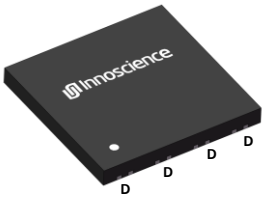
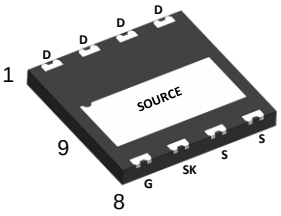
INN650D080BS

1. General description

650V GaN-on-Silicon Enhancement-mode Power Transistor in Dual Flat No-lead package (DFN) with 8 mm × 8 mm size

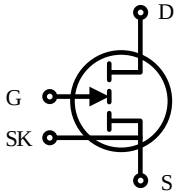
2. Features





- Enhancement mode transistor-Normally off power switch
- Ultra high switching frequency
- No reverse-recovery charge
- Low gate charge, low output charge
- Qualified for industrial applications according to JEDEC Standards
- ESD safeguard
- RoHS, Pb-free, REACH-compliant

3. Applications



- AC-DC converters
- DC-DC converters
- BCM/DCM totem pole PFC
- Fast battery charging
- High density power conversion
- High efficiency power conversion

4. Key performance parameters

Table 1 Key performance parameters at T_j = 25 °C

Parameter	Value	Unit
$V_{DS,max}$	650	V
$R_{DS(on),max}$ @ V_{GS} = 6 V	80	mΩ
$Q_{G,typ}$ @ V_{DS} = 400 V	6.2	nC
$I_{D,pulse}$	58	A
Q_{OSS} @ V_{DS} = 400 V	60	nC
Q_{rr} @ V_{DS} = 400 V	0	nC

5. Pin information

Table 2 Pin information

Gate	Drain	Kelvin Source	Source
8	1,2,3,4	7	5,6,9

Table 3 Ordering information

Type/Ordering Code	Package	Product Code
INN650D080BS	DFN 8X8	65D080B

Table of contents

1. General description 1
2. Features 1
3. Applications 1
4. Key performance parameters 1
5. Pin information 1
6. Maximum ratings 3
7. Thermal characteristics 4
8. Electric characteristics 5
9. Electric characteristics diagrams 7
10. Package outlines 13
11. Reel information 14
12. Recommended PCB footprint 15
13. Revision history 16

6. Maximum ratings

at T_j = 25 °C unless otherwise specified

Exceeding the maximum ratings may destroy the device. For further information, contact Innoscience sales office

Table 4 Maximum ratings

Parameter	Symbol	Values	Unit	Note/Test Condition
Drain source voltage	$V_{DS,max}$	650	V	V_{GS} = 0 V, T_j = -55 °C to 150 °C
Drain source voltage transient [1]	$V_{DS,transient}$	800	V	V_{GS} = 0 V
Drain source voltage, pulsed [2]	$V_{DS,pulse}$	750	V	T_j = 25 °C; total time < 10 h
				T_j = 125 °C; total time < 1 h
Continuous current, drain source	I_D	29	A	T_c = 25 °C
Pulsed current, drain source [3]	$I_{D,pulse}$	58	A	T_c = 25 °C; V_{GS} = 6 V; t_{PULSE} = 10 µs
Pulsed current, drain source [3]	$I_{D,pulse}$	29	A	T_c = 125 °C; V_{GS} = 6 V; t_{PULSE} = 10 µs
Gate source voltage, continuous	V_{GS}	-6 to +7	V	T_j = -55 °C to 150 °C
Gate source voltage, pulsed	$V_{GS,pulse}$	-20 to +10	V	T_j = -55 °C to 150 °C; t_{PULSE} = 50 ns, f = 100 kHz; open drain
Power dissipation	P_{tot}	188	W	T_c = 25 °C
Operating temperature	T_j	-55 to +150	˚C	
Storage temperature	T_{stg}	-55 to +150	˚C	

1 $V_{DS,transient}$ is intended for non-repetitive events, t_{PULSE} < 200 µs

2 $V_{DS,pulse}$ is intended for repetitive pulse, t_{PULSE} < 100 ns

3 Limit was extracted from characterization test, not measured during production

7. Thermal characteristics

Table 5 Thermal characteristics

Parameter	Symbol	Values	Unit	Note/Test Condition
Thermal resistance, junction-ambient	R_{thJA}	33.6	°C/W	
Thermal resistance, junction-case	R_{thJC}	0.52	°C/W	
Maximum reflow soldering temperature	T_{sold}	260	°C	MSL3

8. Electric characteristics

at T_j = 25 °C, unless specified otherwise

Table 6 Static characteristics

Parameter	Symbol	Values			Unit	Note/Test Condition
		Min.	Typ.	Max.		
Gate threshold voltage	$V_{GS(th)}$	1.2	1.7	2.5	V	I_D = 30.7 mA; V_{DS} = V_{GS}; T_j = 25 °C
		-	1.6	-		I_D = 30.7 mA; V_{DS} = V_{GS}; T_j = 150 °C
Drain-source leakage current	I_{DSS}	-	5	65	μA	V_{DS} = 650 V; V_{GS} = 0 V; T_j = 25 °C
		-	13	390		V_{DS} = 650 V; V_{GS} = 0 V; T_j = 150 °C
Gate-source leakage current	I_{GSS}	-	163	-	μA	V_{GS} = 6 V; V_{DS} = 0 V
Drain-source on-state resistance	$R_{DS(on)}$	-	60	80	mΩ	V_{GS} = 6 V; I_D = 8 A; T_j = 25 °C
		-	135	-	mΩ	V_{GS} = 6 V; I_D = 8 A; T_j = 150 °C
Gate resistance	R_G	-	3	-	Ω	f = 5 MHz; open drain

