40mΩ, 650V, Super Junction N-Channel Power MOSFET

General Description

The Sanrise FRC65R040B is a high voltage power MOSFET, fabricated using advanced super junction technology. The resulting device has extremely low on resistance, low gate charge and fast switching time, making it especially suitable for applications which require superior power density and outstanding efficiency.
The FRC65R040B break down voltage is 650V and it has a high rugged avalanche characteristics.
The FRC65R040B is available in TO-247 package.

Symbol

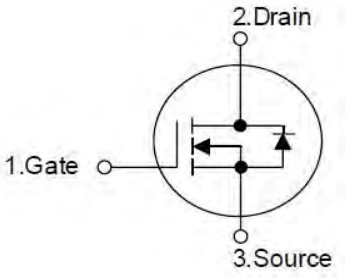

Figure 1 Symbol of FRC65R040B

Features

- Ultra Low $R_{DS(ON)}$ = 40mΩ @ V_{GS} = 10V.
- Ultra Low Gate Charge, Qg=210nC typ.
- Fast switching capability
- Robust design with better EAS performance
- EMI Improved
- Non-automotive Qualified

Package Type

TO-247

Figure 2 Package Type of FRC65R040B

Application

- Telecom Power
- EV Charger

Ordering Information

FRC65R040B□□–□

Circuit Type

Package
T: TO-247

E: Lead Free
G: Green

Blank: Tube
TR: Tape & Reel

Package	Part Number		Marking ID		Packing Type
	Lead Free	Green	Lead Free	Green	
TO-247	FRC65R040BT-E	FRC65R040BT-G	SRC65R040BT	SRC65R040BTG	Tube

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Absolute Maximum Ratings[Note 1]

Parameter		Symbol	Rating	Unit
Drain-Source Voltage		V_{DSS}	650	V
Gate-Source Voltage (static)		V_{GSS}	±20	V
Gate-Source Voltage (dynamic), AC (f>1 Hz)		V_{GSS}	±30	V
Continuous Drain Current	T_C=25ºC	I_D	77	A
	T_C=125ºC		34	
Pulsed Drain Current (Note 2)		I_{DM}	231	A
Avalanche Energy, Single Pulse (Note 3)		E_{AS}	264	mJ
Avalanche Energy, Repetitive (Note 2)		E_{AR}	0.264	mJ
Avalanche Current, Repetitive (Note 2)		I_{AR}	2.8	A
Continuous Diode Forward Current		I_S	77	A
Diode Pulse Current		$I_{S.PULSE}$	231	A
MOSFET dv/dt Ruggedness, V_{DS}<=480V		dv/dt	80	V/ns
Reverse Diode dv/dt, V_{DS}<=480V, I_{SD}<=I_D		dv/dt	50	V/ns
Operating Junction Temperature		T_J	150	ºC
Storage Temperature		T_{STG}	-55 to 150	ºC
Lead Temperature (Soldering, 10 sec)		T_{LEAD}	260	ºC

Note:

1. Absolute maximum ratings are those values beyond which the device could be permanently damaged. Absolute maximum ratings are stress ratings only and functional device operation is not implied.
2. Repetitive Rating: Pulse width limited by maximum junction temperature
3. I_{AS} =2.8A, V_{DD} = 60V, R_G = 25Ω, Starting T_J = 25°C

Thermal characteristics

Parameter (TO247-package)	Symbol	Min	Typ	Max	Unit
Thermal Resistance，Junction-to-Case	R_{thJC}	-		0.22	ºC/W
Thermal Resistance，Junction-to-Ambient	R_{thJA}	-		62	

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Electrical Characteristics

T_J = 25℃, unless otherwise specified.

Parameter		Symbol	Test Conditions	Min	Typ	Max	Unit
Statistic Characteristics							
Drain-Source Breakdown Voltage		BV_{DSS}	V_{GS}=0V, I_D=250uA	650			V
Zero Gate Voltage Drain Current		I_{DSS}	V_{DS}=650V, V_{GS}=0V			20	uA
Gate-Body Leakage Current	Forward	I_{GSSF}	V_{GS}=20V, V_{DS}=0V			100	nA
	Reverse	I_{GSSR}	V_{GS}=-20V, V_{DS}=0V			-100	
Gate Threshold Voltage		$V_{GS(TH)}$	V_{DS}=V_{GS}, I_D=1.85mA	3.5	4.3	5.0	V
Static Drain-Source On-Resistance		$R_{DS(ON)}$	V_{GS}=10V, I_D=34A		35	40	mΩ
Gate Resistance		R_G	f=1MHz, Open Drain		2.0		Ω
Dynamic Characteristics							
Input Capacitance		C_{ISS}	V_{DS}=25V, V_{GS}=0V, f=1MHz		4.9		nF
Output Capacitance		C_{OSS}			4.8		nF
Reverse Transfer Capacitance		C_{RSS}			341		pF
Effective output capacitance, energy related NOTE5		$C_{O(er)}$	V_{GS}=0V, V_{DS}=0…480V		185		pF
Effective output capacitance, time related NOTE6		$C_{O(tr)}$			1264		
Turn-on Delay Time		$t_{d(on)}$	V_{DD}=400V, I_D=34A R_G=3.3Ω, V_{GS}=10V		14		ns
Rise Time		t_r			8		
Turn-off Delay Time		$t_{d(off)}$			102		
Fall Time		t_f			6.1		
Gate Charge Characteristics							
Gate to Source Charge		Q_{gs}	V_{DD}=480V, I_D=34A V_{GS}=0 to 10V		31.7		nC
Gate to Drain Charge		Q_{gd}			104		
Gate Charge Total		Q_g			210		
Gate Plateau Voltage		$V_{plateau}$			6.3		V
Reverse Diode Characteristics							
Drain-Source Diode Forward Voltage		V_{SD}	V_{GS}=0V, I_{SD}=34A		0.86	1.1	V
Reverse Recovery Time		t_{rr}	V_R=400V, I_F=34A dI$_F$/dt=100A/us		176		ns
Reverse Recovery Charge		Q_{rr}			1.28		uC
Peak Reverse Recovery Current		I_{rrm}			14.5		A

