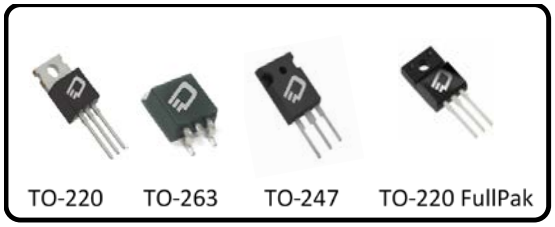
# 650V, 80mΩ, 40.8 Amp Super Junction Power

## Ordering Information

| Part Number | Package Option |
|---|---|
| D3S080N65B-U | TO-220 |
| D3S080N65D-U | TO-247 |
| D3S080N65E-U | TO-263 |
| **D3S080N65F-U** | **TO-220 Fullpak** |

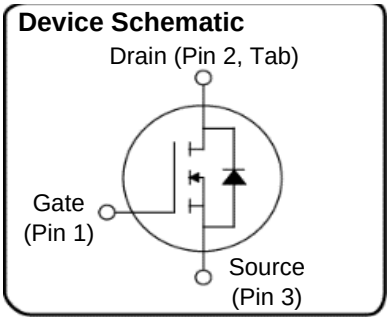
**Package Options**




## Description

+FET™ is an advanced Super Junction Power MOSFET offering excellent efficiency through low Rds-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.

**Device Schematic**




RoHS

### Features

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

### Benefits

- LOW CONDUCTION LOSSES
- HIGH EFFICIENCY
- EXCELLENT AVALANCHE PERFORMANCE

**Table 1** Key Parameters

| Parameter | Value | Unit |
|---|---|---|
| $V_{DSS}$ @ $T_{jmax}$ | 710 | V |
| RDS(on) max | < 80 | mΩ |
| Qg typ | 77 | nC |
| $I_D$ @ 25 ºC | 40.8 | A |

### Applications

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

# Contents

## Maximum Ratings

| Parameter | Symbol | Values | | | | Unit | Condition |
|---|---|---|---|---|---|---|---|
| | | Min | Typ | Max | | | |
| | | | | TO220, TO247, TO263 | 220FP | | |
| Continuous drain current | $I_D$ | | | 40.8 | 20.3 | A | $T_c$ = 25ºC |
| | | | | 25.8 | 12.8 | A | $T_c$ = 100ºC |
| Pulsed drain current | $I_{D, pulse}$ | | | 175 | 81 | A | $T_c$ = 25ºC |
| Avalanche energy, single pulse | $E_{AS}$ | | | 650 | 650 | mJ | $I_D$ = 7.2A; $V_{DD}$ = 50V, VGS = 10V, L=10mH, RG=25 Ohms |
| Avalanche energy, repetitive | $E_{AR}$ | | | 1 | 1 | mJ | $I_D$ = 7.2; $V_{DD}$ = 50V |
| Avalanche current, repetitive | $I_{AS}$ | | | 8.7 | 8.7 | A | |
| MOSFET dv/dt ruggedness | dv/dt | | | 50 | 50 | V/ns | $V_{DS}$ = 0….480V |
| Gate source voltage (static) | $V_{GS}$ | -30 | | 30 | 30 | V | Static |
| Gate source voltage (dynamic) | $V_{GS}$ | -30 | | 30 | 30 | V | AC (F>1Hz) |
| Power dissipation | $P_{tot}$ | | | 305 | 60 | W | $T_c$ = 25ºC |
| Storage temperature | $T_{stg}$ | -55 | | 150 | 150 | ºC | |
| Operating junction temperature | $T_j$ | -55 | | 150 | 150 | ºC | |
| Mounting torque | | | | 60 | | N-cm | M3 and M3.5 screws |
| | | | | | 50 | N-cm | M3 screw |
| Isolation Voltage* | $V_{ISO}$ | 3.5 | | | | kV | TO-220 FullPak Only |
| Continuous diode forward current | $I_{SD}$ | | | 43.6 | 20.3 | A | Tc = 25ºC |
| Diode pulse current | $I_{S, pulse}$ | | | 175 | 81 | A | Tc = 25ºC |
| Reverse diode dv/dt | dv/dt | | | 15 | 15 | V/ns | $V_{DS}$=0…480V, $I_{SD}$<=$I_S$, $T_j$ = 25ºC |
| Maximum diode commutation speed | $di_f/dt$ | | | 500 | 500 | A/µs | $V_{DS}$=0…480V, $I_{SD}$<=$I_S$, $T_j$ = 25ºC |

## Thermal Characteristics

**Table 3** Thermal Characteristics

| Symbol | Parameter | Packages | | | | Unit |
|---|---|---|---|---|---|---|
| | | TO-220 | TO-263 | TO-247 | TO-220FP | |
| $R_{thjC}$ | Thermal resistance, junction-case | 0.41 | 0.41 | 0.41 | 1.89 | ºC/W |
| $R_{thjA}$ | Thermal resistance, junction-ambient | 42 | 42 | 42 | 44 | ºC/W |
| $R_{thjT}$ | Thermal resistance, junction-ambient for SMD version | | 30 | | | ºC/W |
| $T_S$ | Soldering temperature, wavesoldering only allowed at leads | 260 | 260 | 260 | 260 | ºC |

