

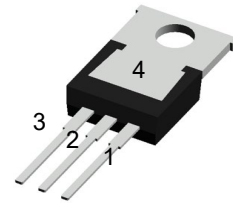
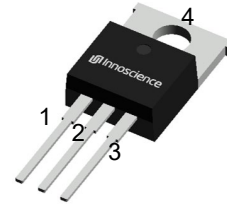
INN700TH140C

1. General description

700V GaN-on-Silicon Enhancement-mode Power Transistor in TO-220 package.

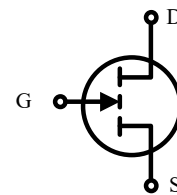
2. Features

- 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
- Totem pole PFC
- Fast battery charging
- High density power conversion
- High efficiency power conversion



4. Key performance parameters

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

Parameter	Value	Unit
$V_{DS,max}$	700	V
$R_{DS(on),max}$ @ $V_{GS} = 6\text{ V}$	140	m Ω
$Q_{G,typ}$ @ $V_{DS} = 400\text{ V}$	3.5	nC
$I_{D,pulse}$	32	A
Q_{OSS} @ $V_{DS} = 400\text{ V}$	33	nC
Q_{rr} @ $V_{DS} = 400\text{ V}$	0	nC

5. Pin information

Table 2 Pin information

Gate	Source	Drain
1	2,4	3

Table 3 Ordering information

Type/Ordering Code	Package	Product Code
INN700TH140C	TO-220	70TH140C

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6. Maximum ratings

at $T_j = 25\text{ °C}$ unless otherwise specified.

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

Table 4 Maximum ratings

Parameter	Symbol	Values	Unit	Note/Test Condition
Drain source voltage	$V_{DS, \max}$	700	V	$V_{GS} = 0\text{ V}$, $T_j = -55\text{ °C}$ to 150 °C
Drain source voltage transient ¹	$V_{DS, \text{transient}}$	800	V	$V_{GS} = 0\text{ V}$
Drain source voltage, pulsed ²	$V_{DS, \text{pulse}}$	750	V	$T_j = 25\text{ °C}$; total time < 10 h
				$T_j = 125\text{ °C}$; total time < 1 h
Continuous current, drain source	I_D	17	A	$T_c = 25\text{ °C}$
Pulsed current, drain source ³	$I_{D, \text{pulse}}$	32	A	$T_c = 25\text{ °C}$; $V_{GS} = 6\text{ V}$; $t_{\text{PULSE}} = 10\text{ }\mu\text{s}$
Pulsed current, drain source ³	$I_{D, \text{pulse}}$	18	A	$T_c = 125\text{ °C}$; $V_{GS} = 6\text{ V}$; $t_{\text{PULSE}} = 10\text{ }\mu\text{s}$
Gate source voltage, continuous ⁴	V_{GS}	-6 to +7	V	$T_j = -55\text{ °C}$ to 150 °C
Gate source voltage, pulsed	$V_{GS, \text{pulse}}$	-20 to +10	V	$T_j = -55\text{ °C}$ to 150 °C ; $t_{\text{PULSE}} = 50\text{ ns}$, $f = 100\text{ kHz}$; open drain
Power dissipation	P_{tot}	92	W	$T_c = 25\text{ °C}$
Operating temperature	T_j	-55 to +150	°C	
Storage temperature	T_{stg}	-55 to +150	°C	

1. $V_{DS, \text{transient}}$ is intended for non-repetitive events, $t_{\text{PULSE}} < 200\text{ }\mu\text{s}$.

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

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

4. The minimum V_{GS} is clamped by ESD protection circuit, as shown in Figure 10.

7. Thermal characteristics

Table 5 Thermal characteristics

Parameter	Symbol	Values	Unit	Note/Test Condition
Thermal resistance, junction-ambient	R_{thJA}^1	42	°C/W	
Thermal resistance, junction-case	R_{thJC}	1.35	°C/W	
Maximum reflow soldering temperature	T_{sold}	260	°C	

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

8. Electric characteristics

at $T_j = 25\text{ °C}$, 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	$I_D = 17.2\text{ mA}$; $V_{DS} = V_{GS}$; $T_j = 25\text{ °C}$
		-	1.7	-		$I_D = 17.2\text{ mA}$; $V_{DS} = V_{GS}$; $T_j = 150\text{ °C}$
Drain-source leakage current	I_{DSS}	-	0.6	25	μA	$V_{DS} = 700\text{ V}$; $V_{GS} = 0\text{ V}$; $T_j = 25\text{ °C}$
		-	7	-		$V_{DS} = 700\text{ V}$; $V_{GS} = 0\text{ V}$; $T_j = 150\text{ °C}$
Gate-source leakage current	I_{GSS}	-	70	-	μA	$V_{GS} = 6\text{ V}$; $V_{DS} = 0\text{ V}$
Drain-source on-state resistance	$R_{DS(on)}$	-	106	140	m Ω	$V_{GS} = 6\text{ V}$; $I_D = 5\text{ A}$; $T_j = 25\text{ °C}$
		-	230	-		$V_{GS} = 6\text{ V}$; $I_D = 5\text{ A}$; $T_j = 150\text{ °C}$
Gate resistance	R_G	-	5	-	Ω	$f = 5\text{ MHz}$; open drain

