

# MOSFET – Power, N-Channel, Automotive SUPERFET® III, Easy-drive 650 V, 75 A, 25 mΩ

## NVHL025N65S3

### 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 Easy-drive series helps manage EMI issues and allows for easier design implementation.

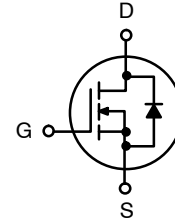
### Features

- AEC-Q101 Qualified
- Max Junction Temperature 150°C
- Typ.  $R_{DS(on)} = 19.9 \text{ m}\Omega$
- Ultra Low Gate Charge (Typ.  $Q_G = 236 \text{ nC}$ )
- Low Effective Output Capacitance (Typ.  $C_{OSS(eff.)} = 2062 \text{ pF}$ )
- 100% Avalanche Tested
- These Devices are Pb-Free and are RoHS Compliant

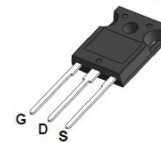
### Typical Applications

- Automotive PHEV-BEV DC-DC Converter
- Automotive Onboard Charger for PHEV-BEV

| $BV_{DSS}$ | $R_{DS(on)} \text{ MAX}$ | $I_D \text{ MAX}$ |
|------------|--------------------------|-------------------|
| 650 V      | 25 mΩ @ 10 V             | 75 A              |



N-Channel MOSFET



TO-247-3LD  
 CASE 340CX

### MARKING DIAGRAM



- \$Y = ON Semiconductor Logo
- &Z = Assembly Plant Code
- &3 = Numeric Date Code
- &K = Lot Code
- NVHL025N65S3 = Specific Device Code

### ORDERING INFORMATION

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

## NVHL025N65S3

### ABSOLUTE MAXIMUM RATINGS (T<sub>C</sub> = 25°C, Unless otherwise specified)

| Symbol                            | Parameter  |                                     | Value       | Unit |
|-----------------------------------|--|-------------------------------------|-------------|------|
| V <sub>DSS</sub>                  | Drain to Source Voltage  |                                     | 650         | V    |
| V <sub>GSS</sub>                  | Gate to Source Voltage   | DC Positive                         | 30          | V    |
|                                   |  | AC Positive, (f > 1 Hz)             | 30          | V    |
|                                   |  | AC Negative, (f > 1 Hz)             | -20         | V    |
| I <sub>D</sub>                    | Drain Current  | Continuous (T <sub>c</sub> = 25°C)  | 75          | A    |
|                                   |  | Continuous (T <sub>c</sub> = 100°C) | 65.8        | A    |
| I <sub>DM</sub>                   | Pulsed Drain Current   | Pulsed (Note 1)                     | 300         | A    |
| E <sub>AS</sub>                   | Single Pulsed Avalanche Energy (Note 2)                              |                                     | 2025        | mJ   |
| E <sub>AR</sub>                   | Repetitive Avalanche (Note 1)  |                                     | 5.95        | mJ   |
| dv/dt                             | MOSFET dv/dt   |                                     | 100         | V/ns |
|                                   | Peak Diode Recovery dv/dt (Note 3)                                   |                                     | 20          | V/ns |
| P <sub>D</sub>                    | Power Dissipation  | (T <sub>c</sub> = 25°C)             | 595         | W    |
|                                   |  | Derate Above 25°C                   | 4.76        | W/°C |
| T <sub>J</sub> , T <sub>STG</sub> | Operating and Storage Temperature Range                              |                                     | -55 to +150 | °C   |
| T <sub>L</sub>                    | 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<sub>AS</sub> = 15 A, R<sub>G</sub> = 25 Ω, starting T<sub>J</sub> = 25°C.
3. I<sub>SD</sub> < 75 A, di/dt ≤ 200 A/ms, VDD ≤ BVDSS, starting T<sub>J</sub> = 25°C.
4. Essentially independent of operating temperature typical characteristics.

