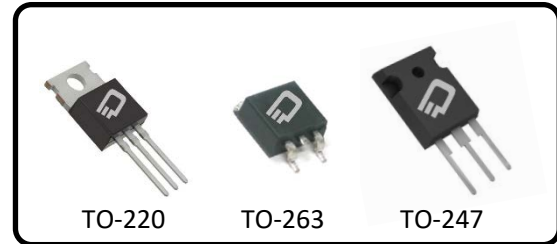


# 650V, 99mΩ, 31.8 A Super Junction Power MOSFET

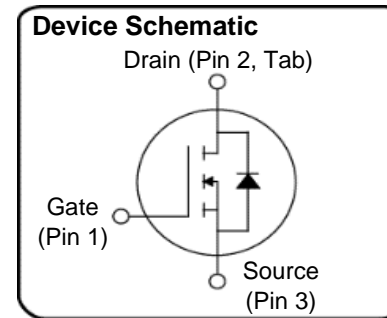
## Ordering Information

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

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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, 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 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

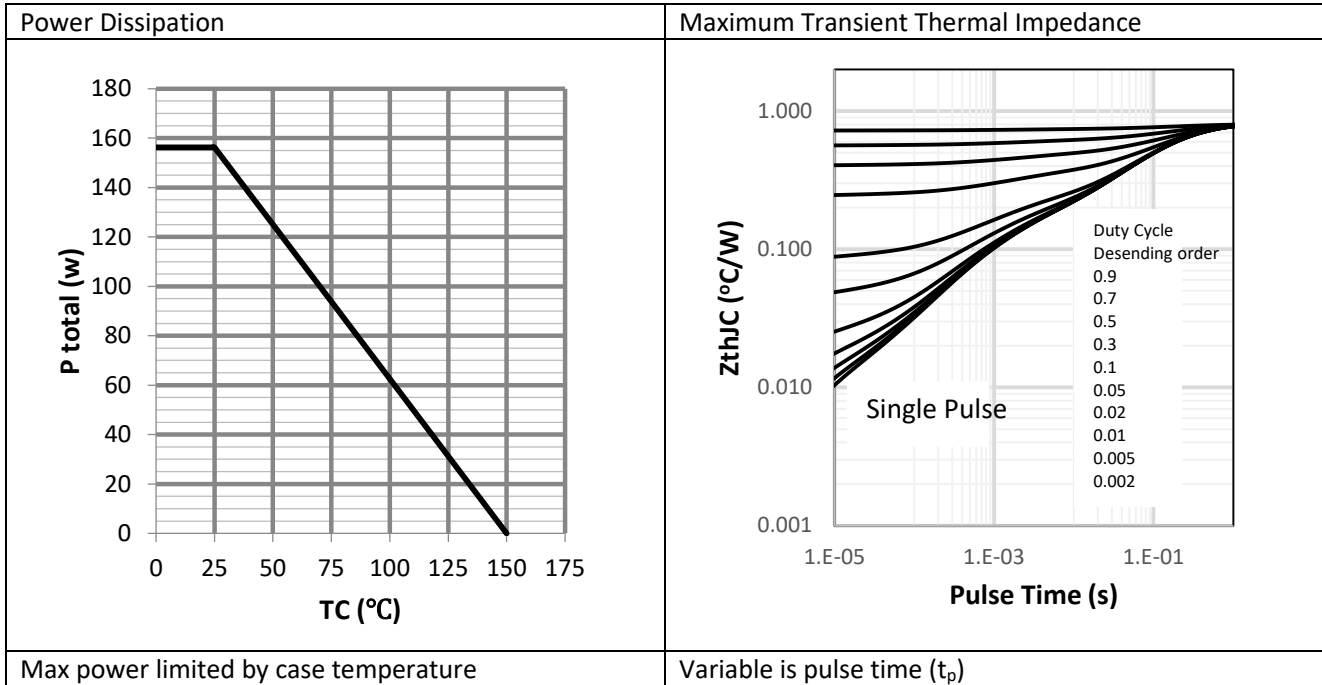
Parameter	Symbol	Values			Unit	Condition
		Min	Typ	Max		
Gate to source charge	$Q_{gs}$		16		nC	$V_{DD} = 480V, I_D = 15.5A,$ $V_{GS} = 10V$
Gate to drain charge	$Q_{gd}$		27		nC	
Gate charge total	$Q_g$		77		nC	
Gate plateau voltage	$V_{plateau}$		5		V	

