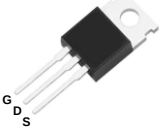


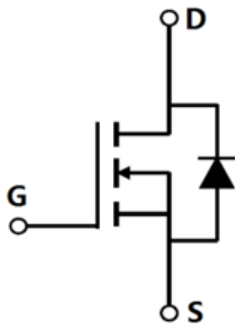
N-channel 60V, 2.3mΩ max.,240A
 SGT MOSFET S2 in TO-220,TO-263 and TO-247

Datasheet - production data

1. Descriptions

TO-220	TO-263	TO-247
		

Schematic Diagram



Key Performance Parameters

Parameters	Value	Unit
BV_{DSS}	60	V
$R_{DS(on),max}$	2.2	mΩ
$Q_{g,typ}$	118	nC
$I_{D,pulse}$	840	A
E_{AS}	1024	mJ

Features

- Extremely low losses due to very low FOM $R_{dson} \cdot Q_g$.
- High-speed switching.
- Qualified for industrial grade applications according to JEDEC.
- 100% UIS Tested.

Applications

High-Efficiency DC-DC Converters, Switching Voltage Regulators and Motor Drivers.

Type/Ordering Code	Package	Marking	Related Links
CSP023N06S2	TO-220	023N06S2	See Appendix A
CSB023N06S2	TO-263		
CSW023N06S2	TO-247		

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2. Maximum Ratings

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

Table 1. Absolute Maximum Ratings

Symbol	Parameter	Values			Unit	Test Condition
		Min.	Typ.	Max.		
V_{DS}	Drain-source voltage ¹⁾	-	-	60	V	$V_{GS}=0V$, $I_D=250\mu A$
I_D	Continuous drain current	-	-	240	A	$T_C=25^\circ\text{C}$
$I_{D,pulse}$	Pulsed drain current	-	-	840	A	$T_C=25^\circ\text{C}$
E_{AS}	Avalanche energy, single pulse ²⁾	-	-	1024	mJ	$I_D=64A$; $V_{DD}=50V$
I_{AS}	Avalanche current	-	-	64	A	-
V_{GS}	Gate source voltage	-20	-	20	V	static; AC ($f>1\text{ Hz}$)
P_{tot}	Power dissipation	-	-	375	W	$T_C=25^\circ\text{C}$
T_j, T_{stg}	Operating and storage temperature	-55	-	175	$^\circ\text{C}$	-
I_S	Continuous diode forward current	-	-	240	A	$T_C=25^\circ\text{C}$
$I_{S,pulse}$	Diode pulse current ²⁾	-	-	840	A	$T_C=25^\circ\text{C}$

1) Limited by T_j max. Maximum duty cycle $D=0.75$.

2) $V_{DD}=50V$, $L=0.5mH$, $R_G=25\Omega$, Starting $T_j=25^\circ\text{C}$.

3. Thermal Characteristics

Table 2. Thermal Characteristics

Symbol	Parameter	Values			Unit	Test Condition
		Min.	Typ.	Max.		
R_{thJC}	Thermal resistance, junction - case	-	-	0.4	°C/W	$T_C = 25^{\circ}\text{C}$
R_{thJA}	Thermal resistance, junction - ambient	-	-	60	°C/W	$T_C = 25^{\circ}\text{C}$
T_{sold}	Soldering temperature, wavesoldering only allowed at leads	-	-	260	°C	Lead Temperature (Soldering, 10 sec)

4. Electrical Characteristics

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

Table 3. Static Characteristics

Symbol	Parameter	Values			Unit	Test Condition
		Min.	Typ.	Max.		
$V_{(BR)DSS}$	Drain-source breakdown voltage	60	-	-	V	$V_{GS}=0V, I_D=250\mu A$
$V_{(GS)th}$	Gate threshold voltage	1.0	1.7	2.5	V	$V_{DS}=V_{GS}, I_D=250\mu A$
I_{DSS}	Zero gate voltage drain current	-	-	1	μA	$V_{DS}=120V, V_{GS}=0V, T_j=25^\circ C$
I_{GSS}	Gate-source leakage current	-	-	± 100	nA	$V_{GS}=\pm 20V, V_{DS}=0V$
$R_{DS(on)}$	Drain-source on-state resistance(TO-263)	-	1.7	2.3	m Ω	$V_{GS}=10V, I_D=20A, T_j=25^\circ C$
	Drain-source on-state resistance(TO-220)	-	1.9			
	Drain-source on-state resistance(TO-247)	-	1.8			
R_G	Gate resistance	-	0.97	-	Ω	$V_{DD}=0V, V_{GS}=0V, F=1MHz$
g_{fs}	Transconductance	-	161	-	S	$V_{DS}=5V, I_D=20A$

Table 4. Dynamic Characteristics

Symbol	Parameter	Values			Unit	Test Condition
		Min.	Typ.	Max.		
C_{iss}	Input capacitance	-	6220	-	pF	$V_{GS}=0V, V_{DS}=25V, f=250kHz$
C_{oss}	Output capacitance	-	1460	-	pF	$V_{GS}=0V, V_{DS}=25V, f=250kHz$
C_{rss}	Reverse transfer capacitance	-	54.5	-	pF	$V_{GS}=0V, V_{DS}=25V, f=250kHz$
$t_{d(on)}$	Turn-on delay time	-	18.5	-	ns	$V_{DD}=30V, V_{GS}=10V, I_D=20A, R_G=1\Omega$
t_r	Rise time	-	7	-	ns	$V_{DD}=30V, V_{GS}=10V, I_D=20A, R_G=1\Omega$
$t_{d(off)}$	Turn-off delay time	-	69.4	-	ns	$V_{DD}=30V, V_{GS}=10V, I_D=20A, R_G=1\Omega$
t_f	Fall time	-	2	-	ns	$V_{DD}=30V, V_{GS}=10V, I_D=20A, R_G=1\Omega$