### THERMAL CHARACTERISTICS

| Symbol           | Parameter                                    | Value | Unit |
|------------------|--|-------|------|
| R <sub>θJC</sub> | Thermal Resistance, Junction to Case, Max    | 0.21  | °C/W |
| R <sub>θJA</sub> | Thermal Resistance, Junction to Ambient, Max | 40    | °C/W |

### PACKAGE MARKING AND ORDERING INFORMATION

| Part Number  | Top Marking  | Package    | Packing Method | Shipping (Qty / Packing) |
|--------------|--------------|------------|----------------|--------------------------|
| NVHL025N65S3 | NVHL025N65S3 | TO-247-3LD | Tube           | 30 Units / Tube          |

# NVHL025N65S3

## ELECTRICAL CHARACTERISTICS (T<sub>C</sub> = 25°C unless otherwise noted)

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

### OFF CHARACTERISTICS

|                                      |   |  |     |      |      |      |
|--------------------------------------|---|--|-----|------|------|------|
| BV <sub>DSS</sub>                    | Drain-to-Source Breakdown Voltage         | V <sub>GS</sub> = 0 V, I <sub>D</sub> = 1 mA, T <sub>J</sub> = 25°C    | 650 | 713  | -    | V    |
|                                      |   | V <sub>GS</sub> = 0 V, I <sub>D</sub> = 1 mA, T <sub>J</sub> = 150°C   | 650 | 755  | -    | V    |
| ΔBV <sub>DSS</sub> / ΔT <sub>J</sub> | Breakdown Voltage Temperature Coefficient | I <sub>D</sub> = 1 mA, Referenced to 25°C                              | -   | 0.34 | -    | V/°C |
| I <sub>DSS</sub>                     | Zero Gate Voltage Drain Current           | V <sub>DS</sub> = 650 V, V <sub>GS</sub> = 0 V                         | -   | 0.30 | 1    | μA   |
|                                      |   | V <sub>DS</sub> = 520 V, V <sub>GS</sub> = 0 V, T <sub>c</sub> = 125°C | -   | 7.92 | -    |      |
| I <sub>GSS</sub>                     | Gate to Body Leakage Current              | V <sub>GS</sub> = +30 V, V <sub>DS</sub> = 0 V                         | -   | 5.27 | +100 | nA   |
|                                      |   | V <sub>GS</sub> = -20 V, V <sub>DS</sub> = 0 V                         | -   | 2.65 | -100 | nA   |

### ON CHARACTERISTICS

|                     |                                      |   |     |      |     |    |
|---------------------|--------------------------------------|---|-----|------|-----|----|
| V <sub>GS(th)</sub> | Gate to Source Threshold Voltage     | V <sub>GS</sub> = V <sub>DS</sub> , I <sub>D</sub> = 3.0 mA             | 2.5 | 3.56 | 4.5 | V  |
| R <sub>DS(on)</sub> | Static Drain to Source On Resistance | V <sub>GS</sub> = 10 V, I <sub>D</sub> = 37.5 A, T <sub>J</sub> = 25°C  | -   | 19.9 | 25  | mΩ |
|                     |                                      | V <sub>GS</sub> = 10 V, I <sub>D</sub> = 37.5 A, T <sub>J</sub> = 100°C | -   | 34.6 | -   | mΩ |
| g <sub>FS</sub>     | Forward Transconductance             | V <sub>DS</sub> = 20 V, I <sub>D</sub> = 75 A                           | -   | 78.5 | -   | S  |

