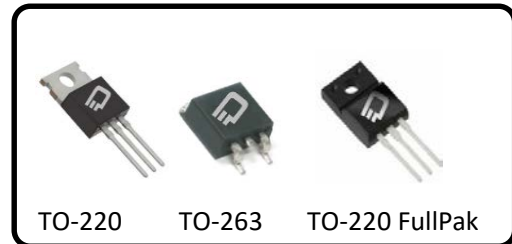


650V, 190mΩ, 21.6 A Super Junction Power MOSFET

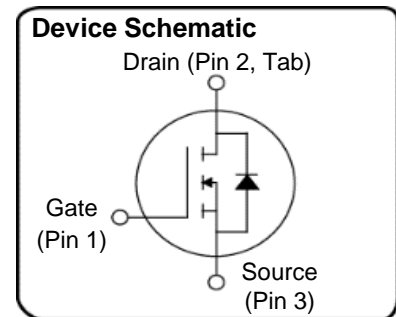
Ordering Information

Part Number	Package Option
D3S190N65B-U	TO-220
D3S190N65E-T	TO-263
D3S190N65F-U	TO-220 FullPak (FP)



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
- LOW OUTPUT CAPACITANCE

Benefits

- LOW CONDUCTION LOSSES
- HIGH EFFICIENCY
- EXCELLENT AVALANCHE PERFORMANCE

Table 1 Key Performance Parameters

Parameters	Value	Unit
$V_{DS} @ T_J \text{ max}$	710	V
$R_{DS(on), \text{max}}$	<190	mΩ
Q_g, typ	28	nC
$I_D @ 25^\circ\text{C}$	21.6	A
C_{oss}	47	pf

Applications

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

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

Table 2 Maximum ratings

Parameter	Symbol	Values				Unit	Note/Test Condition
		Min.	Typ.	Max.			
				220, 263 & 247	220FP		
Continuous drain current(1)	I_D			21.6	11.8	A	$T_C = 25^\circ\text{C}$
				13.7	7.5		$T_C = 100^\circ\text{C}$
Pulsed drain current(2)	$I_{D,pulse}$			86.4	47.4	A	$T_C = 25^\circ\text{C}$
Avalanche energy, single pulse	E_{AS}			399	399	mJ	$I_D=3.5\text{A}, V_{DD}=50\text{V}$
Avalanche energy, repetitive	E_{AR}			1.0	1.0	mJ	$I_D=3.5\text{A}, V_{DD}=50\text{V}$
Avalanche current, repetitive	I_{AR}			3.5	3.5	A	
MOSFET dv/dt ruggedness	dv/dt			50	50	V/ns	$V_{DS}=\dots480\text{V}$
Gate source voltage	V_{GS}	-30		30	30	V	static
		-30		30	30		AC (f > 1HZ)
Power dissipation for TO-220	P_{tot}			187	56	W	$T_C = 25^\circ\text{C}$
Operating and storage temperature	T_J, T_{stg}	-55		150	150	$^\circ\text{C}$	
Mounting torque				60		Ncm	M3 and M3.5 screws
					50		M3 screws
Continuous diode forward current	I_S			21.6	11.8	A	$T_C = 25^\circ\text{C}$
Diode pulsed current	$I_{S,pulse}$			86.4	47.4	A	$T_C = 25^\circ\text{C}$
Reverse diode dv/dt(3)	dv/dt			15	15	V/ns	$V_{DS}=\dots480\text{V}, I_{SD}<I_D$ $T_J = 25^\circ\text{C}$
Maximum diode commutation speed	dif/dt			500	500	A/us	

Table 3 Thermal characteristics

Parameter	Symbol	Values				Unit	Note/Test Condition
		Min.	Typ.	Max.			
				220, 263 & 247	220FP		
Thermal resistance, Junction-case	R_{thJC}			0.75	2.23	$^\circ\text{C}/\text{W}$	
Thermal resistance, Junction-ambient	R_{thJA}			48	50	$^\circ\text{C}/\text{W}$	Leaded
Soldering temperature, wavesoldering only allowed at leads	T_{sold}			260	260	$^\circ\text{C}$	1.6mm form case for 10s

Table 4 Static characteristics

Parameter	Symbol	Values			Unit	Note/Test Condition
		Min.	Typ.	Max.		
Drain to source breakdown voltage	$V_{(BR)DSS}$	650			V	$V_{GS}=0V, I_D=1mA$
Gate threshold voltage	$V_{GS(TH)}$	2.3	3.2	4.5	V	$V_{DS}=V_{GS}, I_D=105\mu A$
Zero gate voltage drain current	I_{DSS}			1	uA	$V_{DS}=650V, V_{GS}=0V, T_J = 25^\circ C$
				40		$V_{DS}=650V, V_{GS}=0V, T_J = 150^\circ C$
Gate to source leakage current	I_{GSS}			100	nA	$V_{GS}=\pm 20V, V_{DS}=0V$
Drain-source on-state resistance	$R_{DS(on)}$		160	190	m Ω	$V_{GS}=10V, I_D=10.8A, T_J = 25^\circ C$
			400		m Ω	$V_{GS}=10V, I_D=10.8A, T_J = 150^\circ C$
Gate resistance	R_G		1.1		Ω	Scaf-F

Table 5 Dynamic characteristics

Parameter	Symbol	Values			Unit	Note/Test Condition
		Min.	Typ.	Max.		
Input capacitance	C_{iss}		1171		pF	$V_{GS}=0V, V_{DS}=100V, f=1MHz$
Output capacitance	C_{oss}		47		pF	
Reverse transfer capacitance	C_{rss}		8		pF	
Effective output capacitance, energy related 1	$C_{o(er)}$		81		pF	$V_{DS}=0\dots 480V, V_{GS}= 0V$
Effective output capacitance, time related 2	$C_{o(tr)}$		205		pF	$I_D=constant, V_{DS}=0\dots 480V, V_{GS}= 0V$
Turn on delay time	$t_{d(on)}$		7.5		ns	$V_{DD}=400V, I_D=10.8A, R_G=3.4\Omega, V_{GS}=13V$
Rising time	t_r		23		ns	
Turn off delay time	$t_{d(off)}$		23		ns	
Fall time	t_f		22		ns	

Table 6 Gate charge characteristics

Parameter	Symbol	Values			Unit	Note/Test Condition
		Min.	Typ.	Max.		
Total gate charge	Q_g		28		nC	$V_{DD}=480V, V_{GS}=0 \text{ to } 10V, I_D=10.8A$
Gate-source charge	Q_{gs}		5.4		nC	
Gate-drain charge	Q_{gd}		13		nC	
Gate plateau voltage	$V_{plateau}$		5.0		V	

Table 7 Reverse diode characteristics

Parameter	Symbol	Values			Unit	Note/Test Condition
		Min.	Typ.	Max.		
Diode forward voltage	V_{SD}		0.87	0.96	V	$I_F=21.6A, V_{GS}=0V, T_J = 25^\circ C$
Reverse recovery time	t_{rr}		334		ns	$I_F=21.6A, dI_F/dt=100A/us$
Reverse recovery charge	Q_{rr}		4.4		uC	
Peak reverse recovery current	I_{rrm}		25.5		A	

