D3 SEMICONDUCTOR®
DEFINING PRECISION POWER

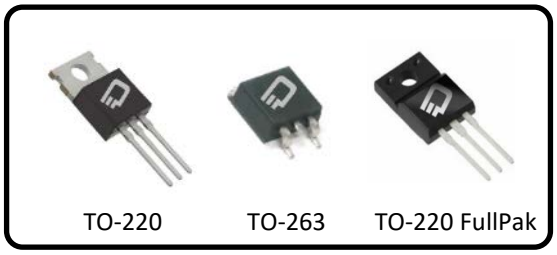
+FET™

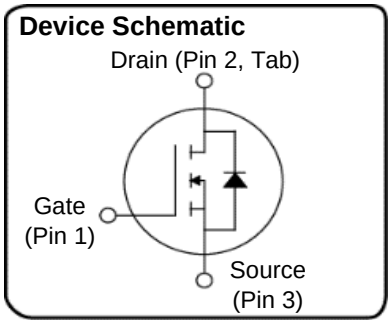
D3S190N65x

650V, 190mΩ, 15.2A N-Channel Enhancement Mode Super Junction Power MOSFET

Ordering Information

Part Number	Package Option
D3S190N65B-U	TO-220
D3S190N65E-U	TO-263
D3S190N65U-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
- HTRB, H3TRB TESTED >3000 HRS

Benefits

- LOW CONDUCTION LOSSES
- HIGH EFFICIENCY
- EXCELLENT AVALANCHE PERFORMANCE

Table 1 Key Maximum Parameters

Parameter	220/263	220FP	Unit
V_{DSS} @ T_{jmax}	710	710	V
RDS(on) max	< 190	<190	mΩ
Qg typ	28	28	nC
I_{Dmax} @ 25 ºC	25.8	13.5	A

Applications

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

Contents

1. Maximum Ratings

Table 2 Maximum Ratings

@ T_j = 25 °C, unless otherwise specified

Parameter	Symbol	Values				Unit	Condition
		Min	Typ	Max			
				220 & 263	220FP		
Continuous drain current	I_D			15.2	8	A	T_c = 25ºC
				9.6	5.1	A	T_c = 100ºC
Pulsed drain current	$I_{D, pulse}$			67	51.6	A	T_c = 25ºC
Avalanche energy, single pulse	E_{AS}			399	399	mJ	I_D = 7.2A; V_{DD} = 50V, VGS = 10V, L=10mH, RG=25 Ohms
Avalanche energy, repetitive	E_{AR}			0.60	0.4	mJ	I_D = 7.2; V_{DD} = 50V
Avalanche current, repetitive	I_{AS}			7.2	7.2	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}			113	28	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}			15.2	8	A	Tc = 25ºC
Diode pulse current	$I_{S, pulse}$			67	51.6	A	Tc = 25ºC
Reverse diode dv/dt	dv/dt			12	12	V/ns	V_{DS}=0…480V, I_{SD}<=I_S, T_j = 25ºC
Maximum diode commutation speed	di_f/dt			350	350	A/µs	V_{DS}=0…480V, I_{SD}<=I_S, T_j = 25ºC

*For TO-220 FullPak only

2. Thermal Characteristics

Table 3 Thermal Characteristics

Symbol	Parameter	Packages			Unit
		TO-220	TO-220FP	TO-263	
$R_{th\text{-}jC}$	Thermal resistance, junction-case	1.1	3.9	1.1	ºC/W
$R_{th\text{-}jA}$	Thermal resistance, junction-ambient	65	80	65	ºC/W
T_S	Soldering temperature, wave soldering only allowed at leads	260	260	260	ºC

3. Electrical Characteristics

@ T_j = 25ºC, unless otherwise specified

Table 4 Static Characteristics

Parameter	Symbol	Values			Unit	Condition
		Min	Typ	Max		
Drain-source breakdown voltage	$V_{(BR)DSS}$	650			V	I_D = 1mA, V_{GS} = 0V
Gate threshold voltage	$V_{GS(TH)}$	2.3	3	3.7	V	V_{DS} = V_{GS}, I_D = 105µA
Zero gate voltage drain current	I_{DSS}			1	µA	V_{DS} = 650V, T_C = 25ºC, V_{GS} = 0V
				50		V_{DS} = 650V, T_C = 125ºC, V_{GS} = 0V
Gate-source leakage current	I_{GSS}			100	nA	V_{GS} = ±30V, V_{DS} = 0V
Drain-source on-state resistance	$R_{DS(on)}$		0.16	0.19	Ω	V_{GS} = 10V, I_D = 8.71 A T_J = 25ºC
			0.40		Ω	V_{GS} = 10V, I_D = 8.71 A, T_J = 150ºC
Gate resistance***	R_G		1.1		Ω	

Table 5 Dynamic Characteristics

Parameter	Symbol	Values			Unit	Condition
		Min	Typ	Max		
Input capacitance	C_{iss}		1360		pF	V_{DS} = 100V, f = 1MHz, V_{GS} = 0V
Output capacitance	C_{oss}		47		pF	
Reverse transfer capacitance	C_{rss}		9.2		pF	
Turn-on delay time	$t_{d(on)}$		9		ns	V_{DD} = 400V, I_D = 6.7A R_G = 3.4Ω, V_{GS} = 13V, di/dt=100A/µs
Rise time	t_r		8		ns	
Turn-off delay time	$t_{d(off)}$		57		ns	
Fall time	t_f		21		ns	

Table 6 Gate Charge Characteristics

Parameter	Symbol	Values			Unit	Condition
		Min	Typ	Max		
Gate to source charge	Q_{gs}		1.2		nC	V_{DD} = 480V, I_D = 6.7A V_{GS} = 0 to 10V
Gate to drain charge	Q_{gd}		12.5		nC	
Gate charge total	Q_g		28.0		nC	
Gate plateau voltage	$V_{plateau}$		5		V	

