fast SiC semiconductor

FF05130M2

Product Datasheet

Silicon Carbide MOSFET

500V, 130mΩ SiC MOSFET – Falcon M2 Series

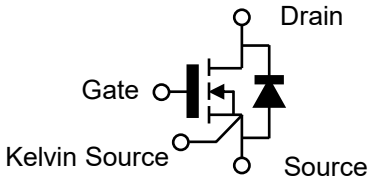
Features

- Optimized $R_{DS(on)}$ with Rapid Switching Behavior
- Compatible with Standard Gate Drivers
- Clean Kelvin-Source Switching Pin-out (TOLL, PDFN)
- High Avalanche Endurance Capability
- Optimized for High Power Density Applications
- RoHS Compliant and Halogen Free

Potential Applications

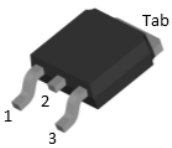
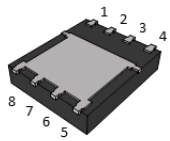
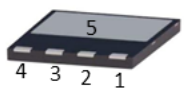
- Switching Mode Power Supply
- PFC & DC/DC Converter
- Portable Adaptor
- Renewable Energy
- Power Inverter
- Motor Driver

Product Information:



Benefits

- Higher System Efficiency
- Increase Parallel Device Convenience
- Enable High Temperature Application
- Allow High Frequency Operation
- Realize Compact and Lightweight Systems
- High Reliability

Product Information	Packaging Type			
	TO-252	PQFN 5x6	TOLL	PDFN 8x8
				
Gate	1	4	1	1
Drain	2, Tab	5, 6, 7, 8	Tab	5
Source	3	1, 2, 3	3, 4, 5, 6, 7, 8	3, 4
Kelvin Source	--	--	2	2
Part Number	FF05130M2A	FF05130M2B	FF05130M2F	FF05130M2G
Marking	FF05130M2	F05130M2	FF05130M2	FF05130M2
Continuous Drain Current	25A	26A	25A	23A

Key Performance Parameters

Parameter	Symbol	Value	Unit
Drain-Source Voltage	V_{DS} @$T_{j(max)}$	500	V
Recommended Gate-Source Turn-On Voltage	V_{GS}	12~15	
Drain-Source On-State Resistance	$R_{DS(on)}$	130	mΩ
Pulse Drain Current	$I_{D,pulse}$	47	A
Power Dissipation	P_{tot}	125	W
Avalanche Energy	E_{AS}	1250	mJ
Gate Charge	Q_G	22.5	nC
Output Capacitive Charge	Q_{oss}	26.6	
Junction & Storage Temperature	T_j, T_{stg}	-55 to 175	°C

For further information about comparable products, please contact (www.fastsic.com).

Maximum Ratings: (Tj = 25°C, unless otherwise specified)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Test Conditions	
Drain-Source Voltage	V_{DSS}	500	--	--	V	V_{GS}=0V, I_D=1mA	
Continuous Drain Current	I_D	--	--	26 19	A	V_{GS}=15V, T_C=25°C V_{GS}=15V, T_C=100°C	By package type[1]
Continuous Body Diode Current	I_S	--	--	21		*V_{GS}=0V, T_C=25°C*	
Pulse Drain Current	$I_{D,pulse}$	--	--	47		Per SOA	
Avalanche Energy, Single Pulse	E_{AS}	--	--	1250	mJ	L=25mH	
Operate Gate Source Voltage	$V_{GS,op}$	-8	--	12~15	V	Recommended operating values	
Transient Gate Source Voltage	$V_{GS,tran.}$	-10	--	19		Transient operating limit (AC f > 1Hz, pulse width < 100ns)	
Power Dissipation	P_{tot}	--	--	125	W	T_c = 25°C	
Junction Temperature	T_j	-55	--	175	°C	--	
Storage Temperature	T_{stg}	-55	--	175			
Soldering Temperature	T_L	--	--	260			

[1] *Per figure section 2~6*

Electrical Characteristics:

Parameter	Symbol	Min.	Typ.	Max.	Unit	Test Conditions
DC Characteristics (at T_j = 25°C, unless otherwise specified)						
Drain-source Breakdown Voltage	$V_{(BR)DSS}$	500	--	--	V	V_{GS}=0V, I_D=1mA, T_j=25°C
Drain-Source On-State Resistance	$R_{DS(on)}$	--	130	--	mΩ	V_{GS}=15V, I_D=6A, T_j=25°C
		--	142	--		V_{GS}=15V, I_D=6A, T_j=175°C
		--	191	--		V_{GS}=12V, I_D=6A, T_j=25°C
		--	163	--		V_{GS}=12V, I_D=6A, T_j=175°C
Gate-Source Threshold Voltage	V_{th}	--	2.5	--	V	V_{GS}=V_{DS}, I_D=6mA
Zero Gate Voltage Drain Current	I_{DSS}	--	<1	1000	μA	V_{DS}=500V, V_{GS}=0V, T_j=25°C
Gate-Source Leakage Current	I_{GSS}	--	--	100	nA	V_{GS}=15V, V_{DS}=0V
Body Diode Forward Voltage	V_{SD}	--	3.2	--	V	V_{GS}=0V, I_S=3A, T_j=25°C
		--	2.6	--		V_{GS}=0V, I_S=3A, T_j=175°C
AC Characteristics (at T_j = 25°C, unless otherwise specified)						
Input Capacitance	C_{iss}	--	669.8	--	pF	V_{DS}=300V, V_{GS}=0V, f=250kHz, V_{AC}=25mV
Output Capacitance	C_{oss}	--	50.9	--		
Reverse Capacitance	C_{rss}	--	3.9	--		
Effective Output Capacitance, energy related	$C_{o(er)}$[1]	--	59.4	--		
Effective Output Capacitance, time related	$C_{o(tr)}$[2]	--	88.9	--		
C_{oss} Stored Energy	E_{oss}	--	2.7	--	μJ	
Output Capacitive Charge	Q_{oss}	--	26.6	--	nC	
Internal Gate Resistance	$R_{G,int.}$	--	5.5	--	Ω	f=1MHz, V_{AC}=25mV

[1] $C_{o(er)}$ is a fixed capacitance that gives the same stored energy as C_{oss} while V_{DS} is rising from 0 to 300V.

[2] $C_{o(tr)}$ is a fixed capacitance that gives the same charging time as C_{oss} while V_{DS} is rising from 0 to 300V.

Switching Characteristics:

Parameter	Symbol	Min.	Typ.	Max.	Unit	Test Conditions
Gate Characteristics						
Gate to Source Charge	Q_{GS}	--	5.5	--	nC	V_{DS}=300V, V_{GS}=0V/+15V, I_D=6A
Gate to Drain Charge	Q_{GD}	--	6.9	--		
Total Gate Charge	Q_G	--	22.5	--		
Inductive Load						
Turn On Delay Time	$t_{d(on)}$	--	15.5	--	nC	V_{DS}=300V, I_D=6A, V_{GS}=0/+15V, $R_{G(ext.)}$= 4.7Ω
Rise Time	t_r	--	16.9	--		
Turn Off Delay Time	$t_{d(off)}$	--	18.0	--		
Fall Time	t_f	--	10.7	--		
Turn On Switching Energy	E_{on}	--	53.3	--		
Turn Off Switching Energy	E_{off}	--	2.5	--		
Body Diode Characteristics						
Forward Recovery Charge	Q_{fr}	--	81.1	--	nC	V_{GS}=0V, I_S=6A, V_{DS}=300V, di/dt= 1360A/μs *Q_{fr} herein excluded the Q_{oss} value.
Forward Recovery Time	t_{fr}	--	15.9	--	ns	
Peak Foreard Recovery Current	I_{frm}	--	10.2	--	A	

[1] Test are based on TO-220-3L PKG

Thermal Characteristics:

Parameter	Symbol	Min.	Typ.	Max.	Unit	Test Conditions
Thermal Impedance, junction-case	$R_{th\text{-}jc}$	--	1.28	--	K/W	*TO-252*
		--	1.20	--		*PQFN 5x6*
		--	1.29	--		*TOLL*
		--	1.51	--		*PDFN 8x8*
Thermal Impedance, junction-ambient	$R_{th\text{-}ja}$	--	40	--		*Device on PCB, with 6 cm² of cooling area*