Table 8 Thermal Performance

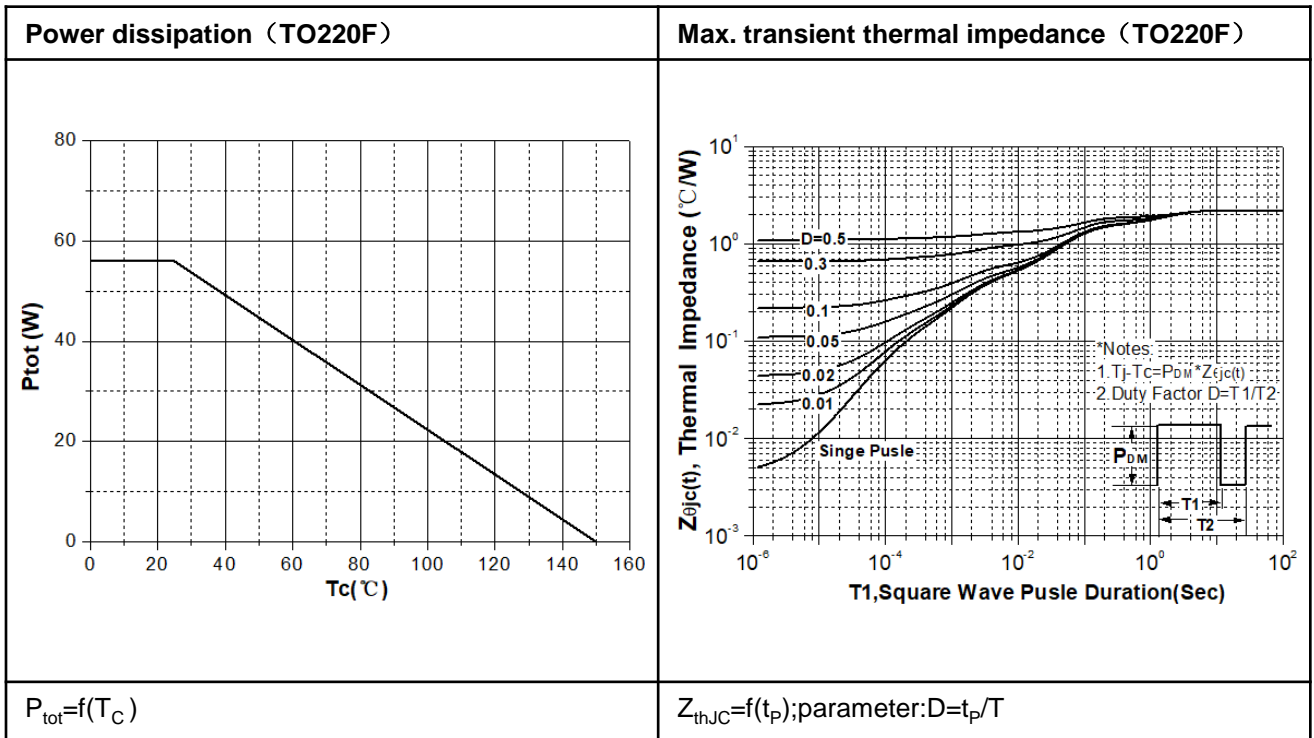
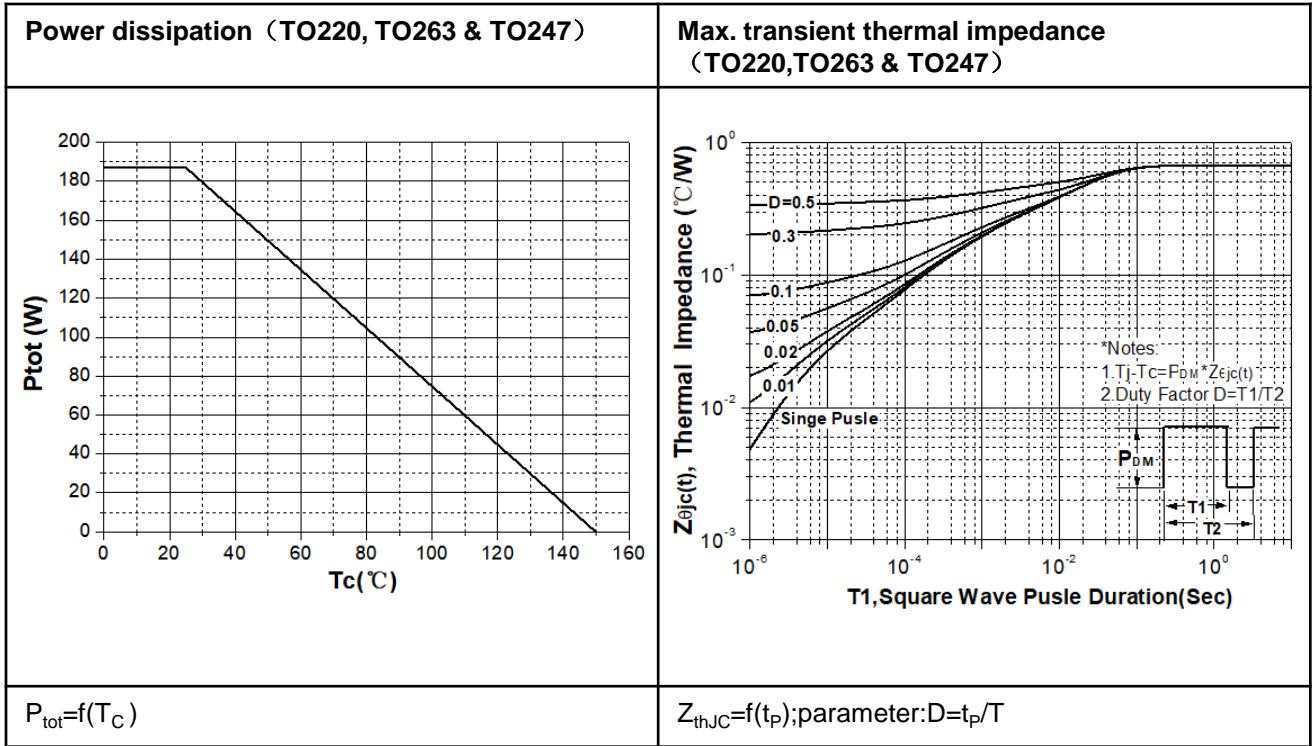