### DYNAMIC CHARACTERISTICS

|                        |                                   |  |           |      |       |    |
|------------------------|-----------------------------------|--|-----------|------|-------|----|
| C <sub>iss</sub>       | Input Capacitance                 | V <sub>DS</sub> = 400 V, V <sub>GS</sub> = 0 V, f = 1 MHz                          | -         | 7330 | -     | pF |
| C <sub>oss</sub>       | Output Capacitance                |  | -         | 197  | -     | pF |
| C <sub>rss</sub>       | Reverse Transfer Capacitance      |  | -         | 33.6 | -     | pF |
| C <sub>oss(eff.)</sub> | Effective Output Capacitance      | V <sub>DS</sub> = 0 V to 400 V, V <sub>GS</sub> = 0 V                              | -         | 2062 | -     | pF |
| C <sub>oss(er.)</sub>  | Energy Related Output Capacitance | V <sub>DS</sub> = 0 V to 400 V, V <sub>GS</sub> = 0 V                              | -         | 285  | -     | pF |
| Q <sub>g(tot)</sub>    | Total Gate Charge                 | V <sub>DS</sub> = 400 V, V <sub>GS</sub> = 10 V, I <sub>D</sub> = 75 A<br>(Note 4) | -         | 236  | -     | nC |
| Q <sub>gs</sub>        | Gate to Source Gate Charge        |  | -         | 59.3 | -     | nC |
| Q <sub>gd</sub>        | Gate to Drain "Miller" Charge     |  | -         | 97.3 | -     | nC |
| R <sub>G</sub>         | Gate Resistance                   |  | f = 1 MHz | -    | 0.818 | -  |

### SWITCHING CHARACTERISTICS

|                     |                     |  |   |      |   |    |
|---------------------|---------------------|--|---|------|---|----|
| t <sub>d(on)</sub>  | Turn-On Delay Time  | V <sub>DD</sub> = 400 V, I <sub>D</sub> = 75 A, V <sub>GS</sub> = 10 V,<br>R <sub>G</sub> = 2 Ω (Note 4) | - | 43.3 | - | ns |
| t <sub>r</sub>      | Turn-On Rise Time   |  | - | 109  | - | ns |
| t <sub>d(off)</sub> | Turn-Off Delay Time |  | - | 120  | - | ns |
| t <sub>f</sub>      | Fall Time           |  | - | 107  | - | ns |

### DRAIN-SOURCE DIODE CHARACTERISTICS

|                 |  |  |   |      |     |    |
|-----------------|--|--|---|------|-----|----|
| I <sub>S</sub>  | Maximum Continuous Drain to Source Diode Forward Current | -  | - | 75   | A   |    |
| I <sub>SM</sub> | Maximum Pulsed Drain to Source Diode Forward Current     | -  | - | 300  | A   |    |
| V <sub>SD</sub> | Drain to Source Diode Forward Voltage                    | V <sub>GS</sub> = 0 V, I <sub>SD</sub> = 37.5 A                              | - | 0.88 | 1.2 | V  |
| t <sub>rr</sub> | Reverse Recovery Time                                    | V <sub>GS</sub> = 0 V, I <sub>SD</sub> = 75 A dI <sub>F</sub> /dt = 100 A/μs | - | 714  | -   | nS |
| Q <sub>rr</sub> | Reverse Recovery Charge                                  |  | - | 26.4 | -   | 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.

