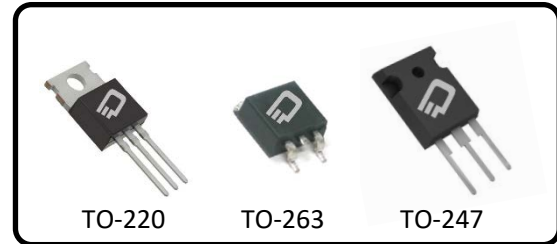


## 650V, 99mΩ, 31.8 A Super Junction Power MOSFET

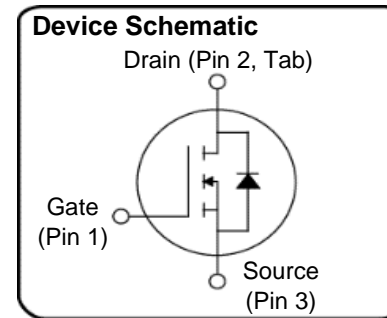
### Ordering Information

| Part Number  | Package Option |
|--------------|----------------|
| D3S099N65B-U | TO-220         |
| D3S099N65D-U | TO-247         |
| D3S099N65E-U | TO-263         |



### Description

+FET™ is an advanced Super Junction Power MOSFET offering excellent efficiency through low  $R_{DS(ON)}$  and low gate charge. +FET™ is a rugged device with precision charge balance implementation designed for demanding uses such as enterprise power computing power supplies, motor control, lighting and other challenging power conversion applications.



### Features

- LOW  $R_{DS(ON)}$
- FAST SWITCHING
- HIGH  $E_{AS}$
- REL TEST SPEC: JESD-22
- HTRB >3000 HRS

**Table 1** Key Parameters

| Parameter            | Value | Unit |
|----------------------|-------|------|
| $V_{DSS} @ T_{jmax}$ | 710   | V    |
| $R_{DS(on) max}$     | < 99  | mΩ   |
| $Q_g typ$            | 77    | nC   |
| $I_D @ 25 °C$        | 44.9  | A    |

### Benefits

- LOW CONDUCTION LOSSES
- HIGH EFFICIENCY
- EXCELLENT AVALANCHE PERFORMANCE

### Applications

- POWER FACTOR CORRECTION
- SERVER POWER SUPPLIES
- TELECOM POWER SUPPLIES
- INVERTERS
- MOTOR CONTROL

## Contents

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## Maximum Ratings

**Table 2** Maximum Ratings

 @  $T_j = 25^\circ\text{C}$ , unless otherwise specified

| Parameter                        | Symbol                | Values |     |      | Unit             | Condition  |
|----------------------------------|-----------------------|--------|-----|------|------------------|--|
|                                  |                       | Min    | Typ | Max  |                  |  |
| Continuous drain current         | $I_D$                 |        |     | 31.8 | A                | $T_C = 25^\circ\text{C}$   |
|                                  |                       |        |     | 23.7 | A                | $T_C = 100^\circ\text{C}$  |
| Pulsed drain current             | $I_{D, \text{pulse}}$ |        |     | 127  | A                | $T_C = 25^\circ\text{C}$   |
| Avalanche energy, single pulse   | $E_{AS}$              |        |     | 650  | mJ               | $I_D = 8.7\text{A}; V_{DD} = 50\text{V}, V_{GS} = 10\text{V}, L = 17\text{mH}, R_G = 25\ \Omega$ |
| Avalanche energy, repetitive     | $E_{AR}$              |        |     | 1.0  | mJ               | $I_D = 8.7\text{A}; V_{DD} = 50\text{V}$   |
| Avalanche current, repetitive    | $I_{AR}$              |        |     | 8.7  | A                |  |
| MOSFET dv/dt ruggedness          | dv/dt                 |        |     | 50   | V/ns             | $V_{DS} = 0 \dots 400\text{V}$   |
| Gate source voltage (static)     | $V_{GS}$              | -30    |     | 30   | V                | Static   |
| Gate source voltage (dynamic)    | $V_{GS}$              | -30    |     | 30   | V                | AC ( $F > 1\text{Hz}$ )  |
| Power dissipation                | $P_{tot}$             |        |     | 154  | W                | TO-220, TO-263, TO-247, $T_C = 25^\circ\text{C}$   |
| Storage temperature              | $T_{stg}$             | -55    |     | 150  | $^\circ\text{C}$ |  |
| Operating junction temperature   | $T_j$                 | -55    |     | 150  | $^\circ\text{C}$ |  |
| Mounting torque                  |                       |        |     | 60   | N-cm             |  |
| Continuous diode forward current | $I_{SD}$              |        |     | 31.8 | A                | $T_C = 25^\circ\text{C}$   |
| Diode pulse current              | $I_{S, \text{pulse}}$ |        |     | 127  | A                | $T_C = 25^\circ\text{C}$   |
| Reverse diode dv/dt              | dv/dt                 |        |     | 15   | V/ns             | $V_{DS} = 0 \dots 400\text{V}, I_{SD} \leq I_S, T_j = 25^\circ\text{C}$                          |
| Maximum diode commutation speed  | $di/dt$               |        |     | 500  | A/ $\mu\text{s}$ | $V_{DS} = 0 \dots 400\text{V}, I_{SD} \leq I_S, T_j = 25^\circ\text{C}$                          |

## Thermal Characteristics

**Table 3** Thermal Characteristics

| Symbol           | Parameter  | Values |        |        | Unit |
|------------------|--|--------|--------|--------|------|
|                  |  | TO-220 | TO-263 | TO-247 |      |
| R <sub>thC</sub> | Thermal resistance, junction-case                          | 0.81   | 0.81   | 0.81   | °C/W |
| R <sub>thA</sub> | Thermal resistance, junction-ambient                       | 62     | 62     | 50     | °C/W |
| R <sub>thT</sub> | Thermal resistance, junction-ambient for SMD version       |        | 30     |        | °C/W |
| T <sub>s</sub>   | Soldering temperature, wavesoldering only allowed at leads | 260    | 260    | 260    | °C   |

