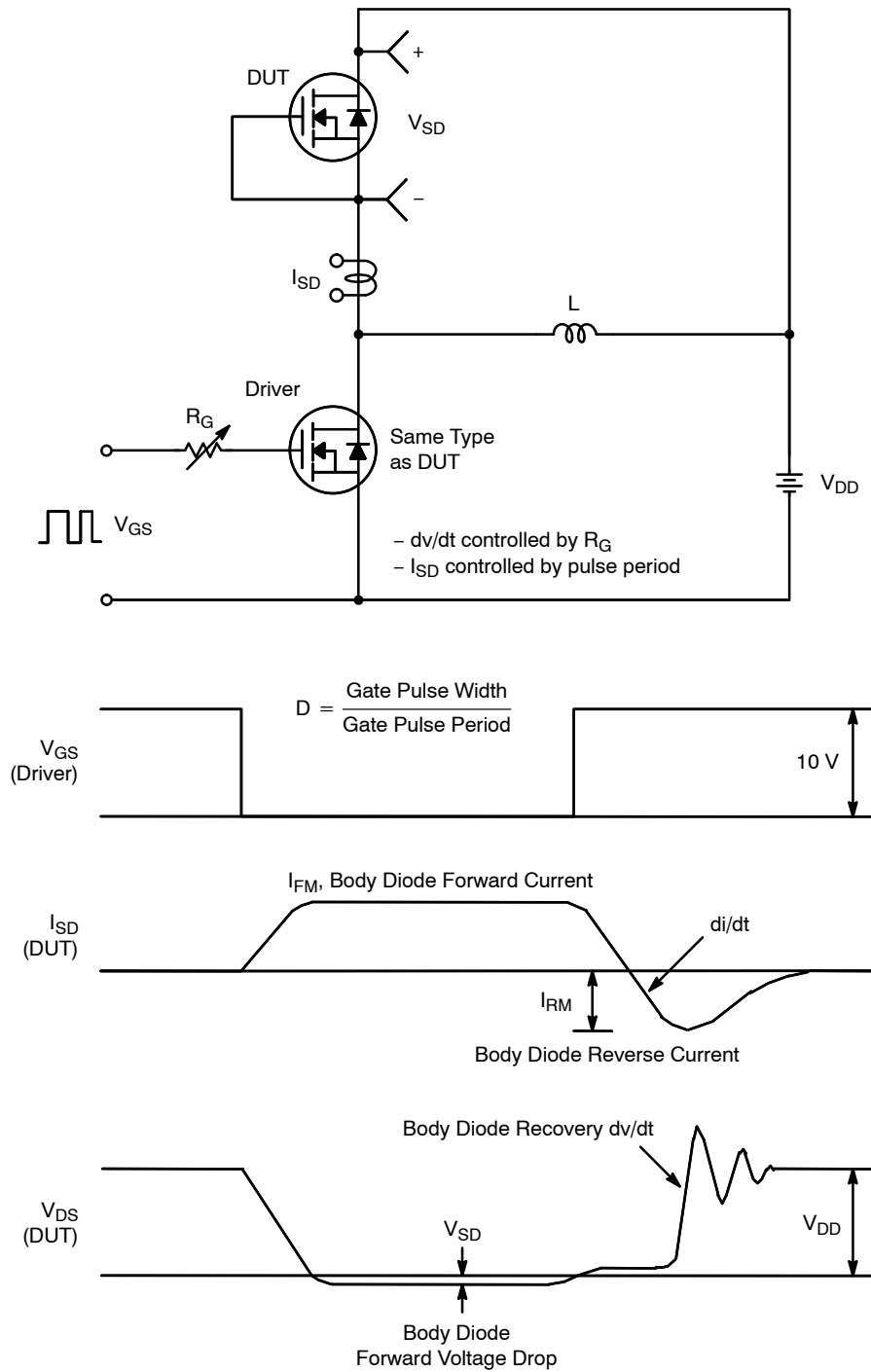


Figure 15. Unclamped Inductive Switching Test Circuit & Waveforms

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

# MECHANICAL CASE OUTLINE

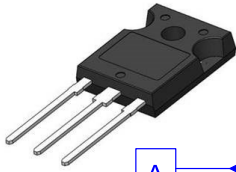
## PACKAGE DIMENSIONS

ON Semiconductor®



TO-247-3LD  
CASE 340CX  
ISSUE A

DATE 06 JUL 2020



NOTES: UNLESS OTHERWISE SPECIFIED.

- A. DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD FLASH, AND TIE BAR EXTRUSIONS.
- B. ALL DIMENSIONS ARE IN MILLIMETERS.
- C. DRAWING CONFORMS TO ASME Y14.5 - 2009.
- D. DIMENSION A1 TO BE MEASURED IN THE REGION DEFINED BY L1.
- E. LEAD FINISH IS UNCONTROLLED IN THE REGION DEFINED BY L1.

| DIM | MILLIMETERS |       |       |
|-----|-------------|-------|-------|
|     | MIN         | NOM   | MAX   |
| A   | 4.58        | 4.70  | 4.82  |
| A1  | 2.20        | 2.40  | 2.60  |
| A2  | 1.40        | 1.50  | 1.60  |
| D   | 20.32       | 20.57 | 20.82 |
| E   | 15.37       | 15.62 | 15.87 |
| E2  | 4.96        | 5.08  | 5.20  |
| e   | ~           | 5.56  | ~     |
| L   | 19.75       | 20.00 | 20.25 |
| L1  | 3.69        | 3.81  | 3.93  |
| ØP  | 3.51        | 3.58  | 3.65  |
| Q   | 5.34        | 5.46  | 5.58  |
| S   | 5.34        | 5.46  | 5.58  |
| b   | 1.17        | 1.26  | 1.35  |
| b2  | 1.53        | 1.65  | 1.77  |
| b4  | 2.42        | 2.54  | 2.66  |
| c   | 0.51        | 0.61  | 0.71  |
| D1  | 13.08       | ~     | ~     |
| D2  | 0.51        | 0.93  | 1.35  |
| E1  | 12.81       | ~     | ~     |
| ØP1 | 6.60        | 6.80  | 7.00  |

### GENERIC MARKING DIAGRAM\*



- XXXXX = Specific Device Code
- A = Assembly Location
- Y = Year
- WW = Work Week
- G = 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. Some products may not follow the Generic Marking.

|                         |                    |  |
|-------------------------|--------------------|--|
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