

INV120EQ035A

120V Bi-directional Enhancement-mode GaN Power Transistor

INV120EQ035A

1. General description

Bi-directional GaN-on-Silicon enhancement mode high-electron-mobility-transistor (HEMT) in En-FCQFN with 4.0 mm x 6.0 mm package size.

2. Features

- Bi-directional blocking capability
- GaN-on-Silicon E-mode HEMT technology
- Ultra-low on resistance

3. Applications

- BMS battery protection
- High side load switch in bi-directional converter
- Switch circuits in multiple power supplier system

4. Key performance parameters

Table 1 Key performance parameters at $T_J = 25\text{ }^{\circ}\text{C}$

Parameter	Value	Unit
$V_{DD, \max}$	120	V
$R_{DD(on), \max}$ @ $V_G = 5\text{ V}$	3.5	m Ω
$Q_{G, \text{typ}}$ @ $V_{DD} = 60\text{ V}$	102	nC
I_D, DC	100	A

5. Pin information

Table 2 Pin information

Pin	Pin description	Pin function
1,2,25	Gate	Driver Gate
3-7,9,11,21,23	Drain1	Power Drain1
8,10,12-20,22,24	Drain2	Power Drain2

Table 3 Ordering information

Type/Ordering Code	Package	Product Code
INV120EQ035A	En-FCQFN 4X6	L01

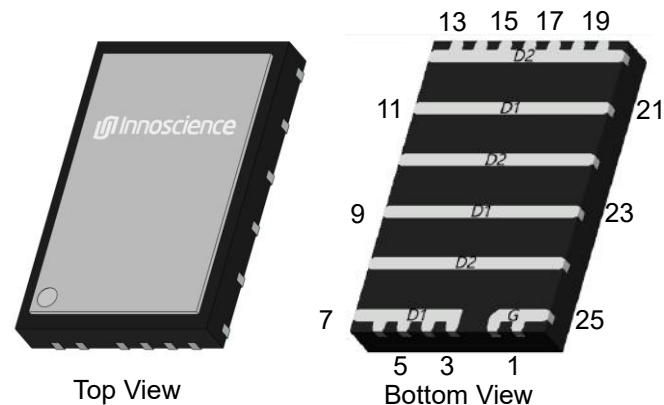
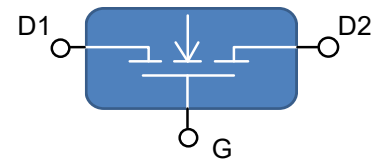


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6. Maximum ratings

at $T_J = 25\text{ }^{\circ}\text{C}$ unless otherwise specified.

Continuous application of maximum ratings can deteriorate transistor lifetime. For further information, contact Innoscience sales office.

Table 4 Maximum ratings

SYMBOL	PARAMETER	MAX	UNIT
V_{DD}	Drain1-to-Drain2 Voltage or Drain2-to-Drain1 Voltage	120	V
$V_{DD(tr)}$	Drain1-to-Drain2 Voltage or Drain2-to-Drain1 Voltage ¹ ($V_{GD}=0V$, 1h total time, $T_A=T_{JMAX}$)	144	V
V_{DG}	Drain1-to-Gate Voltage or Drain2-to-Gate Voltage	120	V
V_{GD}	Gate-to-Drain1 Voltage or Gate-to-Drain2 Voltage	6	V
I_D	Continuous Drain Current ($T_A = 25\text{ }^{\circ}\text{C}$)	100	A
I_{DM}	Pulsed Drain Current (25°C , $T_{Pulse} = 100\text{ }\mu\text{s}$)	320	A
T_J	Operating Temperature	-40 to 150	$^{\circ}\text{C}$
T_{STG}	Storage Temperature	-40 to 150	$^{\circ}\text{C}$

Note:

1. Provided as measure of robustness under abnormal operating conditions and not recommended for normal operation;

7. Thermal characteristics

Table 5 Thermal characteristics

SYMBOL	PARAMETER	TYP	UNIT	Note/Test Condition
$R_{\theta JC}$	Thermal Resistance, Junction to Case	0.24	°C/W	-
$R_{\theta JB}$	Thermal Resistance, Junction to Board	1.31	°C/W	-
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient ²	56.63	°C/W	-
T_{sold}	Maximum reflow soldering temperature	260	°C	MSL3

Note:

2. $R_{\theta JA}$ is determined with the device mounted on one square inch of copper pad, single layer 2 oz copper on FR4 board.

