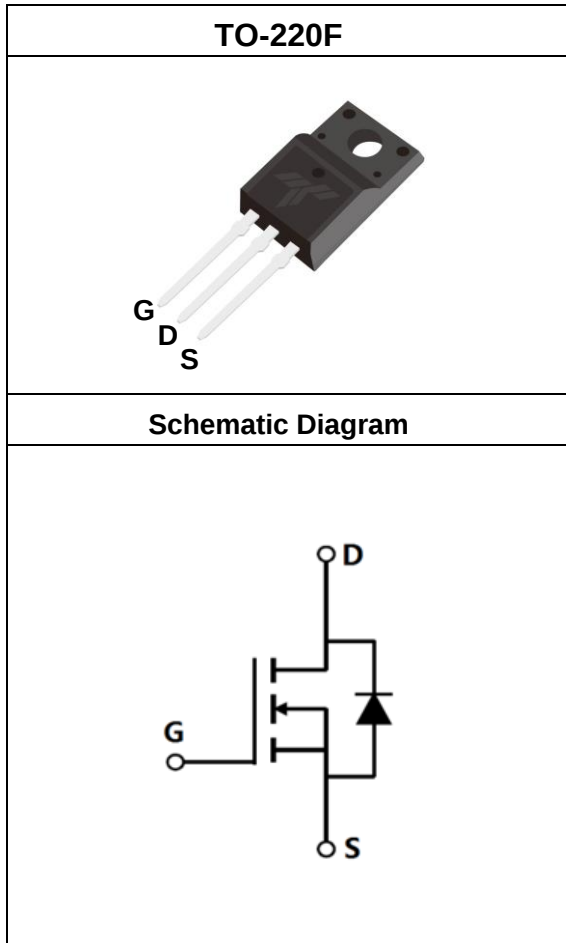


N-channel 120V, 9.0mΩ max., 16A
 SGT MOSFET S2 in TO-220F

Datasheet - production data

1. Descriptions



Key Performance Parameters

Parameters	Value	Unit
BV_{DSS}	120	V
$R_{DS(on),max}$	9.0	mΩ
$Q_{g,typ}$	36.4	nC
$I_{D,pulse}$	56	A
E_{AS}	400	mJ

Features

- Extremely low losses due to very low FOM $R_{ds(on)} \cdot Q_g$.
- 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
CSA090N12S2	TO-220F	090N12S2	see Appendix A

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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⁾	-	-	120	V	$V_{GS}=0V$, $I_D=250\mu A$
I_D	Continuous drain current	-	-	16 11.5	A	$T_C=25^\circ\text{C}$ $T_C=100^\circ\text{C}$
$I_{D,pulse}$	Pulsed drain current	-	-	56	A	$T_C=25^\circ\text{C}$
E_{AS}	Avalanche energy, single pulse ²⁾	-	-	400	mJ	$I_D=40A$; $V_{DD}=50V$
I_{AS}	Avalanche current	-	-	40	A	-
V_{GS}	Gate source voltage	-20	-	20	V	static; AC ($f>1\text{ Hz}$)
P_{tot}	Power dissipation	-	-	30	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	-	-	16	A	$T_C=25^\circ\text{C}$
$I_{S,pulse}$	Diode pulse current ²⁾	-	-	56	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	-	-	5.0	°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	120	-	-	V	$V_{GS}=0V, I_D=250\mu A$
$V_{(GS)th}$	Gate threshold voltage	2	3.0	4	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	-	7.8	9.0	m Ω	$V_{GS}=10V, I_D=45A, T_j=25^\circ C$
R_G	Gate resistance	-	2.1	-	Ω	$V_{DD}=0V, V_{GS}=0V, F=1MHz$
g_{fs}	Transconductance		44		S	$V_{DS}=5V, I_D=20A$

Table 4. Dynamic Characteristics

Symbol	Parameter	Values			Unit	Test Condition
		Min.	Typ.	Max.		
C_{iss}	Input capacitance	-	2650	-	pF	$V_{GS}=0V, V_{DS}=60V, f=250kHz$
C_{oss}	Output capacitance	-	346	-	pF	$V_{GS}=0V, V_{DS}=60V, f=250kHz$
C_{rss}	Reverse transfer capacitance	-	10.5	-	pF	$V_{GS}=0V, V_{DS}=60V, f=250kHz$
$t_{d(on)}$	Turn-on delay time	-	37	-	ns	$V_{DD}=60V, V_{GS}=10V, I_D=20A, R_G=10\Omega$
t_r	Rise time	-	63	-	ns	$V_{DD}=60V, V_{GS}=10V, I_D=20A, R_G=60\Omega$
$t_{d(off)}$	Turn-off delay time	-	56	-	ns	$V_{DD}=60V, V_{GS}=10V, I_D=20A, R_G=10\Omega$
t_f	Fall time	-	15	-	ns	$V_{DD}=90V, V_{GS}=10V, I_D=20A, R_G=10\Omega$