1. Electrical Characteristics Diagrams

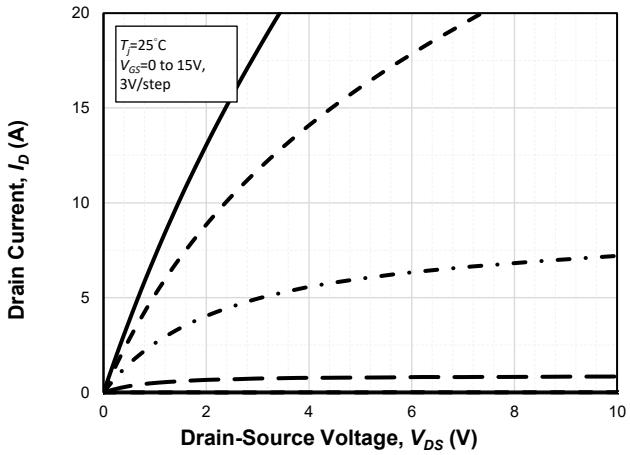


Fig. 1-1 Typical Output Characteristics at T_j=25˚C

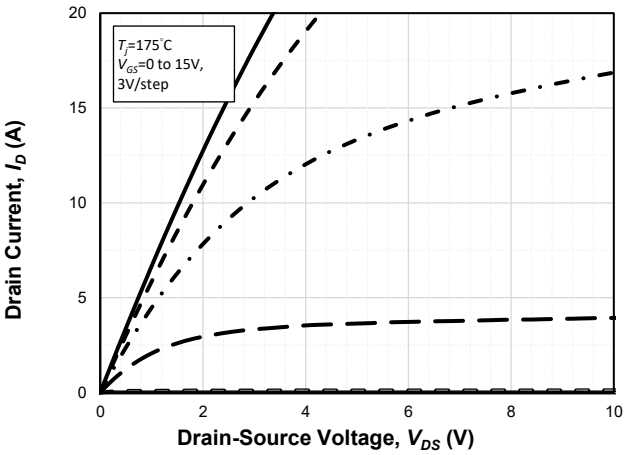


Fig. 1-2 Typical Output Characteristics at T_j=175˚C

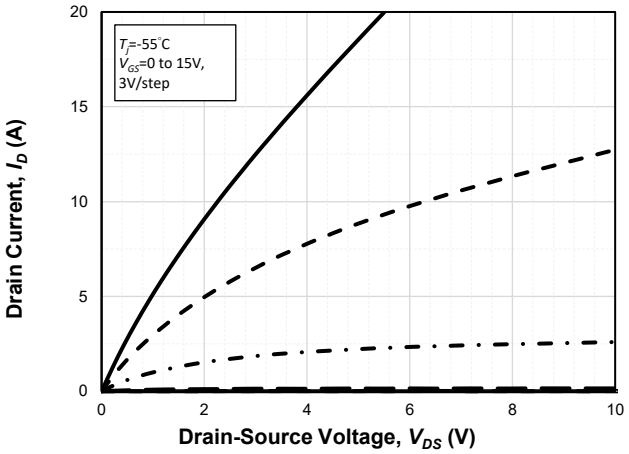


Fig. 1-3 Typical Output Characteristics at T_j=-55˚C

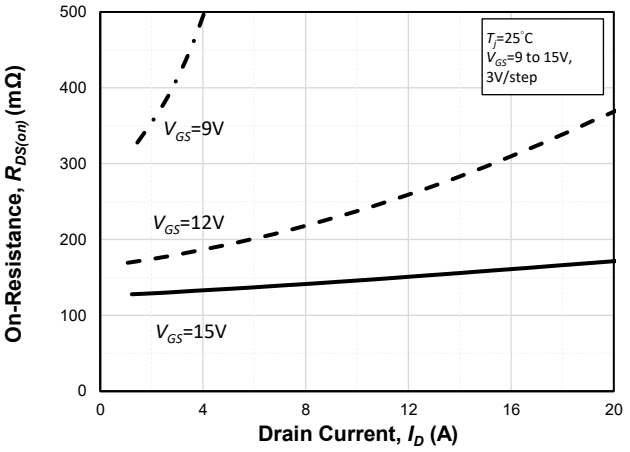


Fig. 1-4 Typ. $R_{DS(on)}$ vs. I_D with Various V_{GS}

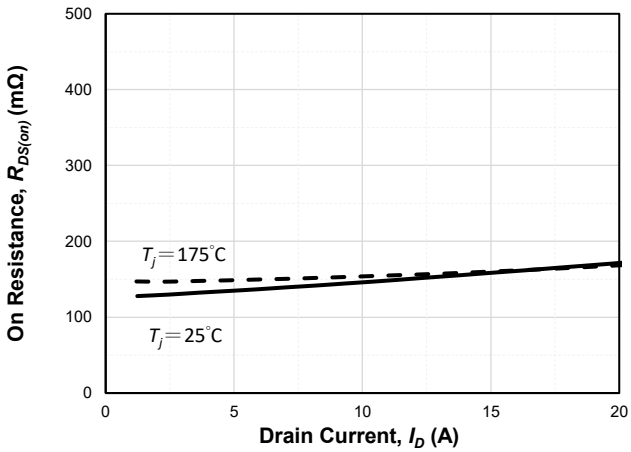


Fig. 1-5 Typ. $R_{DS(on)}$ vs. I_D with Various T_j, V_{GS}=15V

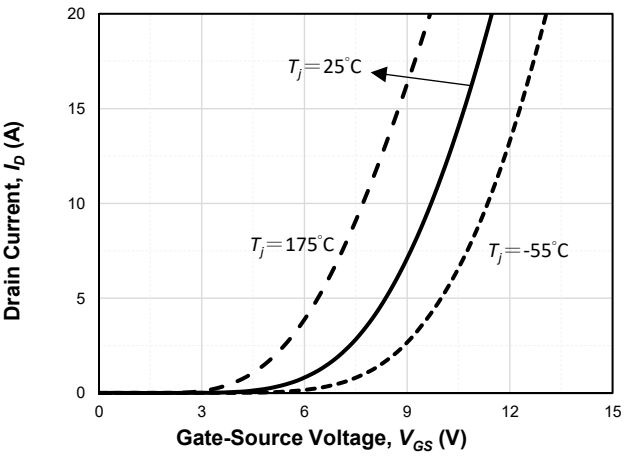


Fig. 1-6 Typ. I_D vs. V_{GS} with Various T_j, V_{DS}=10V

1. Electrical Characteristics Diagrams

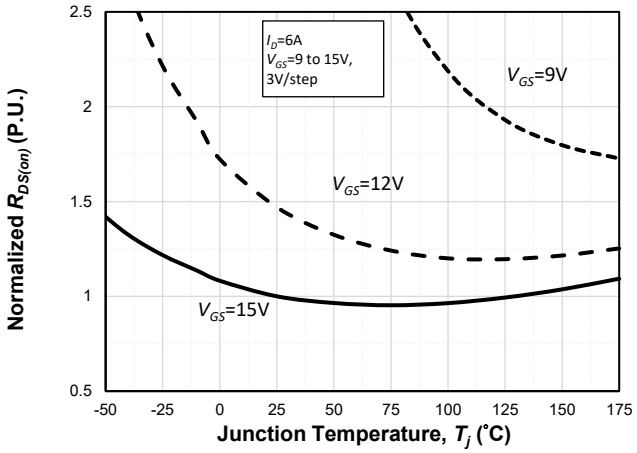


Fig. 1-7 Normalized $R_{DS(on)}$ vs. T_j with Various V_{GS}

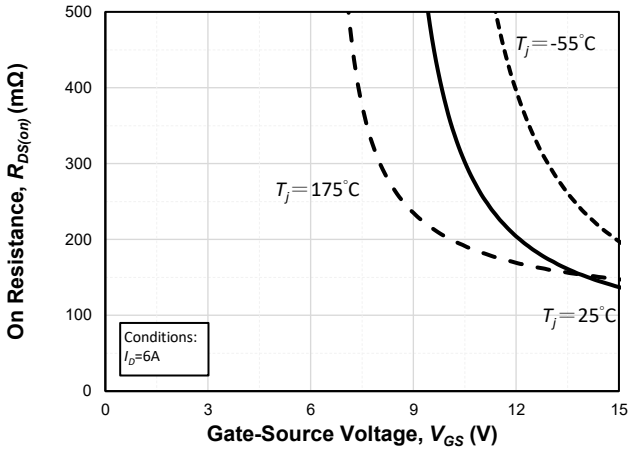


Fig. 1-8 Typ. $R_{DS(on)}$ vs. V_{GS} with Various T_j