TYPICAL CHARACTERISTICS

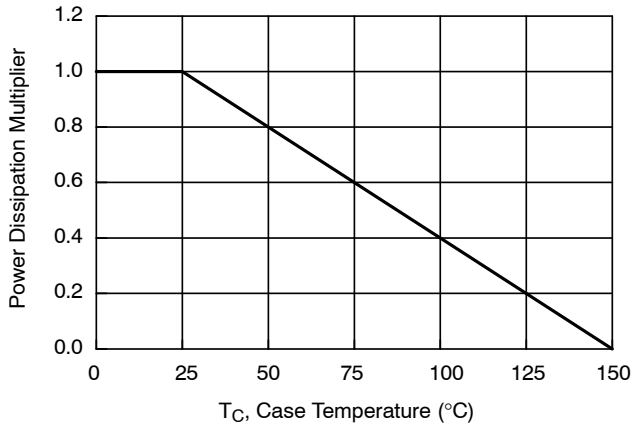


Figure 1. Normalized Power Dissipation vs. Case Temperature

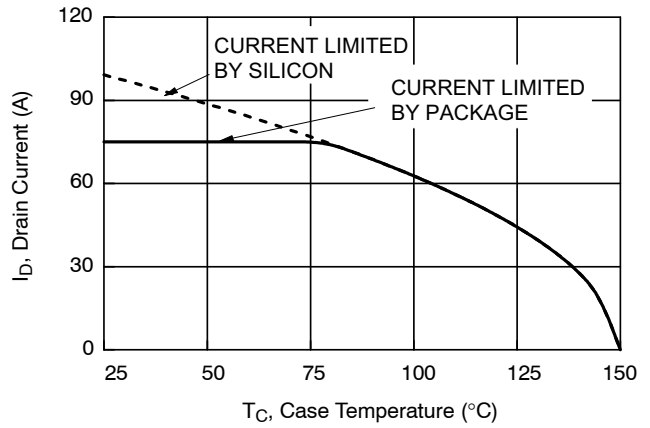


Figure 2. Maximum Continuous Drain Current vs. Case Temperature

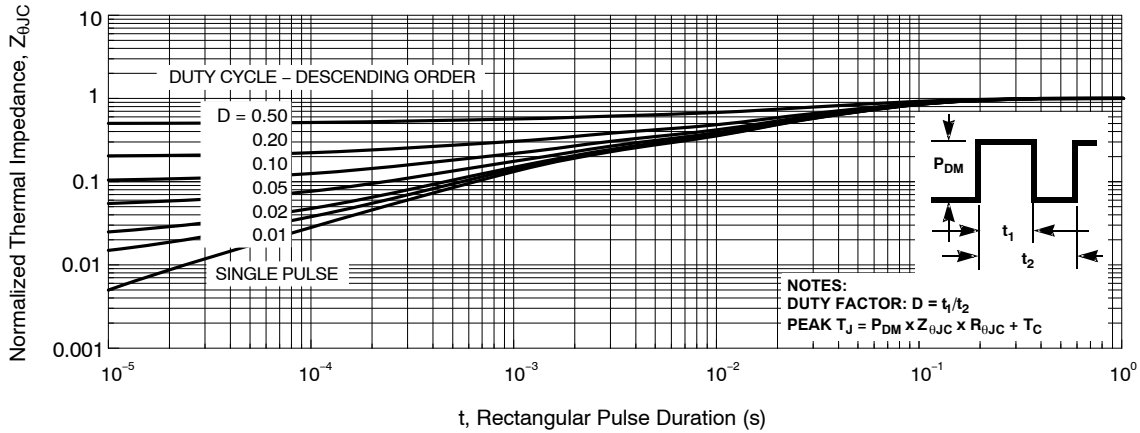


Figure 3. Normalized Maximum Transient Thermal Impedance

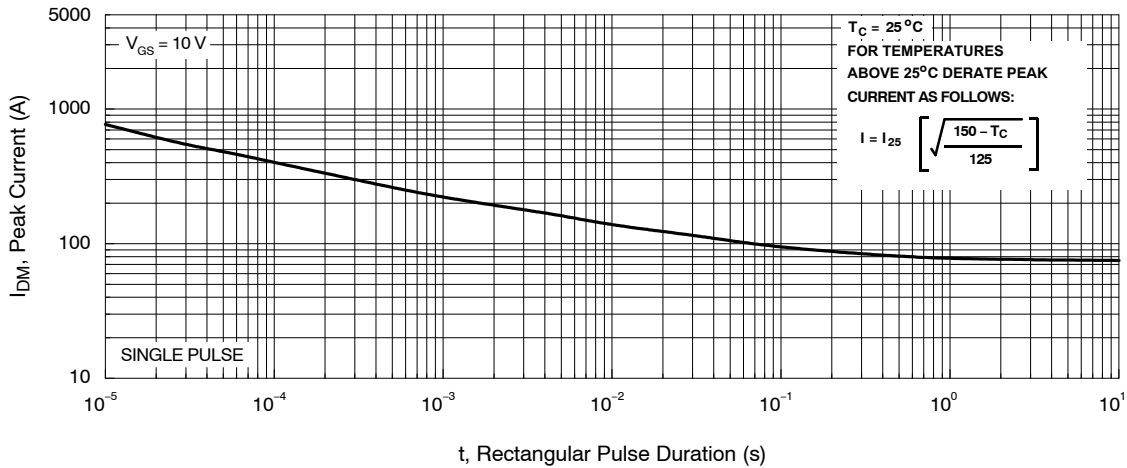


Figure 4. Peak Current Capability

TYPICAL CHARACTERISTICS (continued)

