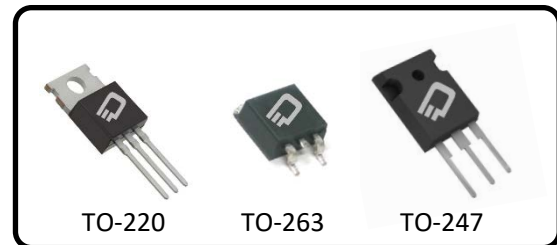


650V, 99mΩ, 31.8 A Super Junction Power MOSFET

Ordering Information

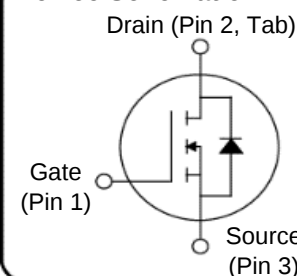
Part Number	Package Option
D3S099N65B-U	TO-220
D3S099N65D-U	TO-247
D3S099N65E-U	TO-263



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.

Device Schematic



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
$R_{DS(on)} max$	< 99	mΩ
$Q_g typ$	77	nC
$I_D @ 25 ^\circ C$	44.9	A

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°C, unless otherwise specified

Parameter	Symbol	Values			Unit	Condition
		Min	Typ	Max		
Continuous drain current	I _D			31.8	A	T _C = 25°C
				23.7	A	T _C = 100°C
Pulsed drain current	I _{D, pulse}			127	A	T _C = 25°C
Avalanche energy, single pulse	E _{AS}			650	mJ	I _D = 8.7A; V _{DD} = 50V, V _{GS} = 10V, L=17mH, R _G =25 Ohms
Avalanche energy, repetitive	E _{AR}			1.0	mJ	I _D = 8.7A; V _{DD} = 50V
Avalanche current, repetitive	I _{AR}			8.7	A	
MOSFET dv/dt ruggedness	dv/dt			50	V/ns	V _{DS} = 0...400V
Gate source voltage (static)	V _{GS}	-30		30	V	Static
Gate source voltage (dynamic)	V _{GS}	-30		30	V	AC (F>1Hz)
Power dissipation	P _{tot}			154	W	TO-220, TO-263, TO-247, T _C = 25°C
Storage temperature	T _{stg}	-55		150	°C	
Operating junction temperature	T _j	-55		150	°C	
Mounting torque				60	N-cm	
Continuous diode forward current	I _{SD}			31.8	A	T _C = 25°C
Diode pulse current	I _{S, pulse}			127	A	T _C = 25°C
Reverse diode dv/dt	dv/dt			15	V/ns	V _{DS} =0...400V, I _{SD} ≤I _S , T _j = 25°C
Maximum diode commutation speed	di _f /dt			500	A/μs	V _{DS} =0...400V, I _{SD} ≤I _S , T _j = 25°C

Thermal Characteristics

Table 3 Thermal Characteristics

Symbol	Parameter	Values				Unit
		TO-220	TO-263	TO-247		
R_{thJC}	Thermal resistance, junction-case	0.81	0.81	0.81		°C/W
R_{thJA}	Thermal resistance, junction-ambient	62	62	50		°C/W
R_{thJT}	Thermal resistance, junction-ambient for SMD version		30			°C/W
T_s	Soldering temperature, wavesoldering only allowed at leads	260	260	260		°C

Electrical Characteristics

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

Table 4

Parameter	Symbol	Values			Unit	Condition
		Min	Typ	Max		
Drain-source breakdown voltage	V_{DS}	650			V	$I_D = 1\text{mA}$, $V_{GS} = 0\text{V}$
Gate threshold voltage	$V_{GS(th)}$	2.3	3	3.7	V	
Zero gate voltage drain current	I_{DSS}			1	μA	$V_{DS} = 650\text{V}$, $T_c = 25^\circ\text{C}$
				50		$V_{DS} = 650\text{V}$, $T_c = 125^\circ\text{C}$
Gate-source leakage current	I_{GSS}			100	nA	
Drain-source on-state resistance	$R_{DS(on)}$		0.062	0.099	Ω	$V_{GS} = 10\text{V}$, $I_D = 15.9\text{A}$, $T_c = 25^\circ\text{C}$
	$R_{DS(on)}$		0.160			$V_{GS} = 10\text{V}$, $I_D = 15.9\text{A}$, $T_c = 150^\circ\text{C}$
Gate resistance	R_G		1		Ω	

Table 5

Parameter	Symbol	Values			Unit	Condition
		Min	Typ	Max		
Input capacitance	C_{iss}		4240		pF	$V_{DS} = 100\text{V}$, $f = 1\text{MHz}$, $V_{GS} = 0\text{V}$
Output capacitance	C_{oss}		97.5		pF	
Reverse transfer capacitance	C_{rss}		16.5		pF	
Turn-on delay time	$t_{d(on)}$		17		ns	$V_{DD} = 400\text{V}$, $I_D = 15.9\text{A}$ $R_G = 1\Omega$, $V_{GS} = 10\text{V}$
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	$V_{DD} = 480V$, $I_D = 15.5A$, $V_{GS} = 10V$
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		μC	
Peak reverse recovery current	I_{rrm}		50.0		A	