Table 5. Gate Charge Characteristics

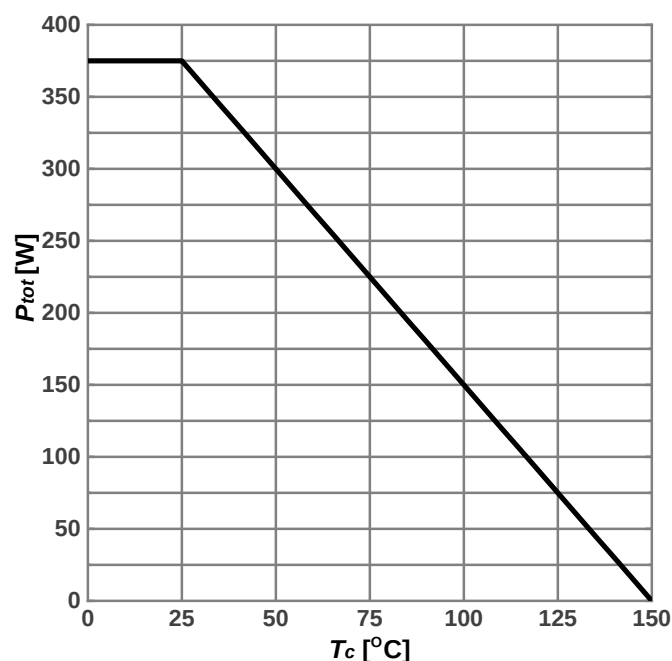
Symbol	Parameter	Values			Unit	Test Condition
		Min.	Typ.	Max.		
Q_{gs}	Gate to source charge	-	10.7	-	nC	$V_{DD}=30V, I_D=20A, V_{GS}=0 \text{ to } 10V$
Q_{gd}	Gate to drain charge	-	21.4	-	nC	$V_{DD}=30V, I_D=20A, V_{GS}=0 \text{ to } 10V$
Q_g	Gate charge total	-	118	-	nC	$V_{DD}=30V, I_D=20A, V_{GS}=0 \text{ to } 10V$
$V_{plateau}$	Gate plateau voltage	-	2.1	-	V	$V_{DD}=30V, I_D=20A, V_{GS}=0 \text{ to } 10V$

Table 6. Reverse Diode Characteristics

Symbol	Parameter	Values			Unit	Test Condition
		Min.	Typ.	Max.		
V_{SD}	Diode forward voltage	-	0.75	1.2	V	$V_{GS}=0V, I_F=20A, T_f=25^\circ C$
t_{rr}	Reverse recovery time	-	46.5	-	ns	$V_R=30V, I_F=20A, di_F/dt=100A/\mu s$
Q_{rr}	Reverse recovery charge	-	61.92	-	nC	$V_R=30V, I_F=20A, di_F/dt=100A/\mu s$
I_{rrm}	Peak reverse recovery current	-	0.2	-	A	$V_R=30V, I_F=20A, di_F/dt=100A/\mu s$