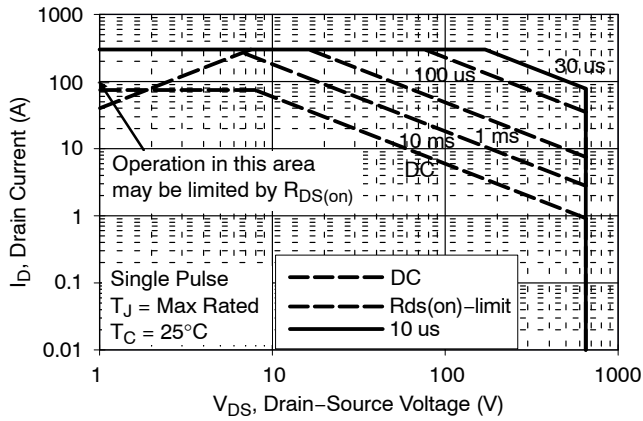


Figure 5. Forward Bias Safe Operating Area

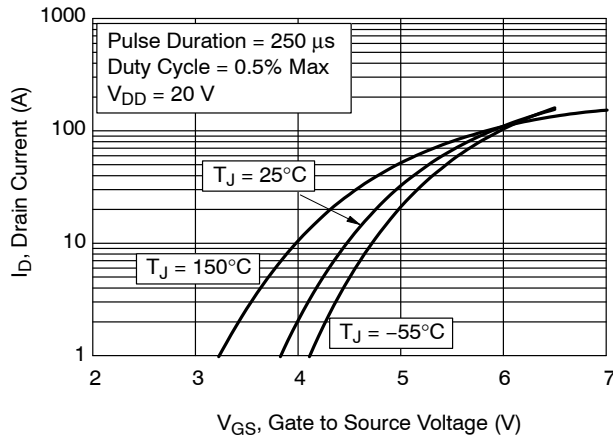


Figure 6. Transfer Characteristic

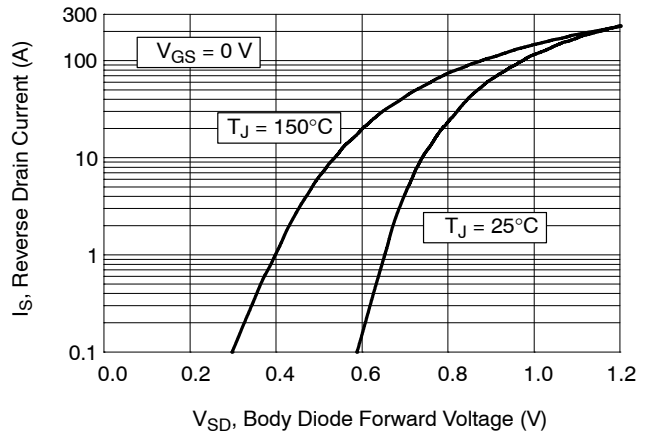


Figure 7. Forward Diode Characteristics

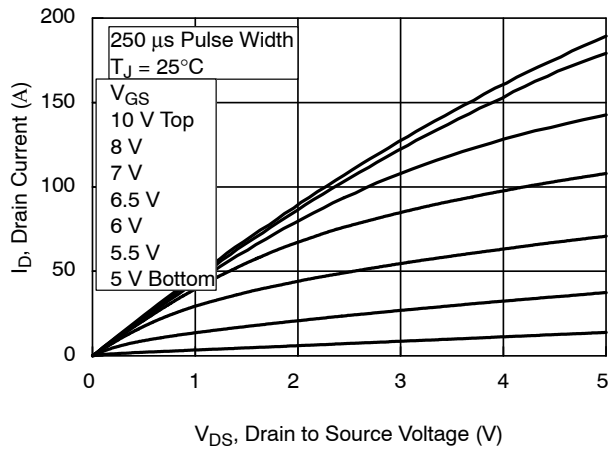


Figure 8. Saturation Characteristics

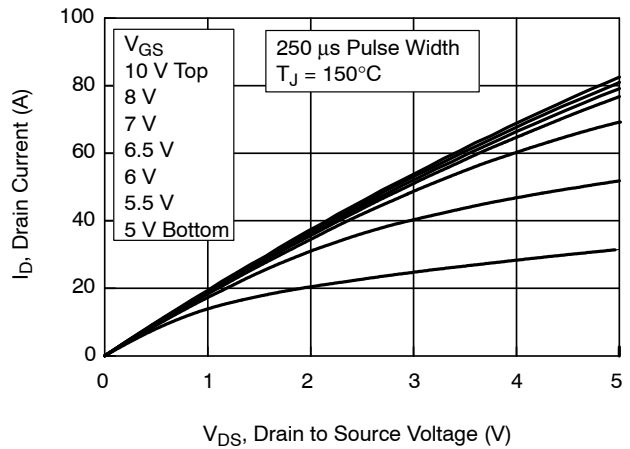


Figure 9. Saturation Characteristics

TYPICAL CHARACTERISTICS (continued)