Electrical Characteristics Graphs

Table 8 Thermal Performance

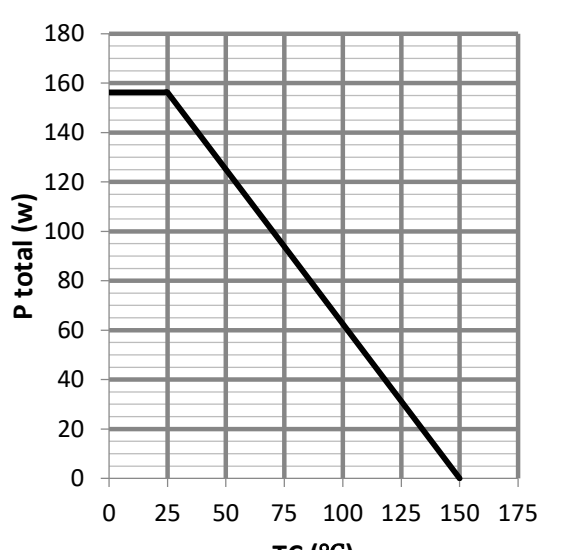
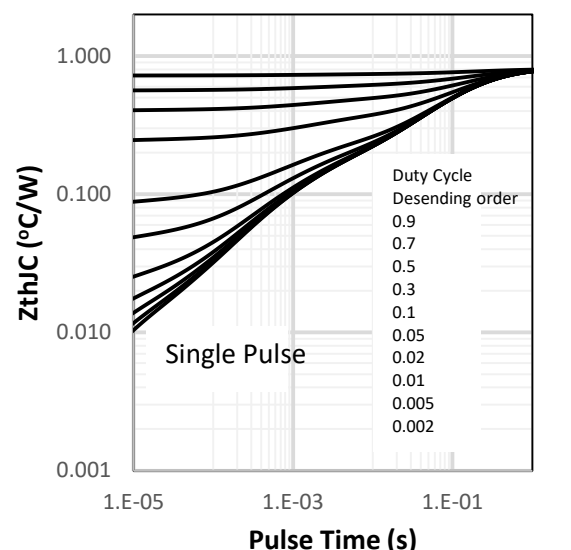
Power Dissipation	Maximum Transient Thermal Impedance
 A line graph showing the relationship between total power dissipation (P total in Watts) and case temperature (TC in °C). The y-axis ranges from 0 to 180 W in increments of 20. The x-axis ranges from 0 to 175 °C in increments of 25. The curve is a horizontal line at 160 W from 0 °C to 25 °C, and then a straight line sloping downwards to 0 W at 150 °C.	 A log-log graph showing the maximum transient thermal impedance (ZthJC in °C/W) versus pulse time (s). The y-axis ranges from 0.001 to 1.000 °C/W. The x-axis ranges from 1.E-05 to 1.E-01 s. Multiple curves are shown for different duty cycles, with a legend indicating 'Duty Cycle Descending order' from 0.9 to 0.002. A 'Single Pulse' curve is also shown, which is the lowest curve on the graph.
Max power limited by case temperature	Variable is pulse time (t_p)

Table 9 Output Characteristics

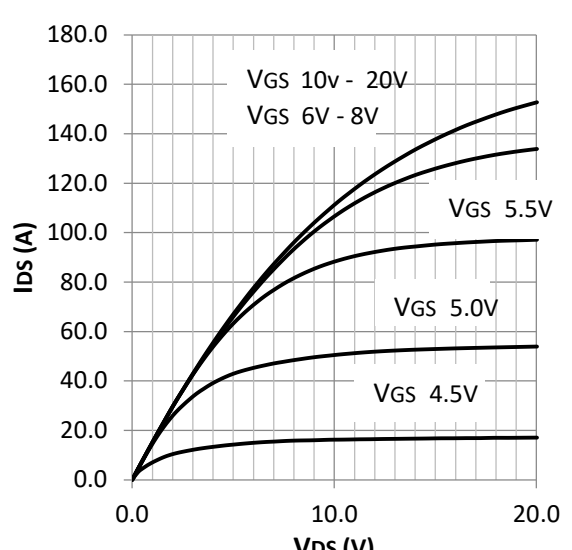
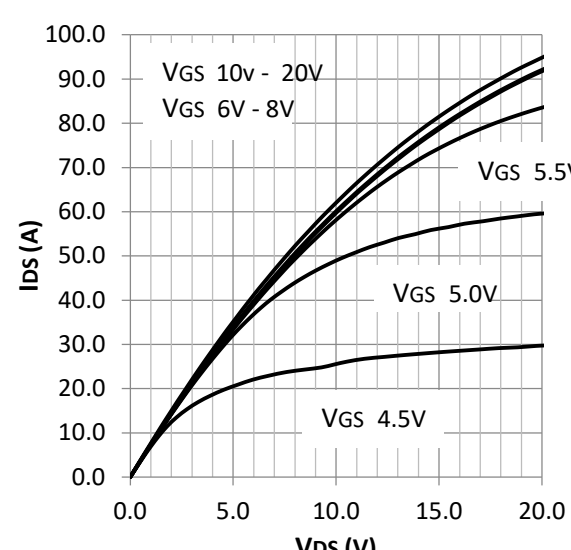
Typical Output Characteristics	Typical Output Characteristics
 A graph showing drain current (ID in A) versus drain-source voltage (VDS in V) at a case temperature (TC) of 25°C. The y-axis ranges from 0.0 to 180.0 A in increments of 20.0. The x-axis ranges from 0.0 to 20.0 V in increments of 10.0. Multiple curves are shown for different gate-source voltages (VGS): 10V - 20V, 6V - 8V, 5.5V, 5.0V, and 4.5V. The curves show that ID increases with VDS and VGS.	 A graph showing drain current (ID in A) versus drain-source voltage (VDS in V) at a case temperature (TC) of 125°C. The y-axis ranges from 0.0 to 100.0 A in increments of 10.0. The x-axis ranges from 0.0 to 20.0 V in increments of 5.0. Multiple curves are shown for different gate-source voltages (VGS): 10V - 20V, 6V - 8V, 5.5V, 5.0V, and 4.5V. The curves show that ID increases with VDS and VGS, but the overall current levels are lower than at 25°C.
$T_C = 25^\circ\text{C}$; Variable is V_{GS}	$T_C = 125^\circ\text{C}$; Variable is V_{GS}