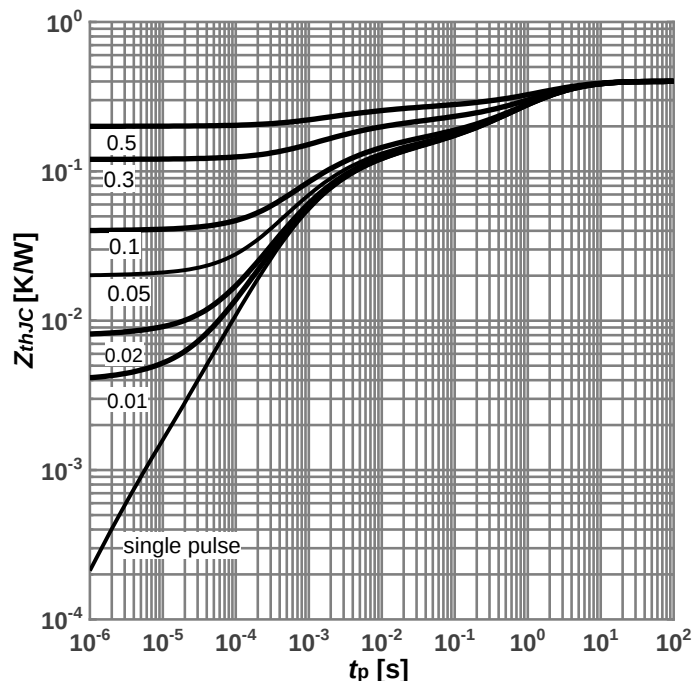
5. Electrical Characteristics Diagrams

Diagram 1: Power dissipation



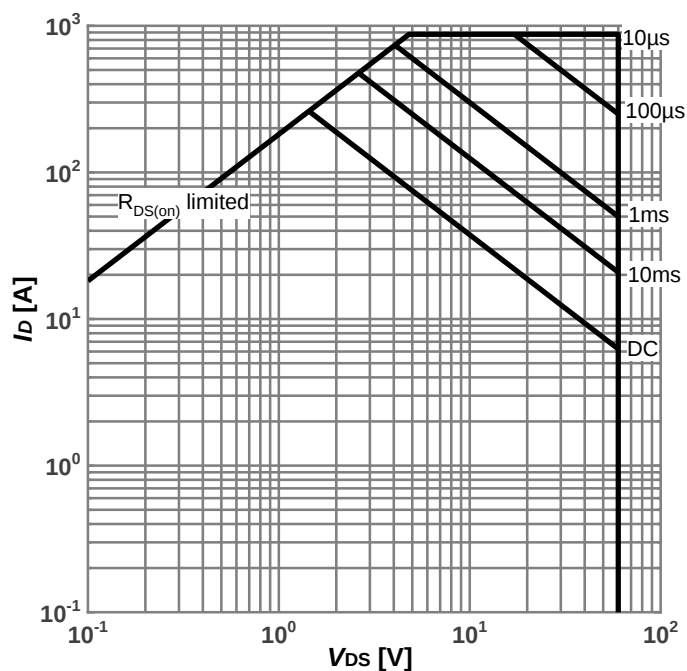
$$P_{tot}=f(T_c)$$

Diagram 2: Max. transient thermal impedance



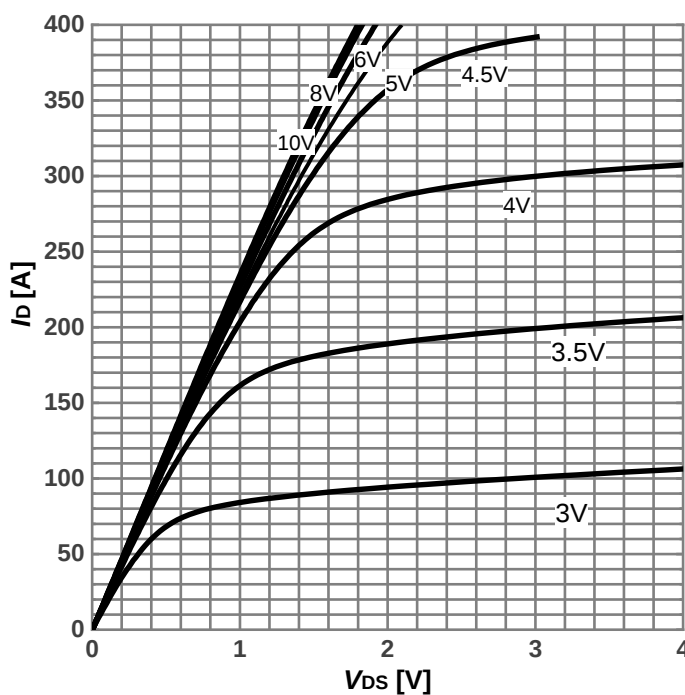
$$Z_{thJC}=f(t_p); \text{ parameter: } D= t_p/T$$

Diagram 3: Safe operating area



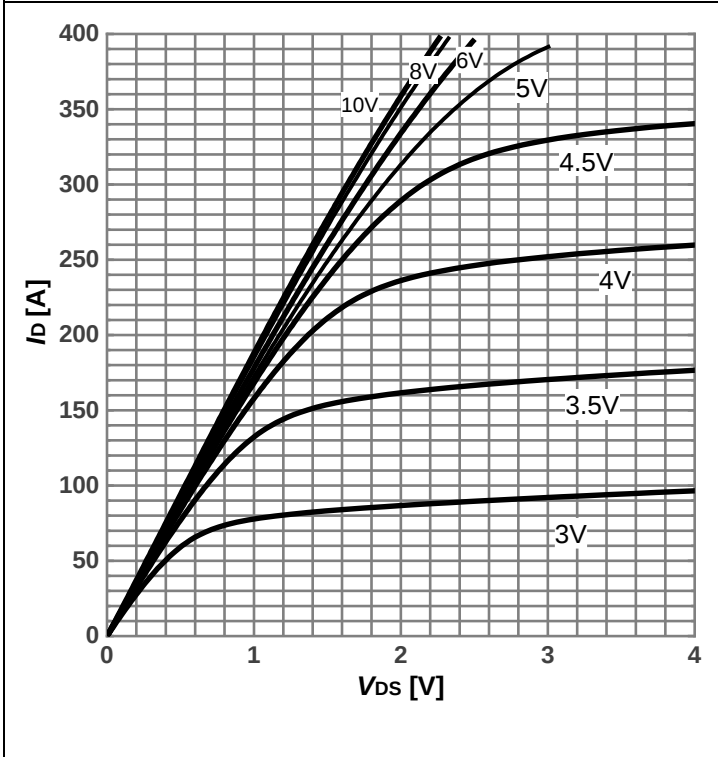
$$I_D=f(V_{DS}); T_J=25^{\circ}\text{C}; D=0; \text{ parameter: } t_p$$

Diagram 4: Typ. output characteristics



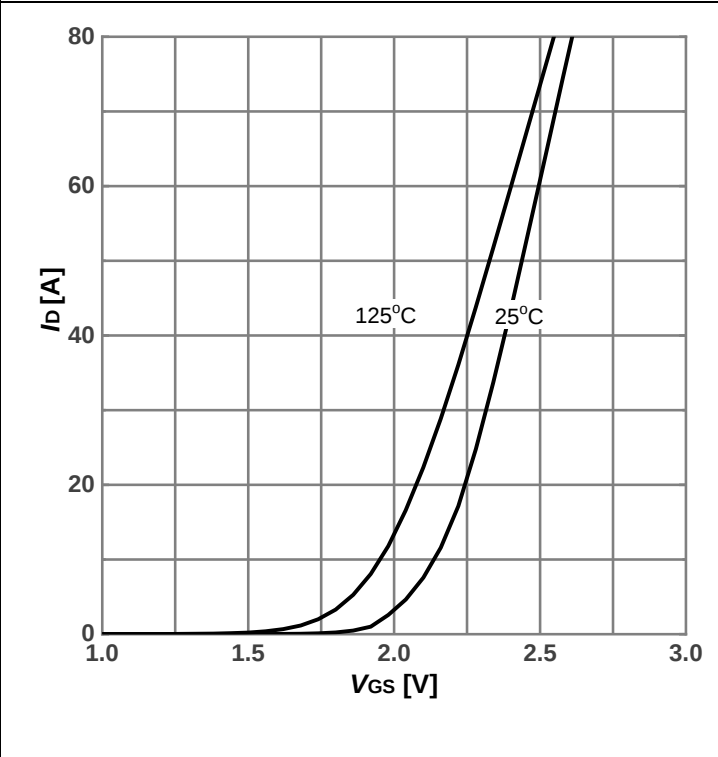
$$I_D=f(V_{DS}); T_J=25^{\circ}\text{C}; \text{ parameter: } V_{GS}$$

