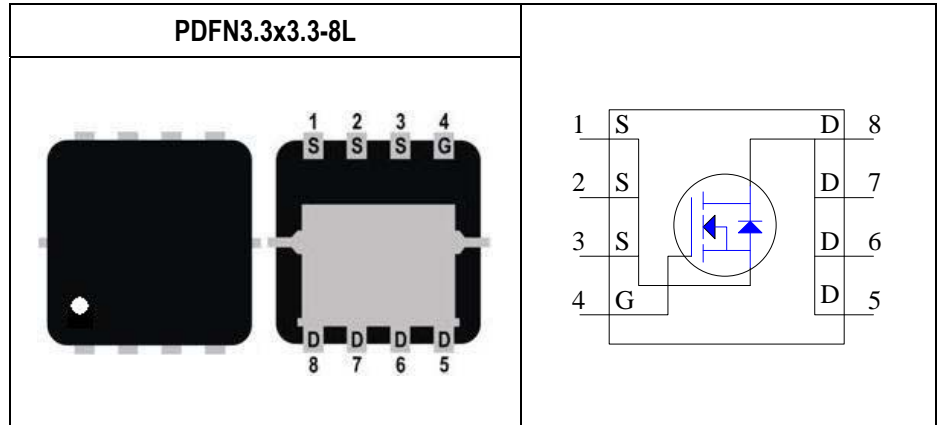


Parameter	Value	Unit
$V_{DS}$	60	V
$R_{DS(ON) max. V_{GS}=10V}$	9.8	mΩ
$R_{DS(ON) max. V_{GS}=4.5V}$	15.4	mΩ
$I_D$	44.8	A
$Q_{g 10V}$	15.6	nC
$Q_{gd}$	3.5	nC
$Q_{SW}$	5.5	nC



Features	Application
<ul style="list-style-type: none"> <li>Low On-Resistance <math>R_{DS(on)}</math></li> <li>Low Input Capacitance</li> <li>Low Gate Charge</li> <li>Fully Characterized Capacitance and Avalanche</li> <li>Pb-free lead plating; RoHS compliant</li> </ul>	<ul style="list-style-type: none"> <li>AC to DC adaptor</li> <li>DC to DC Converter</li> <li>Switch Mode Power Supply</li> <li>Lithium-Ion Secondary Batteries</li> <li>MOSFET for synchronous rectification in SMPS</li> </ul>

## Ordering Information

Ordering Code	RoHS Status	Package	Package Code	Packing	Quantity
DG60N12E	Halogen-Free	PDFN3.3x3.3-8L	E	Tape & Reel	5,000

## Absolute Maximum Ratings ( $T_J=25^\circ\text{C}$ unless otherwise noted)

Parameter	Symbol	Value	Unit	
Drain-Source Voltage	$V_{DS}$	60	V	
Gate-Source Voltage	$V_{GS}$	$\pm 20$	V	
Drain Current-Continuous <sup>Note 1</sup>	$I_D$	$T_C=25^\circ\text{C}$	44.8	A
		$T_C=100^\circ\text{C}$	28.3	A
Drain Current-Continuous <sup>Note 2</sup>	$I_D$	$T_A=25^\circ\text{C}$	10	A
		$T_A=70^\circ\text{C}$	8	A
Drain Current-Pulsed <sup>Note 3</sup>	$I_{DM}$	55	A	
Avalanche Current	$I_{AR}$	16.3	A	
Single Pulse Avalanche Energy <sup>Note 4</sup>	$E_{AS}$	13.3	mJ	
Maximum Power Dissipation	$P_D$	$T_C=25^\circ\text{C}$	30.1	W
		$T_C=100^\circ\text{C}$	12	W
		$T_A=25^\circ\text{C}$	1.51	W
		$T_A=70^\circ\text{C}$	0.97	W
Operating and Storage Temperature Range	$T_J, T_{STG}$	-55 to 150	$^\circ\text{C}$	

## Thermal Resistance Ratings

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Thermal resistance, Junction-Case <sup>Note 5</sup>	$R_{\theta JC}$	Steady State	-	-	4.15	$^\circ\text{C/W}$
Thermal resistance, Junction-Ambient <sup>Note 5</sup>	$R_{\theta JA}$	Steady State	-	-	82.46	$^\circ\text{C/W}$

### Notes:

- Limited by silicon chip capability and  $R_{\theta JC}$  junction-to-case thermal resistance.
- The maximum current rating is limited by package and  $R_{\theta JA}$  junction-to-ambient thermal resistance.
- Must be ensure junction temperature does not exceed 150-degree C. (Pulse Width  $\leq 100\mu\text{s}$ , Duty  $\leq 2\%$ )
- Limited by  $T_{Jmax}$ , starting  $T_J=25^\circ\text{C}$ ,  $L=0.1\text{mH}$ ,  $R_g=25\Omega$ ,  $I_D=16.3\text{A}$ ,  $V_{GS}=10\text{V}$ .
- The value of thermal resistance is measured with the single device mounted on 1 inch<sup>2</sup> FR-4 PCB with 2 oz. copper under a still air environment temperature is 25 $^\circ\text{C}$  based on JEDEC standard JESD51-14 and JESD51-2a. Thermal resistance obtained depends on the user's specific board design and given application.