Table 7 Dynamic characteristics

Parameter	Symbol	Values			Unit	Note/Test Condition
		Min.	Typ.	Max.		
Input capacitance	C_{iss}	-	125	-	pF	$V_{GS} = 0\text{ V}$; $V_{DS} = 400\text{ V}$; $f = 100\text{ kHz}$
Output capacitance	C_{oss}	-	41	-	pF	$V_{GS} = 0\text{ V}$; $V_{DS} = 400\text{ V}$; $f = 100\text{ kHz}$
Reverse transfer Capacitance	C_{rss}	-	0.4	-	pF	$V_{GS} = 0\text{ V}$; $V_{DS} = 400\text{ V}$; $f = 100\text{ kHz}$
Effective output capacitance, energy related ¹	$C_{o(er)}$	-	59	-	pF	$V_{GS} = 0\text{ V}$; $V_{DS} = 0\text{ to }400\text{ V}$
Effective output capacitance, time related ²	$C_{o(tr)}$	-	82	-	pF	$V_{GS} = 0\text{ V}$; $V_{DS} = 0\text{ to }400\text{ V}$
Output charge	Q_{oss}	-	33	-	nC	$V_{GS} = 0\text{ V}$; $V_{DS} = 0\text{ to }400\text{ V}$
Turn-on delay time	$t_{d(on)}$	-	3	-	ns	$V_{DS} = 400\text{ V}$; $I_D = 10\text{ A}$; $L = 318\text{ }\mu\text{H}$; $V_{GS} = 6\text{ V}$; $R_{on} = 10\text{ }\Omega$; $R_{off} = 2\text{ }\Omega$; See Figure 22
Turn-off delay time	$t_{d(off)}$	-	4	-	ns	
Rise time	t_r	-	5	-	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	-	3.5	-	nC	$V_{GS} = 0$ to 6 V; $V_{DS} = 400$ V; $I_D = 5$ A
Gate-source charge	Q_{GS}	-	0.3	-	nC	
Gate-drain charge	Q_{GD}	-	1.2	-	nC	
Gate Plateau Voltage	V_{Plat}	-	2.1	-	V	$V_{DS} = 400$ V; $I_D = 5$ A

Table 9 Reverse conduction characteristics

Parameter	Symbol	Values			Unit	Note/Test Condition
		Min.	Typ.	Max.		
Source-Drain reverse voltage	V_{SD}	-	2.4	-	V	$V_{GS} = 0$ V; $I_S = 5$ A
Pulsed current, reverse	$I_{S, pulse}$	-	-	32	A	$V_{GS} = 6$ V; $t_{PULSE} = 10$ μ s
Reverse recovery charge	Q_{rr}	-	0	-	nC	$I_S = 5$ 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 $T_j = 25\text{ }^\circ\text{C}$, unless specified otherwise

