

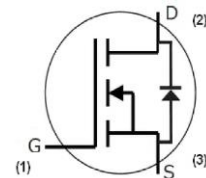
650V 35mΩ Silicon Carbide Power MOSFET

Features

- High blocking voltage with low on-resistance
- High switching speed with low capacitance
- Very fast and robust intrinsic body diode with low reverse recovery
- Very low switching losses
- Excellent avalanche ruggedness
- RoHS compliant

Benefits

- Greater system efficiency
- Reduced cooling requirements
- Increased power density
- Increased system switching frequency
- Easy to parallel and simple to drive



Potential Applications

- Solar inverters
- Uninterrupted power supplies
- Switch mode power supplies
- Motor drives

Package Type: TO-247-3L



Description

The Sanan Semiconductor 650V/35mΩ silicon carbide power MOSFET uses advanced SiC MOSFET technology with low on-resistance, low switching losses, and a high operation temperature of 175°C. It is suitable for use in high frequency circuits and provides a reduction in overall system size, increased efficiency and increased switching frequency. It has been widely used in applications including solar inverters, uninterrupted power supplies, switch mode power supplies, and motor drives. Using RoHS compliant components, it is qualified for use in industrial application.

Product Specifications

Device	V _{DS}	I _D (25°C)	R _{(DS)on}	Marking
SMS0650035K	650V	60A	35mΩ	MS0650035K

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Table 1. Maximum Ratings

($T_C = 25^{\circ}\text{C}$, unless otherwise specified)

Parameter	Symbol	Value	Unit	Test conditions
Drain-source voltage	V_{DSmax}	650	V	$V_{GS} = 0V, I_D = 100\mu A$
Gate-source voltage, max. transient voltage	V_{GSmax}	-10/+25		$t_p \leq 0.5\mu s, D < 1\%$
Gate-source voltage, max. static voltage	V_{GSmax}	-8/+22		
Gate-source voltage	V_{GSop}	-5/+18		Recommended operation values
Continuous drain current	I_D	60	A	$V_{GS} = 18V$
		42		$V_{GS} = 18V, T_C = 100^{\circ}\text{C}$
Pulsed drain current	$I_{D(pulse)}$	150	A	Pulse width t_p limited by T_{jmax}
Power dissipation	P_{tot}	272	W	
Operating junction temperature	T_j	-55~175	$^{\circ}\text{C}$	
Storage temperature	T_{stg}	-55~175	$^{\circ}\text{C}$	
Soldering temperature	T_L	260	$^{\circ}\text{C}$	1.6mm from case for 10s
Mounting torque	M	0.7	Nm	M3 screw

Table 2. Thermal Resistances

Parameter	Symbol	Values			Unit	Test condition
		Min.	Typ.	Max.		
Thermal resistance from junction to case	$R_{th(j-c)}$	/	0.46	/	$^{\circ}\text{C/W}$	
Thermal resistance from junction to ambient	$R_{th(j-a)}$	/	/	40	$^{\circ}\text{C/W}$	

Table 3. Static Electrical Characteristics

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

Parameter	Symbol	Values			Unit	Test conditions
		Min.	Typ.	Max.		
Drain-source breakdown voltage	$V_{(BR)DSS}$	650	/	/	V	$V_{GS} = 0V, I_D = 100\mu A$
Gate threshold voltage	$V_{GS(th)}$	1.8	2.7	4.2		$V_{DS} = V_{GS}, I_D = 6.5mA$
		/	2.0	/		$V_{DS} = V_{GS}, I_D = 6.5mA, T_j = 175^{\circ}\text{C}$
Drain-source leakage current	I_{DSS}	/	1	50	μA	$V_{DS} = 650V, V_{GS} = 0V$
Gate-source leakage current	I_{GSS}	/	1	250	nA	$V_{GS} = 18V, V_{DS} = 0V$
Drain-source on-state resistance	$R_{DS(on)}$	/	45	/	m Ω	$V_{GS} = 15V, I_D = 22A$
		/	35	46		$V_{GS} = 18V, I_D = 22A$
		/	46	/		$V_{GS} = 18V, I_D = 22A, T_j = 175^{\circ}\text{C}$
Transconductance	g_{fs}	/	14	/	S	$V_{DS} = 20V, I_D = 22A$
		/	13	/		$V_{DS} = 20V, I_D = 22A, T_j = 175^{\circ}\text{C}$
Internal gate resistance	$R_{g(int)}$	/	3.8	/	Ω	$f = 1MHz, V_{AC} = 25mV$

Table 4. Dynamic Electrical Characteristics

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

Parameter	Symbol	Values			Unit	Test conditions
		Min.	Typ.	Max.		
Input capacitance	C _{iSS}	/	1628	/	pF	V _{GS} = 0V, V _{DS} = 600V, f = 100KHz, V _{AC} = 25mV
Output capacitance	C _{oSS}	/	145	/		
Reverse transfer capacitance	C _{rSS}	/	8	/		
C _{oSS} stored energy	E _{oSS}	/	30	/	μJ	V _{DD} = 400V, V _{GS} = -5/+18V, I _D = 22A, I _{GS} = 1mA
Gate to source charge	Q _{GS}	/	23	/	nC	
Gate to drain charge	Q _{GD}	/	20	/		
Total gate charge	Q _G	/	73	/		

Table 5. Switching Characteristics

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

Parameter	Symbol	Values			Unit	Test conditions
		Min.	Typ.	Max.		
Turn-on delay time	$t_{d(on)}$	/	11	/	ns	$V_{DD} = 400V$, $V_{GS} = -5/+18V$, $I_D = 22A$, $R_{G(ext)} = 2.4\Omega$, $L = 110\mu H$ $T_j = 25^{\circ}C$
Rise time	t_r	/	30	/		
Turn-off delay time	$t_{d(off)}$	/	25	/		
Fall time	t_f	/	8	/		
Turn-on switching energy	E_{on}	/	182	/	μJ	
Turn-off switching energy	E_{off}	/	20	/		
Turn-on delay time	$t_{d(on)}$	/	10	/	ns	$V_{DD} = 400V$, $V_{GS} = -5/+18V$, $I_D = 22A$, $R_{G(ext)} = 2.4\Omega$, $L = 110\mu H$ $T_j = 175^{\circ}C$
Rise time	t_r	/	32	/		
Turn-off delay time	$t_{d(off)}$	/	30	/		
Fall time	t_f	/	10	/		
Turn-on switching energy	E_{on}	/	219	/	μJ	
Turn-off switching energy	E_{off}	/	21	/		

Table 6. Reverse SiC Diode Characteristics

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

Parameter	Symbol	Values			Unit	Test conditions
		Min.	Typ.	Max.		
Diode forward voltage	V_{SD}	/	4.2	/	V	$V_{GS} = -5V, I_{SD} = 22A$
		/	3.7	/		$V_{GS} = -5V, I_{SD} = 22A, T_j = 175^\circ\text{C}$
Continuous diode forward current	I_S	/	/	60	A	$V_{GS} = -5V, T_C = 25^\circ\text{C}$
Diode pulse current	$I_{S, pulse}$	/	/	150	A	$V_{GS} = -5V$, pulse width t_p limited by T_{jmax}
Reverse recovery time	t_{rr}	/	25	/	ns	$V_{GS} = -5V, I_{SD} = 22A, V_R = 400V, di/dt = 1.05kA/\mu s, T_j = 25^\circ\text{C}$
Reverse recovery charge	Q_{rr}	/	0.17	/	μC	
Peak reverse recovery current	I_{rrm}	/	12	/	A	
Reverse recovery time	t_{rr}	/	27	/	ns	$V_{GS} = -5V, I_{SD} = 22A, V_R = 400V, di/dt = 1.11kA/\mu s, T_j = 175^\circ\text{C}$
Reverse recovery charge	Q_{rr}	/	0.27	/	μC	
Peak reverse recovery current	I_{rrm}	/	16	/	A	