## Electrical Characteristics

@ T<sub>j</sub> = 25°C, unless otherwise specified

**Table 4**

| Parameter                        | Symbol              | Values |       |       | Unit | Condition   |
|----------------------------------|---------------------|--------|-------|-------|------|---|
|                                  |                     | Min    | Typ   | Max   |      |   |
| Drain-source breakdown voltage   | V <sub>DSS</sub>    | 650    |       |       | V    | I <sub>D</sub> = 1mA, V <sub>GS</sub> = 0V                            |
| Gate threshold voltage           | V <sub>GS(th)</sub> | 2.3    | 3     | 3.7   | V    |   |
| Zero gate voltage drain current  | I <sub>DSS</sub>    |        |       | 1     | μA   | V <sub>DS</sub> = 650V, T <sub>C</sub> = 25°C                         |
|                                  |                     |        |       | 50    |      | V <sub>DS</sub> = 650V, T <sub>C</sub> = 125°C                        |
| Gate-source leakage current      | I <sub>GSS</sub>    |        |       | 100   | nA   |   |
| Drain-source on-state resistance | R <sub>DS(on)</sub> |        | 0.062 | 0.099 | Ω    | V <sub>GS</sub> = 10V, I <sub>D</sub> = 15.9A, T <sub>C</sub> = 25°C  |
|                                  | R <sub>DS(on)</sub> |        | 0.160 |       |      | V <sub>GS</sub> = 10V, I <sub>D</sub> = 15.9A, T <sub>C</sub> = 150°C |
| Gate resistance                  | R <sub>G</sub>      |        | 1     |       | Ω    |   |

**Table 5**

| Parameter                    | Symbol              | Values |      |     | Unit | Condition  |
|------------------------------|---------------------|--------|------|-----|------|--|
|                              |                     | Min    | Typ  | Max |      |  |
| Input capacitance            | C <sub>iss</sub>    |        | 4240 |     | pF   | V <sub>DS</sub> = 100V, f = 1MHz,<br>V <sub>GS</sub> = 0V                                    |
| Output capacitance           | C <sub>oss</sub>    |        | 97.5 |     | pF   |  |
| Reverse transfer capacitance | C <sub>rss</sub>    |        | 16.5 |     | pF   |  |
| Turn-on delay time           | t <sub>d(on)</sub>  |        | 17   |     | ns   | V <sub>DD</sub> = 400V, I <sub>D</sub> = 15.9A<br>R <sub>G</sub> = 1Ω, V <sub>GS</sub> = 10V |
| Rise time                    | t <sub>r</sub>      |        | 24   |     | ns   |  |
| Turn-off delay time          | t <sub>d(off)</sub> |        | 90   |     | ns   |  |
| Fall time                    | t <sub>f</sub>      |        | 23   |     | ns   |  |

**Table 6** Gate Charge Characteristics

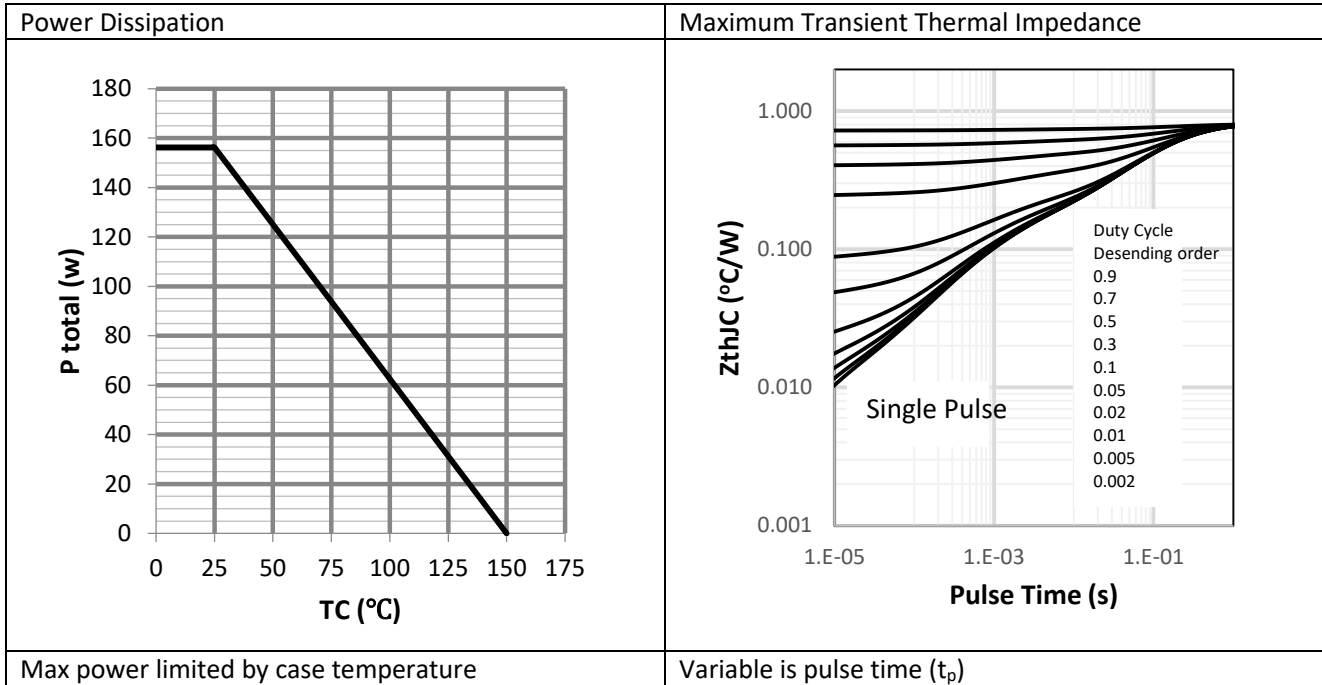
| Parameter             | Symbol        | Values |     |     | Unit | Condition                                       |
|-----------------------|---------------|--------|-----|-----|------|---|
|                       |               | Min    | Typ | Max |      |   |
| Gate to source charge | $Q_{gs}$      |        | 16  |     | nC   | $V_{DD} = 480V, I_D = 15.5A,$<br>$V_{GS} = 10V$ |
| Gate to drain charge  | $Q_{gd}$      |        | 27  |     | nC   |   |
| Gate charge total     | $Q_g$         |        | 77  |     | nC   |   |
| Gate plateau voltage  | $V_{plateau}$ |        | 5   |     | V    |   |