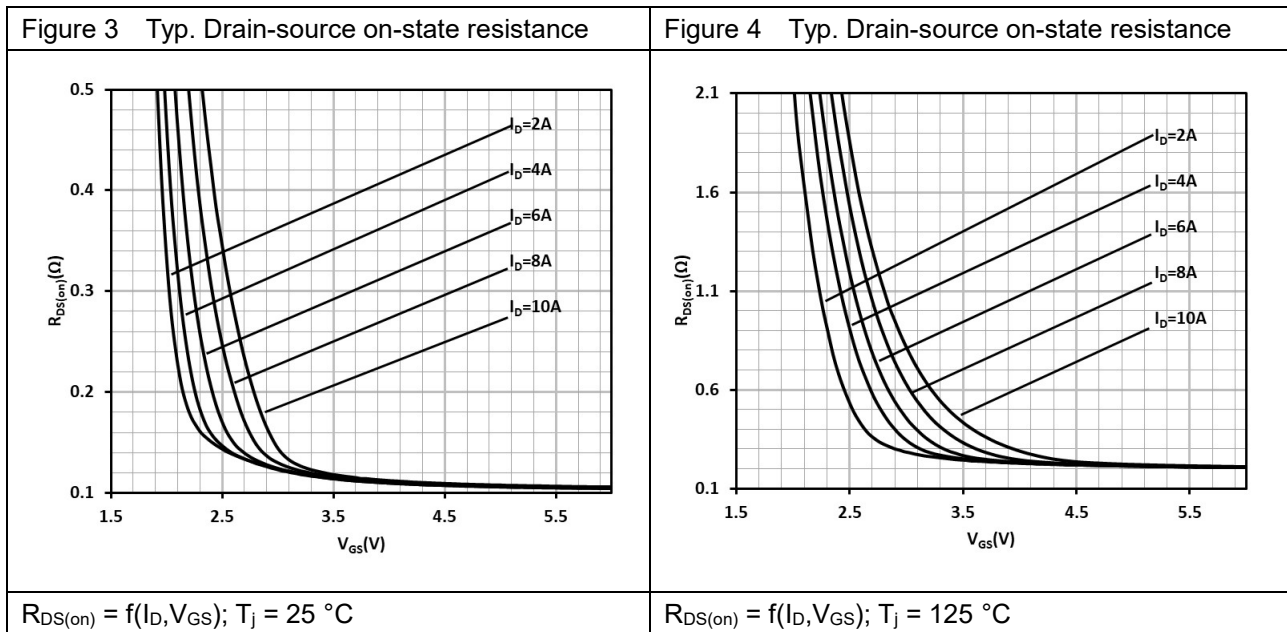
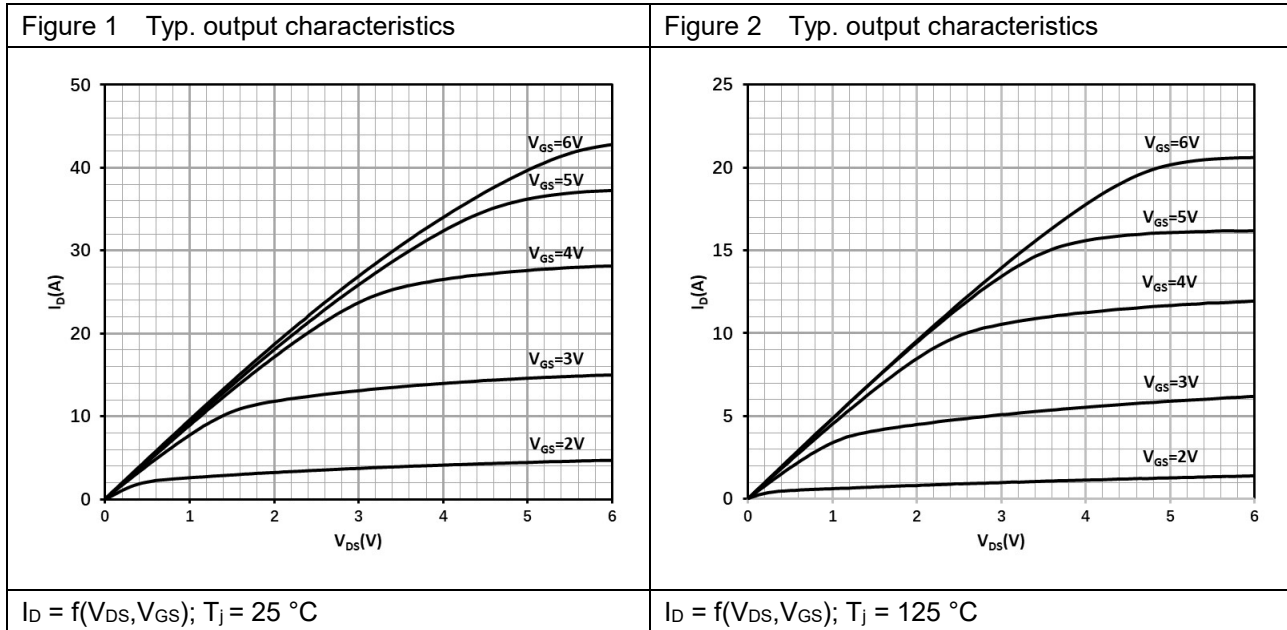
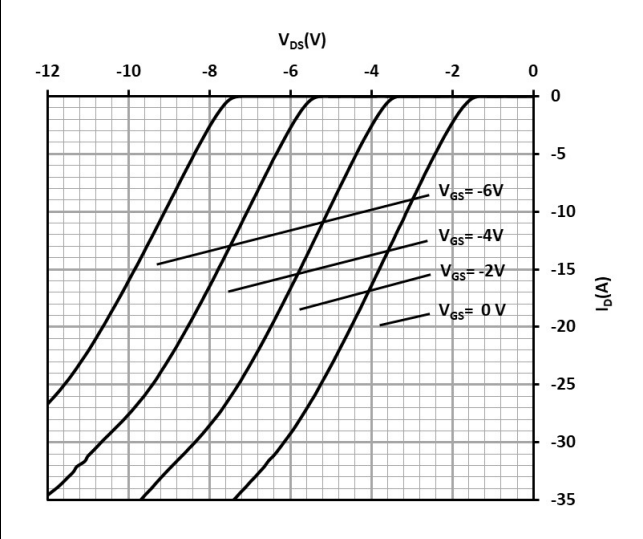
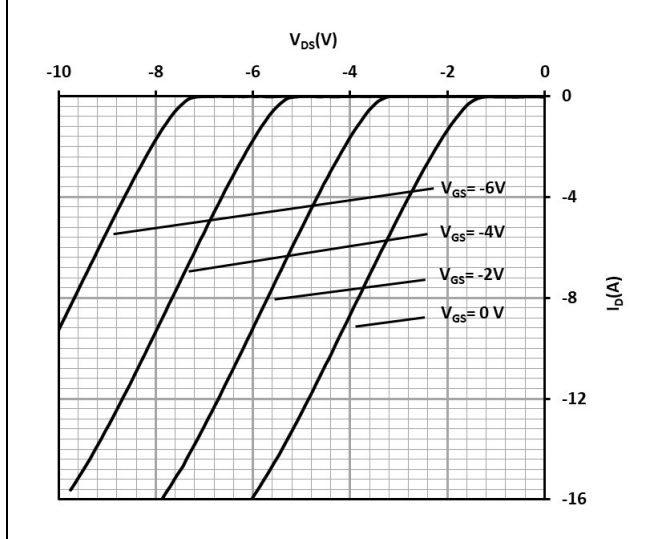


