

# 1200 V 135 mΩ SiC MOSFET

## Silicon Carbide MOSFET

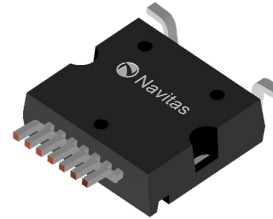
Trench-Assisted Planar Technology

$V_{DS}$	=	1200 V
$R_{DS(ON)}$ (Typ.)	=	135mΩ
$I_D$ ( $T_c = 100^\circ\text{C}$ )	=	13 A

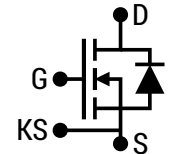
### Features

- Gen3F (3rd Generation) Technology
- Most Stable  $R_{DS(ON)}$  over Temperature
- Low  $C_{OSS}$ ,  $C_{RSS}$  and Balanced  $C_{ISS}/C_{RSS}$
- Lower  $Q_{GD}$  and Balanced  $R_{G(INT)}$
- Electromagnetically Optimized Design
- Robust Body Diode with Low  $V_F$  and Low  $Q_{RR}$
- Superior Cost-Performance Index
- AEC-Q101 Qual in Progress and PPAP Capable

### Package



HV-T2PAK



D = Drain (8-9, Tab)  
 G = Gate (1)  
 S = Source (3-7)  
 KS = Kelvin Source (2)



### Advantages

- Leading Performance and Robustness
- Lowest Conduction Losses at all Temperatures
- Lesser Switching Spikes and Lower Losses
- Faster and More Efficient Switching
- Reduced Ringing
- Ease of Paralleling without Thermal Runaway
- Excellent Power Density and System Efficiency
- Enhanced System Reliability

### Applications

- xEV - DC-DC
- Solar / PV
- Energy Storage Systems
- Uninterruptible Power Supply
- Motor Control

### Absolute Maximum Ratings (At $T_c = 25^\circ\text{C}$ Unless Otherwise Stated)

Parameter	Symbol	Conditions	Values	Unit	Note
Drain-Source Voltage	$V_{DS(max)}$	$V_{GS} = 0\text{ V}, I_D = 100\ \mu\text{A}$	1200	V	
Gate-Source Voltage (Dynamic)	$V_{GS(max)}$		-10 / +22	V	
Gate-Source Voltage (Static)	$V_{GS(op)-ON}$	Recommended Operation	18	V	Note 1
	$V_{GS(op)-OFF}$		-5 to -3		
Continuous Drain Current	$I_D$	$T_c = 25^\circ\text{C}, V_{GS} = -5 / +18\text{ V}$	18	A	Fig. 16
		$T_c = 100^\circ\text{C}, V_{GS} = -5 / +18\text{ V}$	13		
		$T_c = 135^\circ\text{C}, V_{GS} = -5 / +18\text{ V}$	9		
Pulsed Drain Current	$I_{D(pulse)}$	$t_p \leq 3\ \mu\text{s}, D \leq 1\%, V_{GS} = 18\text{ V}$	48	A	Note 2
Power Dissipation	$P_D$	$T_c = 25^\circ\text{C}$	87	W	Fig. 17
Non-Repetitive Avalanche Energy	$E_{AS}$	$L = 36\text{ mH}, I_{AV} = 2\text{ A}$	72	mJ	
Operating Junction and Storage Temperature	$T_j, T_{stg}$		-55 to 175	$^\circ\text{C}$	

Note 1: This product can support 0V turn-off gate drive voltage with optimized PCB layout and gate drive circuit configuration.

Note 2: Pulse Width  $t_p$  Limited by  $T_{j(max)}$

**NOTE:** This datasheet provides preliminary specifications. Parameters, conditions and values are subject to change.

**Electrical Characteristics (At  $T_C = 25^\circ\text{C}$  Unless Otherwise Stated)**

Parameter	Symbol	Conditions	Values			Unit	Note
			Min.	Typ.	Max.		
Drain-Source Breakdown Voltage	$V_{DSS}$	$V_{GS} = 0\text{ V}, I_D = 100\ \mu\text{A}$	1200			V	
Zero Gate Voltage Drain Current	$I_{DSS}$	$V_{DS} = 1200\text{ V}, V_{GS} = 0\text{ V}$		1	50	$\mu\text{A}$	
Gate Source Leakage Current	$I_{GSS}$	$V_{DS} = 0\text{ V}, V_{GS} = 22\text{ V}$ $V_{DS} = 0\text{ V}, V_{GS} = -10\text{ V}$			100 -100	nA	
Gate Threshold Voltage	$V_{GS(th)}$	$V_{DS} = V_{GS}, I_D = 5\text{ mA}$	2.2	3.1	4.3	V	Note 3
Transconductance	$g_{fs}$	$V_{DS} = 10\text{ V}, I_D = 8\text{ A}$ $V_{DS} = 10\text{ V}, I_D = 8\text{ A}, T_j = 175^\circ\text{C}$		4.4 4.3		S	Fig. 5
Drain-Source On-State Resistance	$R_{DS(on)}$	$V_{GS} = 18\text{ V}, I_D = 8\text{ A}$ $V_{GS} = 18\text{ V}, I_D = 8\text{ A}, T_j = 175^\circ\text{C}$		135 245	180	m $\Omega$	Fig. 6-9
Input Capacitance	$C_{iss}$			575			
Output Capacitance	$C_{oss}$			26		pF	Fig. 12
Reverse Transfer Capacitance	$C_{rss}$			2.5			
$C_{oss}$ Stored Energy	$E_{oss}$	$V_{DS} = 800\text{ V}, V_{GS} = 0\text{ V}$		10		$\mu\text{J}$	Fig. 13
$C_{oss}$ Stored Charge	$Q_{oss}$	$f = 500\text{ KHz}, V_{AC} = 25\text{ mV}$		37		nC	
Effective Output Capacitance (Energy Related)	$C_{o(er)}$			31		pF	Note 4
Effective Output Capacitance (Time Related)	$C_{o(tr)}$			46			
Gate-Source Charge	$Q_{gs}$	$V_{DS} = 800\text{ V}, V_{GS} = -5 / +18\text{ V}$		7			
Gate-Drain Charge	$Q_{gd}$	$I_D = 8\text{ A}$		7		nC	Fig. 11
Total Gate Charge	$Q_g$	Per JEDEC JEP-192		27			
Internal Gate Resistance	$R_{G(int)}$	$V_{GS} = 18\text{ V}, f = 1\text{ MHz}, V_{AC} = 25\text{ mV}$		1.3		$\Omega$	
Turn-On Switching Energy (Body Diode)	$E_{on}$	$T_j = 25^\circ\text{C}, V_{GS} = -5/+18\text{V}, R_{G(ext)} = 10\ \Omega, L = 160.0\ \mu\text{H}, I_D = 8\text{ A}, V_{DD} = 800\text{ V}$		53		$\mu\text{J}$	Fig. 24-27
Turn-Off Switching Energy (Body Diode)	$E_{off}$			10			
Turn-On Delay Time	$t_{d(on)}$			16			
Rise Time	$t_r$	$V_{DD} = 800\text{ V}, V_{GS} = -5/+18\text{V}$		8			
Turn-Off Delay Time	$t_{d(off)}$	$R_{G(ext)} = 10\ \Omega, L = 160.0\ \mu\text{H}, I_D = 8\text{ A}$		14		ns	Fig. 26
Fall Time	$t_f$	Timing relative to $V_{DS}$ , Inductive load		7			

Note 3: Tested after applying 30ms pulse at  $V_{GS} = +25\text{V}$

Note 4:  $C_{o(er)}$ , a lumped capacitance that gives same stored energy as  $C_{oss}$  while  $V_{DS}$  is rising from 0 to 800V.