**Table 7** Body Diode

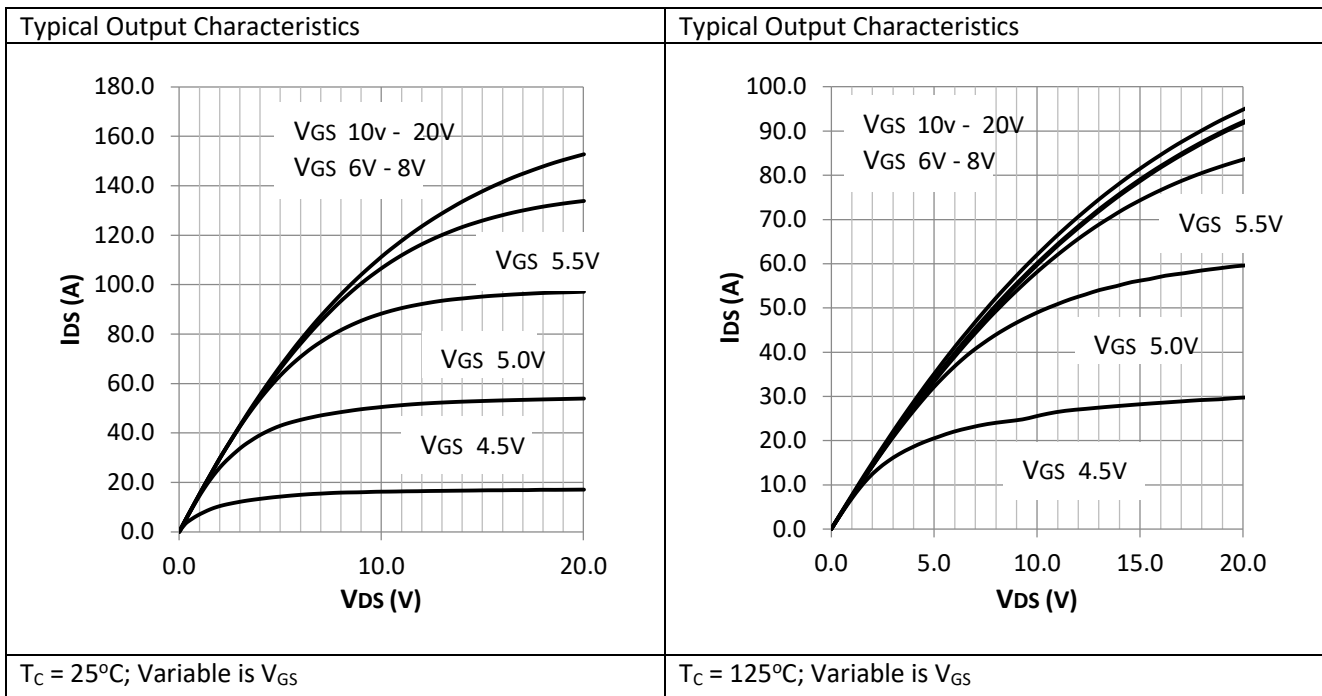
| Parameter                     | Symbol    | Values |      |      | Unit    | Condition  |
|-------------------------------|-----------|--------|------|------|---------|--|
|                               |           | Min    | Typ  | Max  |         |  |
| Diode source-drain current    | $I_{SD}$  |        |      | 38.3 | A       |  |
| Diode forward voltage         | $V_{fd}$  |        | 0.95 | 1.5  | V       | $I_{SD} = 31.8A, V_{GS} = 0V$  |
| Reverse recovery time         | $t_{rr}$  |        | 468  |      | ns      | $I_{SD} = 31.8A, di/dt = 100A/\mu S$<br>$V_{DD} = 60V, T_C = 25^\circ C$ |
| Reverse recovery charge       | $Q_{rr}$  |        | 9.5  |      | $\mu C$ |  |
| Peak reverse recovery current | $I_{rrm}$ |        | 50.0 |      | A       |  |