Table 7 Reverse Diode Characteristics

Parameter	Symbol	Values				Unit	Condition
		Min	Typ	Max			
				220 & 263	220FP		
Diode source-drain current	I_{SD}			15.2	8	A	
Diode forward voltage	V_{fd}		0.9	1.2		V	I_{SD} = 15.2, V_{GS} = 0V, T_J = 25ºC
Reverse recovery time	t_{rr}		225			ns	I_F = 6.7A, V_{GS} = 13V L = 500µH di/dt = 100A/µS V_{DD} = 400V, T_J = 25ºC
Reverse recovery charge	Q_{rr}		1.9			µC	
Peak reverse recovery current	I_{rrm}		16.6		8.3	A	

4. Electrical Characteristics Graphs

Table 8 Thermal Performance TO220 & TO247

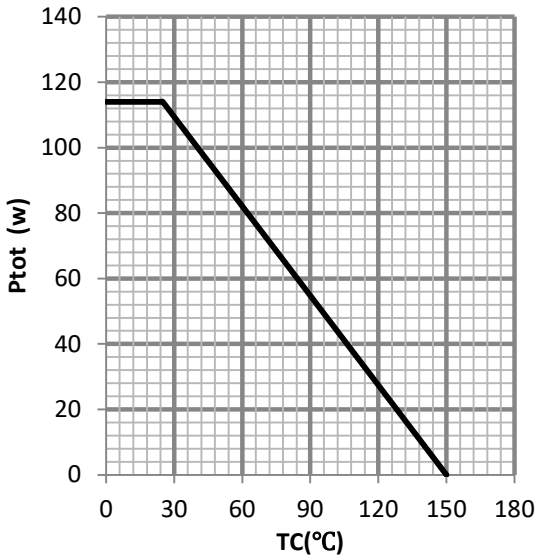
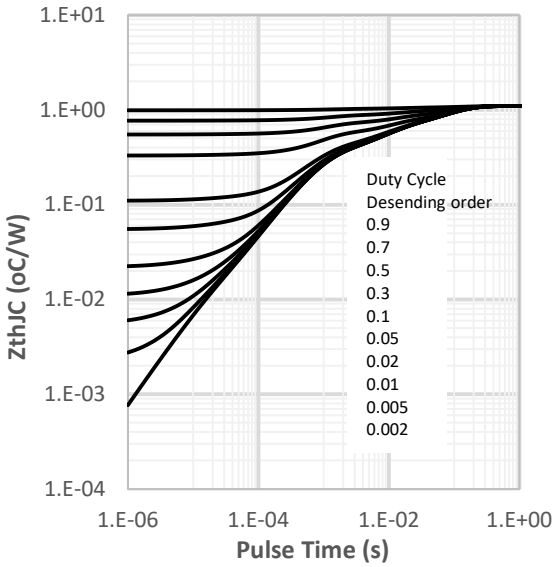
Power Dissipation Non-Isolated T0220 & TO247	Maximum Transient Thermal Impedance
	
Max power limited by case temperature	Variable is pulse time (t_p) TO220 & TO247

Table 8 Thermal Performance TO220 FULL PAK

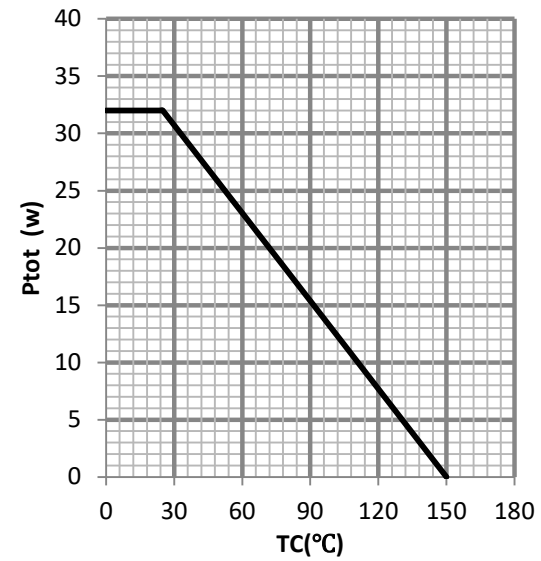
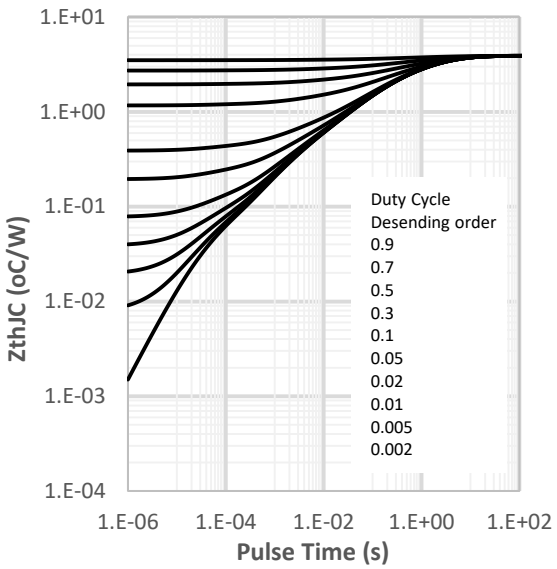
Power Dissipation Isolated T0220 Full Pak	Maximum Transient Thermal Impedance
	
Max power limited by case temperature	Variable is pulse time (t_p) TO220 Full Pak