Table 5. Gate Charge Characteristics

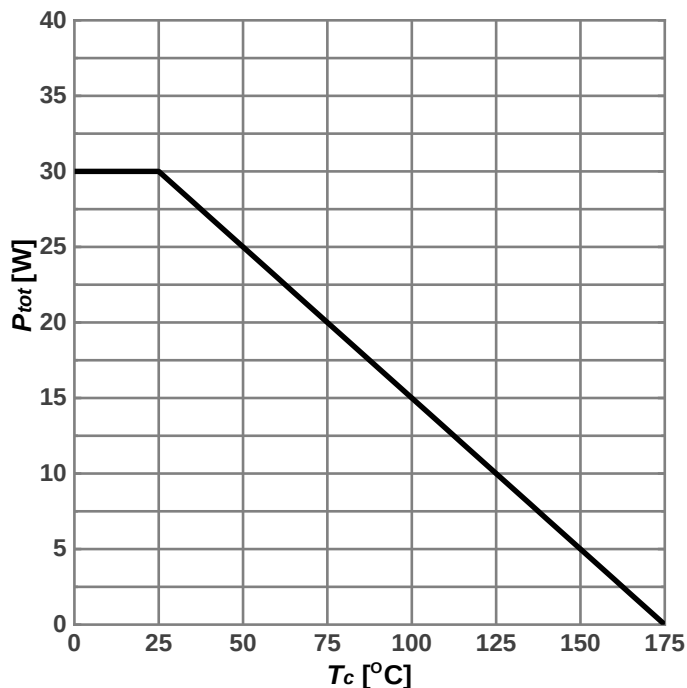
Symbol	Parameter	Values			Unit	Test Condition
		Min.	Typ.	Max.		
Q_{gs}	Gate to source charge	-	36.4	-	nC	$V_{DD}=60V, I_D=20A, V_{GS}=0 \text{ to } 10V$
Q_{gd}	Gate to drain charge	-	9.4	-	nC	$V_{DD}=60V, I_D=20A, V_{GS}=0 \text{ to } 10V$
Q_g	Gate charge total	-	5.8	-	nC	$V_{DD}=60V, I_D=20A, V_{GS}=0 \text{ to } 10V$
$V_{plateau}$	Gate plateau voltage	-	3.75	-	V	$V_{DD}=60V, I_D=20A, V_{GS}=0 \text{ to } 10V$

Table 6. Reverse Diode Characteristics

Symbol	Parameter	Values			Unit	Test Condition
		Min.	Typ.	Max.		
V_{SD}	Diode forward voltage	-	0.83	1.2	V	$V_{GS}=0V, I_F=20A, T_j=25^\circ C$
t_{rr}	Reverse recovery time	-	63.7	-	ns	$V_R=60V, I_F=20A, di_F/dt=100A/\mu s$
Q_{rr}	Reverse recovery charge	-	82	-	nC	$V_R=60V, I_F=20A, di_F/dt=100A/\mu s$