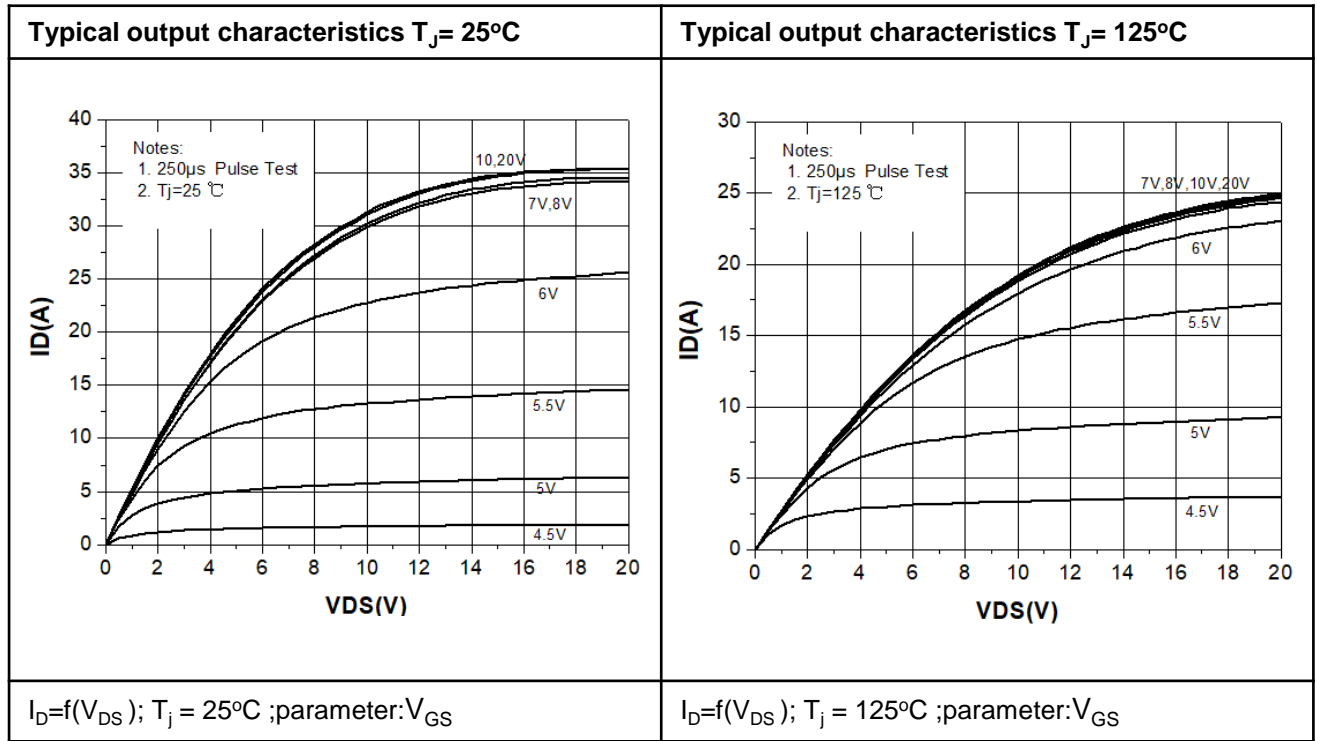
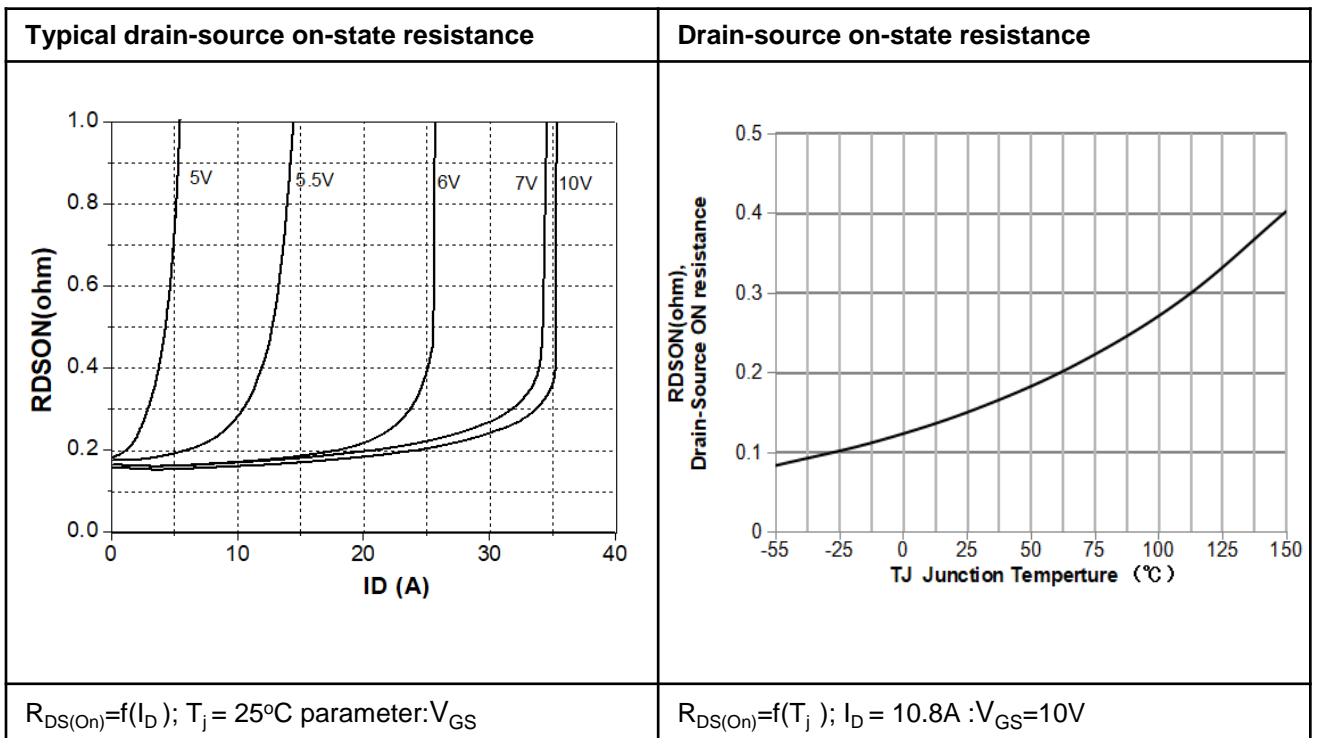
Table 9 Output Characteristics