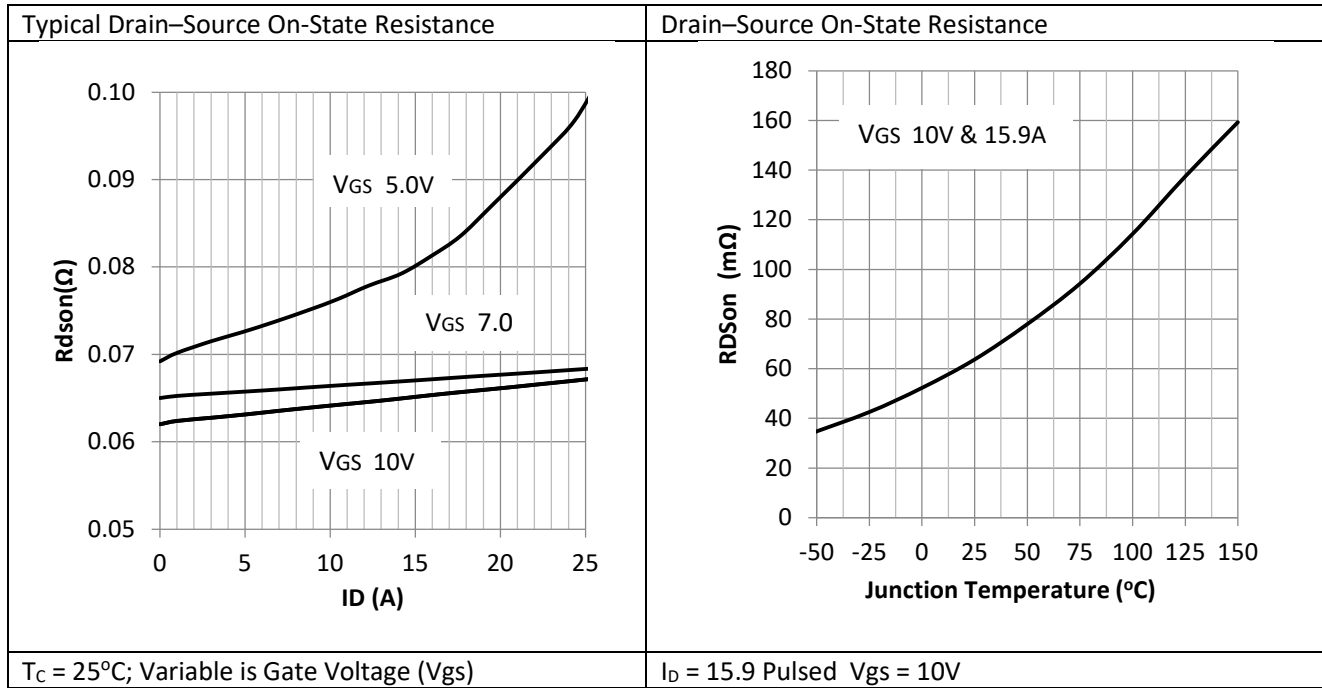
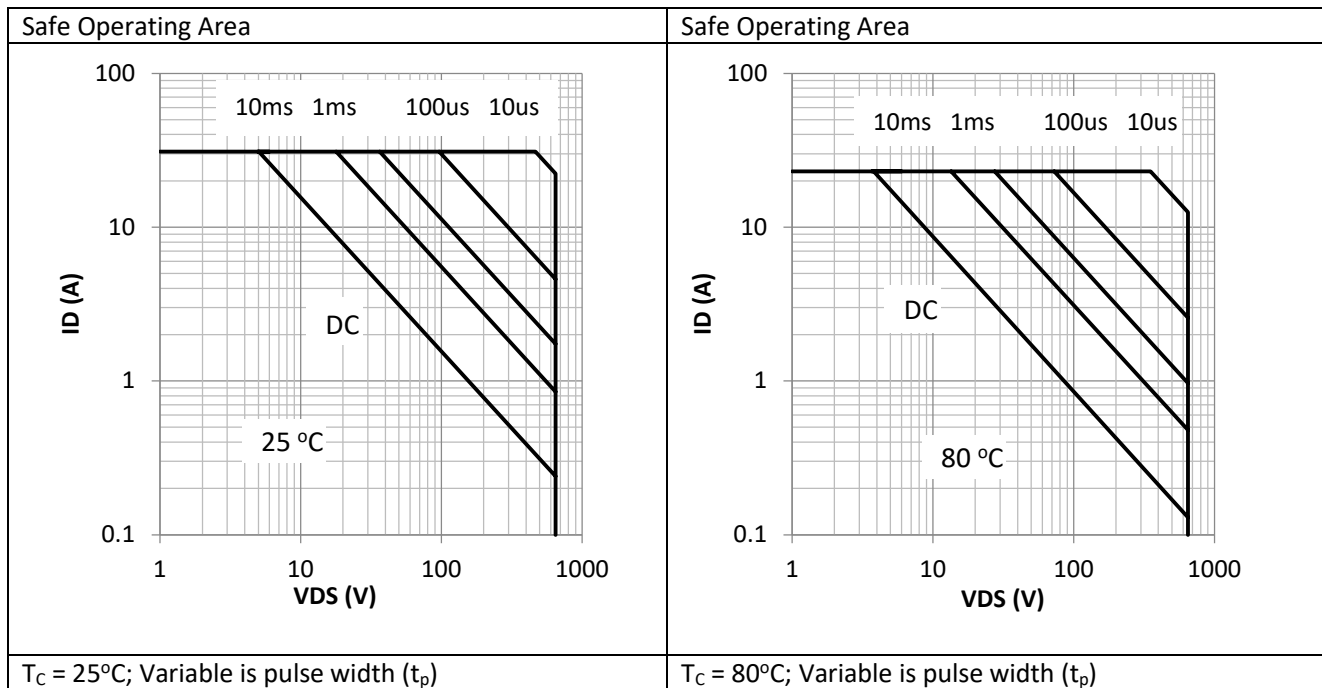
Table 10 Drain-Source Resistance