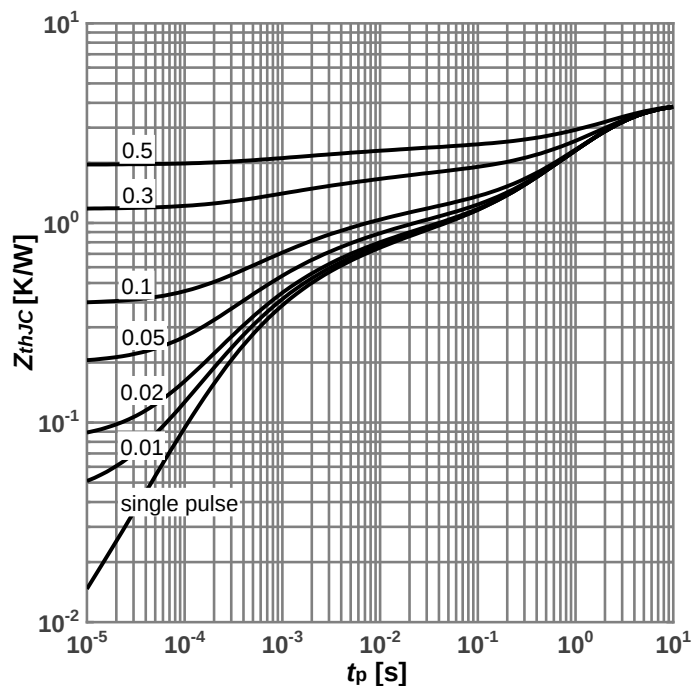
5. Electrical Characteristics Diagrams

Diagram 1: Power dissipation



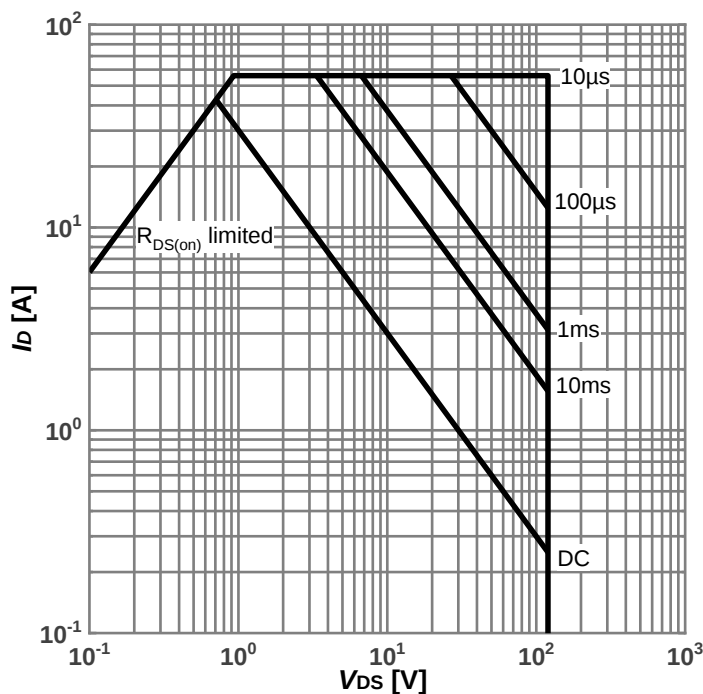
$$P_{tot}=f(T_c)$$

Diagram 2: Max. transient thermal impedance



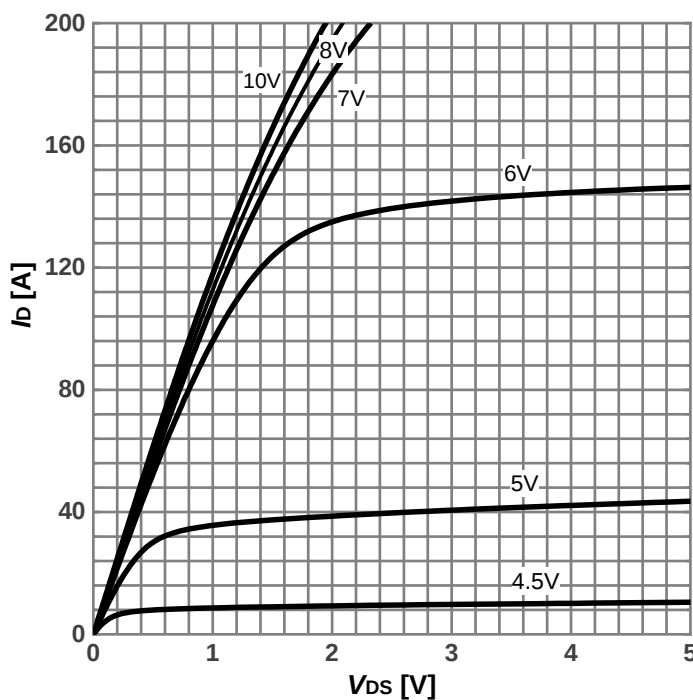
$$Z_{thJC}=f(t_p); \text{ parameter: } D= t_p/T$$