Note:

5. $C_{O(er)}$ is a fixed capacitance that gives the same stored energy as C_{OSS} while V_{DS} is rising from 0 to 480V

6. $C_{O(tr)}$ is a fixed capacitance that gives the same charging time as C_{OSS} while V_{DS} is rising from 0 to 480 V

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Typical Performance Characteristics

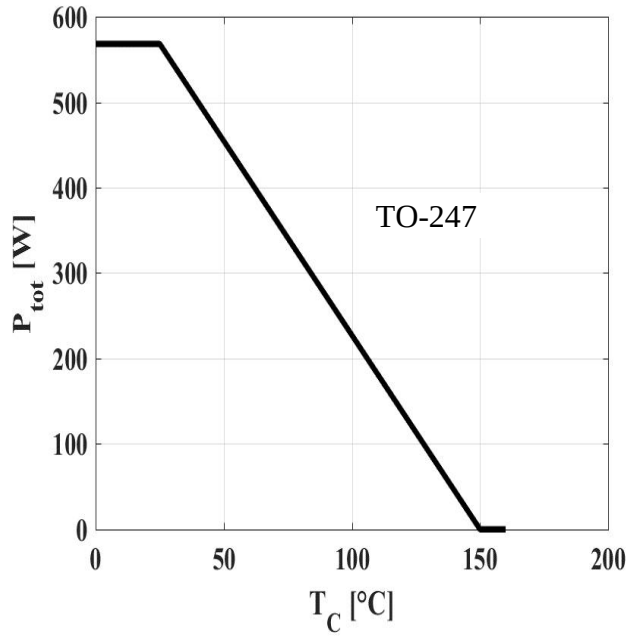
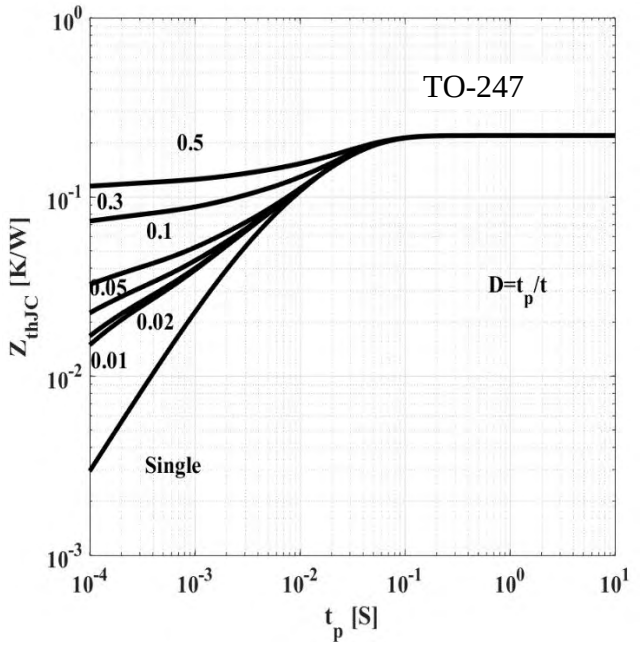
Figure 3: Power Dissipation	Figure 4: Max. Transient Thermal Impedance
	