Table 9 Output Characteristics

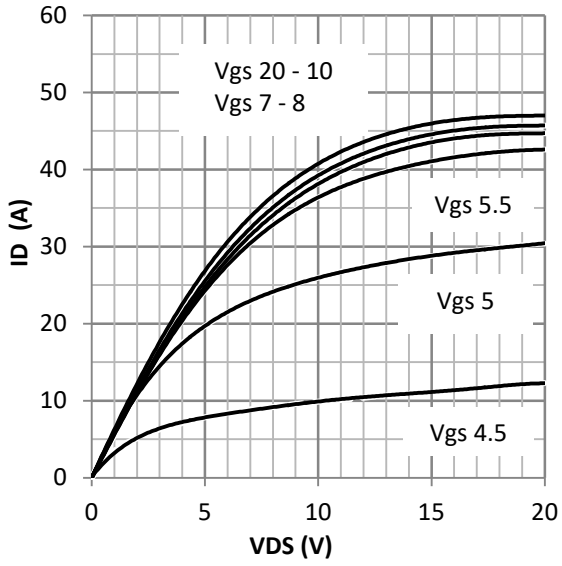
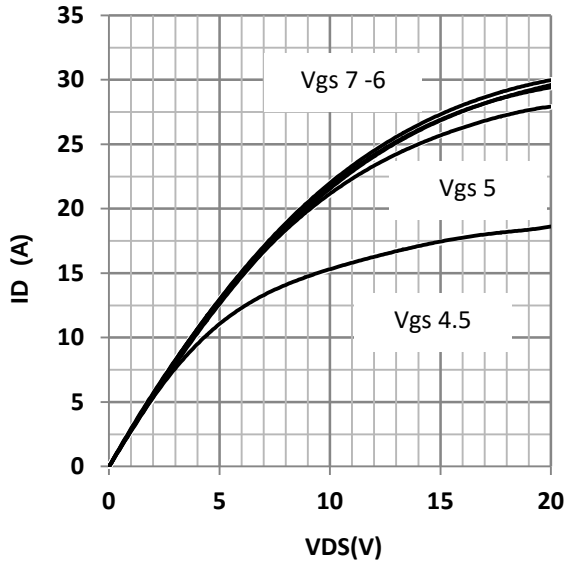
Typical Output Characteristics	Typical Output Characteristics
	
T_C = 25°C; Variable is V_{GS}	T_C = 125°C; Variable is V_{GS}

Table 10 Drain-Source Resistance

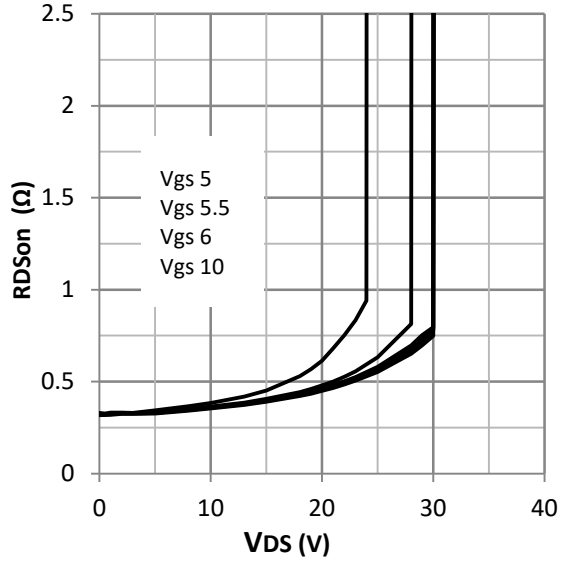
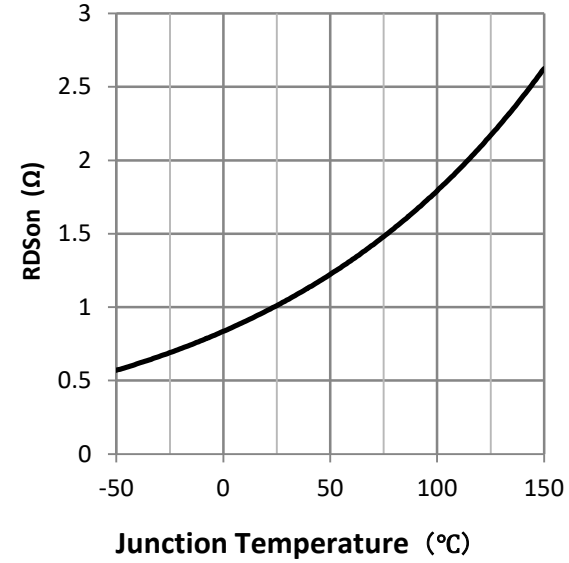
Typical Drain-Source On-State Resistance	Drain-Source On-State Resistance
	