Figure 5 Typ. channel reverse characteristics



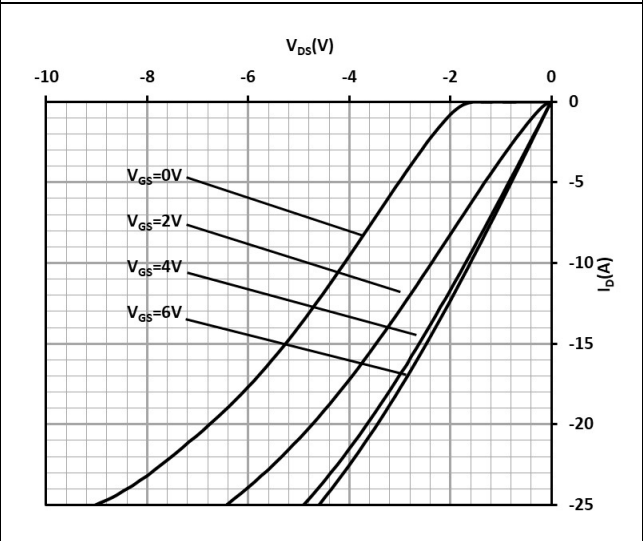
$I_D = f(V_{DS}, V_{GS}); T_j = 25\text{ }^\circ\text{C}$

Figure 6 Typ. channel reverse characteristics



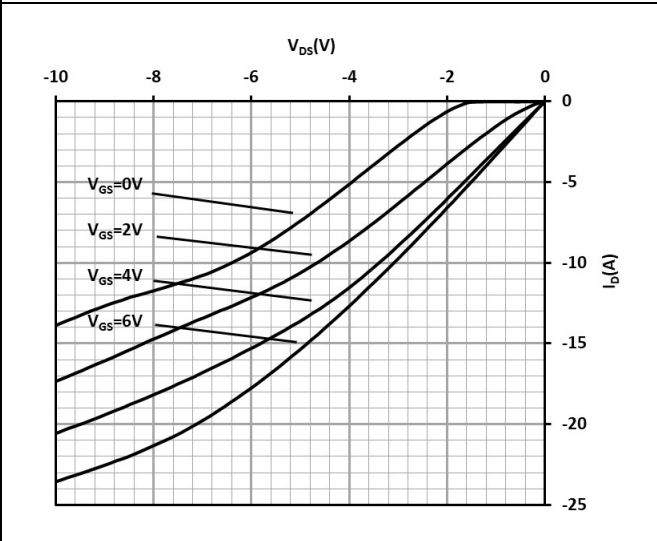
$I_D = f(V_{DS}, V_{GS}); T_j = 125\text{ }^\circ\text{C}$