Table 11 Safe Operating Area


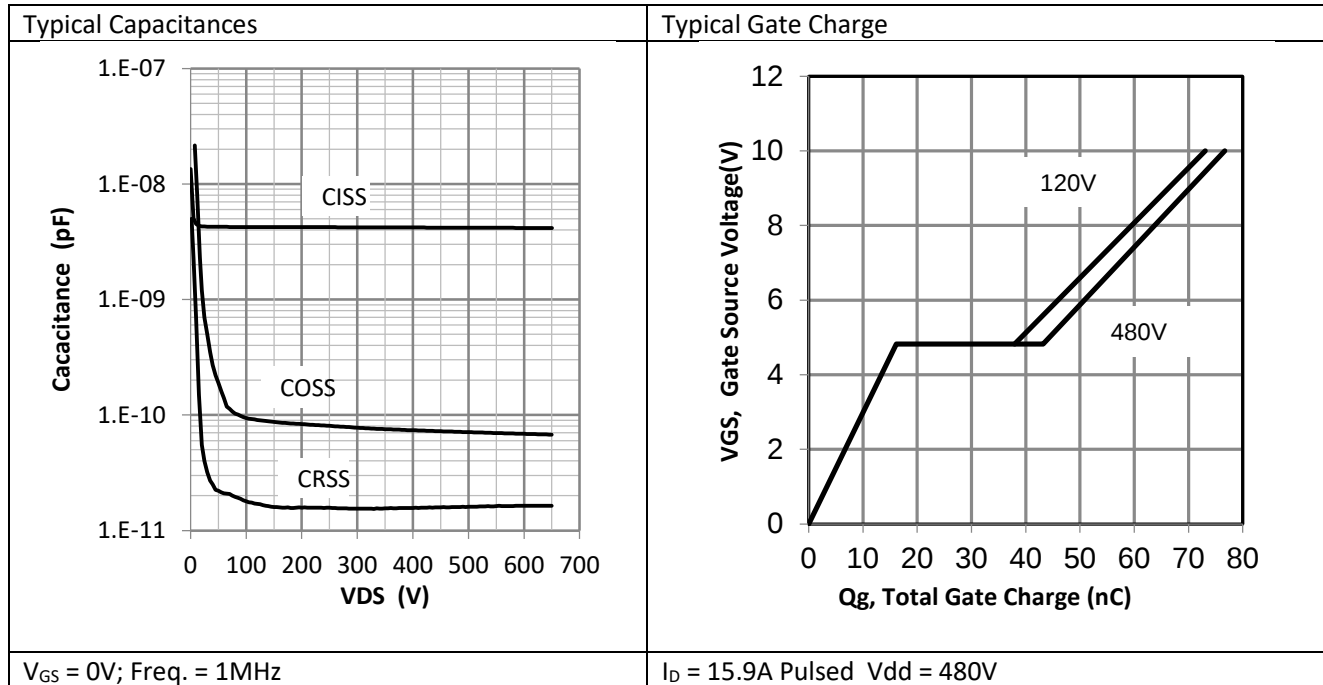
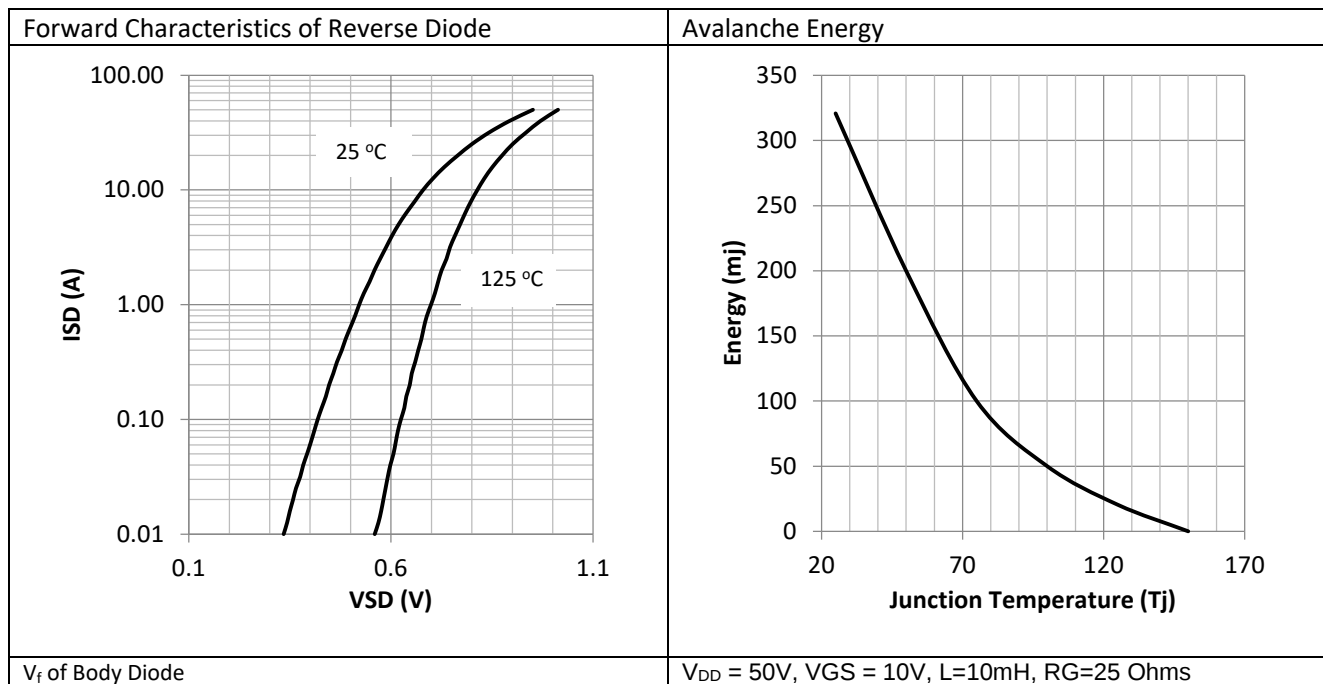
Table 12 Typical Capacitances and Gate Charge