T_j = 25°C; Variable is gate voltage (V_{GS})	I_D = 13.4A, V_{GS}=10V

Table 11 Safe Operating Area TO220 TO247

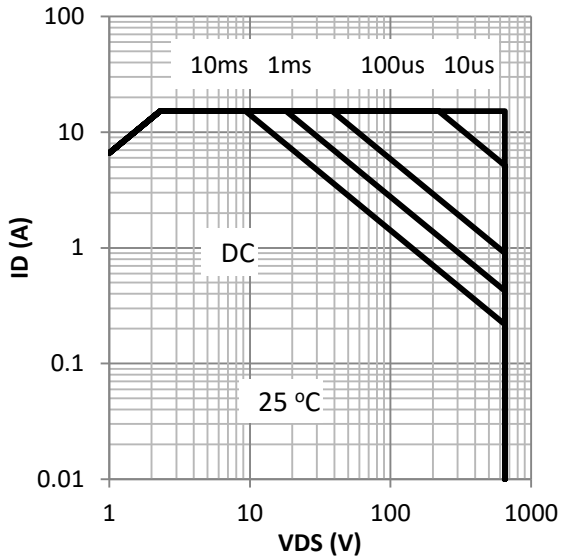
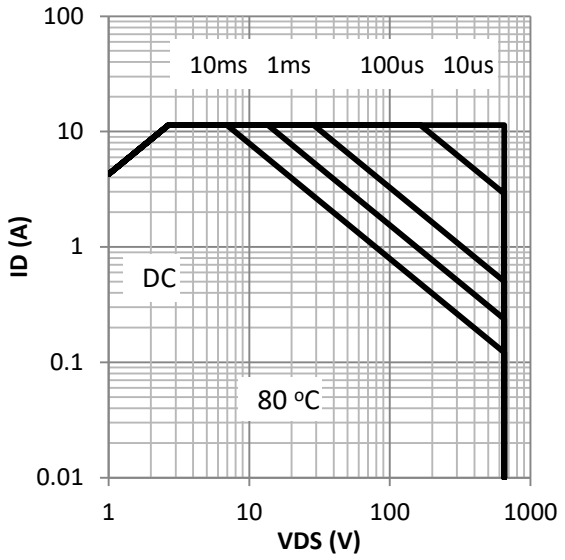
Safe Operating Area	Safe Operating Area
	
T_C = 25°C; Variable is pulse width (t_p)	T_C = 80°C; Variable is pulse width (t_p)

Table 11 Safe Operating Area TO220 FULL PAK

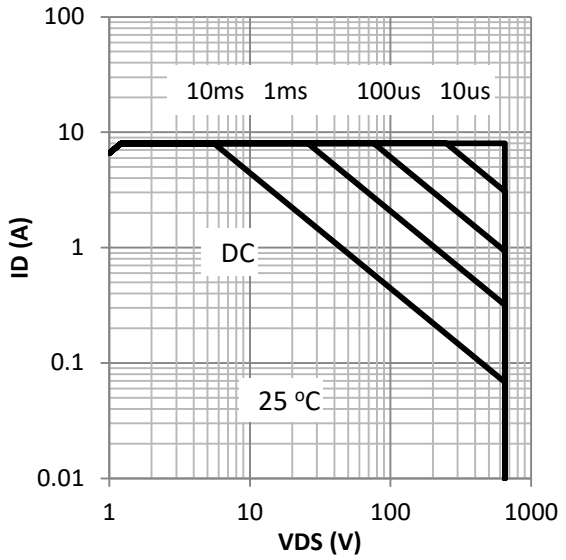
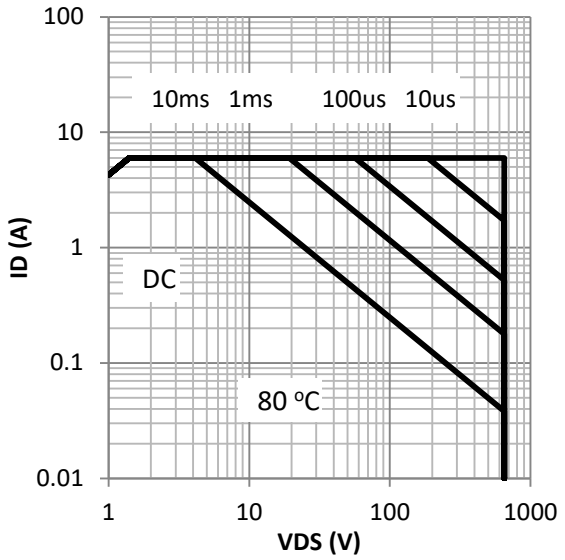
Safe Operating Area TO220 FULL PAK	Safe Operating Area TO220 FULL PAK
	
T_C = 25°C; Variable is pulse width (t_p)	T_C = 80°C; Variable is pulse width (t_p)

Table 12 Typical Capacitances and Gate Charge

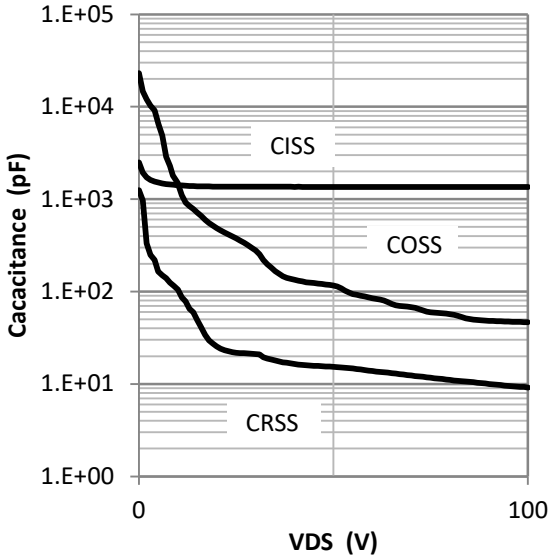
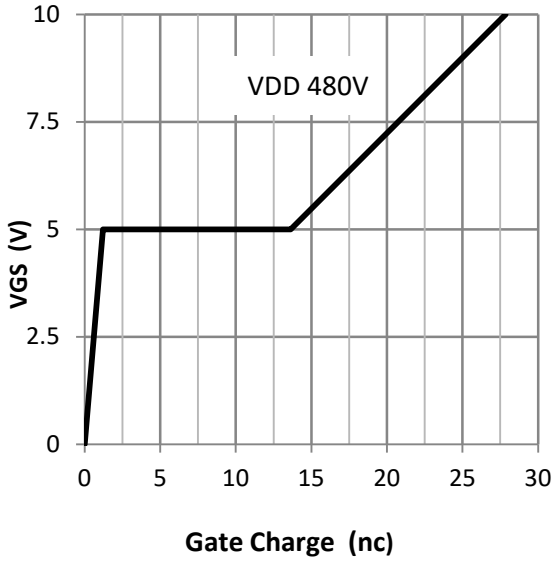
Typical Capacitances	Typical Gate Charge
	