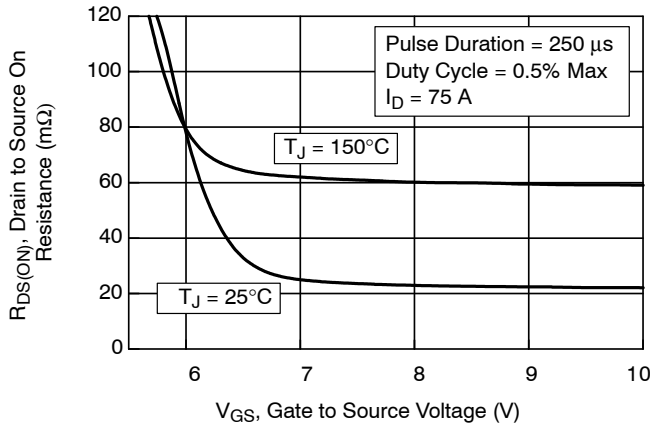


Figure 10.  $R_{DS(on)}$  vs. Gate Voltage

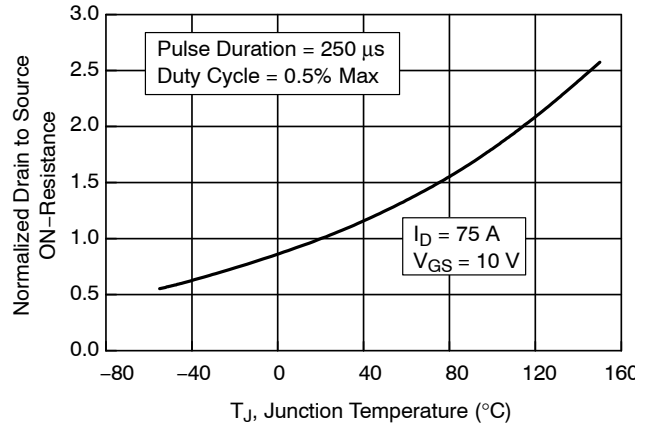


Figure 11. Normalized  $R_{DS(on)}$  vs. Junction Temperature

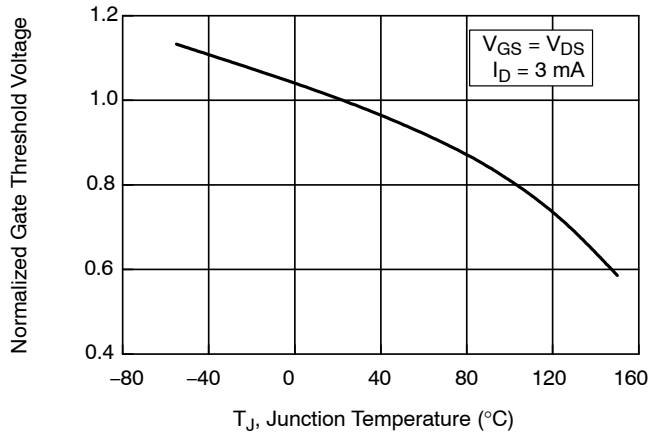


Figure 12. Normalized Gate Threshold Voltage vs. Temperature

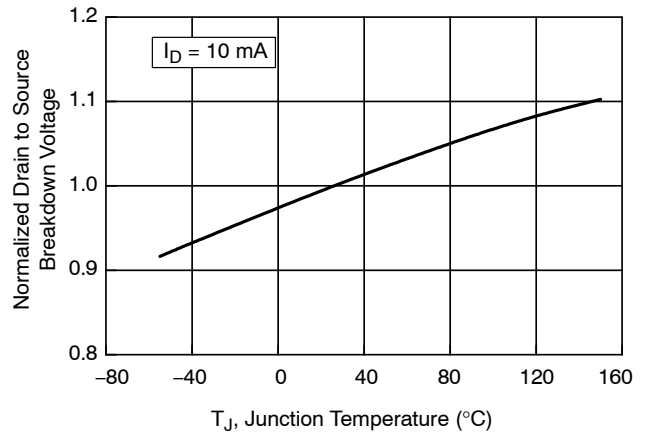