## Electrical Characteristics Graphs

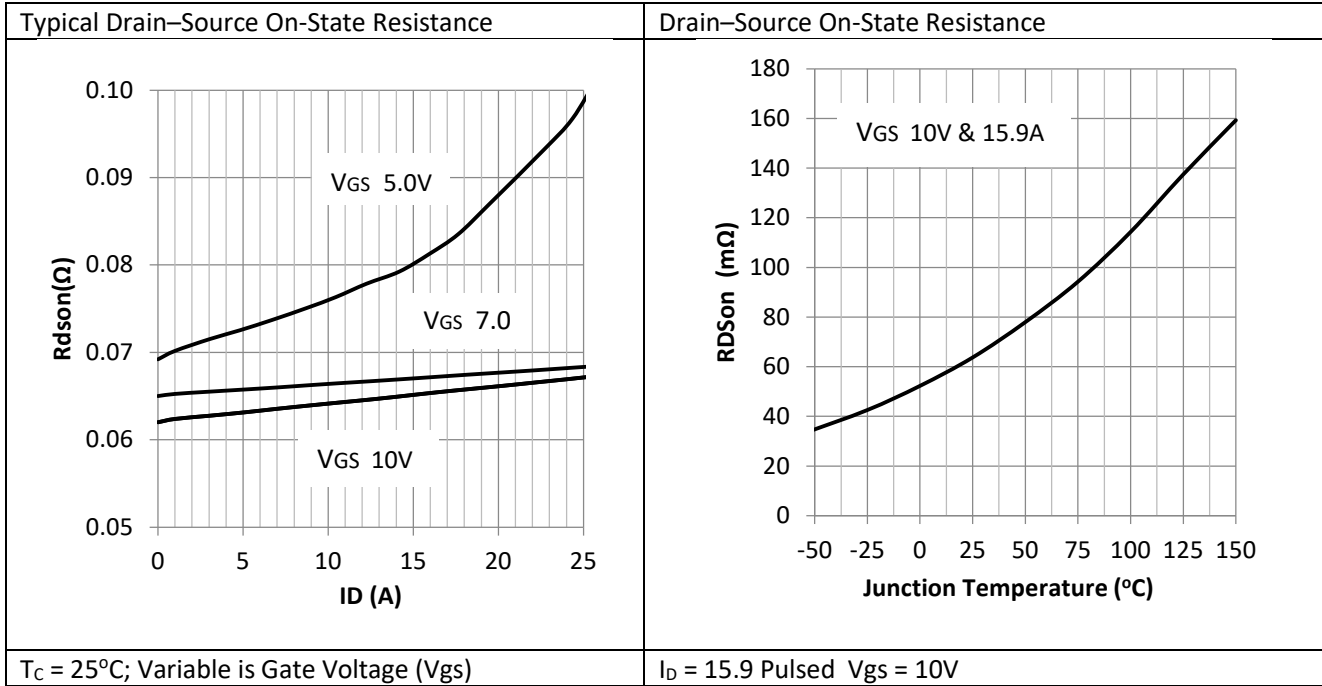
**Table 8 Thermal Performance**



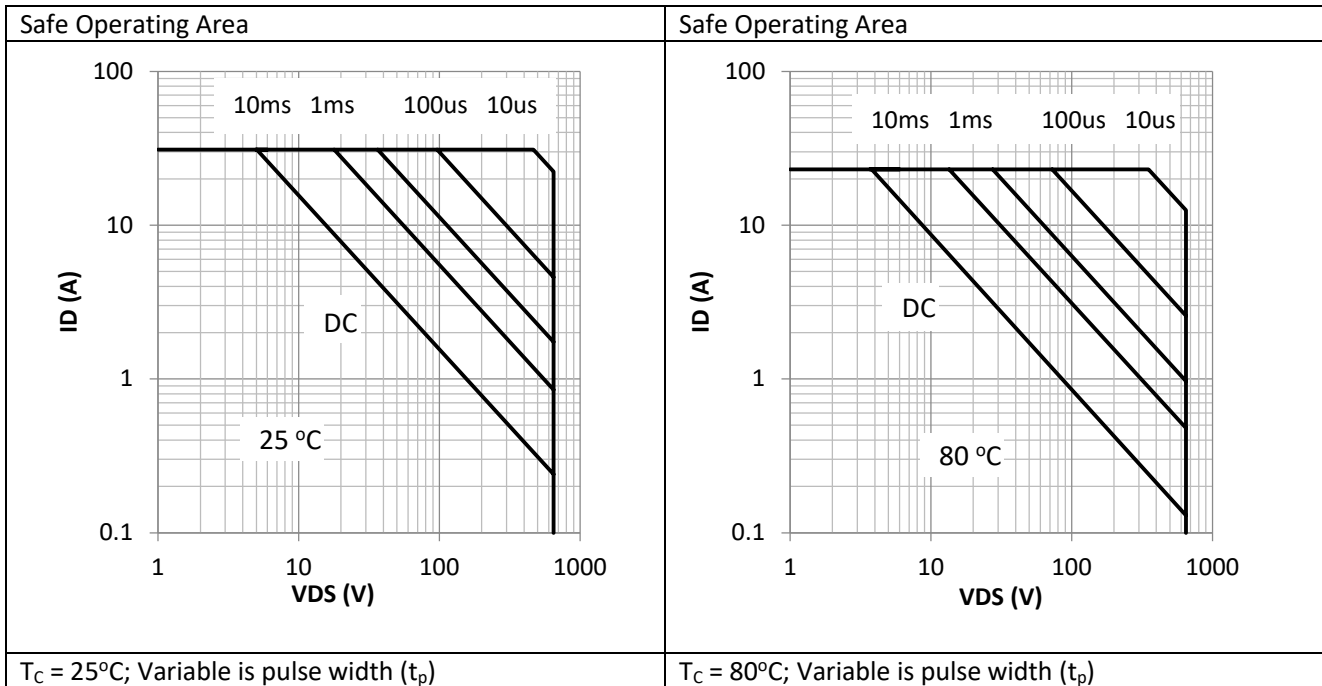
**Table 9 Output Characteristics**



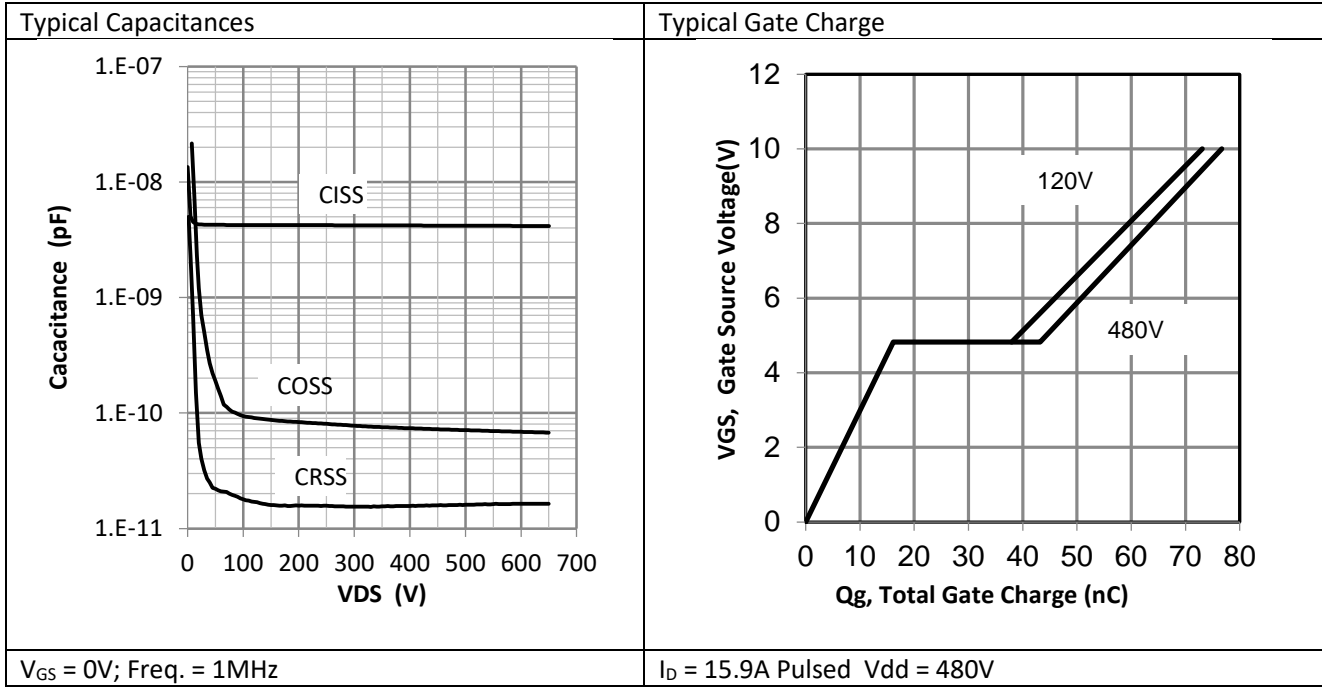
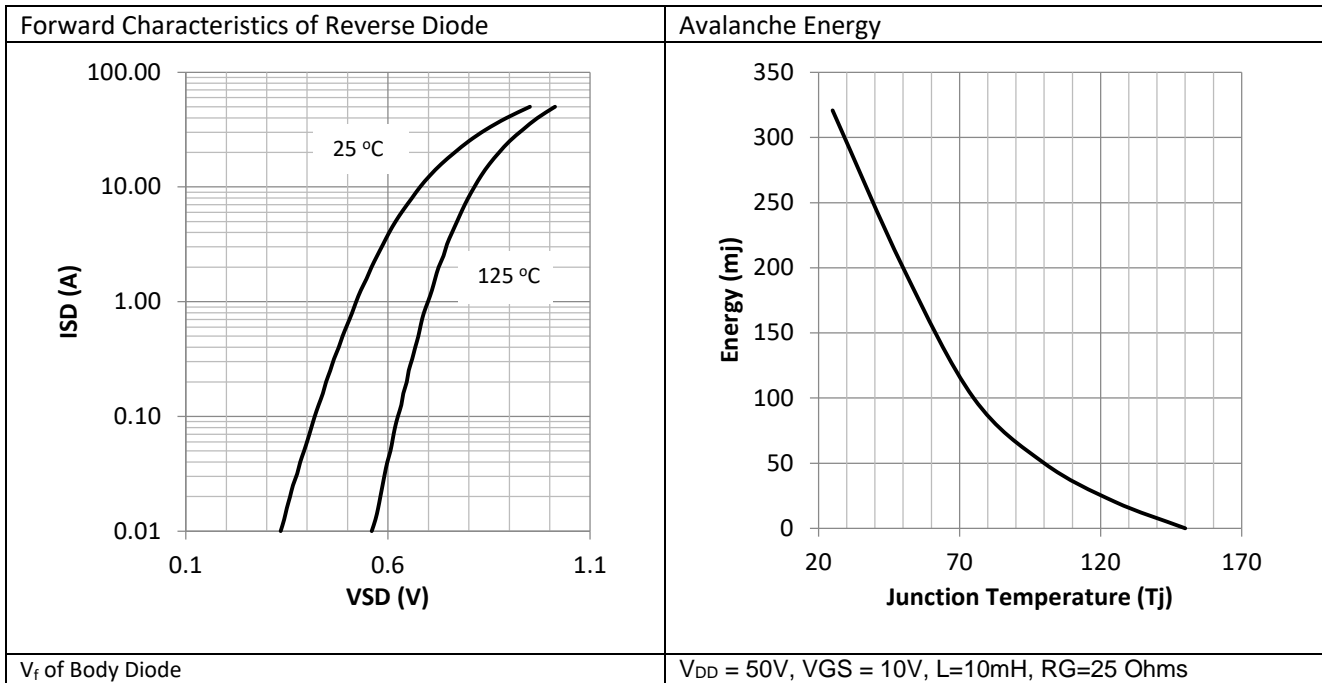
**Table 10 Drain-Source Resistance**