Table 10 Drain Source Resistance


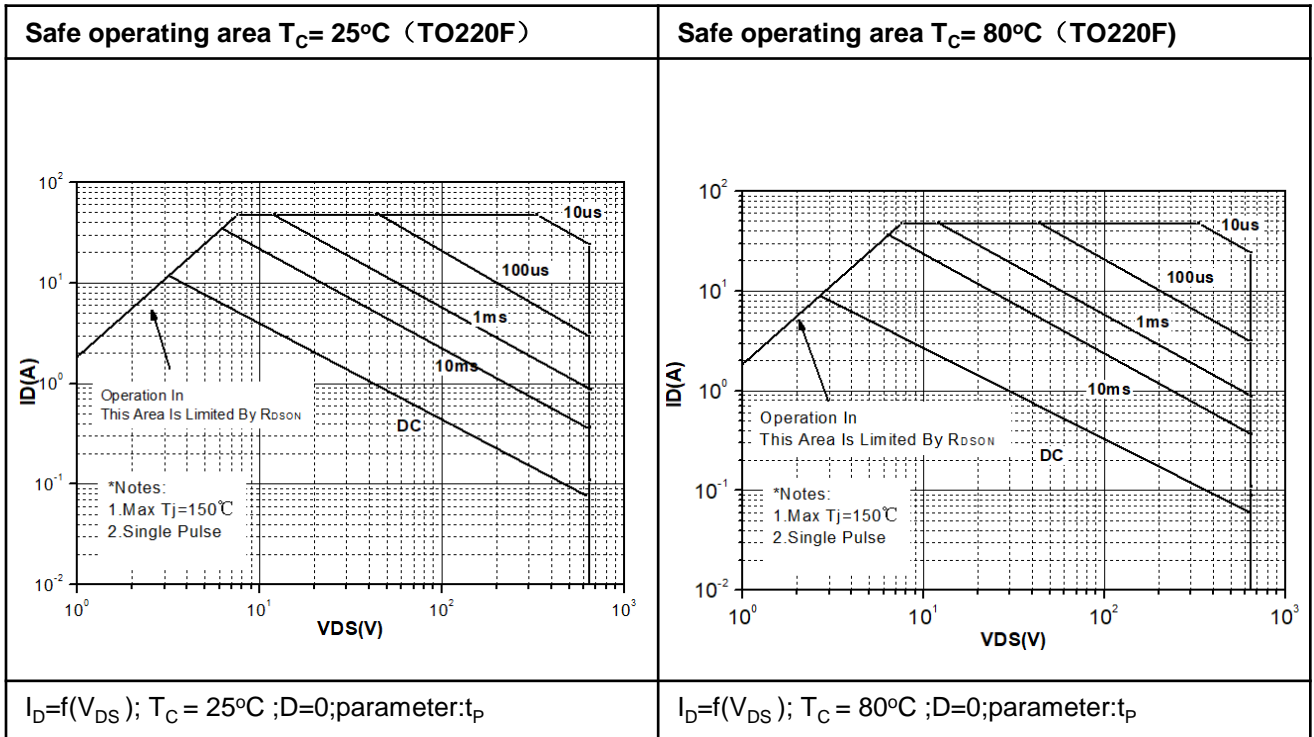
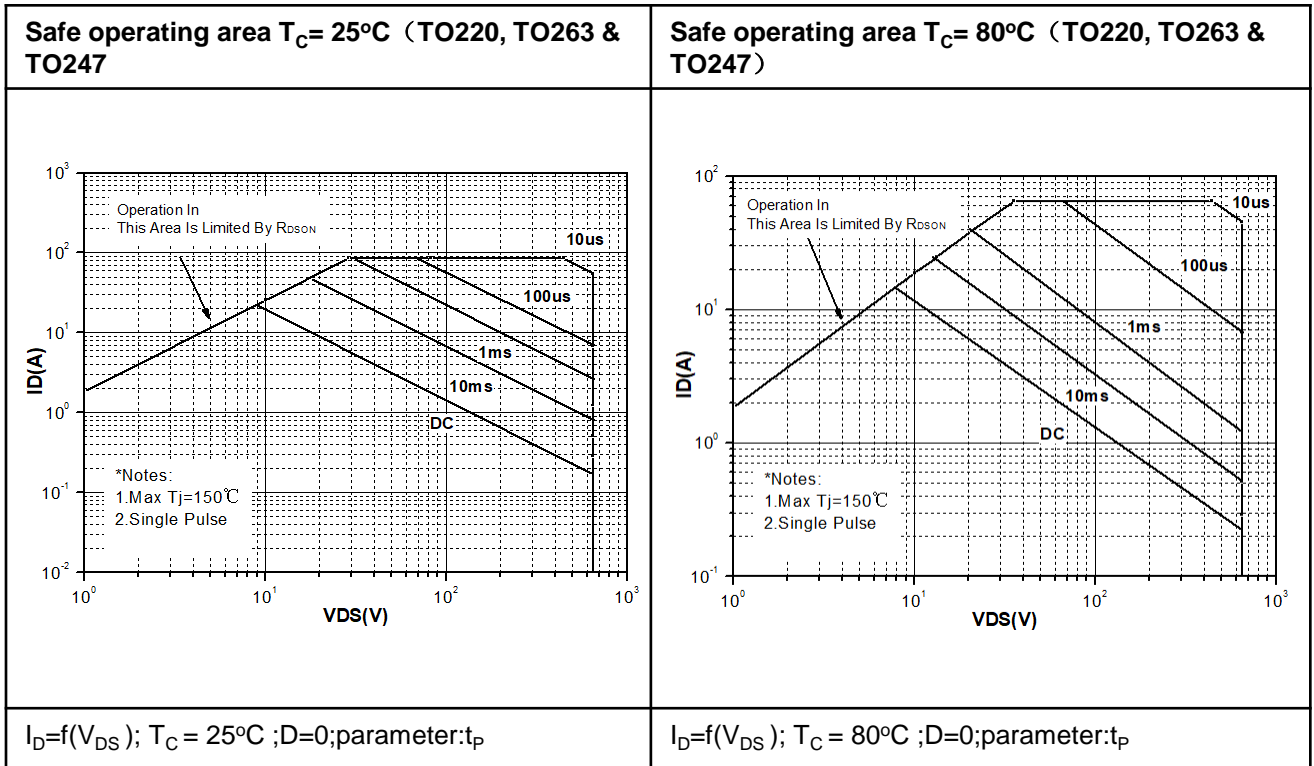
Table 11 Safe Operating Area