8. Electric characteristics

at $T_J = 25\text{ }^{\circ}\text{C}$, unless specified otherwise

Table 6 Static characteristics

SYMBOL	PARAMETER	MIN	TYP	MAX	UNIT	TEST CONDITIONS
I_{D1D2}	Drain1-to-Drain2 Leakage	-	1	6	μA	$V_{D2} = V_G = 0\text{ V}$, $V_{D1} = 100\text{ V}$
I_{D2D1}	Drain2-to-Drain1 Leakage	-	1	6	μA	$V_{D1} = V_G = 0\text{ V}$, $V_{D2} = 100\text{ V}$
I_{GD}	Gate-to-Drain Forward Leakage	-	1	4	μA	$V_{D1} = V_{D2} = 0\text{ V}$, $V_G = 5\text{ V}$
	Gate-to-Drain Forward Leakage		2	8	μA	$V_{D1} = V_{D2} = 0\text{ V}$, $V_G = 5.5\text{ V}$
	Gate-to-Drain Forward Leakage	-	4.5	18	μA	$V_{D1} = V_{D2} = 0\text{ V}$, $V_G = 6\text{ V}$
$V_{GD1(TH)}$	Gate Threshold Voltage	0.8	1.1	2.5	V	$V_{D1} = 0\text{ V}$, $V_{D2} = V_G$, $I_{D2D1} = 13\text{ mA}$
$V_{GD2(TH)}$	Gate Threshold Voltage	0.8	1.1	2.5	V	$V_{D2} = 0\text{ V}$, $V_{D1} = V_G$, $I_{D1D2} = 13\text{ mA}$
$R_{D1D2(on)}$	Drain1-to-Drain2 On-state Resistance ³	-	2.5	3.5	$\text{m}\Omega$	$V_{D2} = 0\text{ V}$, $V_{GD} = 5\text{ V}$, $I_{D1D2} = 25\text{ A}$
$R_{D2D1(on)}$	Drain2-to-Drain1 On-state Resistance ³	-	2.5	3.5	$\text{m}\Omega$	$V_{D1} = 0\text{ V}$, $V_{GD} = 5\text{ V}$, $I_{D2D1} = 25\text{ A}$

Note:

3. $R_{DS(on)}$ is measured without prior drain bias or switching stress.

Table 7 Dynamic characteristics ⁴

SYMBOL	PARAMETER	MIN	TYP	MAX	UNIT	TEST CONDITIONS
C _{ISS}	Input Capacitance	-	3300	-	pF	V _G = 0 V, V _D = 60V
C _{OSS}	Output Capacitance	-	810	-		
C _{RSS}	Reverse Transfer Capacitance	-	380	-		
R _G	Gate Resistance	-	5	-	Ω	f = 5 MHz, Open drain
Q _G	Total Gate Charge	-	102	-	nC	V _D = 60 V, V _G = 5 V, I _D = 25 A
Q _{GD1}	Gate-to-Drain1 Charge	-	5.5	-		V _{D1} = 0, V _{D2} = 60V, I _{D2D1} = 25 A
Q _{GD1}	Gate-to-Drain1 Charge	-	66	-		V _{D2} = 0, V _{D1} = 60V, I _{D1D2} = 25 A
Q _{GD2}	Gate-to-Drain2 Charge	-	5.5	-		V _{D2} = 0, V _{D1} = 60V, I _{D1D2} = 25 A
Q _{GD2}	Gate-to-Drain2 Charge	-	66	-		V _{D1} = 0, V _{D2} = 60V, I _{D2D1} = 25 A
Q _{OSS}	Output Charge	-	95	-		V _G = 0 V, V _D = 60V
Q _{rr}	Reverse recovery charge	-	0	-		V _{DS} = 50 V, I _D = 25 A

Note:

4. Guaranteed by design.

9. Electric characteristics diagrams

at $T_J = 25^\circ\text{C}$ unless otherwise specified.

Note: In Charts, V_{D1D2} can be V_{D2D1} with same characteristic chart due to Bi-directional feature.

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

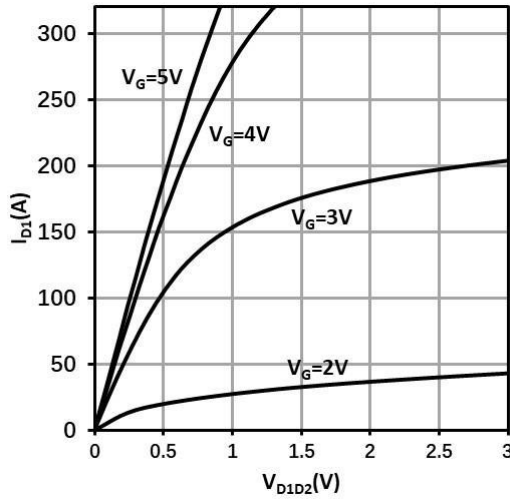


Fig. 2 Typical Output Characteristics ($T_J=125^\circ\text{C}$)