Diagram 5: Typ. output characteristics



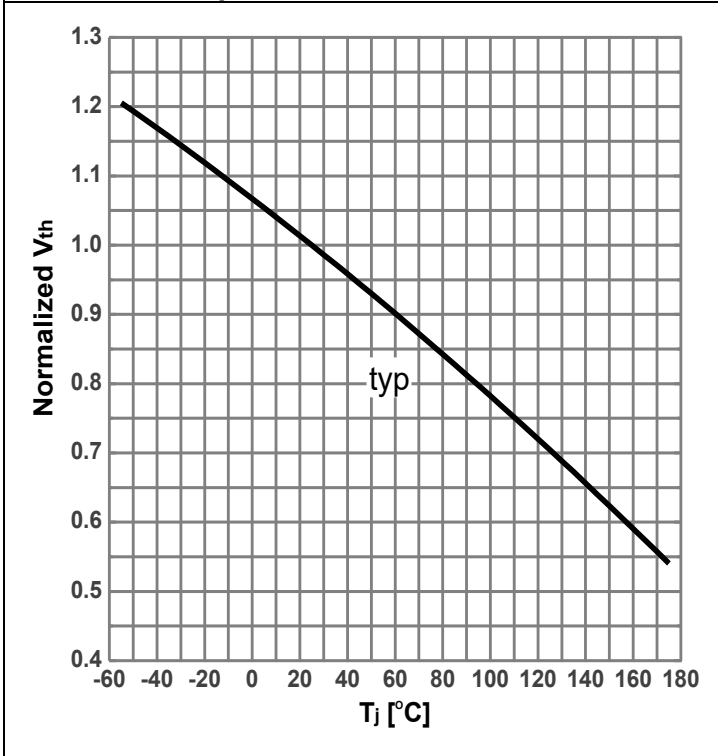
$I_D=f(V_{DS})$; $T_J=125^{\circ}\text{C}$; parameter: V_{GS}

Diagram 6: Typ. transfer characteristics



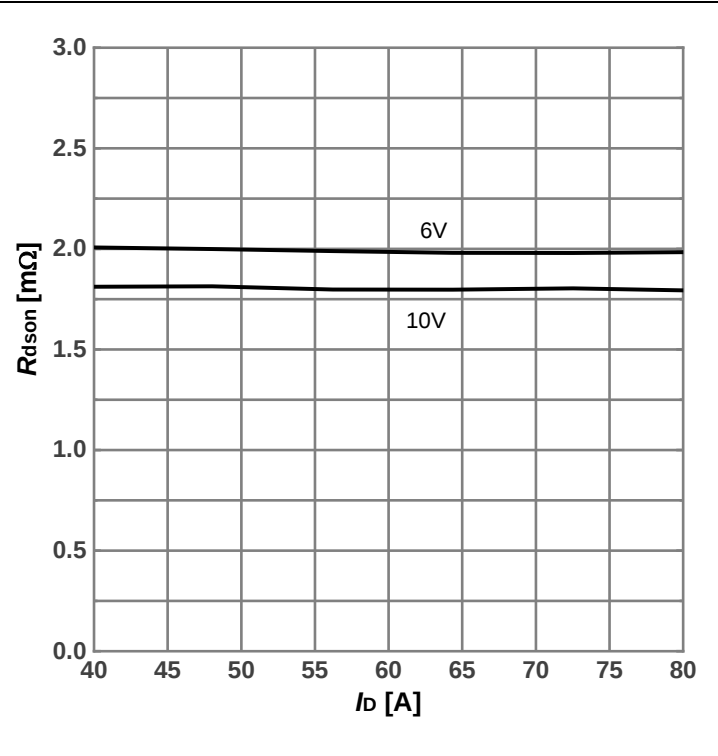
$I_D=f(V_{GS})$; $V_{DS}=5\text{V}$; parameter: T_J