Figure 7 Typ. channel reverse characteristics



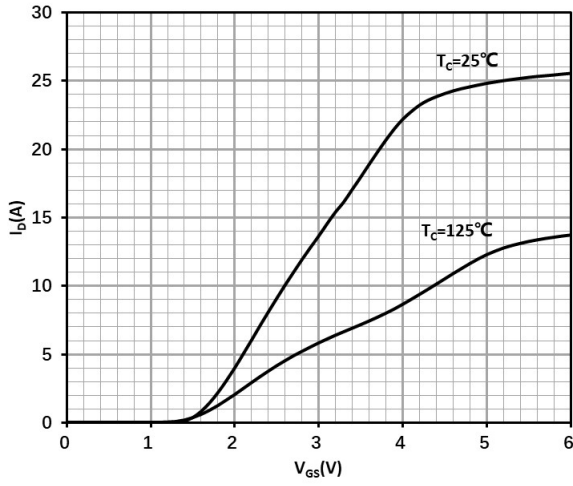
$I_D = f(V_{DS}, V_{GS}); T_j = 25\text{ }^\circ\text{C}$

Figure 8 Typ. channel reverse characteristics



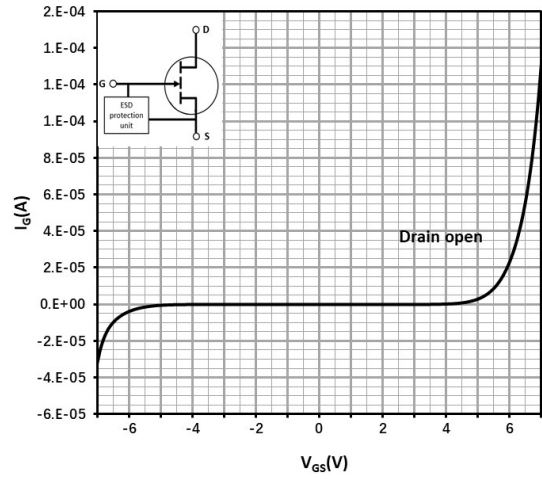
$I_D = f(V_{DS}, V_{GS}); T_j = 125\text{ }^\circ\text{C}$

Figure 9 Typ. transfer characteristics



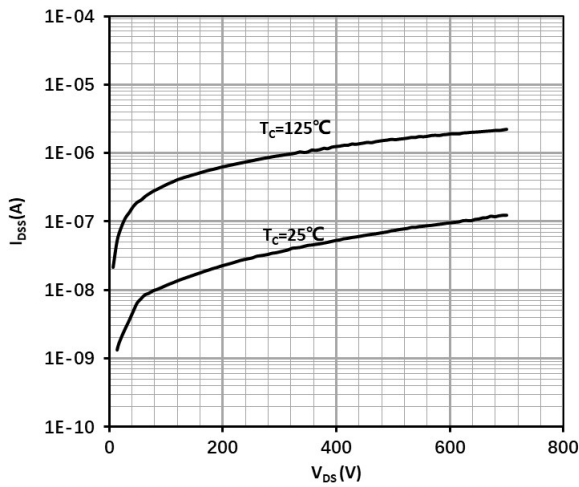
$I_D = f(V_{GS}); V_{DS} = 3\text{ V}$

Figure 10 Typ. Gate-to-Source leakage



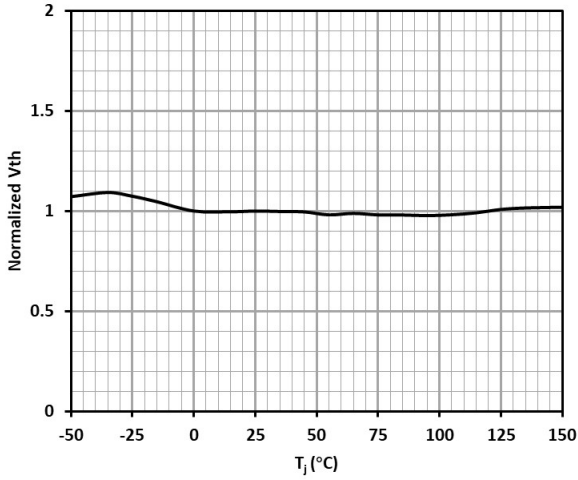
$I_G = f(V_{GS}); I_G$ reverse turn on by ESD unit

Figure 11 Drain-source leakage characteristics



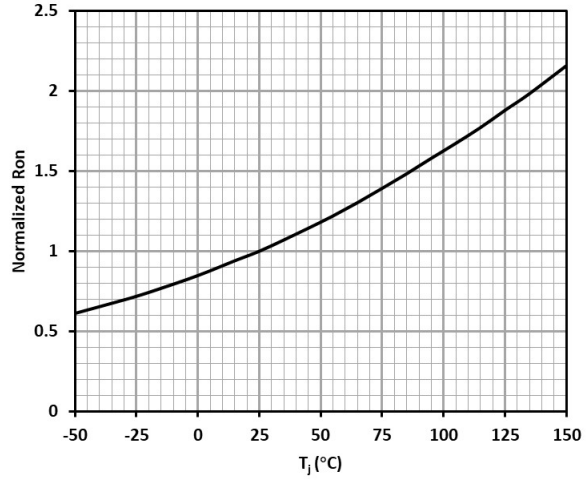
$I_{DSS} = f(V_{DS}); V_{GS} = 0\text{ V}$