V_{GS} = 0V; Freq. = 1MHz	I_D = 13.4A Pulsed

Table 13 Diode Forward Characteristics and Avalanche Energy

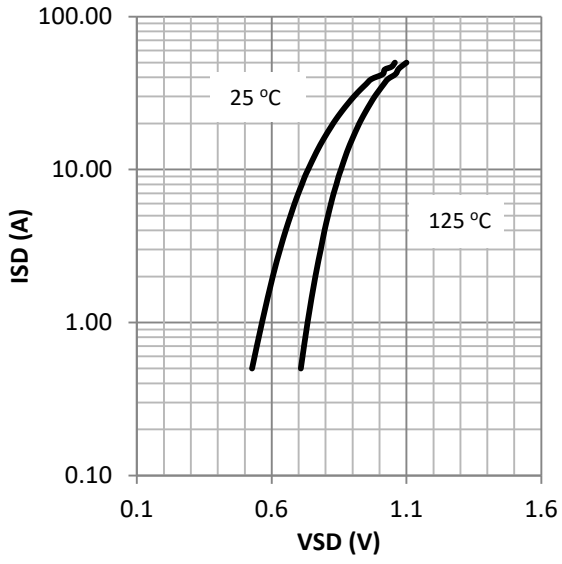
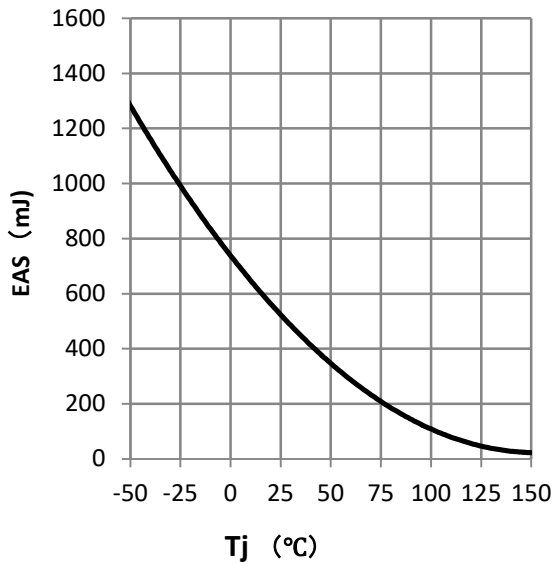
Forward Characteristics of Reverse Diode	Avalanche Energy
	
Pulsed Current	L = 80mH, 50Vdd, 10Vgs

Table 14 Drain-Source Breakdown Voltage and Typical Transfer Characteristics

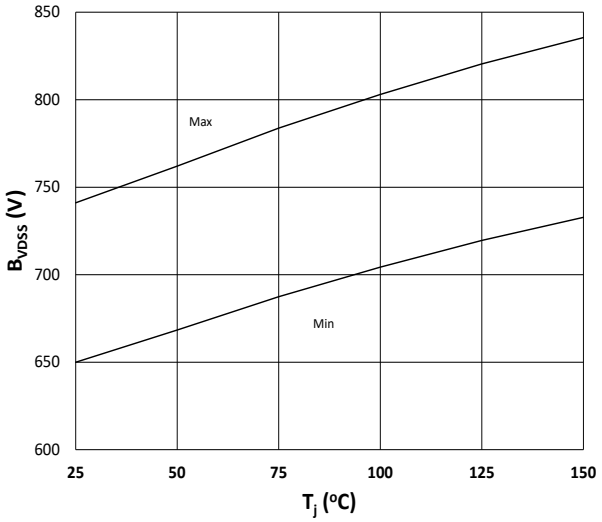
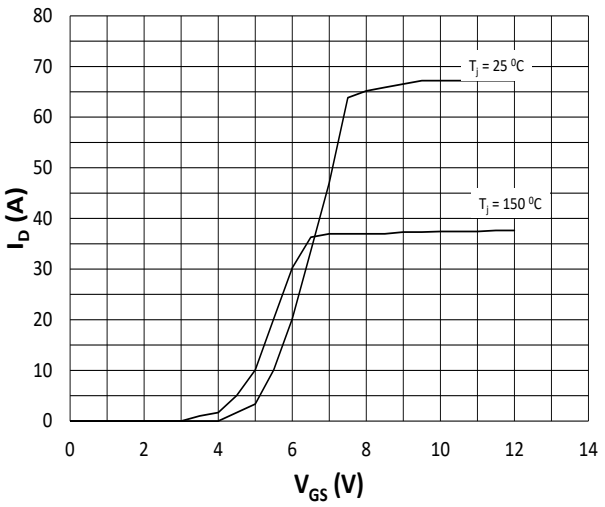
Drain-Source Breakdown Voltage	Typical Transfer Characteristics
	