$P_{tot} = f(T_c)$	$Z_{(thJC)} = f(t_p)$; parameter: $D = t_p/T$

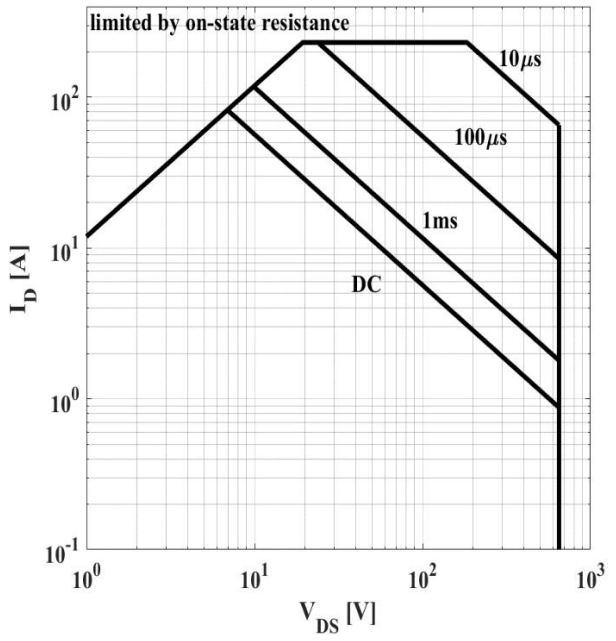
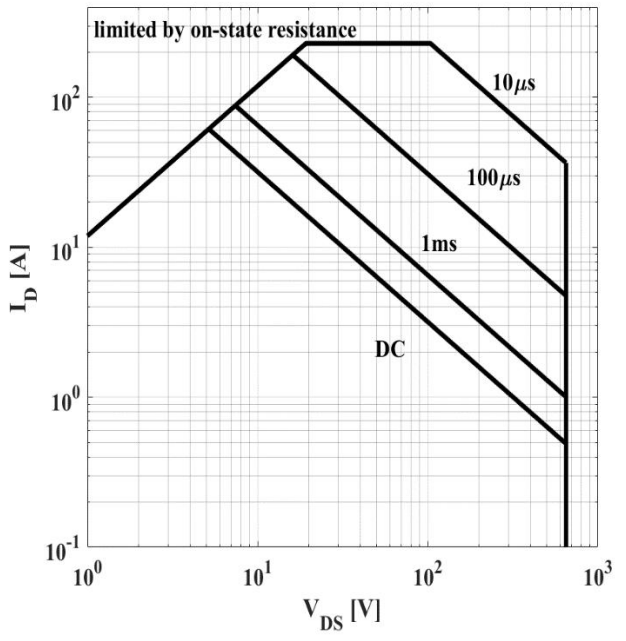
Figure 5: Safe Operating Area	Figure 6: Safe Operating Area
	
$I_D = f(V_{DS})$; T_c= 25ºC; V_{GS}>7V; parameter t_p	$I_D = f(V_{DS})$; T_c= 80ºC; V_{GS}>7V; parameter t_p

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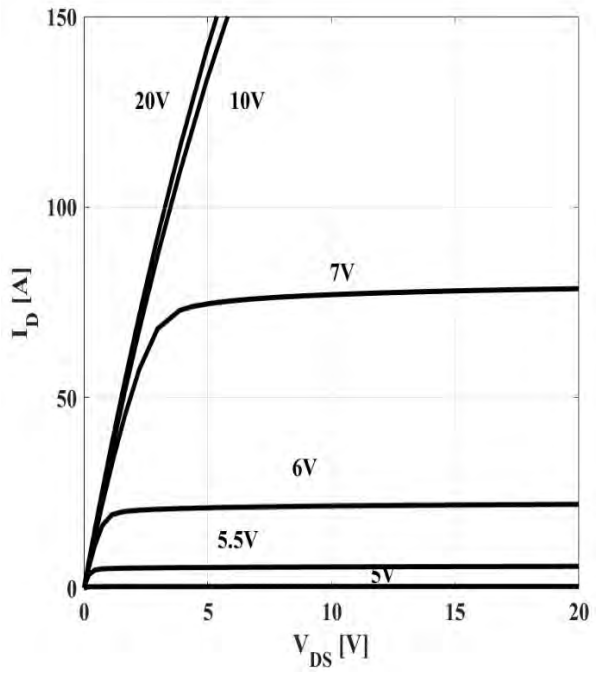
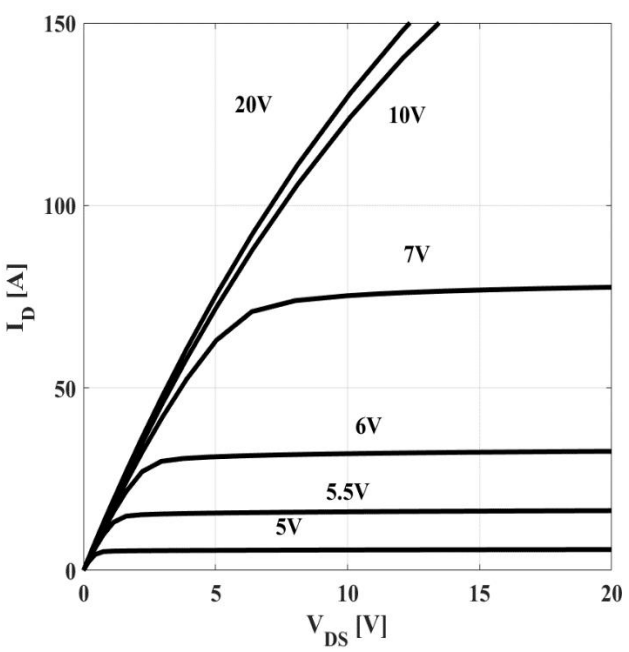
Figure 7: Typ. Output Characteristics