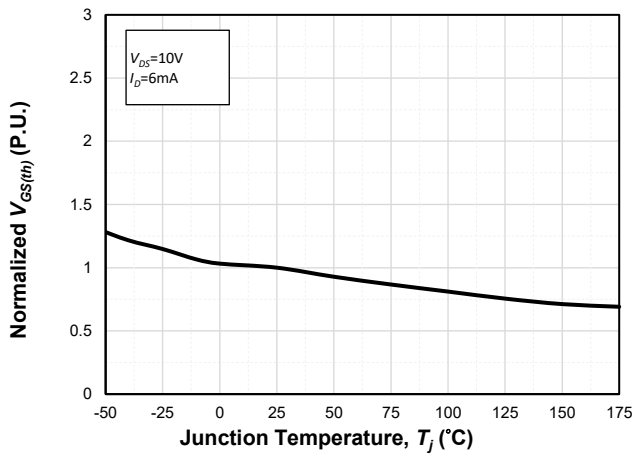


Fig. 1-9 Normalized V_{th} vs. T_j

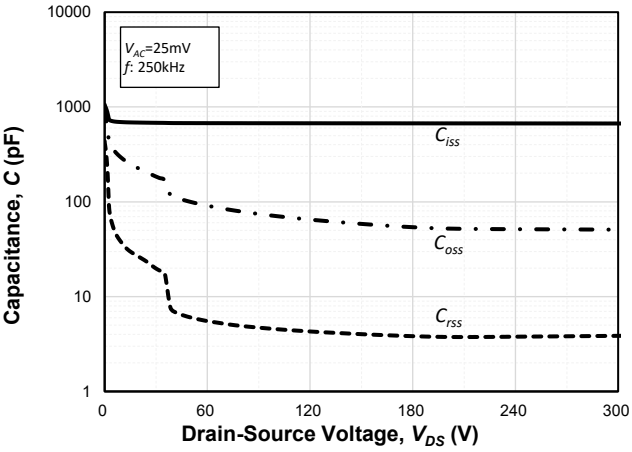


Fig. 1-10 Typ. Capacitance vs. V_{DS} at f_{sw}=250kHz

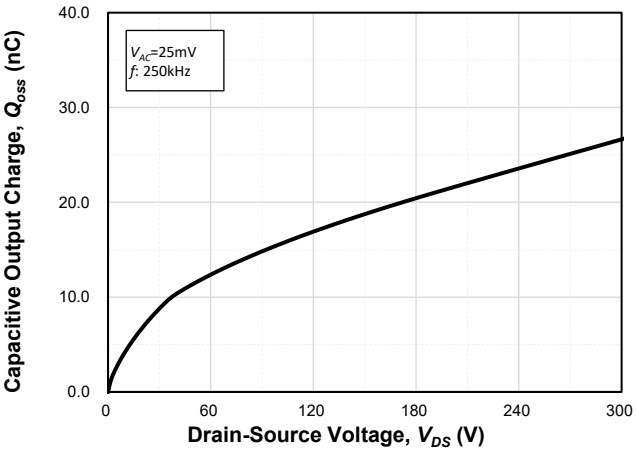


Fig. 1-11 Typ. Capacitive Output Charge at f_{sw}=250kHz

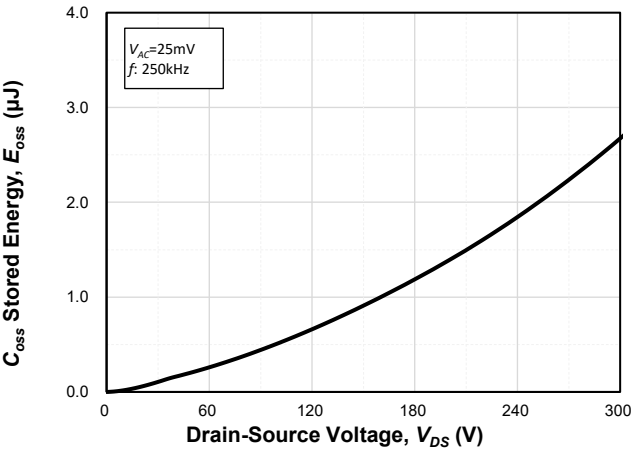


Fig. 1-12 Typ. CossStored Energy at fsw=250kHz

1. Electrical Characteristics Diagrams

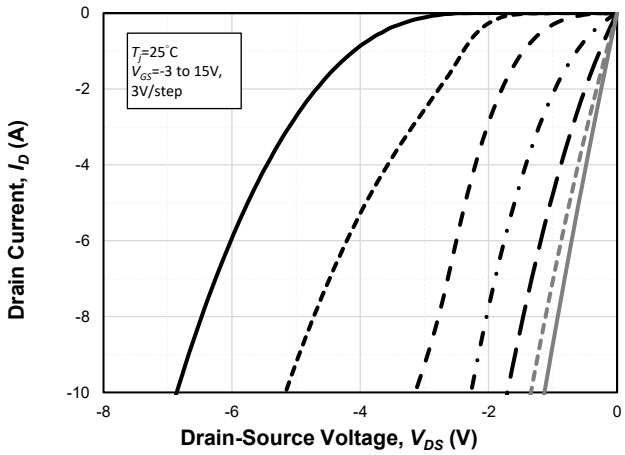


Fig. 1-13 Typical Forward Characteristics of Reverse Conduction at T_j=25˚C

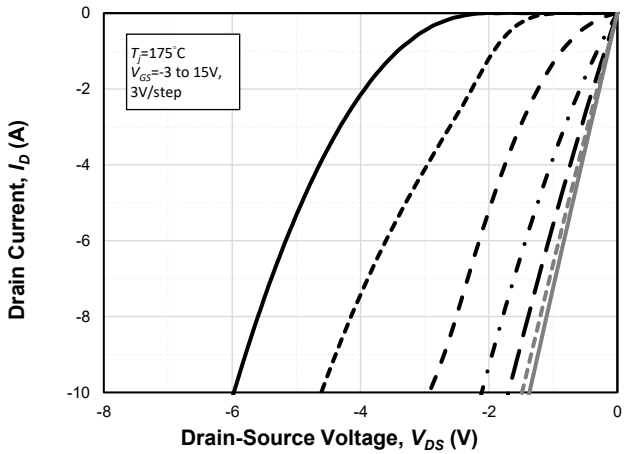


Fig. 1-14 Typical Forward Characteristics of Reverse Conduction at T_j=175˚C

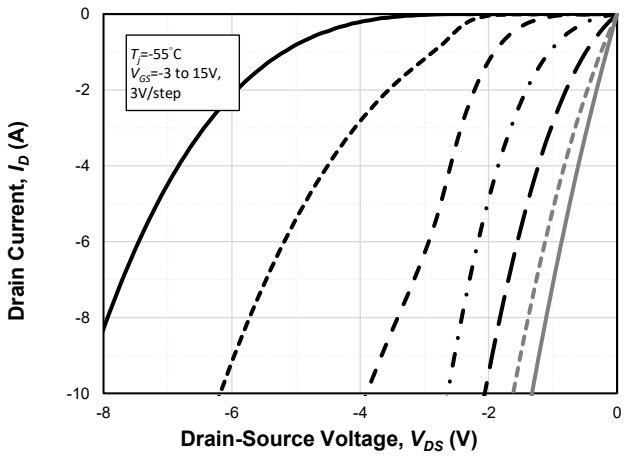


Fig. 1-15 Typical Forward Characteristics of Reverse Conduction at T_j=-55˚C

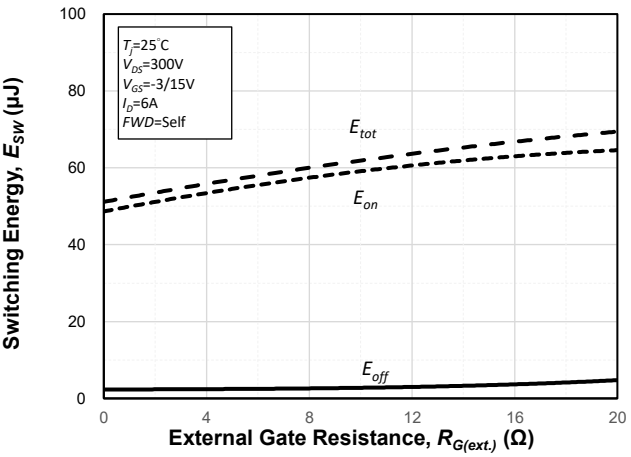


Fig. 1-16 Typ. Switching Energy vs. $R_{G(ext.)}$

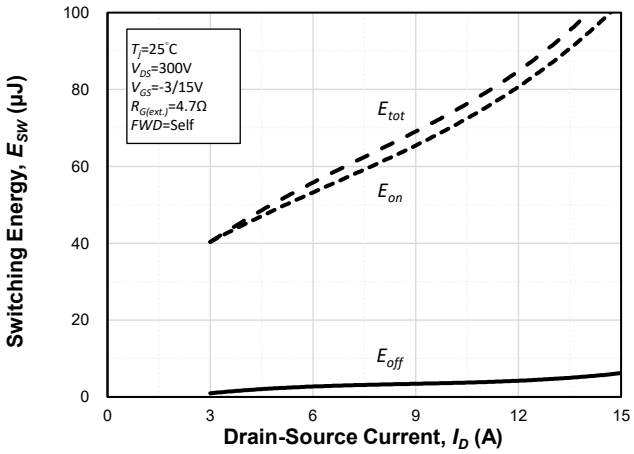