Table 13 Diode Forward Characteristics and Avalanche Energy


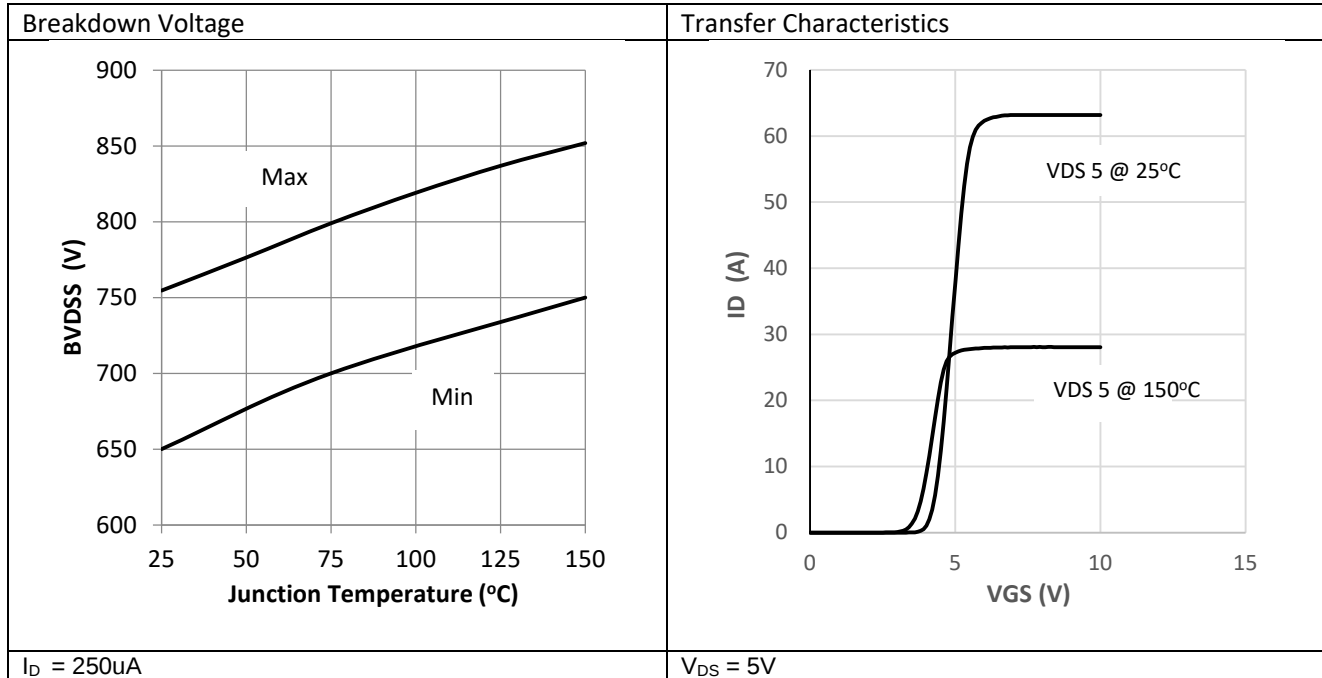
Table 14 Drain – Source Breakdown Voltage and Typical Transfer Characteristics


Table 15 Diode Recovery Characteristics

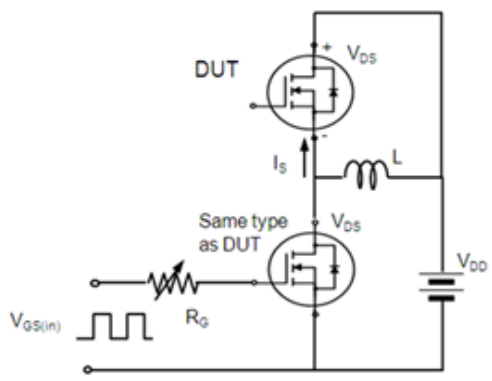
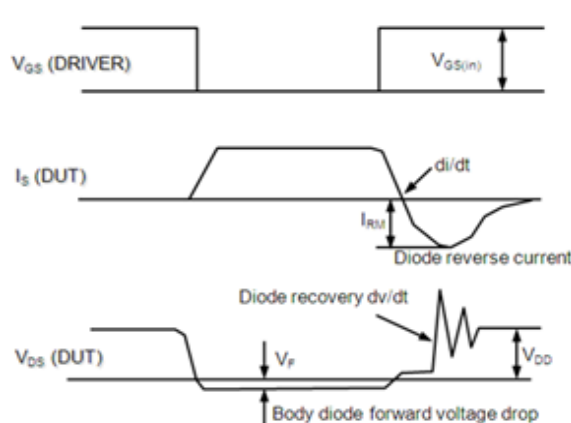
Test Circuit for Diode Recovery	Test Waveform for Diode Recovery
 *. dv/dt controlled by R_G *. I_S controlled by pulse period	