Figure 13. Normalized Drain to Source Breakdown Voltage vs. Junction Temperature

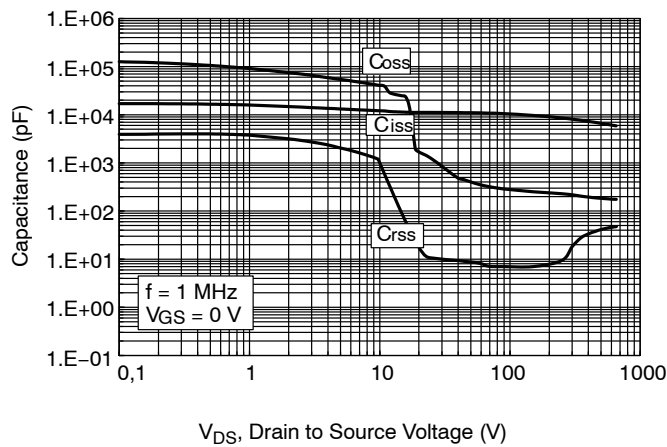


Figure 14. Capacitance vs. Drain to Source Voltage

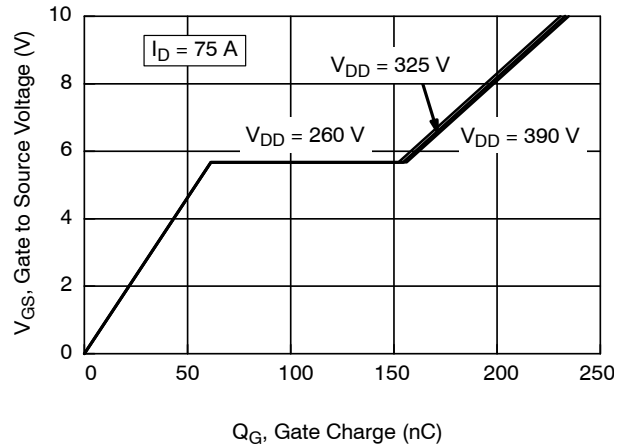


Figure 15. Gate Charge vs. Gate to Source Voltage

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## TYPICAL CHARACTERISTICS (continued)