## Electrical Characteristics

@ $T_j$ = 25ºC, unless otherwise specified

### Table 4

| Parameter | Symbol | Values | | | Unit | Condition |
|---|---|---|---|---|---|---|
| | | Min | Typ | Max | | |
| Drain-source breakdown voltage | $V_{DSS}$ | 650 | | | V | $I_D$ = 1mA, $V_{GS}$ = 0V |
| Gate threshold voltage | $V_{(GS)th}$ | 2.3 | 3 | 3.7 | V | |
| Zero gate voltage drain current | $I_{DSS}$ | | | 1 | µA | $V_{DS}$ = 650V, $T_c$ = 25ºC |
| | | | | 50 | | $V_{DS}$ = 650V, $T_c$ = 125ºC |
| Gate-source leakage current | $I_{GSS}$ | | | 100 | nA | |
| Drain-source on-state resistance | $R_{DS(on)}$ | | 0.062 | 0.080 | Ω | $V_{GS}$ = 10V, $I_D$ = 15.9A, $T_c$ = 25ºC |
| | $R_{DS(on)}$ | | 0.183 | | | $V_{GS}$ = 10V, $I_D$ = 10 A, $T_c$ = 150ºC |
| Gate resistance | $R_G$ | | 1 | | Ω | |

### Table 5

| Parameter | Symbol | Values | | | Unit | Condition |
|---|---|---|---|---|---|---|
| | | Min | Typ | Max | | |
| Input capacitance | $C_{iss}$ | | 4240 | | pF | $V_{DS}$ = 100V, f = 1MHz, $V_{GS}$ = 0V |
| Output capacitance | $C_{oss}$ | | 97.5 | | pF | |
| Reverse transfer capacitance | $C_{rss}$ | | 16.5 | | pF | |
| Turn-on delay time | $t_{d(on)}$ | | 17 | | ns | $V_{DD}$ = 400V, $I_D$ = 15.9A $R_G$ = 1Ω, $V_{GS}$ = 10V |
| Rise time | $t_r$ | | 24 | | ns | |
| Turn-off delay time | $t_{d(off)}$ | | 90 | | ns | |
| Fall time | $t_f$ | | 23 | | ns | |

**Table 6** Gate Charge Characteristics

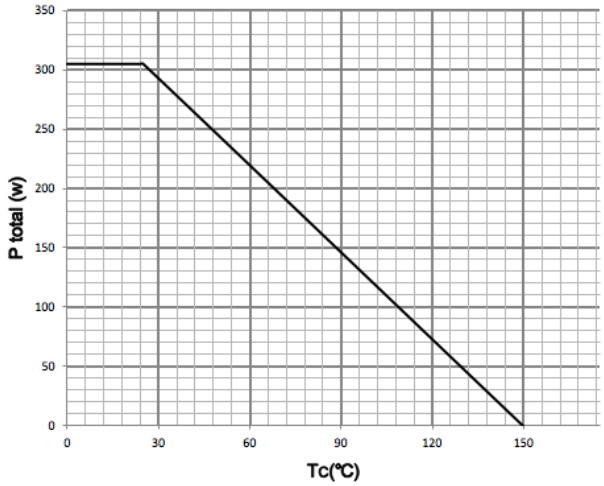
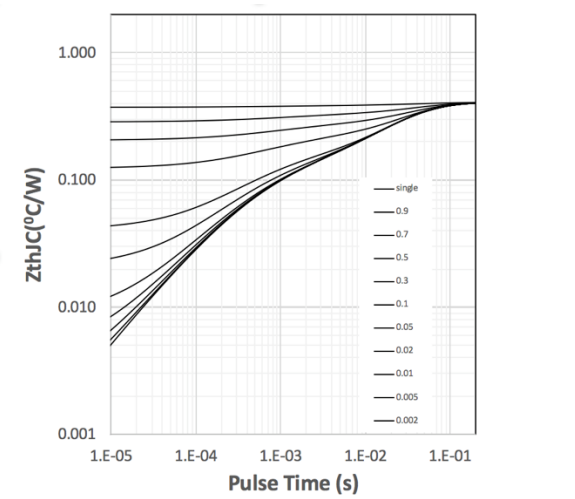
| Parameter | Symbol | Values | | | Unit | Condition |
|---|---|---|---|---|---|---|
| | | Min | Typ | Max | | |
| Gate to source charge | $Q_{gs}$ | | 16 | | nC | $V_{DD}$ = 480V, $I_D$ = 15.9A, $V_{GS}$ = 10V |
| Gate to drain charge | $Q_{gd}$ | | 27 | | nC | |
| Gate charge total | $Q_g$ | | 77 | | nC | |
| Gate plateau voltage | $V_{plateau}$ | | 5 | | V | |

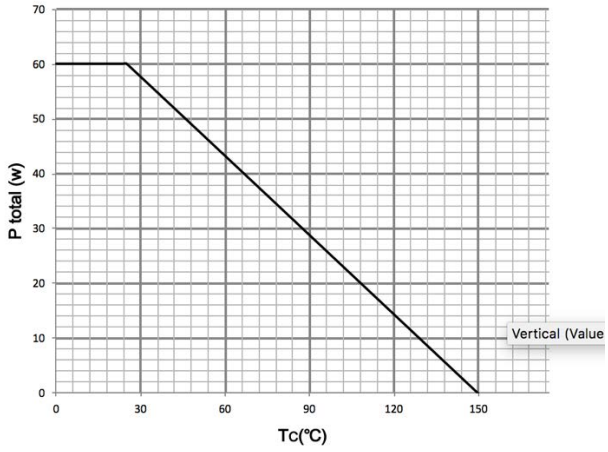
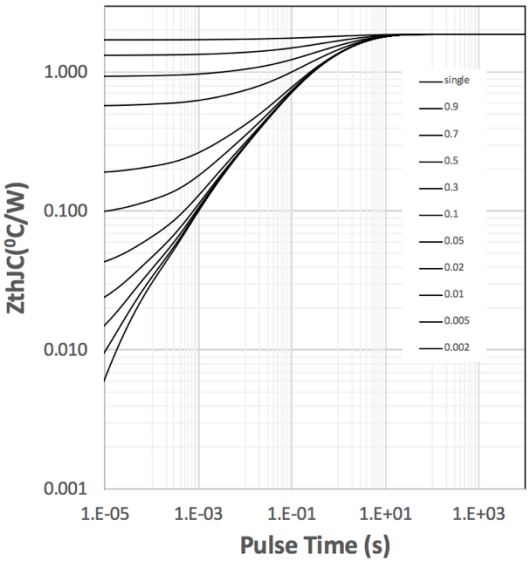
**Table 7** Body Diode