Diagram 3: Safe operating area



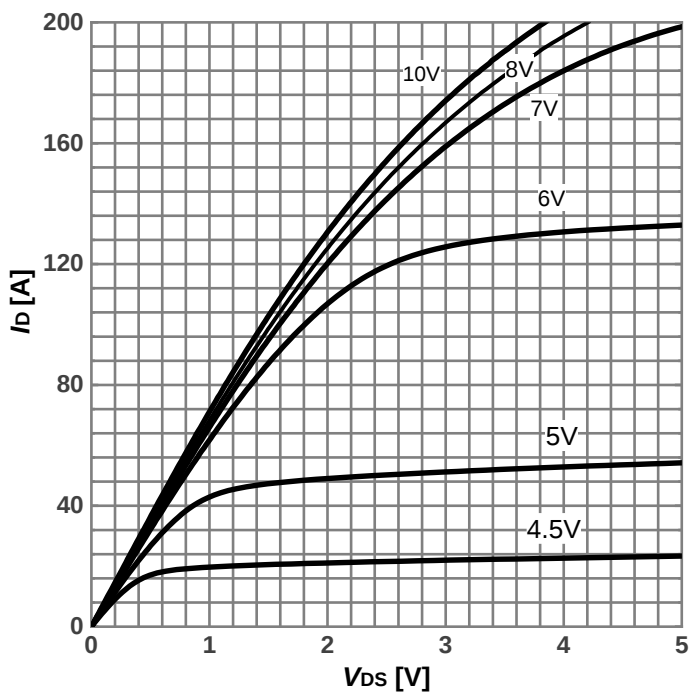
$$I_D=f(V_{DS}); T_J=25^{\circ}\text{C}; D=0; \text{ parameter: } t_p$$

Diagram 4: Typ. output characteristics



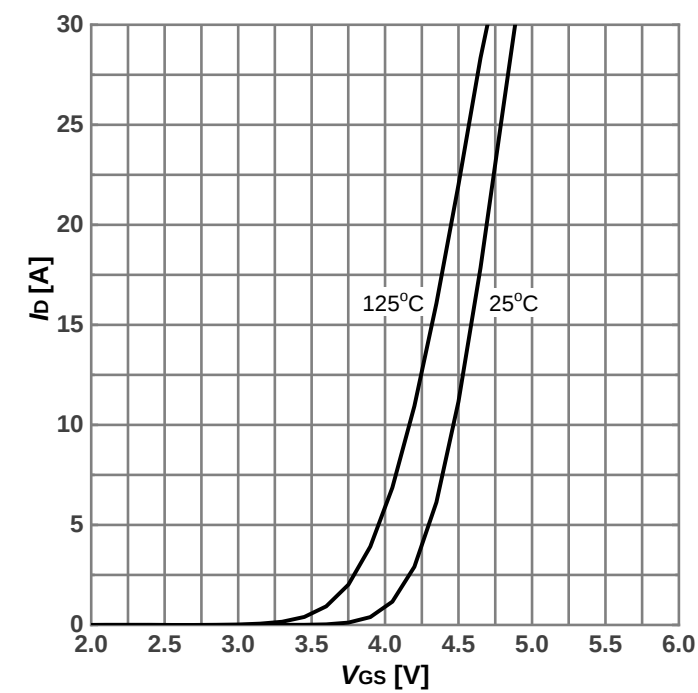
$$I_D=f(V_{DS}); T_J=25^{\circ}\text{C}; \text{ parameter: } V_{GS}$$

Diagram 5: Typ. output characteristics



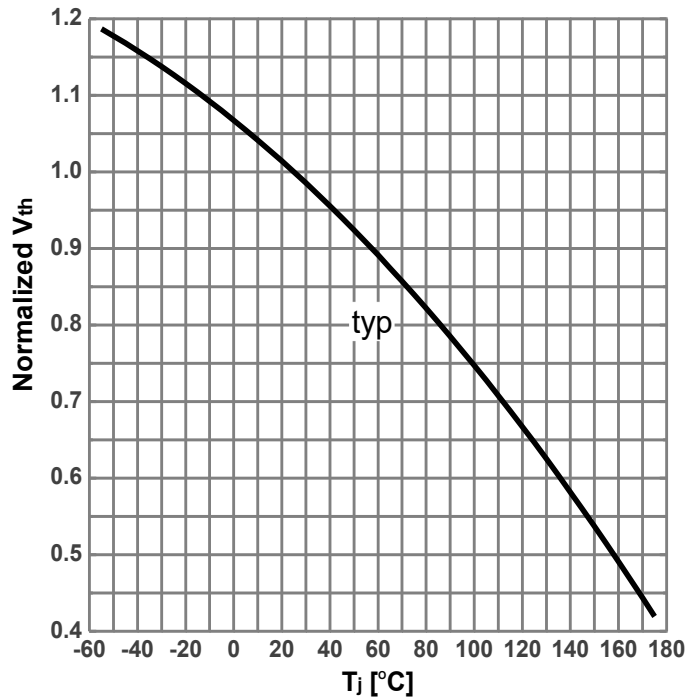
$I_D=f(V_{DS})$; $T_J=125^{\circ}\text{C}$; parameter: V_{GS}