$C_{o(tr)}$ , a lumped capacitance that gives same charging times as  $C_{oss}$  while  $V_{DS}$  is rising from 0 to 800V.

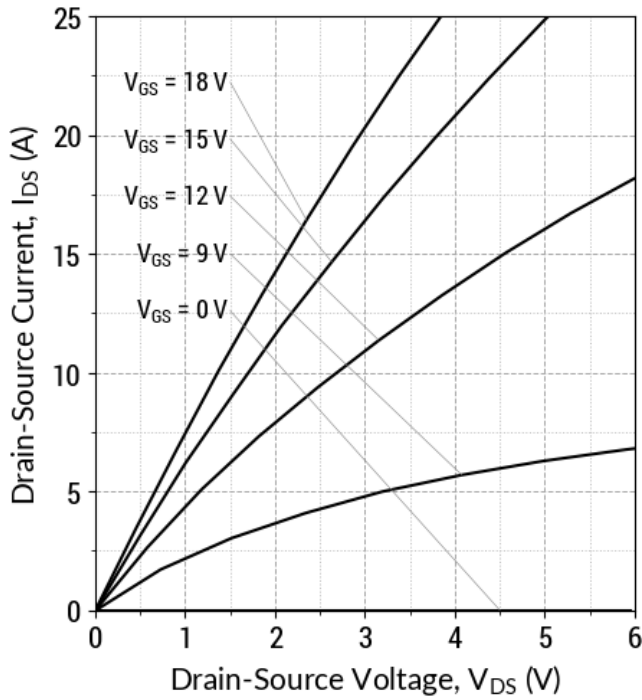
**Reverse Diode Characteristics**

Parameter	Symbol	Conditions	Values			Unit	Note
			Min.	Typ.	Max.		
Diode Forward Voltage	$V_{SD}$	$V_{GS} = -5\text{ V}, I_{SD} = 4\text{ A}$		4.4		V	Fig. 18-19
		$V_{GS} = -5\text{ V}, I_{SD} = 4\text{ A}, T_j = 175^\circ\text{C}$		3.9			
Continuous Diode Forward Current	$I_S$	$V_{GS} = -5\text{ V}, T_c = 25^\circ\text{C}$			13	A	
		$V_{GS} = -5\text{ V}, T_c = 100^\circ\text{C}$			8		
Diode Pulse Current	$I_{S(pulse)}$	$V_{GS} = -5\text{ V}$		32		A	Note 2
Reverse Recovery Time	$t_{rr}$			14		ns	
Reverse Recovery Charge	$Q_{rr}$	$V_{GS} = -5\text{ V}, I_{SD} = 8\text{ A}, V_R = 800\text{ V}$ $dif/dt = 2000\text{ A}/\mu\text{s}, T_j = 25^\circ\text{C}$		30		nC	
Peak Reverse Recovery Current	$I_{rm}$			2.3		A	
Reverse Recovery Time	$t_{rr}$			22		ns	
Reverse Recovery Charge	$Q_{rr}$	$V_{GS} = -5\text{ V}, I_{SD} = 8\text{ A}, V_R = 800\text{ V}$ $dif/dt = 2000\text{ A}/\mu\text{s}, T_j = 175^\circ\text{C}$		75		nC	
Peak Reverse Recovery Current	$I_{rm}$			3		A	

**Package Characteristics**

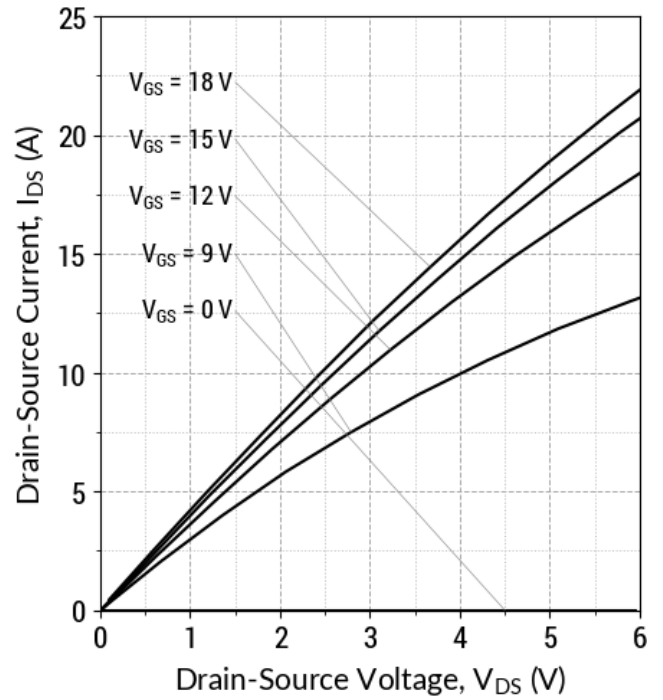
Parameter	Symbol	Conditions	Values	Unit	Note
Max Thermal Resistance, Junction - Case	$R_{thJC-Max}$	Maximum	1.73	$^\circ\text{C}/\text{W}$	Fig. 14
Weight	$W_T$		2.45	g	
Moisture Sensitivity Level	MSL		1		
EMC Material Group			II		

Fig 1: Typical Output Characteristics ( $T_j = 25^\circ\text{C}$ )



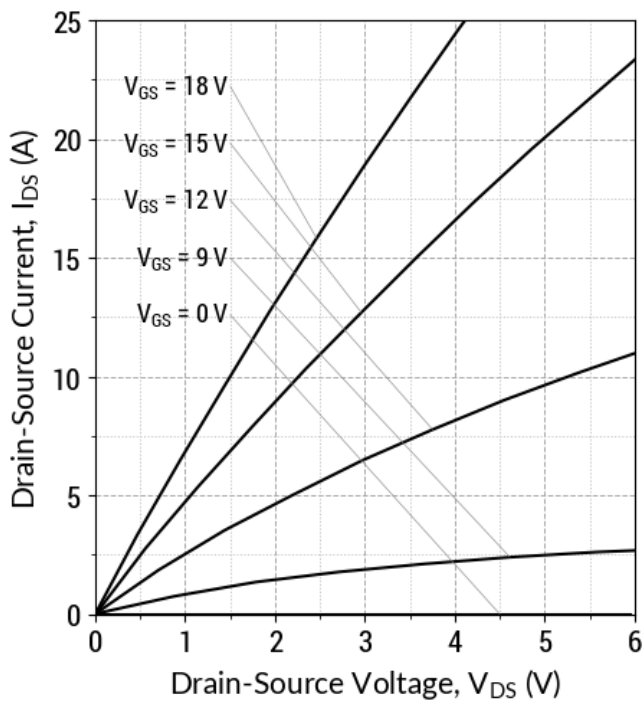
$I_D = f(V_{DS}, V_{GS}); t_p = 50 \mu\text{s}$

Fig 2: Typical Output Characteristics ( $T_j = 175^\circ\text{C}$ )