Table 7 Dynamic characteristics

Parameter	Symbol	Values			Unit	Note/Test Condition
		Min.	Typ.	Max.		
Input capacitance	C_{iss}	-	225	-	pF	V_{GS} = 0 V; V_{DS} = 400 V; f = 100 kHz
Output capacitance	C_{oss}	-	70	-	pF	V_{GS} = 0 V; V_{DS} = 400 V; f = 100 kHz
Reverse transfer Capacitance	C_{rss}	-	0.5	-	pF	V_{GS} = 0 V; V_{DS} = 400 V; f = 100 kHz
Effective output capacitance, energy related [1]	$C_{o(er)}$	-	105	-	pF	V_{GS} = 0 V; V_{DS} = 0 to 400 V
Effective output capacitance, time related [2]	$C_{o(tr)}$	-	150	-	pF	V_{GS} = 0 V; V_{DS} = 0 to 400 V
Output charge	Q_{OSS}	-	60	-	nC	V_{GS} = 0 V; V_{DS} = 0 to 400 V
Turn-on delay time	$t_{d(on)}$	-	3	-	ns	V_{DS} = 400 V; I_D = 16 A; L = 318 μH; V_{GS} = 6 V; R_{on} = 10 Ω; R_{off} = 2 Ω; See Figure 22
Turn-off delay time	$t_{d(off)}$	-	5	-	ns	
Rise time	t_r	-	4	-	ns	
Fall time	t_f	-	4	-	ns	

1. $C_{O(er)}$ is the fixed capacitance that gives the same stored energy as C_{OSS} while V_{DS} is rising from 0 to 400 V
2. $C_{O(tr)}$ is the fixed capacitance that gives the same charging time as C_{OSS} while V_{DS} is rising from 0 to 400 V

Table 8 Gate charge characteristics

Parameter	Symbol	Values			Unit	Note/Test Condition
		Min.	Typ.	Max.		
Gate charge	Q_G	-	6.2	-	nC	V_{GS} = 0 to 6 V; V_{DS} = 400 V; I_D = 8 A
Gate-source charge	Q_{GS}	-	0.5	-	nC	
Gate-drain charge	Q_{GD}	-	2.2	-	nC	
Gate plateau Voltage	V_{Plat}	-	2.2	-	V	V_{DS} = 400 V; I_D = 8 A

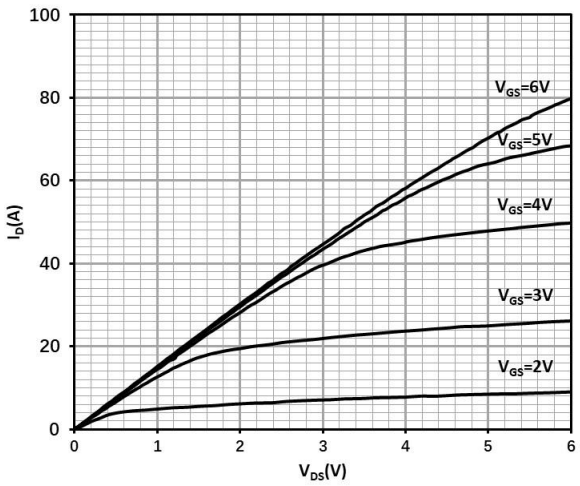
Table 9 Reverse conduction characteristics

Parameter	Symbol	Values			Unit	Note/Test Condition
		Min.	Typ.	Max.		
Source-drain reverse voltage	V_{SD}	-	2.3	-	V	V_{GS} = 0 V; I_S = 8 A
Pulsed current, reverse	$I_{S,pulse}$	-	-	58	A	V_{GS} = 6 V; t_{PULSE} = 10 µs
Reverse recovery charge	Q_{rr}	-	0	-	nC	I_S = 8 A; V_{DS} = 400 V
Reverse recovery time	t_{rr}	-	0	-	ns	
Peak reverse recovery current	I_{rrm}	-	0	-	A	

9. Electric characteristics diagrams

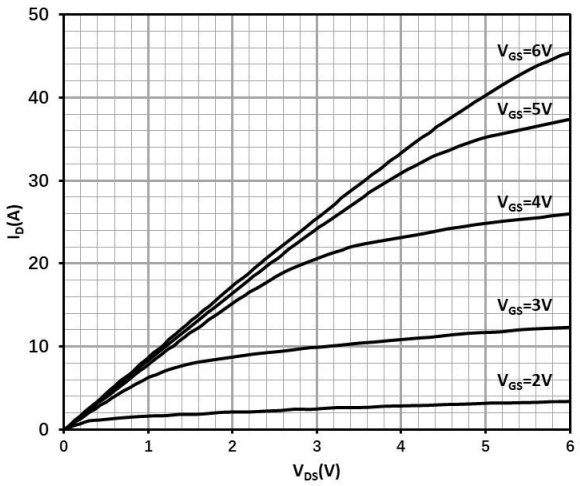
at T_j = 25 °C, unless specified otherwise