**Electrical Characteristics (T<sub>J</sub>=25°C unless otherwise noted)**

STATIC CHARACTERISTICS						
Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Drain-Source Breakdown Voltage	$V_{(BR)DSS}$	$V_{GS}=0V, I_{DS}=250\mu A$	60	-	-	V
Zero Gate Voltage Drain Current	$I_{DSS}$	$V_{DS}=60V, V_{GS}=0V$	-	-	1	$\mu A$
		$V_{DS}=60V, V_{GS}=0V, T_J=105^\circ C$	-	-	100	$\mu A$
Gate-Body Leakage	$I_{GSS}$	$V_{GS}=\pm 20V, V_{DS}=0V$	-	-	$\pm 100$	nA

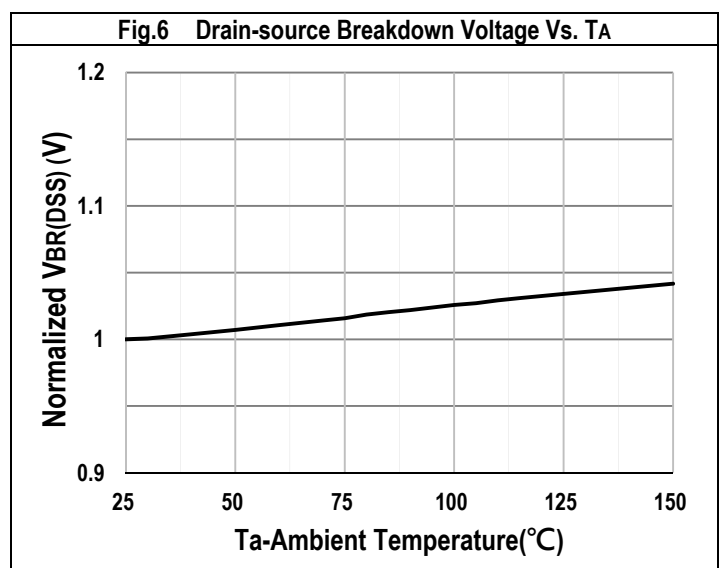
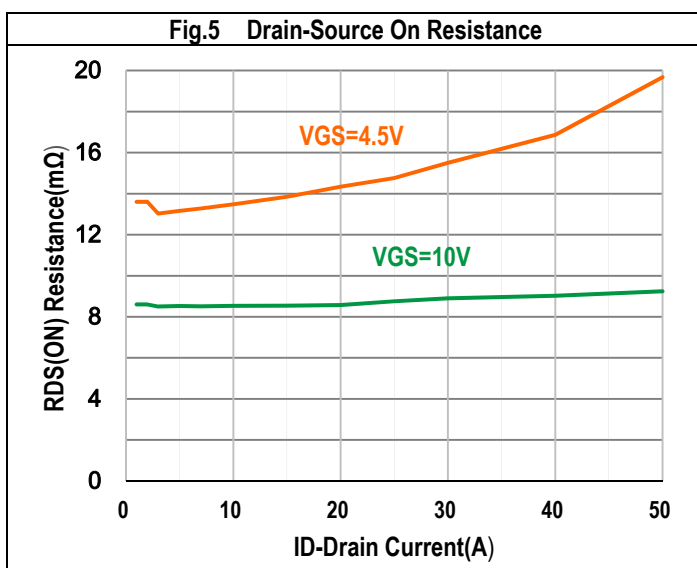
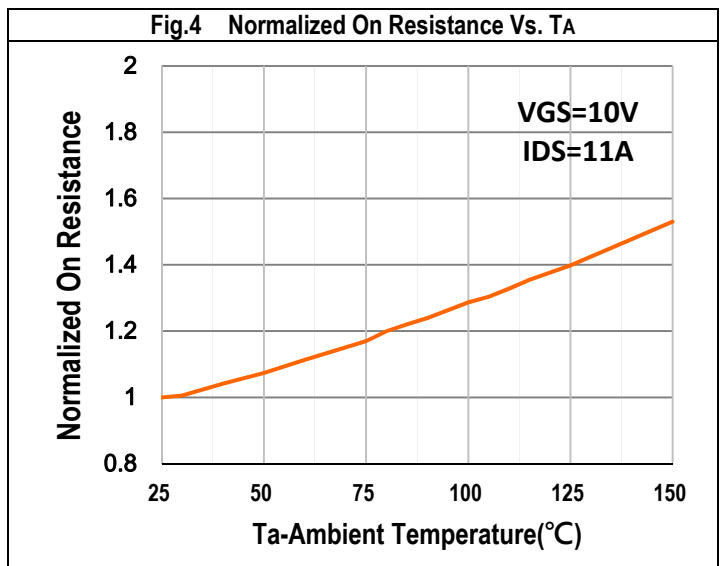