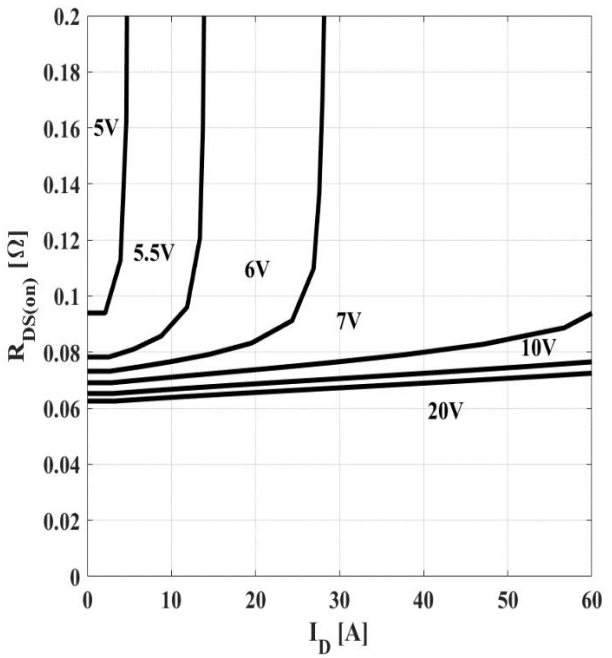
$I_D = f(V_{DS})$; Tj= 25ºC; parameter: V_{GS}

Figure 8: Typ. Output Characteristics



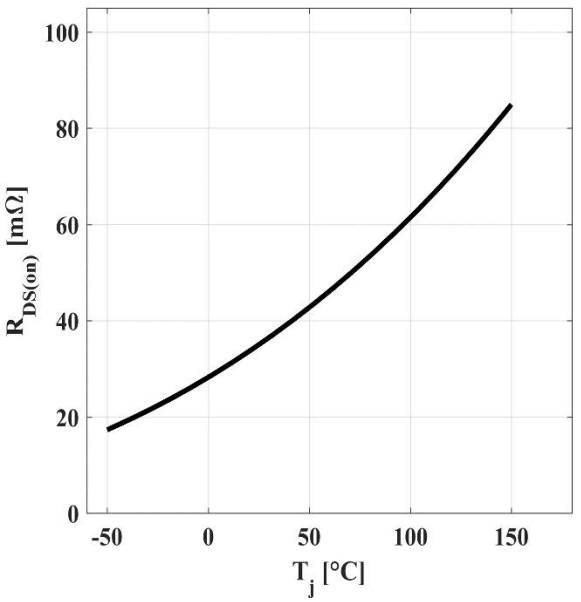
$I_D = f(V_{DS})$; T_j= 125ºC; parameter: V_{GS}

Figure 9: Typ. Drain-Source On-State Resistance



$R_{DS(ON)}$ =f(I_D); T_j=125ºC; parameter: V_{GS}

Figure 10: Typ. Drain-Source On-State Resistance



$R_{DS(ON)}$=f(T_j); I_D=34A; V_{GS}=10V

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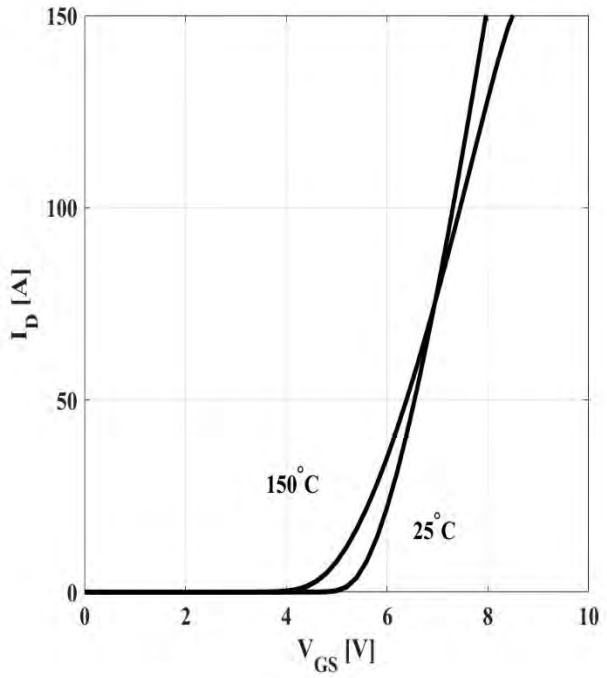
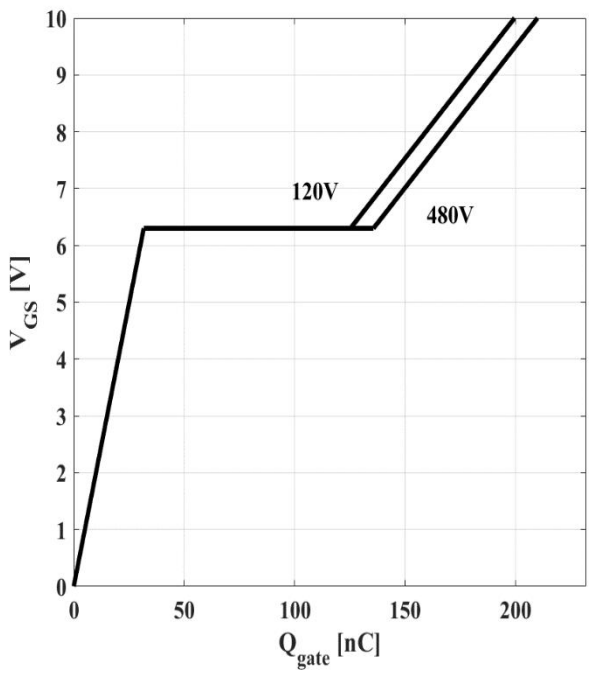
Figure 11: Typ. Transfer Characteristics