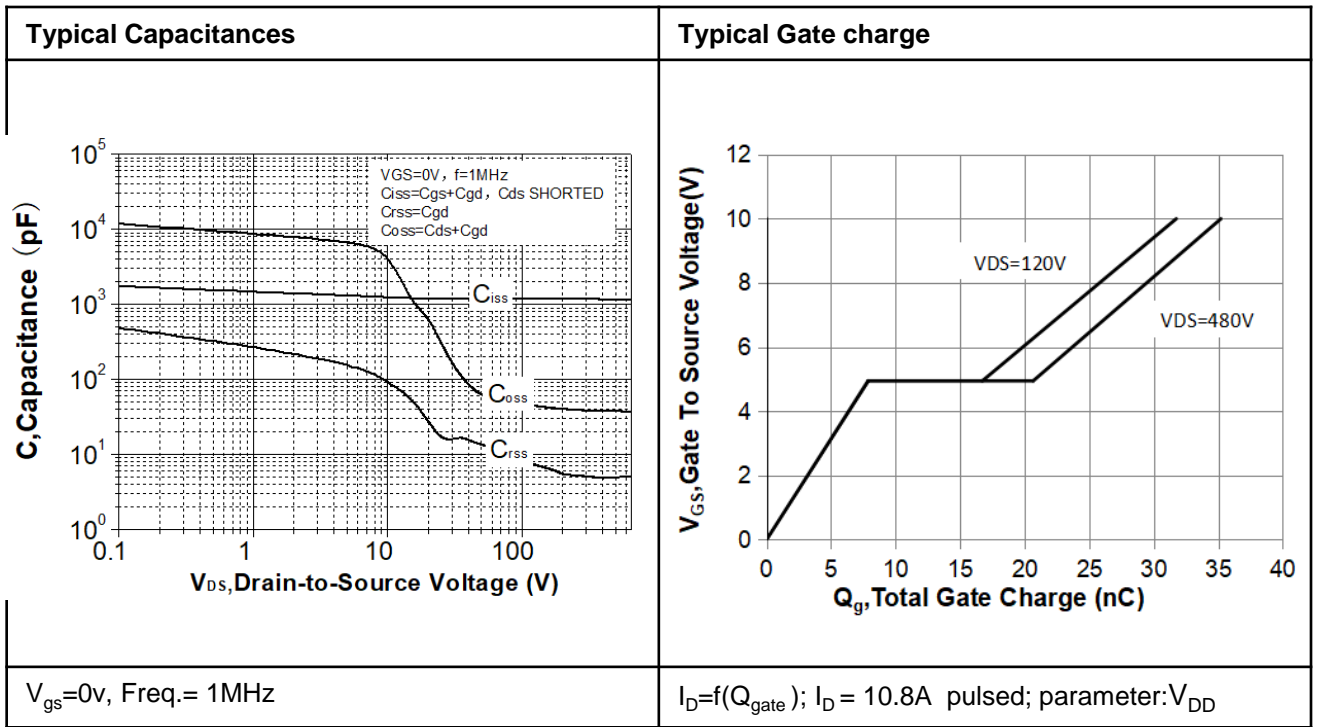
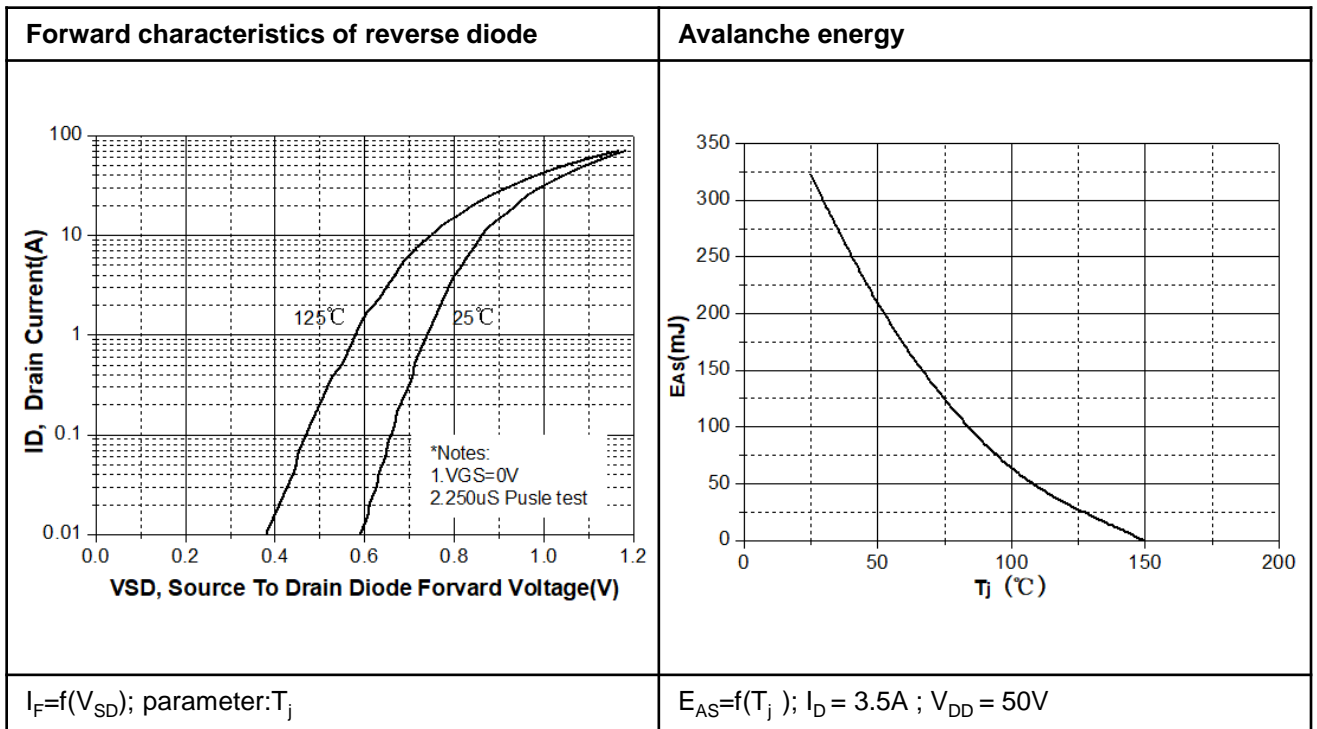
Table 12 Capacitance and Gate Charge

Table 13 Diode Characteristics and Avalanche Energy


Table 14 Breakdown Voltage and Transfer Characteristics

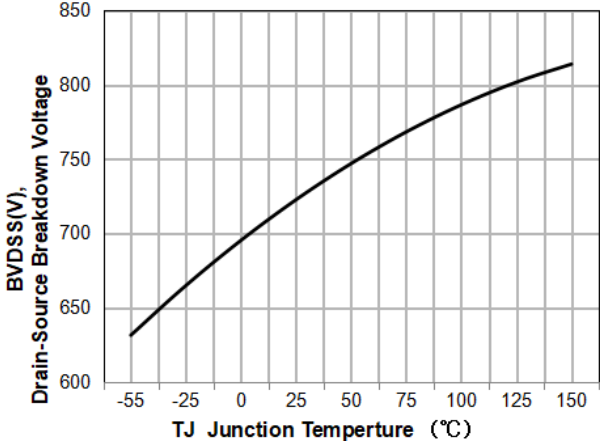
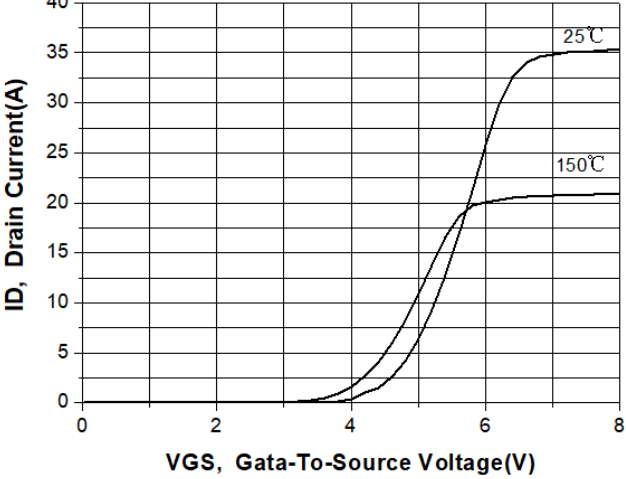
Drain-source breakdown voltage	Transfer Characteristics
 <p>The graph shows the Drain-Source Breakdown Voltage (BVDSS) in Volts (V) on the y-axis (ranging from 600 to 850) versus the TJ Junction Temperature in degrees Celsius (°C) on the x-axis (ranging from -55 to 150). The curve shows a non-linear increase in breakdown voltage as temperature increases, starting at approximately 630V at -55°C and reaching about 815V at 150°C.</p>	 <p>The graph shows the Drain Current (ID) in Amperes (A) on the y-axis (ranging from 0 to 40) versus the Gate-To-Source Voltage (VGS) in Volts (V) on the x-axis (ranging from 0 to 8). Two curves are shown for different temperatures: 25°C and 150°C. The 25°C curve shows a higher drain current for a given gate voltage compared to the 150°C curve, indicating a decrease in transconductance with increasing temperature.</p>
$V_{BR(DSS)} = f(T_j); I_D = 1\text{mA}$	$I_D = f(V_{GS}); V_{DS} > 2 I_D R_{DS(On)max}; \text{parameter: } T_j$