Table 16 Switching Time Characteristics

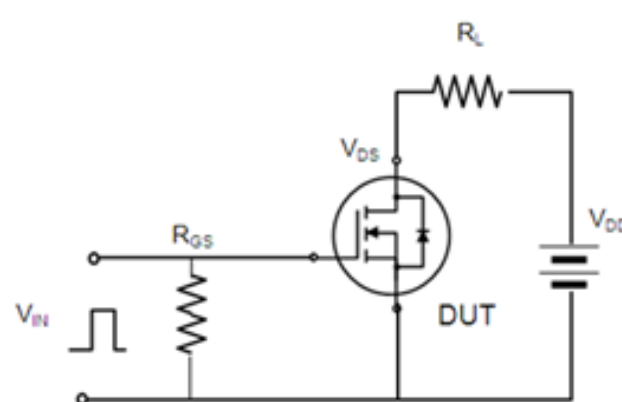
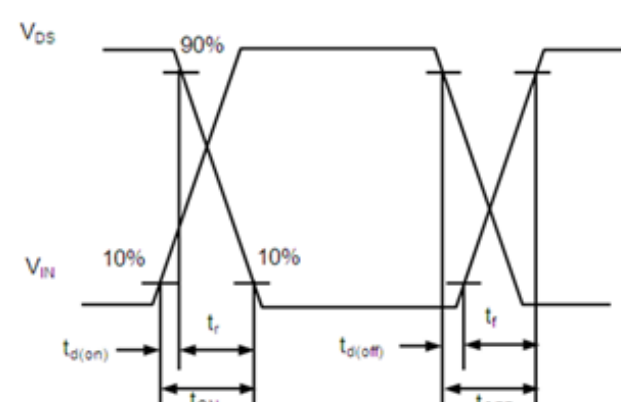
Test Circuit for Switching Time	Test Waveform for Switching Time
	

Table 17 Gate Charge Characteristics