Diagram 6: Typ. transfer characteristics



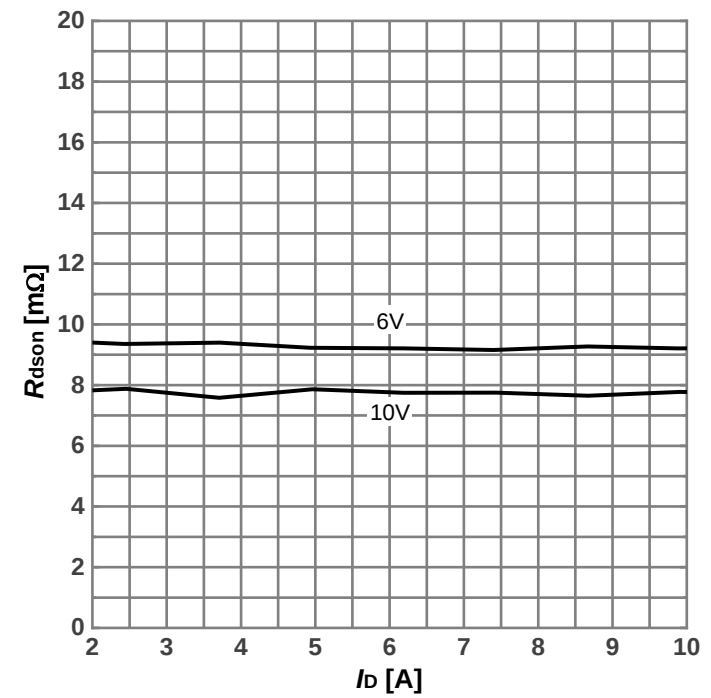
$I_D=f(V_{GS})$; $V_{DS}=5\text{V}$; parameter: T_J