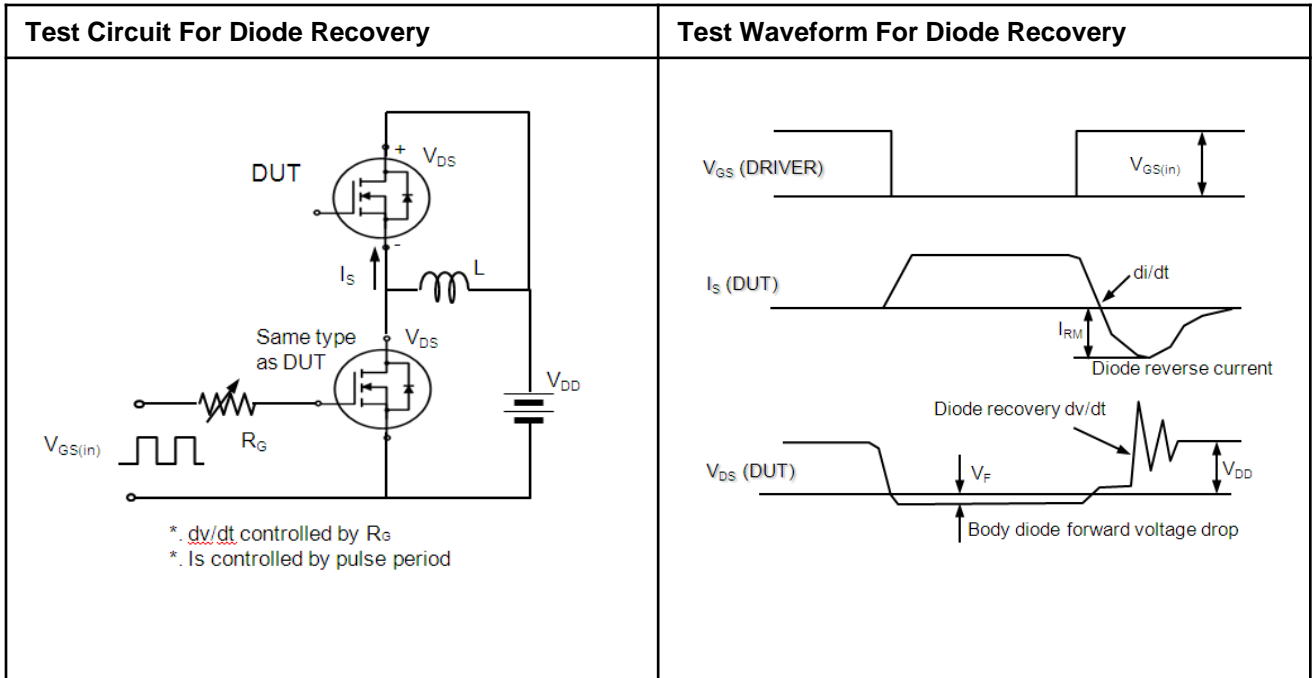
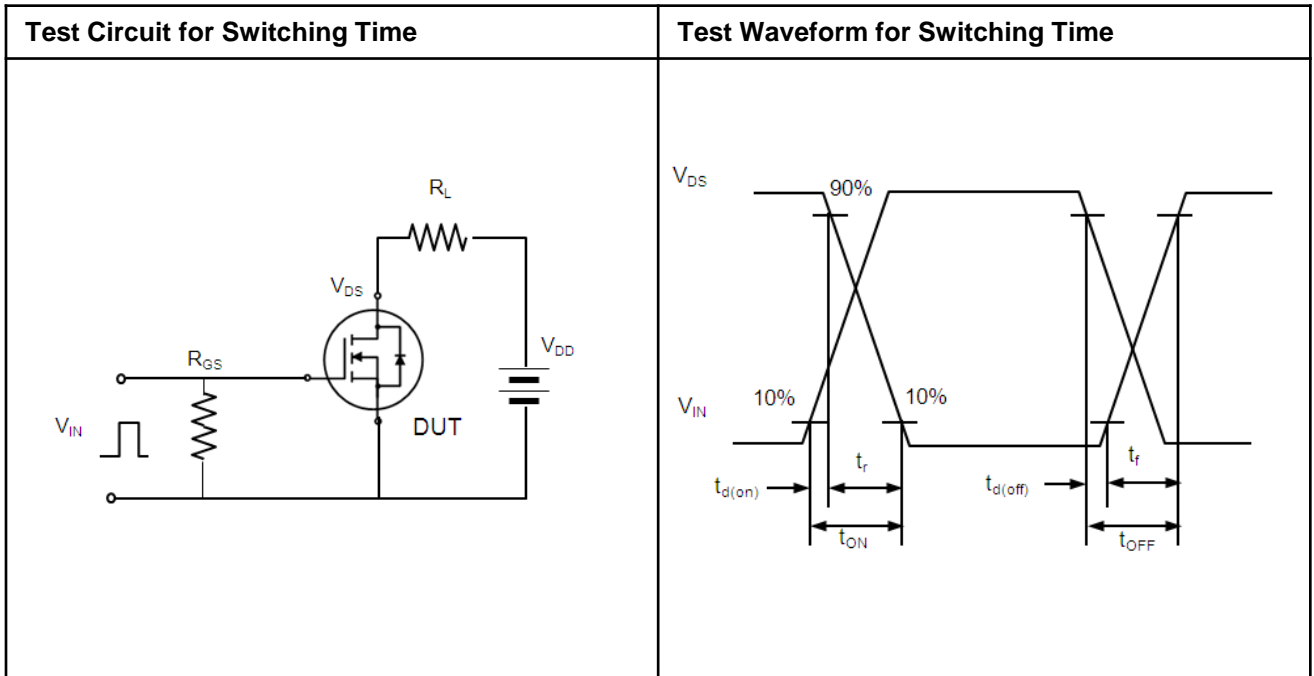
Table 15 Diode Recovery Characteristic