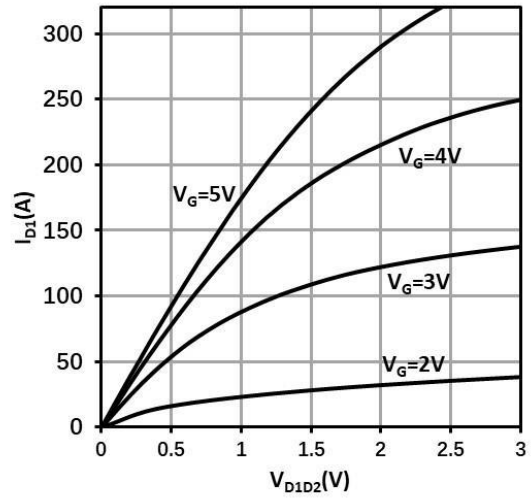


Fig.3 Typical Drain On-state Resistance ($T_J=25^\circ\text{C}$)

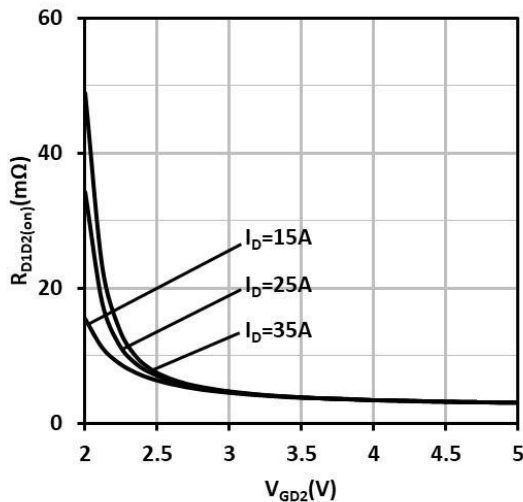


Fig. 4 Typical Drain On-state Resistance ($T_J=125^\circ\text{C}$)

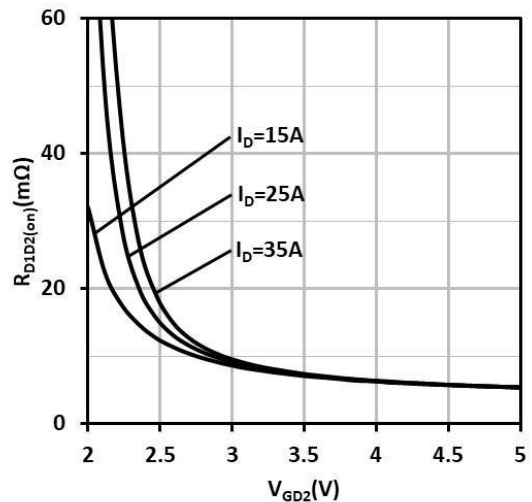


Fig. 5 Normalized On-State Resistance vs. Temp.

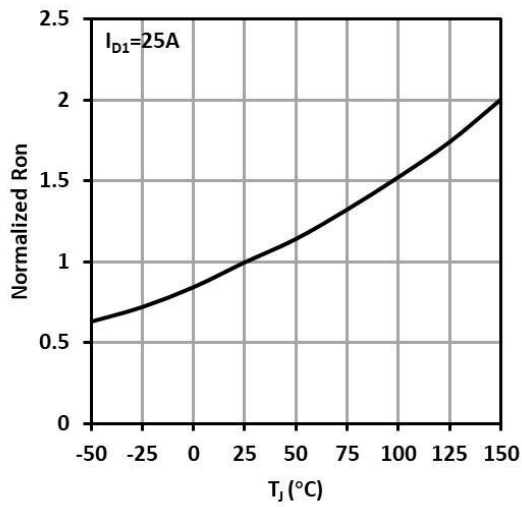


Fig. 6 Typical Transfer Characteristics

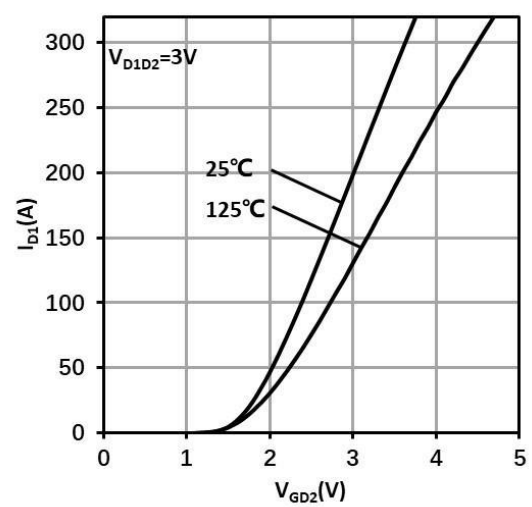


Fig. 7 Typ. Reverse Drain-Source Characteristics ($V_{GS2} \leq 0, T_J = 25^{\circ}C$)