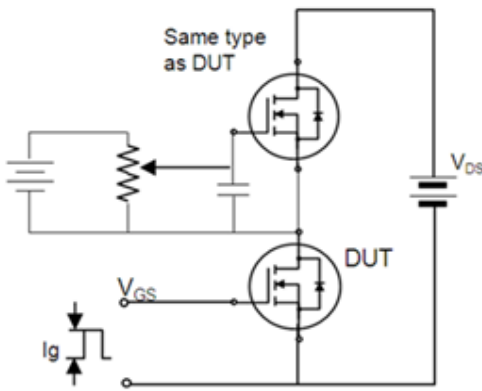
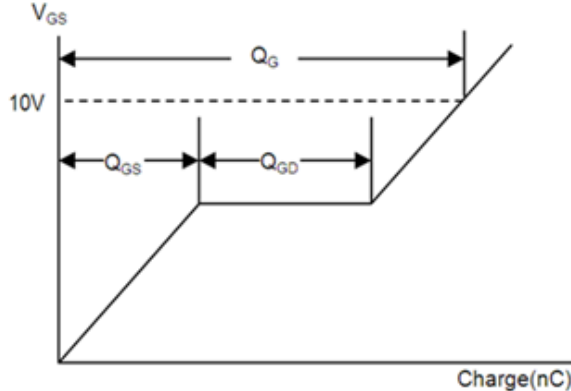
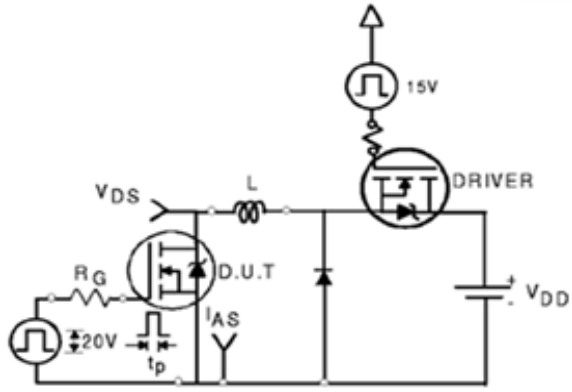
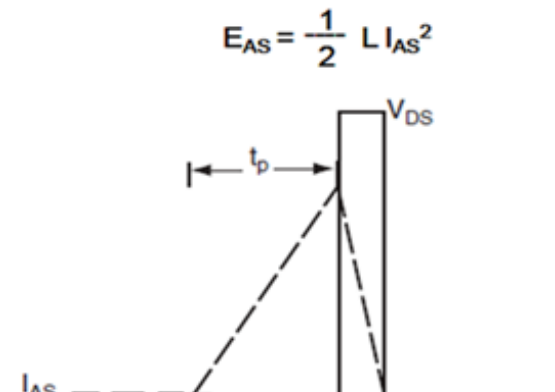
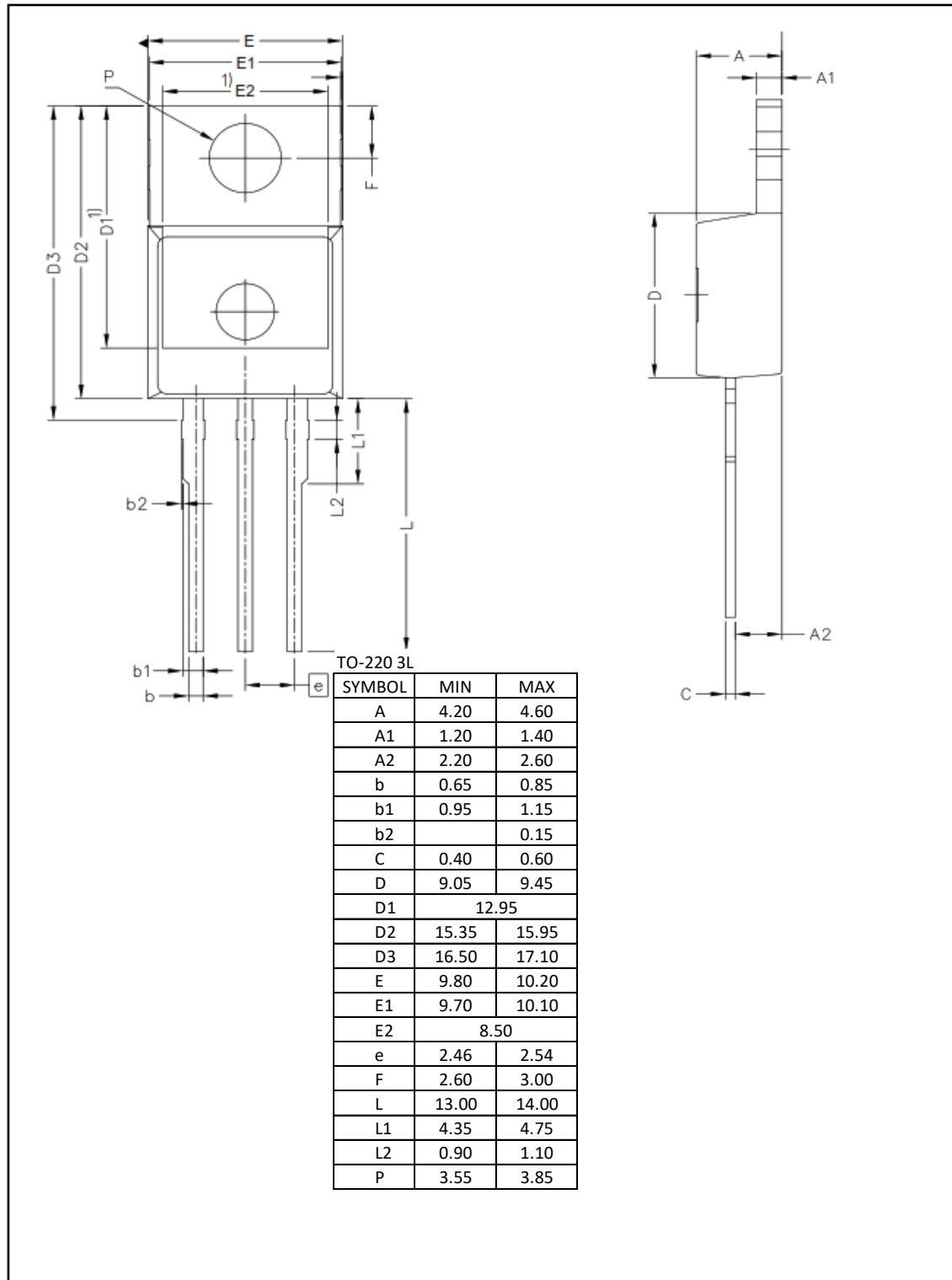
Test Circuit for Gate Charge	Test Waveform for Gate Charge
	