Fig. 1-17 Typ. Switching Energy vs. I_D

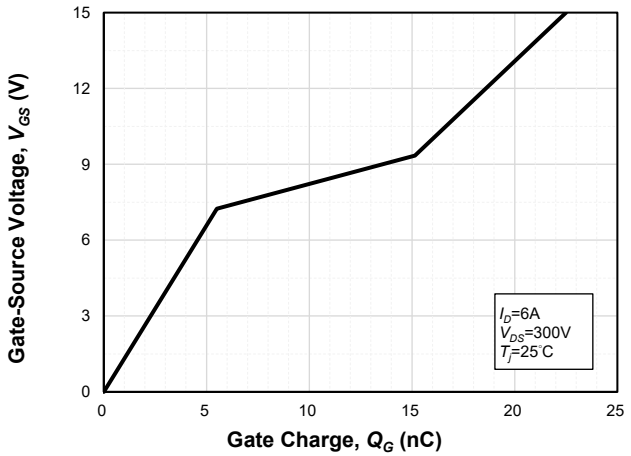


Fig. 1-18 Typ. Gate Charge

2. Drain Power Dissipation

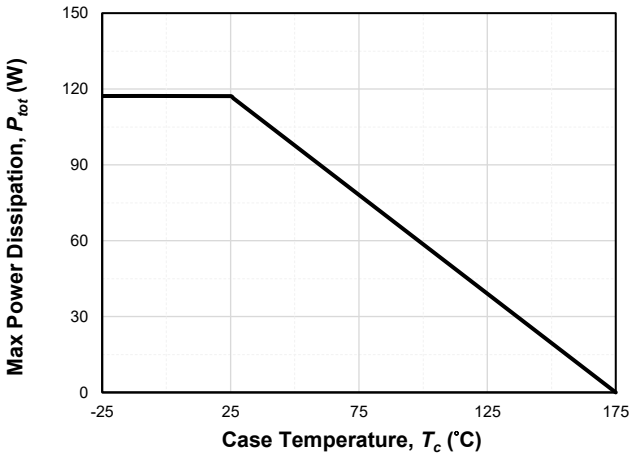


Fig. 2-1 Power Dissipation at V_{GS}=15V, T_j≤175°C (TO-252)

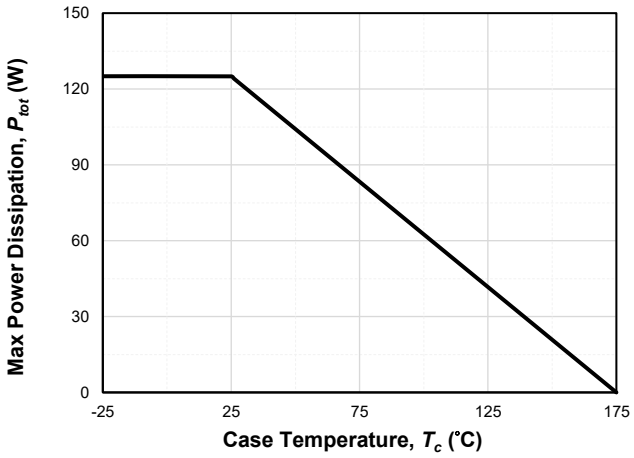


Fig. 2-2 Power Dissipation at V_{GS}=15V, T_j≤175°C (PQFN 5x6)

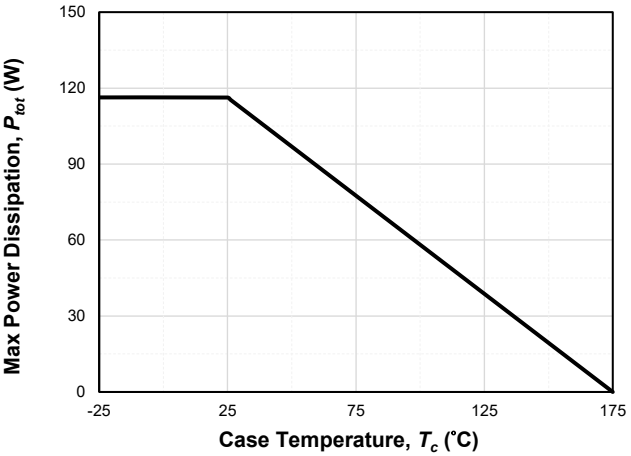


Fig. 2-3 Power Dissipation at V_{GS}=15V, T_j≤175°C (TOLL)

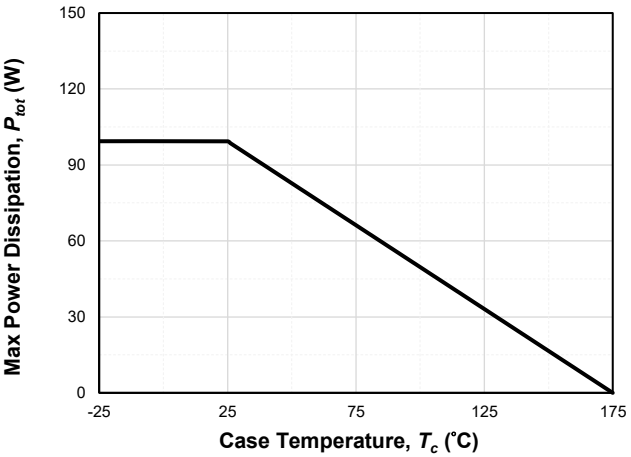


Fig. 2-4 Power Dissipation at V_{GS}=15V, T_j≤175°C (PDFN 8x8)

3. Drain Current Dissipation

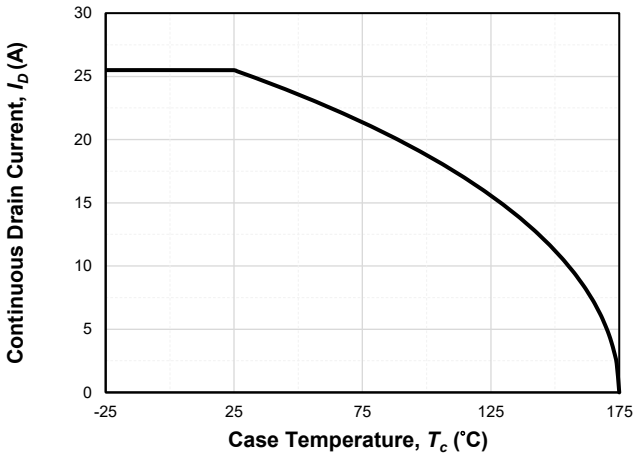


Fig. 3-1 Current Dissipation at V_{GS}=15V, T_j≤175°C (TO-252)

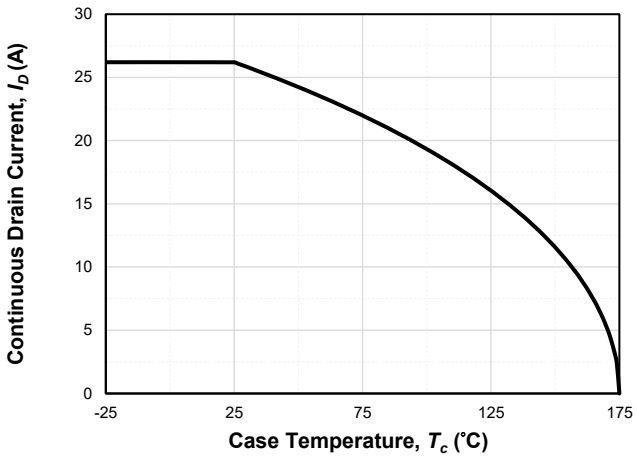


Fig. 3-2 Current Dissipation at V_{GS}=15V, T_j≤175°C (PQFN 5x6)

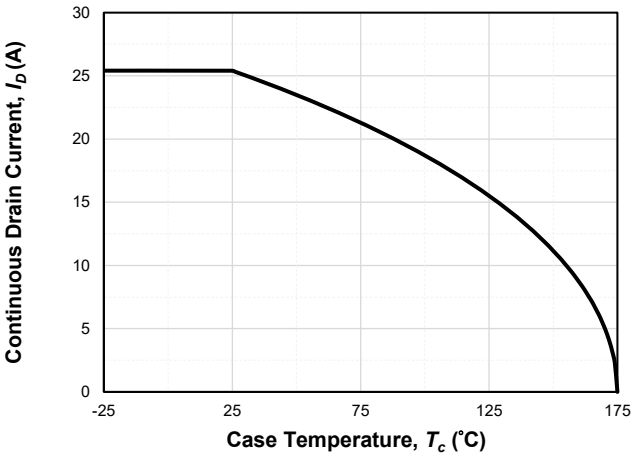


Fig. 3-3 Current Dissipation at V_{GS}=15V, T_j≤175°C (TOLL)