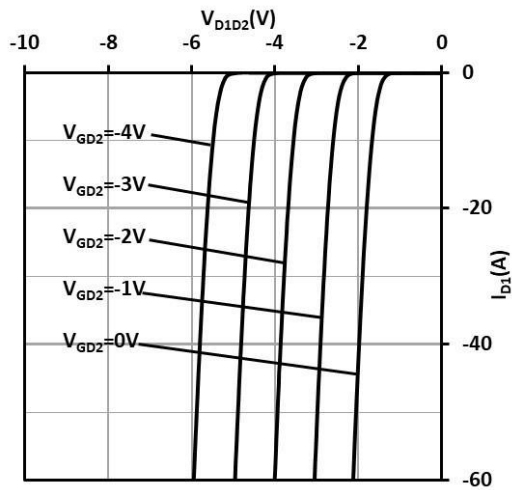


Fig. 8 Typ. Reverse Drain-Source Characteristics ($V_{GS2} \geq 0, T_J = 25^{\circ}C$)

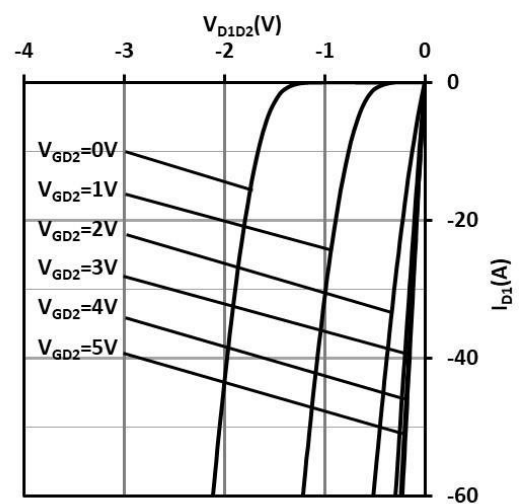


Fig. 9 Typ. Reverse Drain-Source Characteristics
($V_{GD2} \leq 0$, $T_J = 125^\circ\text{C}$)

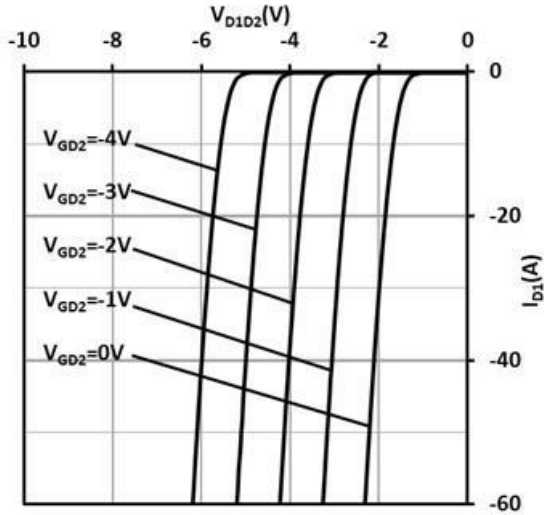


Fig. 10 Typ. Reverse Drain-Source Characteristics
($V_{GD2} \geq 0$, $T_J = 125^\circ\text{C}$)