Electrical Characteristic Diagrams

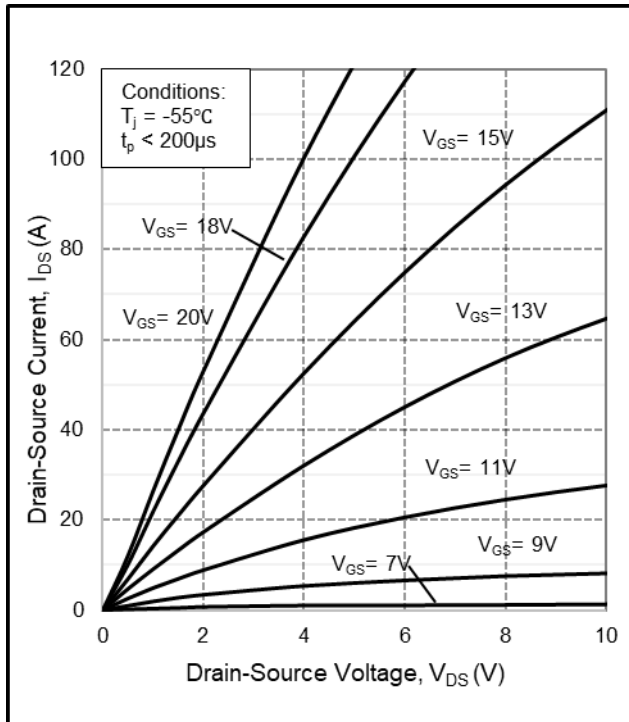


Figure 1. Output characteristics at $T_j = -55^\circ\text{C}$

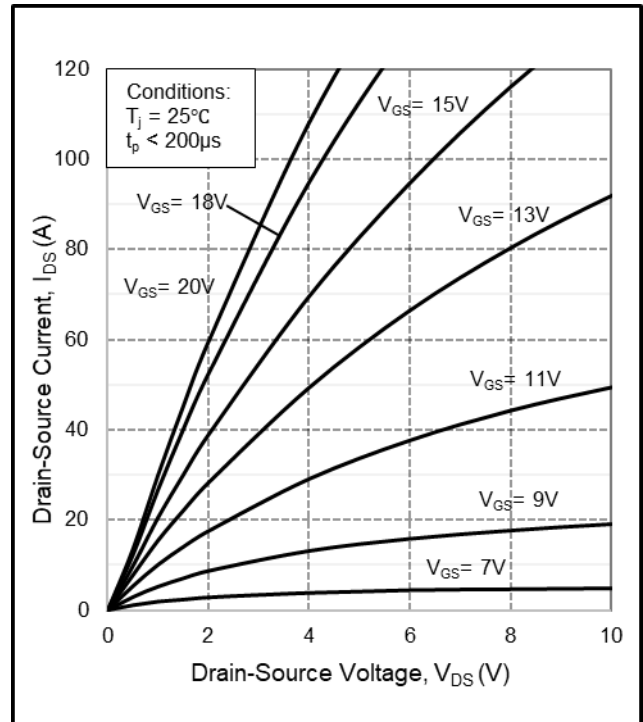


Figure 2. Output characteristics at $T_j = 25^\circ\text{C}$

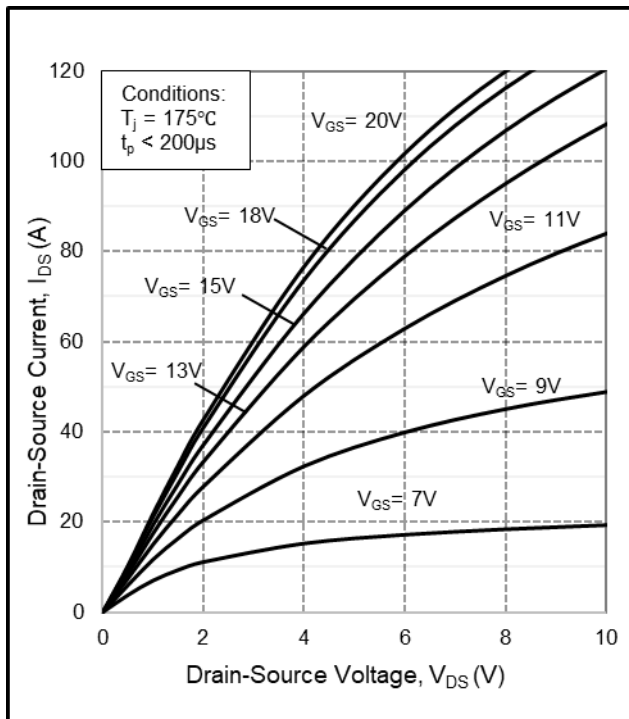


Figure 3. Output characteristics at $T_j = 175^\circ\text{C}$

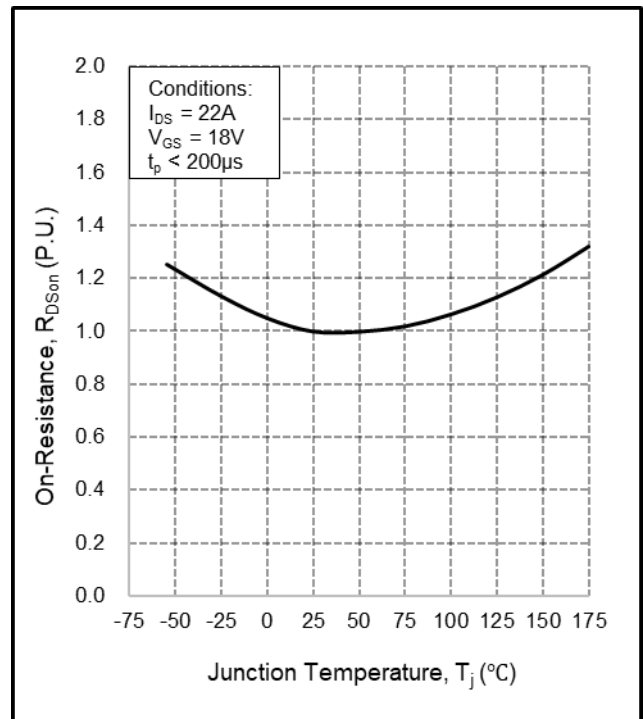


Figure 4. Normalized on-resistance vs. temperature

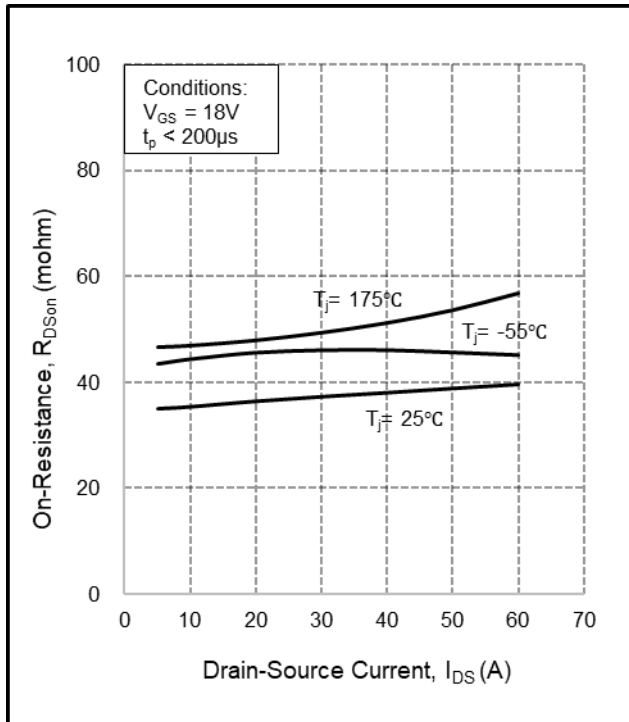