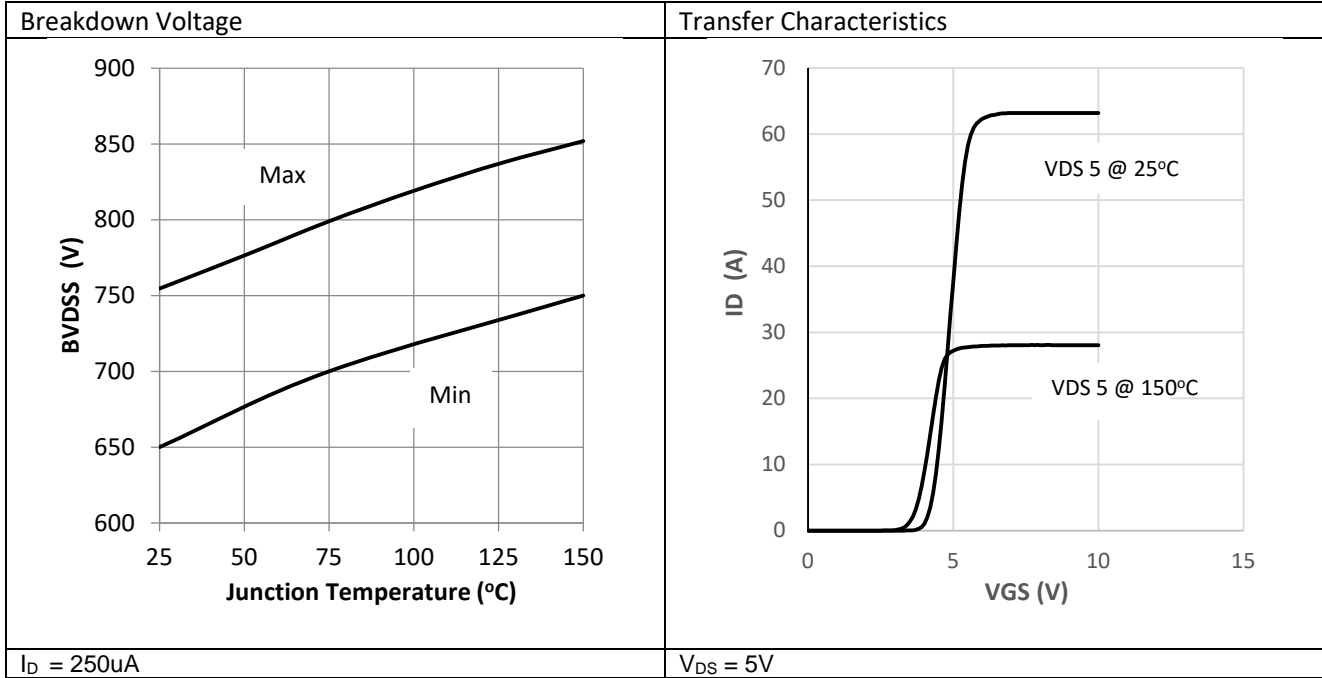
**Table 11 Safe Operating Area**



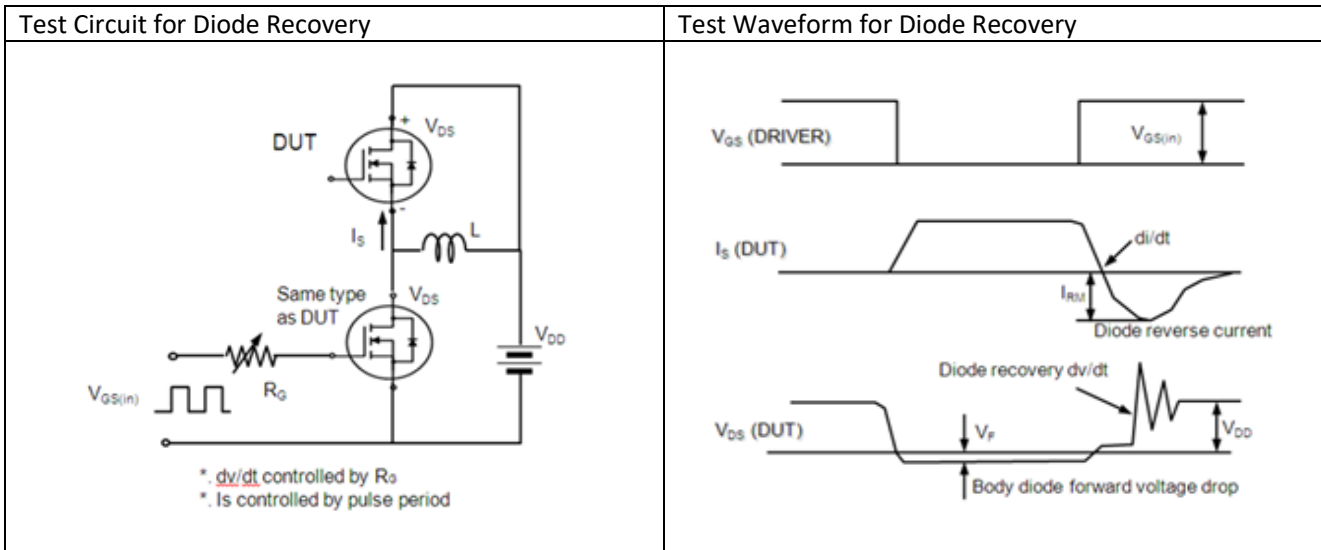


**Table 12 Typical Capacitances and Gate Charge**

**Table 13 Diode Forward Characteristics and Avalanche Energy**


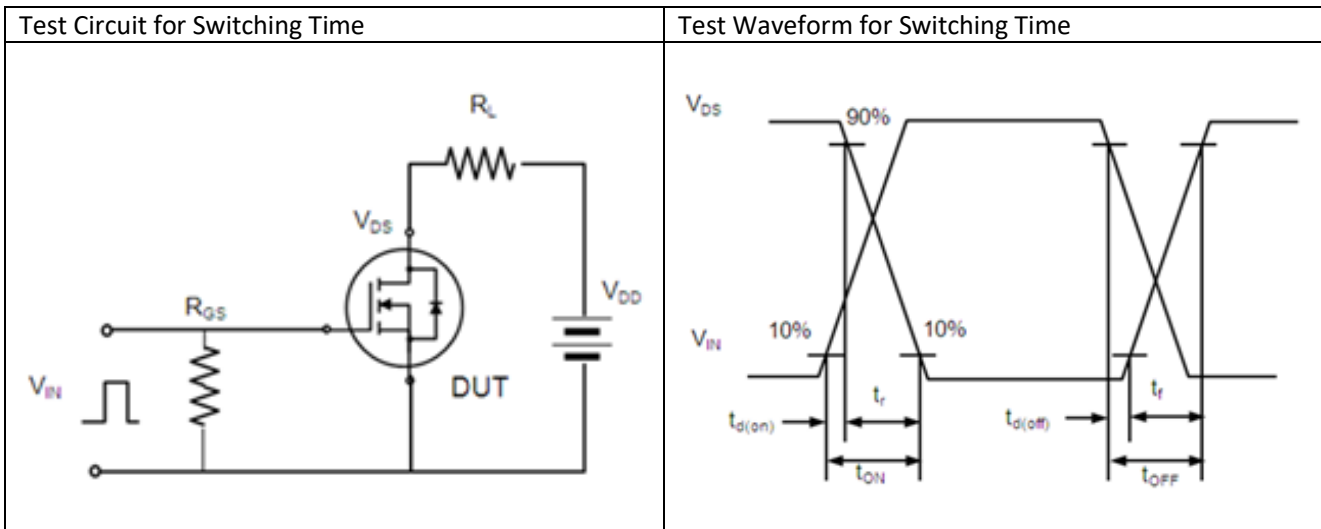