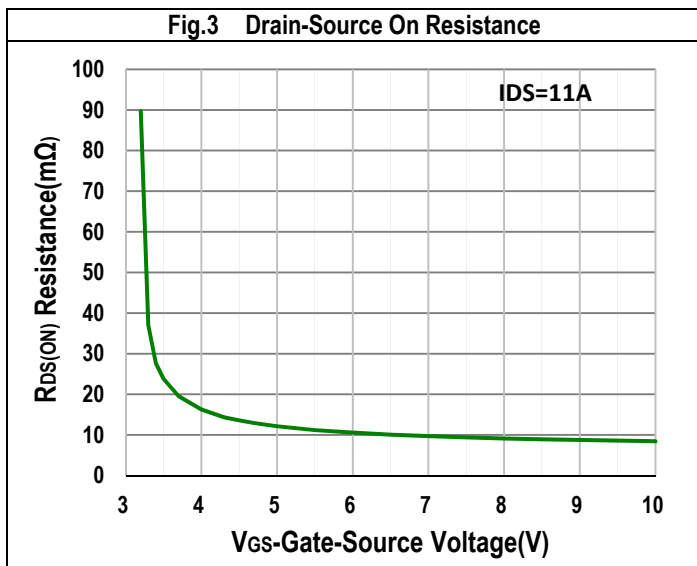
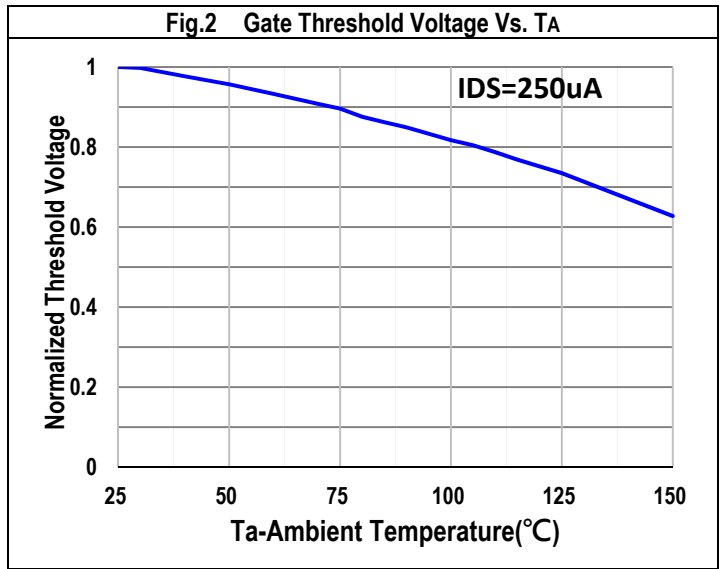
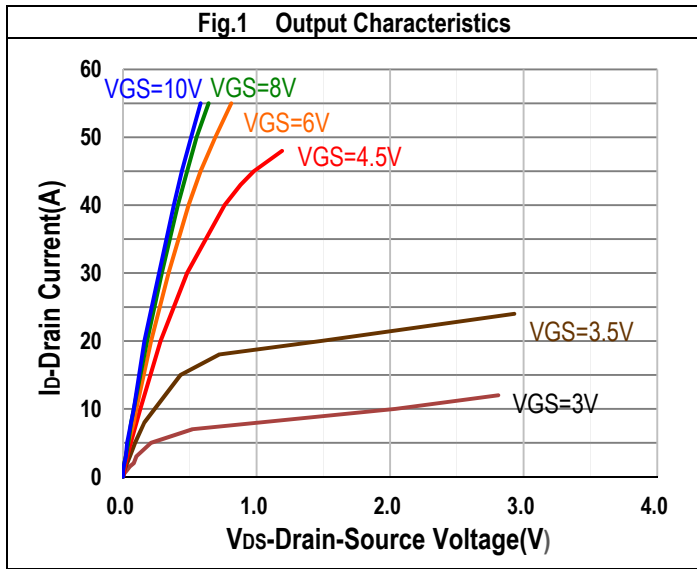
STATIC CHARACTERISTICS						
Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Gate Threshold Voltage	$V_{GS(TH)}$	$V_{DS}=V_{GS}, I_{DS}=250\mu A$	1.3	1.7	2.1	V
Drain-Source On-State Resistance	$R_{DS(ON)}$	$V_{GS}=10V, I_{DS}=20A$	-	8.5	9.8	m $\Omega$
		$V_{GS}=4.5V, I_{DS}=10A$	-	13.4	15.4	m $\Omega$
Gate Resistance	$R_g$	$V_{GS}=0V, V_{DS}=0V, f=1MHz$	-	1.5	-	$\Omega$
Forward Transconductance	$g_{fs}$	$V_{DS}=5V, I_{DS}=11A$	-	10	-	S