I_D = 250µA	V_{DS}=20V

Table 15 Drain-Source Breakdown Voltage

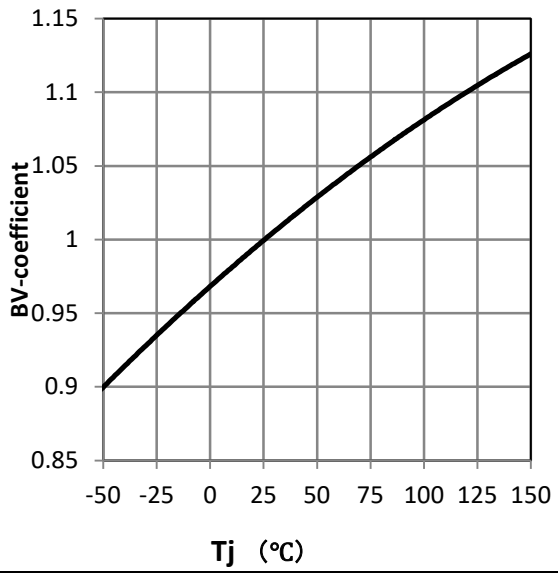
	
I_D = 250µA	

Table 15 Diode Recovery Characteristics

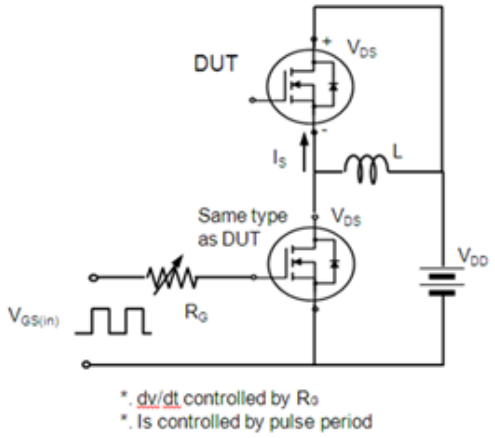
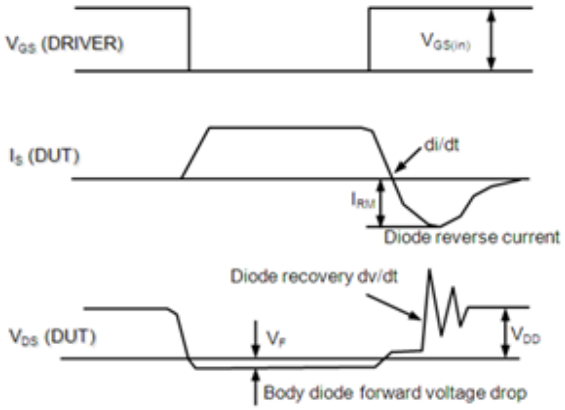
Test Circuit for Diode Recovery	Test Waveform for Diode Recovery
	

Table 16 Switching Time Characteristics

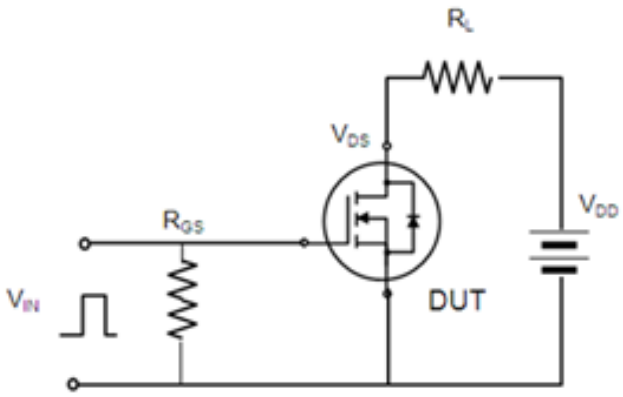
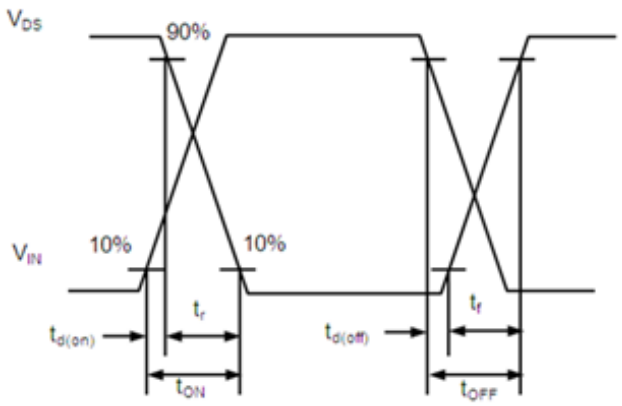
Test Circuit for Switching Time	Test Waveform for Switching Time
	

Table 17 Gate Charge Characteristics

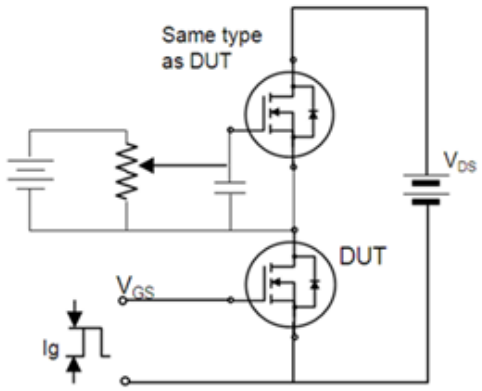
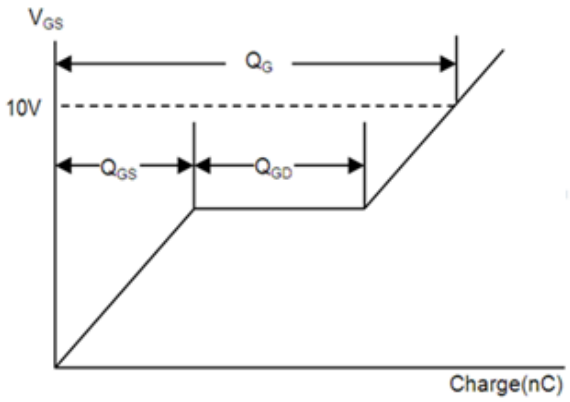
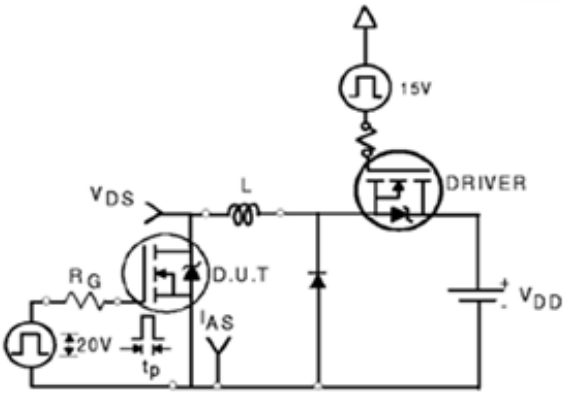
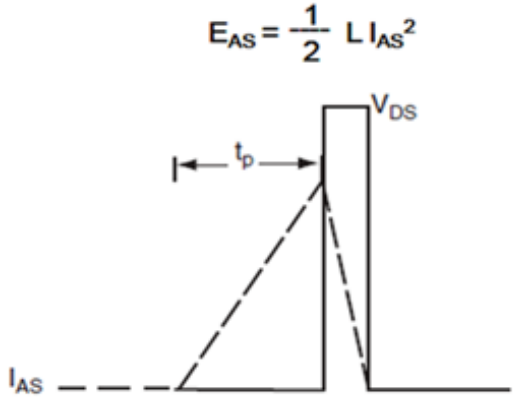
Test Circuit for Gate Charge	Test Waveform for Gate Charge
	