Figure 1 Typ. output characteristics



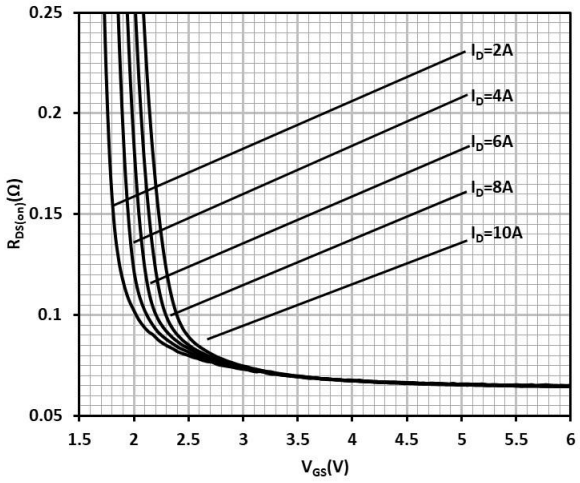
$I_D = f(V_{DS},V_{GS})$; T_j = 25 °C

Figure 2 Typ. output characteristics



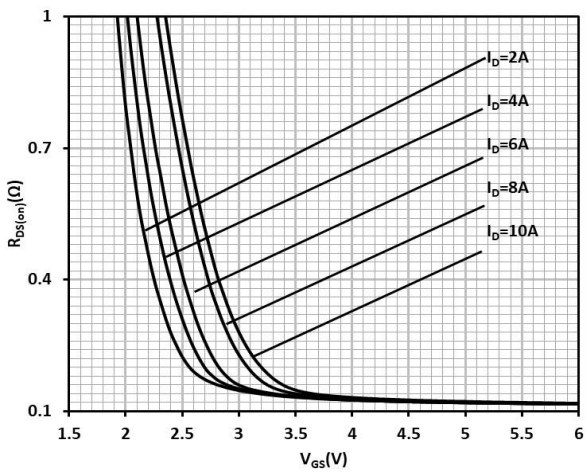
$I_D = f(V_{DS},V_{GS})$; T_j = 125 °C

Figure 3 Typ. Drain-source on-state resistance



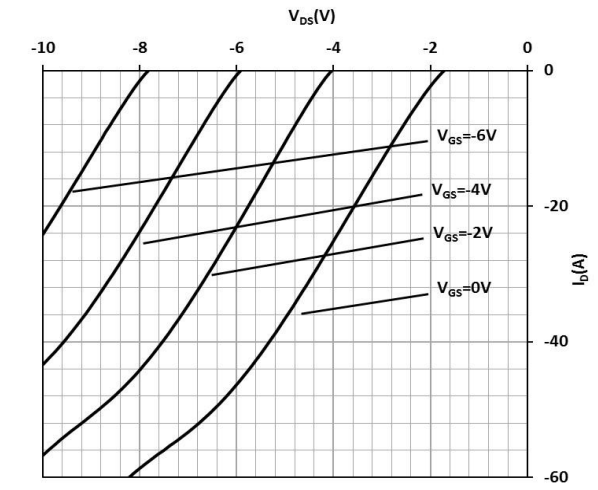
$R_{DS(on)} = f(I_D,V_{GS})$; T_j = 25 °C

Figure 4 Typ. Drain-source on-state resistance



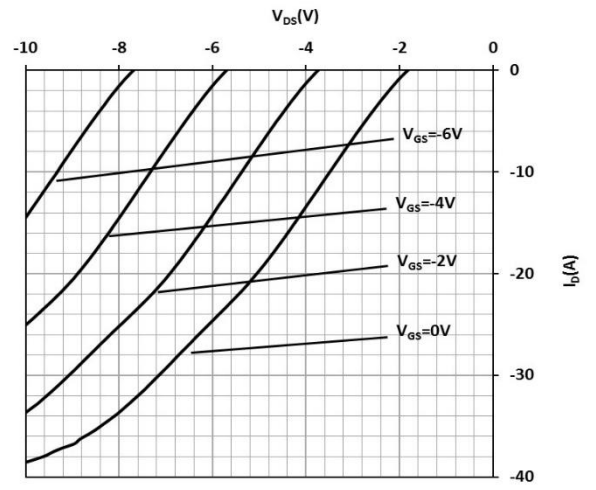
$R_{DS(on)} = f(I_D,V_{GS})$; T_j = 125 °C