Diagram 7: Gate threshold voltage vs. Junction temperature



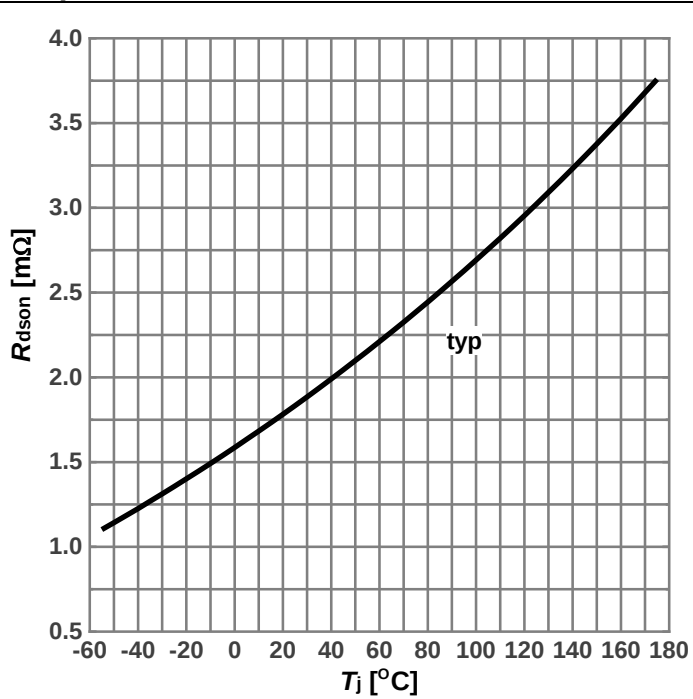
$V_{th}=f(T_J)$; $I_D=250\mu\text{A}$

Diagram 8: On-state resistance vs. Drain current



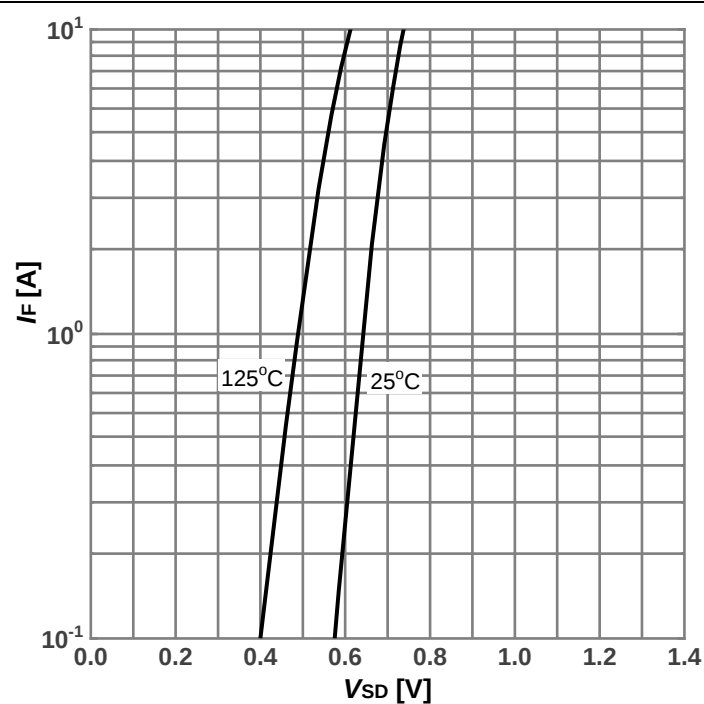
$R_{DS(on)}=f(I_D)$; $T_J=25^{\circ}\text{C}$; parameter: V_{GS}

Diagram 9: On-state resistance vs. Junction temperature



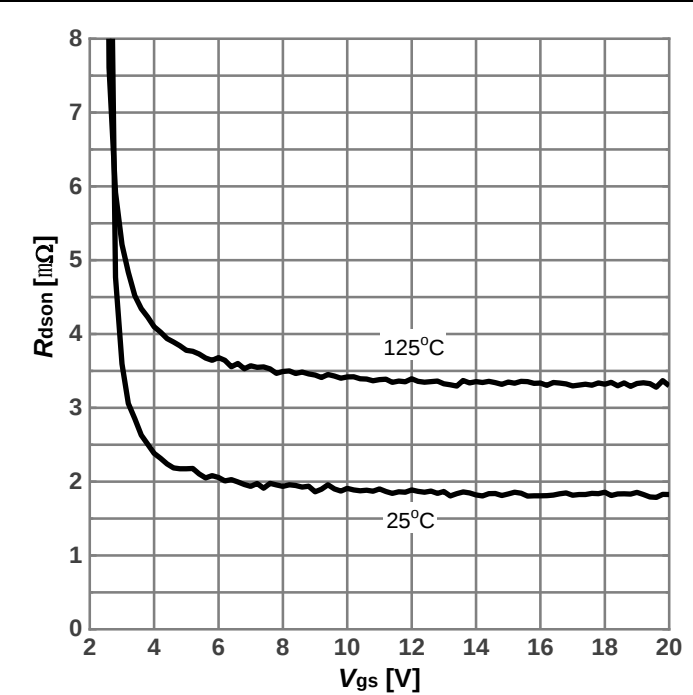
$R_{DS(on)}=f(T_j)$; $I_D=20A$; $V_{GS}=10V$