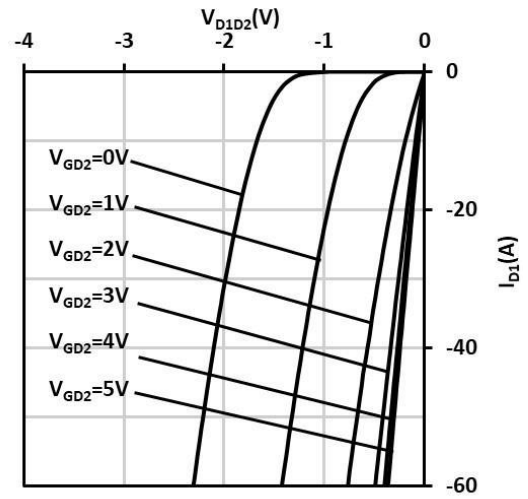


Fig. 11 Typ. Capacitances Characteristics

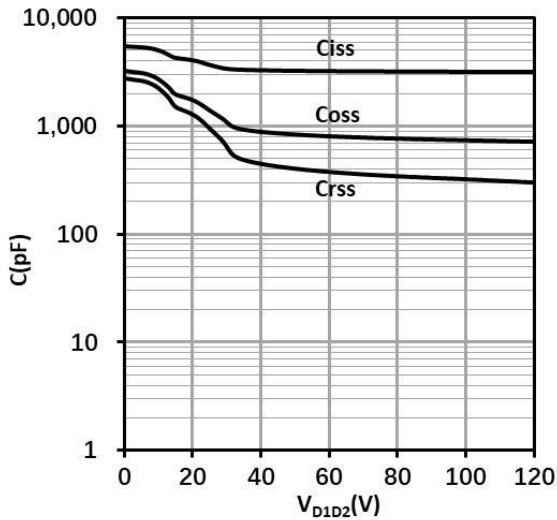


Fig. 12 Typ. Gate Charge

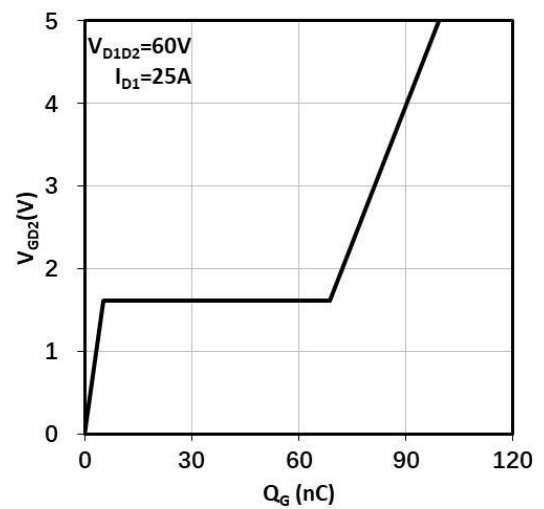


Fig. 13 Normalized Threshold Voltage vs. Temp.