Figure 5. On-resistance vs. drain current
for various temperatures

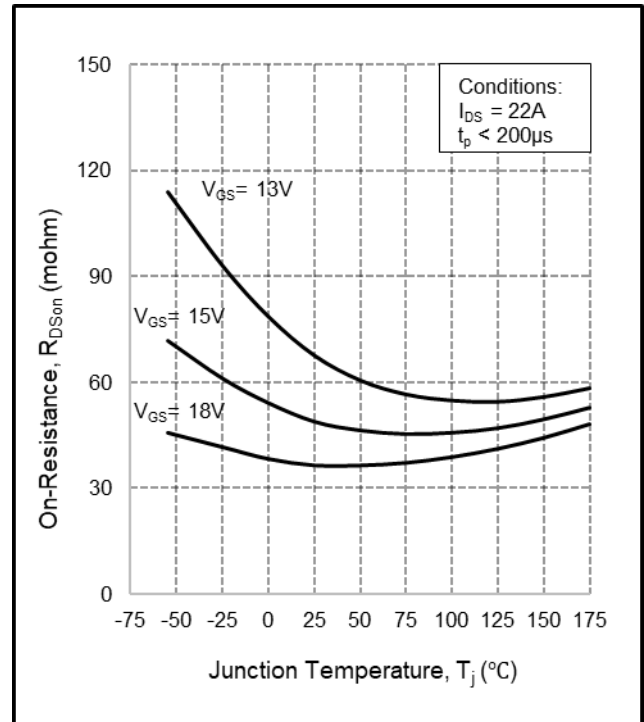


Figure 6. On-resistance vs. temperature
for various gate voltages

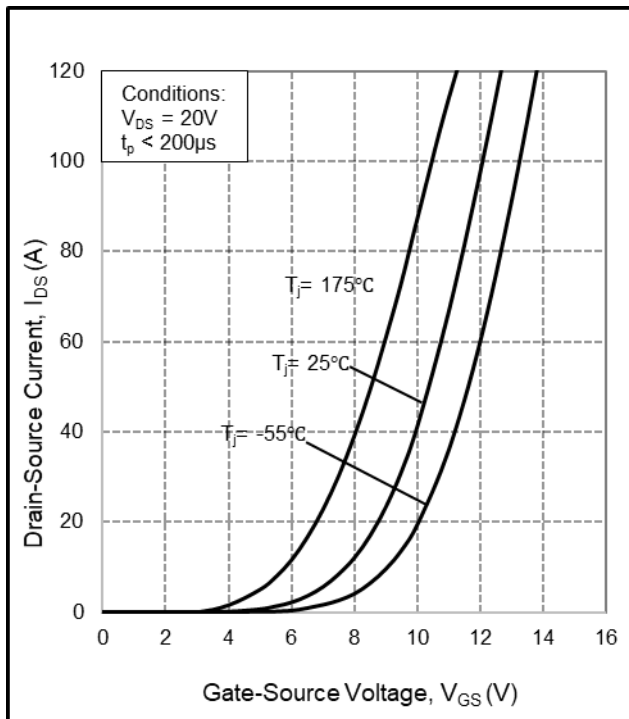


Figure 7. Transfer characteristic
for various junction temperatures

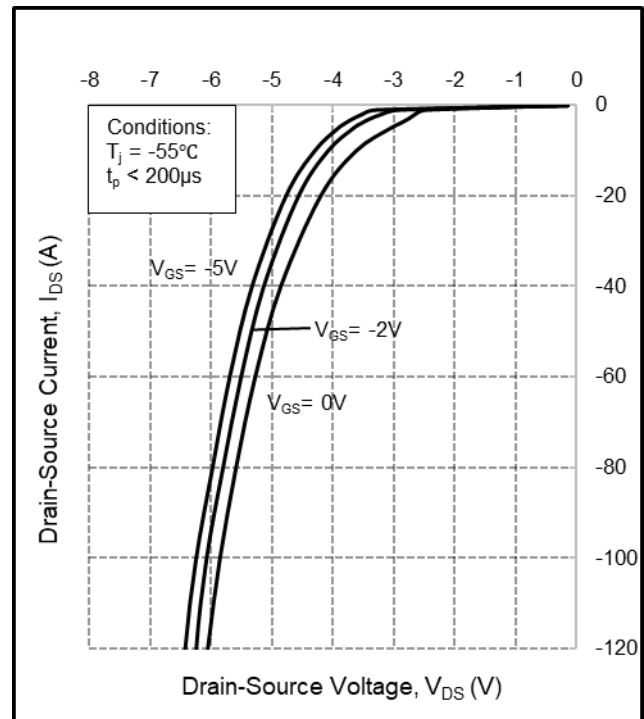


Figure 8. Body diode characteristic at $T_J = -55^\circ\text{C}$

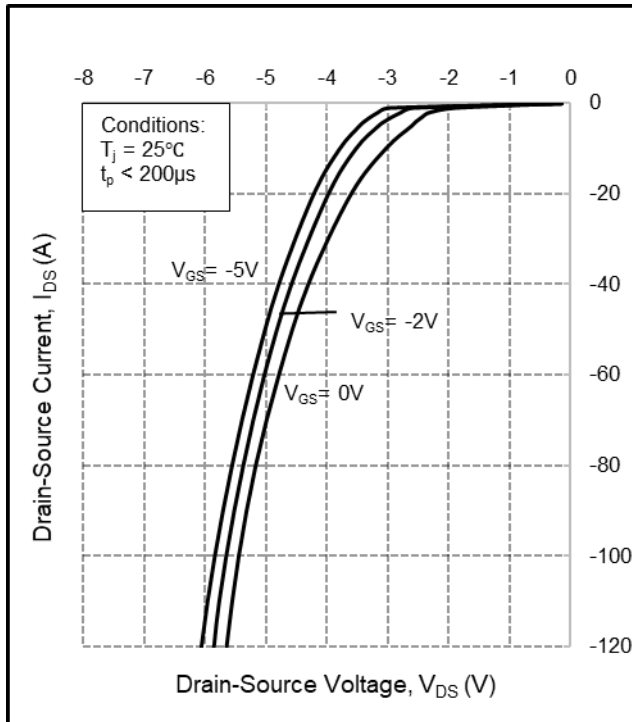