Diagram 10: Forward characteristics of reverse diode



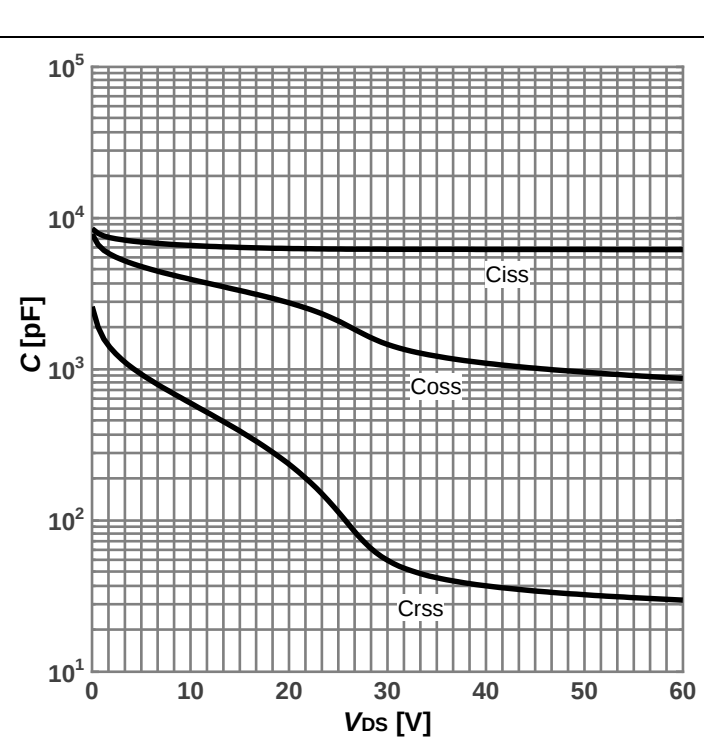
$I_F=f(V_{SD})$; parameter: T_j

Diagram 11: On-state resistance vs. Vgs characteristics

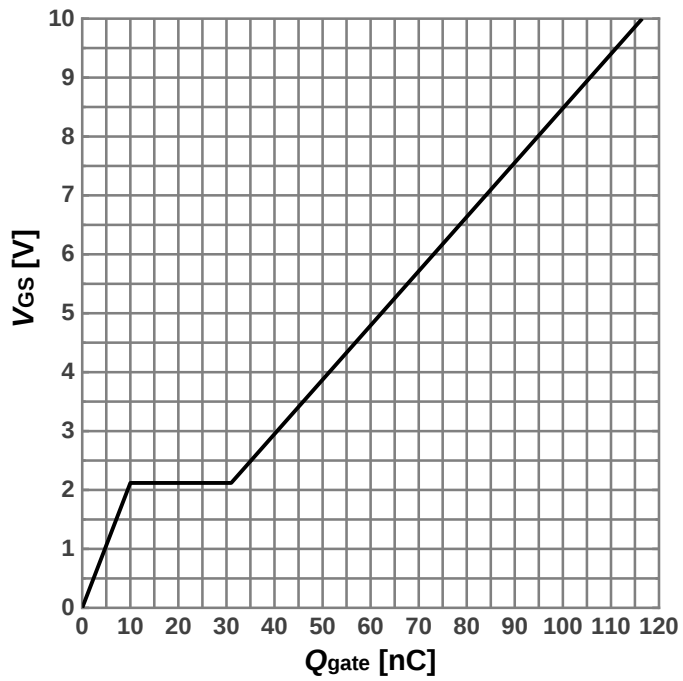


$R_{DS(on)}=f(V_{GS})$; $T_j=25^{\circ}C$; $I_D=20A$

Diagram 12: Typ. capacitances



$C=f(V_{DS})$; $V_{GS}=0V$; $f=250kHz$

Diagram 13: Typ. gate charge

$V_{GS}=f(Q_{gate})$; $I_D=20A$ pulsed; $V_{DS}=30V$

6. Test Circuits

Table 7. Diode Characteristics

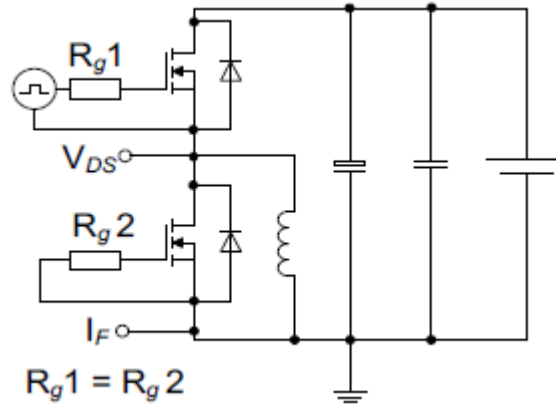
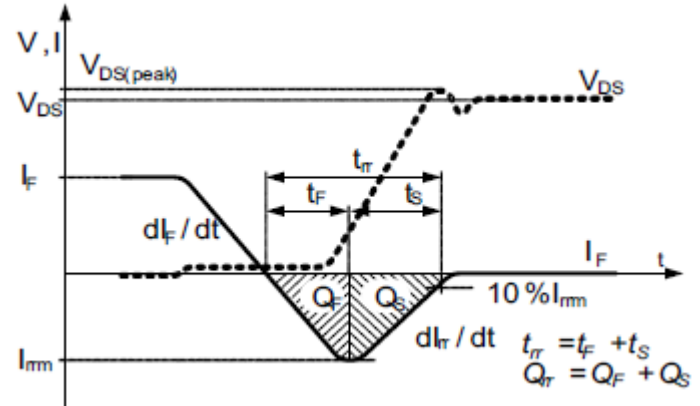
Test circuit for diode characteristics	Diode recovery waveform
	