**Table 14 Drain – Source Breakdown Voltage and Typical Transfer Characteristics**



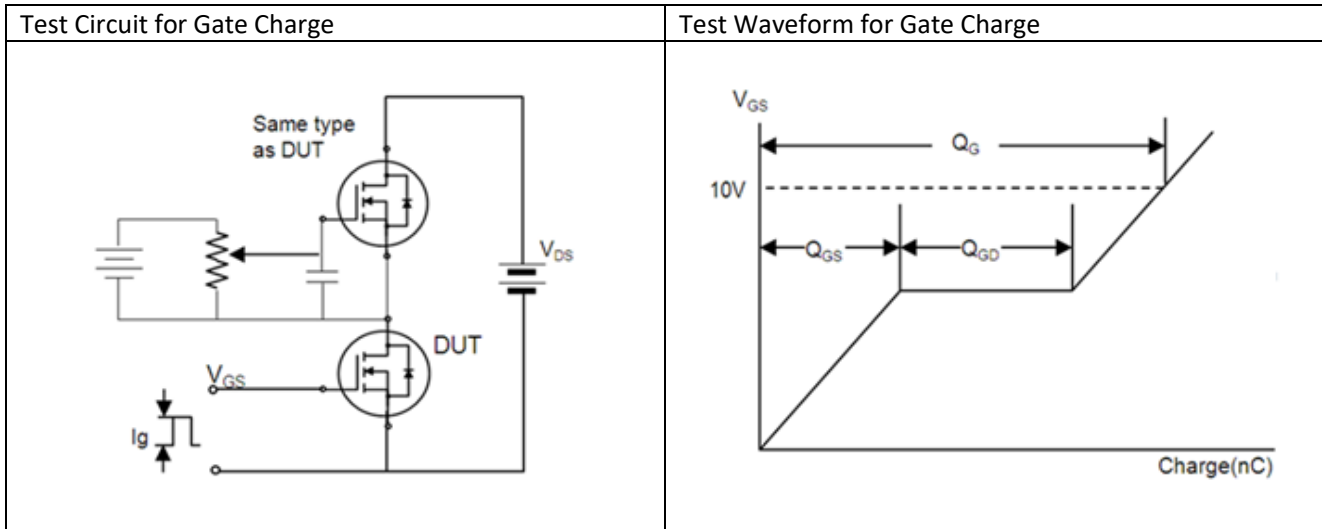
**Table 15 Diode Recovery Characteristics**



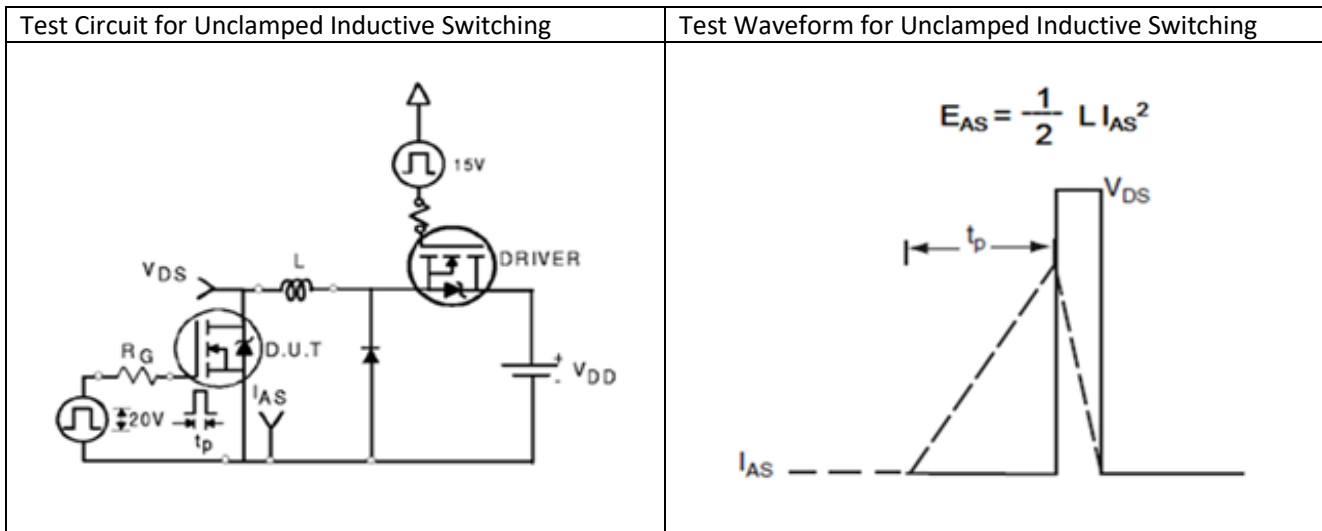
**Table 16 Switching Time Characteristics**