Figure 5 Typ. channel reverse characteristics



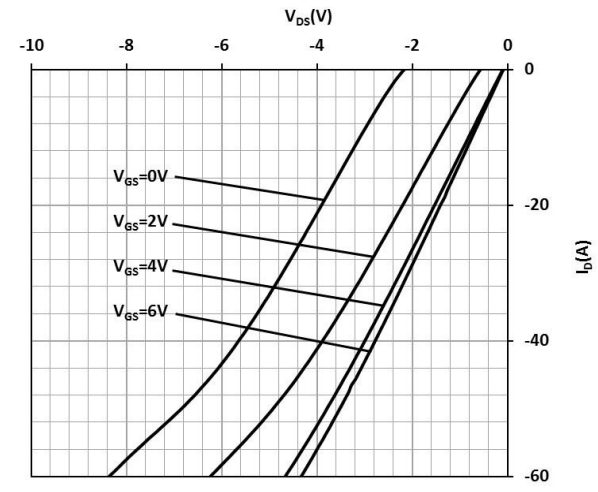
$I_D = f(V_{DS},V_{GS})$; T_j= 25 °C

Figure 6 Typ. channel reverse characteristics



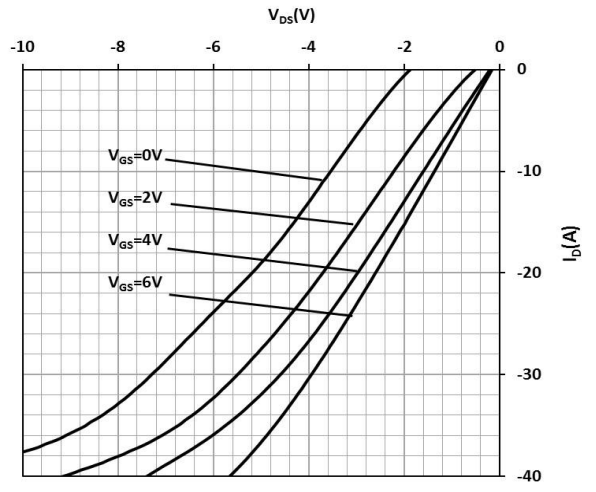
$I_D = f(V_{DS},V_{GS})$; T_j = 125 °C

Figure 7 Typ. channel reverse characteristics



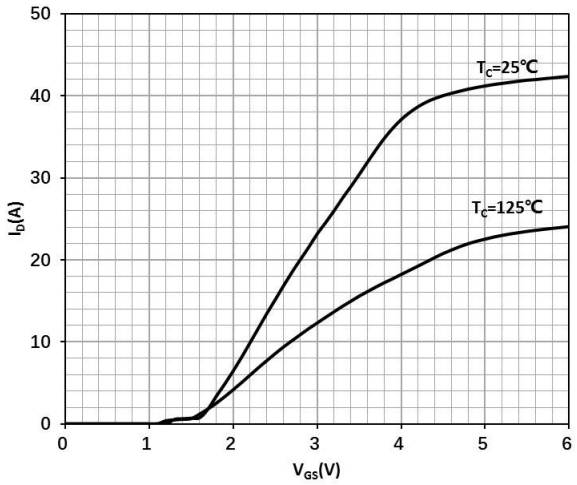
$I_D = f(V_{DS},V_{GS})$; T_j = 25 °C

Figure 8 Typ. channel reverse characteristics



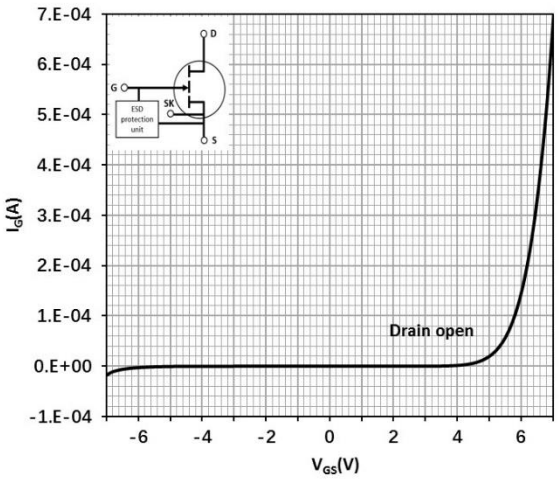
$I_D = f(V_{DS},V_{GS})$; T_j = 125 °C

Figure 9 Typ. transfer characteristics



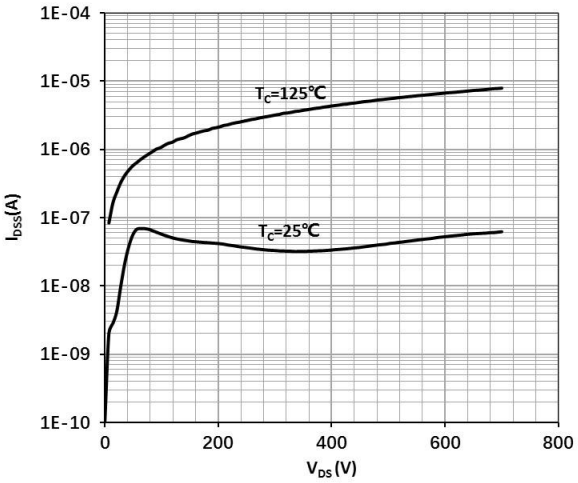
$I_D = f(V_{GS})$; V_{DS}= 3 V

Figure 10 Typ. Gate-to-Source leakage



$I_G = f(V_{GS})$

Figure 11 Drain-source leakage characteristics



$I_{DSS} = f(V_{DS})$; V_{GS} = 0 V

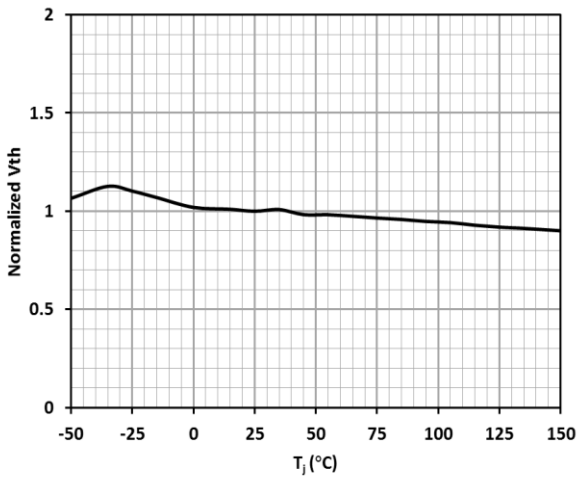
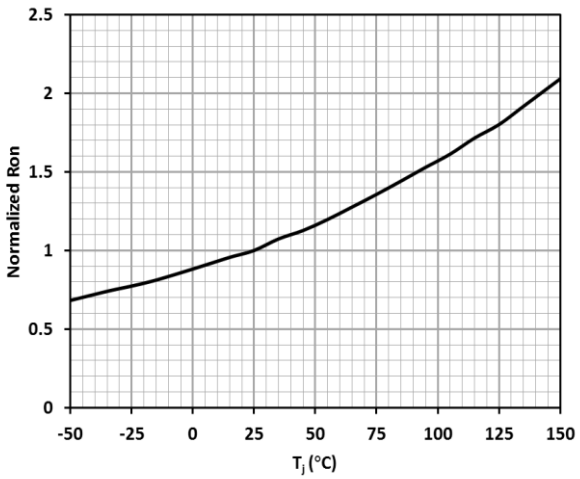
Figure 12 Gate threshold voltage	Figure 13 Drain-source on-state resistance
	
$V_{TH} = f(T_j)$; $V_{GS} = V_{DS}$; I_D = 30.7 mA	$R_{DS(on)} = f(T_j)$; I_D = 8 A; V_{GS}=6V