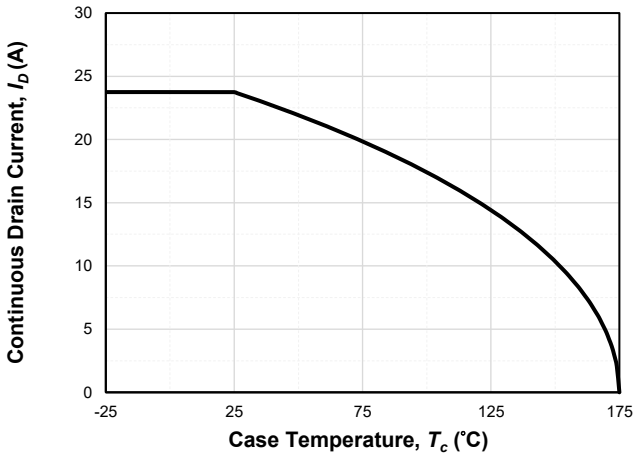


Fig. 3-4 Current Dissipation at V_{GS}=15V, T_j≤175°C (PDFN 8x8)

4. Body Diode Current Dissipation

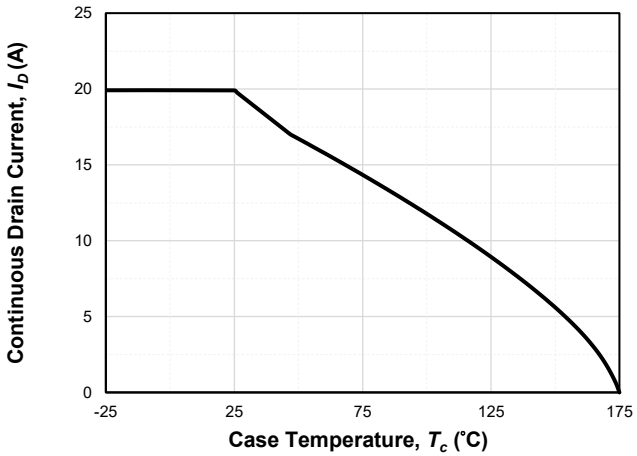


Fig. 4-1 Body Diode Current Dissipation at V_{GS}=0V, T_j≤175˚C (TO-252)

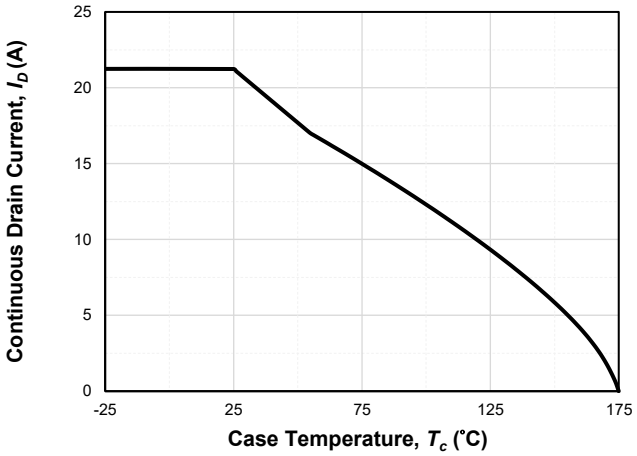


Fig. 4-2 Body Diode Current Dissipation at V_{GS}=0V, T_j≤175˚C (PQFN 5x6)

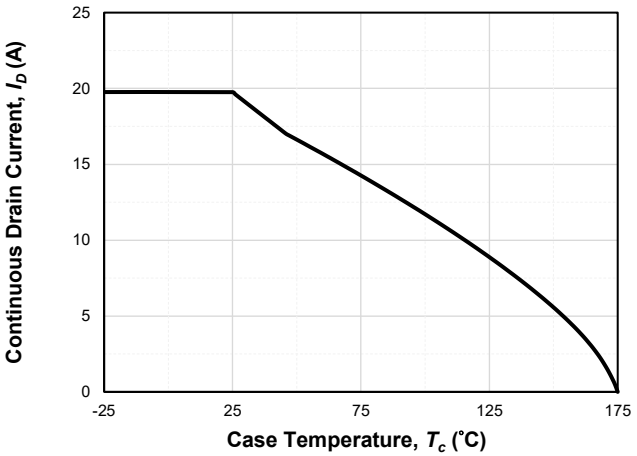


Fig. 4-3 Body Diode Current Dissipation at V_{GS}=0V, T_j≤175˚C (TOLL)

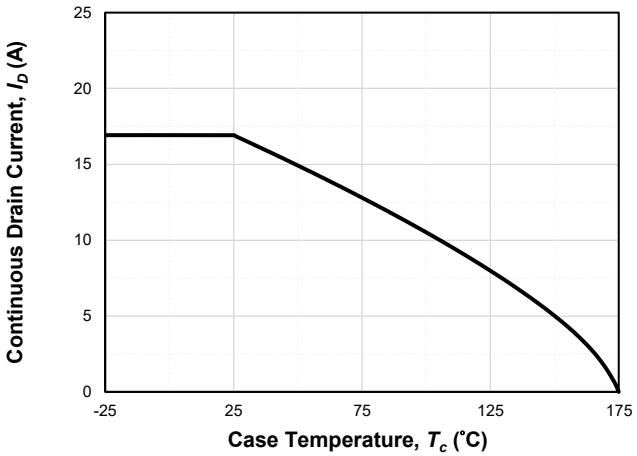


Fig. 4-4 Body Diode Current Dissipation at V_{GS}=0V, T_j≤175˚C (PDFN 8x8)

5. Thermal Impedance

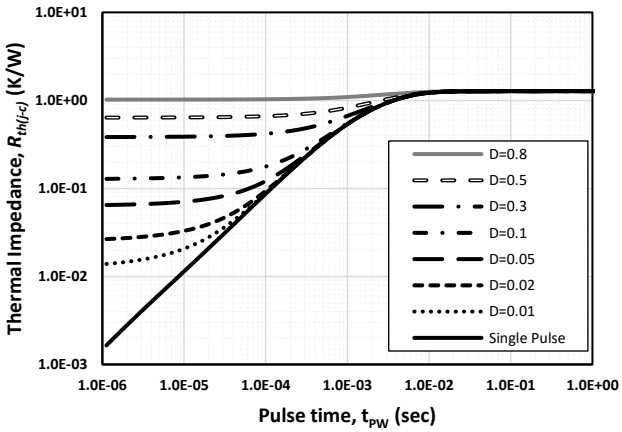


Fig. 5-1 Typ. Transient Thermal Impedance $R_{th\text{-}jc}$ (TO-252)

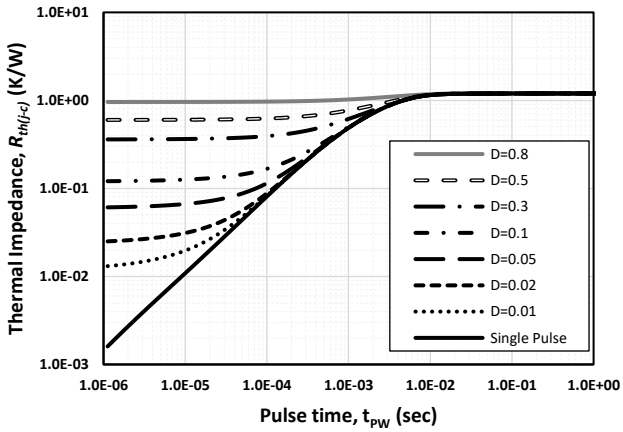


Fig. 5-2 Typ. Transient Thermal Impedance $R_{th\text{-}jc}$ (PQFN 5x6)

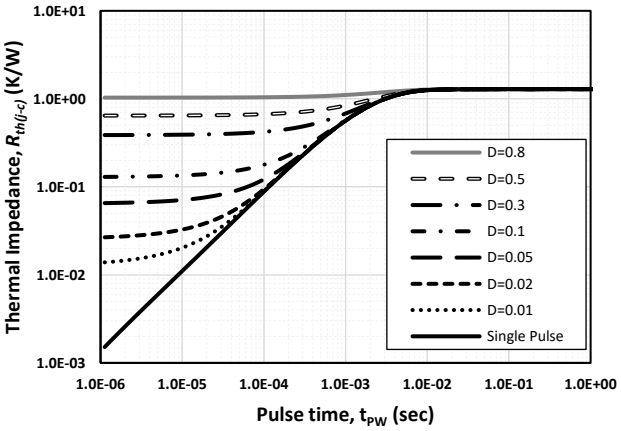


Fig. 5-3 Typ. Transient Thermal Impedance $R_{th\text{-}jc}$ (TOLL)