**Table 7** Body Diode

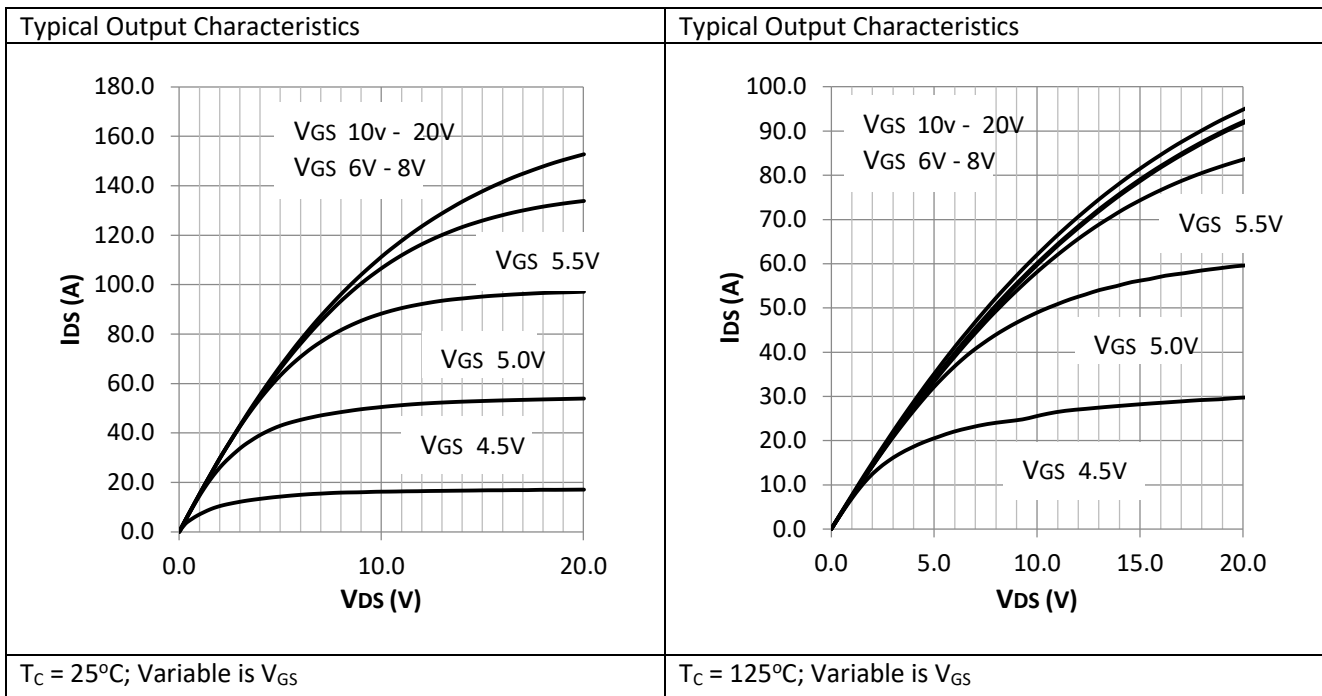
Parameter	Symbol	Values			Unit	Condition
		Min	Typ	Max		
Diode source-drain current	$I_{SD}$			38.3	A	
Diode forward voltage	$V_{fd}$		0.95	1.5	V	$I_{SD} = 31.8A, V_{GS} = 0V$
Reverse recovery time	$t_{rr}$		468		ns	$I_{SD} = 31.8A, di/dt = 100A/\mu S$ $V_{DD} = 60V, T_C = 25^\circ C$
Reverse recovery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