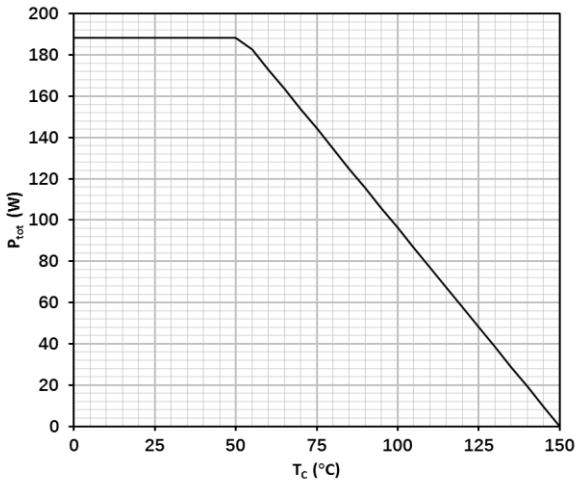
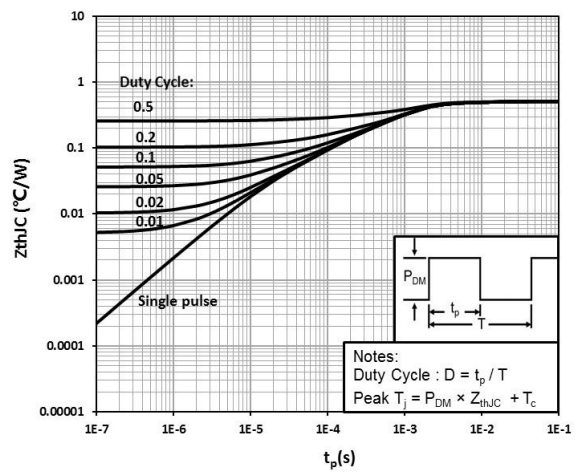
Figure 14 Power dissipation	Figure 15 Max.transient thermal impedance
	
$P_{tot} = f(T_C)$	$Z_{thJC} = f(t_P, D)$

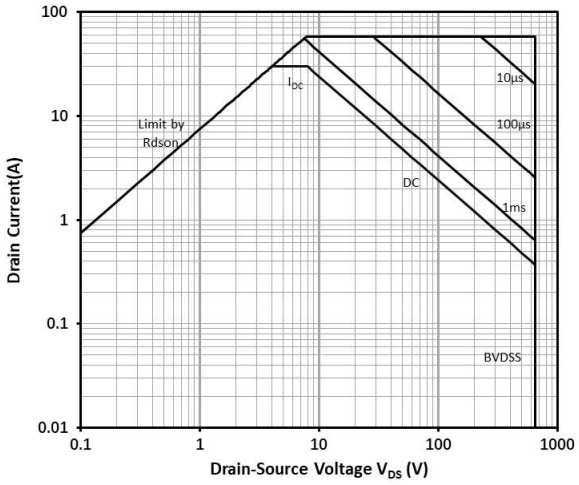
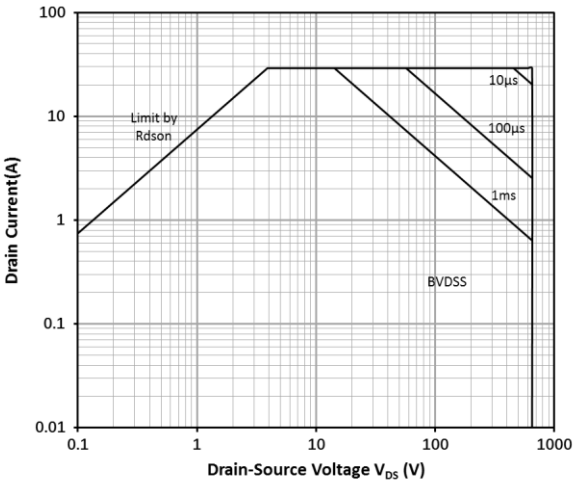
Figure 16 Safe operating area	Figure 17 Safe operating area
	
$I_D = f(V_{DS})$; $T_C = 25$ °C	$I_D = f(V_{DS})$; $T_C = 125$ °C

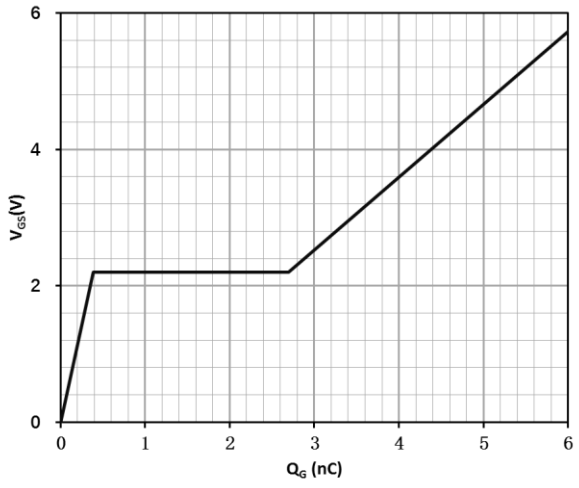
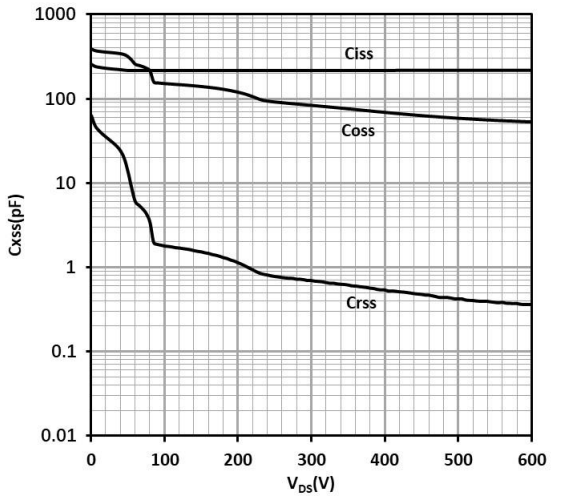
Figure 18 Typ. gate charge	Figure 19 Typ. capacitances
	