Diagram 7: Gate threshold voltage vs. Junction temperature

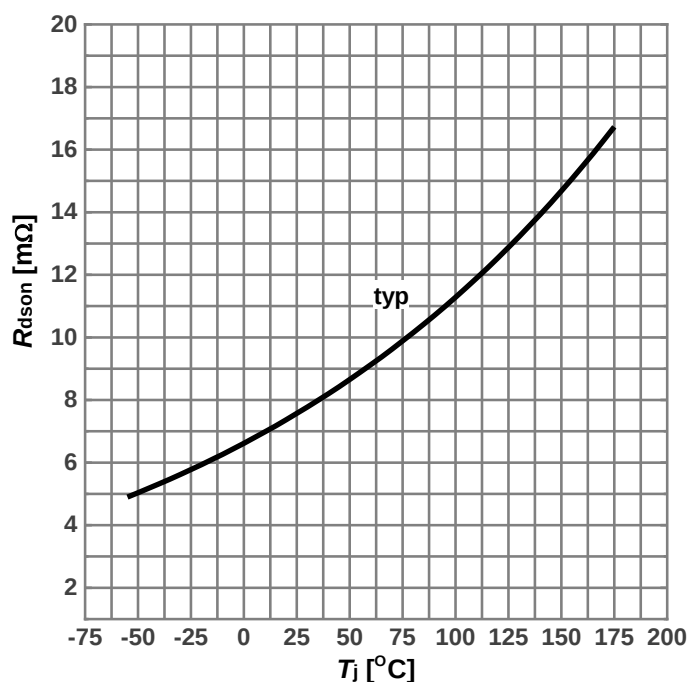


$V_{th}=f(T_J)$; $I_D=250\mu\text{A}$

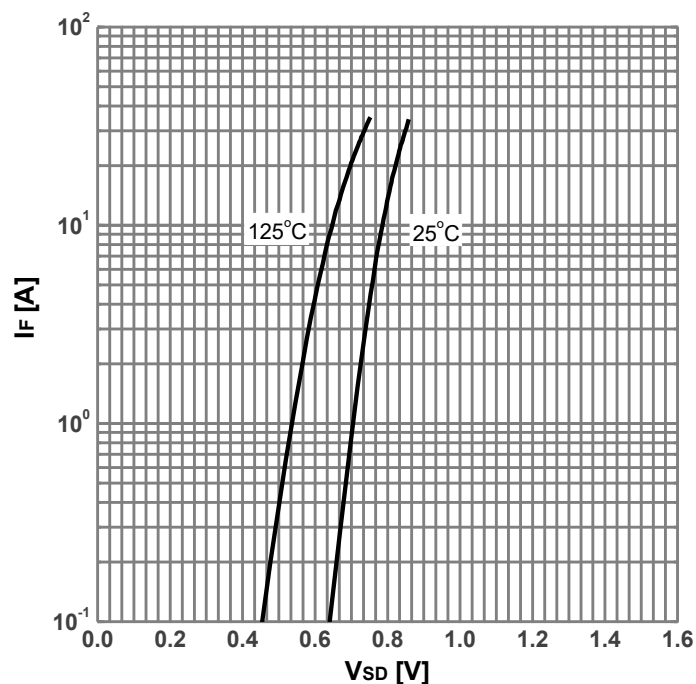
Diagram 8: On-state resistance vs. Drain current



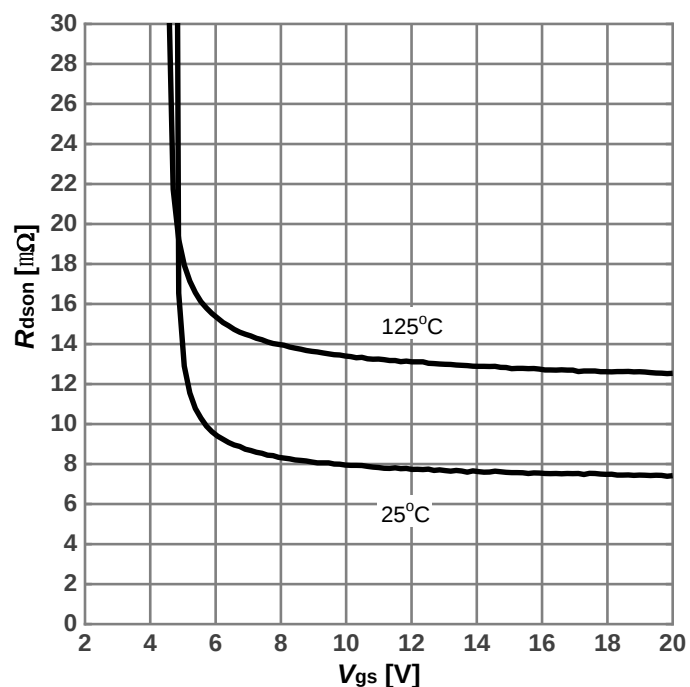
$R_{DS(on)}=f(I_D)$; $T_J=25^{\circ}\text{C}$; parameter: V_{GS}

Diagram 9: On-state resistance vs. Junction temperature

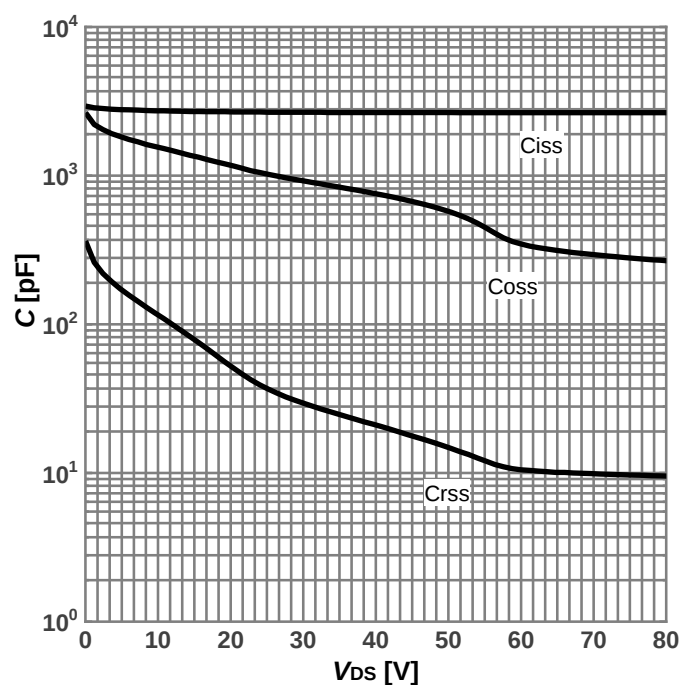
$$R_{DS(on)} = f(T_j); I_D = 20A; V_{GS} = 10V$$