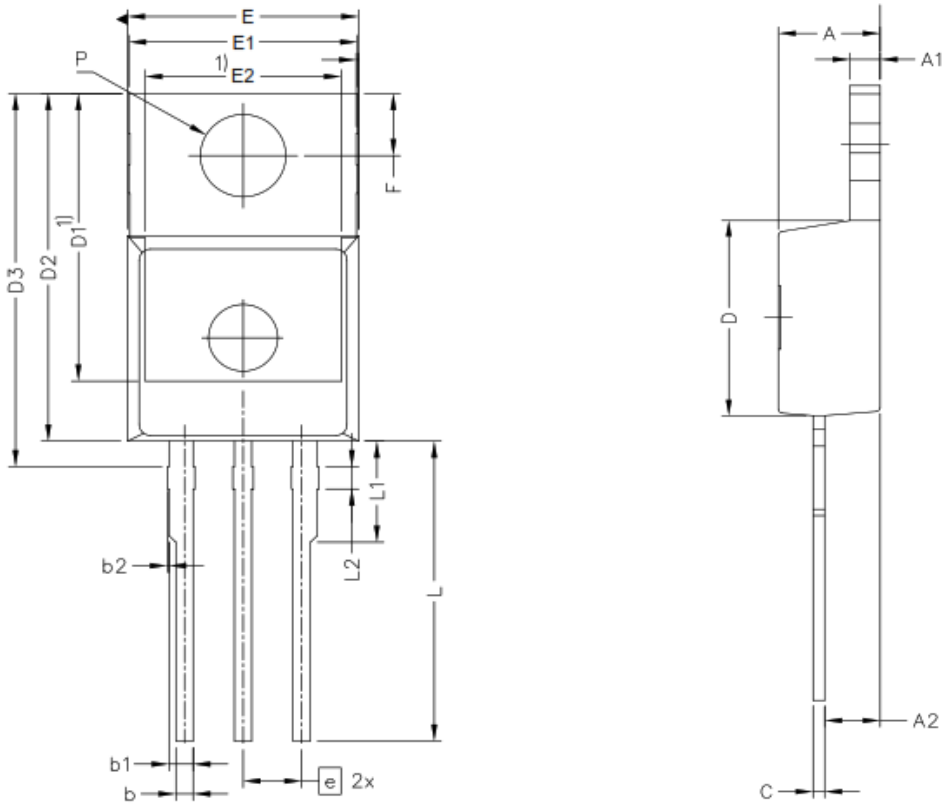
Table 18 Unclamped Inductive Switching Characteristic

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

5. Package Outlines

4a) TO-220

D3 Semiconductor TO-220-3L

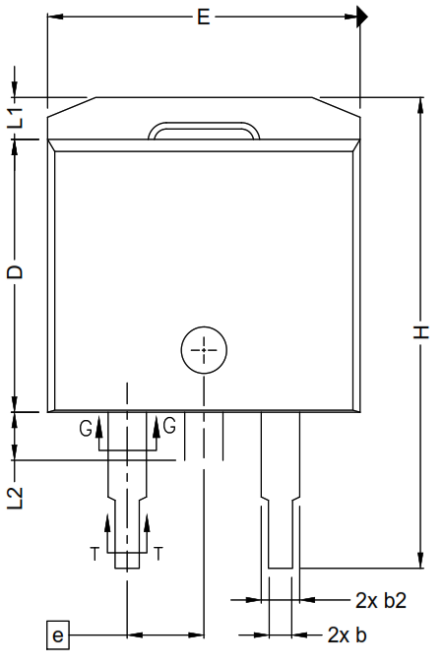


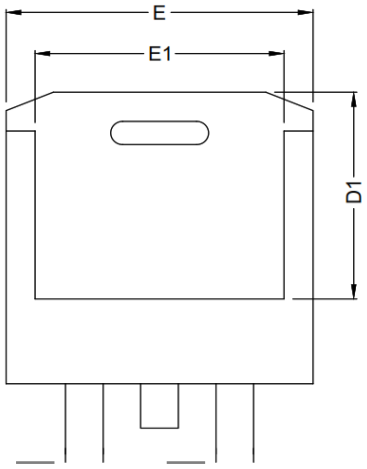
TO-220 3L

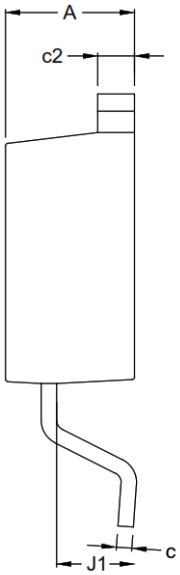
SYMBOL	MIN	MAX
A	4.20	4.60
A1	1.20	1.40
A2	2.20	2.60
b	0.65	0.85
b1	0.95	1.15
b2		0.15
C	0.40	0.60
D	9.05	9.45
D1	12.95	
D2	15.35	15.95
D3	16.50	17.10
E	9.80	10.20
E1	9.70	10.10
E2	8.50	
e	2.46	2.54
F	2.60	3.00
L	13.00	14.00
L1	4.35	4.75
L2	0.90	1.10
P	3.55	3.85