Figure 9. Body diode characteristic at $T_j = 25^\circ\text{C}$

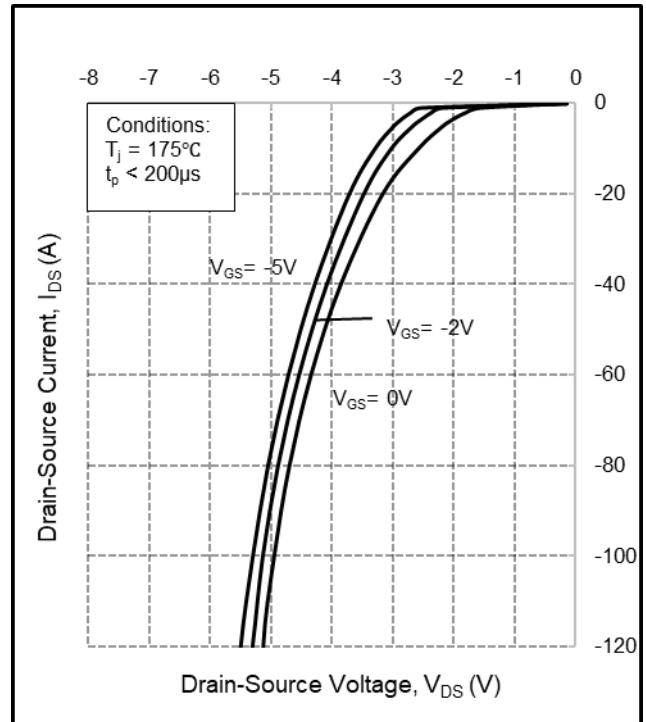


Figure 10. Body diode characteristic at $T_j = 175^\circ\text{C}$

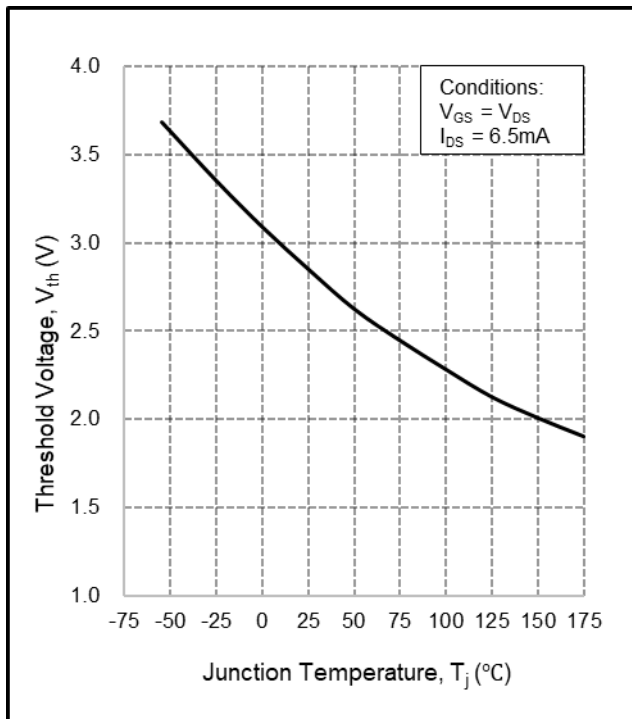


Figure 11. Threshold voltage vs. temperature

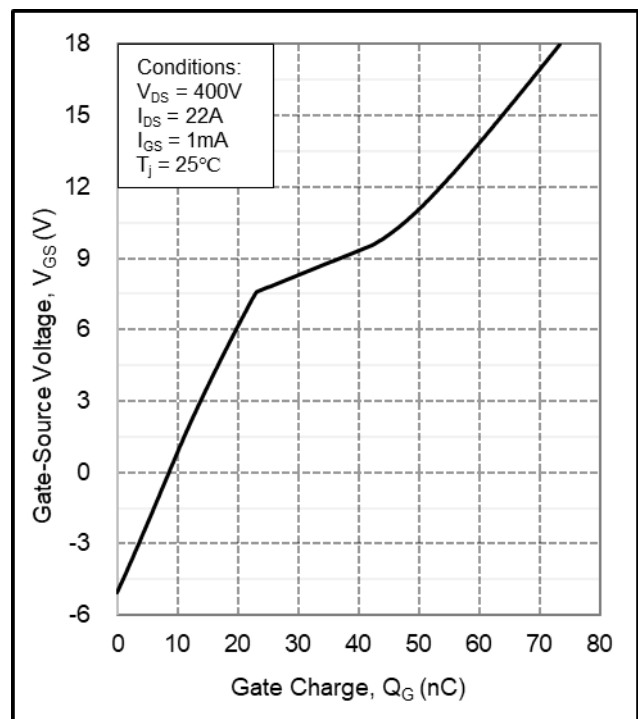


Figure 12. Gate Charge Characteristic

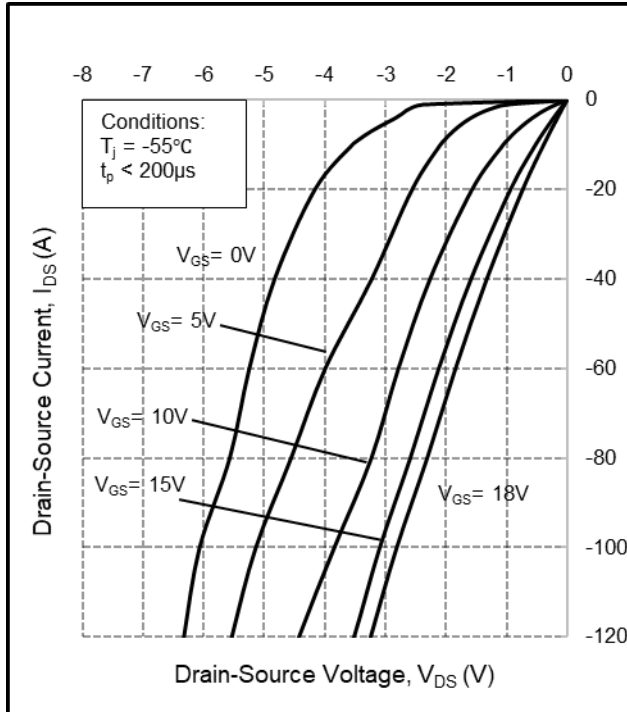


Figure 13. 3rd quadrant characteristic
at $T_j = -55^\circ\text{C}$

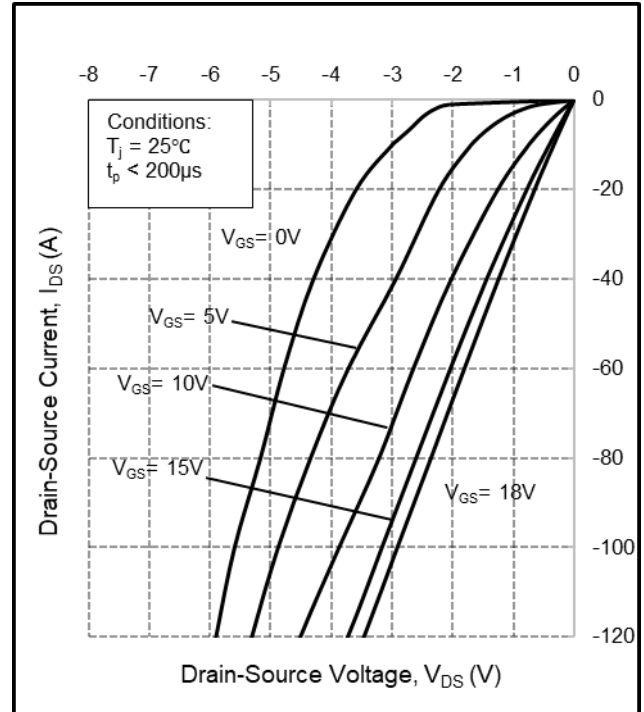