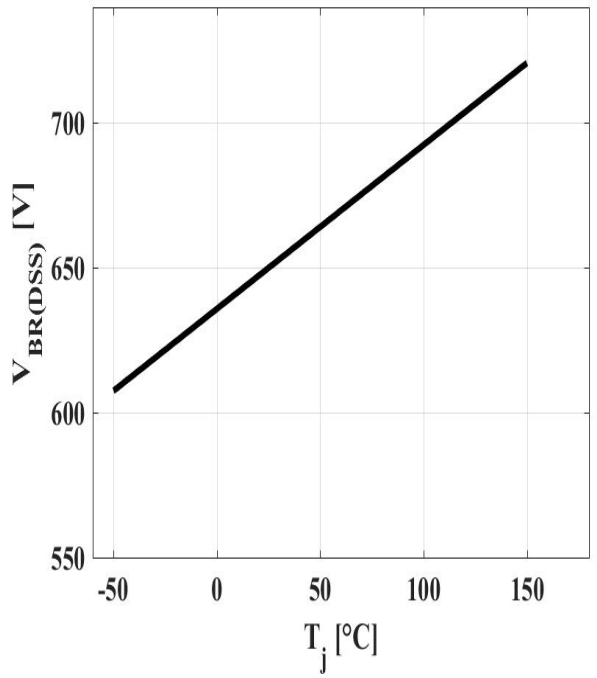
$I_D = f(V_{GS})$; $V_{DS} = 20V$

Figure 12: Typ. Gate Charge



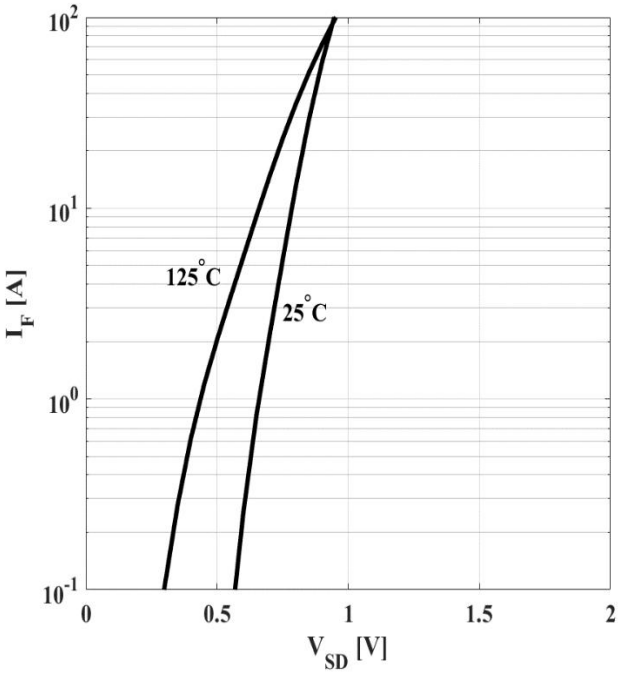
$V_{GS}= f(Q_{gate})$, $I_D= 34A$ pulsed