Diagram 10: Forward characteristics of reverse diode

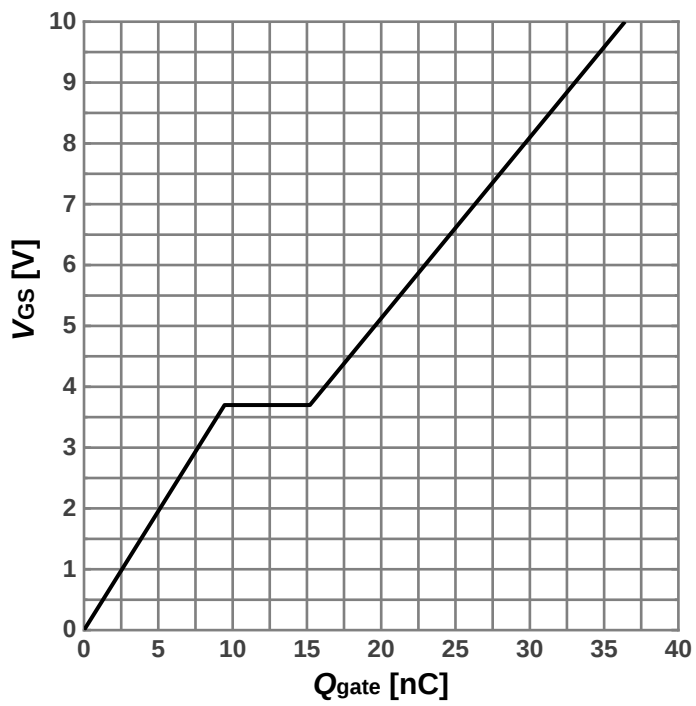
$$I_F = f(V_{SD}); \text{parameter: } T_j$$

Diagram 11: On-state resistance vs. Vgs characteristics

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

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; $V_{DS}=60V$

6. Test Circuits

Table 7. Diode Characteristics

Test circuit for diode characteristics $R_{g1} = R_{g2}$	Diode recovery waveform $t_T = t_F + t_S$ $Q_T = Q_F + Q_S$
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Table 8. Switching Times