Figure 14. 3rd quadrant characteristic
at $T_j = 25^\circ\text{C}$

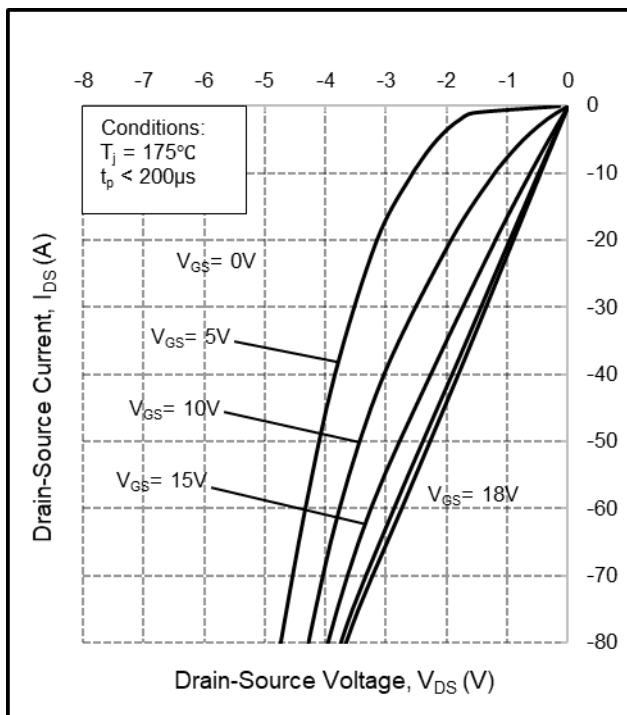


Figure 15. 3rd quadrant characteristic
at $T_j = 175^\circ\text{C}$

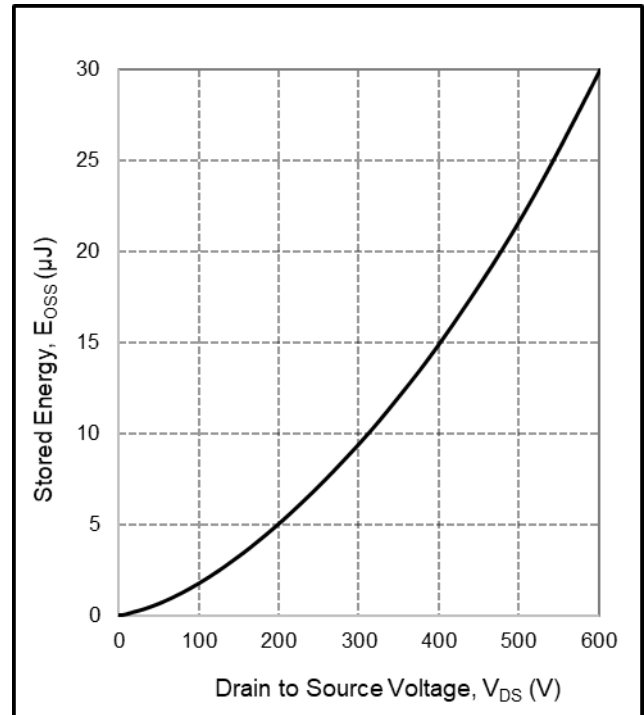


Figure 16. Output capacitor stored energy

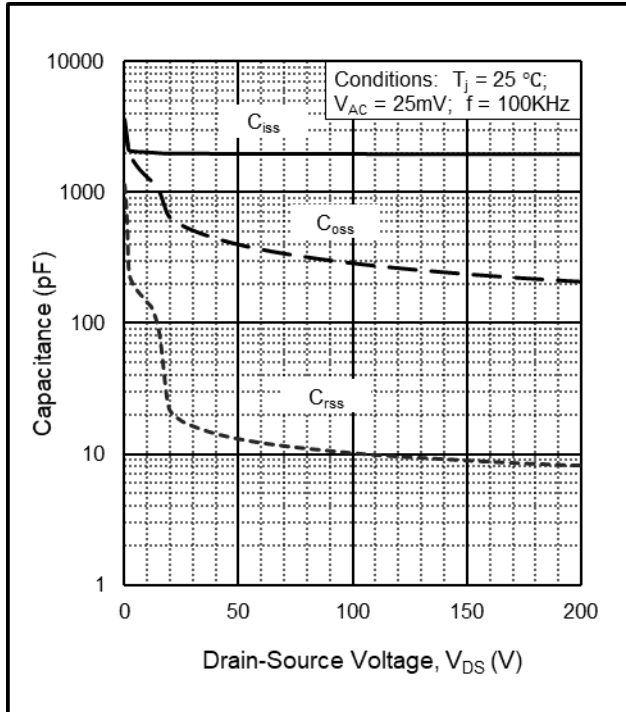


Figure 17. Capacitance vs. drain-source voltage
(0 - 200V)

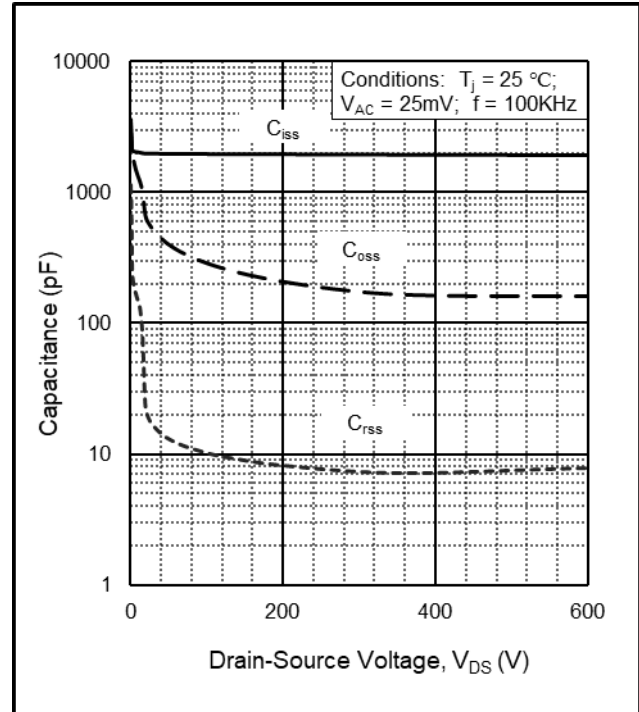


Figure 18. Capacitance vs. drain-source voltage
(0 - 600V)