Table 18 Unclamped Inductive Switching Characteristic

Test Circuit for Unclamped Inductive Switching	Test Waveform for Unclamped Inductive Switching
	

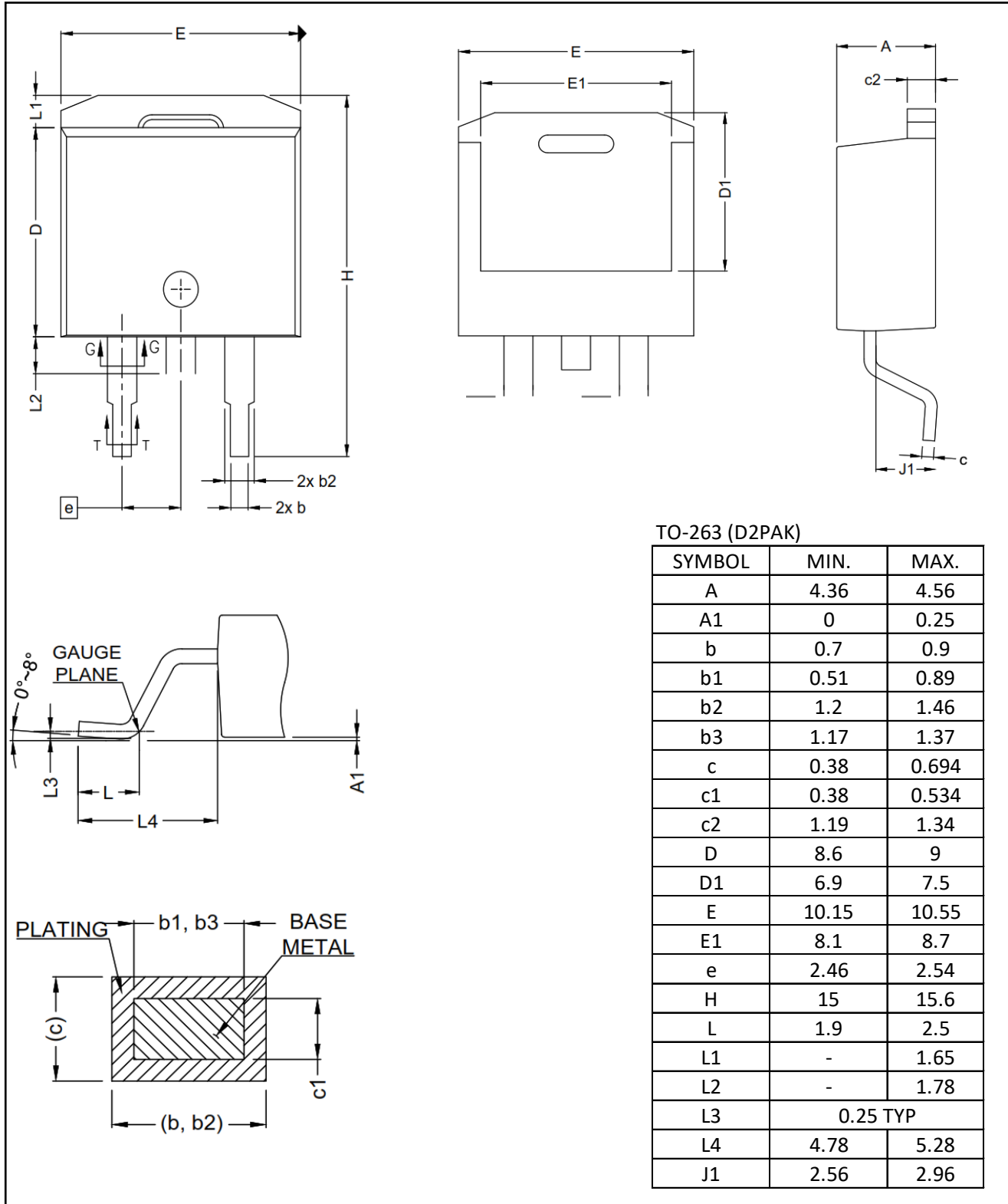
4a) TO-220

D3 Semiconductor TO-220-3L



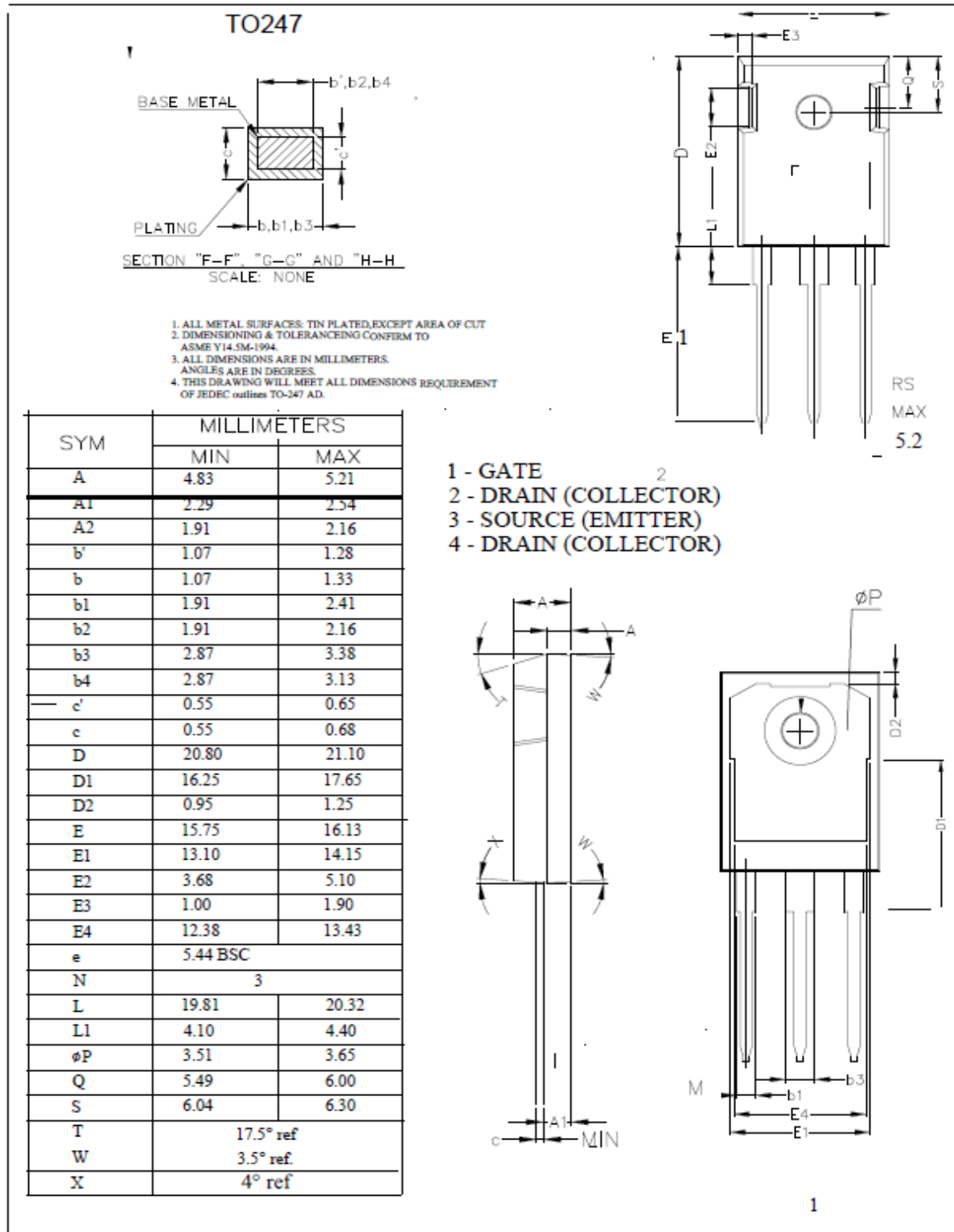
4b) TO-263

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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Офис по работе с юридическими лицами:

105318, г.Москва, ул.Щербаковская д.3, офис 1107, 1118, ДЦ «Щербаковский»

Телефон: +7 495 668-12-70 (многоканальный)

Факс: +7 495 668-12-70 (доб.304)

E-mail: info@moschip.ru

Skype отдела продаж:

moschip.ru

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