Figure 13: Drain-Source Breakdown Voltage



$V_{BR(DSS)}=f(T_j)$; $I_D=10mA$

Figure 14: Forward Characteristics of Reverse Diode



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

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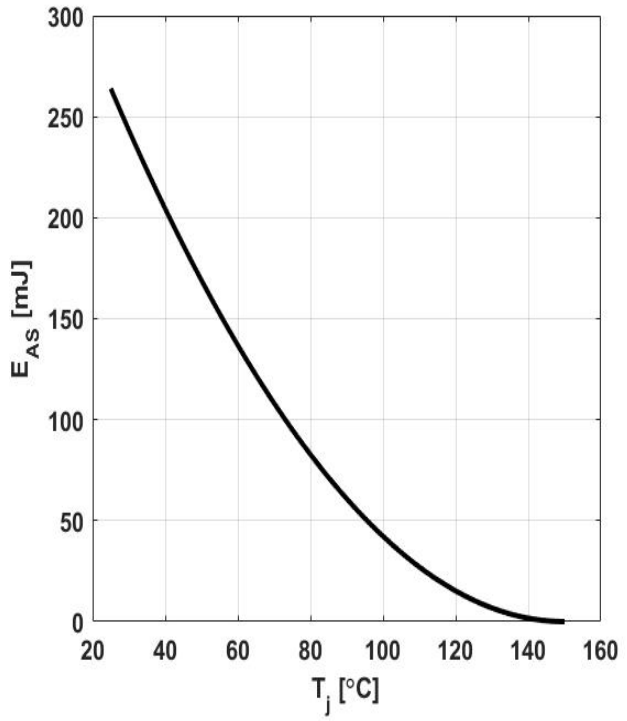
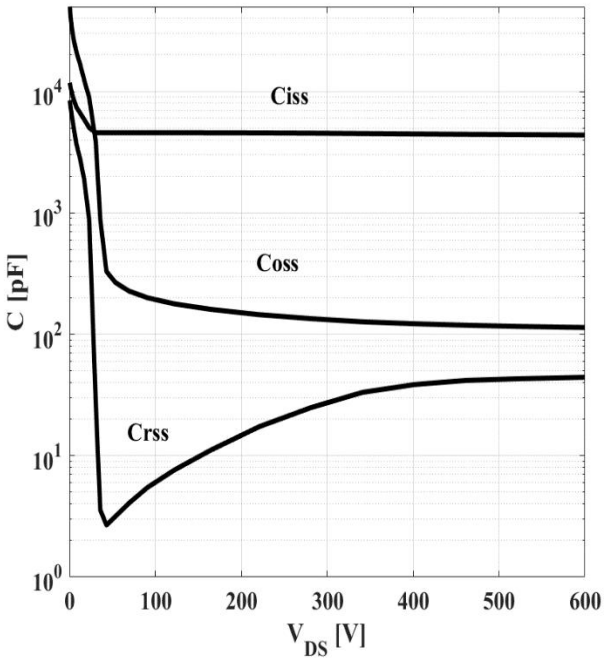
Figure 15: Avalanche Energy



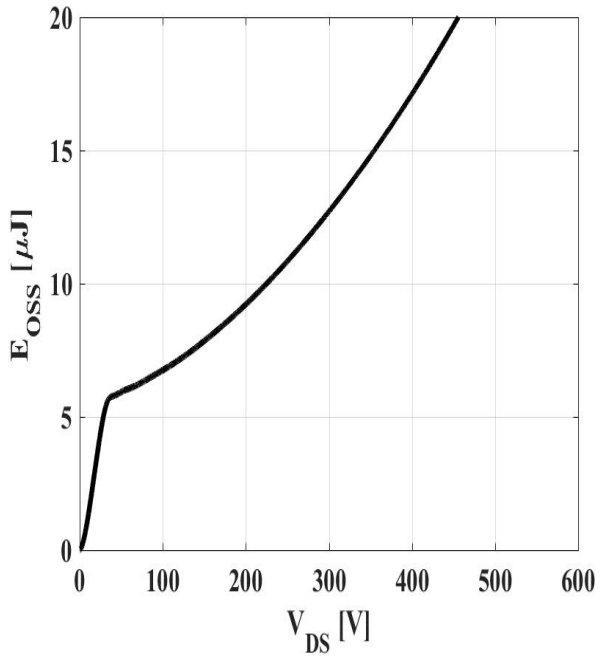
$E_{AS}=f(T_j)$; $I_D=2.8A$; $V_{DD}=60V$