## Electrical Characteristics Graphs

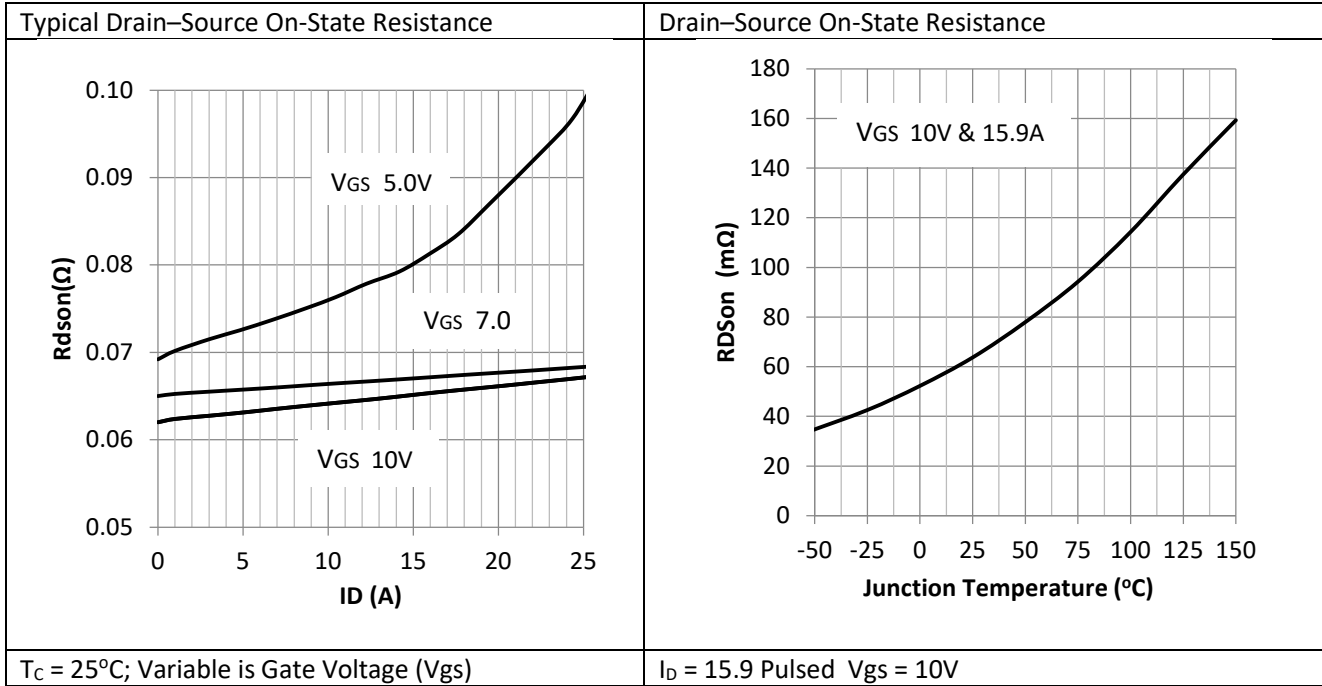
**Table 8 Thermal Performance**



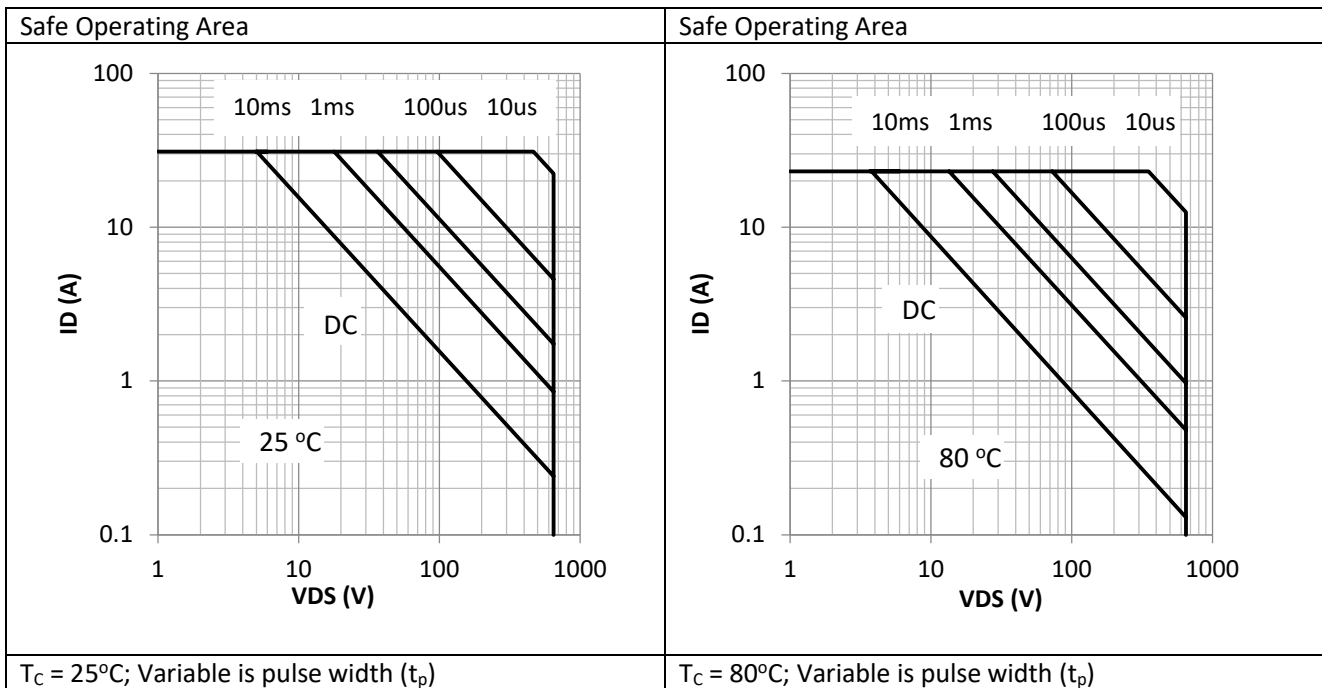