**Table 17 Gate Charge Characteristics**



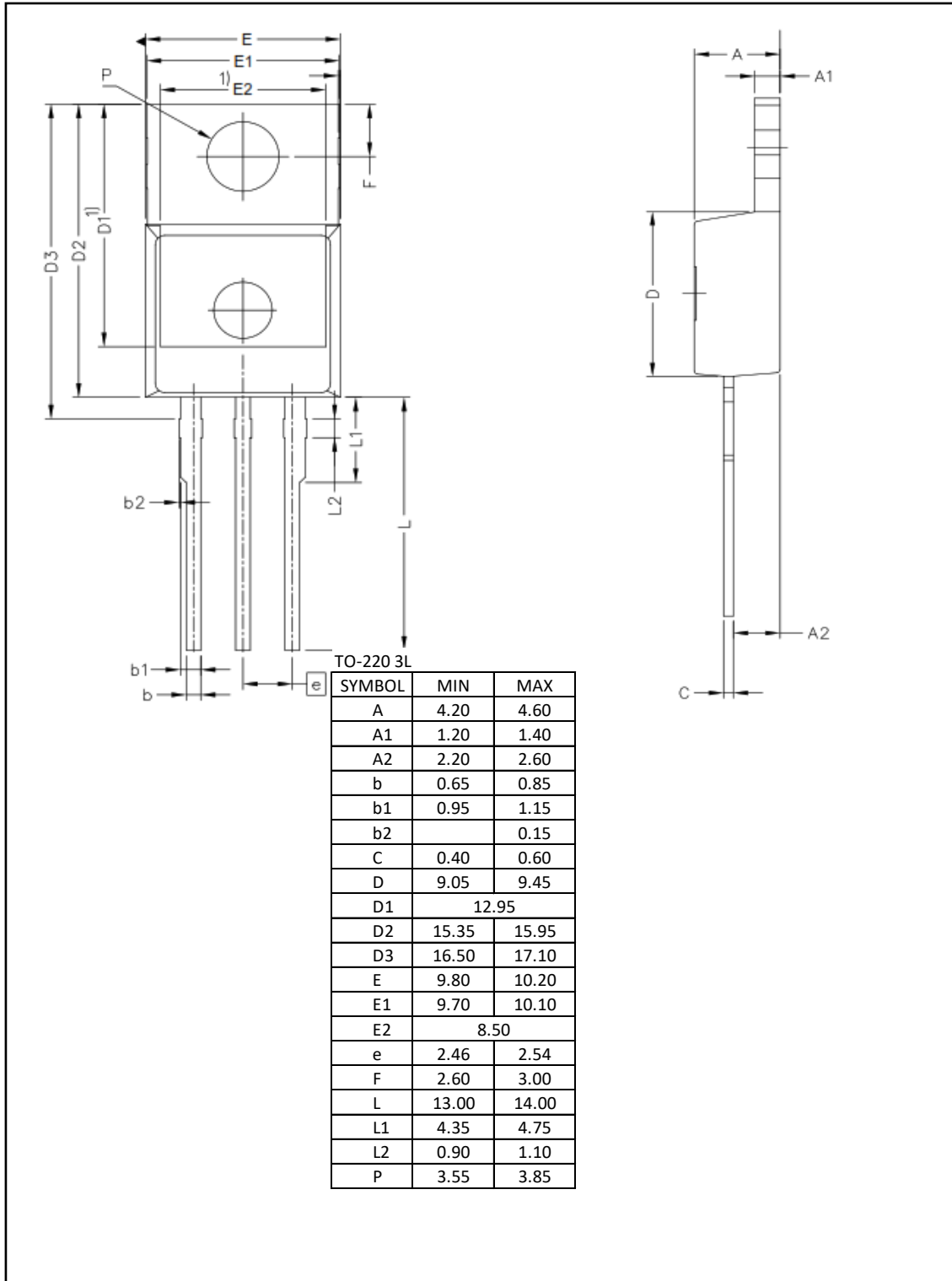
**Table 18 Unclamped Inductive Switching Characteristic**