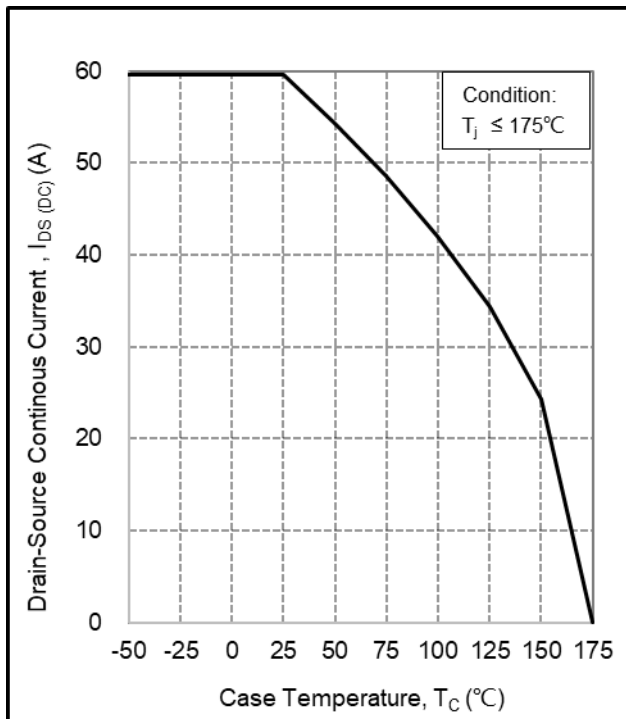


Figure 19. Continuous drain current derating
vs. temperature

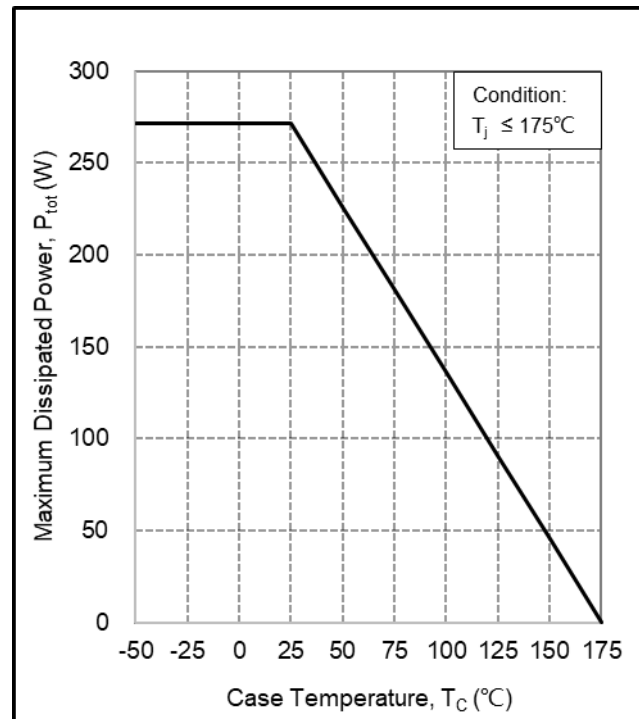


Figure 20. Maximum power dissipation derating
vs. temperature

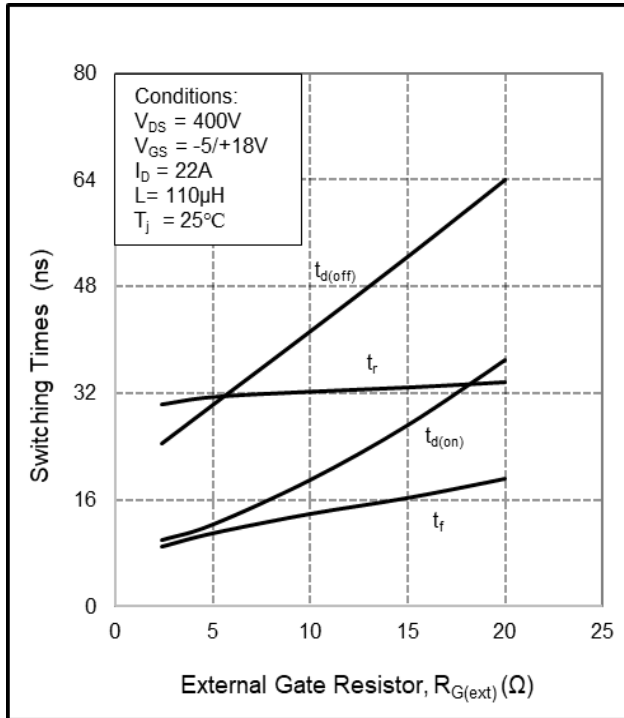


Figure 21. Switching Times vs. $R_{G(ext)}$

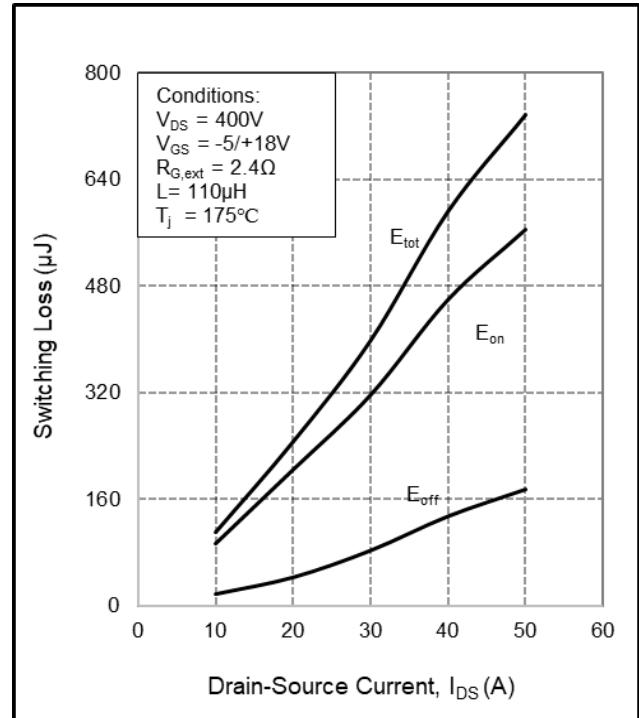


Figure 22. Clamped inductive Switching energy vs. drain current

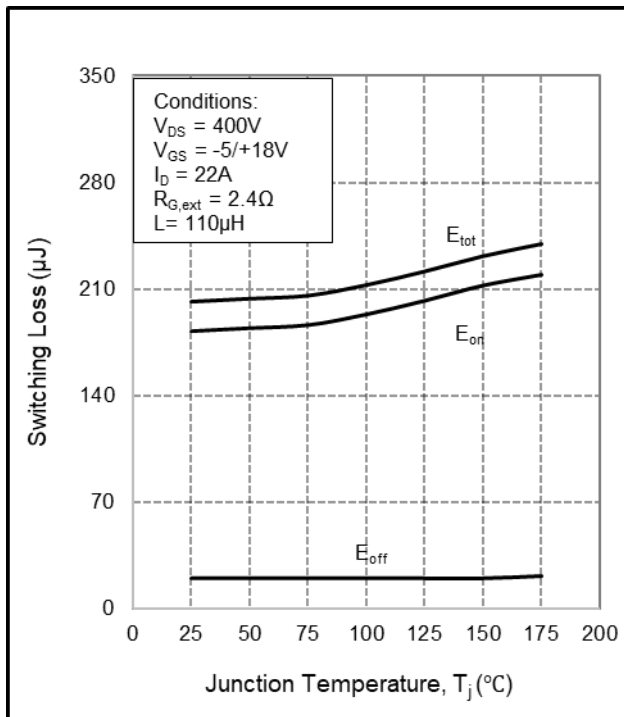