Figure 16: Typ. Capacitances



$C=f(V_{DS})$; $V_{GS}=0$; f=1MHz

Figure 17: C_{OSS} Stored Energy



$E_{OSS}=f(V_{DS})$

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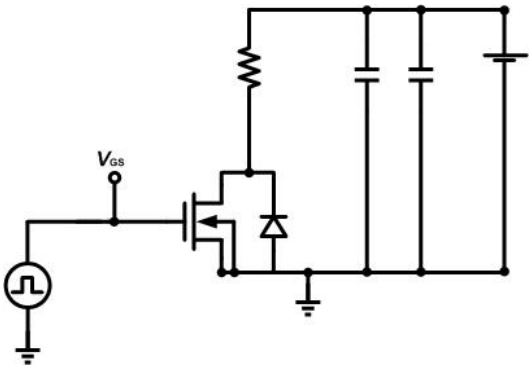
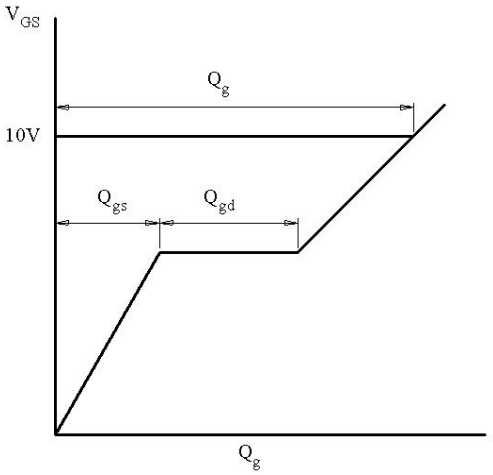
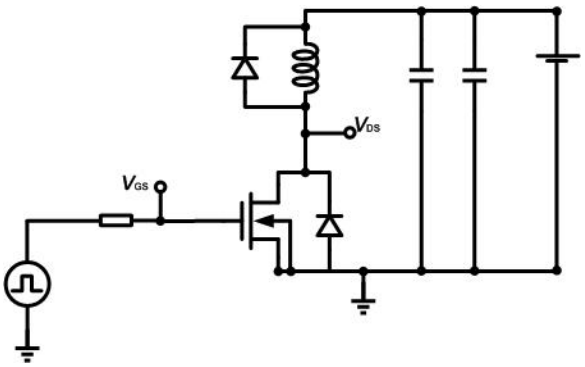
Test Circuits

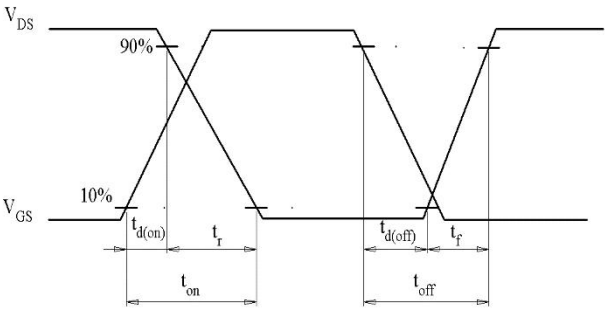
1. Gate Charge Test Circuit & Waveform



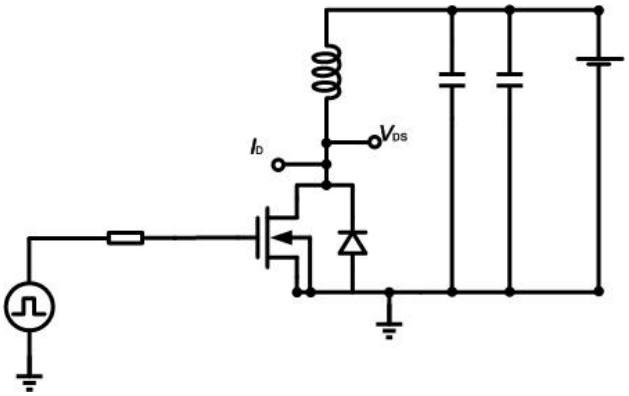


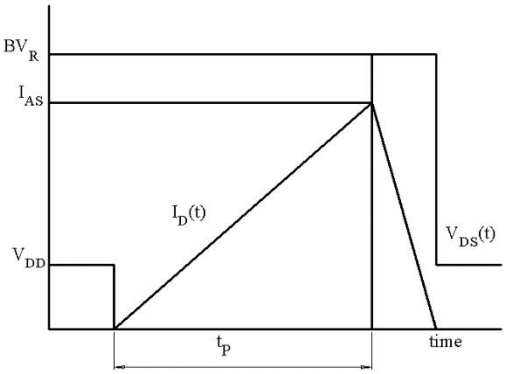
2. Switch Time Test Circuit





3. Unclaimed Inductive Switching Test Circuit & Waveforms





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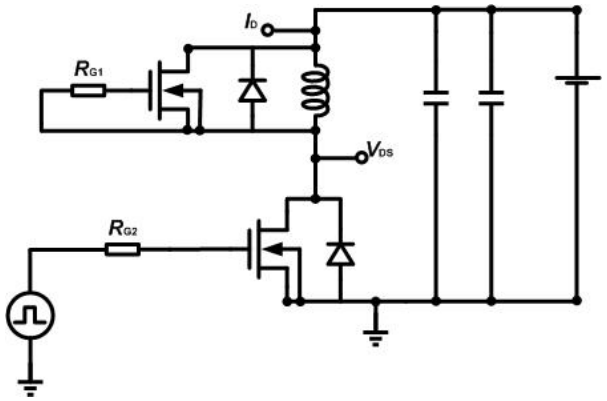
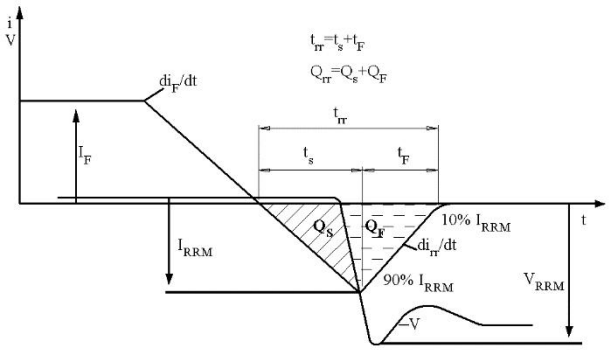
4. Test Circuit and Waveform for Diode Characteristics