Package Outlines

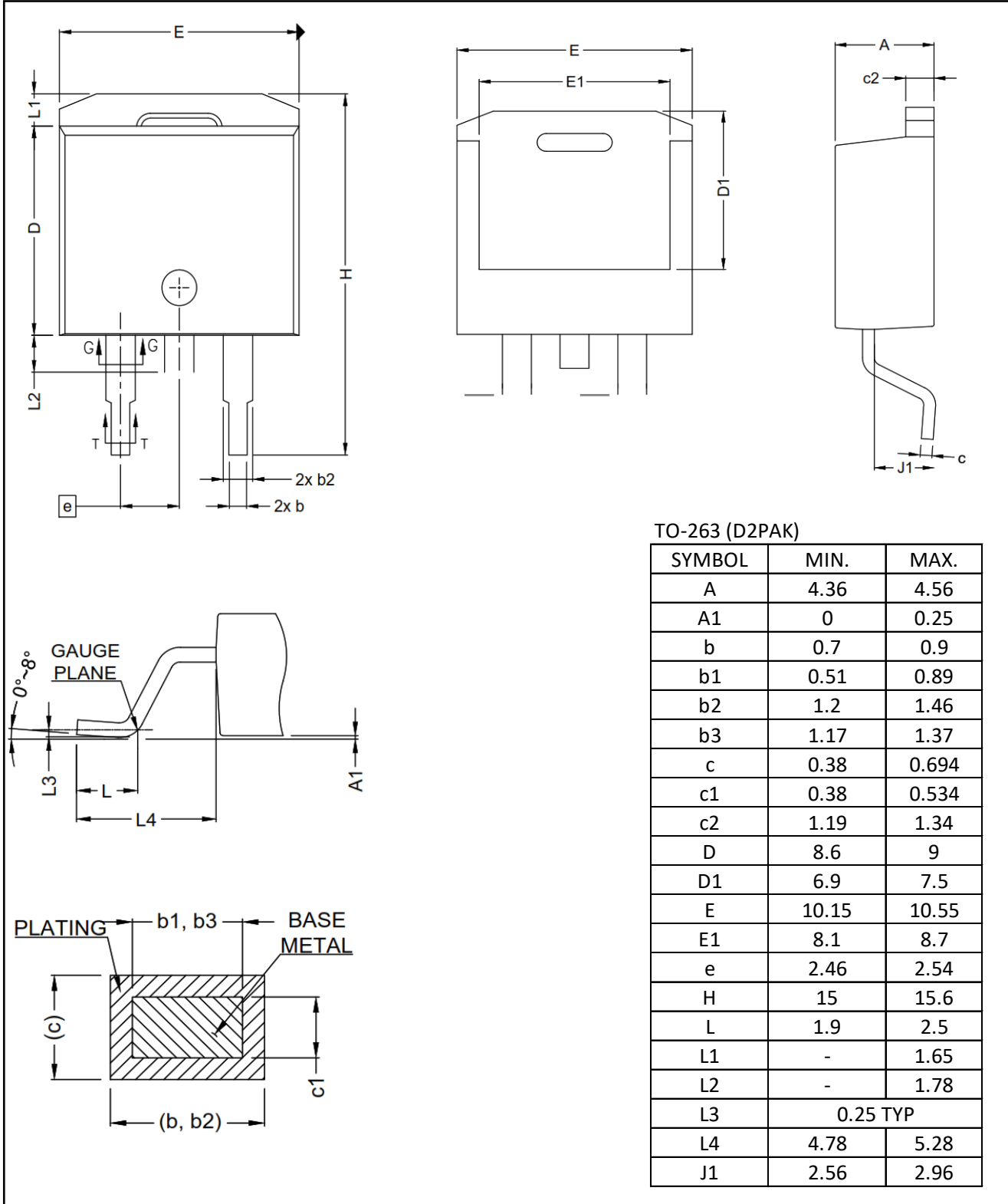
4a) TO-220

**D3 Semiconductor TO-220-3L**



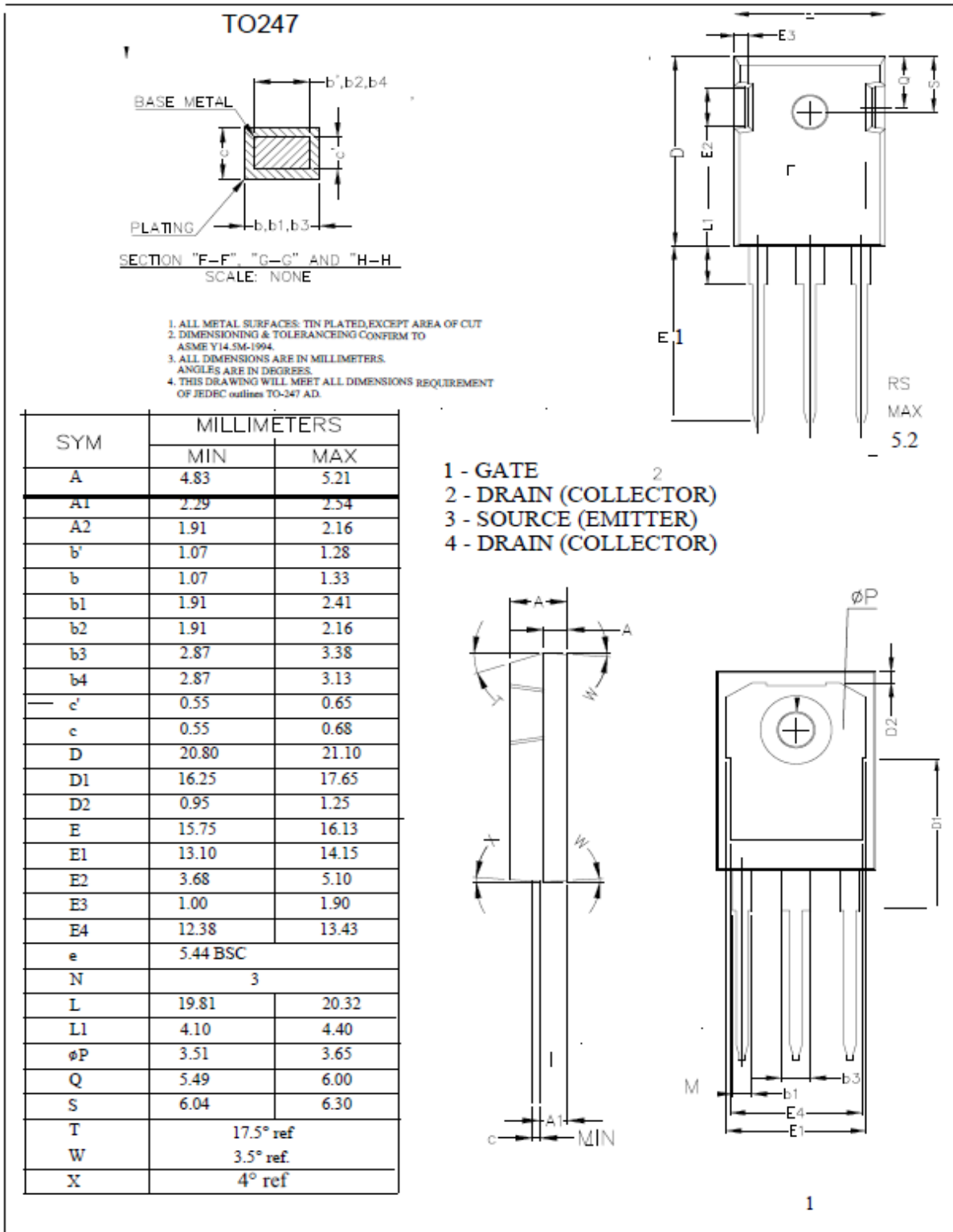
4b) TO-263

**D3 Semiconductor TO-263 (D2PAK)**



4c) TO-247

**D3 Semiconductor TO-247 -3L**



## Revision History

| Revision | Release Date | Comments                                       |
|----------|--------------|--|
| 1.0      | 1-Nov-2016   | Preliminary Datasheet                          |
| 1.1      | 1-July-2017  | Updated data tables and added packaging detail |
| 2.3      | 20-Nov-2017  | Added TO247 Package and Designers Datasheet    |
| 2.4      | 11-Dec-2017  | Added Test Circuits                            |

## Resources

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