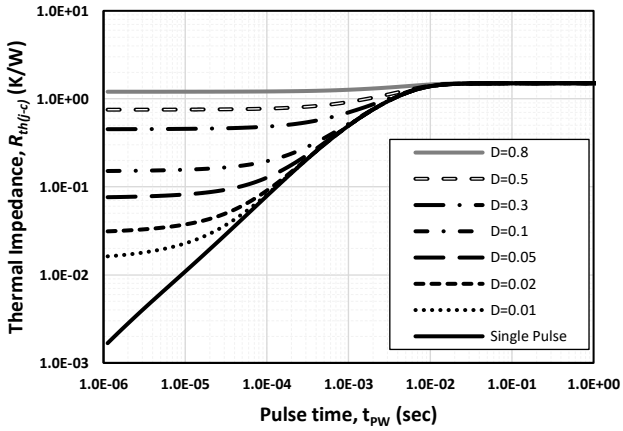


Fig. 5-4 Typ. Transient Thermal Impedance $R_{th\text{-}jc}$ (PDFN 8x8)

6. Safe Operating Area (25˚C)

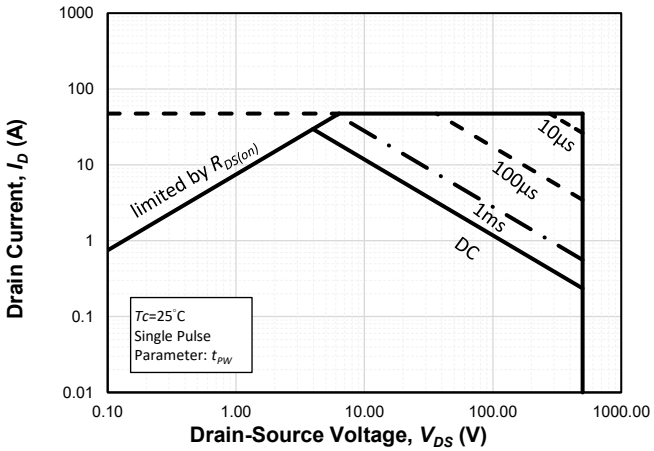


Fig. 6-1 Safe Operating Area at T_c=25˚C (TO-252)

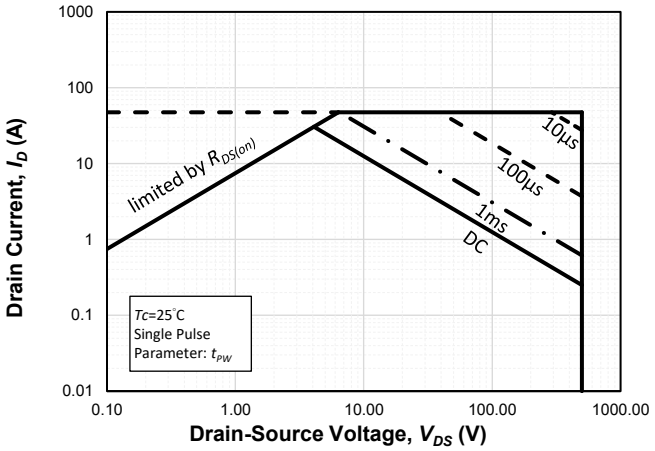


Fig. 6-2 Safe Operating Area at T_c=25˚C (PQFN 5x6)

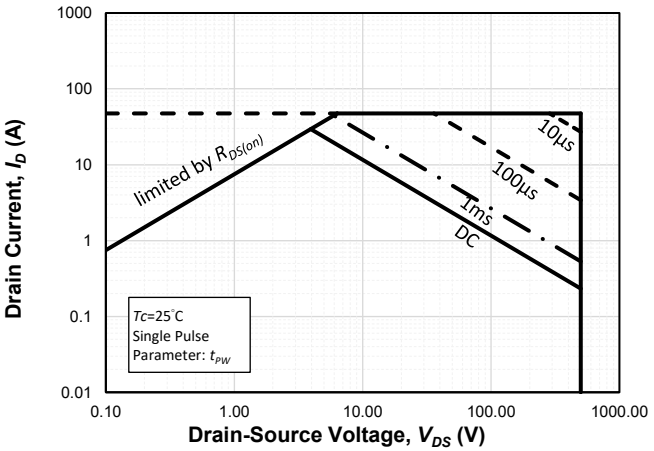


Fig. 6-3 Safe Operating Area at T_c=25˚C (TOLL)

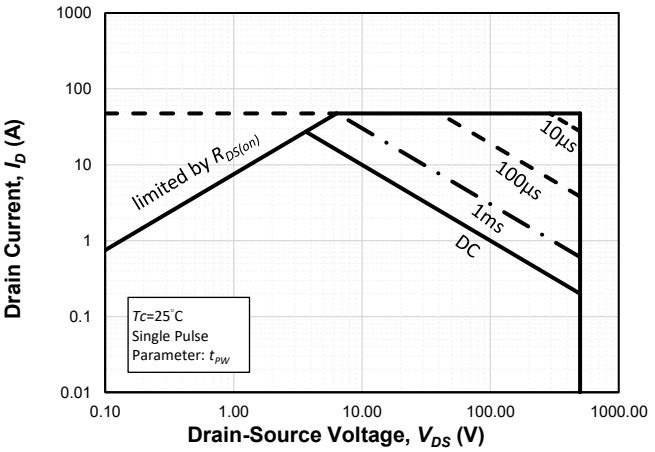


Fig. 6-4 Safe Operating Area at T_c=25˚C (PDFN 8x8)

7. Safe Operating Area (100˚C)

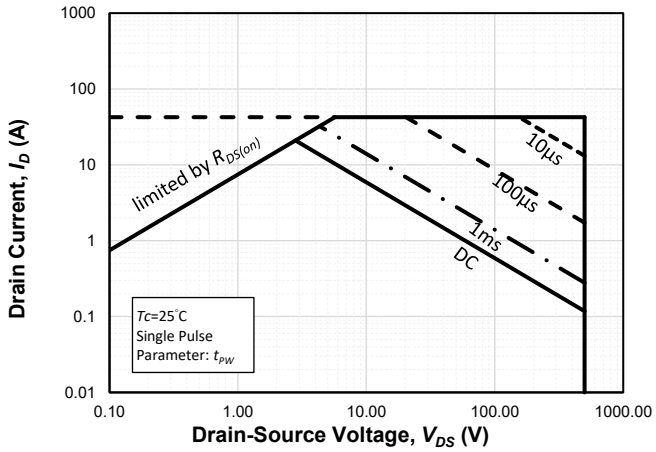


Fig. 7-1 Safe Operating Area at T_c=100˚C (TO-252)

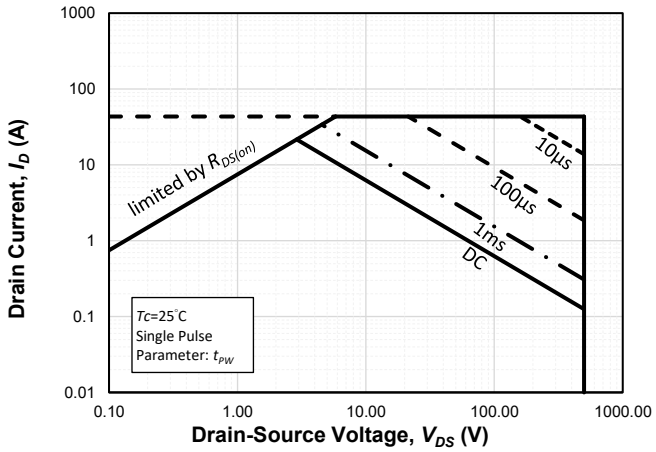


Fig. 7-2 Safe Operating Area at T_c=100˚C (PQFN 5x6)

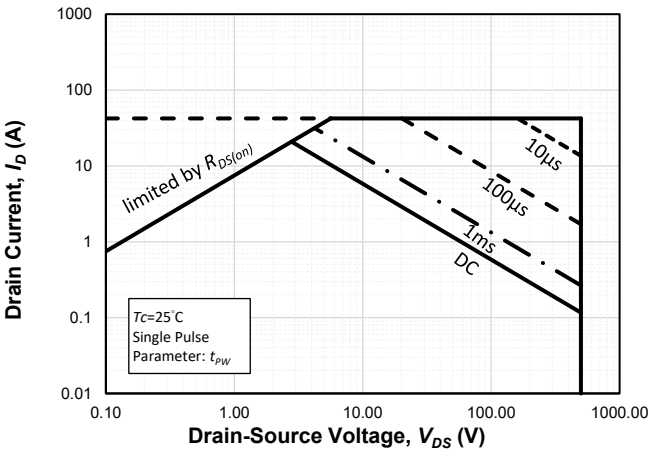


Fig. 7-3 Safe Operating Area at T_c=100˚C (TOLL)