Figure 23. Clamped inductive Switching energy vs. temperature

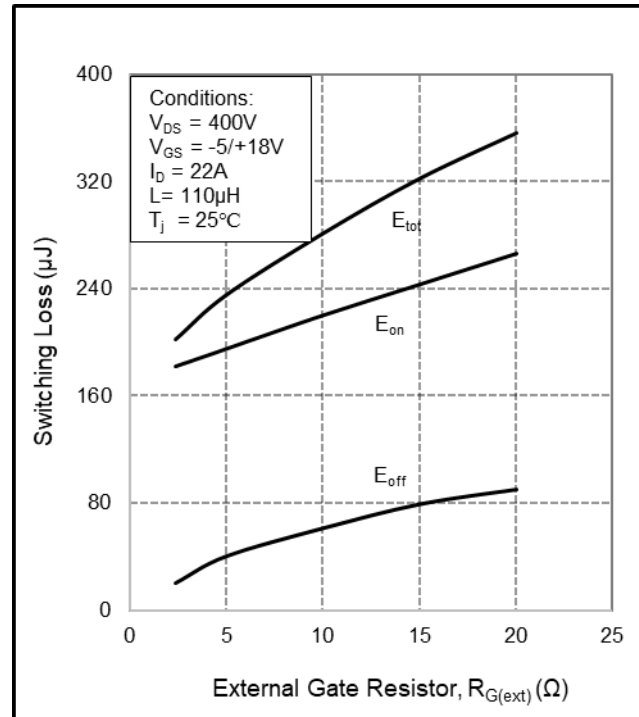


Figure 24. Clamped inductive Switching energy vs. $R_{G(ext)}$

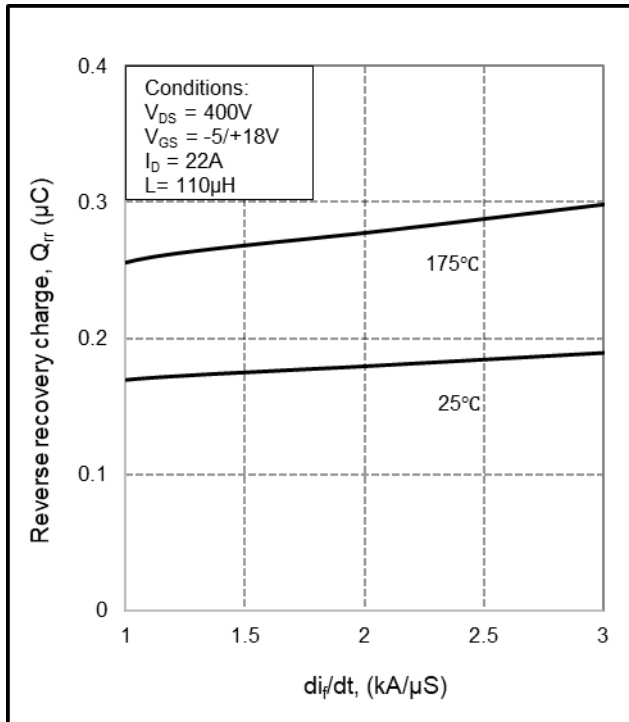


Figure 25. Reverse recovery charge vs. di/dt

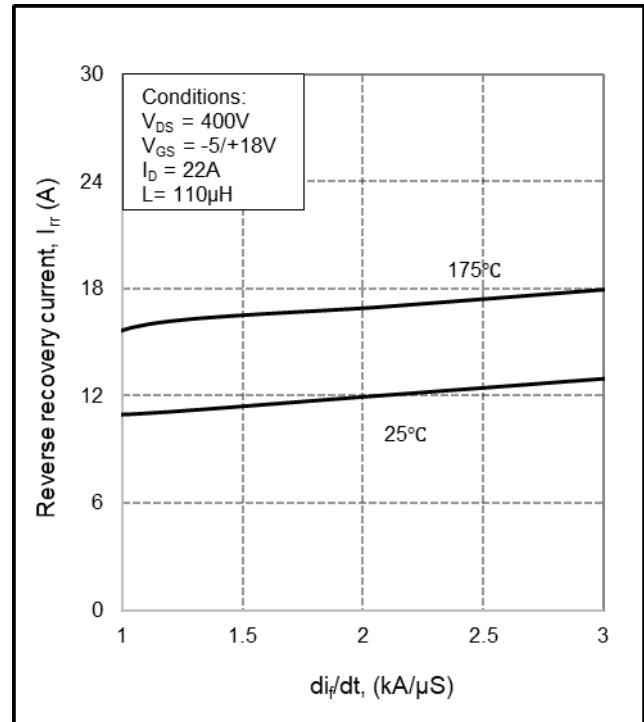


Figure 26. Reverse recovery current vs. di/dt

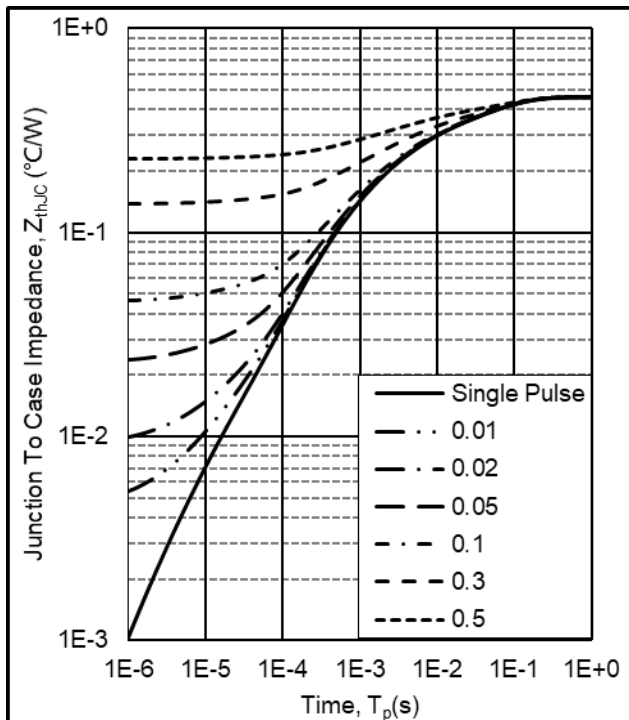


Figure 27. Transient thermal impedance
(Junction - Case)