Figure 12 Gate threshold voltage



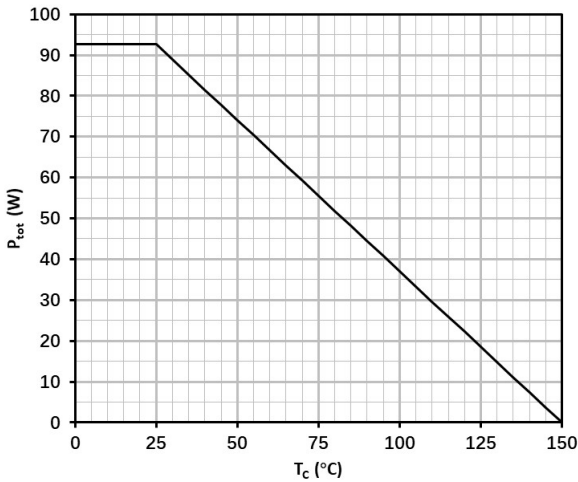
$V_{TH} = f(T_j)$; $V_{GS} = V_{DS}$; $I_D = 17.2 \text{ mA}$

Figure 13 Drain-source on-state resistance



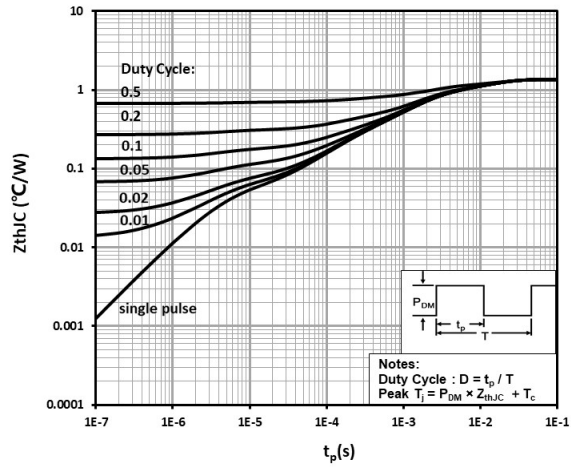
$R_{DS(on)} = f(T_j)$; $I_D = 5 \text{ A}$; $V_{GS} = 6\text{V}$