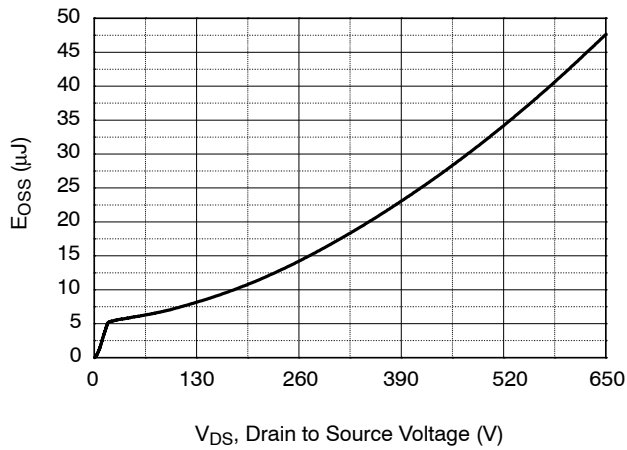


Figure 16. E<sub>OSS</sub> vs. Drain to Source Voltage

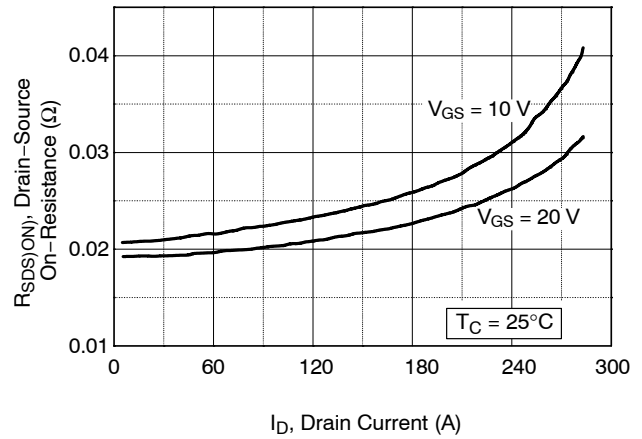


Figure 17. On-Resistance Variation vs. Drain Current and Gate Voltage

# MECHANICAL CASE OUTLINE

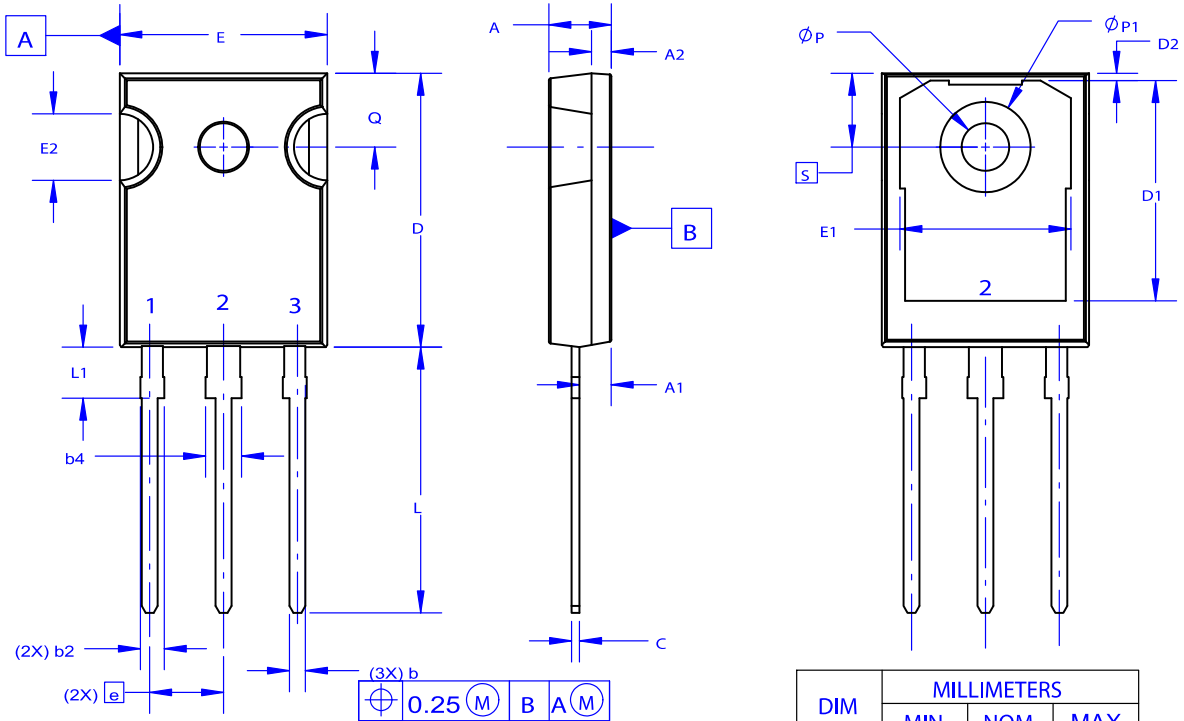
## PACKAGE DIMENSIONS

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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| <b>DESCRIPTION:</b>     | <b>TO-247-3LD</b>  | <b>PAGE 1 OF 1</b>   |

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