| Parameter | Symbol | Values | | | Unit | Condition |
|---|---|---|---|---|---|---|
| | | Min | Typ | Max | | |
| Diode source-drain current | $I_{SD}$ | | | 43.6 | 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/µS $V_{DD}$ = 60V, $T_c$ = 25ºC |
| Reverse recovery charge | $Q_{rr}$ | | 9.5 | | µC | |
| Peak reverse recovery current | $I_{rrm}$ | | 50.0 | | A | |

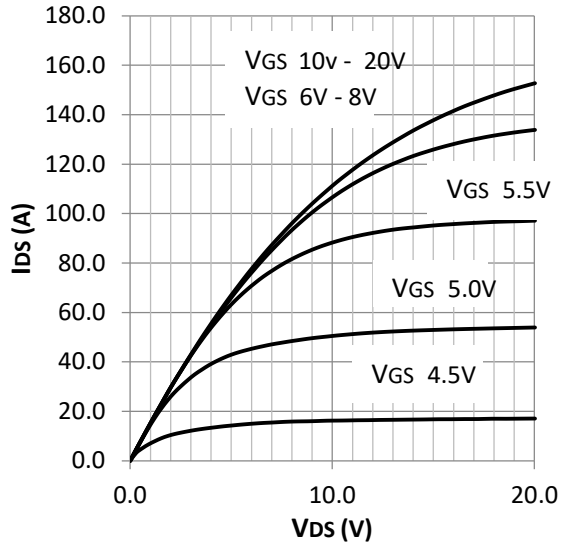
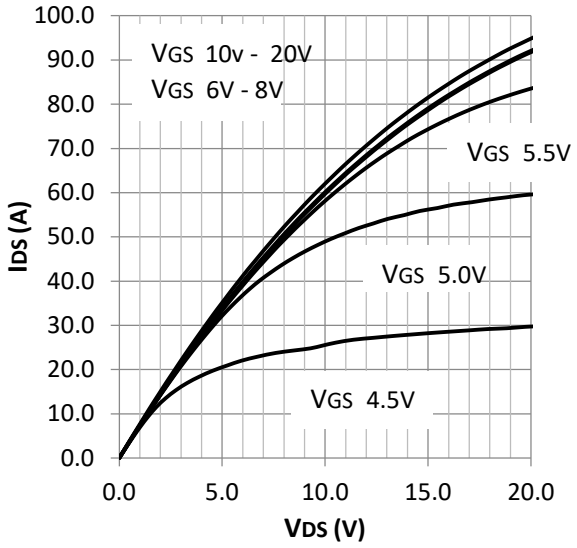
# Electrical Characteristics Graphs

## Table 8 Thermal Performance

| Power Dissipation TO220, TO247, TO263 | Maximum Transient Thermal Impedance |
|---|---|
|  |  |
| Max power limited by case temperature | Variable is pulse time ($t_p$) TO220, TO247, TO263 |

| Power Dissipation TO220FP | Maximum Transient Thermal Impedance (TO220FP) |
|---|---|
|  |  |
| Max power limited by case temperature | Variable is pulse time ($t_p$) TO220FP |

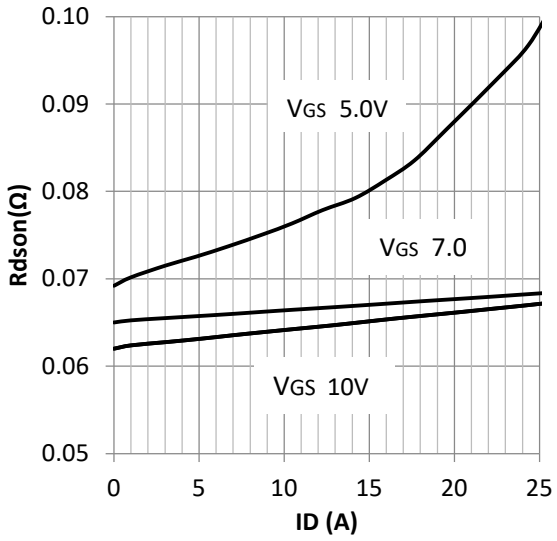
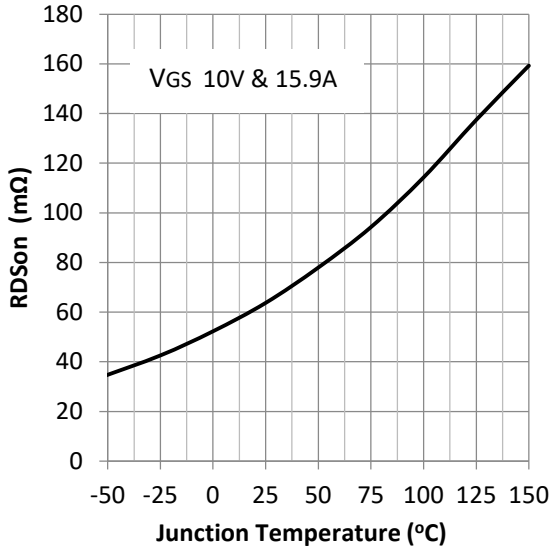
## Table 9 Output Characteristics

| Typical Output Characteristics | Typical Output Characteristics |
|---|---|
|  |  |
| $T_C$ = 25°C; Variable is $V_{GS}$ | $T_C$ = 125°C; Variable is $V_{GS}$ |