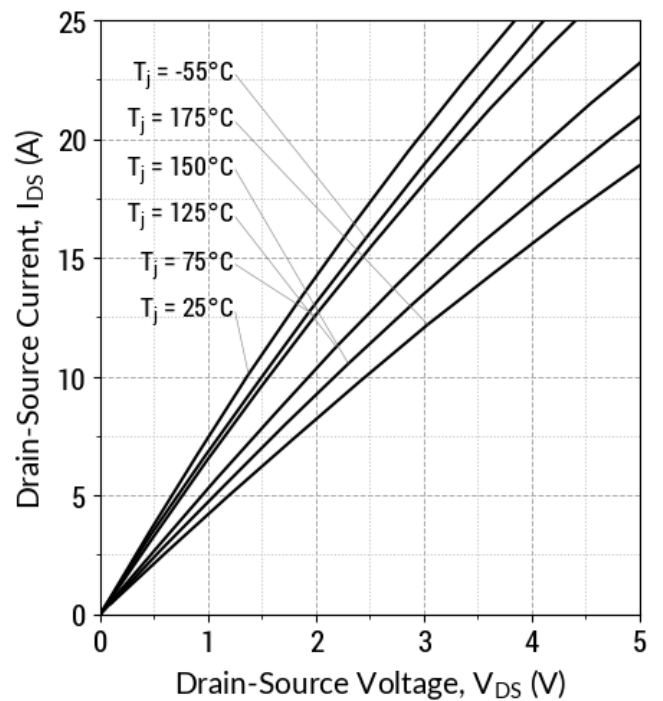
$I_D = f(V_{DS}, V_{GS}); t_p = 50 \mu\text{s}$

Fig 3: Typical Output Characteristics ( $T_j = -55^\circ\text{C}$ )



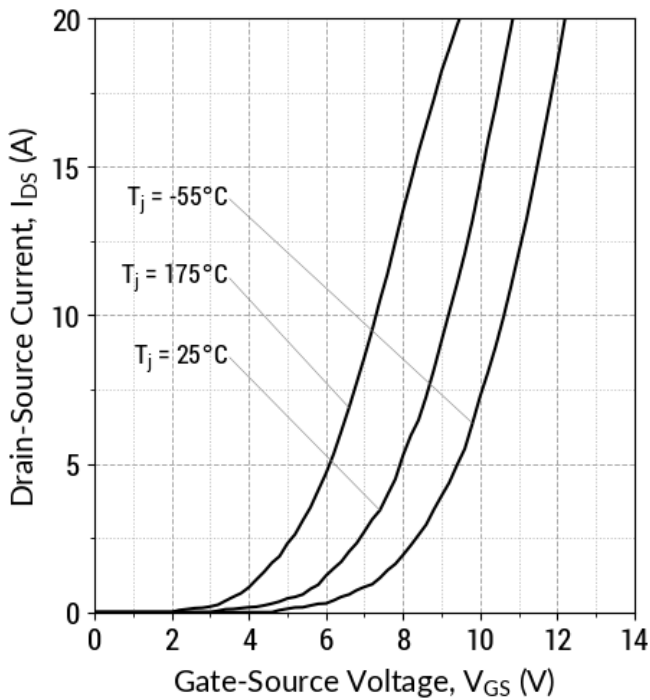
$I_D = f(V_{DS}, V_{GS}); t_p = 50 \mu\text{s}$

Fig 4: Typical Output Characteristics ( $V_{GS} = 18\text{V}$ )



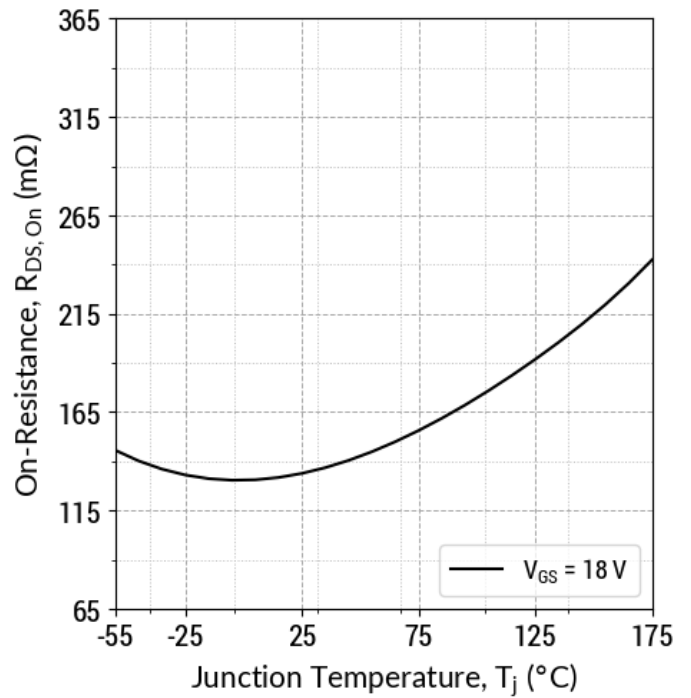
$I_D = f(V_{DS}, T_j); t_p = 50 \mu\text{s}$

Fig 5: Typical Transfer Characteristics ( $V_{DS} = 10\text{ V}$ )



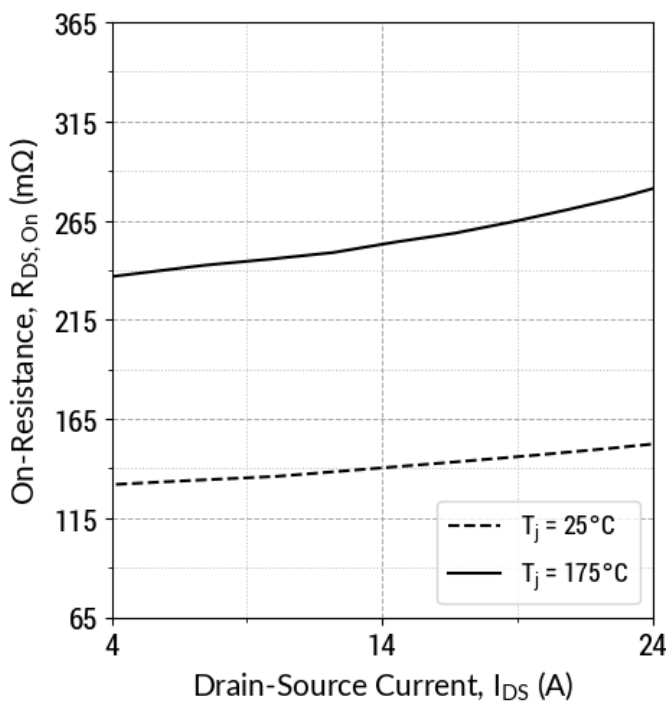
$I_D = f(V_{GS}, T_j); t_p = 100\ \mu\text{s}$