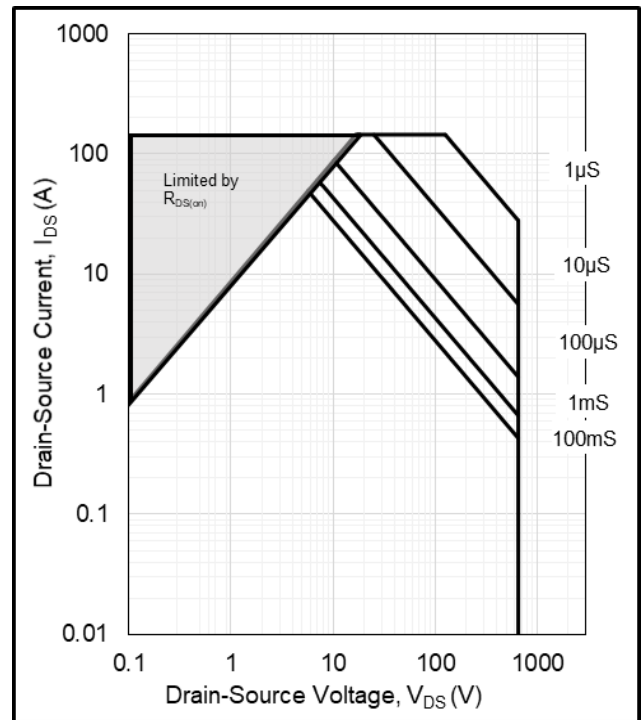


Figure 28. Safe Operating Area

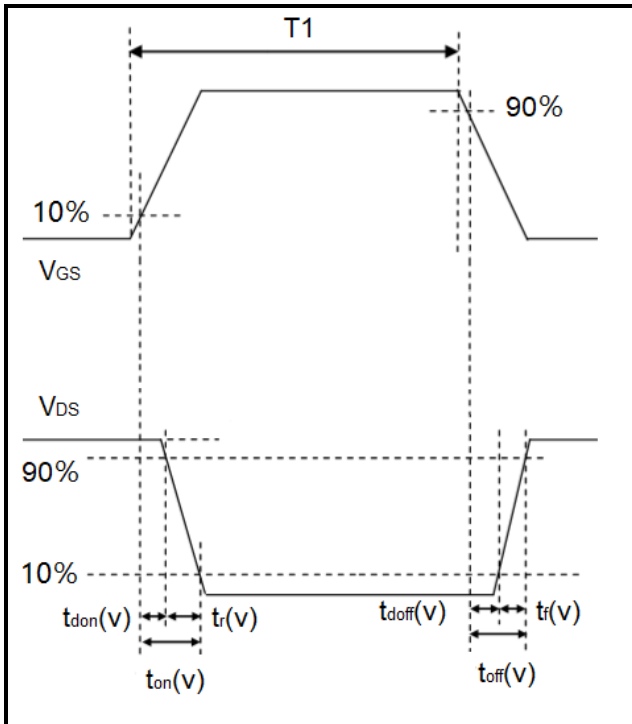


Figure 29. Switching times definition

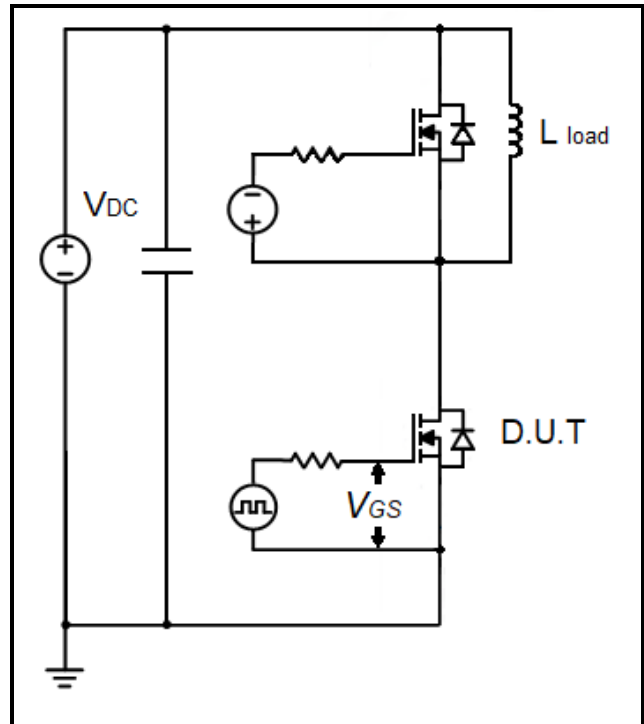
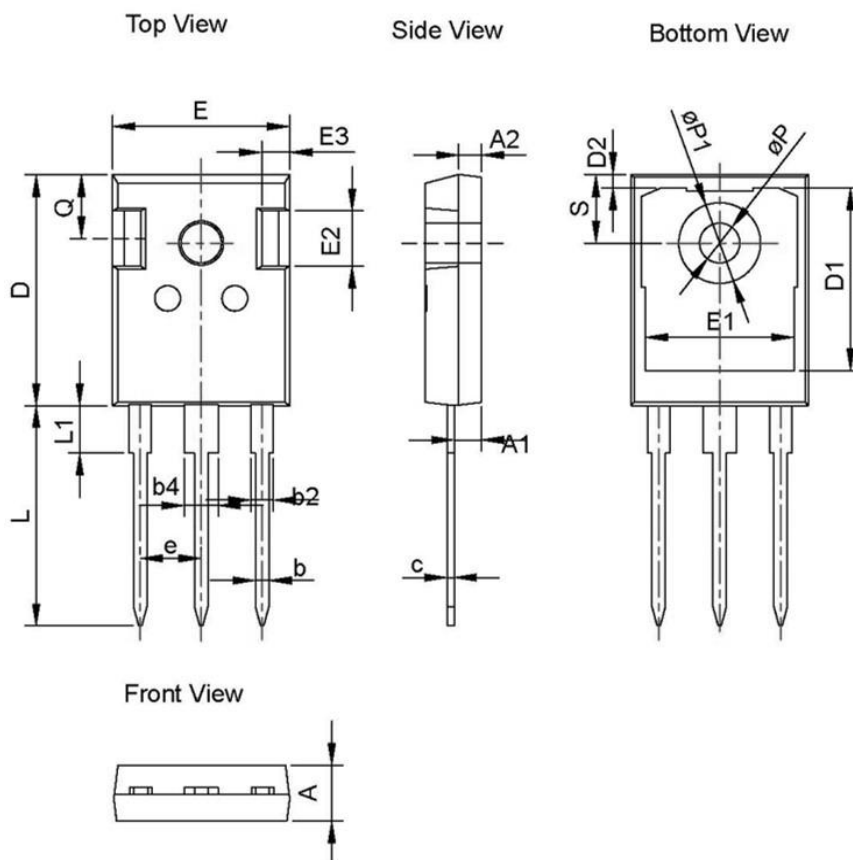


Figure 30. Clamped inductive switching waveform test circuit

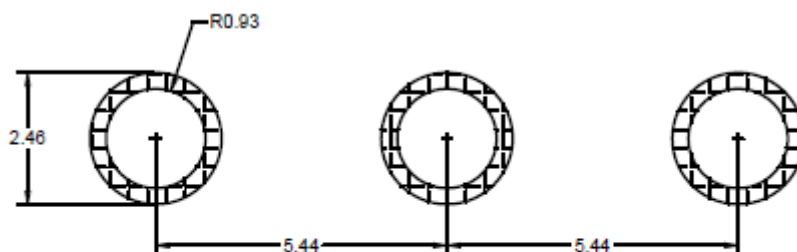
Package Information



Dimension unit: [mm]			
Symbol	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	0.60	0.75
D	20.70	21.00	21.30
D1	16.25	16.55	16.85
D2	1.00	1.20	1.35
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	5.44 BSC		
L	19.62	19.92	20.22
L1	-	-	4.30
øP	3.40	3.60	3.80
øP1	-	-	7.30
Q	5.40	5.80	6.20
S	6.20 BSC		

Recommended Solder Pad Layout

Note: All dimensions are in mm



TO-247-3L

Ordering Information

Part number	SMS0650035K-ISATH
Package	TO-247-3L
Unit quantity	300 EA
Packing type	Tube

Important Notices – Read Carefully

Before you use our products, you are requested to carefully read this document and fully understand its contents. Sanan Semiconductor Co., Ltd. shall not be in any way responsible or liable for failure, malfunction or accident arising from the use of Sanan's products.

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