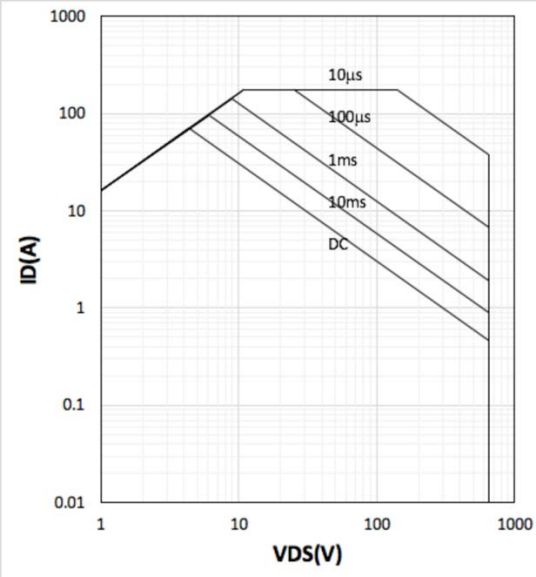
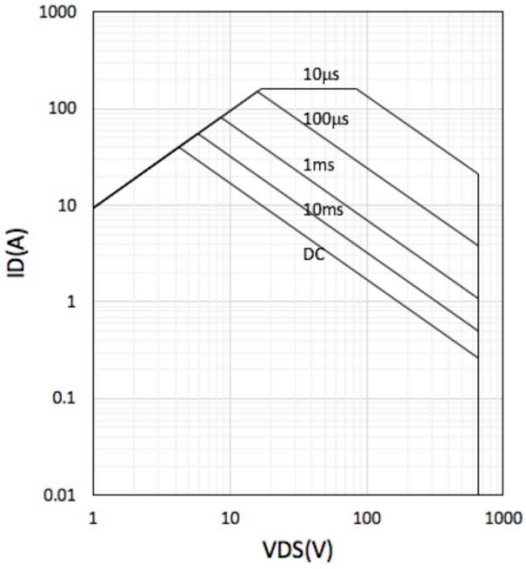


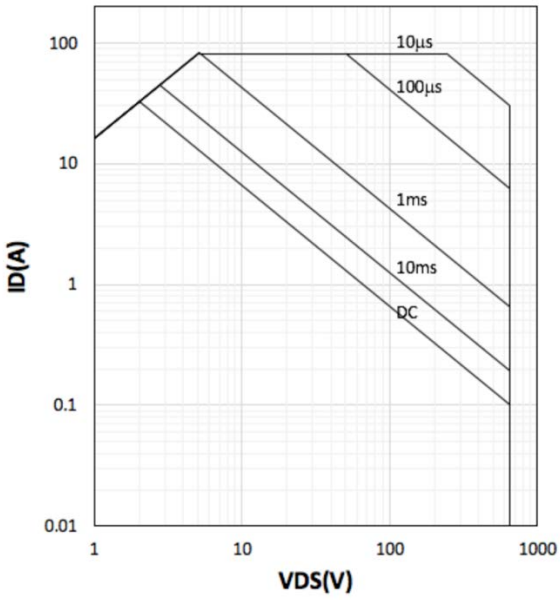
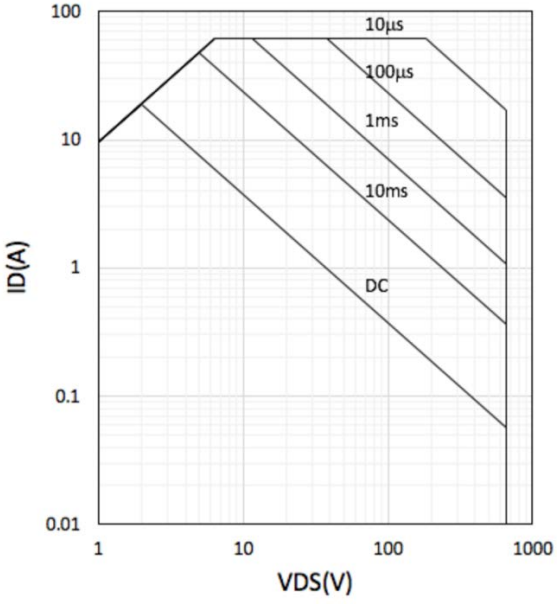


## Table 10 Drain-Source Resistance

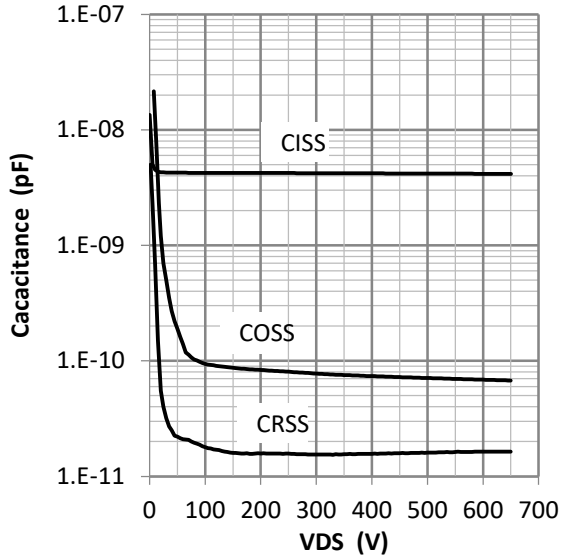
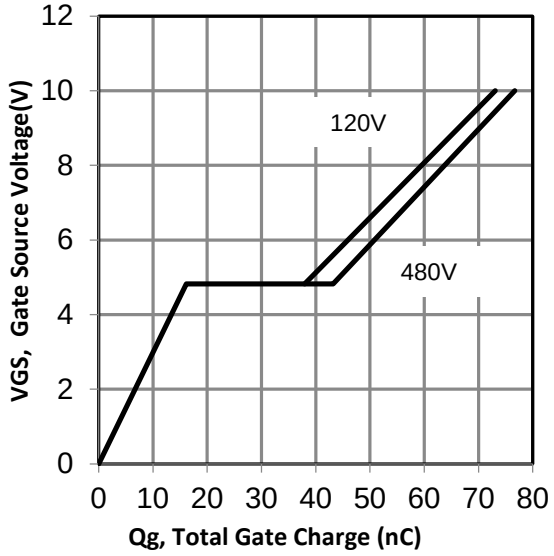
| Typical Drain–Source On-State Resistance | Drain–Source On-State Resistance |
|---|---|
|  |  |
| $T_C$ = 25°C; Variable is Gate Voltage (Vgs) | $I_D$ = 15.9 Pulsed Vgs = 10V |