**Table 9 Output Characteristics**



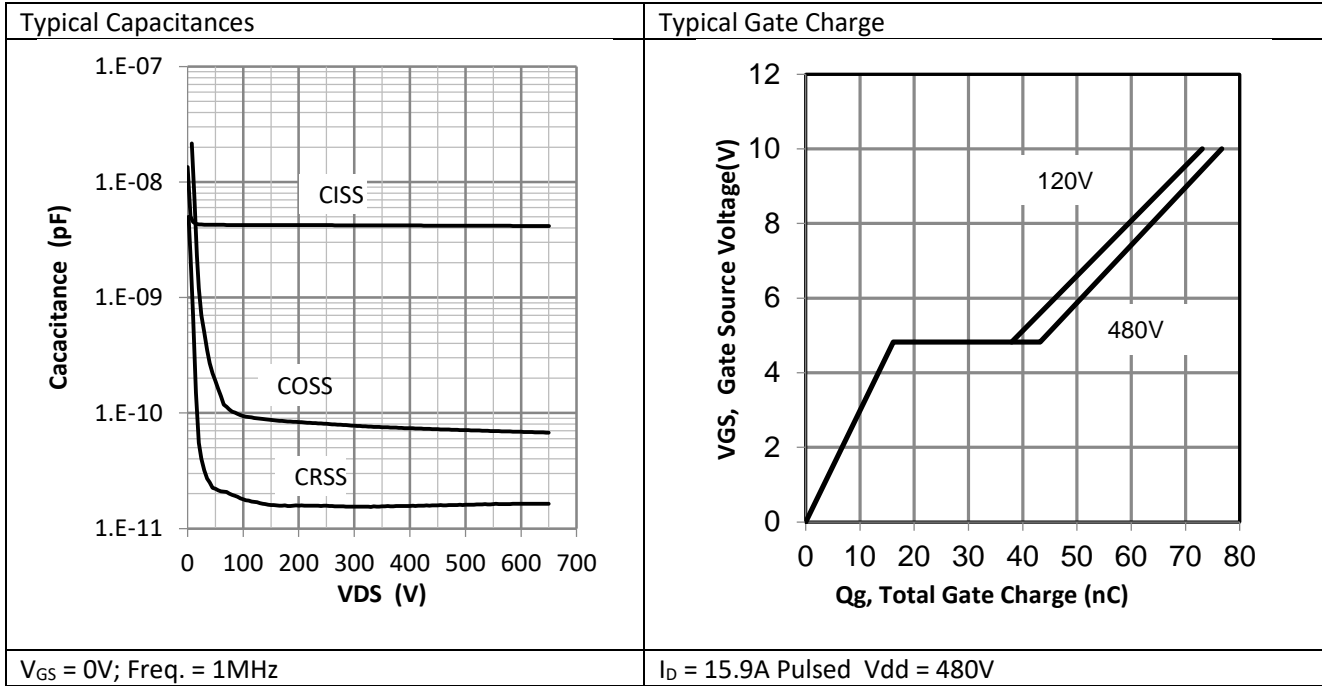
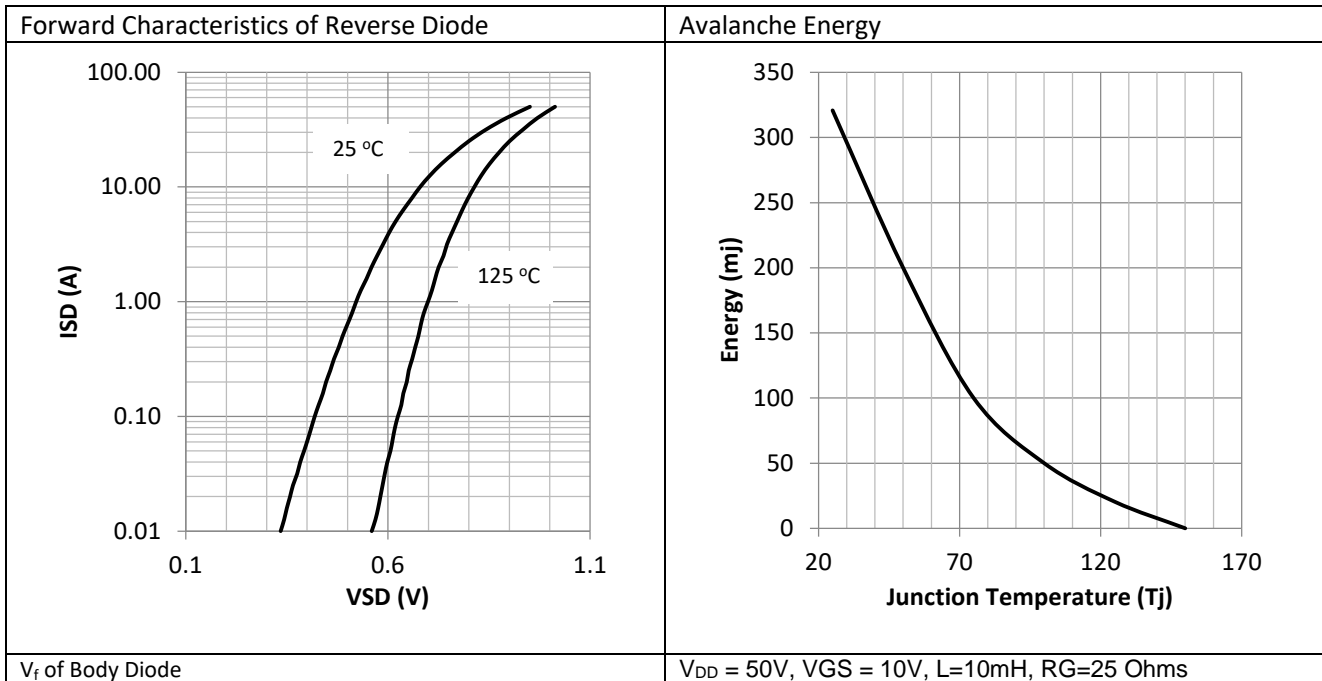
**Table 10 Drain-Source Resistance**