Table 8. Switching Times

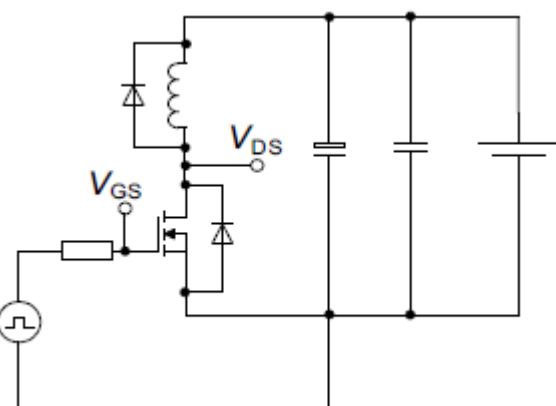
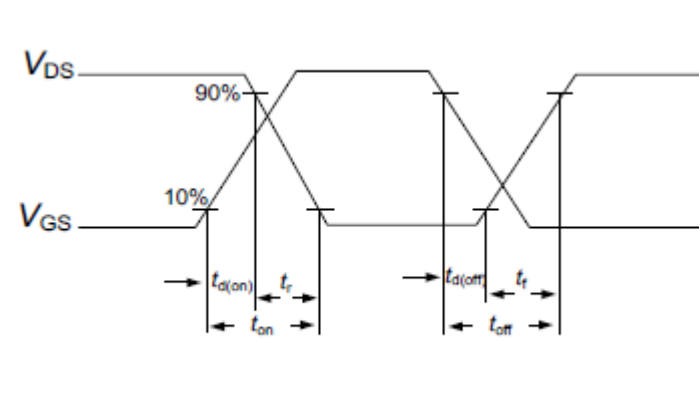
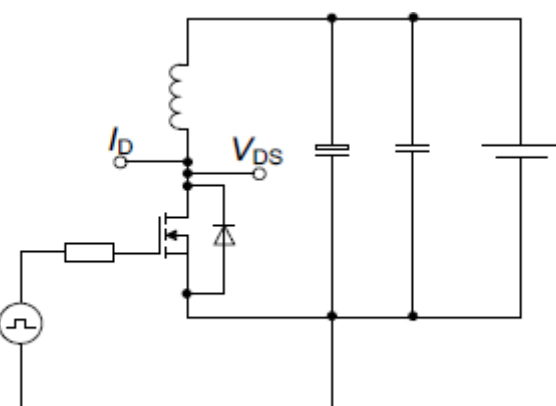
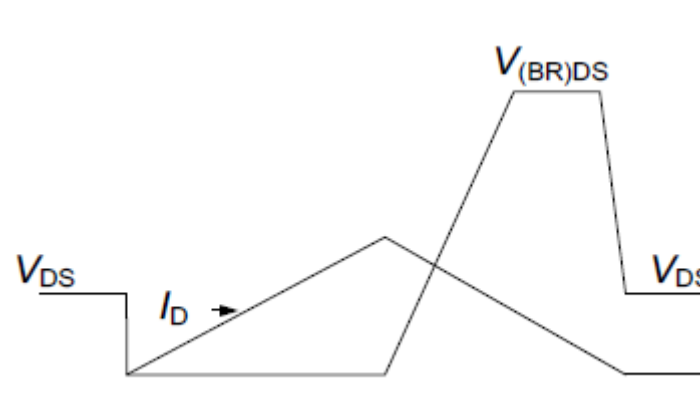
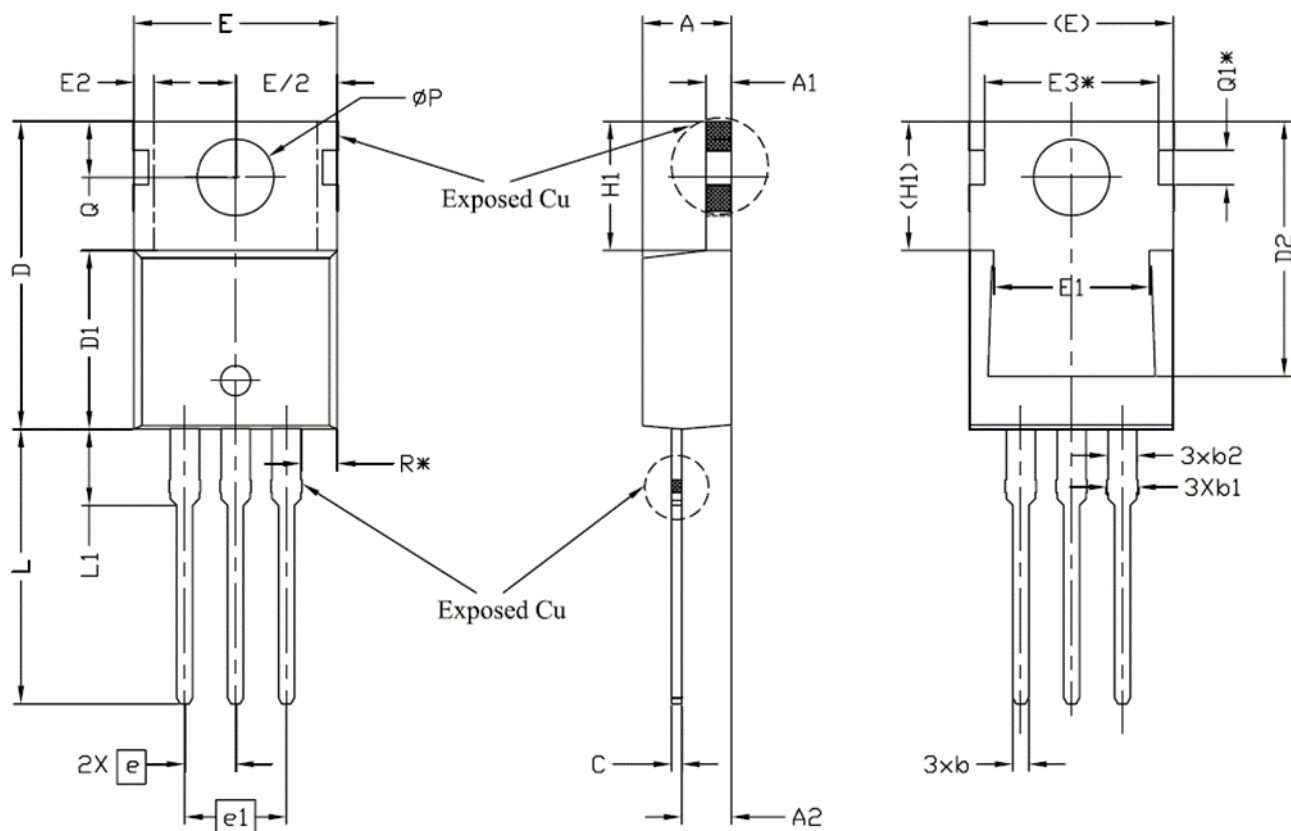
Switching times test circuit for inductive load	Switching times waveform
	

Table 9. Unclamped Inductive Load

Unclamped inductive load test circuit	Unclamped inductive waveform
	

7. Package Outlines

Figure 1 Outline TO-220 Dimensions in mm



SYMBOL	DIMENSIONS			NOTES
	MIN.	NOM.	MAX.	
A	4.24	4.44	4.64	
A1	1.15	1.27	1.40	
A2	2.30	2.48	2.70	
b	0.70	0.80	0.90	
b1	1.20	1.55	1.75	
b2	1.20	1.45	1.70	
c	0.40	0.50	0.60	
D	14.70	15.37	16.00	4
D1	8.82	8.92	9.02	
D2	12.43	12.73	12.83	5
E	9.96	10.16	10.36	4,5
E1	6.86	7.77	8.89	5
E2	-	-	0.76	6
E3*	8.70REF.			
e	2.54BSC			
e1	5.08BSC			
H1	6.30	6.45	6.60	5,6
L	13.47	13.72	13.97	
L1	3.60	3.80	4.00	
ØP	3.75	3.84	3.93	
Q	2.60	2.80	3.00	
Q1*	1.73REF.			
R*	1.82REF.			