## Table 11 Safe Operating Area

| Safe Operating Area | Safe Operating Area |
|---|---|
|  |  |
| $T_C$ = 25°C; Variable is pulse width ($t_p$) | $T_C$ = 80°C; Variable is pulse width ($t_p$) |

| Safe Operating Area (TO220FP) | Safe Operating Area (TO220P) |
|---|---|
|  |  |
| $T_C$ = 25°C; Variable is pulse width ($t_p$) | $T_C$ = 80°C; Variable is pulse width ($t_p$) |

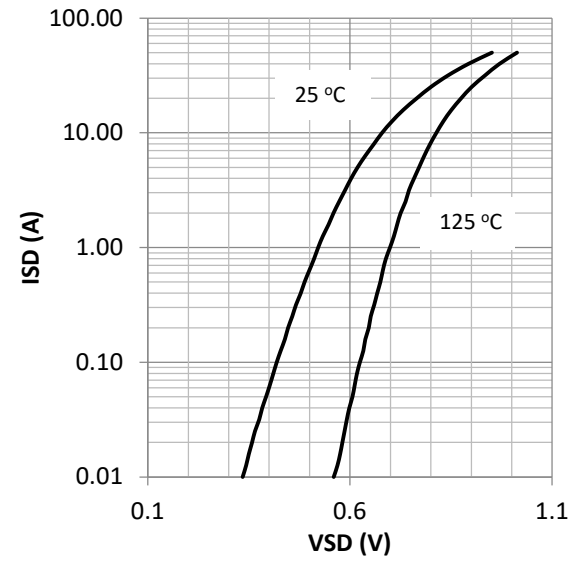
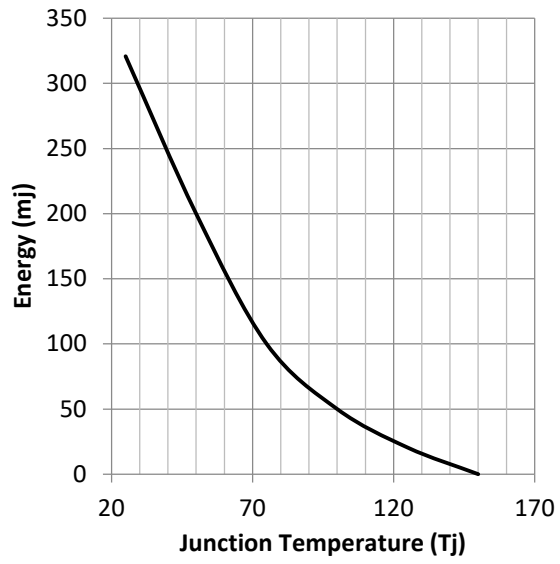
## Table 12 Typical Capacitances and Gate Charge

| Typical Capacitances | Typical Gate Charge |
|---|---|
|  |  |
| $V_{GS}$ = 0V; Freq. = 1MHz | $I_D$ = 15.9A Pulsed Vdd = 480V |

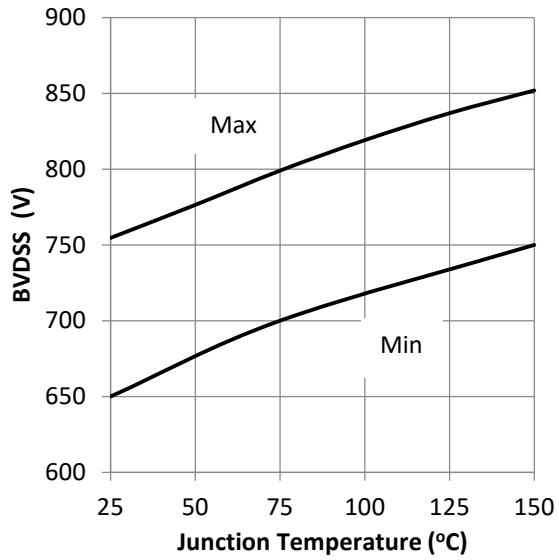




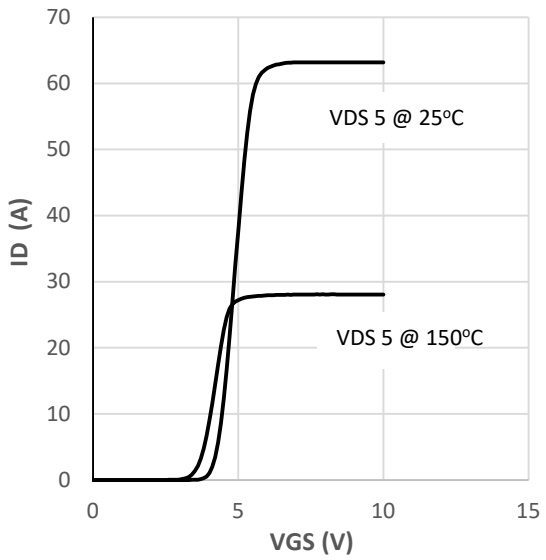
## Table 13 Diode Forward Characteristics and Avalanche Energy

| Forward Characteristics of Reverse Diode | Avalanche Energy |
|---|---|
|  |  |
| $V_f$ of Body Diode | $V_{DD}$ = 50V, VGS = 10V, L=10mH, RG=25 Ohms |