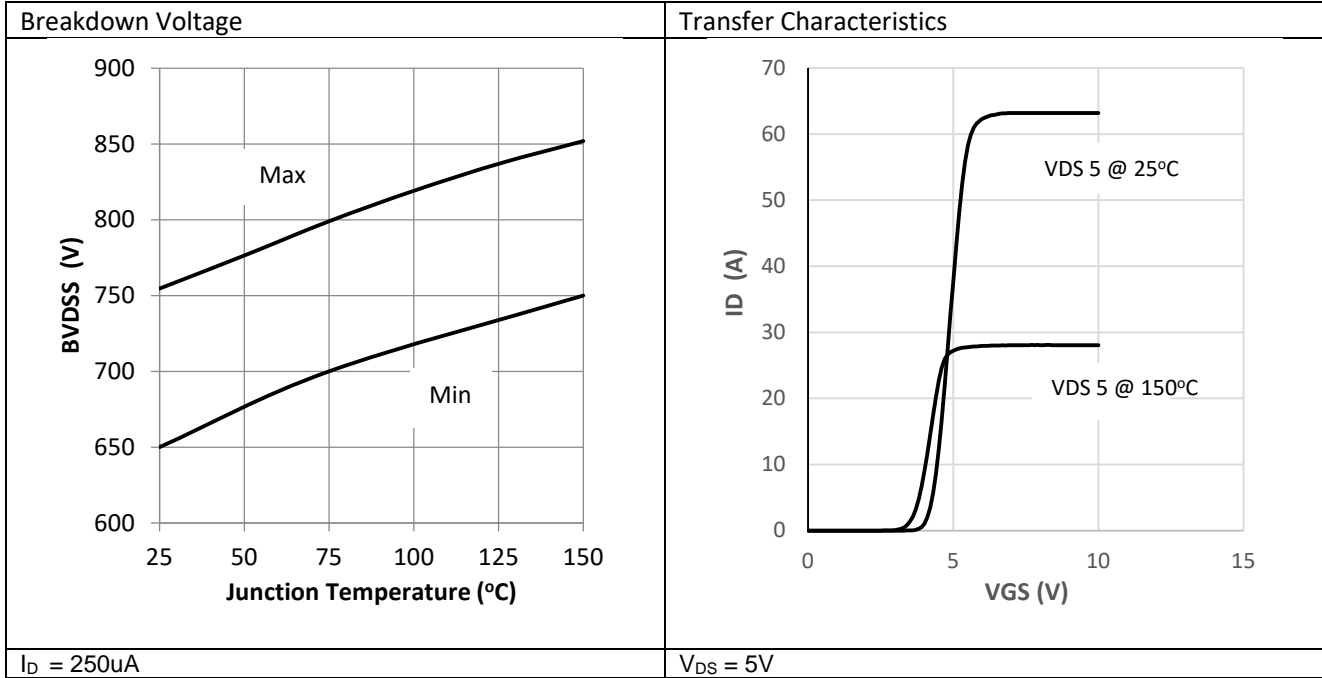
**Table 11 Safe Operating Area**



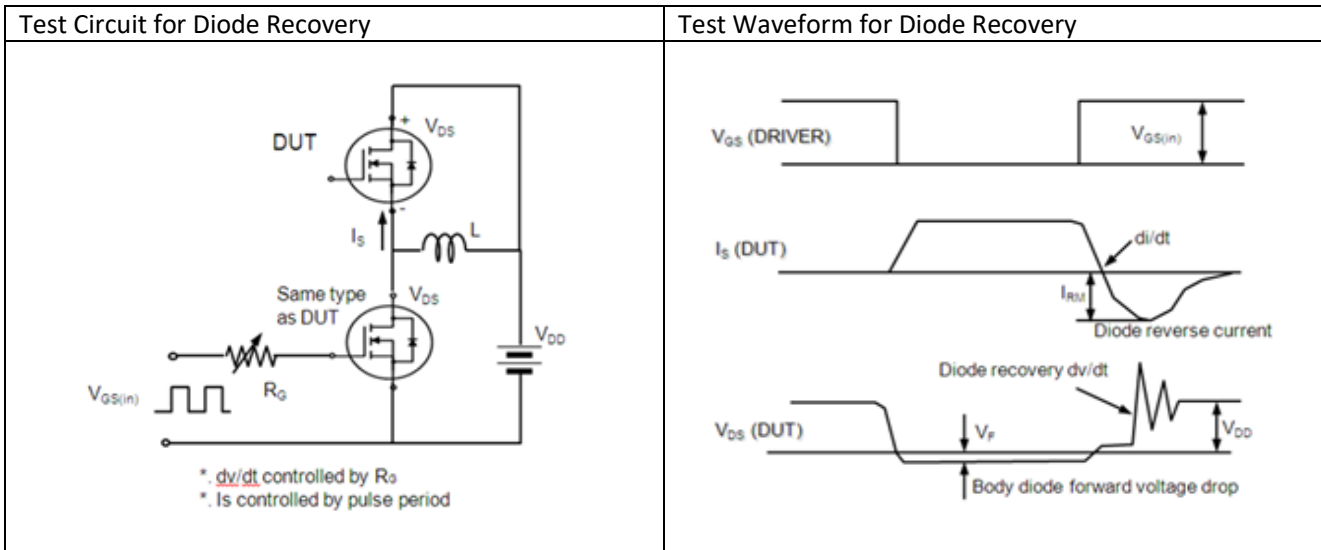


**Table 12 Typical Capacitances and Gate Charge**

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


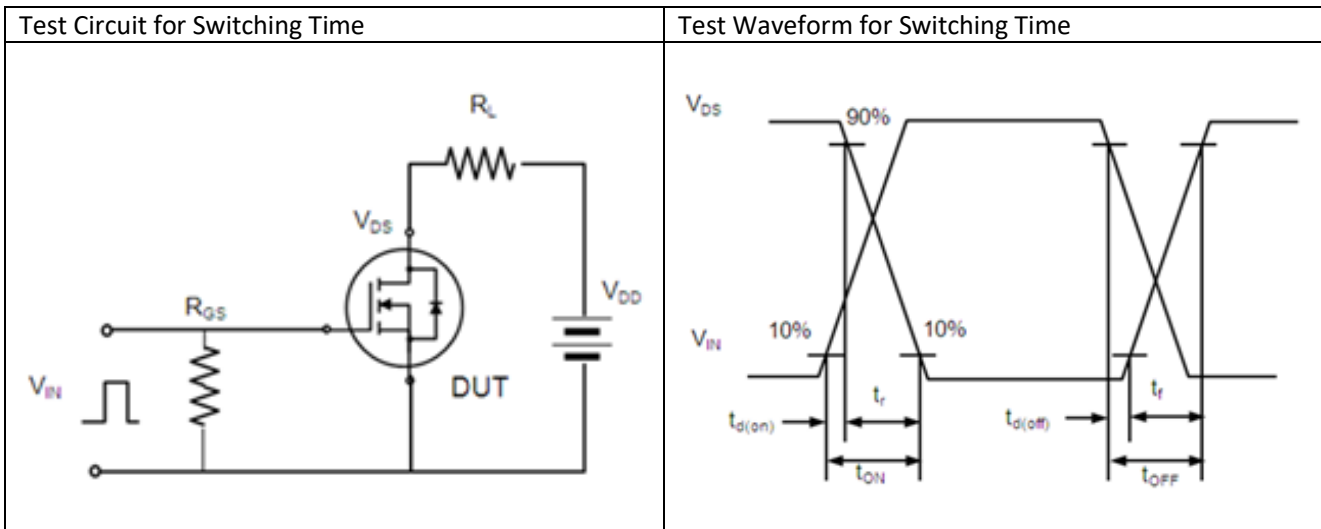
**Table 14 Drain – Source Breakdown Voltage and Typical Transfer Characteristics**