$V_{GS} = f(Q_G)$; $V_{DCLINK} = 400$ V; $I_D = 8$ A	$C_{XSS} = f(V_{DS})$; Freq. = 100 kHz

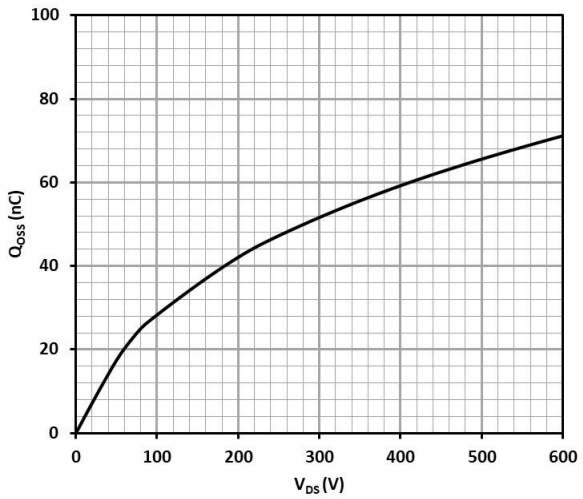
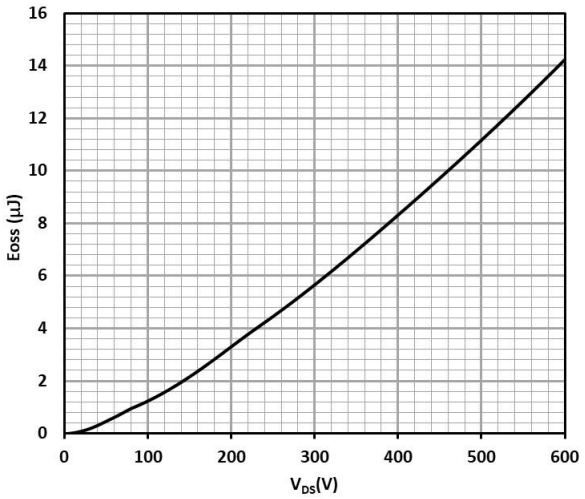
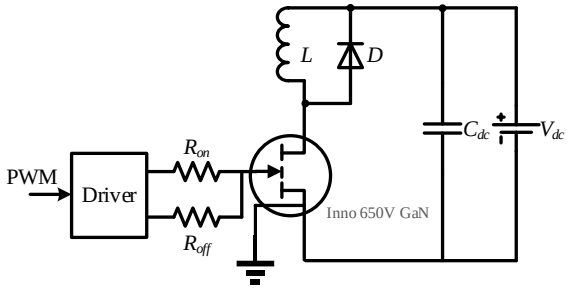
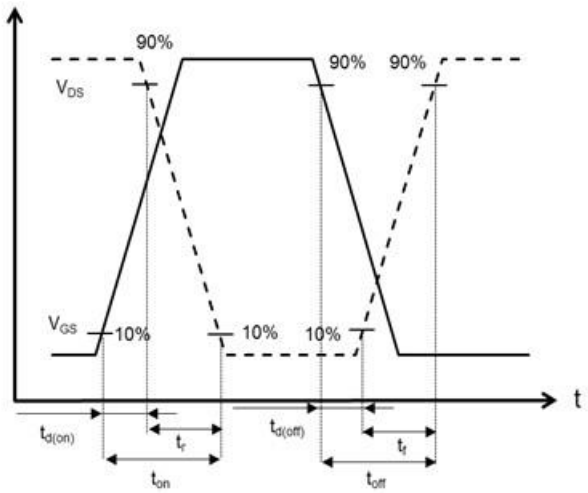
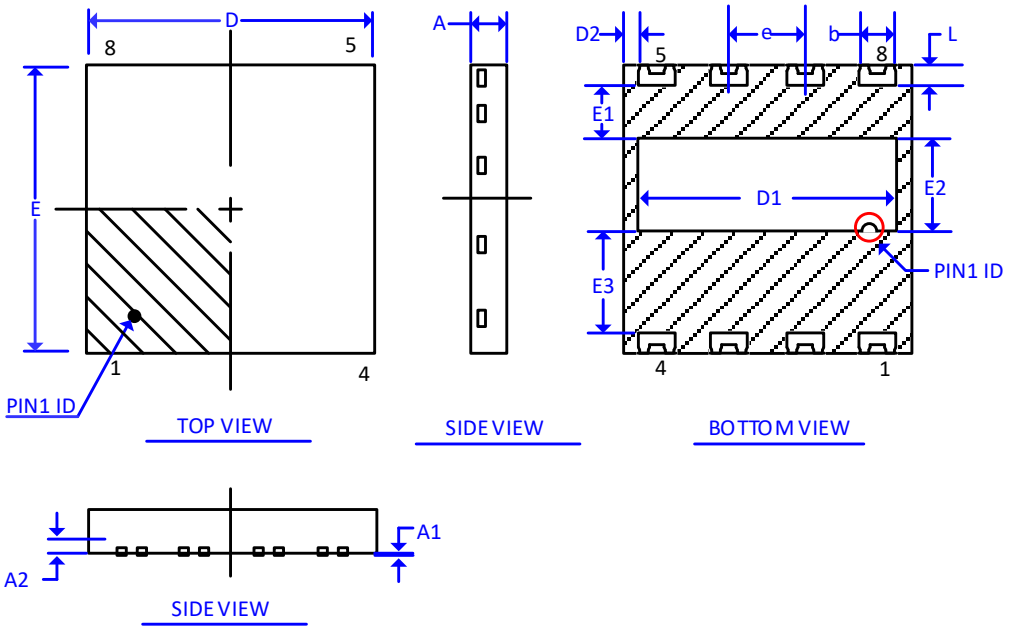
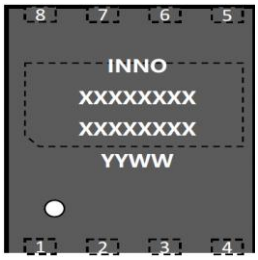
Figure 20 Typ. output charge	Figure 21 Typ. C_{OSS} stored Energy
	