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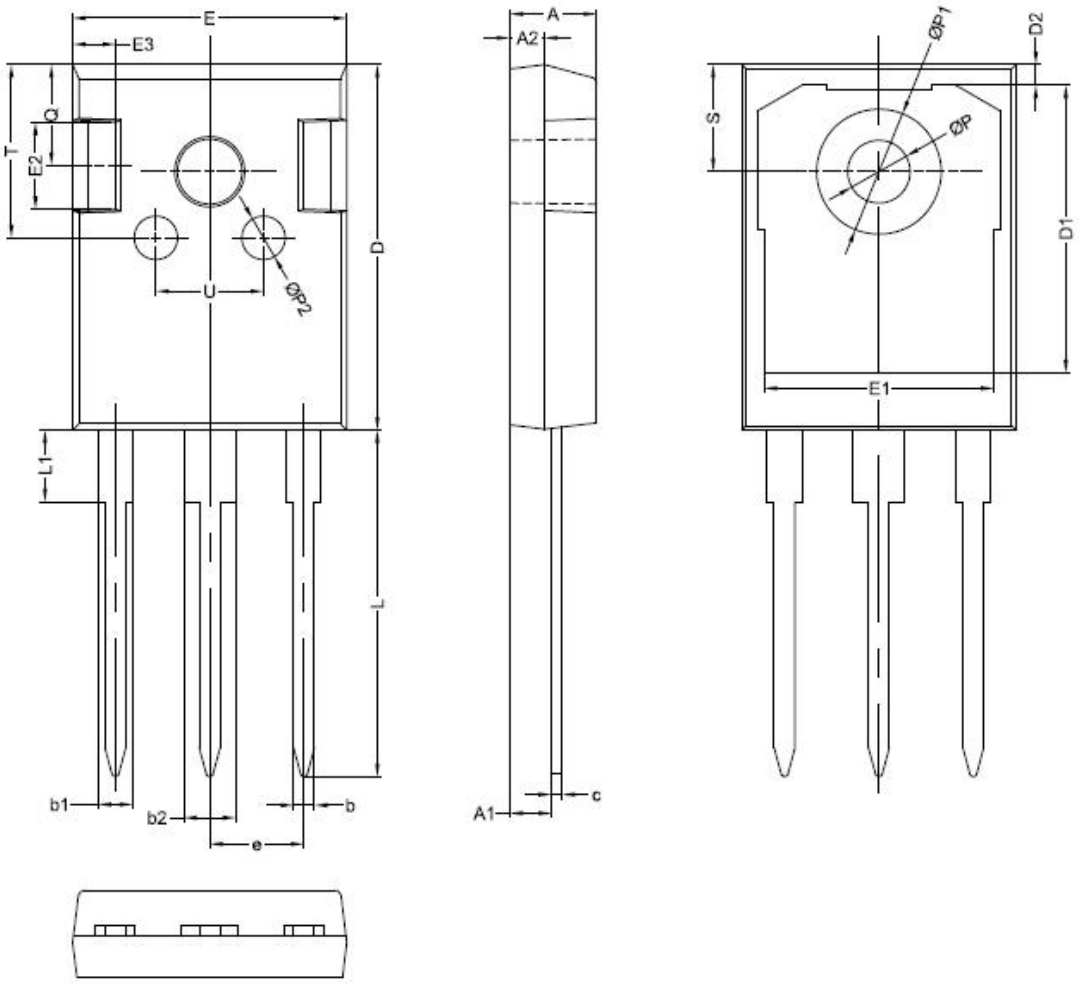
Mechanical Dimensions

TO-247 **Unit: mm**



Symbol	Dimensions(mm)			Symbol	Dimensions(mm)		
	Min.	Typ.	Max.		Min.	Typ.	Max.
A	4.80	5.00	5.20	E2	-	5.00	-
A1	2.21	2.41	2.61	E3	-	2.50	-
A2	1.90	2.00	2.10	e	5.44(BSC)		
b	1.10	1.20	1.35	L	19.42	19.92	20.42
b1	-	2.00	-	L1	-	4.13	-
b2	-	3.00	-	P	3.50	3.60	3.70
c	0.55	0.60	0.75	P1	-	-	7.40
D	20.80	21.00	21.20	P2	-	2.50	-
D1	-	16.55	-	Q	-	5.80	-
D2	-	1.20	-	S	6.05	6.15	6.25
E	15.60	15.80	16.00	T	-	10.00	-
E1	-	13.30	-	U	-	6.20	-