Fig 6: Typical  $R_{DS(ON)}$  v/s Temperature



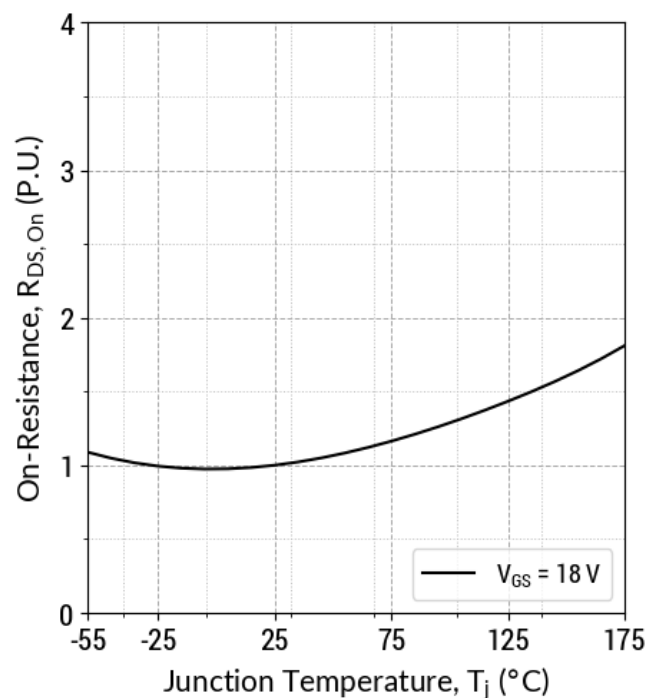
$R_{DS(ON)} = f(T_j, V_{GS}); t_p = 50\ \mu\text{s}; I_D = 8\text{ A}$

Fig 7: Typical  $R_{DS(ON)}$  v/s Drain Current



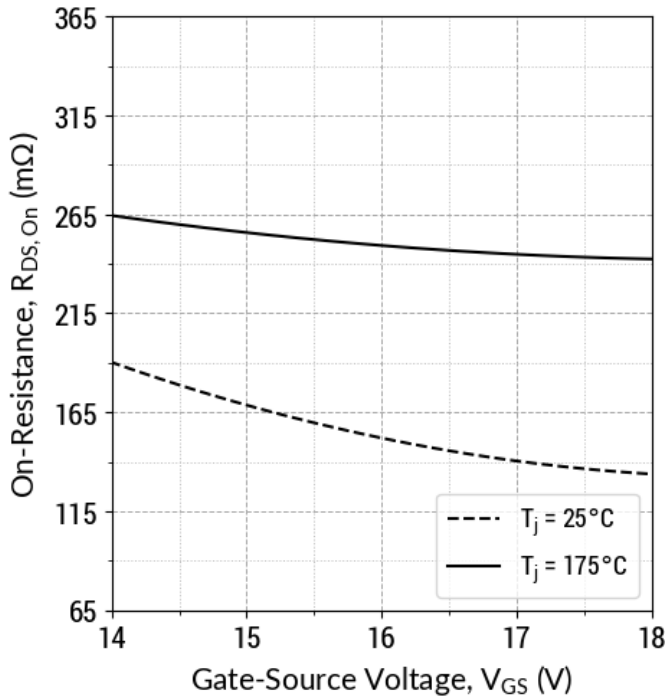
$R_{DS(ON)} = f(T_j, I_D); t_p = 50\ \mu\text{s}; V_{GS} = 18\text{ V}$

Fig 8: Typical Normalized  $R_{DS(ON)}$  v/s Temperature



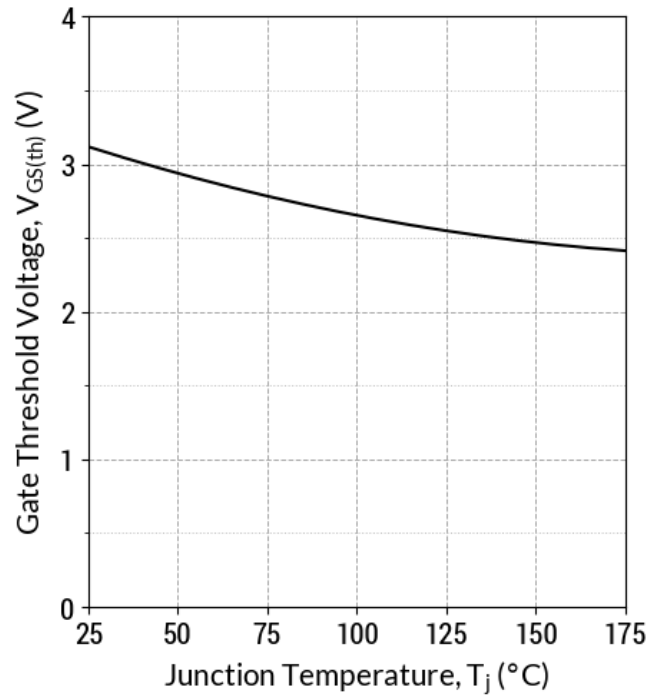
$R_{DS(ON)} = f(T_j); t_p = 50\ \mu\text{s}; I_D = 8\text{ A}$

Fig 9: Typical  $R_{DS(ON)}$  v/s Gate Voltage



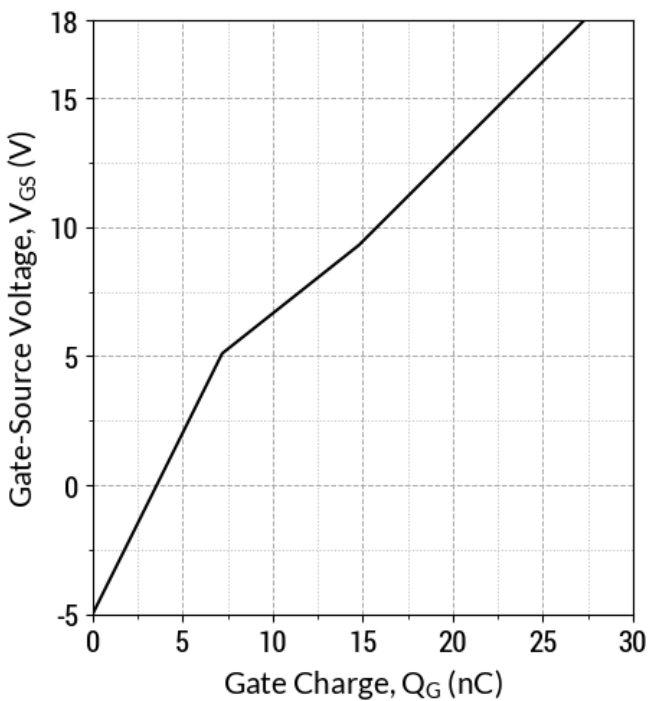
$R_{DS(ON)} = f(T_j, V_{GS}); t_P = 50 \mu\text{s}; I_D = 8 \text{ A}$

Fig 10: Typical Threshold Voltage Characteristics



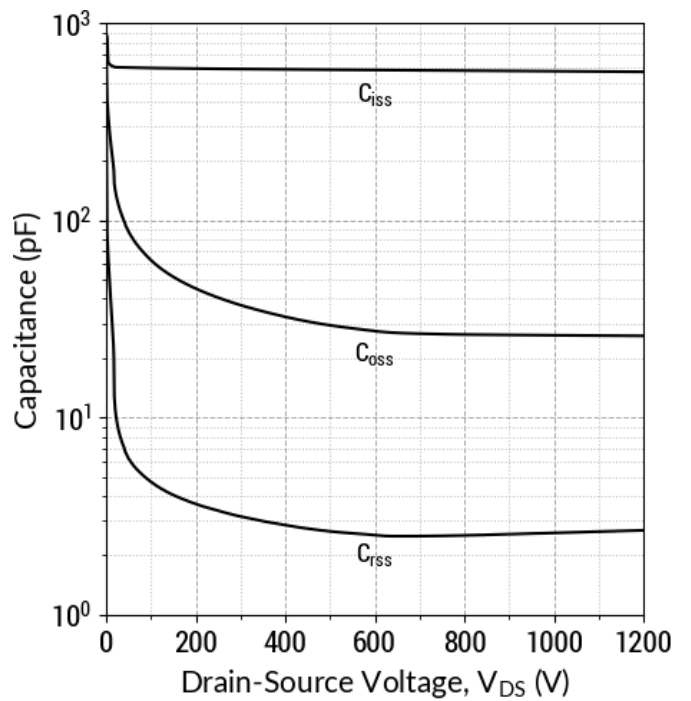
$V_{GS(th)} = f(T_j); V_{DS} = V_{GS}; I_D = 5 \text{ mA}$