Q_{OSS} = f(V_{DS}); Freq. = 100 kHz	E_{OSS} = f(V_{DS}); Freq. = 100 kHz

Figure 22 Switching time test circuit	Figure 23 Switching times waveform
	
V_{DS} = 400 V, I_D = 16 A, L = 318 µH, V_{GS} = 6 V, R_{on} = 10 Ω, R_{off} = 2 Ω	

10. Package outlines



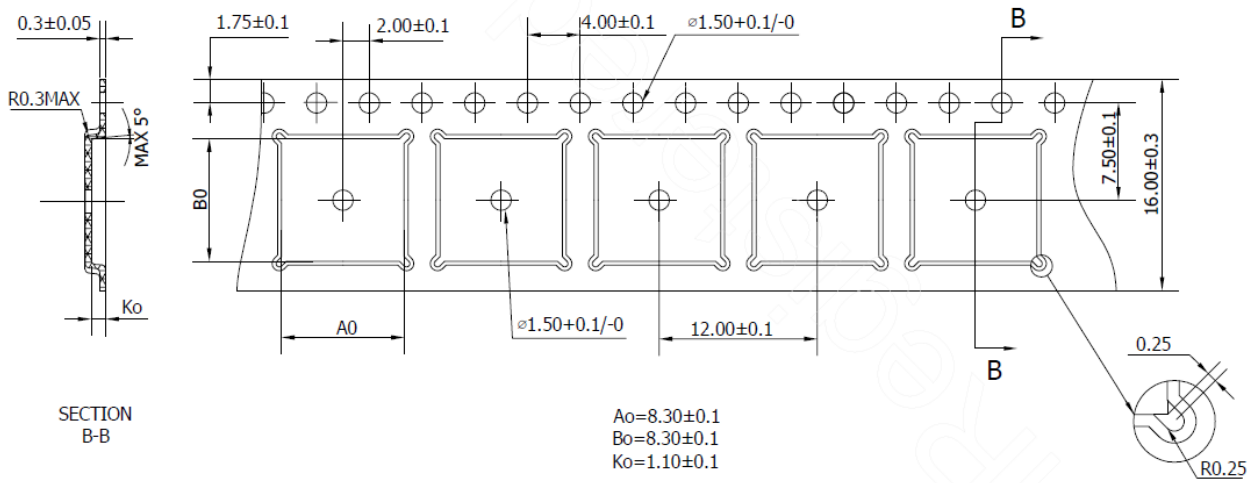
SYMBOL	DIMENSION			SYMBOL	DIMENSION		
	MIN	NOM	MAX		MIN	NOM	MAX
A	0.80	0.90	1.00	E	8.00 B.S.C		
A1	0.00	0.02	0.05	E1	0.90	1.00	1.10
A2	---	0.203 ref	---	E2	3.10	3.20	3.30
b	0.92	1.00	1.05	E3	2.70	2.80	2.90
D	8.00 B.S.C			e	2.00 B.S.C		
D1	6.84	6.94	7.04	L	0.40	0.50	0.60
D2	0.40	0.50	0.60				