DYNAMIC CHARACTERISTICS						
Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Input Capacitance	$C_{iss}$	$V_{DD}=60V, V_{DS}=30V, V_{GS}=0V, f=1MHz$	-	834	-	pF
Output Capacitance	$C_{oss}$	$V_{DD}=60V, V_{DS}=30V, V_{GS}=0V, f=1MHz$	-	364	-	pF
Reverse Transfer Capacitance	$C_{rss}$	$V_{DD}=60V, V_{DS}=30V, V_{GS}=0V, f=1MHz$	-	31	-	pF
Turn-On Delay Time	$T_{d(on)}$	$V_{DS}=30V, V_{GS}=10V, I_{DS}=14A, R_{GEN}=3\Omega$	-	7.9	-	nS
Rise Time	$t_r$	$V_{DS}=30V, V_{GS}=10V, I_{DS}=14A, R_{GEN}=3\Omega$	-	2	-	nS
Turn-Off Delay Time	$T_{d(off)}$	$V_{DS}=30V, V_{GS}=10V, I_{DS}=14A, R_{GEN}=3\Omega$	-	19.7	-	nS
Fall Time	$t_f$	$V_{DS}=30V, V_{GS}=10V, I_{DS}=14A, R_{GEN}=3\Omega$	-	5.2	-	nS

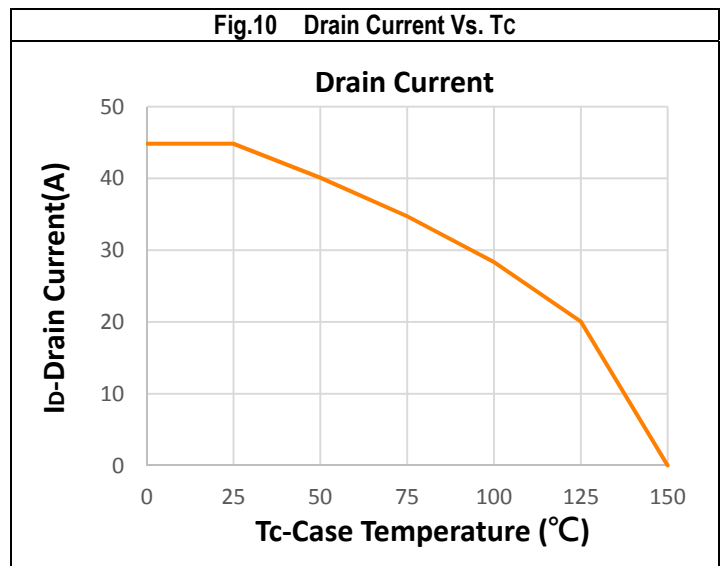
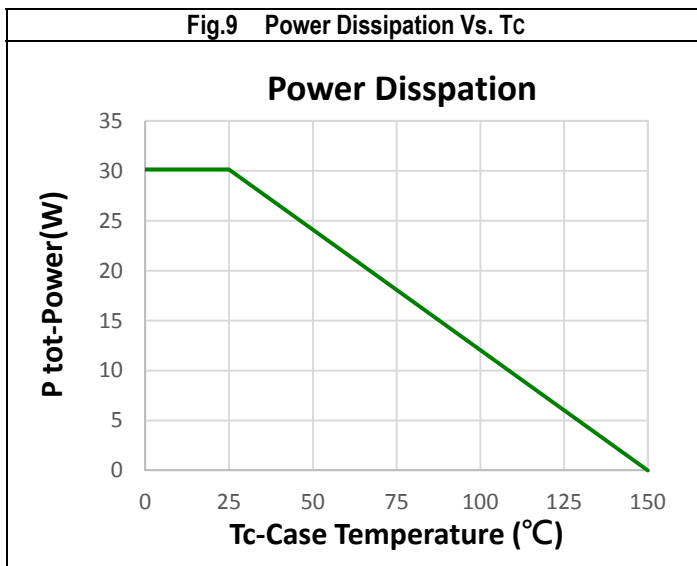
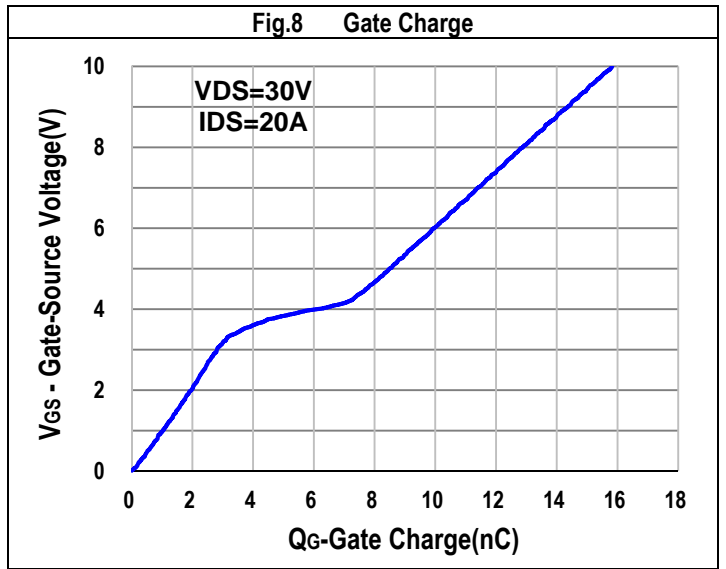
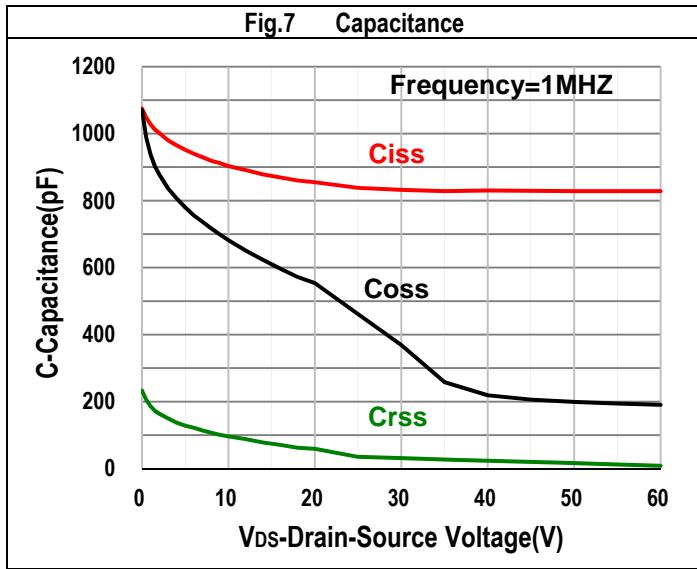
GATE CHARGE CHARACTERISTICS						
Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Gate to Source Gate Charge	$Q_{gs}$	$V_{DD}=30V, I_D=20A, V_{GS}=0$ to 10V	-	3.7	-	nC
Gate charge at threshold	$Q_{g(th)}$	$V_{DD}=30V, I_D=20A, V_{GS}=0$ to 10V	-	1.6	-	nC
Gate to Drain Charge	$Q_{gd}$	$V_{DD}=30V, I_D=20A, V_{GS}=0$ to 10V	-	3.5	-	nC
Switching charge	$Q_{SW}$	$V_{DD}=30V, I_D=20A, V_{GS}=0$ to 10V	-	5.5	-	nC
Gate charge total	$Q_{g 10V}$	$V_{DD}=30V, I_D=20A, V_{GS}=0$ to 10V	-	15.6	-	nC
	$Q_{g 4.5V}$	$V_{DD}=30V, I_D=20A, V_{GS}=0$ to 4.5V	-	7.6	-	nC
Gate plateau voltage	$V_{plateau}$	$V_{DD}=30V, I_D=20A, V_{GS}=0$ to 10V	-	3.9	-	V
Gate charge total, sync. FET ( $Q_g - Q_{gd}$ )	$Q_{g(sync)}$	$V_{DS}=0.1V, V_{GS}=0$ to 10V	-	12.1	-	nC