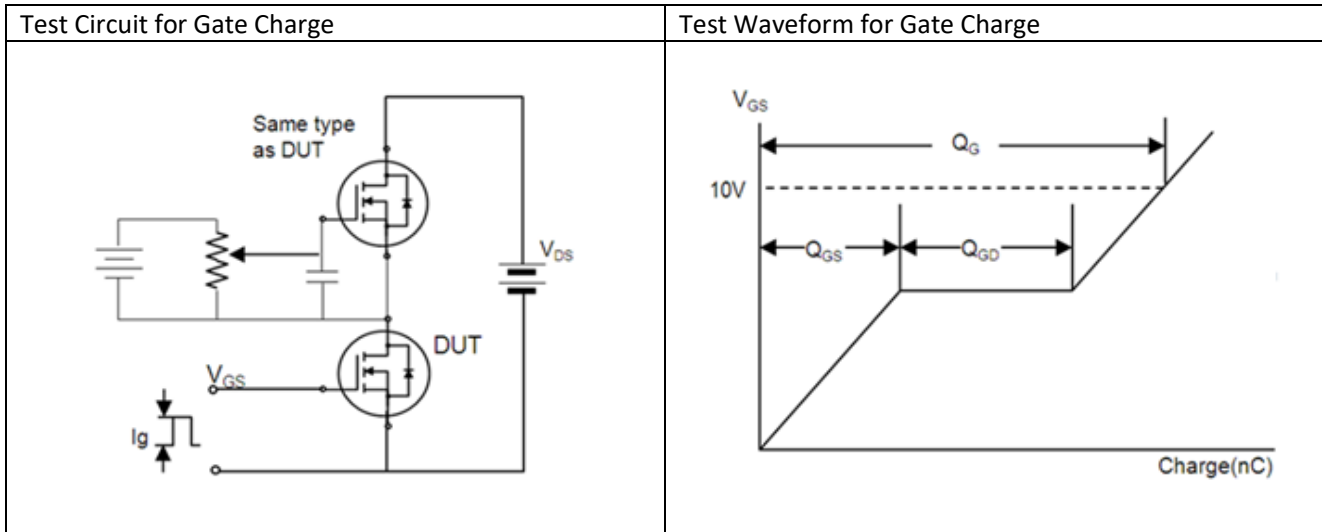
**Table 15 Diode Recovery Characteristics**



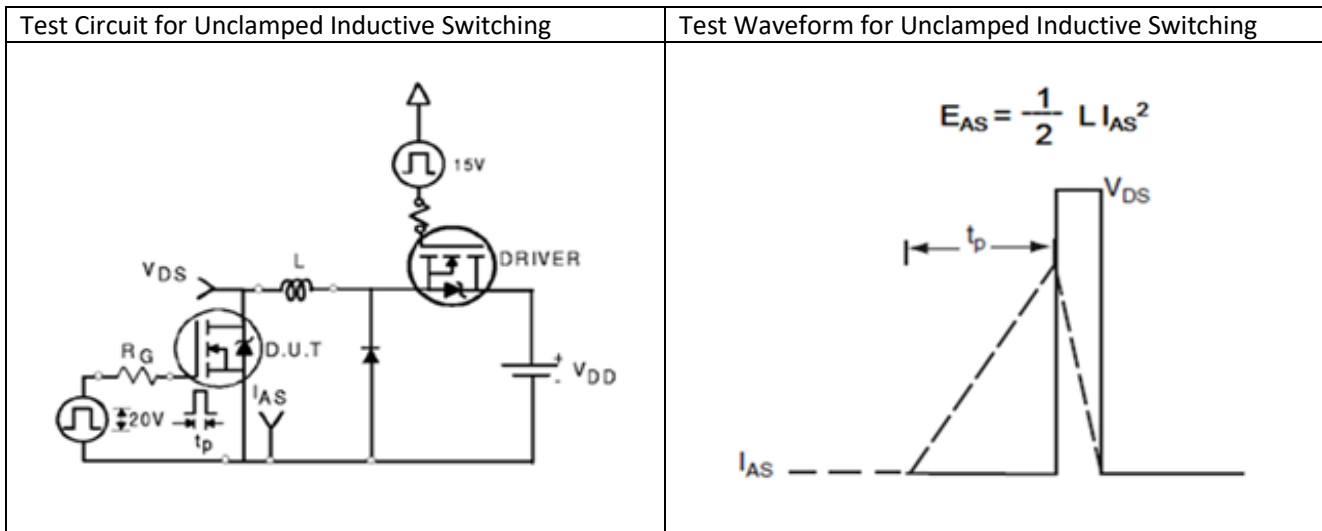
**Table 16 Switching Time Characteristics**