Figure 14 Power dissipation



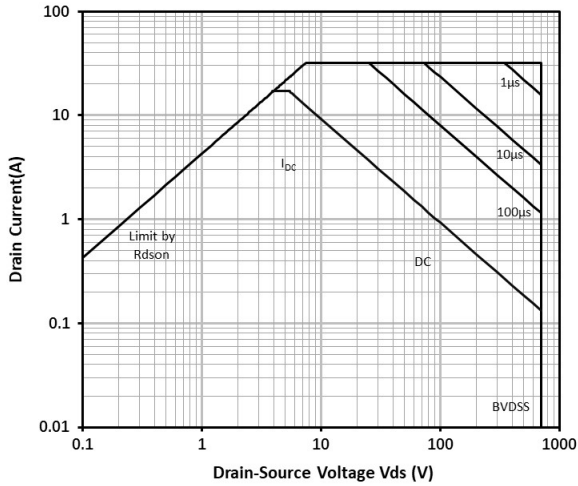
$P_{tot} = f(T_c)$

Figure 15 Max.transient thermal impedance



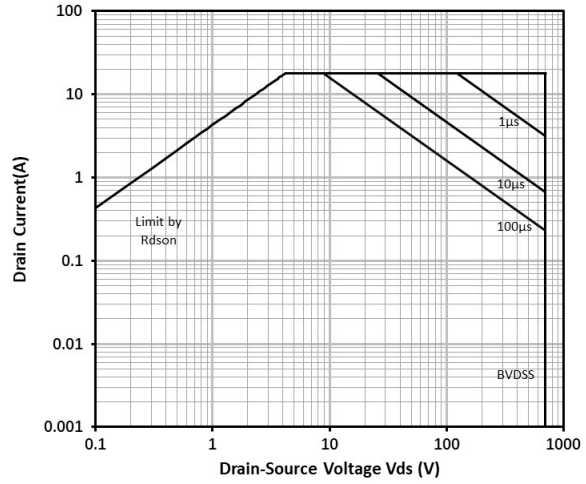
$Z_{thJC} = f(t_p, D)$

Figure 16 Safe operating area



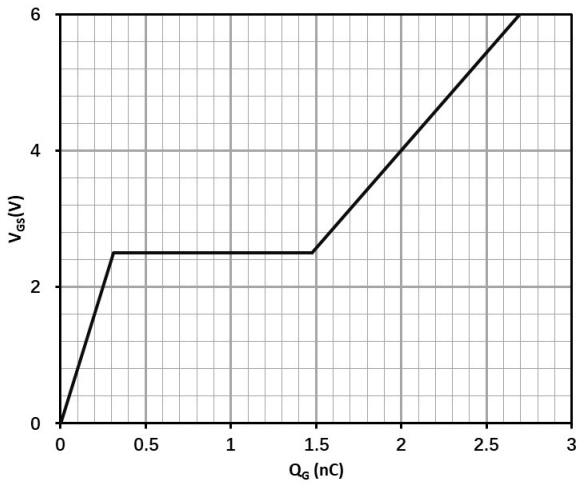
$I_D = f(V_{DS}); T_C = 25\text{ }^\circ\text{C}$

Figure 17 Safe operating area



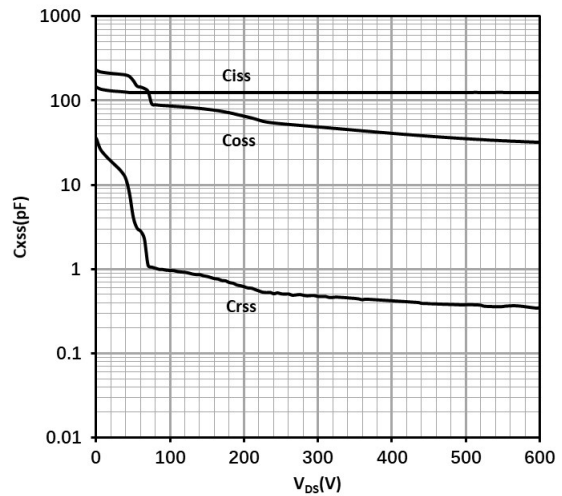
$I_D = f(V_{DS}); T_C = 125\text{ }^\circ\text{C}$

Figure 18 Typ. gate charge



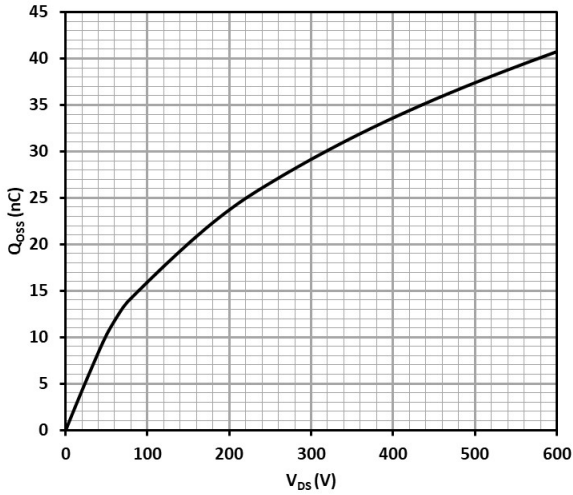
$V_{GS} = f(Q_G); V_{DCLINK} = 400\text{ V}; I_D = 5\text{ A}$

Figure 19 Typ. capacitances



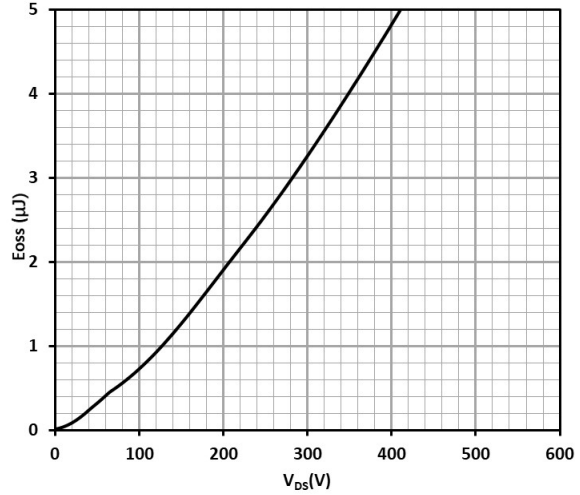
$C_{XSS} = f(V_{DS}); \text{Freq.} = 100\text{ kHz}$

Figure 20 Typ. output charge



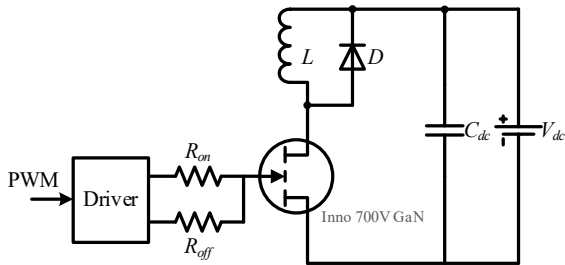
$Q_{oss} = f(V_{DS}); \text{Freq.} = 100 \text{ kHz}$