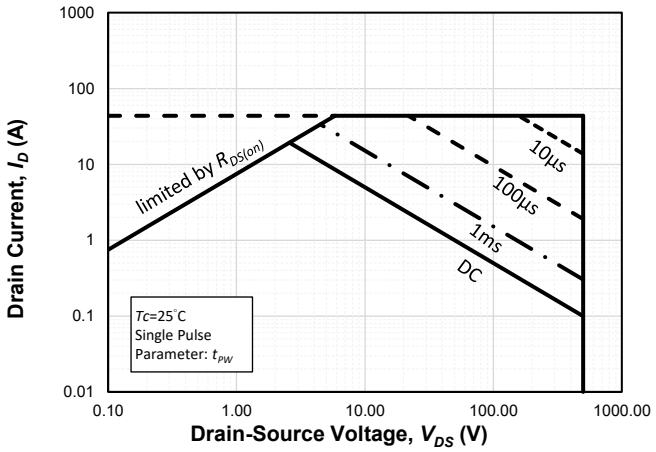
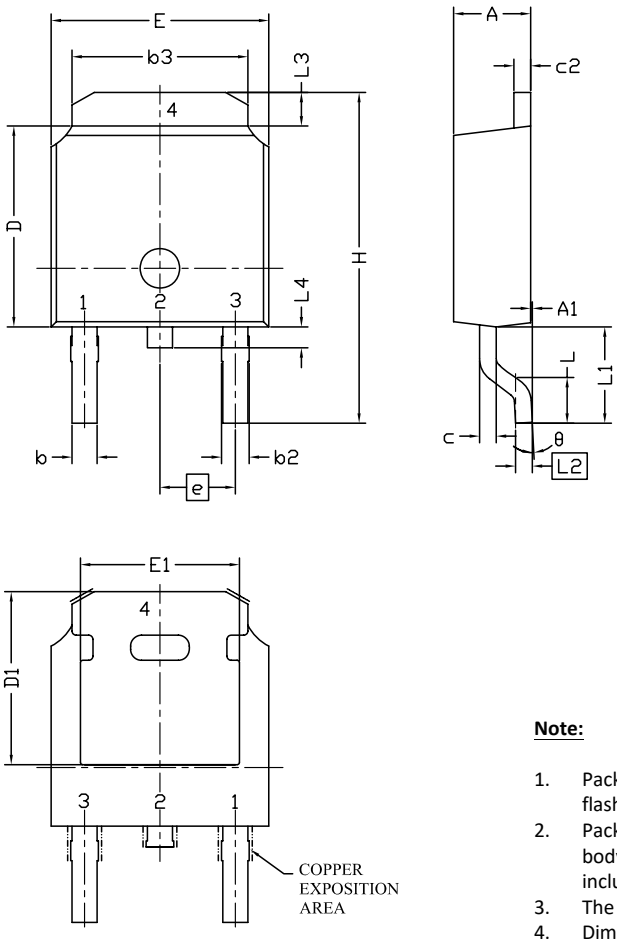


Fig. 7-4 Safe Operating Area at T_c=100˚C (PDFN 8x8)

Package Outline (TO-252, DPAK)

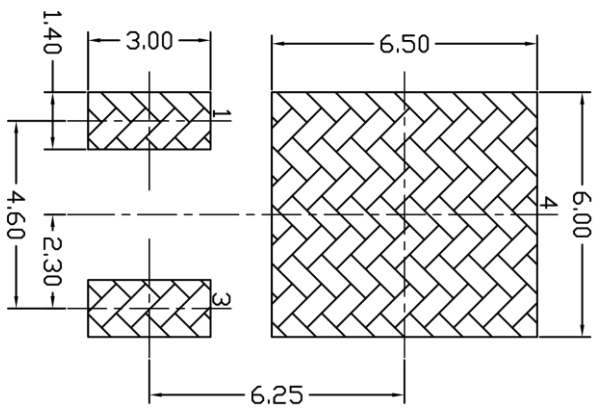


Symbol	Dimension (Millimeters)		
	Min.	Nom.	Max.
E	6.40	6.60	6.73
L	1.40	1.52	1.77
L1		2.743 REF.	
L2		0.508 BSC.	
L3	0.89	--	1.27
L4	0.64	--	1.01
D	6.00	6.10	6.22
H	9.40	10.00	10.40
b	0.64	0.76	0.88
b2	0.77	0.84	1.14
b3	5.21	5.34	5.46
e		2.286 BSC.	
A	2.20	2.30	2.38
A1	0.00	--	0.127
c	0.46	0.50	0.60
c2	0.46	0.50	0.58
D1	5.21	--	--
E1	4.40	--	--
θ	0°	--	10°

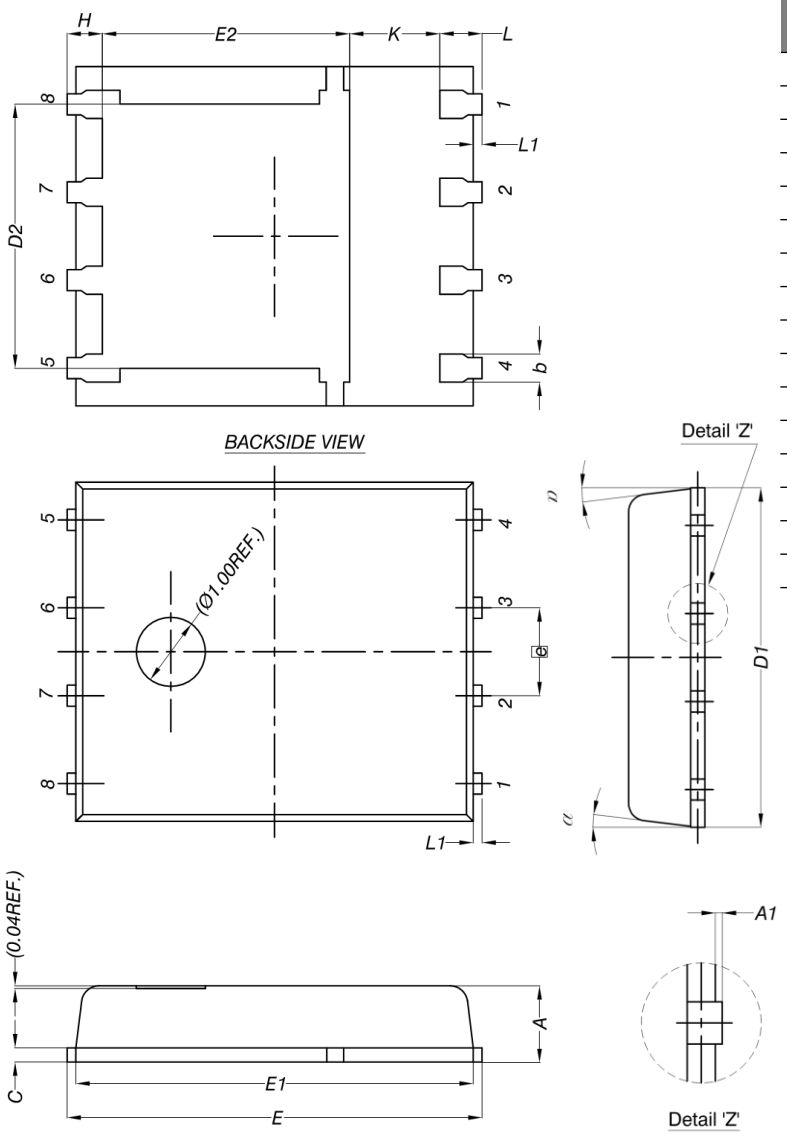
Note:

1. Package body sizes exclude mold flash, protrusion, or gate burrs. Mold flash, protrusion or gate burrs shall not exceed 0.10 mm per side.
2. Package body sizes determined at the outermost extremes of the plastic body exclusive of mold flash, gate burrs, and inter-lead flash, but including any mismatch between the top and bottom of the plastic body.
3. The package top may be smaller than the package bottom.
4. Dimension “b” does not include dambar protrusion. Allowable dambar protrusion shall be 0.10 mm total in excess of “b” dimension at the maximum material condition. The dambar cannot be located on the lower radius of the foot.