**Table 17 Gate Charge Characteristics**



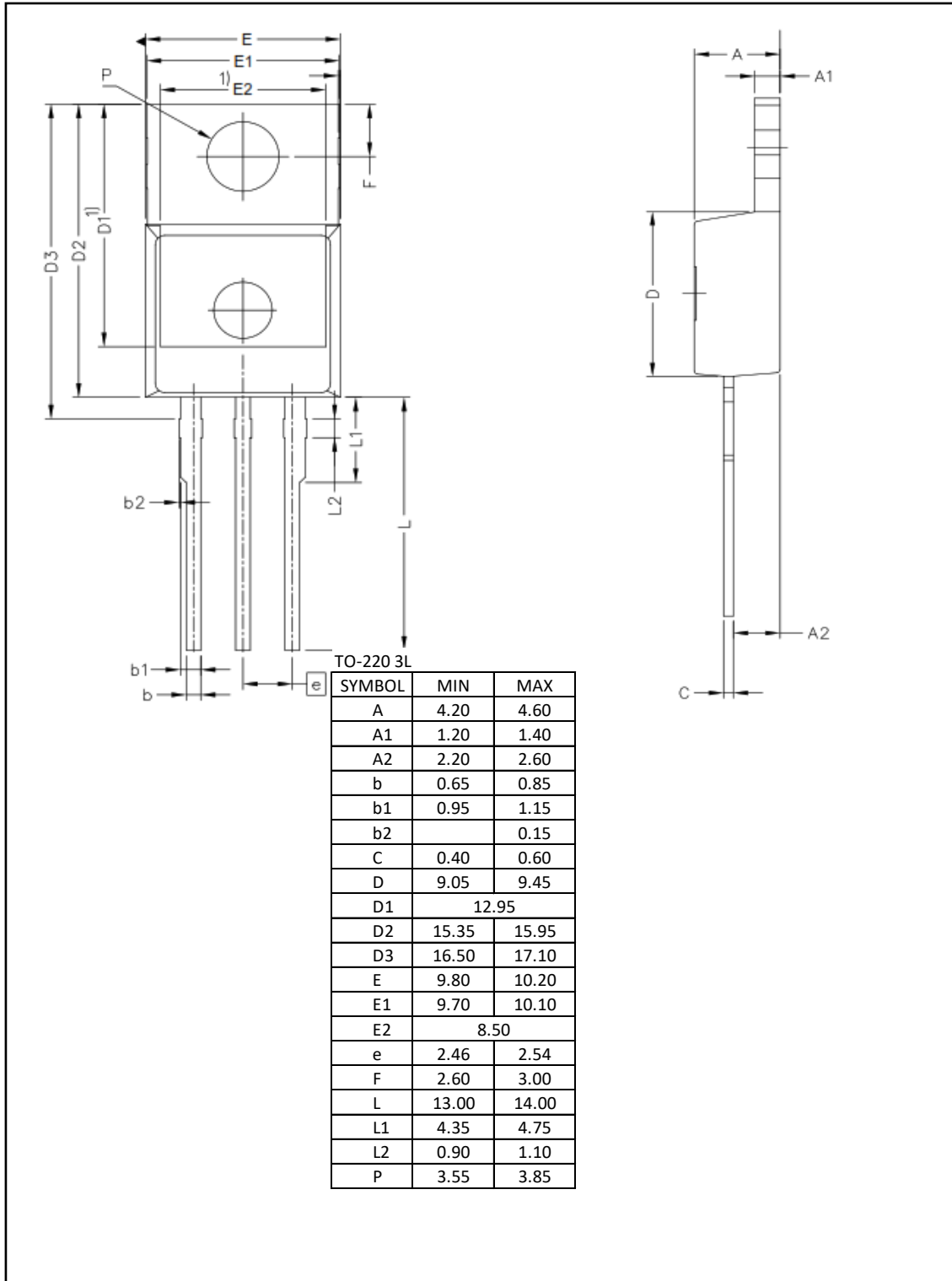
**Table 18 Unclamped Inductive Switching Characteristic**