DRAIN-SOURCE DIODE CHARACTERISTICS AND MAXIMUM RATINGS						
Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Body Diode continuous forward current	$I_S$	$T_C=25^\circ C$	-	-	44.8	A
Body Diode pulse current	$I_{SM}$	$T_C=25^\circ C$	-	-	55	A
Body Diode Forward Voltage	$V_{SD}$	$V_{GS}=0V, I_S=1A$	-	0.7	1.0	V
Body Diode Reverse Recovery Time	$t_{rr}$	$V_{DD}=30V, I_F=11A, di/dt=100A/\mu s$	-	28.4	-	nS
		$V_{DD}=30V, I_F=11A, di/dt=200A/\mu s$	-	24	-	nS
Body Diode Reverse Recovery Charge	$Q_{rr}$	$V_{DD}=30V, I_F=11A, di/dt=100A/\mu s$	-	15	-	nC
		$V_{DD}=30V, I_F=11A, di/dt=200A/\mu s$	-	26.1	-	nC

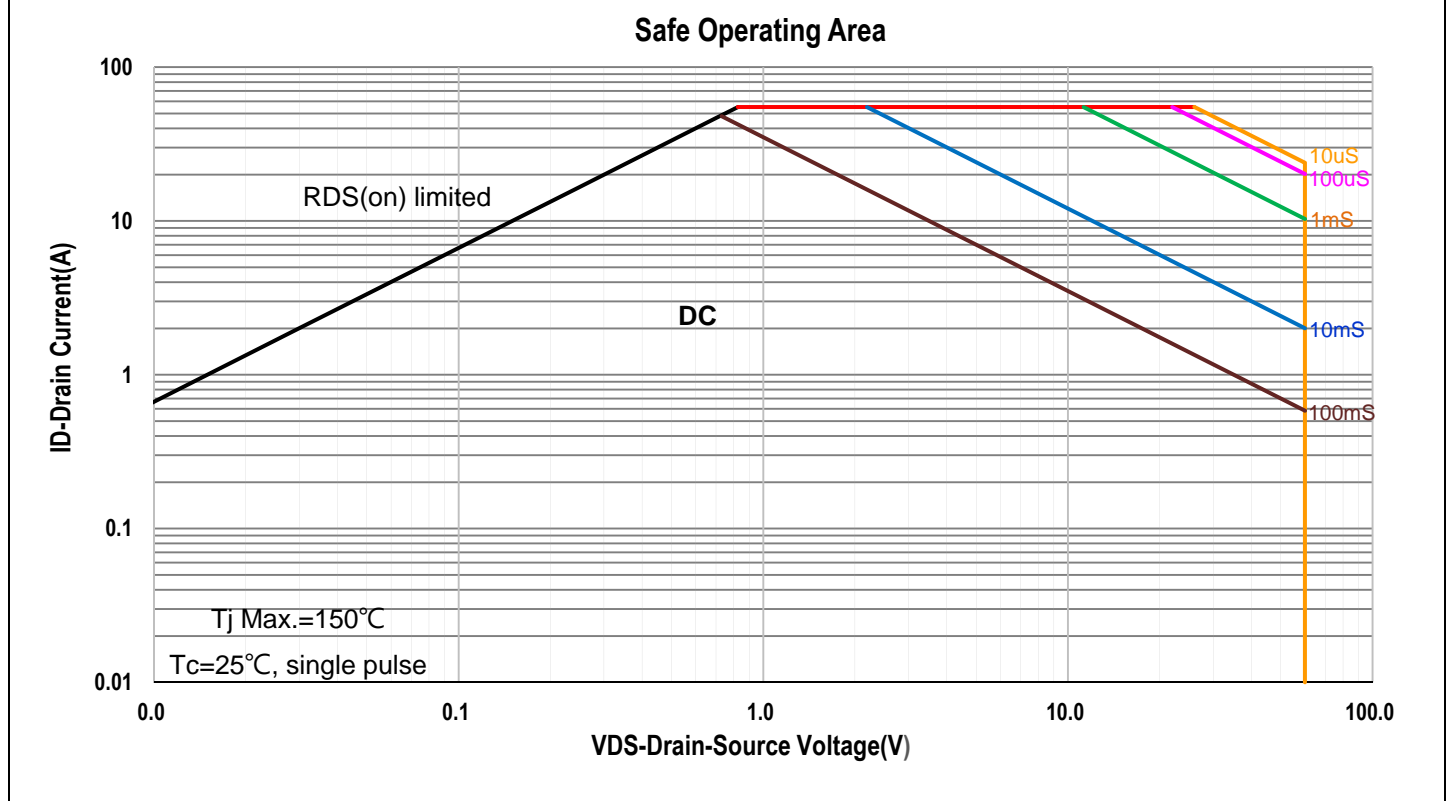
Typical Operating Characteristics



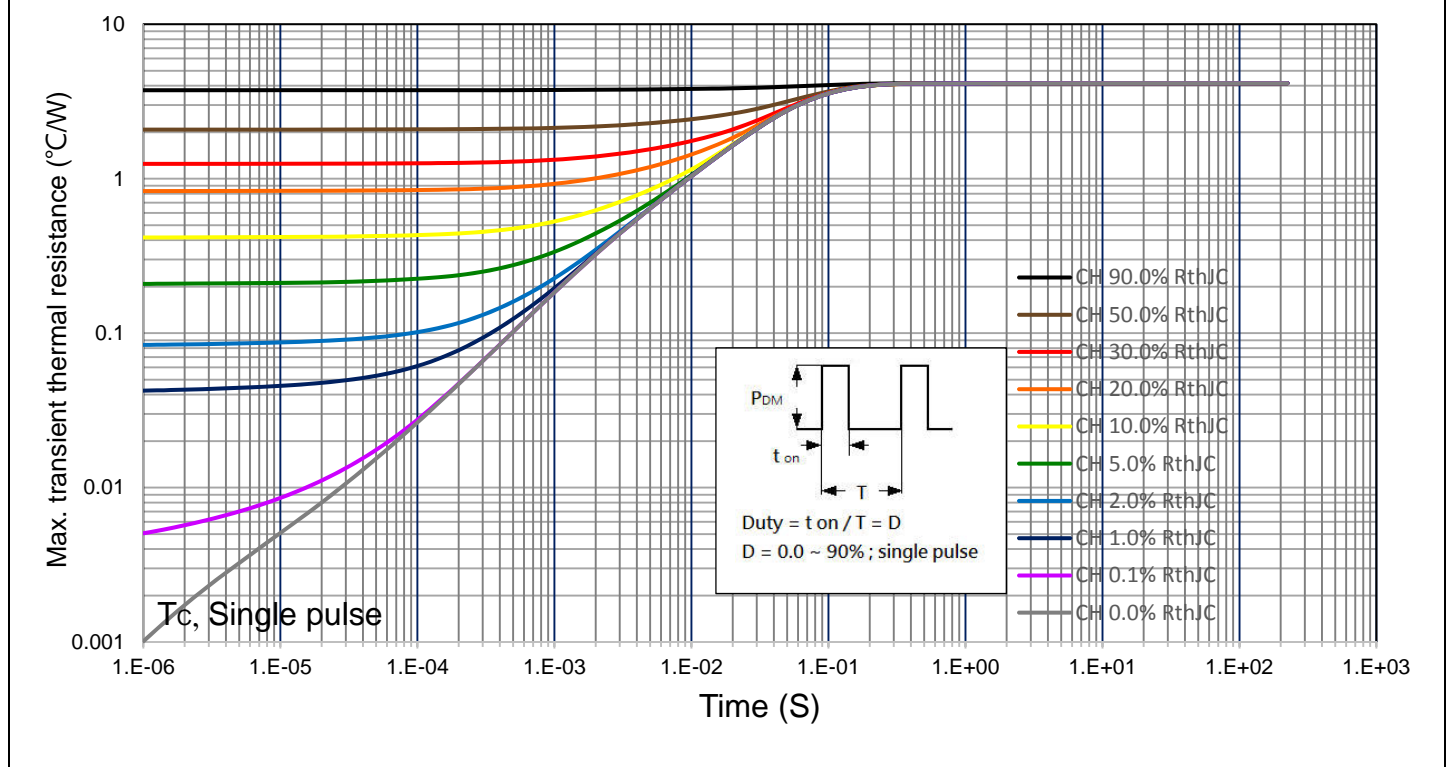
Typical Operating Characteristics (Cont.)