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

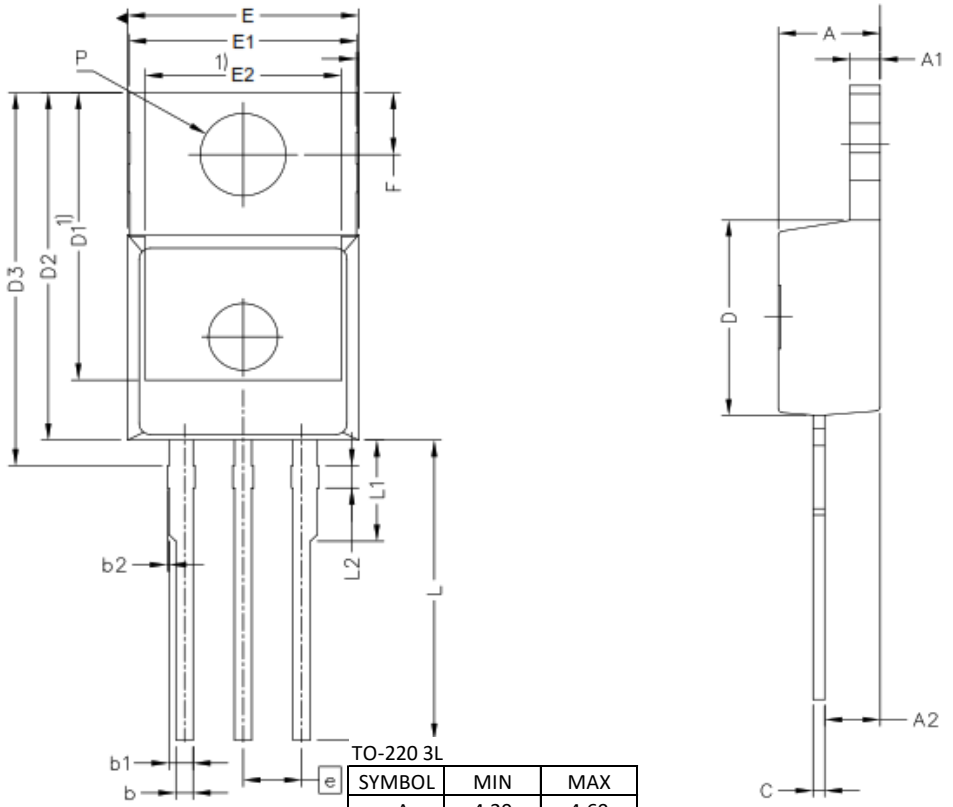



$I_D$ = 250uA




$V_{DS}$ = 5V

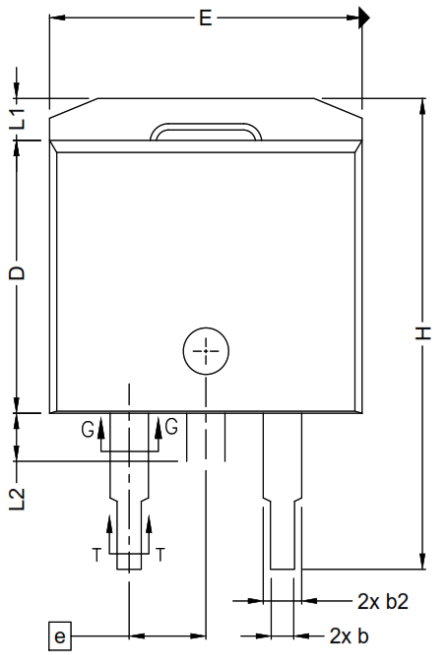
# D3 Semiconductor TO-220-3L

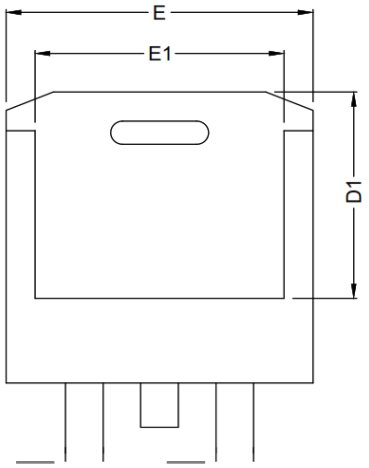


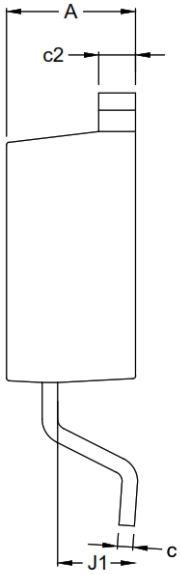

TO-220 3L

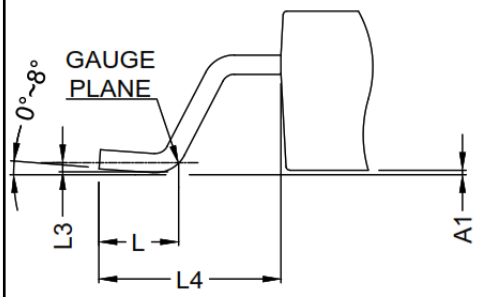
| SYMBOL | MIN | MAX |
|---|---|---|
| A | 4.20 | 4.60 |
| A1 | 1.20 | 1.40 |
| A2 | 2.20 | 2.60 |
| b | 0.65 | 0.85 |
| b1 | 0.95 | 1.15 |
| b2 | | 0.15 |
| C | 0.40 | 0.60 |
| D | 9.05 | 9.45 |
| D1 | 12.95 | |
| D2 | 15.35 | 15.95 |
| D3 | 16.50 | 17.10 |
| E | 9.80 | 10.20 |
| E1 | 9.70 | 10.10 |
| E2 | 8.50 | |
| e | 2.46 | 2.54 |
| F | 2.60 | 3.00 |
| L | 13.00 | 14.00 |
| L1 | 4.35 | 4.75 |
| L2 | 0.90 | 1.10 |
| P | 3.55 | 3.85 |