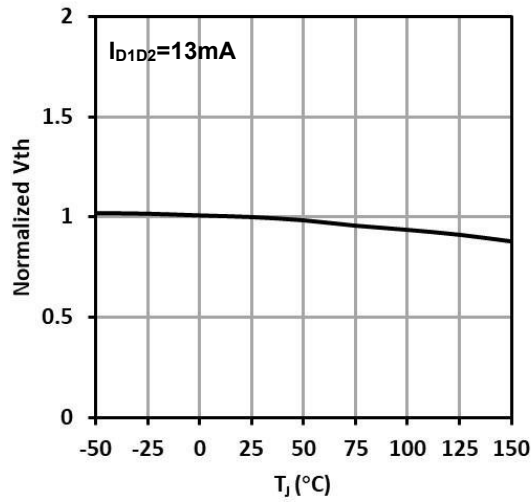


Fig. 14 Output Charge

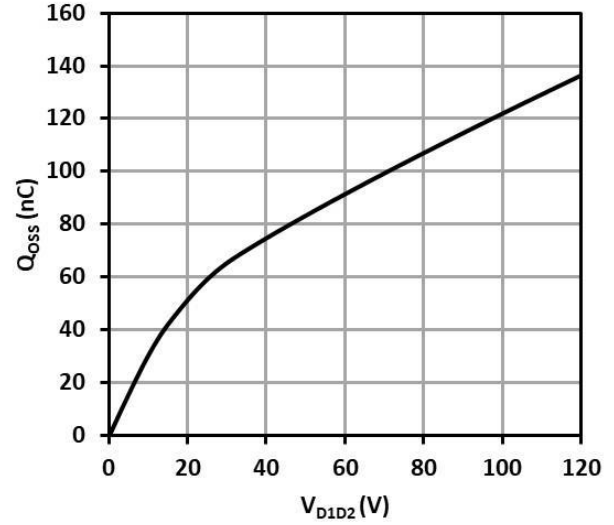


Fig. 15 Output Capacitance Stored Energy

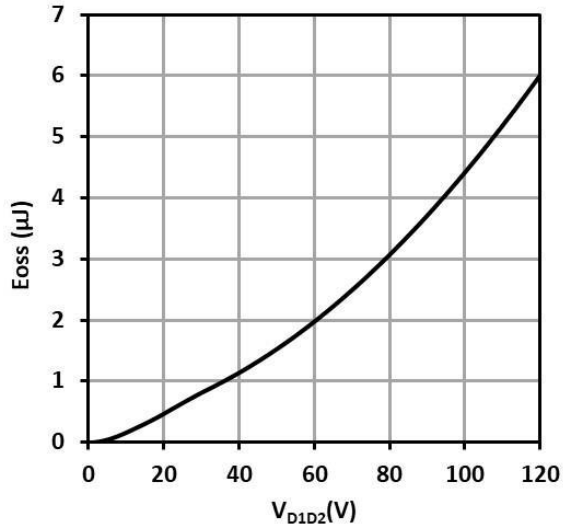


Fig. 16 Power Dissipation