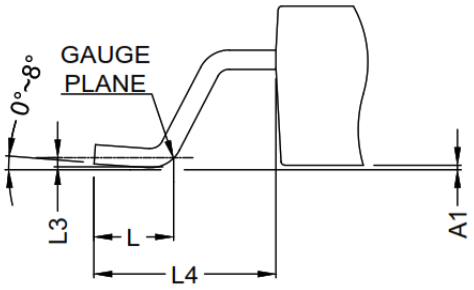
4b) TO-263

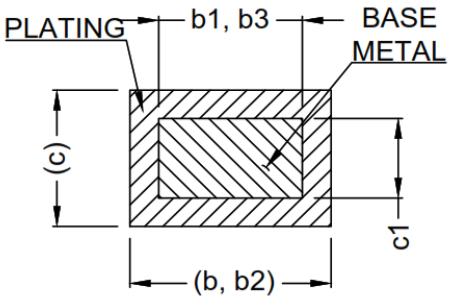
D3 Semiconductor TO-263 (D2PAK)









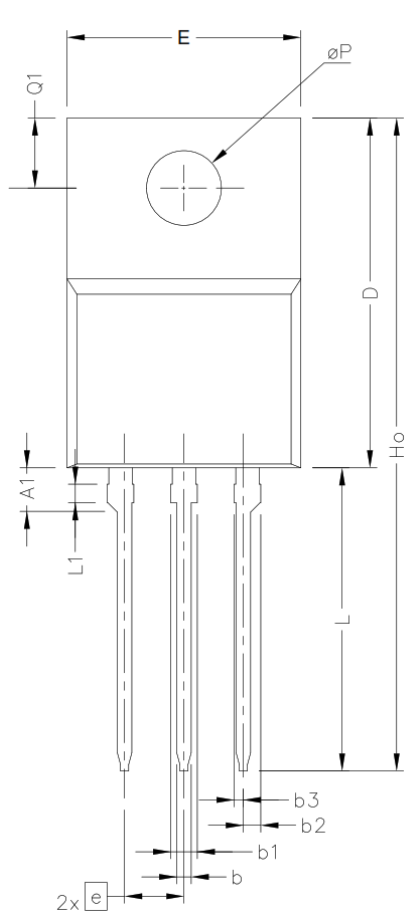


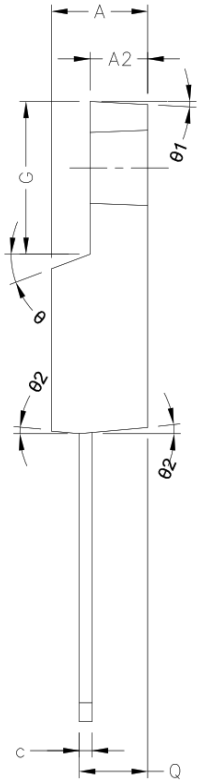
TO-263 (D2PAK)

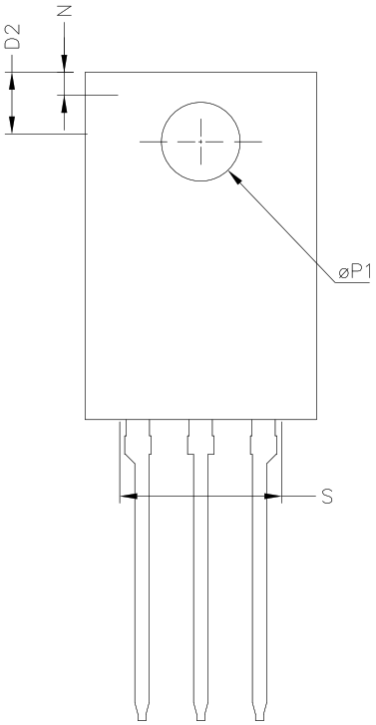
SYMBOL	MIN.	MAX.
A	4.36	4.56
A1	0	0.25
b	0.7	0.9
b1	0.51	0.89
b2	1.2	1.46
b3	1.17	1.37
c	0.38	0.694
c1	0.38	0.534
c2	1.19	1.34
D	8.6	9
D1	6.9	7.5
E	10.15	10.55
E1	8.1	8.7
e	2.46	2.54
H	15	15.6
L	1.9	2.5
L1	-	1.65
L2	-	1.78
L3	0.25 TYP	
L4	4.78	5.28
J1	2.56	2.96

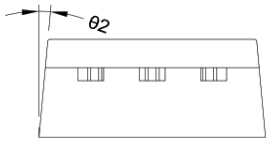
4c) TO-220 FullPak

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.	

6. Revision History

Revision	Release Date	Comments
1.0	1-November-2016	Preliminary Datasheet Release
2.0	15-June-2017	Added graphs and finalized info
2.1	10-Oct-2017	Added FullPak information
2.5	17-Nov-2017	Designers Data Sheet
2.7	20-Nov-2017	Designers Data Sheet Update info

7. Resources

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