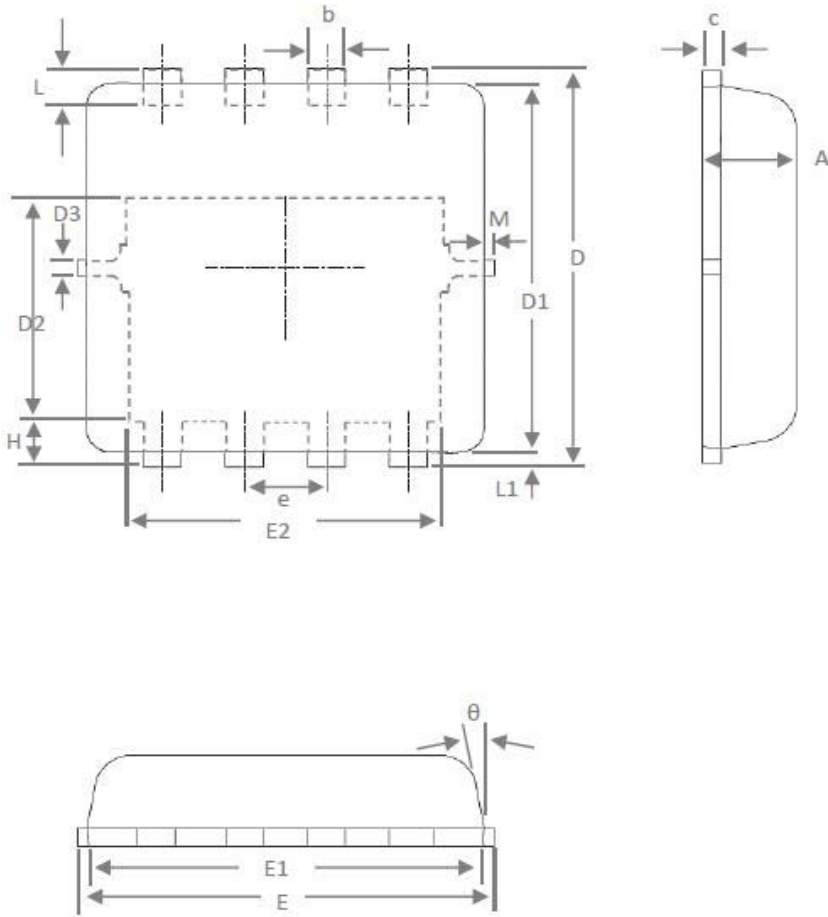
**Fig.11 Safe Operation Area**



**Fig.12 Transient Thermal Impedance**




## Package of Dimension



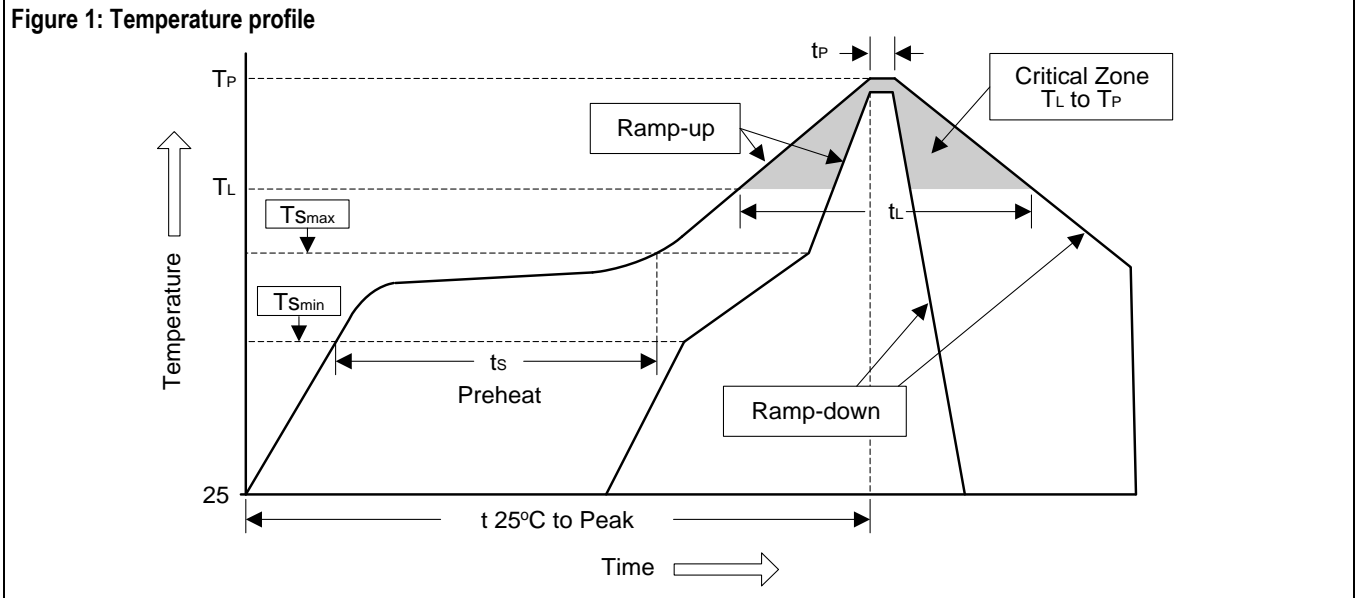
Symbol	Min	Nor	Max
A	0.70	0.75	0.80
b	0.25	0.30	0.35
c	0.10	0.15	0.25
D	3.25	3.35	3.45
D1	3.00	3.10	3.20
D2	1.78	1.88	1.98
D3	-	0.13	-
E	3.00	3.30	3.40
E1	3.00	3.15	3.20
E2	2.39	2.49	2.59
e	0.65BSC		
H	0.30	0.39	0.50
L	0.30	0.40	0.50
L1	-	0.13	-
θ	-	10°	12°
M	-	-	0.15

## Marking Information

PDFN 3.3x3.3-8L (E)	Marking Rule
<p data-bbox="124 365 293 398">Laser Marking</p> 	<p data-bbox="807 365 1070 398"><u>Line 1</u> : Device Name</p> <p data-bbox="807 409 903 443"><u>60N12E</u></p> <p data-bbox="807 499 1038 533"><u>Line 2</u> : Date Code</p> <p data-bbox="807 544 922 577">YMMXXX</p> <p data-bbox="807 633 983 667">Y : Year Code</p> <p data-bbox="807 678 1027 712">MM : Month Code</p> <p data-bbox="807 723 1062 757">XXX : Serial Number</p>

## Soldering Methods for Silicongear's Products

1. Storage environment: Temperature=10°C to 35°C Humidity=65%±15%
2. Reflow soldering of surface-mount devices



Profile Feature	Sn-Pb Eutectic Assembly	Pb-Free Assembly