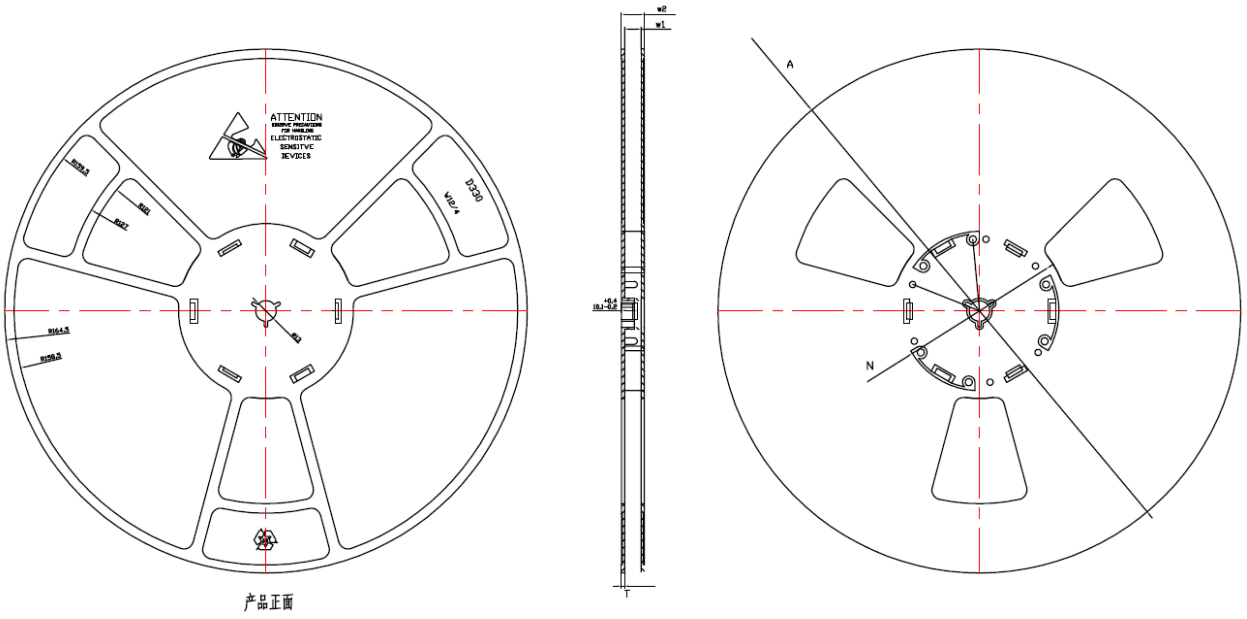


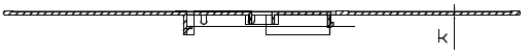
Row	Description	Example
Row1	Company name	INNO
Row2	Product code (In short)	XXXXXXXX
Row3	ASSY lot No.	XXXXXXXX
Row4	Date code	YYWW

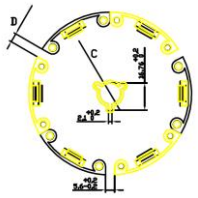
Notes:
(1) Dimension and tolerance conform to ASME Y14.5-2009.
(2) All dimension are in millimeters.
(3) Lead coplanarity shall be 0.1 millimeters max.
(4) Complies with JEDEC MO-229.
(5) Drawing is not to scale.
(6) Dimensions do not include mold protrusion.
(7) Package outline exclusive of metal burr dimensions.

11. Reel information



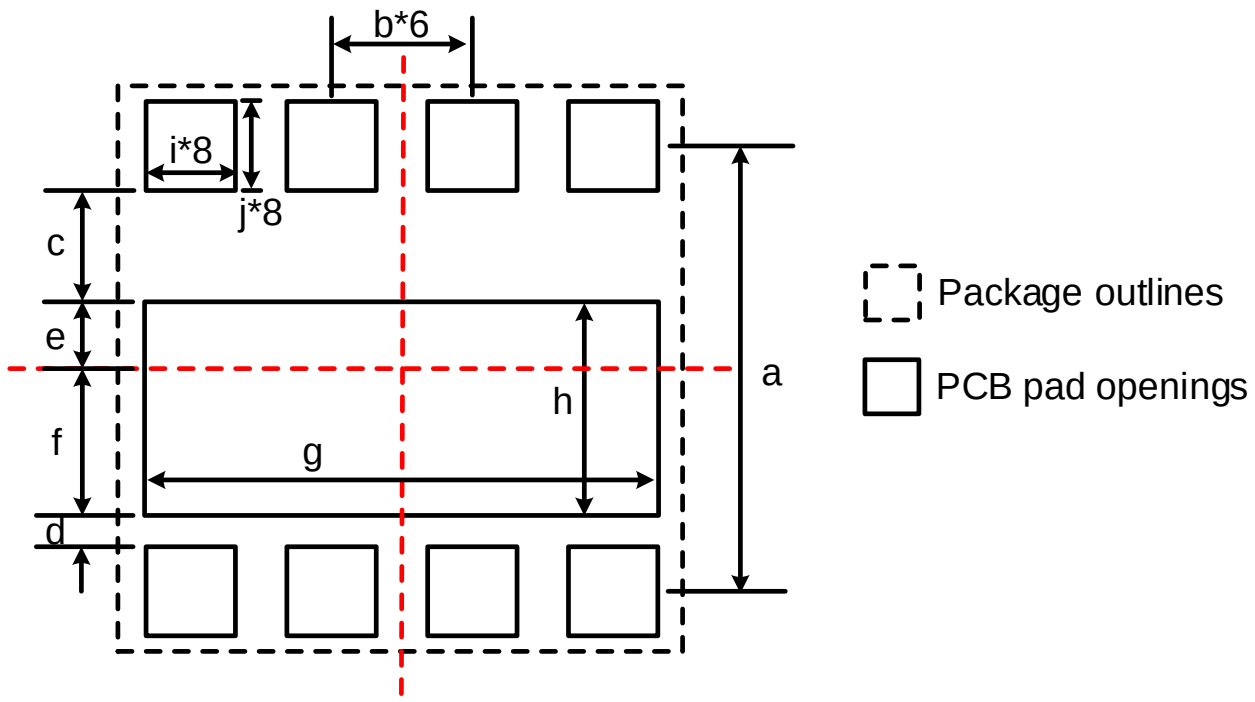






SYMBOL	DIMENSION(mm)		
	MIN	NOM	MAX
A	328	330	332
N	98	100	102
C	12.90	13.10	13.30
D	5.10	5.60	6.10
w1	16.40	16.40	18.40
w2	20.60	20.60	22.60
T	1.95	2.10	2.25
K	1.30	1.40	1.55

12. Recommended PCB footprint



SYMBOL	DIMENSION	SYMBOL	DIMENSION
a	7.800	f	2.750
b	2.000	g	7.500
c	2.325	h	3.700
d	0.525	i	1.400
e	0.950	j	1.250

Notes:
(1) All dimension are in millimeters.
(2) Drawing is not to scale.

13. Revision history

Major changes since the last revision

Revision	Date	Description of changes
1.0	2022-11-11	Rev. 1.0 release

Important Notice

The information provided in this document is intended as a guide only and shall not in any event be regarded as a guarantee of conditions, characteristics or performance. Innoscience does not assume any liability arising out of the application or use of any product described herein, including but not limited to any personal injury, death, or property or environmental damage. No licenses, patent rights, or any other intellectual property rights is granted or conveyed. Innoscience reserves the right to modify without notice.