Fig 11: Typical Gate Charge Characteristics



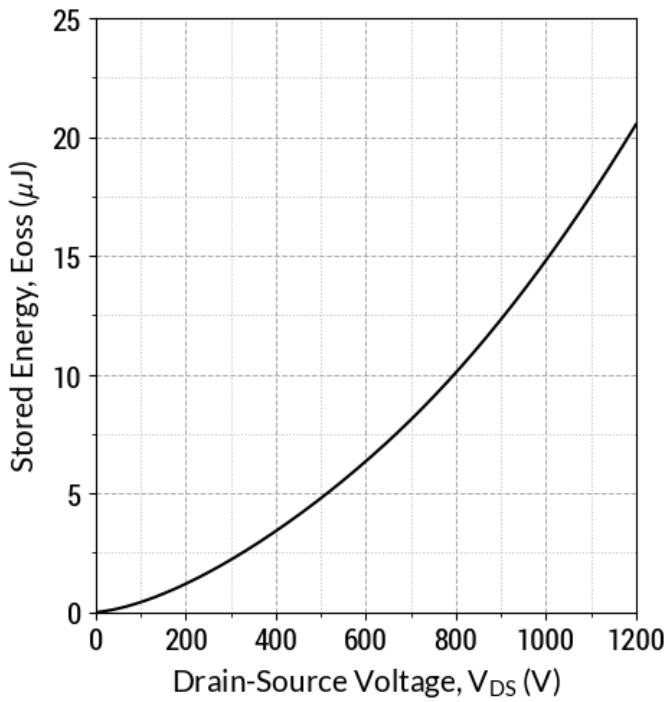
$I_D = 8 \text{ A}; V_{DS} = 800 \text{ V}; T_c = 25^\circ\text{C}$

Fig 12: Typical Capacitance v/s Drain-Source Voltage



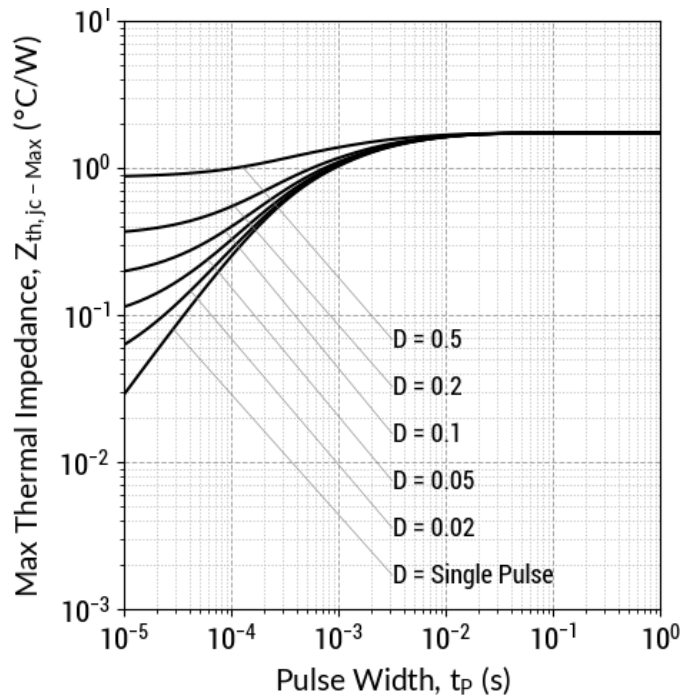
$f = 500 \text{ KHz}; V_{AC} = 25\text{mV}$

Fig 13: Output Capacitor Stored Energy



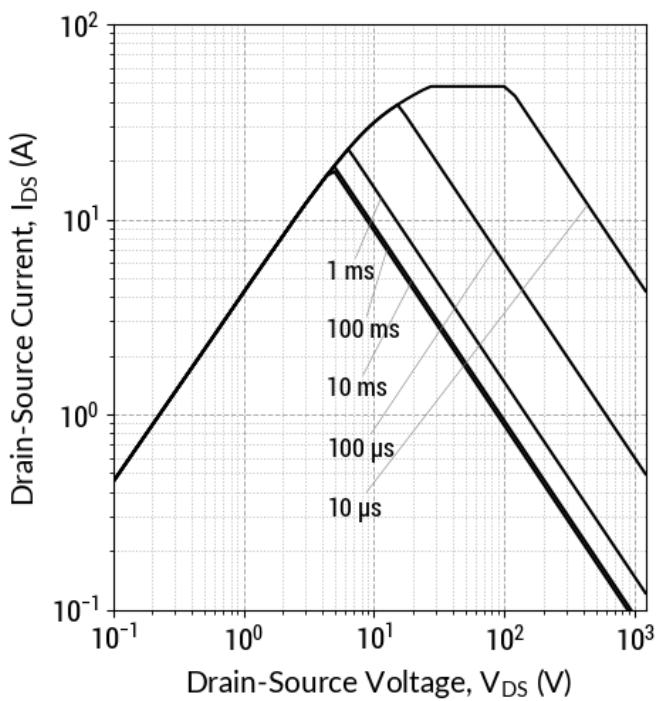
$E_{oss} = f(V_{DS})$

Fig 14: Max. Transient Thermal Impedance



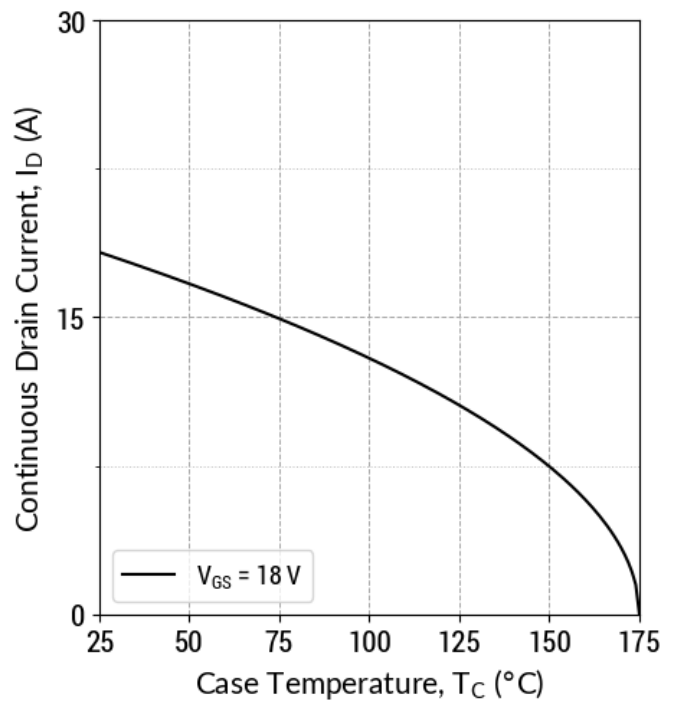
$Z_{th,jc} = f(t_p, D); D = t_p/T$

Fig 15: Safe Operating Area ( $T_c = 25^{\circ}C$ )