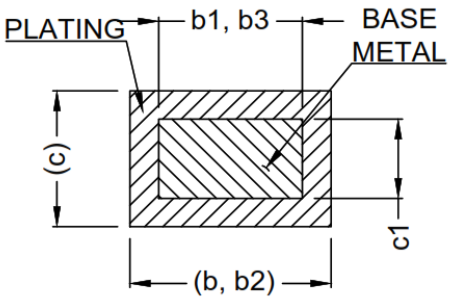
# D3 Semiconductor TO-263 (D2PAK)



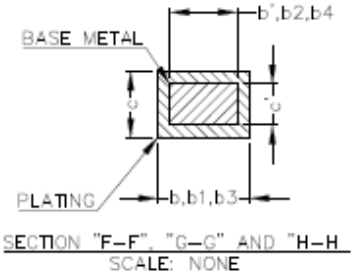



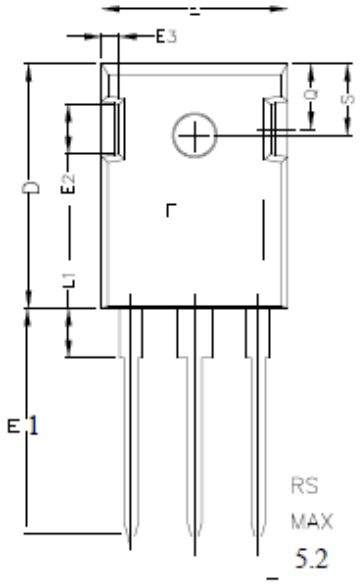

TO-263 (D2PAK)

| SYMBOL | MIN. | MAX. |
|---|---|---|
| A | 4.36 | 4.56 |
| A1 | 0 | 0.25 |
| b | 0.7 | 0.9 |
| b1 | 0.51 | 0.89 |
| b2 | 1.2 | 1.46 |
| b3 | 1.17 | 1.37 |
| c | 0.38 | 0.694 |
| c1 | 0.38 | 0.534 |
| c2 | 1.19 | 1.34 |
| D | 8.6 | 9 |
| D1 | 6.9 | 7.5 |
| E | 10.15 | 10.55 |
| E1 | 8.1 | 8.7 |
| e | 2.46 | 2.54 |
| H | 15 | 15.6 |
| L | 1.9 | 2.5 |
| L1 | - | 1.65 |
| L2 | - | 1.78 |
| L3 | 0.25 TYP | |
| L4 | 4.78 | 5.28 |
| J1 | 2.56 | 2.96 |

# D3 Semiconductor TO-247-3L



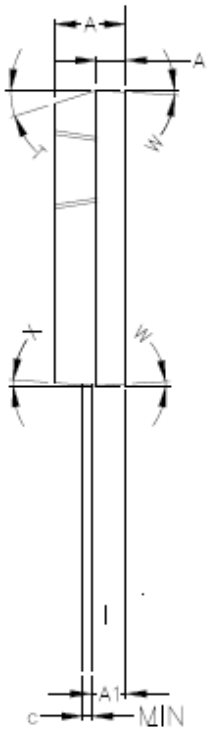

SECTION "F–F", "G–G" AND "H–H
SCALE: NONE

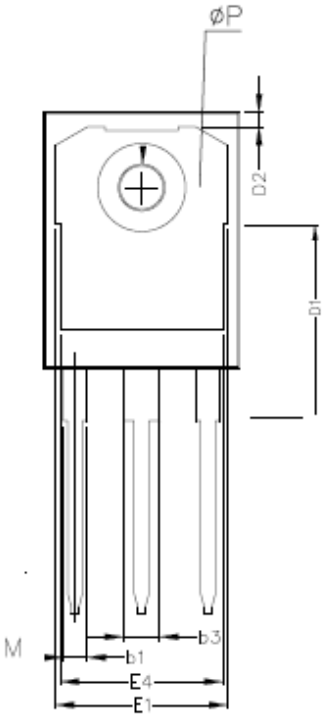



1. ALL METAL SURFACES: TIN PLATED,EXCEPT AREA OF CUT
2. DIMENSIONING & TOLERANCEING CONFIRM TO ASME Y14.5M-1994.
3. ALL DIMENSIONS ARE IN MILLIMETERS. ANGLES ARE IN DEGREES.
4. THIS DRAWING WILL MEET ALL DIMENSIONS REQUIREMENT OF JEDEC outlines TO-247 AD.