Package Outlines

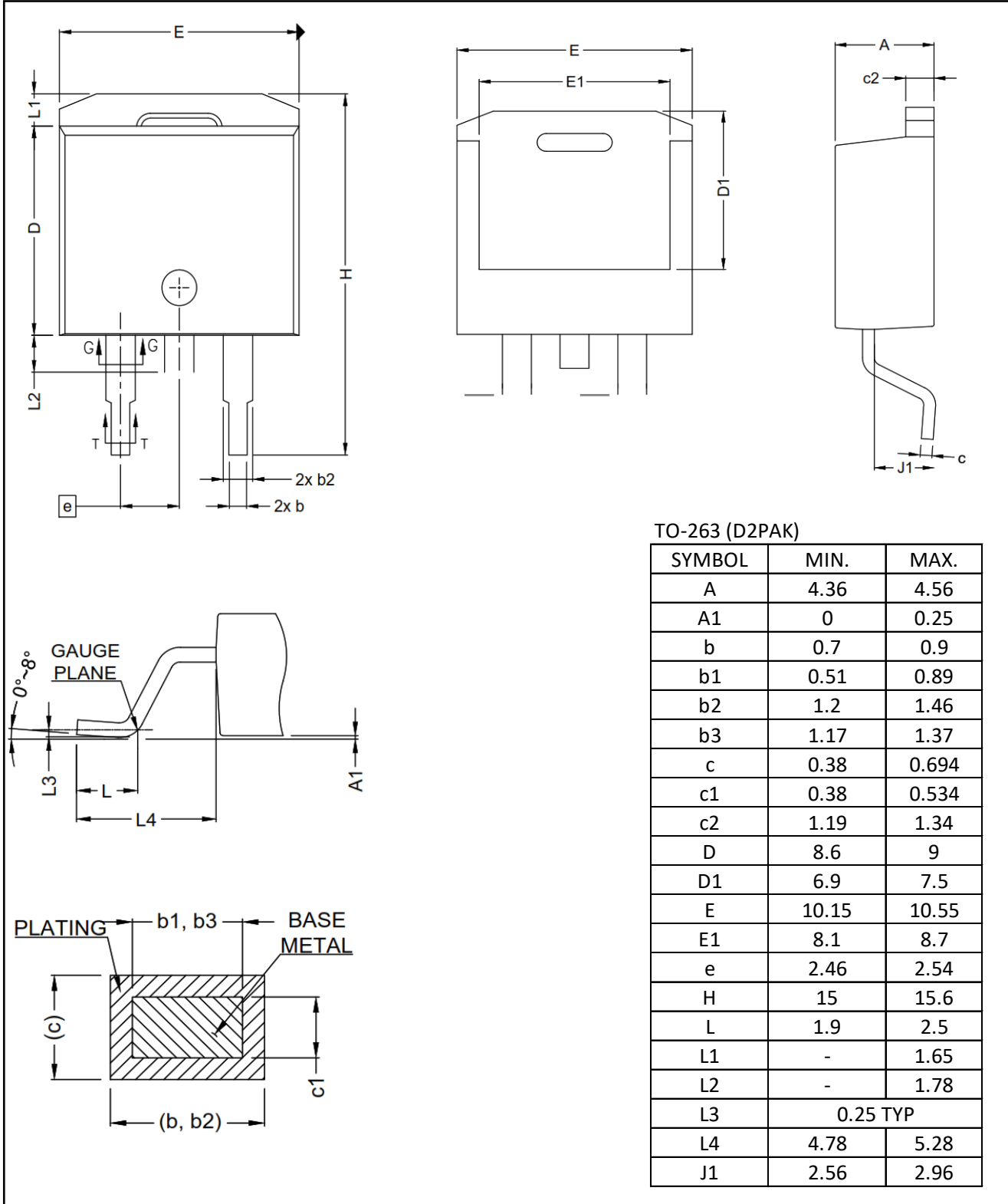
4a) TO-220

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



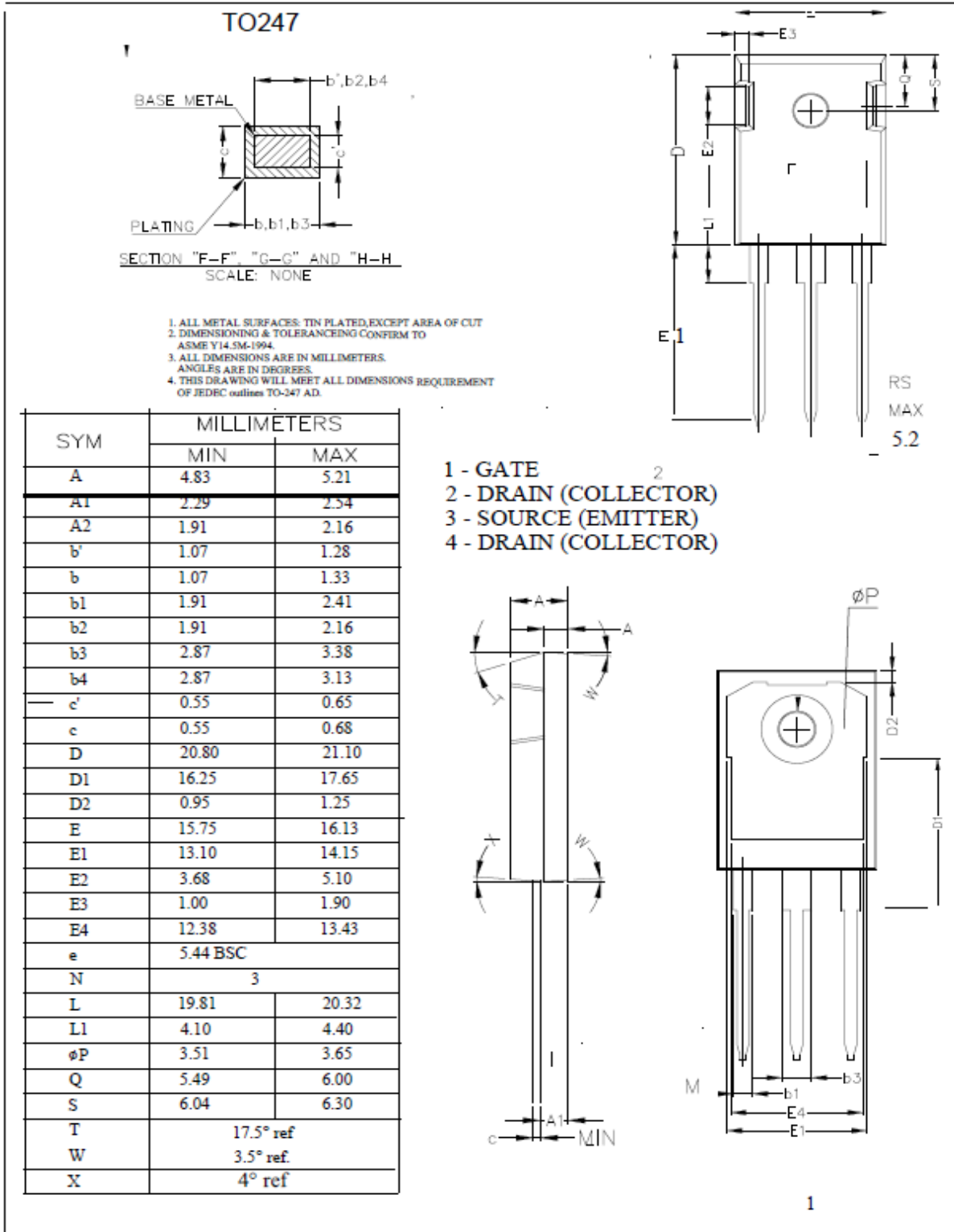
4b) TO-263

**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

[www.d3semi.com](http://www.d3semi.com)

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