Table 16 Switching Time Characteristic


Table 17 Gate Charge Characteristic

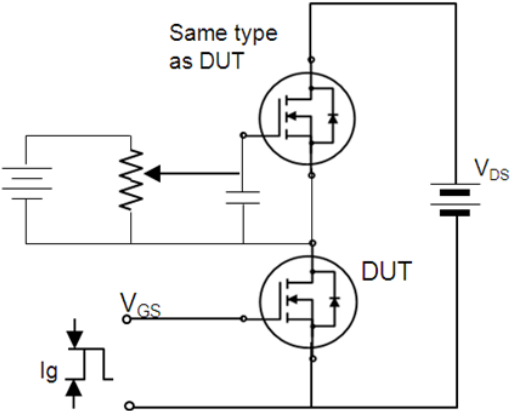
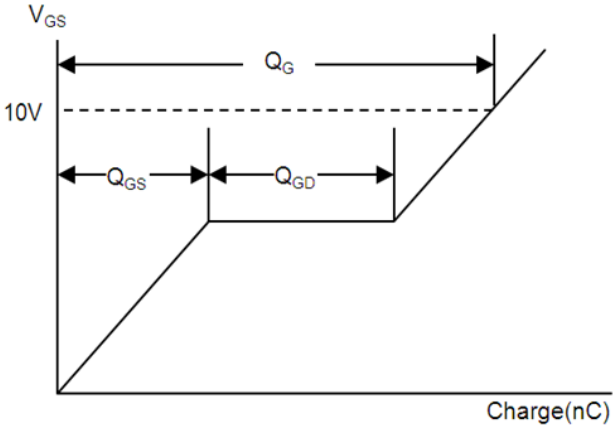
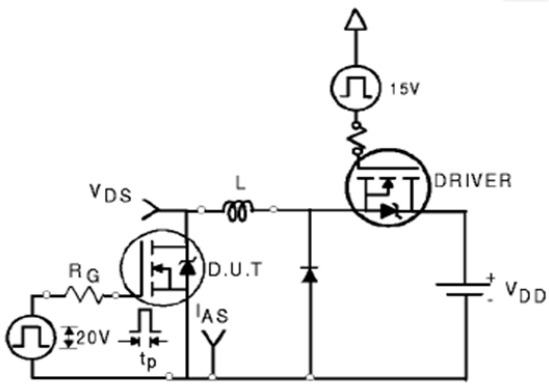
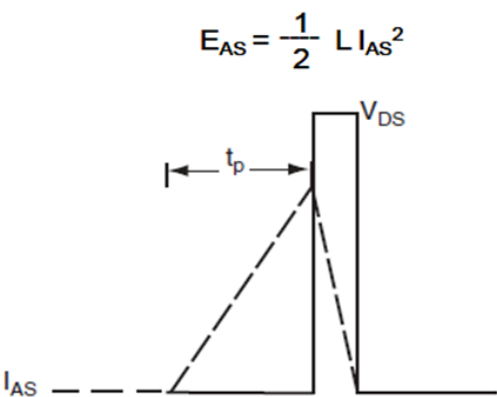
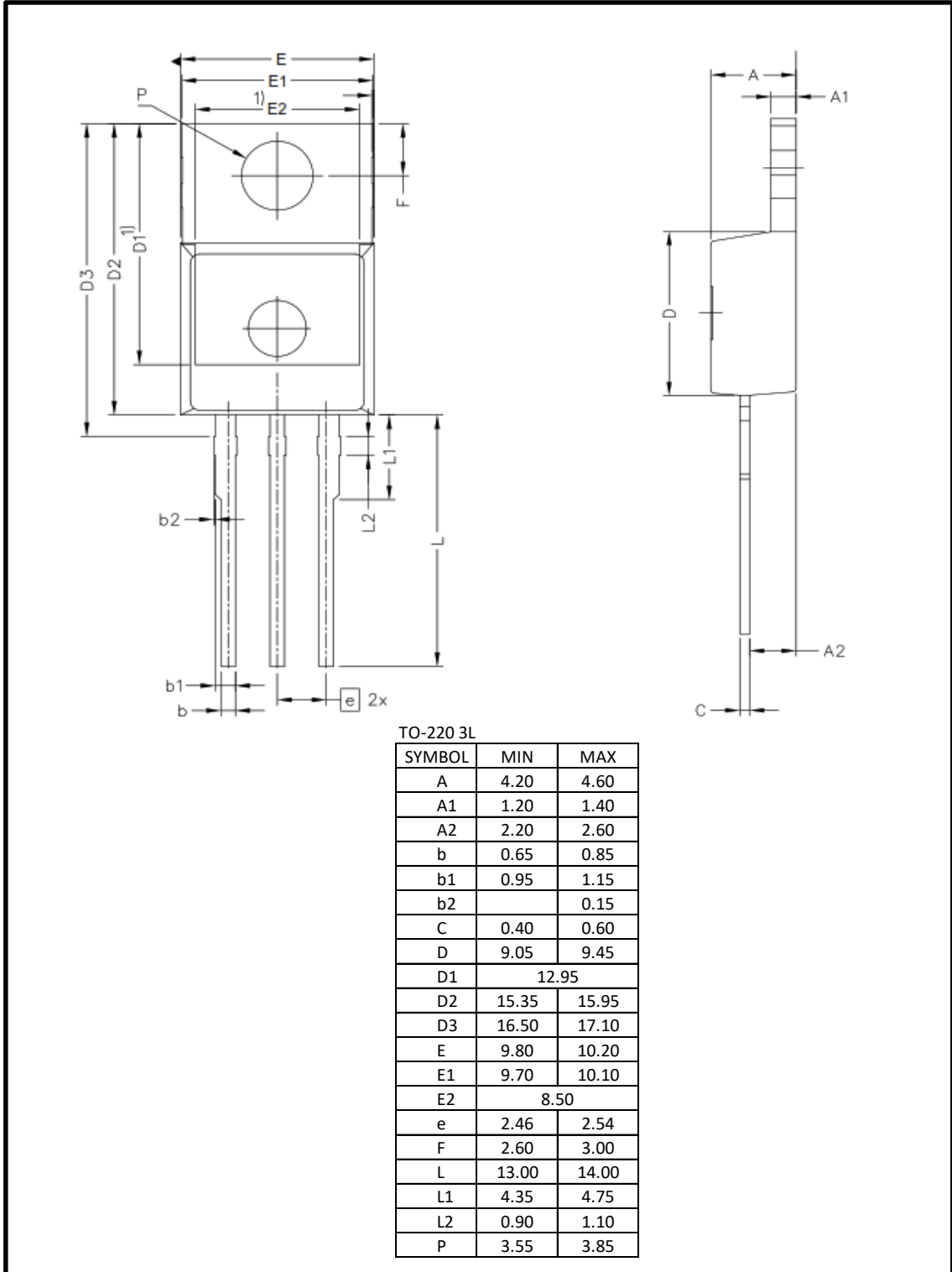
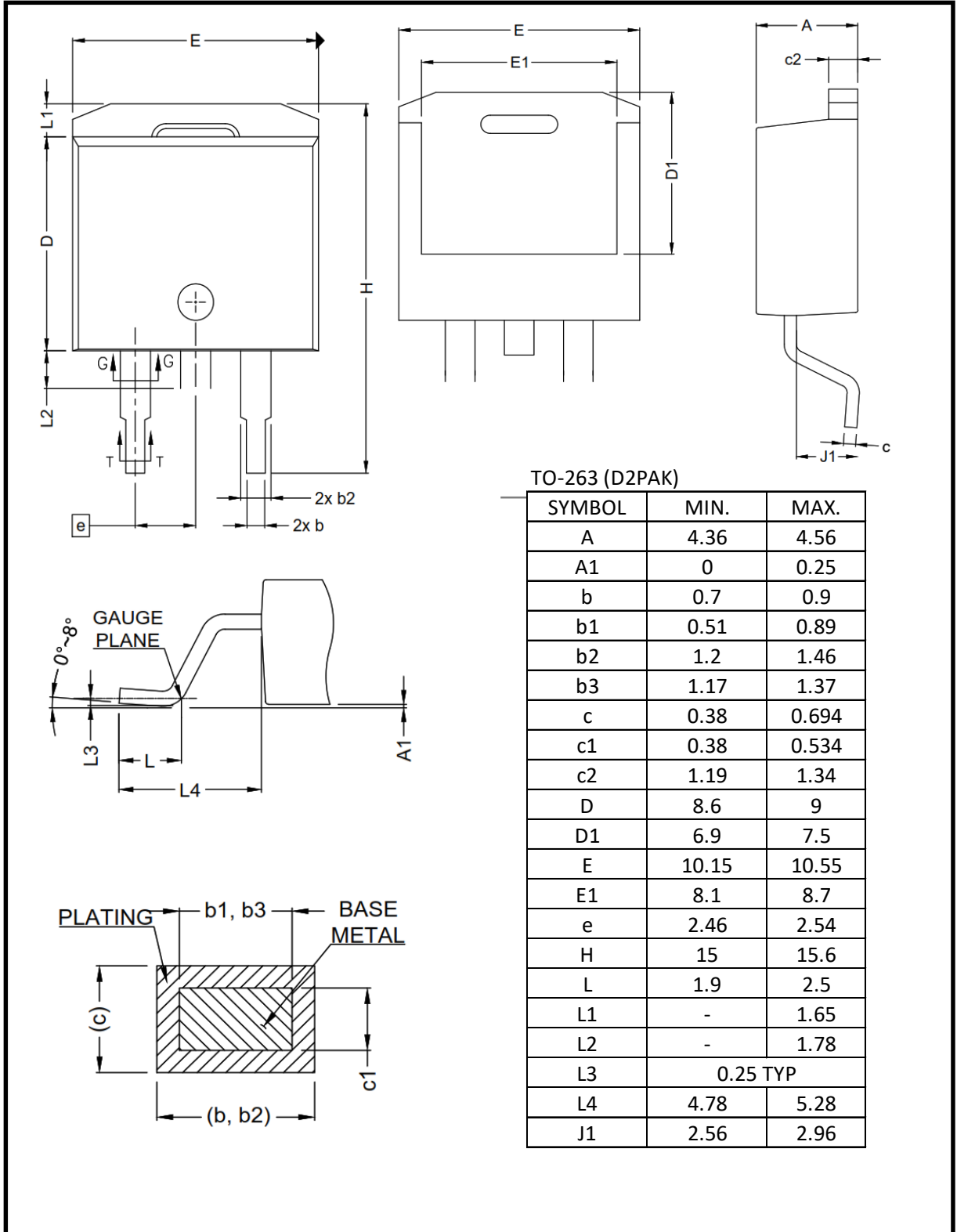
Test Circuit For Gate Charge	Test Waveform For Gate Charge
	