Land Pattern (Only for Reference)



Package Outline (PQFN 5 x 6)

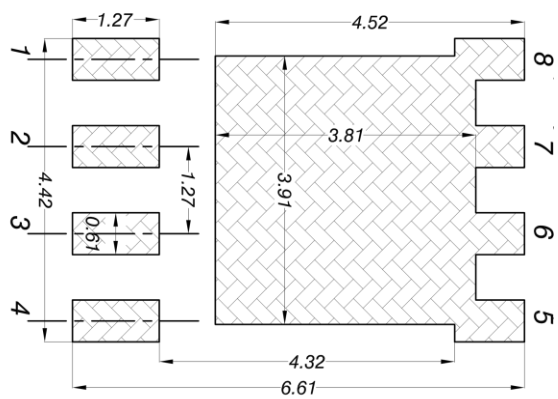


Symbol	Dimension (Millimeters)		
	Min.	Nom.	Max.
A	0.90	1.00	1.10
A1	0	--	0.05
b	0.33	0.41	0.51
C	0.20	0.25	0.30
D1	4.80	4.90	5.00
D2	3.61	3.81	3.96
E	5.90	6.00	6.10
E1	5.70	5.75	5.80
E2	3.38	3.58	3.78
e		1.27 BSC.	
H	0.41	0.51	0.61
K	1.10	--	--
L	0.51	0.61	0.71
L1	0.06	0.13	020
α	0°	--	12°

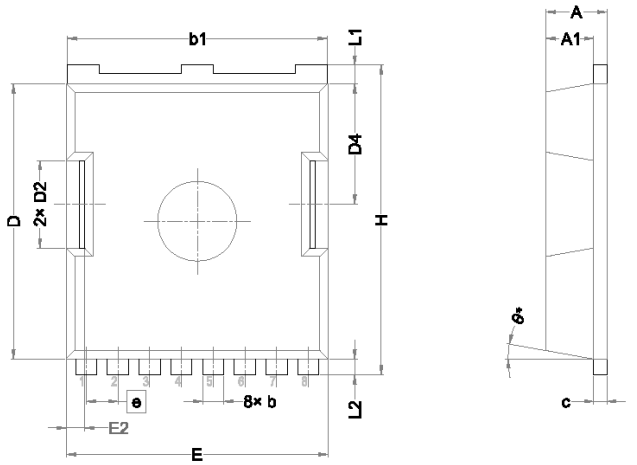
Note:

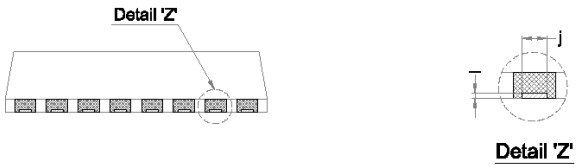
1. Package body sizes exclude mold flash, protrusion, or gate burrs. Mold flash, protrusion or gate burrs shall not exceed 0.10 mm per side
2. Package body sizes determined at the outermost extremes of the plastic body exclusive of mold flash, tie bar, tie bar burrs, gate burrs, and inter-lead flash, but including any mismatch between the top and bottom of the plastic body.
3. The package top may be smaller than the package bottom.

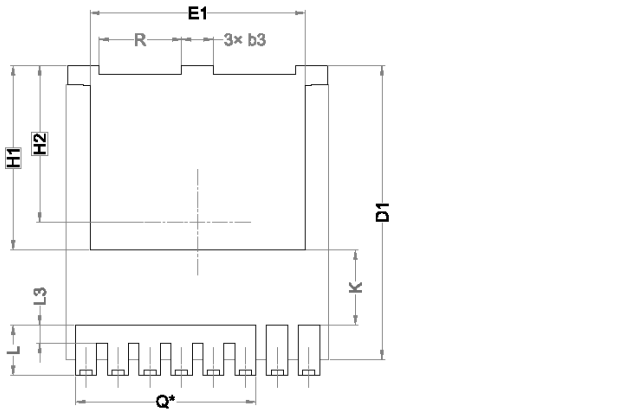
Land Pattern (Only for Reference)

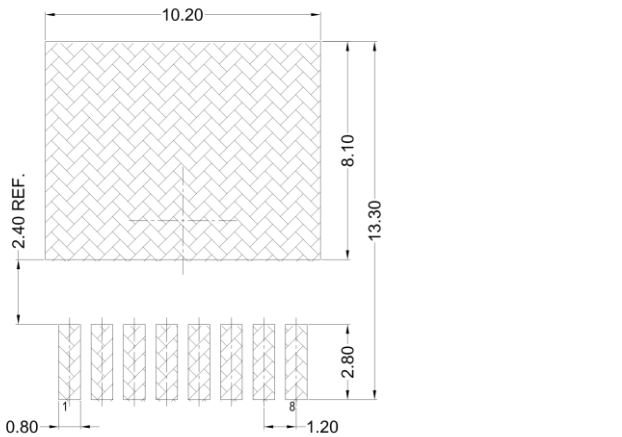


Package Outline (TOLL, MO-299B)









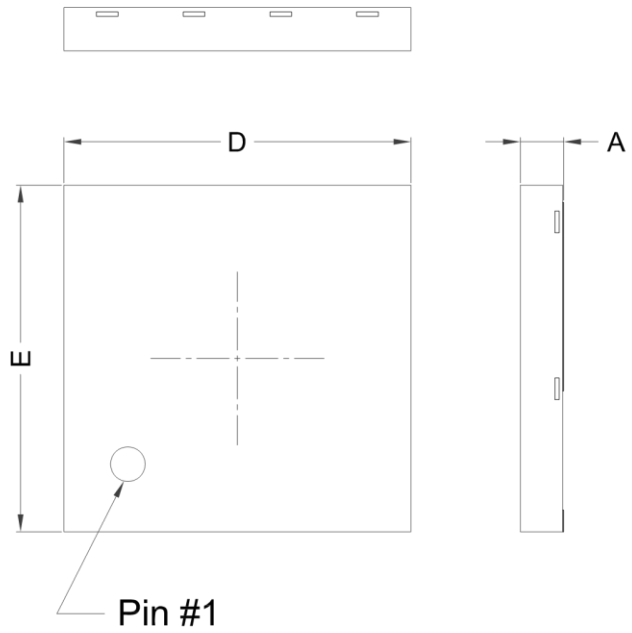
Land Pattern (Only for reference)

Symbol	Dimension (Millimeters)		
	Min.	Nom.	Max.
A	2.20	2.30	2.40
A1	1.70	1.80	1.90
b	0.70	0.80	0.90
b1	9.70	9.80	9.90
b3	1.10	1.20	1.30
c	0.40	0.50	0.60
D	10.28	10.38	10.48
D1	10.98	11.08	11.18
D2	3.20	3.30	3.40
D4	4.45	4.55	4.65
E	9.80	9.90	10.00
E1	8.00	8.10	8.20
E2	0.60	0.70	0.80
e		1.20 BSC.	
H	11.58	11.68	11.78
H1		6.95 BSC.	
H2		5.89 BSC.	
i		0.10 REF.	
j		0.46REF.	
K		2.80 REF.	
L	1.40	1.90	2.10
L1	0.60	0.70	0.80
L2	0.50	0.60	0.70
L3	0.30	0.70	0.80
N		8	
Q		6.80 REF.	
R	3.00	3.10	3.20
θ		10° REF.	

Note:

1. Dimensions do not inclusive burrs and mold flash.
2. "*" is for reference.

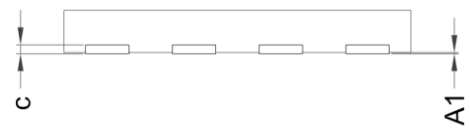
Package Outline (PDFN 8 x 8)

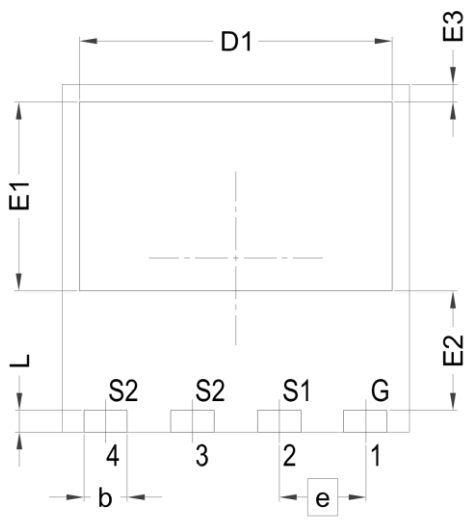


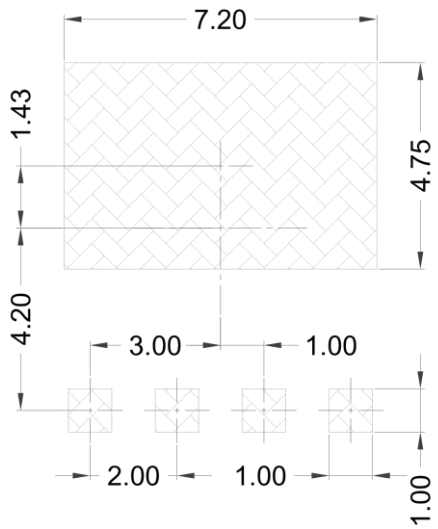
Symbol	Dimension (Millimeters)		
	Min.	Nom.	Max.
A	0.90	1.00	1.10
A1	0.00	-	0.05
b	0.90	1.00	1.10
c	0.10	0.20	0.30
D	7.90	8.00	8.10
D1	7.10	7.20	7.30
E	7.90	8.00	8.10
E1	4.25	4.35	4.45
E2	2.65	2.75	2.85
E3	0.30	0.40	0.50
e		2.00 BSC.	
L	0.40	0.50	0.60

Note:

1. All dimensions are in mm.
2. Dimensions are not inclusive burrs and mold flash.







Land Pattern (Only for reference)

Revision History

Date	Revision	Changes
25.07	Preliminary	1st issue
25.09	Preliminary	Add PDFN 8x8

Important Note (Disclaimer)

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