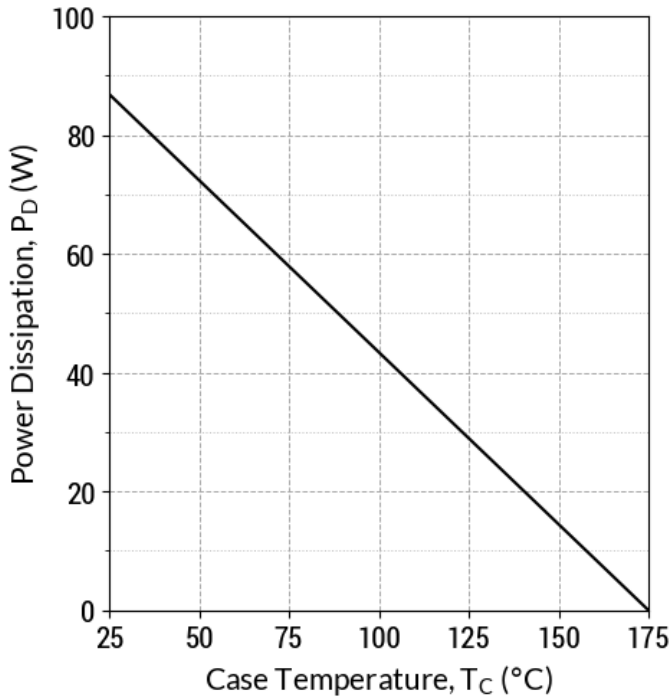
$I_D = f(V_{DS}, t_p); T_j \leq 175^{\circ}C; D = 0$

Fig 16: Current De-rating Curve



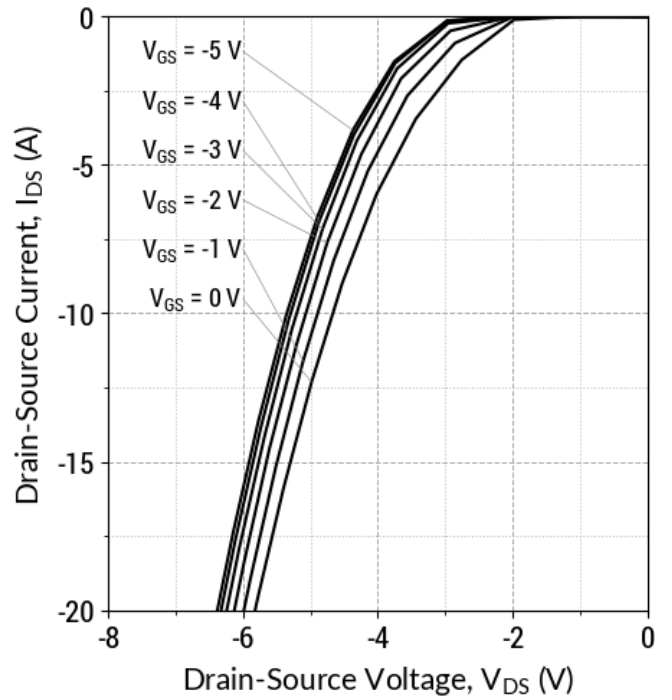
$I_D = f(T_C); T_j \leq 175^{\circ}C$

Fig 17: Power De-rating Curve



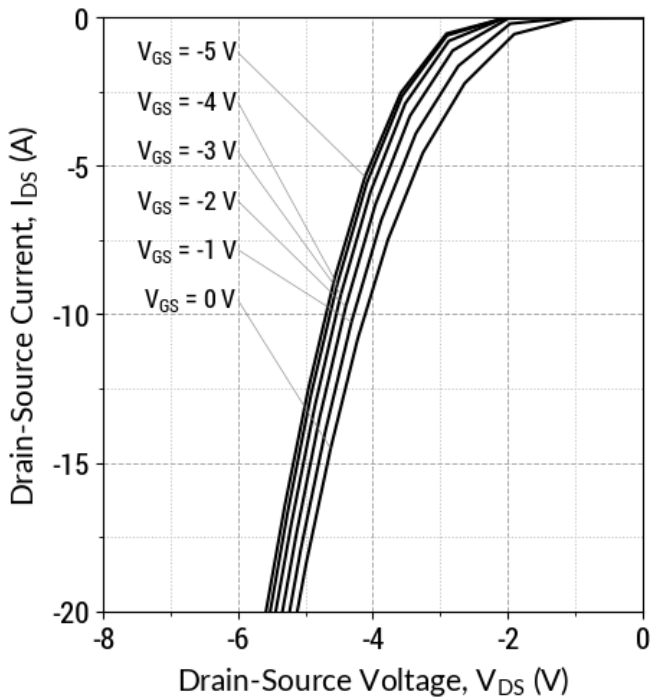
$P_D = f(T_C); T_j \leq 175^\circ\text{C}$

Fig 18: Typical Body Diode Characteristics ( $T_j = 25^\circ\text{C}$ )



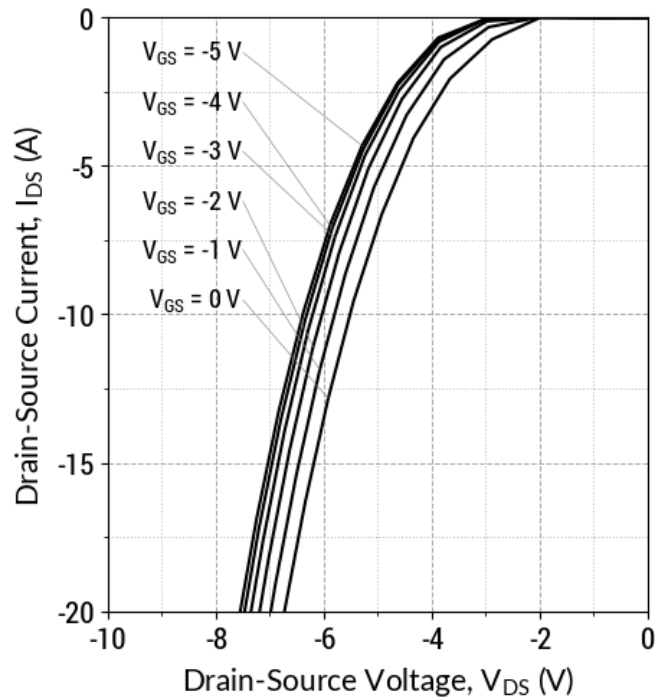
$I_D = f(V_{DS}, V_{GS}); t_P = 50 \mu\text{s}$

Fig 19: Typical Body Diode Characteristics ( $T_j = 175^\circ\text{C}$ )



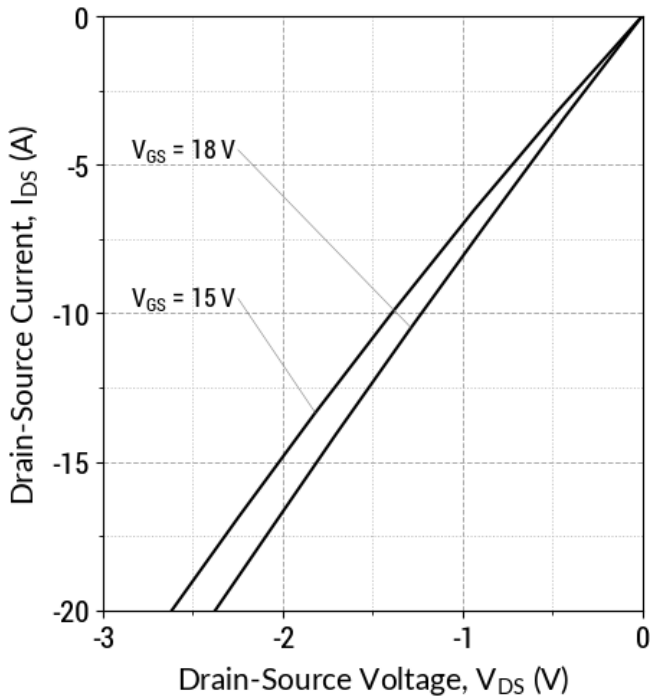
$I_D = f(V_{DS}, V_{GS}); t_P = 50 \mu\text{s}$