Figure 21 Typ. Coss stored Energy



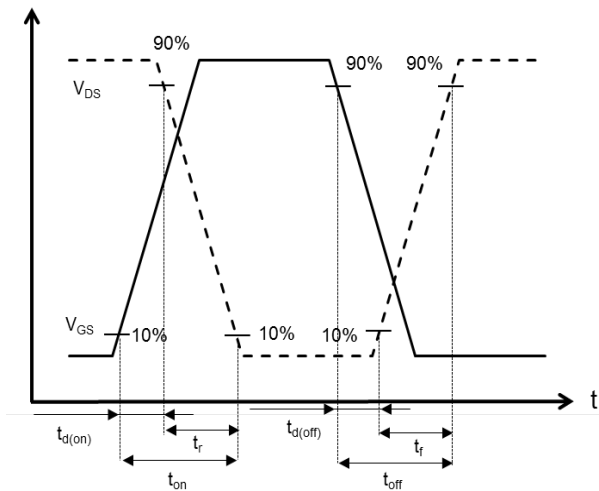
$E_{oss} = f(V_{DS}); \text{Freq.} = 100 \text{ kHz}$

Figure 22 Typ. Switching times with inductive load

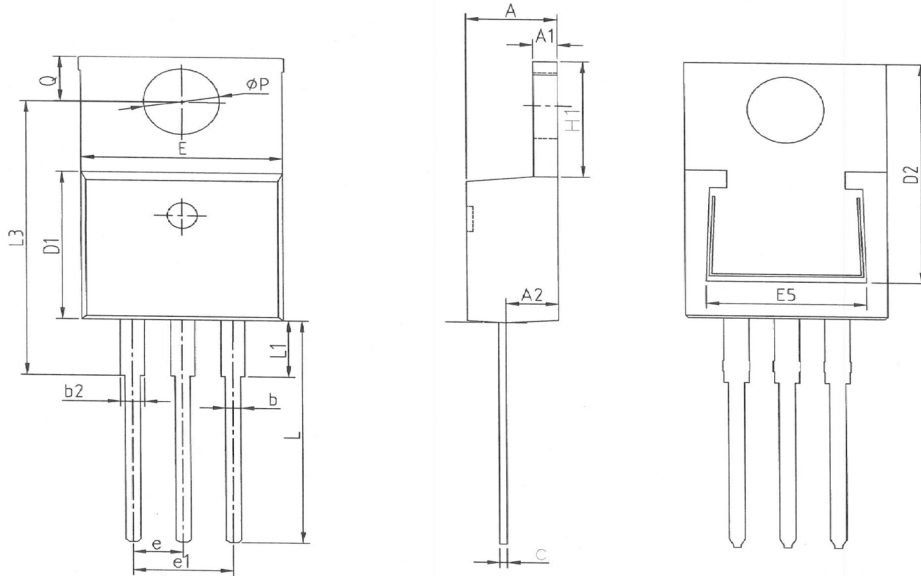


$V_{DS} = 400 \text{ V}, I_D = 10 \text{ A}, L = 318 \text{ μH}, V_{GS} = 6 \text{ V},$
 $R_{on} = 10 \text{ Ω}, R_{off} = 2 \text{ Ω}$

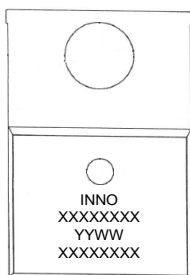
Figure 23 Typ. Switching times waveform



10. Package outlines



SYMBOL	MM			SYMBOL	MM		
	MIN	NOM	MAX		MIN	NOM	MAX
A	4.37	4.57	4.77	E5	6.80	8.20	8.60
A1	1.22	1.27	1.42	e	2.54 BSC		
A2	2.49	2.69	2.89	e1	5.08 BSC		
b	0.75	0.81	0.96	H1	6.10	6.30	6.50
b2	1.22	1.27	1.47	L	13.10	13.40	13.70
c	0.30	0.38	0.48	L1	-	3.75	4.10
D1	8.50	8.70	8.90	L3	15.80	16.00	16.40
D2	12.00	12.40	12.80	ΦP	3.70	3.84	3.99
E	9.86	10.16	10.36	Q	2.54	2.74	2.94



ROW	Description	Example
Row1	Company name	INNO
Row2	Product code	XXXXXXXXX
Row3	Date code	YYWW
Row4	ASSY lot No.	XXXXXXXXX

Notes:

- (1) All dimension are in millimeters.
- (2) Drawing is not to scale.
- (3) Dimensions do not include mold protrusion.
- (4) Package outline exclusive of metal burr dimensions.

11. Revision history

Major changes since the last revision

Revision	Date	Description of changes
1.0	2023-04-21	1.0 version

Important Notice

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