Average ramp-up rate ( $T_L$ to $T_P$ )	<3°C/sec	<3°C/sec
Preheat		
- Temperature Min ( $T_{Smin}$ )	100°C	150°C
- Temperature Max ( $T_{Smax}$ )	150°C	200°C
- Time (min to max) ( $t_s$ )	60 to 120 sec	60 to 180 sec
$T_{Smax}$ to $T_L$		
- Ramp-up Rate	<3°C/sec	<3°C/sec
Time maintained above:		
- Temperature ( $T_L$ )	183°C	217°C
- Time ( $t_L$ )	60 to 150 sec	60 to 150 sec
Peak Temperature ( $T_P$ )	240°C +0/-5°C	260°C +0/-5°C
Time within 5°C of actual Peak Temperature ( $t_P$ )	10 to 30 sec	20 to 40 sec
Ramp-down Rate	<6°C/sec	<6°C/sec
Time 25°C to Peak Temperature	<6 minutes	<8 minutes

### 3. Flow (wave) soldering (solder dipping)

Products	Peak Temperature	Dipping Time
Pb devices.	245°C ±5°C	5sec ±1sec
Pb-Free devices.	260°C +0/-5°C	5sec ±1sec



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## Revision History

Document Revision History			
Device	Date	Revision	Description (major change from last revision)
DG60N12E	Feb-15-2023	02	<ul style="list-style-type: none"><li>- Update symbol</li><li>- P<sub>D</sub> parameter revision</li><li>- Update typical operating characteristic diagrams Fig.11</li><li>- Added package dimensions section.</li><li>- Added revision history section.</li></ul>