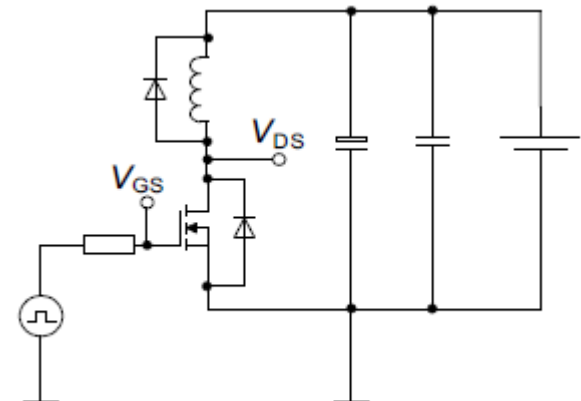
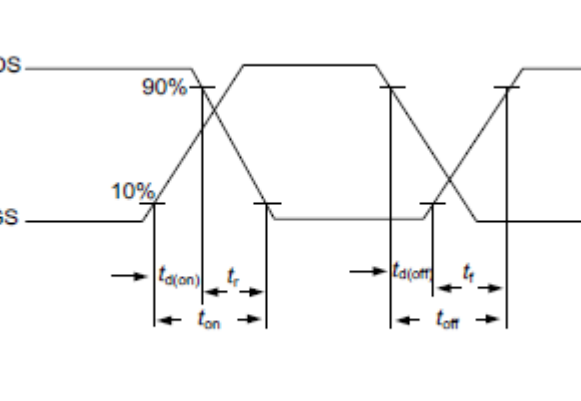
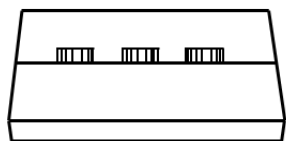
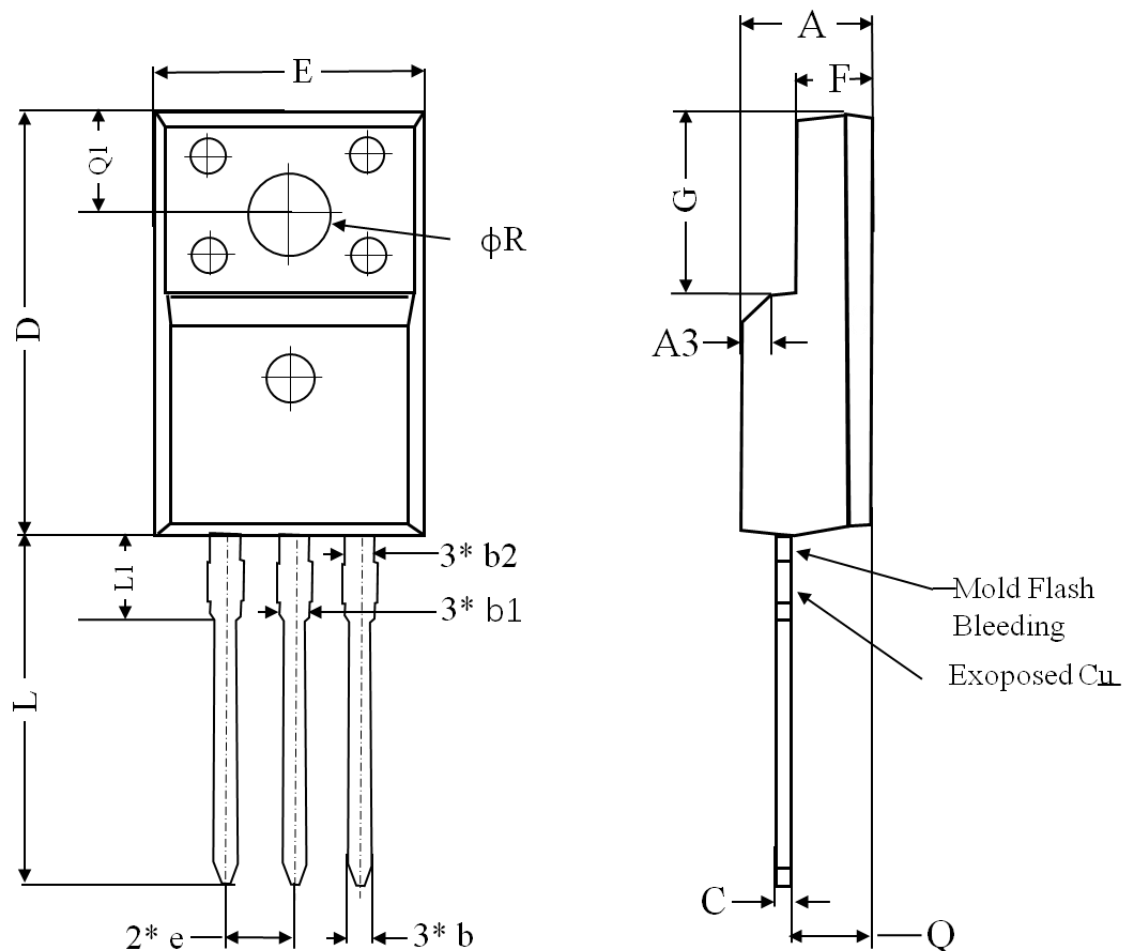
Switching times test circuit for inductive load	Switching times waveform
	

Table 9. Unclamped Inductive Load

Unclamped inductive load test circuit 	Unclamped inductive waveform 
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7. Package Outlines

Figure 1 Outline TO-220 FullPAK Dimensions in mm



Note:

1. All Dimension Are In mm.
2. Package Body Sizes Exclude Mold Flash And Burrs Mold Flash Should Be less Than 6 Mil.

SYMBOL	DIMENSIONS		
	Min.	Nom.	Max.
A	4.60	4.70	4.80
b	0.70	0.80	0.91
b1	1.20	1.30	1.47
b2	1.10	1.20	1.30
C	0.45	0.50	0.63
D	15.80	15.87	15.97
e	2.54		
E	10.00	10.10	10.30
F	2.44	2.54	2.64
G	6.50	6.70	6.90
L	12.90	13.10	13.30
L1	3.13	3.23	3.33
Q	2.65	2.75	2.85
Q1	3.20	3.30	3.40
Φr	3.08	3.18	3.28

8. Appendix

CoolSemi Webpage: www.coolsemi.com.