| SYM | MILLIMETERS | |
|---|---|---|
| | MIN | MAX |
| A | 4.83 | 5.21 |
| A1 | 2.29 | 2.54 |
| A2 | 1.91 | 2.16 |
| b' | 1.07 | 1.28 |
| b | 1.07 | 1.33 |
| b1 | 1.91 | 2.41 |
| b2 | 1.91 | 2.16 |
| b3 | 2.87 | 3.38 |
| b4 | 2.87 | 3.13 |
| c' | 0.55 | 0.65 |
| c | 0.55 | 0.68 |
| D | 20.80 | 21.10 |
| D1 | 16.25 | 17.65 |
| D2 | 0.95 | 1.25 |
| E | 15.75 | 16.13 |
| E1 | 13.10 | 14.15 |
| E2 | 3.68 | 5.10 |
| E3 | 1.00 | 1.90 |
| E4 | 12.38 | 13.43 |
| e | 5.44 BSC | |
| N | 3 | |
| L | 19.81 | 20.32 |
| L1 | 4.10 | 4.40 |
| øP | 3.51 | 3.65 |
| Q | 5.49 | 6.00 |
| S | 6.04 | 6.30 |
| T | 17.5° ref | |
| W | 3.5° ref. | |
| X | 4° ref | |

1 - GATE
2 - DRAIN (COLLECTOR)
3 - SOURCE (EMITTER)
4 - DRAIN (COLLECTOR)

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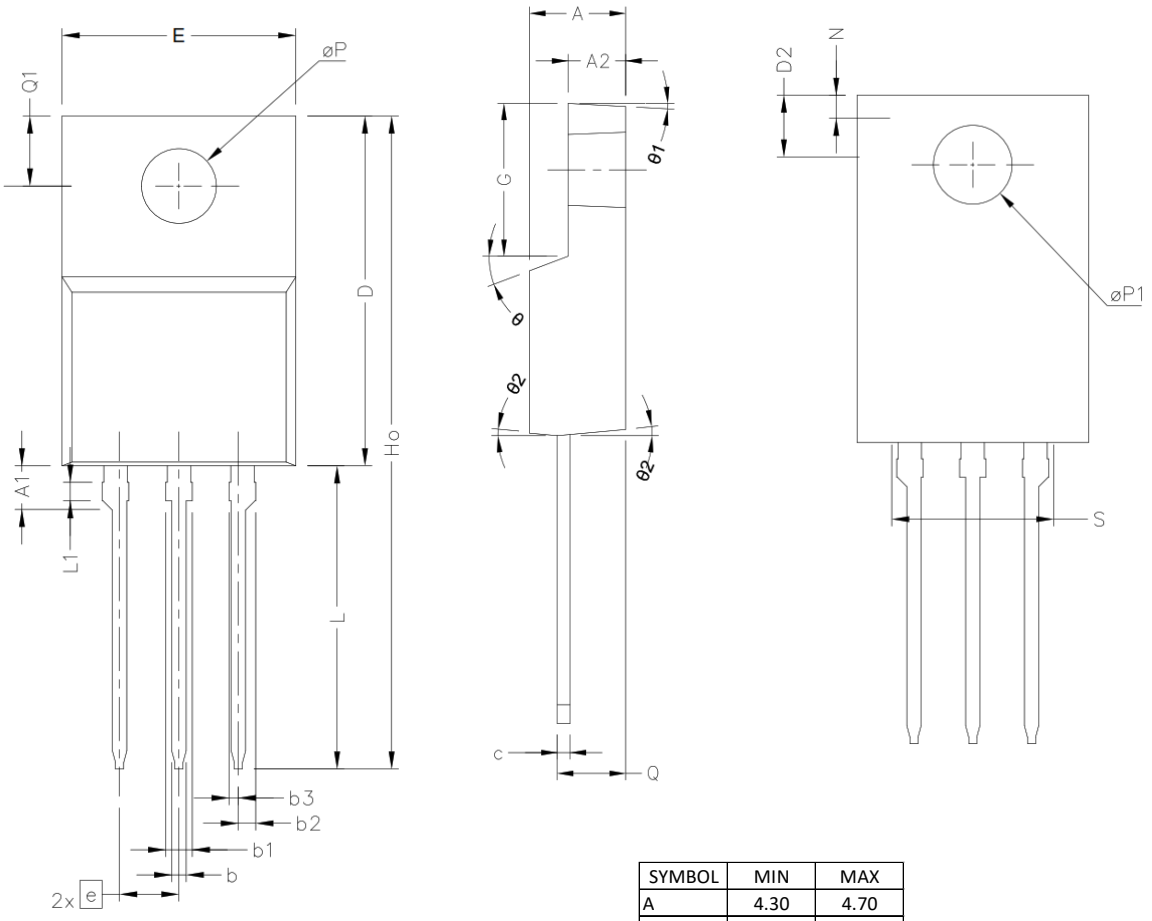
## D3 Semiconductor TO-220 FullPak




| SYMBOL | MIN | MAX |
|---|---|---|
| A | 4.30 | 4.70 |
| A1 | 1.80 | 2.10 |
| A2 | 2.50 | 2.90 |
| b | 0.54 | 0.84 |
| b1 | 0.99 | 1.29 |
| b2 | 0.56 | 0.93 |
| b3 | 0.24 | 0.55 |
| c | 0.49 | 0.79 |
| D | 14.70 | 15.30 |
| D2 | 2.66 | |
| e | 2.29 | 2.79 |
| E | 9.70 | 10.30 |
| G | 6.70 | 7.10 |
| Ho | 28.00 | |
| L | 12.50 | 13.50 |
| L1 | 0.70 | 0.90 |
| N | 2.86 | |
| øP | 3.05 | 3.40 |
| øP1 | 3.40 | |
| Q | 3.10 | 3.30 |
| Q1 | 2.70 | 3.30 |
| S | 7.00 | |
| θ1 | 3 deg. | |
| θ2 | 5 deg. | |

## Revision History

| Revision | Release Date | Comments |
|---|---|---|
| 1.0 | 1-June-2016 | Preliminary Datasheet Draft |
| 1.1 | 1-Nov-2017 | Datasheet Characterization Update |
| 1.2 | 23-Nov-2018 | Correct TO263 to E (Tape & Reel) |
| 2.0 | 18-APR-2019 | Update Characterizaton |

## Resources

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