Fig 20: Typical Body Diode Characteristics ( $T_j = -55^\circ\text{C}$ )



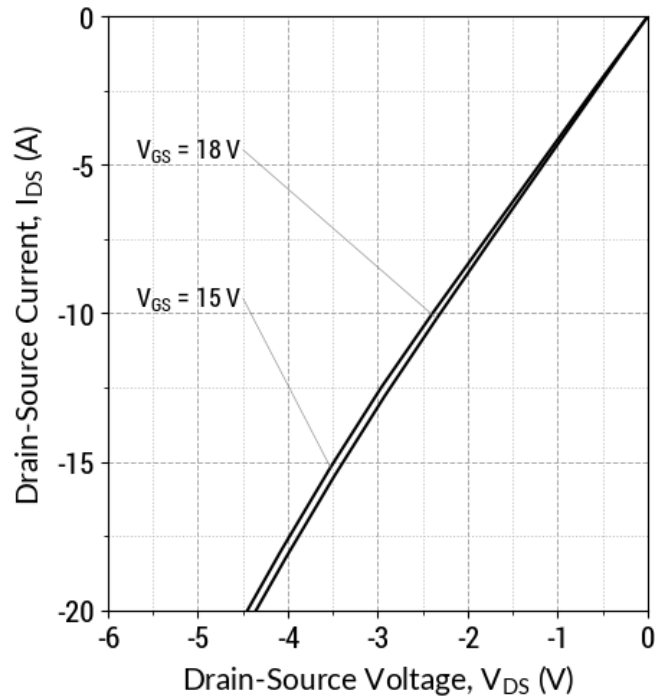
$I_D = f(V_{DS}, V_{GS}); t_P = 50 \mu\text{s}$

Fig 21: Typical Third Quadrant Characteristics ( $T_j = 25^\circ\text{C}$ )



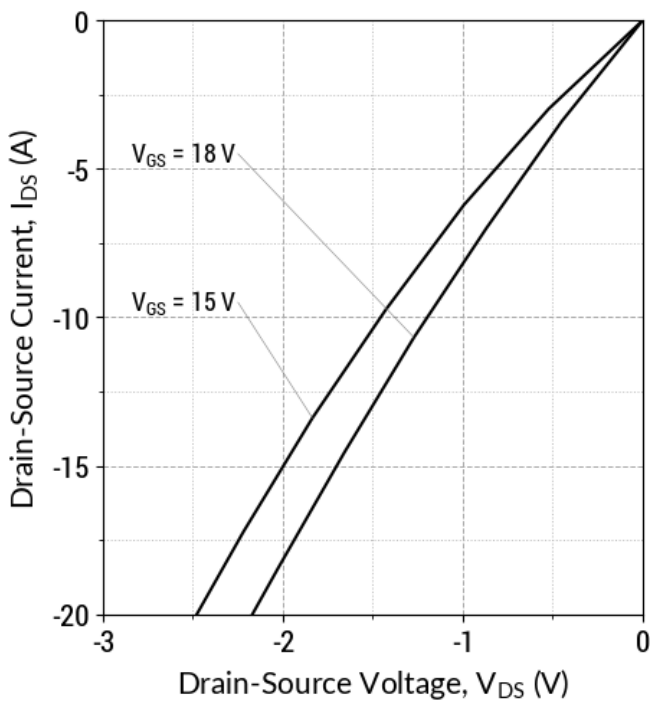
$I_D = f(V_{DS}, V_{GS}); t_P = 50 \mu\text{s}$

Fig 22: Typical Third Quadrant Characteristics ( $T_j = 175^\circ\text{C}$ )



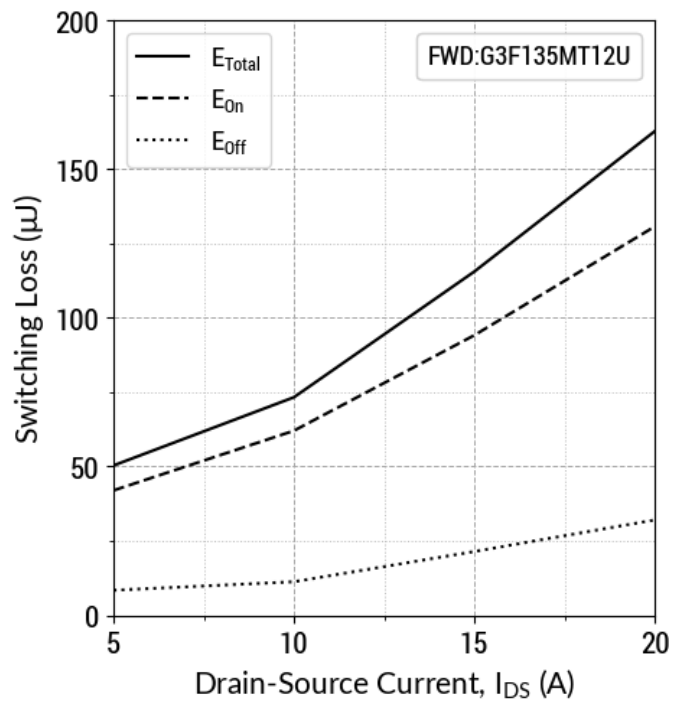
$I_D = f(V_{DS}, V_{GS}); t_P = 50 \mu\text{s}$

Fig 23: Typical Third Quadrant Characteristics ( $T_j = -55^\circ\text{C}$ )



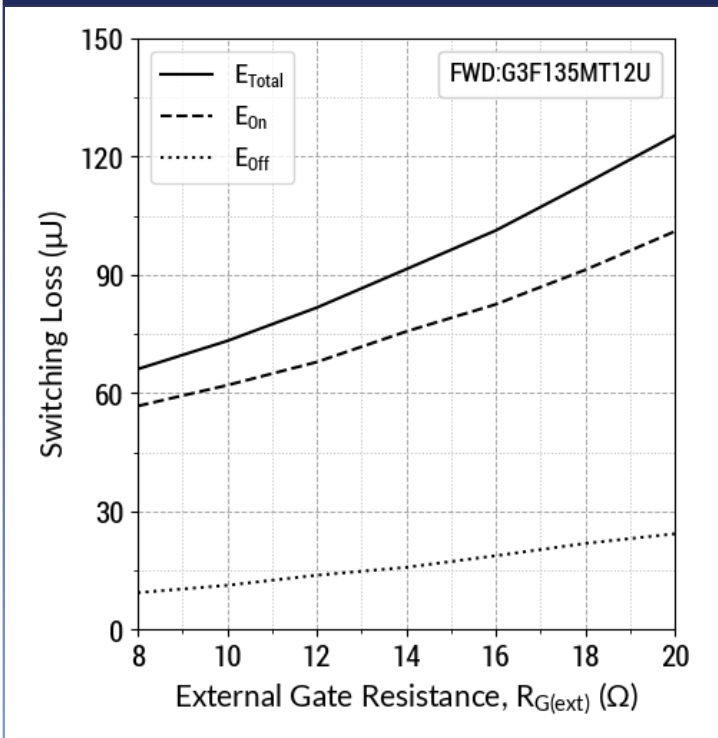
$I_D = f(V_{DS}, V_{GS}); t_P = 50 \mu\text{s}$