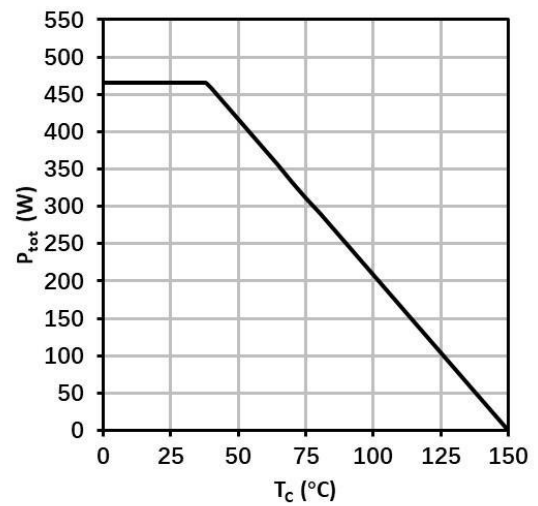


Fig. 17 Safe Operating Area

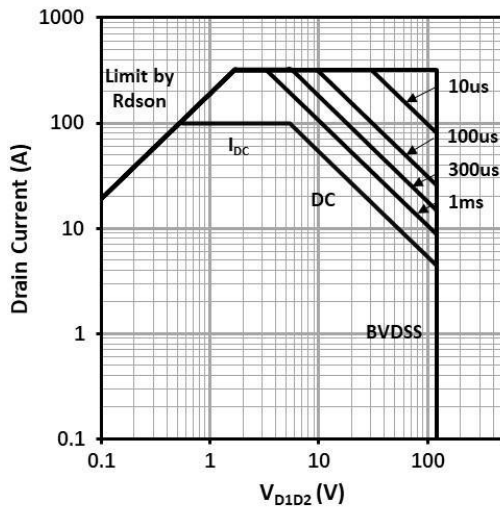
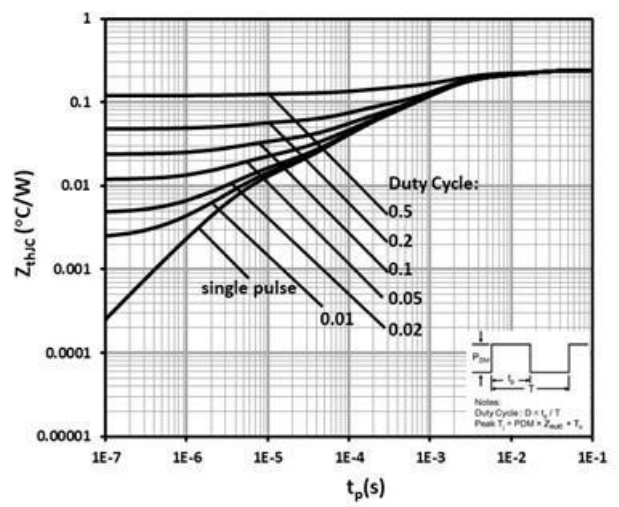
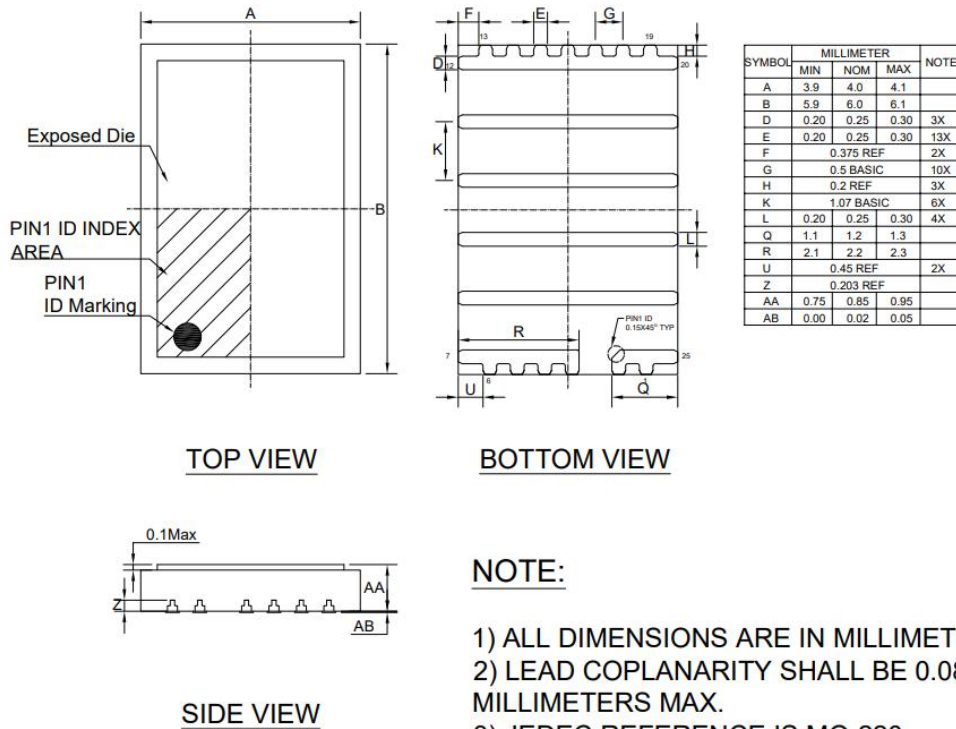