Table 18 Unclamped Inductive Characteristic

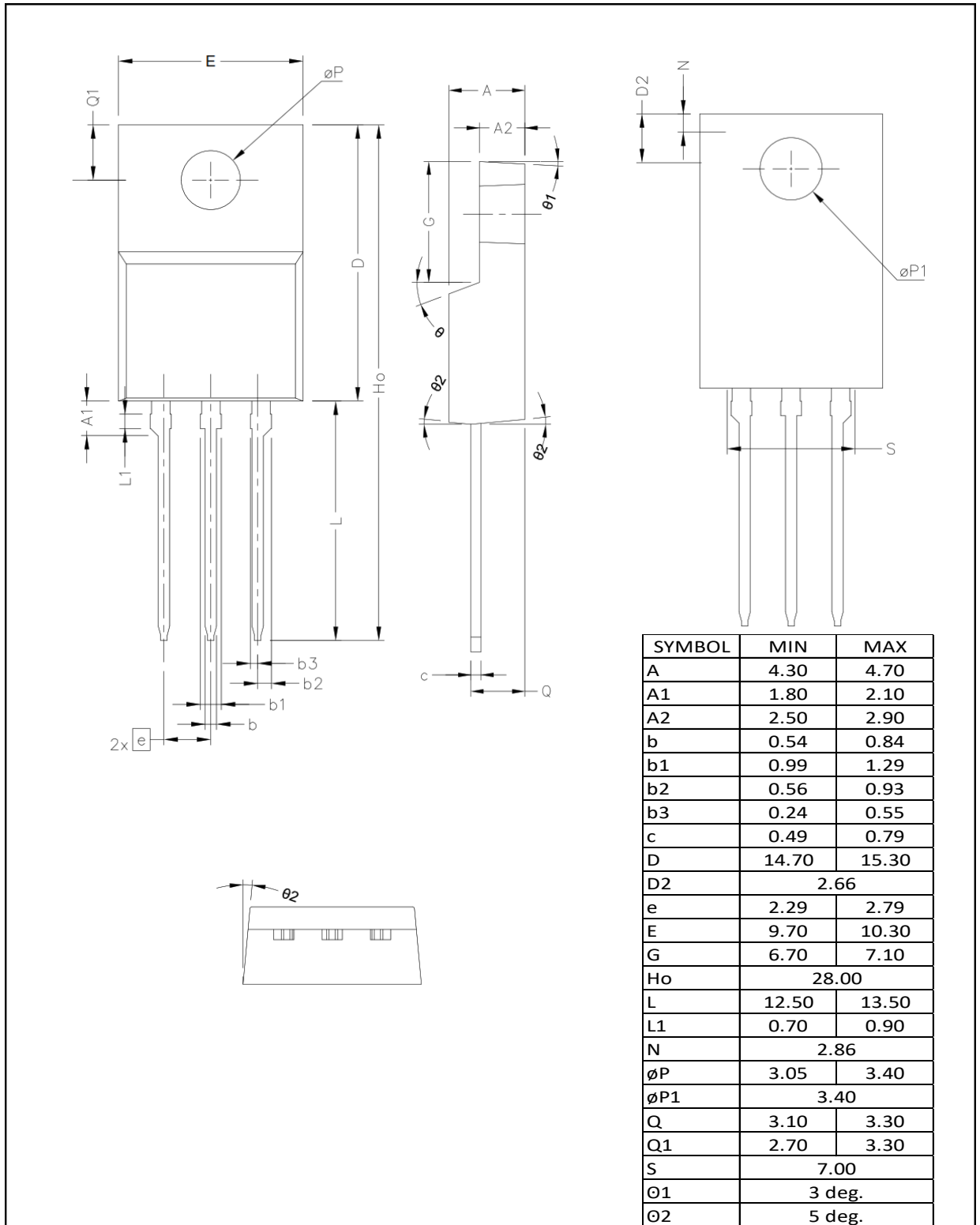
Test Circuit For Unclamped Inductive	Test Waveform For Unclamped Inductive
	 $E_{AS} = \frac{1}{2} L I_{AS}^2$

4a) TO-220


4b) TO-263



4C) TO-220 FullPak



Revision History

Revision	Release Date	Comments
1.0	1-Nov- 2016	Preliminary Datasheet Draft
2.0	15-June-2017	Added graphs
2.1	10-Oct-2017	Added TO220FP Package
2.7	20-Nov-2017	Updated graphs and charts
3.0	2-Jan-2019	Characterization, gen update



Resources

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