Fig 24: Inductive Switching Energy v/s Drain Current ( $V_{DD} = 800\text{V}$ )



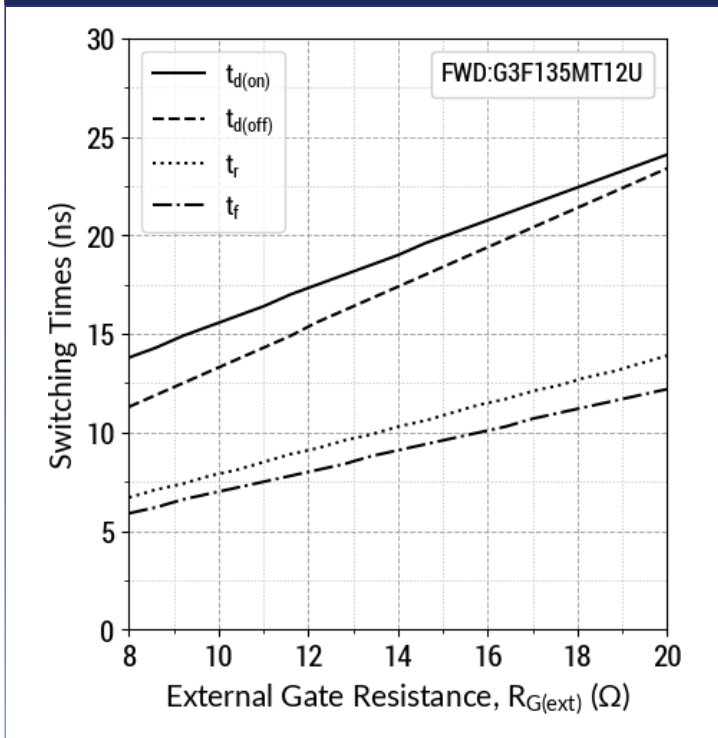
$T_j = 25^\circ\text{C}; V_{GS} = -5/+18\text{V}; R_{G(\text{ext})} = 10 \Omega; L = 160.0 \mu\text{H}$

Fig 25: Inductive Switching Energy v/s  $R_{G(ext)}$   
( $V_{DD} = 800V$ )



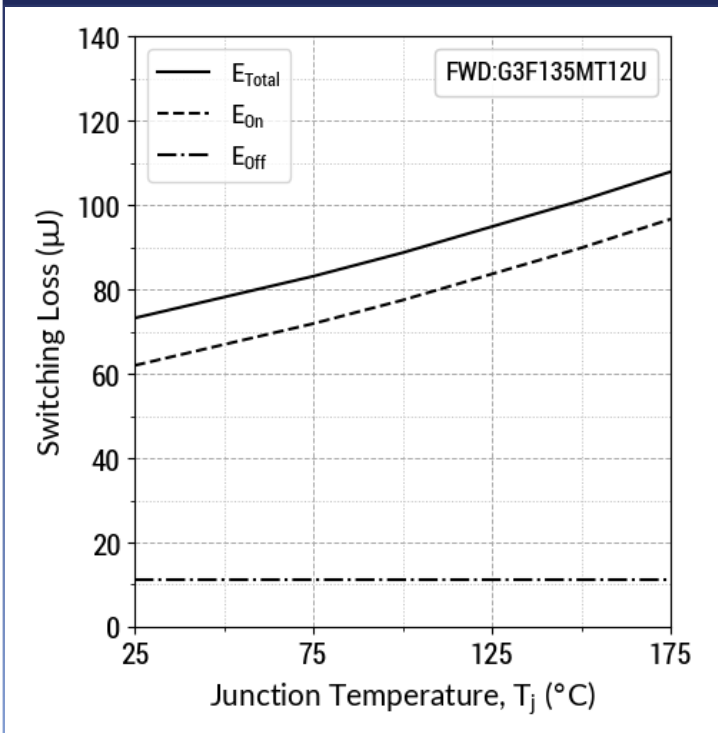
$T_j = 25^\circ C$ ;  $V_{GS} = -5/+18V$ ;  $I_{DS} = 8 A$ ;  $L = 160.0\mu H$

Fig 26: Switching Time v/s  $R_{G(ext)}$   
( $V_{DD} = 800V$ )



$T_j = 25^\circ C$ ;  $V_{GS} = -5/+18V$ ;  $I_{DS} = 8 A$ ;  $L = 160.0\mu H$

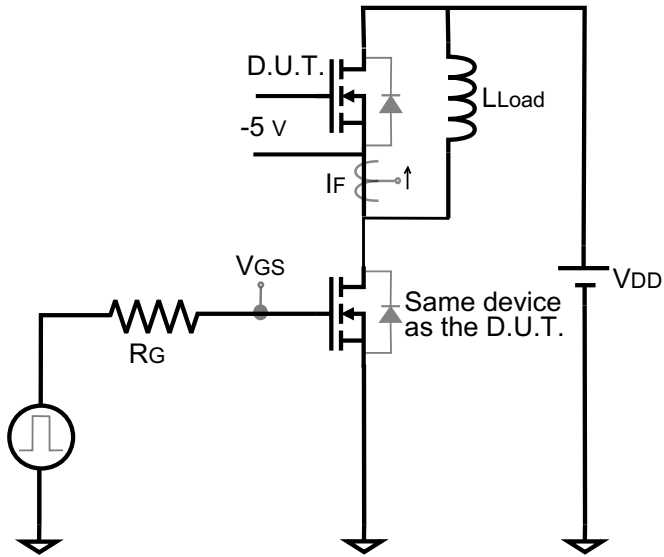
Fig 27: Inductive Switching Energy v/s Temperature  
( $V_{DD} = 800V$ )



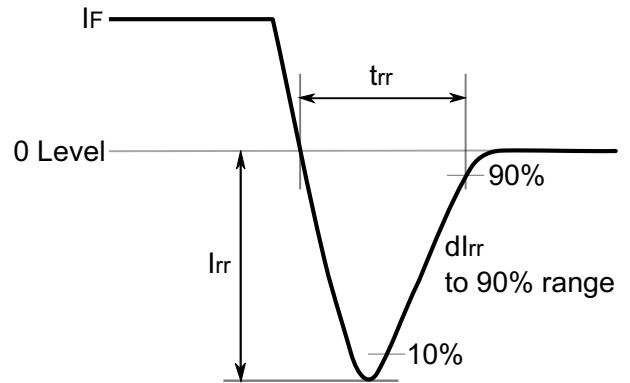
$T_j = 25^\circ C$ ;  $V_{GS} = -5/+18V$ ;  $R_{G(ext)} = 10 \Omega$ ;  $I_{DS} = 8 A$ ;  $L = 160.0\mu H$



Reverse Recovery Circuit



Reverse Recovery Waveform





## Revision History

- Rev 24/Sep: Initial Release (Rev 1.0)

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