Fig. 18 Max. Transient Thermal Impedance

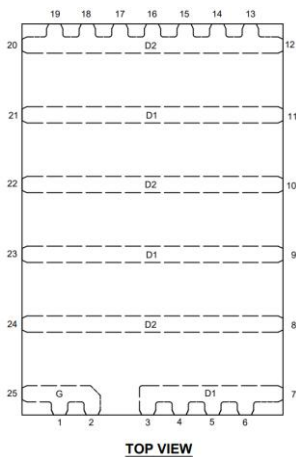


10. Package outlines

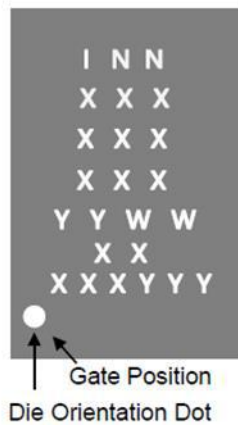
Package Reference



PIN configuration

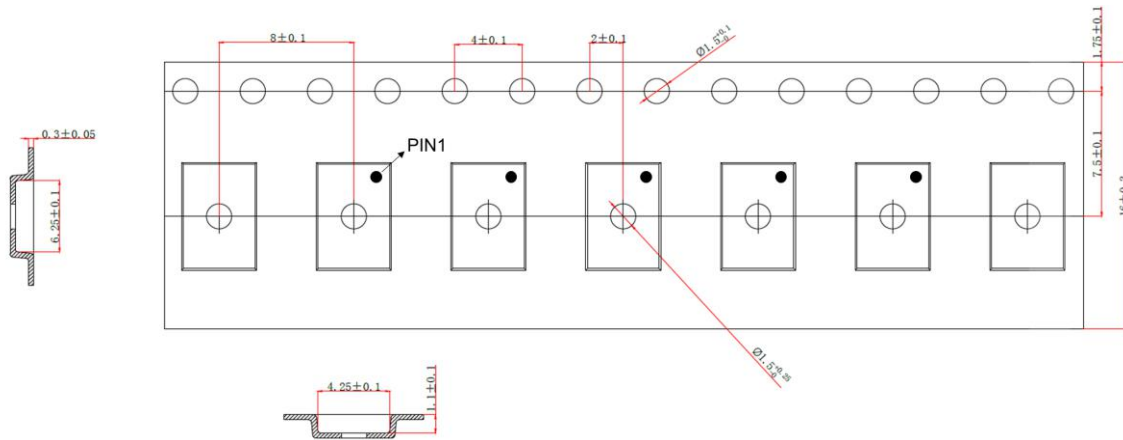


Marking Reference



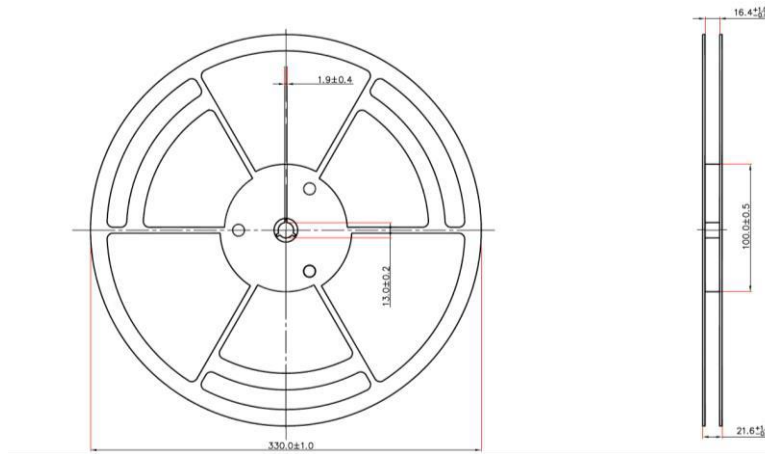
Row	Description	Example
Row1	Company name	INN
Row2	Product code	XXX
Row3	Lot Code	XXX
Row4		XXX
Row5	Date code	YYWW
Row6	Wafer ID	XX
Row7	Location ID	XXXXYY

11. Reel information



NOTES:

1. CARRIER TAPE COLOR: BLACK.
2. COVER TAPE WIDTH: 13.3±0.10.
3. COVER TAPE COLOR: TRANSPARENT.
4. 10 SPROCKET HOLE PITCH CUMULATIVE TOLERANCE ±0.20 MAX.
5. CAMBER NOT TO EXCEED 1MM IN 100MM.
6. MOLD# QFN/DFN/MIS6X4X0.75/0.85.
7. ALL DIMS IN MM.
8. BAN TO USE THE ENVIRONMENT-RELATED SUBSANCES OF JCET PRESCRIBING.

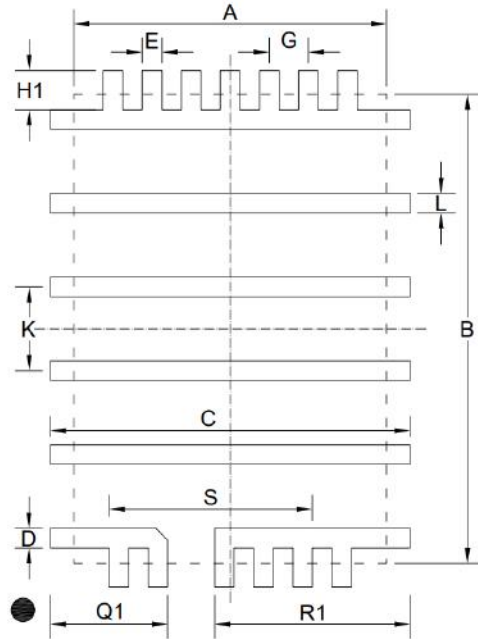


NOTES:

1. 2500 UNITS PER TRAY.
2. COLOR: WHITE.
3. ALL DIM IN mm.
4. GENERAL TOLERANCE±0.25.
5. BAN TO USE THE ENVIRONMENT-RELATED SUBSANCES OF JCET PRESCRIBING.
6. THE DERECTION OF VIEW:

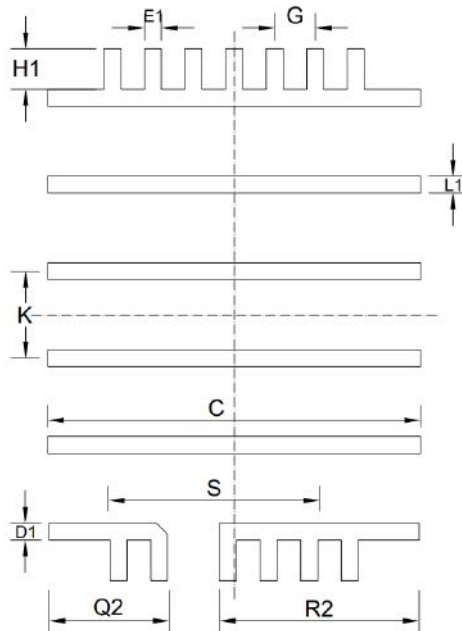
12. Land pattern

Recommended Land Pattern



SYMBOL	MILLIMETER	NOTE
A	4.0	
B	6.0	
C	4.6	5X
D	0.25	3X
E	0.25	13X
G	0.5	10X
H1	0.5	13X
K	1.07	6X
L	0.25	4X
R1	2.5	
Q1	1.5	
S	2.6	

Recommended Stencil drawing



SYMBOL	MILLIMETER	NOTE
C	4.56	5X
D1	0.21	3X
E1	0.21	13X
G	0.5	10X
H1	0.5	13X
K	1.07	6X
L1	0.21	4X
R2	2.46	
Q2	1.46	
S	2.6	

13. Revision history

Major changes since the last revision

Revision	Date	Description of changes
1.0	2024-07-04	Version 1.0 Release

Important Notice

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