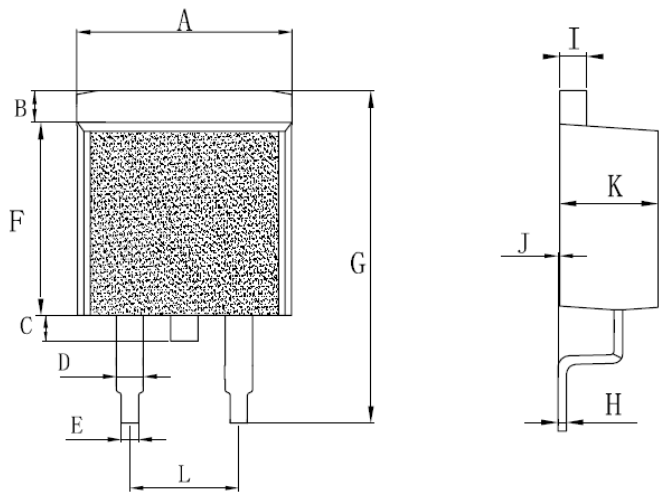
Note:

1. Package Reference: JEDEC TO220, Variation AB.
2. All Dimensions Are In mm.
3. Slot Required, Notch May Be Rounded
4. Dimension D & E Do Not Include Mold Flash. Mold Flash Shall Not Exceed 0.127mm Pre Side. These Dimensions Are Measured At The Outermost Extreme Of The Plastic Body.
5. Thermal Pad Contour Optional Within Dimensions E, H1, D2 & E1.
6. Dimension E2 & H1 Define A Zone Where Stamping And Singulation Irregularities Are Allowed.
7. "*" is reference .

Figure 2 Outline TO-263 Dimensions in mm

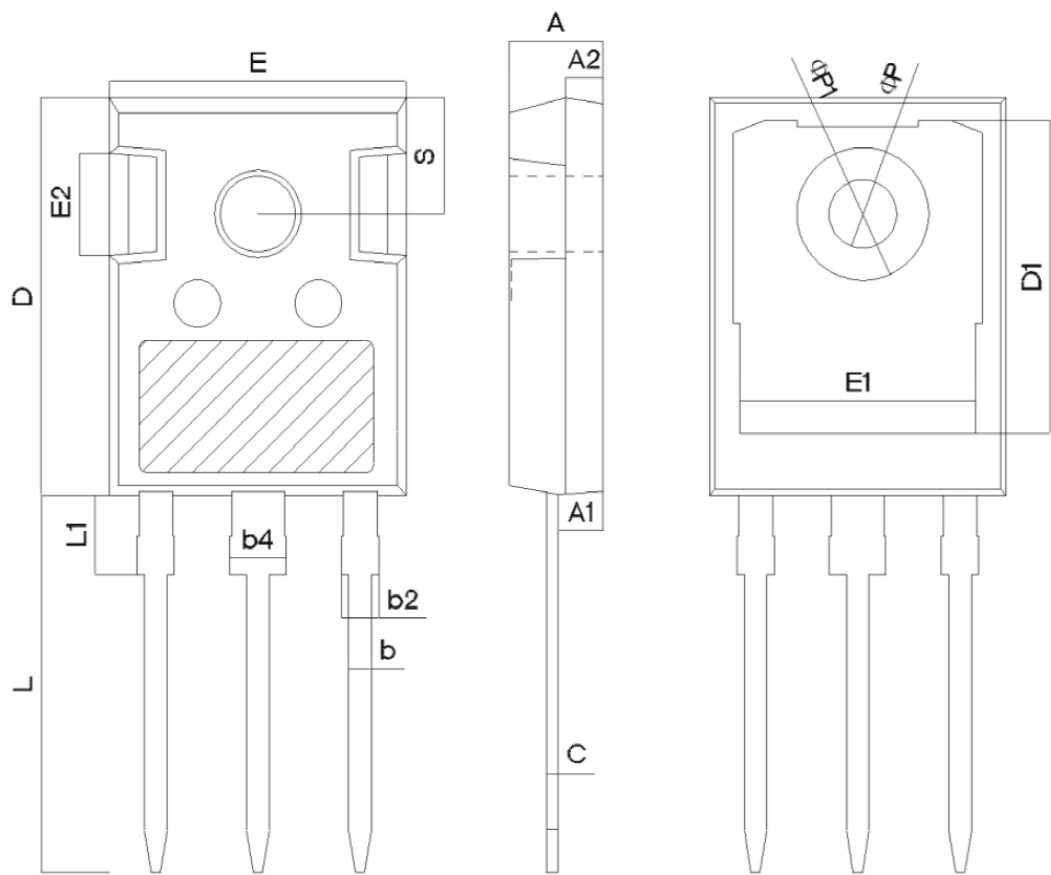
PACKAGE OUTLINE DIMENSIONS

TO-263



DIM.	Unit(mm)		Unit(inch)	
	Min	Max	Min	Max
A	9.7	10.4	0.381	0.409
B	1.31	1.62	0.051	0.063
C	0.65	1.22	0.025	0.048
D	1.15	1.36	0.045	0.053
E	0.62	0.95	0.024	0.037
F	8.75	9.32	0.344	0.366
G	14.75	15.8	0.580	0.622
H	0.32	0.48	0.012	0.018
I	1.18	1.36	0.046	0.053
J	0	0.15	0	0.005
K	4.38	4.86	0.172	0.191
L	4.85	5.23	0.190	0.205

Figure 3 Outline TO-247 Dimensions in mm



SYMBOL	mm		
	MIN	NOM	MAX
A	4.80	5.00	5.20
A1	2.21	2.41	2.61
A2	1.85	2.00	2.15
b	1.11	1.21	1.36
b2	1.91	2.01	2.21
b4	2.91	3.01	3.21
c	0.51	0.61	0.75
D	20.70	21.00	21.30
D1	16.25	16.55	16.85
E	15.50	15.80	16.10
E1	13.00	13.30	13.60
E2	4.80	5.00	5.20
E3	2.30	2.50	2.70
e	5.44BSC		
L	19.62	19.92	20.22
L1	-	-	4.30
ΦP	3.40	3.60	3.80
ΦP1	-	-	7.30
S	6.15BSC		

8. Appendix

CoolSemi Webpage: www.coolsemi.com.